REVIEW QUESTIONS

10.1 What is simple Harmonic Motion? What are the necessary condition for a body to execute simple harmonic motion?

Ans:

Simple Harmonic Motion (S.H.M):

Simple Harmonic motion (S.H.M) is a to and fro oscillatory motion in which acceleration of the body is directly proportional to the displacement of the body from the mean position and it is always directed towards mean position.

Mathematically:

$a \propto -x$

Basic Conditions to Execute S.H.M:

Basic conditions to execute simple harmonic motion as under.

- (i) A system executing simple harmonic motion always vibrates about a fixed position.
- (ii) Its acceleration is always directed towards mean position.
- (iii) Magnitude of acceleration is directly proportional to displacement from the mean position.

10.2 Think of several examples in everyday life of motion that are simple harmonic.

Ans: Example of Simple Harmonic Motion (SHM)

- (i) Motion of a body attached to one end of spring.
- (ii) Motion of bob of simple pendulum.
- (iii) Motion of ball in bowl system.
- (iv) Motion of the prong of the tunning Fork.

10.3 What are damped oscillations? How damping progressively reduces the amplitude of oscillation?

Ans: **Damped Oscillations**

"Any oscillation in which the amplitude of the motion decreases with the time is called damped oscillation".

Damping reduces the amplitude:

Practically in all system the force of friction and resistance retards the motion, so the system do not oscillate for long period of time The friction reduces the mechanical energy of the system as time passes. Due to the reason damping progressively reduces the amplitude of the motion.

10.4 How can you define term wave? Elaborate difference between mechanical and electromagnetic waves.

Ans: **Wave:**

A wave is disturbance in the medium which causes the particles of medium to under go vibratory motion about their mean positions in equal intervals of time.

Examples: Water waves, Waves produced in the strings and springs.

Mechanical Wave

Waves which require a medium for their propagation are called mechanical waves.

Examples:

- Radio Waves
- Television Waves
- X-rays

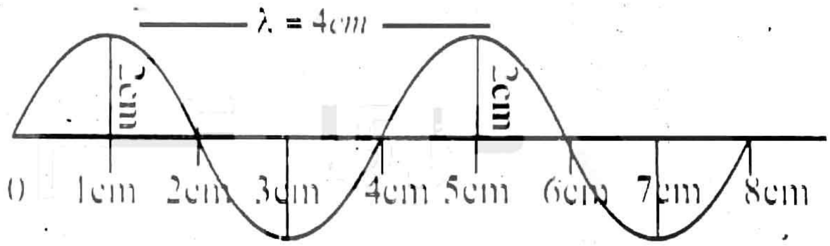
10.5 Distinguish between longitudinal and transverse waves with suitable examples.

Ans:

Longitudinal Waves:	**Transverse Waves:**
• In longitudinal waves the particles of medium move back and forth along the direction of the propagation of wave. • Longitudinal wave is made up of compression and rarefaction **Example:** • Sound wave • Earth quake • Vibration in gas	• In transverse waves particles of medium vibrate perpendicular to the motion of wave. • Transverse wave is made up of crest and trough **Example** • Light wave • Water waves

10.6 Draw a transverse wave with an amplitude of 2 cm and a wavelength of 4cm. Label a crest and trough on the wave.

Ans:



λ = 4cm

10.7 Derive a relationship between speed, frequency and wavelength of a wave. Write a formula relating speed of a wave to its time period and wavelength.

Ans: See Q. No. 9

10.8 Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment.

Ans: See Q. 8

10.9 Explain the following properties of waves with reference to ripple tank experiment.
a. Reflection b. Refraction c. Diffraction

Ans: See Q. 10

10.10 Does increasing the frequency of a wave also increase its wavelength? If not, how are these quantities related?

Ans. No, wavelength does not increase with increase of frequency of waves because frequency depends upon the source which produces waves per second. But the wavelength of the wave depends on the magnitude of vibrating particles.

Relationship of frequency (f) and wavelength (λ)

Generally, frequency (f) and wavelength (λ) are inversely related to each other by the following equation.

$$\lambda = \frac{V}{f}$$

Hence from this equation we conclude that when frequency (f) of waves increases then their wavelength (λ) decreases.

CONCEPTUAL QUESTIONS

10.1 If the length of the simple pendulum is doubled what will be change in its time period?

When the length of simple pendulum is increased its time period increases as we know that

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

According to given condition

If $L = 2\ell$

$$T' = 2\pi\sqrt{\frac{2\ell}{g}}$$

$$= \sqrt{2}\left(2\pi\sqrt{\frac{\ell}{g}}\right)$$

$$T' = \sqrt{2}T$$

Thus time period become $T' = \sqrt{2}T$

10.2 A ball is dropped from certain height onto the floor and keeps bouncing. Is the motion of the ball is simple harmonic motion.

No the motion of the bouncing ball is not the example of SHM. Because it does not fit the definition of SHM which is as follows:

SHM occurs when the net force is proportional to the displacement from the mean position and is always directed towards the mean position.

10.3 A student performed two experiments with a simple pendulum. He/She used two bobs of different masses by keeping other parameters constant. To his/her astonishment the time period of the pendulum did not change! Why?

As $\quad T = 2\pi\sqrt{\frac{\ell}{g}}$

Above formula clearly shows that the time period of the simple pendulum is independent of mass therefore, when a student performed two experiments with the simple pendulum by using two bobs of different mass by keeping other parameters constant. Then time period of simple pendulum remains same.

10.4 What types of waves do not require any material medium for their propagation?

Electromagnetic waves do not require any material medium for their propagation. They are caused due to varying electric and magnetic fields.

Example:

1. Radio waves 2. Light 3. X – Rays etc

10.5 Plane waves in the ripple tank undergo refraction when they move form deep to shallow water. What change occurs in the speed of the waves?

As we know that

$V=f\lambda$

In ripple tank frequency of waves is constant because it is equal to the frequency of vibrator Hence wave speed is directly proportional to wave length. With increase of wavelength speed will also be increased similarly with decrease in wave length wave speed also decreases. As the water wave enter into the shallow region from deep region its wavelength (λ) decreases, due to this speed of wave also decreases.

INFORMATION BASED QUESTIONS AND THEIR ANSWERS

QUICK QUIZ (PAGE 4)

Q. 1 What is the displacement of an object in SHM when the kinetic and potential energies are equal?

Ans. Kinetic energy and potential energy are equal at mid point between mean position and extreme position

Check your understanding (Page 5)

Q.2 Tell whether or not these motions are examples of simple harmonic motion:

(a) Up and down motion of a leaf in water pond.

(b) Motion of a ceiling fan.

(c) Motion of hands of clock.

(d) Motion of a plucked string fixed at both its end.

(e) Movement of honey bee.

Ans. Among all these motions, only example of SHM is the up and down motion of a leaf in water pond about a fixed position.

QUICK QUIZ (PAGE 8)

Q.3 Do mechanical waves pass through vacuum, that is, empty space?

Ans. Mechanical waves require some material medium for their propagation, and hence they cannot pass through empty space i. e vacuum.

Activity (page 14)

Q.4 What do the dark and bright fringes on the screen of ripple tank represents?

Ans. The dark and bright fringes on the screen of ripple tank represent troughs and crests respectively.

Activity (page 14)

Q.5 What happens to the angle of refraction when water waves pass from deep to shallow part of water?

Ans. When water waves travel from deep to shallow water, angle of refraction decreases. it is due to the decrease in the speed of water waves in the shallow water.

Q.6 DO The magnitude of angle of incidence and angle of refraction equal?

Ans. Angle of incidence and angle of refraction are not equal due to different depth of water in shallow and deep parts.

EXERCISE MULTIPLE CHOICE QUESTIONS FROM TEXT BOOK

(1) **Which of the following is an example of simple harmonic motion?**
(a) Motion of a simple pendulum (b) The motion of ceiling fan
(c) The spinning of the Earth on its axis (d) A bouncing ball on floor

(2) **If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendulum's motion will**
(a) Be increased by a factor of 2 (b) Remain the same
(c) Be decreased by a factor of 2 (d) Be decreased by a factor of 4

(3) **Which of the following devices can be used to produce both a transverse and longitudinal waves?**
(a) A string (b) A ripple tank (c) A helical spring (slinky) (d) A tuning fork

(4) **Waves transfer**
(a) Energy (b) Frequency (c) Wavelength (d) Velocity

(5) **Which of the following is a method of energy transfer?**
(a) Conduction (b) Radiation (c) Wave motion (d) All of these

(6) **In a vacuum all electromagnetic waves have the same**
(a) Speed (b) Frequency (c) Amplitude (d) Wavelength

(7) **A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in a distance of 50 cm. The velocity of the wave is**
(a) 53 cm^{-1} (b) 60cms^{-1} (c) 750 cms^{-1} (d) 1500 cms^{-1}

(8) **Which of the following characteristics of a wave is independent of the others**
(a) Speed (b) Frequency (c) Amplitude (d) Wavelength

(9) **The relation between v, f and λ of a wave is**
(a) $vf = \lambda$ (b) $f\lambda = v$ (c) $v\lambda = f$ (d) $v = \dfrac{\lambda}{f}$

ANSWER KEY

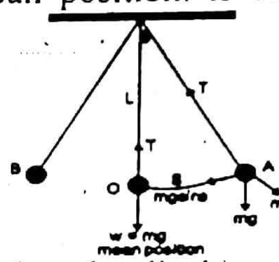
1	2	3	4	5	6	7	8	9
a	b	c	a	d	a	b	c	b

SHORT QUESTIONS

10.1 Simple Harmonic Motion (SHM)

(1) What is meant by oscillation?

Ans: When a body moves back and forth or to and fro about its mean position. is called vibration or oscillation.



Example:

Motion of the Simple Pendulum.

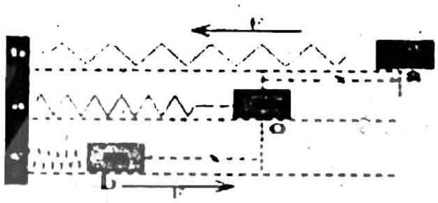
(2) Define Simple Harmonic Motion.

Ans: Simple Harmonic Motion

"The acceleration of a body executing SHM is directly proportional to the displacement of the body from the mean position and is always directed towards the mean position".

Mathematically

$$a \propto -x$$



Where a is acceleration. It is always directed towards the mean position and x is displacement from mean position.

(3) Define Hooke's Law. Give its expression.

Ans: According to Hooke's law the exerted force is directly proportional to change in length.

$$F \propto x$$

(4) How does stiffness of the spring affect the value of k?

Ans: The value of k is a measure of the stiffness of the spring.
Stiff springs have large k values, and soft springs have small k values.

(5) What is the function of restoring force during oscillatory motion?

Ans: A restoring force always pushes or pulls the object performing oscillatory motion towards the mean position.

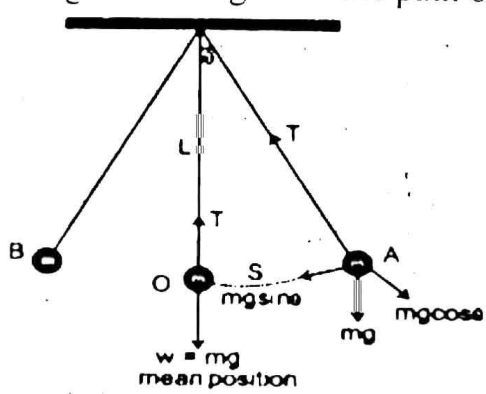
$$F_r = -kx$$

(6) Which type of forces are acting on a displaced pendulum?

OR

Which component of force act as restoring force during the oscillation of simple pendulum.

Ans: The restoring force that causes the pendulum to undergo simple harmonic motion is the component of gravitational force mg $\sin\theta$ tangent to the path of motion.



(7) Define Time Period and Write down formulas of Time Period for mass attached to a spring and for simple Pendulum

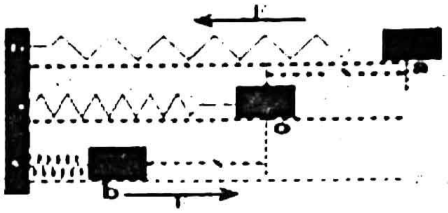
Ans:

Time Period (T):

"Time required to complete one vibration is called time period. It is denoted by T."

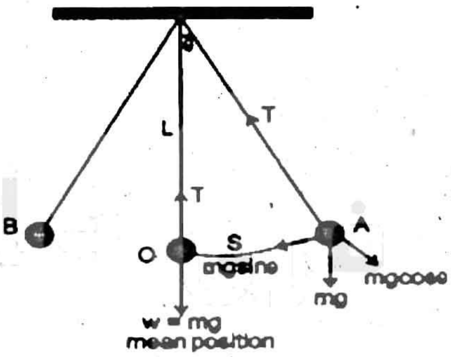
- **The time period T of the simple harmonic motion of a mass m attached to a spring is given by the following equation:**

$$T = 2\pi\sqrt{\frac{m}{k}}\ldots\ldots\ldots$$



- **Formula for the time period of simple pendulum**

$$T = 2\pi\sqrt{\frac{L}{g}}\ldots\ldots\ldots\ldots(10.2)$$



(8) Define following terms which characterize simple harmonic motion.
(i) Vibration **(ii) Time period**
(iii) Frequency **(iv) Amplitude** **(v) Displacement**

Ans:

(i) Vibration:

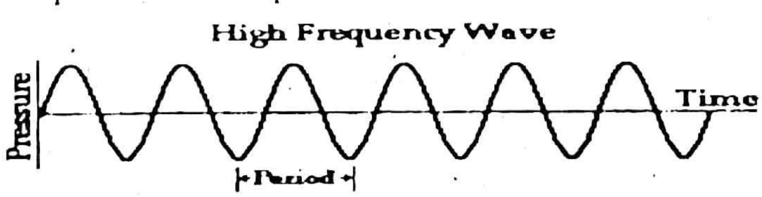
One complete round trip of a vibrating body about its mean position is called one vibration.

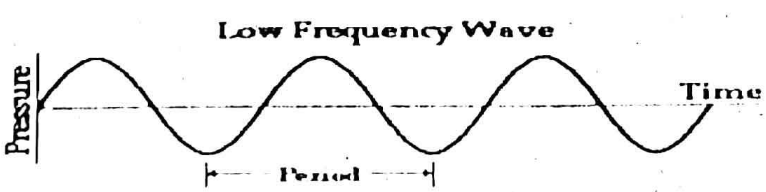
(ii) Time period (T):

The time taken by a vibrating body to complete one vibration is called time period

(iii) Frequency (f):

The number of vibrations per cycle of a vibrating body in one second is called its frequency. It is reciprocal of time period i.e $f = 1/T$



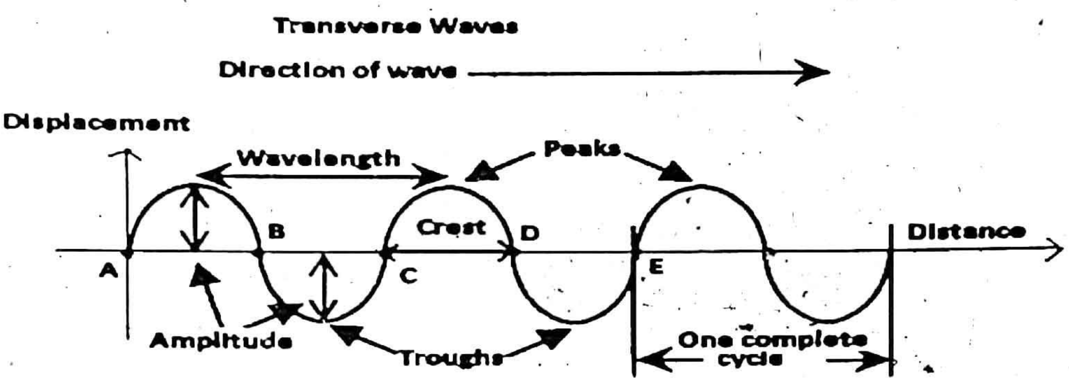


(iv) **Amplitude (A):**

The displacement of a vibrating body on either side from its mean position to extreme position is called its amplitude.

(v) **Displacement (D)**

Distance covered by the vibrating body at any instant during the vibration from mean position.



(9) **Write down important features of Simple Harmonic Motion**

Ans: Important features of SHM are summarized as:

i. A body executing SHM always vibrates about a fixed position.

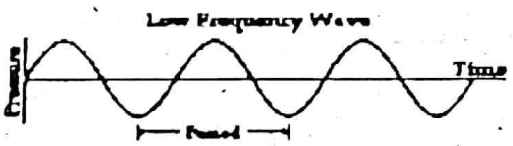
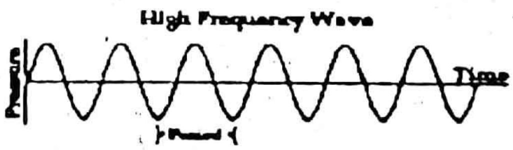
ii. Its acceleration is always directed towards the mean position.

iii. The magnitude of acceleration is always directly proportional to its displacement from the mean position i.e. acceleration will be zero at the mean position while it will be maximum at the extreme positions.

iv. Its velocity is maximum at the mean position and zero on the extreme positions.

(10) **Define time period and frequency in case of vibratory motion.**

Ans:

	Time Period	**Frequency**
Vibratory Motion	The time required to complete one vibration is known as time period.	The number of vibrations completed in one second is known as frequency
Waves	The time required to pass one wave from a certain point is called time period $T = \frac{1}{f}$  	The number of waves passing through a certain point in one second is known as frequency. $f = \frac{1}{T}$ 

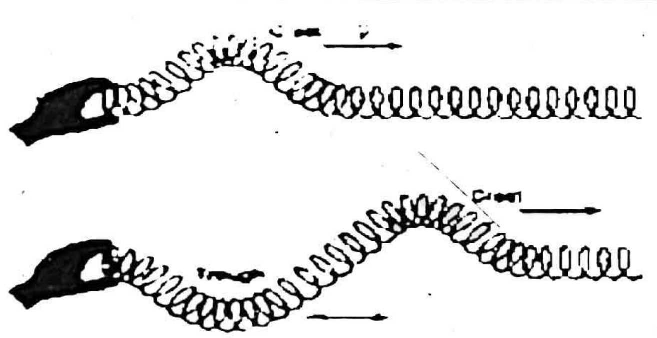
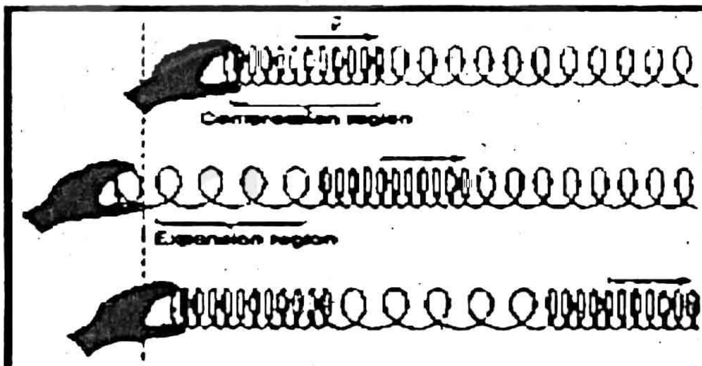
(11) Differentiate between mechanical waves and electromagnetic waves.

Ans:

Mechanical Waves	Electromagnetic Waves
The waves which require a material medium for their propagation are known as mechanical waves. **Examples** • Sound waves • Waves produced on a rope • Water waves	The waves which can propagate with or without material medium are known as electromagnetic waves. **Examples** • X-rays • Radio waves • Heat and light waves

(12) Differentiate between transverse waves and compressional or longitudinal waves.

Ans:

Transverse Waves	Compressional or Longitudinal Waves
The waves in which the direction of vibratory motion of particles of medium is perpendicular to the direction of propagation of waves are called transverse waves. **Examples** • Waves produced in a rope • Water waves  Transverse waves are a series of crests and troughs as the medium moves perpendicular to the direction that the wave travels.	The waves in which the direction of vibratory motion of particles of medium is parallel to the direction of propagation of waves are called compressional or longitudinal waves. **Example** • Sound waves  Longitudinal waves are a series of compressions and rarefactions (expansions).

(13) Write down the relationship between frequency and time period

Ans: Frequency is a reciprocal of time period (They have inverse relationship)

$$f = \frac{1}{T}$$

(14) If we double the length of the pendulum then what will be the time period?

Ans: As we know that

$$T = 2\pi\sqrt{\frac{\ell}{g}} \text{--------} (i)$$

Now ℓ becomes 2ℓ

So

$$T' = 2\pi\sqrt{\frac{2l}{g}}$$

$$= \sqrt{2}\left(2\pi\sqrt{\frac{l}{g}}\right)$$

$$T' = \sqrt{2}\,T$$

Hence Time period is $\sqrt{2}$ times of time period

(15) **Find the time period and frequency of a simple pendulum 1.0 m long at a location where g = 10.ms^{-2}**

Ans:

Given Data

L=1.0m.

g =10.0ms^{-2}.

Required

Time period of simple pendulum T = ?

Frequency of Simple pendulum f =?

Formula

Time Period of Simple Pendulum

$$T = 2\pi\sqrt{\frac{L}{g}}$$

By putting the values

$$T = 2\pi\sqrt{\frac{1.0m}{10.0ms^{-2}}}$$

$$T = 1.99s.$$

Frequency of simple pendulum

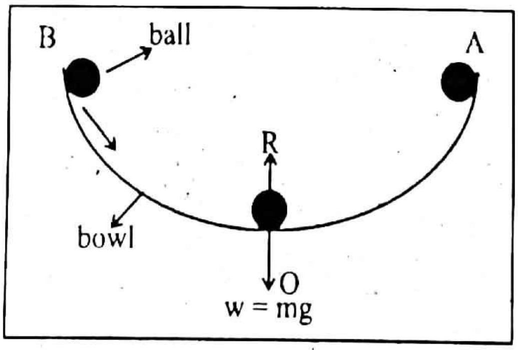
$$f = \frac{1}{T}$$

$$f = \frac{1}{1.99}$$

$$f = 0.5Hz$$

(16) **When the ball is at the center of the bowl what will be the net force?**

Ans: When the ball is at the center of the bowl the net force acting on the ball is zero because at this position weight of the ball acts downward and is equal to the upward normal force of the surface of the bowl.



(17) What is the displacement of an object in a simple harmonic motion when kinetic and potential energy are equal?

Ans: Kinetic energy and potential energy are equal when the body is at the middle of mean and extreme position.

(18) If we replace iron bob of simple pendulum with the wooden bob what will be the affect of time period of simple pendulum?

Ans: The time period of simple pendulum would remain same because period of a pendulum is independent of mass and amplitude.

$$T = 2\pi\sqrt{\frac{L}{g}}$$

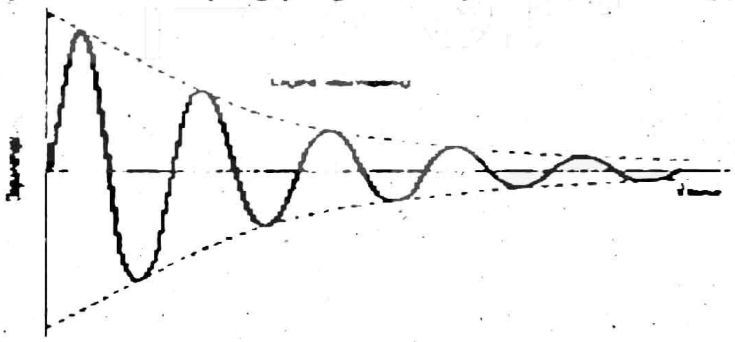
10.2 & 10.3 Damped Oscillations and Wave Motion

(19) What is meant by damped oscillation?

Ans: The oscillations of a system in the presence of some resistive force are damped oscillations.

(20) How does the mechanical energy of system reduce?

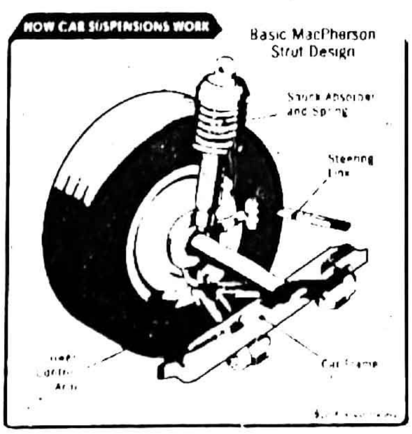
Ans: The friction reduces the mechanical energy of the system as time passes, and the motion is said to be damped, this damping progressively reduces the amplitude of the motion.

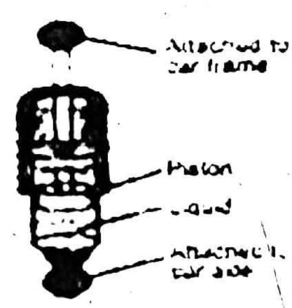


(21) Explain function of the shock absorber (application of the damped oscillation)

Ans: **Shock absorbers**

Shock absorbers are one practical application of damped motion. A shock absorber consists of a piston moving through a liquid such as oil. The upper part of the shock absorber is firmly attached to the body of the car. When the car travels over a bump on the road, the car may vibrate violently. The shock absorbers damp these vibrations and convert their energy into heat energy of the oil.





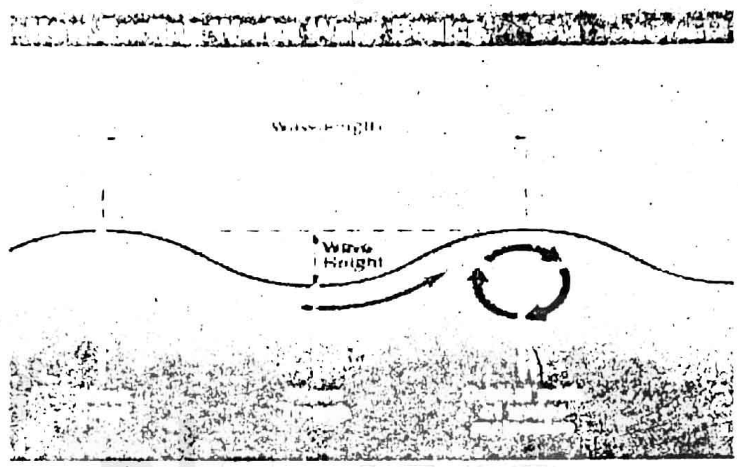
(22) **How a wave can be defined? In which categories are these divided?**

Ans: **Wave**

A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time.

There are two categories of waves.

(i) Mechanical waves (ii) Electromagnetic Waves



(23) **Define electromagnetic waves and give its examples.**

Ans: Waves which do not require any medium for their propagation are give called electromagnetic waves

Examples:

- Radio waves
- Heat waves
- X-rays etc

(24) **Define mechanical waves. Give examples.**

Ans: Waves which require any medium for their propagation are called mechanical waves

Examples:

- Water waves
- Sound waves etc

(25) **Do the mechanical waves pass through a space?**

Ans: No, mechanical waves do not pass through the space because they require medium for their propagation.

10.4 Types of Mechanical Wave

(26) **Define longitudinal or compressional waves?**

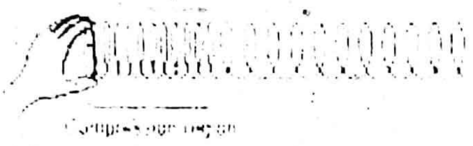
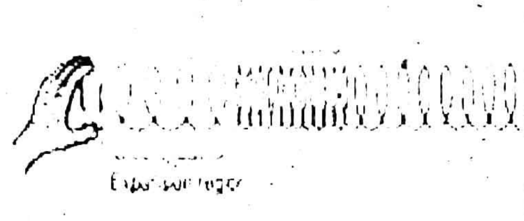
Ans: The waves in which the particles of medium move back and forth along the direction of the propagation of wave are called longitudinal or compressional waves.

Example:

- Sound waves

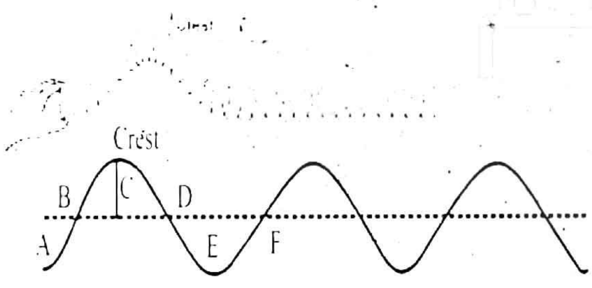
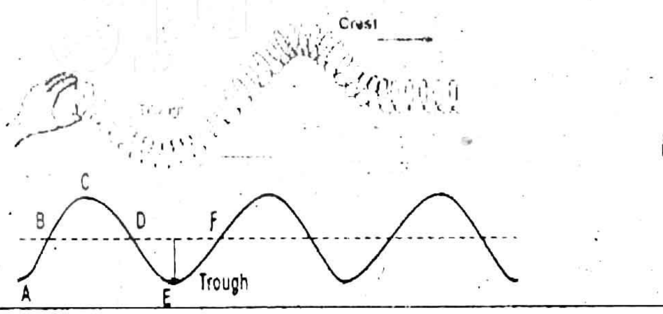
(27) Differentiate between compression and rarefaction?

Ans:

Compression	Rarefaction
The region of a wave where loops of spring are close together is called compression **OR** The region of a wave where particles of medium are closed to each other is called compression of wave. 	The region of a wave where the loops of spring are space apart is called rarefaction. **OR** Region of a wave where the particles of medium are spaced apart is called rarefaction. 

(28) Differentiate between crest and trough?

Ans:

Crest	Trough
The highest point on the wave is called crest. 	The lowest point on the wave is called trough. 

(29) Define transverse waves?

Ans: Transverse waves

The wave in which the particle of medium moves perpendicular to the direction of propagation of wave.

Example:

- Water waves
- Light waves
- Waves produced on a string and spring

(30) What is wave equation?

Ans: The relation between the velocity, frequency and wavelength of the wave is known as wave equation $v = f\lambda$ (wave equation)

(31) How energy can be transferred from one place to other?

Ans: Energy can be transferred from one place to another through waves.

(32) A wave moves on a slinky with frequency of 4 h z and wavelength of 0.4 m. what is the speed of the wave?

Solution:

Given that:

$f = 4Hz$, $\lambda = 0.4m$

Required:

Wave speed $v = ?$

Formula:

Wave speed $v = f\lambda$

$= (4Hz)(0.4m)$

$v = 1.6\ ms^{-1}$

(33) Describe Types of Mechanical Waves.

Longitudinal Waves or Compressional Waves

In longitudinal waves the particles of the medium move back and forth along the direction of propagation of wave.

Example:

- Sound Waves

Transverse Waves:

"The waves in which motion of particles of the medium is perpendicular to the motion of wave."

Examples:

- Waves on the surface of water and light waves are also transverse waves.

10.5 Ripple tank.

(34) Why bright lines are seen on the screen of the ripple tank?

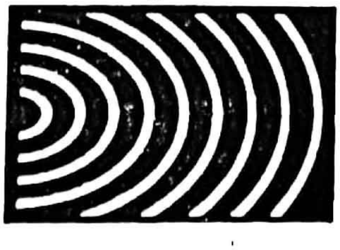
Ans: The crests of the waves appear as bright lines on the paper because they behave like a convex lens and converge the rays of light falling on them. So, bright lines are seen on the screen of the ripple tank.

(35) Why dark lines are seen on the screen of the ripple tank?

Ans: The troughs of the waves appear as dark lines on the paper because they behave like a concave lens and diverge the rays of light falling on them. So, dark lines are seen on the screen of ripple tank.

(36) How can we generate circular waves in a ripple tank?

Ans: We can generate circular waves in a ripple tank by attaching a knob on the lower side of vibrating bar. Now it is lowered in such a way that knob touches the water surface. When vibrator is set on, circular waves are produced on the water surface.

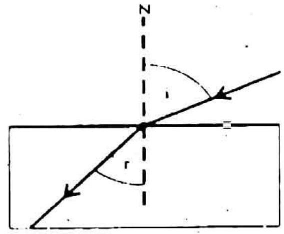


(37) In relation $v = f\lambda$ which two quantities depend upon the properties of the medium and why does third one not?

Ans: In relation $v = f\lambda$, V and λ depend on the properties of the medium while f does not depend on the properties of the medium because f depends upon the frequency of the vibrator.

(38) Why does wavelength decrease in shallow part of water?

Ans: As wavelength changes with the depth of water so there will be a decrease in wavelength of the waves in shallow part of water due to decrease in the speed of the waves.



(39) On what factor refraction of water depends?

Ans: Refraction of water waves depends upon the depth of water waves because speed of water waves depends upon the depth of water. Its speed is reduced when it enters in shallow water. So when water waves enter from deep water to shallow water their wavelength changes but frequency remains the same and refraction of water waves takes place.

(40) What is the effect of diffraction on water waves?

Ans: If we place two obstacles in a line of straight water waves in such a way that separation between them is equal to wavelength of water waves. After passing through the slits between two obstacles, straight water waves are changed into circular waves. But diffraction of waves can only be observed clearly if the size of the slit is nearly equal to wavelength of the wave.

(41) How diffraction is useful in daily life?

Ans: Due to diffraction of radio waves, transmission can be heard in such areas where the waves cannot reach directly.

(42) How do ocean waves cause destruction?

Ans: Sometime, the ocean waves cause the destruction of ships and coastal areas because in case of any disturbance in the ocean, energy is carried by the waves and they travel towards coastal area and causes destruction.

LONG QUESTIONS

10.1 Simple Harmonic Motion (S.H.M)

Q.1 Define simple harmonic motion. Explain it
i. When mass attached to a spring
ii. For ball and bowl system
iii. For simple pendulum

Simple Harmonic Motion

Simple harmonic motion occurs when the net force is proportional to the displacement from the mean position and is always directed toward the mean position. **OR**
When an object oscillates about either side of a fixed position (mean position) such that its acceleration is directly proportional to its displacement from the mean position and is always directed towards the mean position, its motion is called SHM.

(i) Motion of mass attached to a spring

One of the simplest types of oscillatory motion is that of horizontal mass-spring system as shown in fig. if the spring is stretched or compressed through a small displacement x from its mean position, it exerts a force F on the mass.

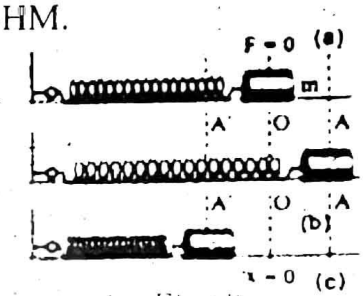


Fig (i)

Hook's Law

According to Hooke's law this force is directly proportional to the change in length x of the spring i.e,

$$F = -kx \quad \text{.........(i)}$$

Where x is the displacement of the mass from its mean position O, and k is a constant called the spring constant defined as

Spring Constant

The ratio of exerted force to the change in length is called spring constant

$$K = \frac{F}{x}$$

The value of k is a measure of the stiffness of the spring. Stiff springs have large k values, and soft springs have small k values. It is measured in Nm^{-1}.

Restoring Force :

A restoring force always pushes or pulls the object performing oscillatory motion towards the mean position.

$$Fr = -F$$

The **negative sign** in **eq. (i)** means that the force exerted by the spring is always directed opposite to the displacement of the mass. Because the spring force always acts toward the mean position, it is sometimes called a restoring force.

$$F_r = -k\,x \quad \text{\_\_\_\_\_\_\_\_\_\_\_\_ (ii)}$$

According to Newton's 2^{nd} Law of Motion

$$Fr = ma$$

Putting the value of Fr into eq (ii)

$$ma = -kx$$

$$a = \frac{-k}{m}x$$

Where $\frac{k}{m}$ = constant $a = -\text{constant}\ x$

$a \propto -x$

This is mathematical form of simple harmonic motion

Direction of acceleration

Initially the mass m is at rest at mean position O and the resultant force on the mass is zero (fig.1-a).

From extreme to mean position

As the mass m moves towards the point O from A, its displacement goes on decreasing. Resultantly, the acceleration of the body also decreases. On reaching the point O, x becomes zero and so acceleration 'a' of the mass m also reduces to zero. But it may be noted that its velocity is maximum at this point.

From mean to extreme position

Due to inertia, the mass m does not stop at the point O but continues its motion towards left till it reaches the point A'. During this motion, the spring is now compressed. Now the restoring force and the acceleration due to it are opposite to the motion of the mass m. This means that the velocity of the mass m starts decreasing as it passes the point O and finally becomes zero as its reaches the point A'.

From extreme to mean Position

After coming to rest at the point A', the body again returns to the point O under the action of the restoring force. This process continues and the body of mass m keeps on vibrating between the point A and A'.

Conclusion

The above motion of a mass attached to a spring is known as "Simple Harmonic Motion

(ii) Ball and bowl system

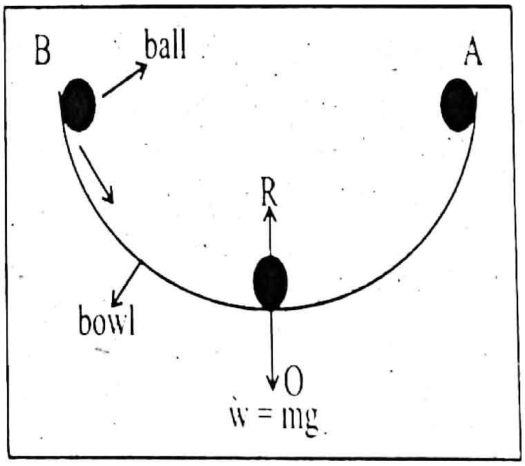
The motion of a ball placed in a bowl is another example of simple harmonic motion.

When ball is at rest (At mean position O):

When the ball is at the mean position O, that is, at the centre of the bowl, net force acting on the ball is zero. In this position weight of the ball acts downward and is equal to the upward normal force of the surface of the bowl. Hence there is no motion.

Observation of motion of ball between extreme positions A and B :

Now if we bring the ball to position **A** and then release it, the ball will start moving towards the mean position **O** due to the restoring force caused by its weight. At position **O** the ball gets maximum speed and due to inertia it moves towards the extreme position (b) while going towards the position **B**, the speed of the ball decreases due to the restoring force which acts towards the mean position. At the position **B**, the ball stops for a while and then again moves towards the mean position O under the action of the restoring force. This to and fro motion of the ball continues about the mean position O till all its energy is lost due to friction.



Conclusion

Thus the to and fro motion of the ball about a mean position placed in a bowl is an example of simple harmonic motion.

(iii) Simple pendulum

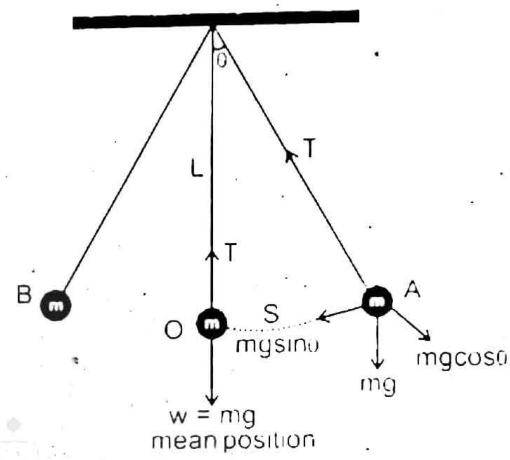
Definition

A simple pendulum consists of a single isolated bob suspended from a frictionless support by a light inextensible string.

Motion of the Simple Pendulum is an example of Simple Harmonic Motion

When bob is at rest (at mean position O):

A simple pendulum also exhibits SHM. It consists of a small bob of mass m suspended from light string of length L fixed at its upper end. In the equilibrium position O, the net force on the bob is zero and the bob is stationary.



Observation of motion of bob:

Now if we bring the bob to extreme position **A**, the net force, is not zero as shown in fig. There is no force acting along the string as the tension in the string cancels the component of the weight mg cos0.

The component of the weight mg $\sin\theta$ is directed towards the mean position and acts as a restoring force. Due to this force the bob starts moving towards the mean position O. At O the bob has got the maximum velocity and due to inertia it does not stop at O rather it continues to move towards the extreme position B during its motion towards point B, the velocity of the bob decreases due to restoring force. The velocity of the bob becomes zero as it reaches the point B, the restoring force mg sinθ still acts towards the mean position O and due to this force the bob again starts moving towards the mean position O. in this way, the bob continues its to and fro motion about the mean position O.

Conclusion

It is clear from the above discussion that the speed of the bob increases while moving from point A to O due to the restoring force which acts towards. O. similarly, when the bob moves from O to B, its speed decreases due to restoring force which again acts towards O. It follows that the acceleration of the bob is always directed towards the mean position O. Hence the motion of a simple pendulum is SHM.

Q. 2 Define Time Period and Write down formulas of Time Period for mass attached to a spring and for simple Pendulum

Time Period (T):

Time required to complete one vibration is called time period. It is denoted by T

- The time period T of the simple harmonic motion of a mass m attached to a spring is given by the following equation:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

- Formula for the time period of simple pendulum

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Q. 3 Define different terms which characterizes simple harmonic motion?

Vibration:

One complete round trip of a vibrating body about its mean position is called one vibration.

Time period (T):

The time taken by a vibrating body to complete one vibration is called time period (T)

Frequency (F):

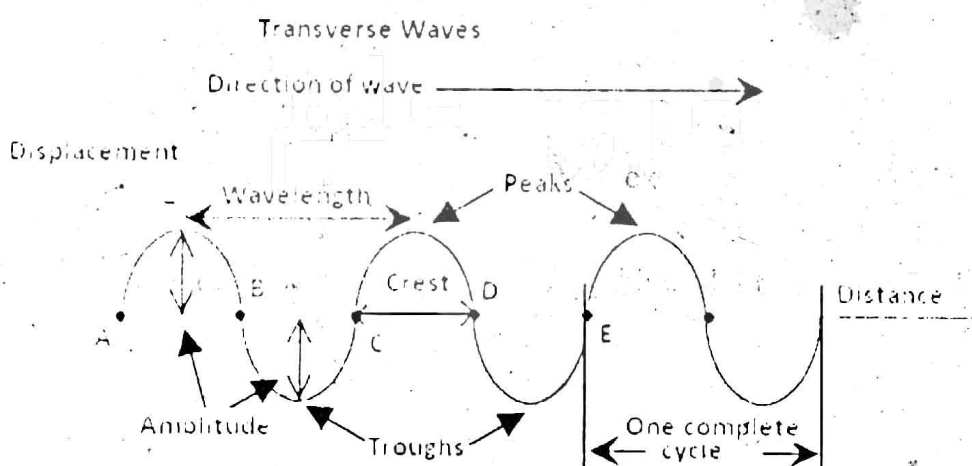
The number of vibrations per cycle of a vibrating body in one second is called its frequency. It is reciprocal of time period i.e $f = 1/T$

Amplitude (A):

The displacement of a vibrating body on either side from its mean position to extreme position is called its amplitude.

Displacement (D)

Distance covered by the vibrating body at any instant during the vibration from mean position.



10.2 Damped oscillations:

Q. 4 What are damped oscillations? How damping progressively reduces the amplitude of oscillation? Describe its one application.

Damped Oscillation:

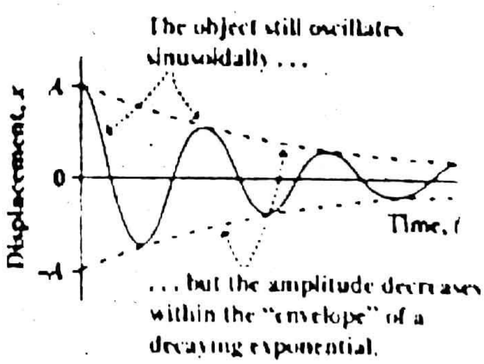
Definition:

"The oscillations of a system in the presence of some resistive force are damped oscillations."

Damping progressively reduces the amplitude of oscillation

Vibratory motion of ideal systems in the absence of any friction or resistance continues indefinitely under the action of a restoring force. Practically, in all systems the force of friction retards the motion, so the system do not oscillate indefinitely.

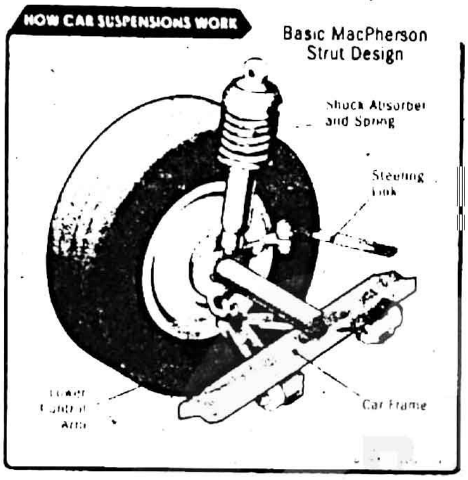
The friction reduces the mechanical energy of the system as time passes, and the motion is said to be damped. This damping progressively reduces the amplitude of the motion as shown in fig.

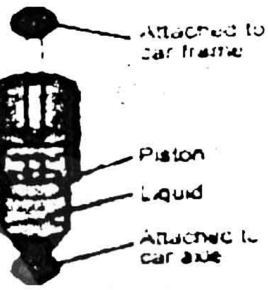


Application

Shock absorbers

In automobiles shock absorbers are one practical application of damped motion. A shock absorber consists of a piston moving through a liquid such as oil as shown in fig. the upper part of the shock absorber is firmly attached to the body of the car. When the car travels over a bump on the road, the car may vibrate violently. The shock absorbers damp these vibrations and convert their energy into heat energy of the oil.





10.3 Wave motion:

Q. 5 What is wave? Explain wave motion with the help of experiments.

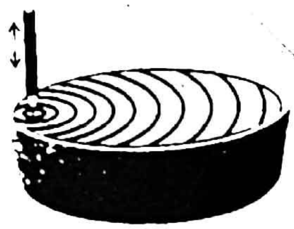
Ans: Wave

"A wave is a disturbance in the medium which cause the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time."

Experiment 1:

Dip one end of a pencil at the edge of a tub containing water; rapidly move the pencil up and down vertically, the ripples emerges outwards on the surface of water.

When we place some small pieces of the cardboard or cork equally spaced, in the direction of the waves, and observe the movement of the pieces as the waves pass. It is observed that every piece of cardboard move up and down about its mean position.



Wave produced by a dipping a pencil in a water tub.

They are not displaced forward from their original position along with the water waves. The motion of these pieces about their mean positions is known as vibratory motion. If we examine the vibratory motion of all the pieces, it can be observed that they do not vibrate together but they have consecutive vibratory motion.

Conclusion

In this experiment, the vibratory motion of the pencil produces a disturbance in the constituent molecules of the water, due to which they start exhibiting vibratory motion about their mean position. Thus this disturbance is transferred along with the wave, and a visible water wave can be observed.

Q. 6 What is wave? Describe its different types.

Wave

"A wave is a disturbance in the medium which causes the particles of the medium to undergo vibratory motion about their mean position in equal intervals of time."

Types of Waves

1. Mechanical waves.
2. Electromagnetic waves

Mechanical waves:

Waves which require any medium for their propagation are called mechanical waves.

Examples:

- Water waves,
- Sound waves
- Waves produced on the strings and springs.

Electromagnetic waves:

Definition:

Waves which do not require any medium for their propagation are called electromagnetic waves.

Examples:

- Radio waves,
- Television waves,
- X-rays, heat and light waves

10.4 Types of Mechanical Waves

Q. 7 Distinguish between longitudinal and transverse waves with suitable examples.

Ans. Longitudinal waves:

In longitudinal waves the particles of the medium move back and forth along the direction of the propagation of wave.

Explanation:

Sound waves also travel from one place to another in longitudinal pattern. Longitudinal waves are also called compressional waves. These waves travel in the form of compressions and rarefactions.

How longitudinal waves are produced:

Longitudinal waves can be produced on a spring placed on a smooth floor. Fix one end of the spring (slinky) with a rigid support and hold another end into your hand. Now give it a regular push and pull quickly in the direction of its length as shown in fig.

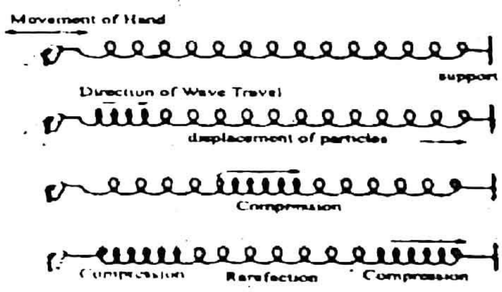


Fig. 10.8: Longitudinal wave on a slinky

A series of disturbances will start moving along the length of the slinky such waves consist of regions called compression, where the loops of the spring are close together, alternating with regions called rarefactions (expansions), where the coils are spaced apart.

Compression and rarefactions:

Compressions are those regions where the particles of the medium are closed together while rarefactions are those regions where particles of the medium are spaced apart. The compression and rarefactions move back and forth along the direction of motion of the wave.

Transverse Waves:

In the case of transverse waves the motion of particles of the medium is perpendicular to the direction of wave.

How transverse waves are produced?

Transverse waves can be produced with the help of slinky. Stretch out a slinky along a smooth floor or on a long bench with one end fixed. Grasp one end of slinky and move it up and down quickly as shown in fig.

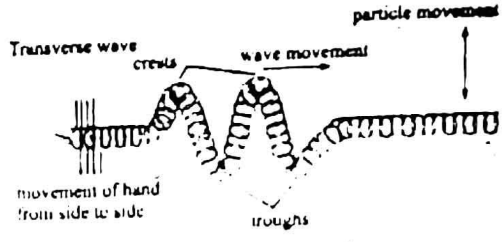


Fig 10.9 Transverse wave on a slinky

A wave in the form of alternative crests and troughs will start traveling towards fixed end.

Crests and Troughs:

Crests are the highest points while the troughs are the lowest points of the particles of the medium from the mean position. The crests and troughs move perpendicular to the direction of the wave.

Waves as carriers of energy

Q. 8 Waves are means of energy transfer with out transfer of matter. Justify this statement with the help of a simple experiment.

Energy can be transferred from one place to another through waves. For example, when we shake the stretched string up and down, we provide our muscular energy to the string. As a result, a set of waves can be seen traveling along the string. The vibrating force from the hand disturbs the particles of the string and sets them in motion. These particles then transfer their energy to the adjacent particles in the string. Energy is thus transferred from one place of the medium to the other in the form of wave.

Water waves also transfer energy from one place to another as explained below:

Experiment:

Drop a stone into a pond of water. Water waves will be produced on the surface of water and will travel outwards as shown in fig place a cork at some distance from the falling stone. When waves reach the cork, it will move up and down along with the motion of the water particles by getting energy from the wave.

Conclusion:

This experiment shows that water waves like other waves transfer energy from one place to other without transferring matter, i.e. water

Q.9 Derive a relation between speed, frequency and wavelength of a wave. Write its formula relating speed of wave to its time period of wave length.

Wave Equation

The relation between the velocity, frequency and wavelength of the wave is known as wave equation.

Derivation of Formula:

Wave is in fact a disturbance in a medium which travels from one place to another and hence have a specific velocity of traveling. This is called the velocity of wave which is defined by

Velocity = distance/time

$$v = \frac{d}{t}$$

If time taken by wave in moving from one point to another is equal to the **time period** then the distance covered by the wave will be equal to one **wavelength.**
Hence we can write:

$$v = \frac{\lambda}{T}$$

But time period T is reciprocal of the frequency i.e $f = \frac{1}{T}$

$$\boxed{v = f\lambda}$$

Note: Above equation is called the wave equation it is ~~true for~~ all type of waves i.e. longitudinal, transverse etc

10.5 Ripple tank

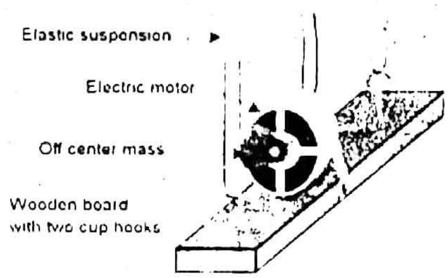
Q. 10 What is ripple tank? Explain its construction and following properties of waves with the reference of ripple tank experiment.
(i) Reflection (ii) Refraction (iii) Diffraction

Definition

"Ripple tank is a device to produce water waves and to study their characteristics."

Construction:

This apparatus consists of a rectangular tray having glass bottom and is placed nearly half meter above the surface of a ~~table as shown in fig.~~ waves can be produced on the surface of water present in the tray by means of a vibrator (paddle).
This vibrator is an oscillating electric motor fixed on a wooden plate over the tray such that its lower surface just touches the surface of water. On setting the vibrator on, this wooden plate starts vibrating to generate plane water waves. An electric bulb is hung above the tray to observe the image of water waves on the paper or screen. The crests and troughs of the waves appear as bright and dark lines, respectively, on the screen.



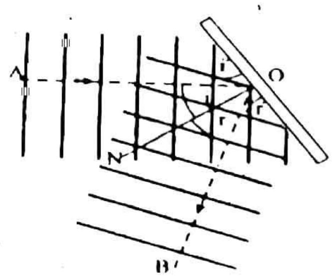
Reflection:

Definition:

"When waves moving in one medium fall on the surface of another medium they bounce back into the first medium such that the angle of incidence is equal to the angle of reflection. This phenomenon is called reflection of waves."

Explanation:

Place a barrier in the ripple tank. The water waves will reflect from the barrier which is placed at an angle to the wave front, the reflected waves can be seen to obey law of reflection i.e. the angle of the incident wave along the normal will be equal to the angle of the reflected wave as shown in fig.



$m\angle i = m\angle r$

Refraction:

Definition:

"When waves from one medium enter in the second medium at some angle their direction of travel may change. This phenomenon is called refraction of waves."

Explanation:

The speed of a wave in water depends on the depth of water. If a block is submerged in the ripple tank, the depth of water in the tank will be shallower over the block than elsewhere. When water waves enter the region of shallow water their wavelength decreases as shown in fig but the frequency of the water waves remains the same in both parts of water because it is equal to the frequency of the vibrator.

Fig 10.14

For the observation of refraction of water waves, we repeat this experiment such that the boundary between the deep and the shallower water is at same angle to the wave front (fig.10.15). Now we will observe that in addition to the change in wavelength the waves change their direction of propagation as well. The direction of propagation is always normal to the wave fronts.

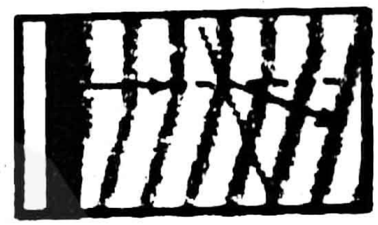


Fig. 10.15 Refraction of water waves

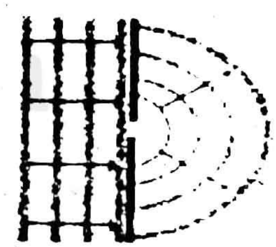
This change of path of water waves while passing from a region of deep water to that of shallower is called refraction.

Diffraction:

Definition:

"The bending or spreading of waves around the sharp edges or corners of obstacles is called diffraction."

Explanation:



We observe the phenomena of diffraction of water waves. Generate plane waves in a ripple tank and place two obstacles in line in such a way that separation between them is equal to the wavelength of water waves. After passing through a small slit between the two obstacles, the waves will spread in every direction and change into almost semicircular pattern as shown in fig (a).

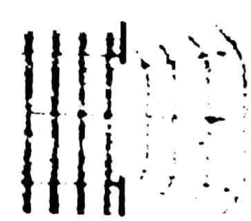


Fig 10.17

Fig (b) shows the diffraction of waves while passing through a slit with size larger than the wavelength of the wave. Only a small diffraction occurs near the corners of the obstacle.

Condition for the Diffraction:

Diffraction of waves can only be observed clearly if the size of the obstacle is comparable with the wavelength of the wave.

NUMERICAL PROBLEMS

10.1 The time period of a simple pendulum is 2s. What will be its length on Earth? What will be its length on the moon if $g_m = g_e / 6$? Where $g_e = 10ms^{-2}$.

Solution:

Given Data:-

Time period of simple pendulum = t = 2 sec. The gravitation all acceleration on earth as well as on moon should be included in given data.

Required:-

(i) Length of pendulum on earth = l_e = ?

(ii) Length of pendulum on moon = l_m = ?

Formula:-

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Solution:-

(i) **For Earth**

$$T = 2\pi\sqrt{\frac{l_e}{g_e}}$$

By taking square on both sides, we have

$$T^2 = 4\pi^2\frac{l_e}{g_e}$$

or

$$l_e = \frac{T^2 \times g_e}{4\pi^2}$$

By putting the values, we have

$$l_e = \frac{(2)^2 \times 10}{4 \times (3.14)^2}$$

$$l_e = \frac{4 \times 10}{4 \times 9.86}$$

$$l_e = 1.02m$$

(ii) **For Moon**

$$T^2 = \frac{4\pi^2 l_m}{g_m}$$

$$l_m = \frac{T^2 g_m}{4 \times \pi^2}$$

By putting the values, we have

$$l_m = \frac{(2)^2 \times 1.6}{4 \times (3.14)^2} = \frac{6.44}{39.44}$$

$$l_m = 0.17m$$

Result:-

Length of pendulum on earth = l_e = 1.02 m

Length of pendulum on moon = l_m = 0.17 m

10.2 A pendulum of length 0.99 m is taken to the moon by an astronaut. The period of the pendulum is 4.9s. What is the value of g on the surface of the moon?

Solution:

Given data:

Length of pendulum on moon = l_m = 0.99m

Time period = 4. 9sec

To Find:

Value of g on moon = g = ?

Formula:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Calculation:

$$4.9sec = 2\times 3.14\sqrt{\frac{0.99}{g}}$$

Squaring

$$g = \frac{4\times(3.14)^2\times 0.99}{(4.9)^2}$$

$g = 1.63\ ms^{-2}$

Result:

Value of g on moon = g = 1.6 ms^{-2}

10.3 Find the time periods of a simple pendulum of 1 meter length, placed on Earth and on moon. The value of g on the surface of moon is 1/6th of its value on Earth. When g_e is $10ms^{-2}$.

Solution:

Given data:

Length of pendulum = l = 1m

Value of g on earth = 10 ms^{-2}

Value of g on moon = 1.62 ms^{-2}

To find:

Time period on earth = T_e = ?

Time period on moon = T_m = ?

Formula:

Calculation:

At Earth:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T_e = 2(3.14)\sqrt{\frac{1}{10}}$$

$T_e = (6.28)\ \sqrt{0.1}$

$T_e = (6.28)\ (0.316)$

$T_e = 1.985$ sec.

$T_e = 2$sec. Ans

At Moon:

$$T_m = 2\pi\sqrt{\frac{l_m}{g_m}}$$

$$T_m = 2(3.14)\ \sqrt{\frac{1}{1.67}}$$

$$T = 2(3.14)\sqrt{0.6172}$$

$T = 4.9$ sec

Results:

Time period on earth = T_e = 2sec

Time period on moon = T_m = 4.9 sec

10.4 A simple pendulum completes one vibration in two seconds. Calculate its length when $g = 10.0\ ms^{-2}$.

Solution:

Given data:

Time period = T = 2sec

$g = 10\ ms^{-2}$

To Find:

Length of simple pendulum = L = ?

Calculation:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Squaring on both sides

$$T^2 = 4\pi^2 \times \frac{l}{g}$$

$$l = \frac{T^2 g}{4\pi^2}$$

$$l = \frac{(2)^2 \times 10}{4 \times (3.14)^2}$$

$$l = \frac{\cancel{4} \times 10}{\cancel{4} \times 9.85}$$

$l = 1.02$ m

Result:

Length of simple pendulum = l = 1.02 m

10.5 **If 100 waves pass through a point of a medium in 20 seconds, what is the frequency and the time period of the wave? If its wavelength is 6cm, calculate the wave speed.**

Solution:

Given data:

No. of waves = 100

Time = 20s

Wavelength = λ = 6cm = 0.06 m

Required:

Wave speed=v=?

Formula:

$$f = \frac{1}{T}$$

$$f = \frac{100}{20}$$

$$f = 5Hz$$

$$T = \frac{1}{f}$$

$$T = \frac{1}{5Hz}$$

$$T = 0.2 \text{ sec}$$

$$V = ?$$

$$V = f\lambda$$

$$V = 5 \times 0.06$$

$$V = 0.3 \text{ ms}^{-1}$$

10.6 **A wooden bar vibrating into the water surface in a ripple tank has frequency of 12Hz. The resulting wave has a wavelength of 3cm. What is the speed of the wave?**

Solution:

Given data:

Frequency f = 12 Hz

Wavelength = λ = 3cm = 0.03 m

Required:

Speed of wave = v = ?

Formula:

$$V = \lambda f$$

Calculations:

$$v = (0.03)(12)$$

$$V = 0.36 \text{ m/s}$$

Results:

Speed of wave is 0.36 m/s

10.7 A transverse wave produced on a spring has a frequency of 190 Hz and travels along the length of the spring of 90m, in 0.5s.

(a) What is the period of wave?

(b) What is the speed of the wave?

(c) What is the wavelength of the wave?

Solution:

Given data:

Frequency = f = 190 Hz

Length = l = 90 m

Time = t = 0.5s

Required:

(i) Time period of wave = T = ?

(ii) Speed of wave = V = ?

(iii) Wavelength of wave = λ = ?

Calculations:

(i) Time period:

$T = 1/f$

$T = 1/190$

$T = 0.005$

$T = 0.01s$

(ii) Speed of wave:

$V = d/t$

$V = 90/0.5$

$V = 180$ m/s

(iii) Wavelength:

$\lambda = v/f$

$\lambda = 180/190$

$\lambda = 0.95$ m

Results:

Time period is 0.01s; speed of wave is 180 m/s and wavelength of wave is 0.95 m

10.8 Water waves in a shallow dish are 6.0 cm long. At one point, the water moves up and down at a rate of 4.8 oscillations per second.

(a) What is the speed of the water waves?

(b) What is the period of the water waves?

Given data:

Length of wave = d = 6.0 cm = 0.06 m

Frequency = f = 4.8 Hz

Required:

(i) Speed of waves = ? (ii) period of waves = ?

Calculations:

(i) Time period:

$T = 1/f$

$T = 1/4.8$

$T = 0.21$ s

(ii) Speed of waves:

$V = d/t$

$V = 0.06/0.21$

$V = 0.29 m/s$

Results:

Time period is 0.21 s and velocity is 0.29 m/s

10.9 At one end of a ripple tank 80 cm across, 5 Hz vibrator produces waves whose wavelength is 40mm. Find the time the waves need to cross the tank.

Solution:

Given data:

Length = l = 80 cm = 0.8 m

Frequency = f = 5Hz

Wavelength = λ = 40mm = 0.04 m

Required:

Time taken = t = ?

Calculation:

As we know that $v = f\lambda$

$V = (5)(0.04) = 0.2 m/s$

And

$v = d/t$

So, $t = d/v$

$t = 0.8/0.02$

$t = 4s$

Results:

Time taken is 4s.

10.10 What is the wavelength of the radio waves transmitted by an FM station at 90 MHz? Where 1M = 10^6, and speed of radio wave is $3 \times 10^8 ms^{-1}$.

Solution:

Given data:

Frequency = f = 90 MHz = 9×10^7 Hz

Speed = v = $3 \times 10^8 m/s$

Required;

Wave length = λ = ?

Formula:

As we know that

$v = f\lambda$

$\lambda = v/f$

Putting values:

Calculation:

$$\lambda = \frac{3\times10^8}{9\times10^7}$$

$$\lambda = \frac{3\times10^{8-7}}{9.0}$$

$\lambda = 3.333m$

Results:

Wavelength is 3.333m

You are using the UNREGISTERED

11.13 If the pitch of the sound is increased what are the changes in the following.

a) The frequency **b) The wavelength**

c) The wave velocity **d) The amplitude of wave**

According to wave equation $V=f\lambda$. If there is an increase in the pitch then there will also be increase in frequency, wavelength decrease, wave velocity will increase? There will be no change in the amplitude of wave.

11.14 If we clap or speak in front of a building while standing at a particular distance, we rehear our sound after sometime. Can you explain how does this happen?

It is due the reflection of sound. When sound is incident on the surface of a medium it bounces back into the first medium. This is known as reflection of sound or echo.

11.15 How can you find the speed of sound by echo method? What factors can affect the accuracy of this method?

See question no. 11

11.16 What is the audible frequency range for human ear? Does this range vary with the age of people? Explain.

See Question no. 14

11.17 Explain that noise is a nuisance.

See Question no. 12

11.18 Describe the importance of acoustic protection.

See Question no. 13

11.19 What are the uses of ultrasound in medicine?

See Question no. 15

CONCEPTUAL QUESTIONS

11.1 Why two tin cans with a string stretched between them could be better way to communicate than merely shouting though the air?

Ans: Two tin cans with a string stretched between them could be better way to communicate than merely shouting through the air because sound travel faster in solids as compared to gases (air).

11.2 We can recognize persons speaking with the same loudness from their voice. How is this possible?

Ans: We can recognize persons speaking with the same loudness from their voice due to quality of their sound which is defined as:

The characteristic of sound by which we can distinguish between two sounds of same loudness and pitch is called quality.

11.3 You can listen to your friend round a corner, but you cannot watch him/her. Why?

Ans: The sound travel through medium in all directions and shows diffraction about the corner therefore we can listen to our friend around a corner due to diffraction but we can not watch him.

11.4 Why must the volume of a stereo in a room with wall-to-wall carpet be tuned higher than in a room with a wooden floor?

Ans: The volume of a stereo in a room with wall-to-wall carpet be tuned higher because maximum absorption of sound takes place through the porous and rough, material of carpet. But through flat surfaces and wooden floor maximum reflection is taking place so low sound is required to make clear sensation.

UNREGISTERED VERSION

11.5 A student says that the two terms speed and frequency of the wave refer to the same thing. What is your response?

Ans: No, speed and frequency are two different terms which can be differentiate as follows.

Speed	Frequency
• The distance covered by the body in unit time • SI unit of speed is ms^{-1}.	• Number of waves passing through the point in one second is called frequency. • SI unit of frequency is Hz.

11.6 Two people are listening to the same music at the same distance. They disagree on its loudness. Explain how this could happen?

Ans: Two people are listening to the same music at the same distance. They disagree on its loudness. Because loudness also depends upon the physical condition of the ears of the listener. A sound appears louder to a person with sensitive ears than to a man with defective ears.

11.7 Is there any difference between echo and reflection of sound? Explain.

Ans: Yes, there is a difference. The reflection can take place at any distance from the denser medium at any time. But echo can be heard after 0.1 second, when distance between listener and reflecting surface is 17 m.

11.8 Will two separate 50dB sound together constitute a 100dB sound? Explain.

Ans: Yes, when two same sound of same loudness and are coherent (same wavelength) each of 50dB will constitute 100dB sound.

11.9 Why ultrasound is useful in medical field?

Ans: Ultrasound has high frequency (above 20,000Hz) and it carry more energy than the audible sound. According to relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics ultrasonics are utilized in medical field.

INFORMATION BASED QUESTIONS AND THEIR ANSWERS

Self Assessment (Page 22)

Q.1 Explain how sound is produced by a school bell?

Ans. When hammer strike the school bell, it starts vibrating and hence produces sound.

Self Assessment (Page 22)

Q.2 Why are sound waves called mechanical waves?

Ans. Sound waves travel in the form of compressions and rarefactions due to the vibrations of the particles of the medium about their mean positions. In other words, sound waves require material medium for their propagation and hence are called mechanical waves.

Self Assessment (Page 22)

Q.3 Suppose you and your friend are on the moon. Can you be able to hear any sound produced by your friend?

Ans. As there is no material medium on the moon for the propagation of sound waves, hence we can not hear any sound produced by our friend on the moon.

Quick Quiz (Page 24)

UNREGISTERED

Q.4 Why the voice of women is more shrill than that of men?

Ans. Voice of women is more shrill than that of men due to high frequency and pitch.

Quick Quiz (Page 24)

Q.5 Which property of sound waves determines its (a) loudness (b) pitch?

Ans. (a) Amplitude of sound wave determines its loudness.

(b) Frequency of sound wave determines its pitch.

Quick Quiz (Page 24)

Q.6 What would happen to the loudness of sound with increase in its frequency?

Ans. Loudness of sound does not depend upon the frequency of sound.

EXERCISE MULTIPLE CHOICE QUESTIONS FROM TEXT BOOK

1. **Which is an example of a longitudinal wave?**

   (a) Sound wave (b) Light wave (c) Radio wave (d) Water wave

2. **How does sound travel from its source to your ear?**

   (a) By changes in air pressure (b) By vibrations in wires or strings

   (c) By electromagnetic wave (d) By infrared waves

3. **Which form of energy is sound?**

   (a) Electrical (b) Mechanical (c) Thermal (d) Chemical

4. **Astronauts in space need to communicate with each other by radio links because**

   (a) Sound waves travel very slowly in space (b) Sound waves travel very fast in space

   (c) Sound waves cannot travel in space (d) Sound waves have low frequency in space

5. **The loudness of a sound is most closely related to its**

   (a) Frequency (b) Period (c) Wavelength (d) Amplitude

6. **For a normal person, audible frequency range for sound wave lie between**

   (a) 10 Hz and 10 kHz (b) 20 Hz and 20 kHz (c) 25 Hz and 25 kHz (d) 30 Hz and 30 kHz

7. **When the frequency of a sound wave is increased, which of the following will decrease?**

   (I) Wavelength (II) Period (III) Amplitude

   (a) I only (b) III only (c) I and II only (d) I and III only

ANSWER KEY

1	2	3	4	5	6	7
a	a	b	c	d	b	c

CHAPTER 11

SOUND

CONCEPT MAP

SOUND

Production	Produced by vibrating sources placed in a medium
Transmission	• Need a medium for transmission • Cannot pass through a vacuum
Measuring its speed	Direct method
Reflection	• Causes formation of echoes • Needs to be considered when designing a concert hall etc.
Detection	Audible to the human ear for sounds between 20 Hz and 20 000 Hz
Pitch and loudness	Related to frequency and amplitude

TOPICAL MULTIPLE CHOICE QUESTIONS

11.1 Sound Waves:

1. **The study of sound is called**
   (a) Acoustic (b) Optics (c) Electrostatics (d) All of these
2. **Sound is produced by ____________.**
   (a) Propagation (b) Vibration (c) Both of these (d) None of these
3. **Sound can travel only in presence of**
   (a) Medium (b) vaccum (c) Air (d) Both a and c
4. **Sound is ____________ Wave**
   (a) Electromagnetic (b) Transverse (c) Longitudinal (d) None of these

11.2 Characteristics of Sound:

5. **Characteristic by which We can distinguish between two sounds of same loudness and pitch is called __________.**
   (a) Loudness (b) Pitch (c) Quality (d) intensity of sound
6. **Pitch of sound depends on**
   (a) Amplitude (b) Frequency (c) Time period (d) Displacement
7. **Distance between two consecutive compressions and rarefactions is the __________ of sound wave.**
   (a) Amplitude (b) Frequency (c) Wave Length (d) none of these
8. **Loudness of sound depends on**
   (a) Amplitude of vibrating body (b) Area of vibrating body
   (c) Distance of vibrating body (d) All of these
9. **__________ is the characteristic of sound by which we can distinguish between a shrill and a grave sound.**
   (a) Pitch (b) loudness (c) Intensity (d) Quality
10. **Frequency of silent whistle Lies between ____________.**
    (a) 20,000Hz - 25,000Hz (b) 20,000Hz - 35,000Hz
    (c) 20Hz - 20,000Hz (d) 15,000Hz - 40,000Hz
11. **The intensity of sound depends on the ____________ of sound.**
    (a) Time period (b) frequency (c) Amplitude (d) None of these
12. **Intensity is a ____________ quantity.**
    (a) Vector (b) Scalar (c) Physical quantity (d) None of these
13. **Intensity of faintest sound is**
    (a) $10^{12}\ Wm^{-2}$ (b) $10^{-12} Wm^{-2}$ (c) $10^{-8} Wm^{-2}$ (d) $10^{-9} Wm^{-2}$

14. **Intensity of loudest audible sound is ______________.**

(a) $10^{-12}Wm^{-2}$ (b) $1Wm^{-2}$ (c) $20Wm^{-2}$ (d) All of these

15. **Intensity of whispering**

(a) $10^{-5}Wm^{-2}$ (b) $10^{-8}Wm^{-2}$ (c) $10^{-9}Wm^{-2}$ (d) $10^{-12}Wm^{-2}$

16. **The loudness of sound is directly proportional to logarithm of intensity, this Law is called ______________.**

(a) Weber Fechner Law (b) Law of Gravitation

(c) Intensity Level (d) Echo

17. **Voice of Child is ______________**

(a) Grave (b) Shrill (c) Faint (d) Loud

18. **I bell is equal to**

(a) 20dB (b) 10dB (c) 100dB (d) 50dB

19. **The amplitude of 100 dB sound is __________**

(a) 1000 (b) 10,000 (c) 100,000 (d) 1001000

20. **By using an __________ we can see sound wave.**

(a) Electroscope (b) Stroboscope (c) Gastroscope (d) Oscilloscope

11.3 Reflection (ECHO) of Sound:

21. **Echo of sound is**

(a) Refraction (b) Reflection (c) Diffraction (d) Interference

22. **The sensation of sound persists in our brain about ______________**

(a) 1s (b) 0.1s (c) 0.01s (d) 2s

23. **For hearing distinct echoes, the minimum distance of obstacle from source of source of sound must be**

(a) 34m (b) 17m (c) 38m (d) 16m

11.4 Speed of Sound:

24. **The speed of sound in solid is about ______________ times that in gases.**

(a) 5 (b) 15 (c) 20 (d) 10

25. **The speed of sound in air at a2 atm pressure and at room temperature (21°C) is**

(a) $320ms^{-1}$ (b) 360m/s (c) $343ms^{-1}$ (d) None of these

26. **The speed of sound varies with ______________**

(a) Temperature (b) Humidity (c) both a and b (d) None of these

27. **The speed of sound in solid is ______________ than liquid and air**

(a) Greater (b) Smaller (c) Equal (d) None of these

28. **Bats can hear Frequencies up to 120,000Hz**

(a) 10,000Hz (b) 120,000Hz (c) 12,00,000Hz (d) 120,00,000Hz

29. **Mice can hear frequencies up to**

(a) 35,00Hz (b) 35,000Hz (c) 45,00Hz (d) 100,000 Hz

30. **Compressions are places Where air is slightly ________ than the surrounding air**

(a) Less (b) Higher (c) Equal (d) None of these

31. **Rarefactions are places where air is slightly ____________ than the surrounding air**

(a) Less (b) Higher (c) Equal (d) None of these

32. **The speed of sound in air was first accurately measured in ____________**

(a) 1838 (b) 1738 (c) 1638 (d) 1938

11.5 Noise Pollution:

33. **Such sound Which are pleasant to our ears are called ____________**

(a) Musical Sound (b) Noise (c) Both a and b (d) None of these

34. **Such sounds which are unpleasant to our ears are called ____________.**

(a) Musical Sound (b) Noise (c) Both a and b (d) None of these

35. **Corresponds to irregular and sudden vibrations produced by some sound**

(a) Noise (b) Musical Sound (c) Notes of tuning fork (d) None of these

36. **The Level of noise recommended in most of countries is**

(a) 75-80dB (b) 85-90dB (c) 95-100dB (d) 115-120dB

37. **The method used to absorb undesirable sound by soft and porous surface is called**

(a) Acoustics (b) Echos (c) Intensity (d) Pitch

38. **Multiple reflections called**

(a) Acoustics (b) reverberations (c) Vibration (d) All of these

39. **We hear sound produce by musical instrument such as**

(a) Flute (b) Violin (c) Harmonic (d) All of these

40. **For a normal person audible frequency rnage for sound wave lie between**

(a) 10^{th} and 10 Khz (b) 20 Hz and 20KHz (c) 25Hz and 25 KHz (d) 30Hz and 30 KHz

41. **Noise correspond ____________ vibration**

(a) Irregular (b) Sudden (c) Both 'a' and 'b' (d) Slowly slowly

42. **Noise has negative effects on human health it cause except**

(a) Aggression (b) Hypertension (c) High stress level (d) Fever/flue

43. **Which are the acoustic protection except**

(a) Lecture Halls (b) Auditorium (c) Theater halls (d) Kitchen

11.6 Audible Frequency Range:

44. **Audible frequency range is**

(a) 200Hz-2000Hz (b) 15Hz-15000Hz (c) 20Hz-20KHz (d) 20Hz-15000Hz

45. **Old people cannot hear sound even above**

(a) 20, 00Hz (b) 15 KIHz (c) 15,000 Hz (d) Both (b) and (c)

46. **Which bird fly easily between wires in the black room**

(a) Sparrow (b) Bat (c) Cow (d) Parrot

47. **The range of the frequency which human, ear can hear is called**

(a) Audible frequency range (b) Ultrasonic waves
(c) Transonic waves (d) None of these

11.7 Ultrasound:

48. Ultrasonics are used to measure the depth of Water by
(a) Acoustics (b) Echo Method (c) Sound Level (d) Diffraction

49. ____________ Waves carry more energy and higher frequency than sound waves
(a) Ultrasonics (b) Infrasonic (c) Audible sound (d) All of these

50. Ultrasonics are used to locate under-water depth the technique is called
(a) Acoustics (b) Reverb ration (c) Sonar (d) Infrasonics

51. Sound waves with frequency less than 20Hz are called ____________.
(a) Ultrasonic (b) Infrasonics (c) Notes (d) Acoustic

52. Ultrasound is the frequency of sound higher than
(a) 20Hz (b) 20KHz (c) 15,000 Hz (d) 25,000 Hz

53. Infrasonic is the frequency of sound less than
(a) 20Hz (b) 20 KHz (c) 15,000 Hz (d) 25,000 Hz

54. According to wave equation $v = f\lambda$ the wavelength of ultra sonic waves are
(a) Very small (b) Very big (c) Both "a" and "b" (d) None of these

55. Powerful ultrasound is now being used to remove blood clot from
(a) Capillaries (b) Arteries (c) Convoluted tubule (d) None of these

56. By which waves small cracks can appear
(a) Ultrasonics (b) Infrasonic (c) NOTSE (d) Sound frequency

57. By ultrasonic waves are destroyed
(a) Germs (b) Bacteria (c) Fungus (d) Both "a" and "b"

58. Whe the frequency of a sound wave is increased which of following decrease
(a) Wave length (b) Period (c) Amplitude (d) Both a and b

59. Bats can hear frequency up to
(a) 120, 000Hz (b) 2,000 Hz (c) 20, 000 Hz (d) 15,000 Hz

60. Researcher in ____________ observed giraffes to stop and wait for the others that were out of sight
(a) 1898 (b) 1993 (c) 2013 (d) None of these

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	a	11	d	21	b	31	a	41	c	51	b
2	b	12	c	22	b	32	b	42	d	52	b
3	d	13	b	23	b	33	a	43	d	53	a
4	c	14	b	24	b	34	b	44	c	54	a
5	c	15	c	25	c	35	a	45	c	55	b
6	b	16	a	26	c	36	b	46	b	56	a
7	c	17	b	27	a	37	a	47	a	57	d
8	d	18	b	28	b	38	b	48	b	58	d
9	a	19	c	29	d	39	d	49	a	59	a
10	a	20	d	30	b	40	b	50	c	60	b

SHORT QUESTIONS

11.1 Sound Waves

11.2 Characteristics Of Sound

11.3 Speed Of Sound

Q.1. What is sound wave? How sound is produced?

Sound Wave

A sound wave is a pattern of disturbance caused by the movement of energy traveling through medium as it propagate away from source of sound.

Like other waves sound is also produced by vibrating bodies. Due to vibration of bodies the air around them also vibrates and the air vibration produces sensation of sound in our ear.

Q.2. Ans: What is tuning fork?

Ans: It is a U-shaped body having two metal prongs with a stem at the bottom and is used for producing sound of particular frequency.

Q.3. Why medium is required for the propagation of sound waves?

Ans: Sound waves are compressional waves in nature. That is the type of mechanical waves and we know that mechanical waves require medium for their propagation. So we can say material medium is necessary for the propagation of sound from one point to another. This material medium can be a gas, a liquid or a solid.

Q.4. Define loudness of sound and what are the factors affecting it?

Ans: Definition

"The characteristic of sound by which a loud and faint sound can be distinguished is called loudness of sound".

Factors affecting loudness of Sound

Following are the factors that affect the loudness of sound.

- Amplitude of vibrating body
- Area of vibrating body
- Distance from vibrating body
- Physical condition of ear

Q.5. Define pitch of the sound

Ans: The characteristic of sound by which a shrill sound can be distinguished from a grave one is called the pitch of the sound.

Dependence on Frequency

It depends upon the frequency, the greater the frequency, the higher the pitch and lower the frequency, the lower the pitch.

Q.6. Define the quality of sound with an example.

Ans: "The characteristic of sound by which two sounds of same loudness and pitch are distinguished from each other is called the quality of sound".

Example

Sounds of flute and piano of given loudness and pitch can be distinguished because the quality of their notes is different.

Dependence:

It depends upon the waveform of the sound waves. The loudness and pitch of these two sounds are the same but their waveforms are different. So their quality is different and can be distinguished from each other

Q.7. What is intensity of sound?

Ans:

Intensity of sound

"Sound energy flowing per second through a unit area held perpendicular to the direction of propagation of sound waves is called the intensity of sound"

Unit

The unit of intensity of sound is watt per square meter (**Wm^{-2}**). Intensity is a physical quantity and can be measured accurately.

Intensities of Faintest and Loudest sound

The intensity of faintest sound is **10^{-12} Wm^{-2}** and the intensity of the loudest sound, which can be heard without pain, is **1 Wm^{-2}**.

Q.8. State Weber Fechner Law

Ans: Weber Fechner Law

It has been proved experimentally that loudness (L) of a sound is directly proportional to the logarithm of intensity.

Mathematically:

$$L \propto \log I$$

$$L = K \log I$$

Where L is loudness of sound, K is proportionality constant and I is intensity of sound.

Q.9. Intensity Level or Sound Level

Ans. The difference between the loudness of any unknown sound and faintest sound ($L - L_0$) is called the intensity level or sound level.

Mathematically:

$$\text{Sound level} = K \log \frac{I}{I_0}$$

Where I is intensity of unknown sound, K is proportionality constant and I_o is intensity of the faintest sound.

Q.10. Define SI unit of sound level (Bel)

Ans. Bel:

If the intensity of any unknown sound is 10 times greater than the intensity I_0 of the faintest audible sound i.e. $I = 10I_0$ then the intensity level of such sound is taken as unit, called Bel. The value of K becomes 1.

Mathematically:

$$\text{Sound Level} = K \log \frac{I}{I_0} \text{ (Bel)}$$

By substituting K = 1, equation becomes

$$\text{Sound Level} = \log \frac{I}{I_0} \text{ (Bel)}$$

Q.11. Find sound level of sound of train?

Ans: Intensity of sound of train is 10^{-2} Wm^{-2} and sound level of faintest sound is 10^{-12} Wm^{-2} then

$$\text{Sound level of sound of train (in bel)} = \log \frac{10^{-2}}{10^{-12}} \text{ (Bel)}$$

$$= \log 10^{10} = 10 \text{ Bel}$$

$$\text{Sound level of sound of train in decibel} = 10 \log \frac{10^{-2}}{10^{-12}} \text{ (dB)}$$

$$= \mathbf{10 \log 10^{10} = 100 \ dB}$$

11.4 Reflection (Echo) Of Sound:

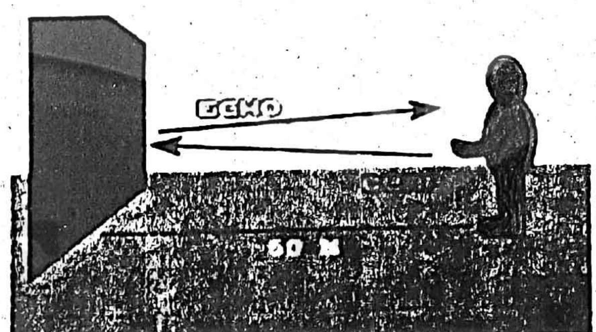
Q.12. How reflection (Echo) of sound can be defined ?

Echo:

"When sound is incident on the surface of a medium it bounces back into the first medium. This phenomenon is called echo or reflection of sound".

Q.13. Calculate minimum distance to hear Echo.

Ans. The sensation of sound persist in our brain for about 0.1s. to hear a clear echo, the time interval between our sound and the reflected sound must be at least 0.1s. If we consider speed of sound to be 340 ms^{-1} at a normal temperature in air, we will hear the echo after 0.1s. The total distance covered by the sound from the point of generation to the reflecting surface and back should be at least 340 ms^{-1} × 0.1 s = 34.0 m. Thus, for hearing distance echoes, the minimum distance of the obstacle from the source of sound must be half of this distance that is 17m. Echoes may be heard more than once due to successive or multiple reflections.



Q.14. Calculate the frequency of a sound wave of speed 340 ms^{-1} and wavelength 0.5m.

Ans.

Solution:

Given that:

Speed of waves $v = 340 \ ms^{-1}$

Wave length $\lambda = 0.5 \ m$

Required

Frequency $= f = ?$

Using the formula $v = f\lambda$

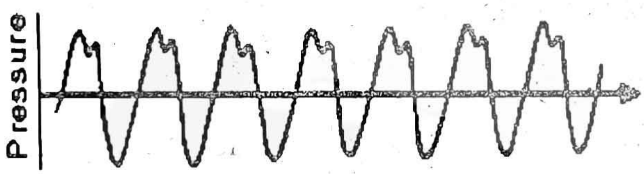
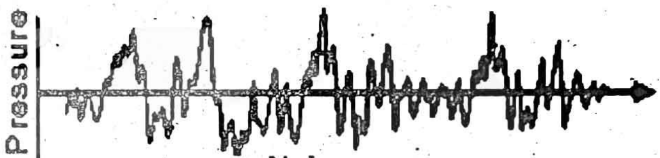
$$f = \frac{v}{\lambda} = \frac{340}{0.5}$$

$$f = 680 Hz$$

11.5 Noise Pollution:

Q.15. What is noise pollution? Explain its sources and effects. How it is reduced? OR Differentiate between music and noise. Explain effects of noise and safe level of noise.

Ans:

Music	Noise
• The sounds that have pleasant effect on our ears are called musical sounds. • The frequency and amplitude of musical sounds change in a regular manner. • Sounds produced by the musical instruments like flute, violin, harmonium are musical sounds.	• The sounds that have jarring or unpleasant effect on our ears are called noise. • The frequency and amplitude of the noise change in irregular manner. • Sounds of traffic or sound produced by hammering in factories are noise.
Examples • We enjoy the programmes of radio or television by hearing sounds of different qualities. • In musical programmes, we hear sound produced by musical instruments such as flute, harmonium, violin, drum etc.	**Examples** • Sound of machinery • The slamming of a door, • Sounds of traffic in big cities.
Waveform:  Music	**Waveform:**  Noise

Q.16. What is meant by Noise Pollution and describe its Sources

Ans. Noise Pollution

Noise pollution has become a major issue of concern in big cities. Noise is a undesirable sound that is harmful for health of human and other species.

Sources:

The sources of noise pollution are given below

- Transportation equipment
- Heavy machinery

These are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms.

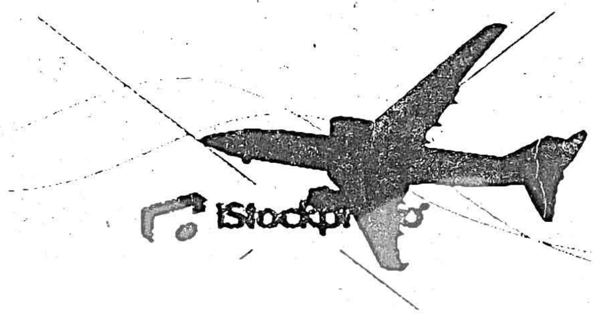
Q.17. What are effects of Noise?

Ans. Effects of Noise:

Noise has negative effects on human health as it can cause conditions such as

- Hearing loss
- Sleep disturbances,
- Aggression,
- Hypertension,
- High stress levels.

Noise can also cause accidents by interfering with communication and warning signals.



Q.18. Enlist any five sound of Music and noise.

Ans. Musical sounds

(i) Sound of harmonium

(ii) Sound of flute

(iii) Sound of tabla

(iv) Sound of songs

(v) Sound of violin

Noises

(i) Sound of traffic

(ii) Sound of moving train

(iii) Sound of aeroplanes

(iv) Sound of crying

(v) Sound of horns

Q.19. What are the major sources of noise in our society?

Ans: Automobiles, aeroplanes, helicopters, trains, heavy machinery, heavy traffic, loud speakers are the major sources of noise pollution in our society.

Q.20. How noise can be reduced?

Ans: Trees and different appliances are used to reduce the noise

Q.21. What do you know by Safe Level of Noise:

Ans. Safe Level of Noise:

A safe level of noise depends on two factors: the level (volume) of the noise; and the period of exposure to the noise. The level of noise recommended in most countries is usually 85-90 dB over an eight hour workday. Noise pollution can be reduced to acceptable level by replacing the noisy machinery with environment friendly machinery and equipments, putting sound-reducing barriers, or using hearing protection devices.

Q.22. Define acoustics protection. Explain importance of acoustic protection.

Ans. Acoustic Protection.

"The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection."

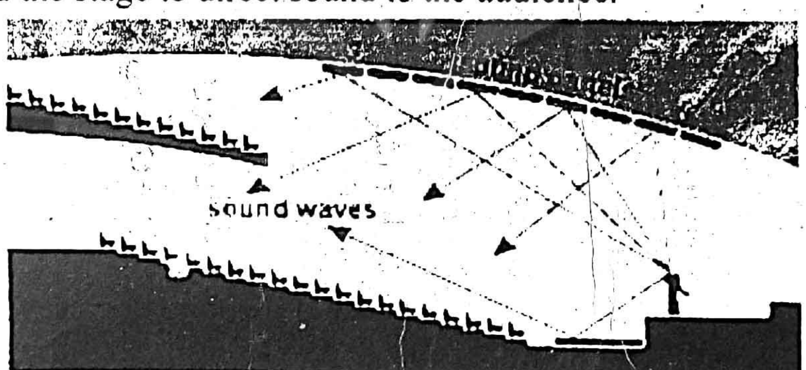
Importance of Acoustic:

Reflection of sound is more prominent if the surface is rigid and smooth and less if the surface is soft and irregular. Soft, porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and softening noises. Thus by using such materials in noisy places, we can reduce the level of noise pollution.

Q.23. What is meant by Reverberation:

Ans. When sound reflects from the wall, ceiling and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations.

In the design of lecture halls, auditorium or theatre halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.



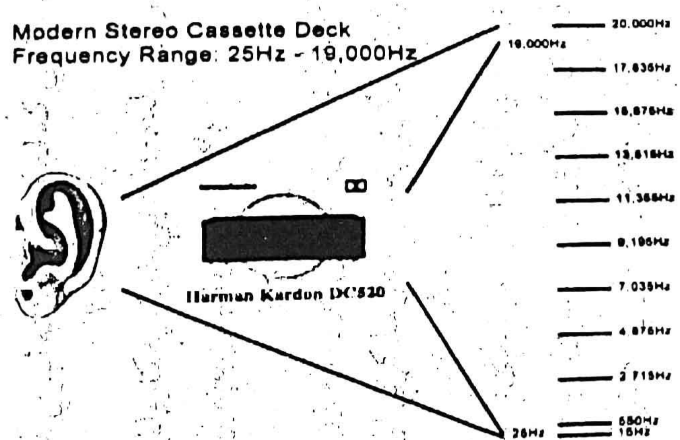
11.6 Audible Frequency Range:

Q.24. What is audible frequency range for human and why we cannot hear if sound ranges more than this range.

Ans: A human ear can hear sound only if its frequency lies between 20 to 20000 Hz. A human ear can neither hear a sound of frequency less than 20 Hz nor a sound of frequency more than 20000 Hz. Sounds of frequency beyond the 20000 Hz are inaudible because the eardrum of human ear cannot vibrate so rapidly. The audible range is different for different persons and it also varies with the age.

Q.25. What is silent whistle and why it is called so?

Ans: Some people use silent whistle to call dogs whose frequency lies between 20,000 Hz to 25,000 Hz and human ear cannot detect it. So, it is silent for human that is why it is called silent but it is not silent for the dogs because their audible range is much more than human.



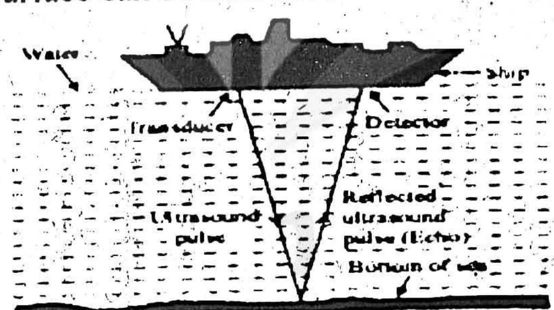
11.7 Ultrasound:

Q.26. What are ultrasonic and why they are used in our life?

Ans: "Sound waves of frequency higher than 20000 Hz are ultrasonics"
It has been seen that ultrasonic waves carry more energy than audible sound waves. Moreover, according to the relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics they are usefully utilized in medical and technical fields.

Q.27. How we can find the depth of ocean?

Ans: Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR, (sound navigation and ranging). The sound waves are sent froma transmitter, and a receiver collects the reflected sound. The time lapse is calculated, knowing the speed of sound in water, the distance of the object from the ocean surface can be estimated



Ultrasonic are used to measure depth of water by echo method (fig 1.a)

LONG QUESTIONS

11.1 Sound Waves:

Q.1 What is sound wave? How sound is produced? Give examples.

Sound Wave

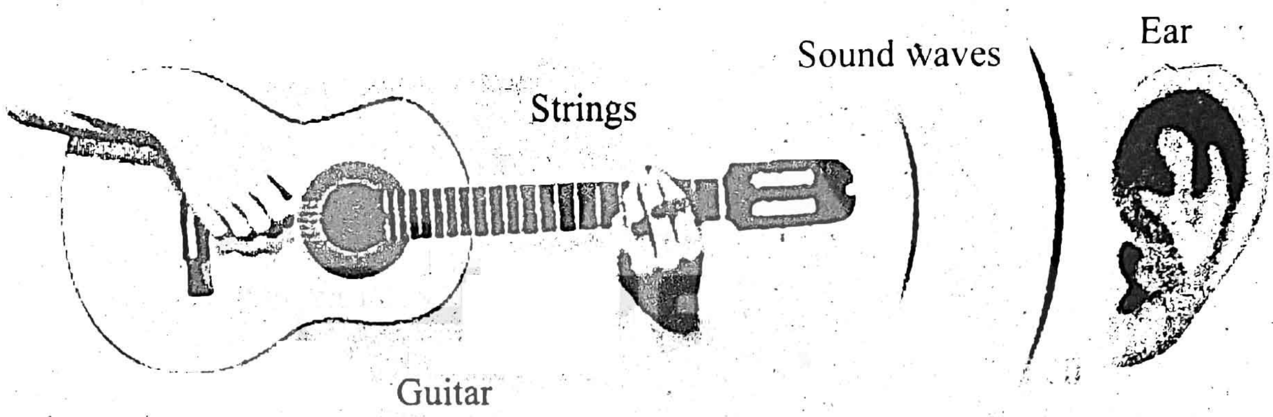
A sound wave is a pattern of disturbance caused by the movement of energy traveling through medium as it propagate away from source of sound.

Production of Sound

Like other waves sound is also produced by vibrating bodies. Due to vibration of bodies the air around them also vibrates. And the air vibration produces sensation of sound in our ear.

Examples:

- In a guitar, sound is produced due to the vibrations of its strings as shown fig (a).

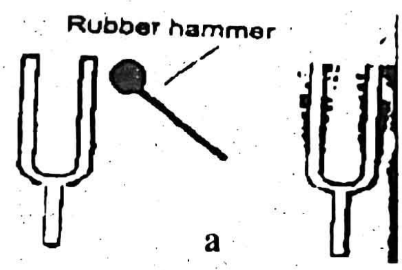


(a)

- Our voice results from the vibrations of our vocal chords.
- Human heart beats and vibrations of other organs like lungs also produce sound waves. Doctors use stethoscope to hear this sound.

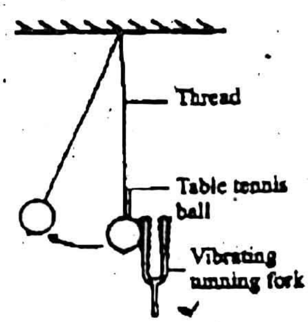
Q.2 With the help of an activity make it clear that sound is produced by vibrating body.

Activity:



a

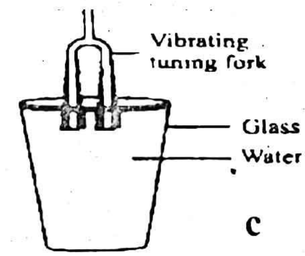
In school laboratories, we use a device called tuning fork which produces a particular sound. If we strike the tuning fork against rubber hammer, the tuning fork will begin to vibrate as shown in fig (a).



b

We can hear the sound produced by tuning fork by bringing it near our ear. We can also feel the vibration by slightly touching one of the prongs of the vibrating tuning fork with a plastic ball suspended from a thread as shown in fig (b).

Touch the ball gently with the prong of a vibrating tuning fork. The tuning fork will push the ball because of its vibration. Now if we dip the vibrating tuning fork into a glass of water, we will see a splash (fig c) vibrations make the water splash?



c

Conclusion:

From this activity we can conclude that sound is produced by vibrating bodies.

Q.3 With the help of an experiment, show that a material medium is required for propagation of sound.

Sound requires material medium for its propagation (Activity:)

Sound waves require some material medium for their propagation, this can be proved by bell jar apparatus (as shown in fig. a). The bell jar is placed on the platform of a vacuum pump.

An electric bell is suspended in the bell jar with the help of two wires connected to a power supply. By setting on the power supply, electric bell will begin to ring. We can hear the sound of the bell. Now start pumping out air from the jar by means of a vacuum pump. The sound of the bell starts becoming more and more feeble and eventually dies out, although bell is still ringing. When we put the air back into the jar we can hear the sound of the bell again.

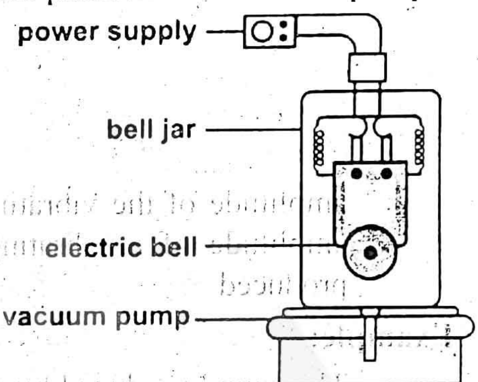


Fig. 11.5: Bell jar apparatus

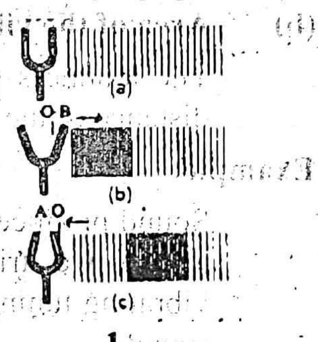
Conclusion:

From this activity we conclude that sound waves can only travel/ propagate in the presence of air (medium).

Q.4 Explain longitudinal nature of sound waves.

Propagation of sound waves produced by vibrating tuning fork can be understood by a vibrating tuning fork (as shown in fig.1).

Before the vibration of tuning fork, density of air molecules on the right side is uniform as shown in fig 1(a).



1

Vibrations of tuning fork after striking with a rubber hammer

When the right prong of tuning fork moves from mean position O to B, it exerts some pressure on the adjacent layer of air molecules and produces a compression. This compressed air layer inn turn compresses the layer next to it and so on as shown fig 1(b).

A moment later, the prong begins to move from B towards A (fig.1(c). Now the pressure in the adjacent layer decreases and a rarefaction is produced. This rarefaction is transferred to the air layer next to it and so on. As the tuning fork moves back and forth rapidly, a series of compressions and rarefactions are created in the air. In this way, sound wave propagates through the air.

Conclusion:

As in the figure the direction of propagation of sound wave is along the direction of oscillating air molecules. This shows the longitudinal nature of sound waves. Distance between two consecutive compressions or rarefactions is the wavelength of sound wave.

11.2 Characteristics Of Sound:

Q.5 Define loudness of sound and what are the factors affecting it?

Ans: Definition

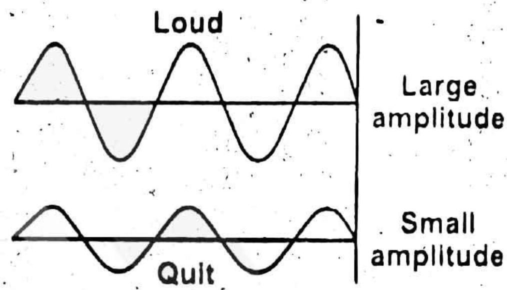
"The characteristic of sound by which a loud and faint sound can be distinguished is called loudness of sound".

Factors affecting loudness of Sound

Following are the factors that affect the loudness of sound.

(i) Amplitude of vibrating body
(ii) Area of vibrating body
(iii)Distance from vibrating body
(iv)Physical condition of ear

(a) Amplitude of the vibrating body:



The loudness of the sound varies directly with the amplitude of the vibrating body (fig.1). The greater the amplitude of a vibrating object the louder the sound produced

Example:

The sound produced by a sitar will be loud if we pluck its wires more violently. Similarly, when we beat a drum forcefully, the amplitude of its membrane increases and we hear a loud sound.

(b) Area of the vibrating body:

The loudness of sound also depends upon the area of the vibrating body. "Lesser the distance of the listener from the vibrating body louder is the sound produced?

Example:

Sound produced by a large drum is louder than that by small one because of its vibrating area. If we strike a tuning fork on a rubber pad, a feeble sound will be heard. But if the vibrating tuning fork is placed vertically on the surface of a bench, we will hear a louder sound.

From this we can conclude that the loudness increases with the area of the vibrating body and vice versa.

(c) Distance from the vibrating body:

Loudness of sound also depends upon the distance of the vibrating body from the listener.

Example

We move away from a drum being beaten violently to avoid uncomfortably loud sound. We also experience that sound is heard to be louder if it travels in the same direction in which the wind blows. It seems to be faint if it travels in the opposite direction.

It is caused by the decrease in amplitude due to increase in distance.

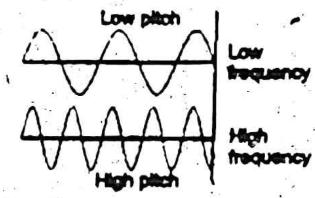
Physical condition of ear

Loudness of sound also depends on the physical condition of ear. A sound appears louder to a person with sensitive ears than to a man with defective ears

Q.6 Pitch: Define pitch of the sound and explain the relation between pitch and frequency with an example?

Ans: The characteristic of sound by which a shrill sound can be distinguished from a grave one is called the pitch of the sound.

Dependence on Frequency



It depends upon the frequency, the greater the frequency, the higher the pitch and lower the frequency, the lower the pitch.

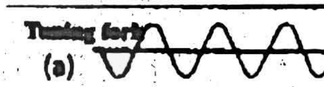
Example:

The frequency of the voice of ladies and children is greater than that of men. Therefore, the voice of ladies and children is shrill and is of high pitch as compared to men.

Q.7 What is meant by quality of sound?

Quality:

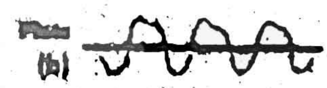
The characteristic of sound by which we can distinguish between two sounds of same loudness and pitch is called quality.



Sound wave form produce by tunning fork

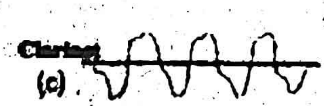
Examples:

While standing outside a room, we can distinguish between the notes of a piano and a flute being played inside the room. This is due to the difference in the quality of these notes.



Sound wave form produce by flute

Fig.1(a),(b),(c) shows the waveform of the sound produced by a tuning fork, flute and clarinet. The loudness the pitch of these three sounds are the same but their waveforms are different. So their quality is different' and they can be distinguished from each other.



Sound wave form produce by clarinet

Q.8 What is intensity of sound and how you will relate intensity of sound with loudness of sound?

Ans: Intensity of sound

"Sound energy flowing per second through a unit area held perpendicular to the direction of propagation of sound waves is called the intensity of sound"

Unit

The unit of intensity of sound is watt per square meter (**Wm^{-2}**). Intensity is a physical quantity and can be measured accurately.

Intensities of Faintest and Loudest sound

The intensity of faintest sound is **10^{-12} Wm^{-2}** and the intensity of the loudest sound, which can be heard without pain, is **1 Wm^{-2}**.

Comparison of intensity with the loudness of sound

It may be remembered that intensity of sound is a physical quantity and it does not depend on condition or sensitiveness of the ear whereas the magnitude of the sensation produced on the ear by a sound is called loudness. The loudness of a sound depends not only on the intensity of sound but also on the physical condition of the ear.

Weber Fechner Law

It has been proved experimentally loudness (L) of a sound is directly proportional to the logarithm of intensity that is given as under:

$$L \propto \log I$$

$$L = K \log I \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Above equation (1) is the mathematical representation of the Weber Fechner law and K is the constant of proportionality.

If L_0 represents the loudness of the faintest audible sound of intensity I_0 and L is the loudness of an unknown sound of intensity I then equation (1) can be written as:

$$L_0 = K \log I_0 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Intensity Level or Sound Level

The difference between the loudness of any unknown sound and faintest sound $(L - L_0)$ is called the intensity level or sound level.

By subtracting equation (2) from equation (1), we have

$$\text{Sound level} = L - L_0 = K \log I - K \log I_0$$

$$\text{Sound level} = L - L_0 = K (\log I - \log I_0)$$

$$\text{Sound level} = K \log \frac{I}{I_0} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

The value of K depends not only on the unit of I and I_0 but also on the unit of intensity level.

Unit of Intensity Level or Sound Level

The unit of intensity level or sound level is Bel.

Bel

If the intensity of any unknown sound is 10 times greater than the intensity I_0 of the faintest audible sound i.e. $I = 10I_0$ then the intensity level of such sound is taken as unit, called Bel.

- It is SI unit of sound level.
- Bel is very large unit of sound level.

The value of K becomes 1 in Weber Fechner law equation. By substituting K = 1, equation (3) becomes:

$$\text{Sound Level} = \log \frac{I}{I_0} \text{ (Bel)} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Decibel

- Generally a smaller unit called decibel is used.
- Decibel is abbreviated as (dB).
- 1 Bel is equal to 10 dB.

If sound level is to measured in decibels then equation (4) can be written as:

$$\text{Sound Level} = 10 \log \frac{I}{I_0} \text{ (dB)} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Calculation of Sound Level of different sounds

Example 1 (Sound level of faintest audible sound)

Intensity or sound level of faintest audible sound can be calculated by substituting $I = I_0 = 10^{-12}\ Wm^{-2}$ in equation (5), we have

Sound level of faintest audible sound is $= 10\log\frac{I}{I_0} = 10\log\frac{I_0}{I_0} = 0\ (dB)$

Example 2 (Sound level of rustle of leaves)

By substituting $I = 10^{-11}$ in equation (5), we have

Sound level of rustle of leaves $= 10\log\frac{I}{I_0} = 10\log\frac{10^{-11}}{10^{-12}} = 10\log 10 = 10dB$

Example 3 (Sound level of whispering)

By substituting $I = 10^{-10}$ in equation (5), we have

Sound level of whispering $= 10\log\frac{I}{I_0} = 10\log\frac{10^{-10}}{10^{-12}} = 10\log 100 = 20dB$

Intensity level of faintest audible sound $= 10\log\frac{I}{I_0}$

$= 10\log\frac{I}{I_0}$

$= 0dB$

((b) As the intensity of the rustle of leaves is $I = 10^{-11}\ Wm^{-2}$
Therefore,
Intensity level due to rustling of leave $= 10\log 10^{-11}/10^{-12}$
$= 10\log 10 = 19dB$

11.3 Reflection (Echo) Of Sound:

Q.9 How reflection (Echo) of sound can be defined and explained.

OR

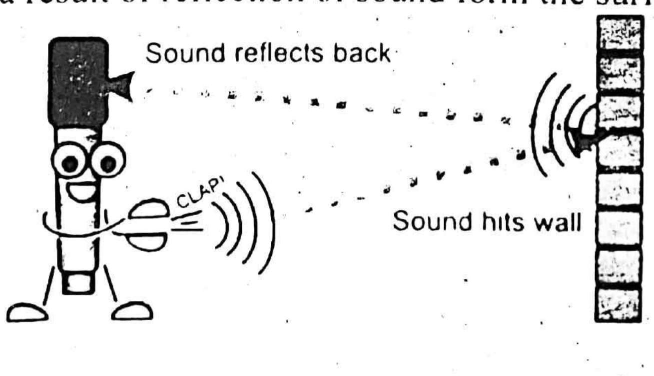
Define Echo and explain it. Also calculate minimum distance to hear Echo.

Echo:

"When sound is incident on the surface of a medium it bounces back into the first medium. This phenomenon is called echo or reflection of sound".

Explanation:

When we clap or shout near a reflecting surface such as a tall building or a mountain, we will hear the same sound again a little later. What causes this? This sound which we hear is called as echo and is a result of reflection of sound form the surface.



Minimum Distance to hear Echo:

The sensation of sound persist in our brain for about 0.1s. to hear a clear echo, the time interval between our sound and the reflected sound must beat least 0.1s. If we consider speed of sound to be 340 ms-1 at a normal temperature in air, we will hear the echo after 0.1s. The total distance covered by the sound form the point of generation to the reflecting surface and back should be at least $340\ ms^{-1} \times 0.1\ s = 34.0$ m. Thus, for hearing distance echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is 17m. Echoes may be heard more than once due to successive or multiple reflections.

11.4 Speed Of Sound:

Q.10 How can calculate speed of sound?

Sound waves can be transmitted only be any medium containing particles that can vibrate. It cannot pass through vacuum. However, the nature of the medium will affect the speed of the sound waves. In general, the speed of sound in a liquid is five times that in gases, the speed of sound in solid is about fifteen times that in gases. The speed of sound in air is affected by changes in some physical conditions such as temperature, pressure and humidity etc.

The speed of sound in air is 343 ms^{-1} at one atmosphere of pressure and room temperature (21°(C). The speed varies wit temperature and humidity. The speed of sound in solids and liquids is faster than in air. Following relation can be used to find the speed of sound.

$V = f\lambda$ .... (11.6)

Where v is the speed, f is the frequency and λ is the wavelength of sound wave.

Measuring speed of sound by Echo Method

Q.11 How can we measure speed of sound by Echo method?

Apparatus:

measuring tape. Stopwatch, flat wall that can produce a good echo.

Procedure:

1. Use the tape to measure a distance of 50 metres form the wall.
2. Now clap you hands in front of the wall at a distance of 50 metres and check if you can clearly hear an echo form the wall. Make sure the echo is not coming from any other wall in the area. The time taken by the sound to travel 100 metres is the time difference between the clap and the echo.
3. Now restart the clapping and start the stopwatch at the first clap. Count the number of claps. And stop the clapping and the stopwatch when you hear the echo of the 10^{th} clap (say)
4. Now find the average time for 10 claps. After calculating the time interval t between claps and using the formula s = vt, we can calculate the speed of the sound.

11.5 Noise Pollution:

Q.12 What is noise pollution? Explain its sources and effects. How it is reduced?

OR

Differentiate between music and noise. Explain effects of noise and safe level of noise.

Music:

"Such sounds which are pleasant to our ears are called musical sounds."

Examples:

- We enjoy the programmes of radio or television by hearing sounds of different qualities.
- In musical programmes, we hear sound produced by musical instruments such as flute, harmonium, violin, drum etc.
  Sound of these instruments cast pleasant effect on our ears.

Noise:

"Sound which has jarring and unpleasant effect on our ears is called noise. Noise corresponds to irregular and sudden vibrations produced by some sounds."

Examples:

- Sound of machinery
- The slamming of a door,
- Sounds of traffic in big cities.

Sound of above mentioned examples cast unpleasant effect on our ears

Noise Pollution and its Sources:

Noise pollution has become a major issue of concern in big cities. Noise is a undesirable sound that is harmful for health of human and other species. The sources of noise pollution are given below.

- Transportation equipment
- Heavy machinery

These are the main sources of noise pollution. For example, noise of machinery in industrial areas, loud vehicle horns, hooters and alarms.

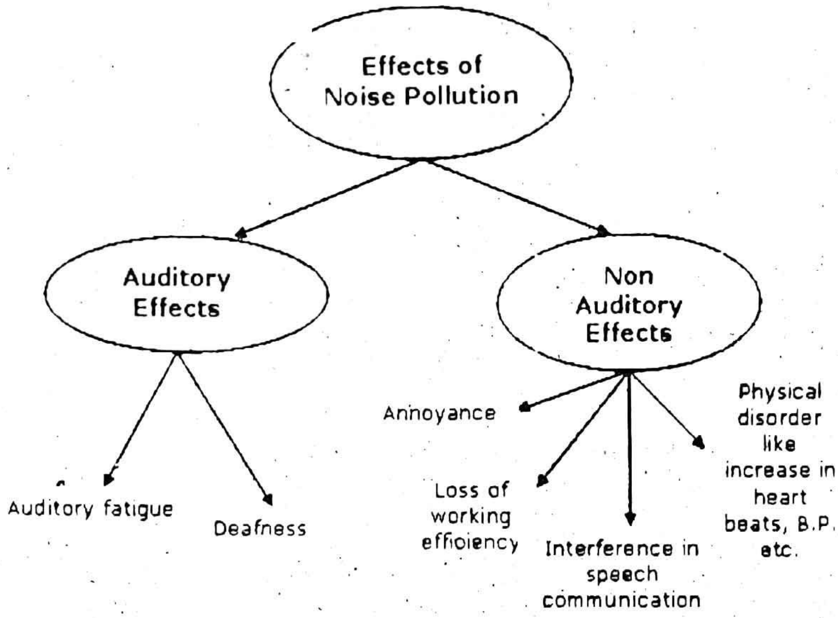
Effects of Noise:

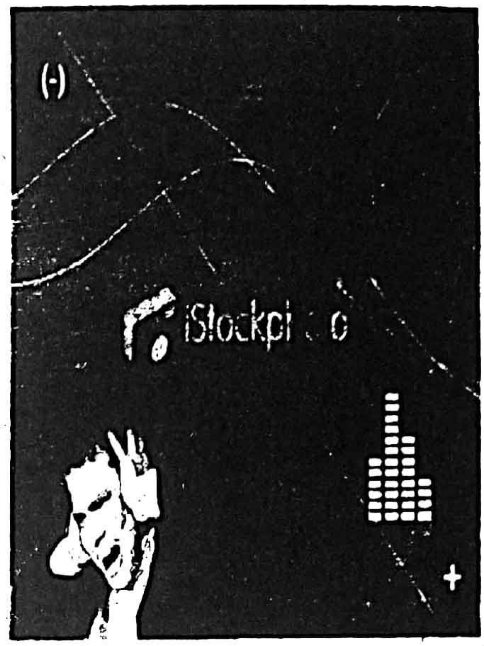
Noise has negative effects on human health as it can cause conditions such as

- Hearing loss
- Sleep disturbances
- Aggression,
- Hypertension
- High stress levels.
- Noise can also cause accidents by interfering with communication and warning signals.

Safe Level of Noise:

A safe level of noise depends on two factors: the level volume of the noise; and the period of exposure to the noise. The level of noise recommended in most countries is usually 85-90 dB over an eight hour workday. Noise pollution can be reduced to acceptable level by replacing the noisy machinery with environment friendly machinery and equipments, putting sound-reducing barriers, or using hearing protection devices.





Q.13 Define acoustics protection. Explain importance of acoustic protection.

Acoustics Protection.

"The technique or method used to absorb undesirable sounds by soft and porous surfaces is called acoustic protection."

Importance of Acoustic:

Reflection of sound is more prominent if the surface is rigid and smooth,, and less if the surface is soft and irregular. Soft porous materials, such as draperies and rugs absorb large amount of sound energy and thus quiet echoes and softening noises. Thus by using such materials in noisy places. We can reduce the level of noise pollution. However, if the surface of classrooms to public halls are too absorbent, the sound level may be low for the audience.

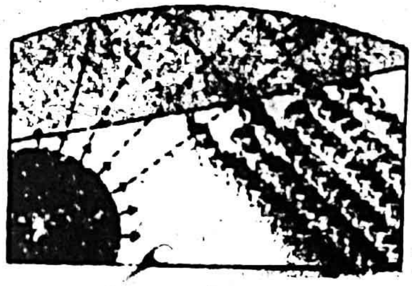
Reverberation:

When sound reflects from the wall, ceiling and floor of a room, the reflecting surfaces are too reflective and the sound becomes garbled. This is due to multiple reflections called reverberations.

In the design of lecture halls, auditorium or theatre halls, a balance must be achieved between reverberation and absorption. It is often advantageous to place reflective surfaces behind the stage to direct sound to the audience.

Curved ceiling of lecture halls:

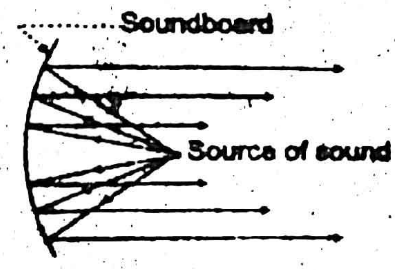
Generally the ceilings of lecture halls, conference halls and theatre halls are curved so that sound after reflection may reach all the corners of the hall (Fig a).



Curved ceiling of conference halls

Curved Sound Board:

Sometimes curved sound boards are place behind the stage so that sound after reflection distributed every across the hall (Fig. b)



Sound board used in big hall

11.6 Audible Frequency Range:

Q.14 What do you know about audible frequency range?

Audible Frequency Range:

"The range of the frequencies which a human ear can hear is called the audible frequency range."

Explanation:

We know that sound is produced by a vibrating body. A normal human ear can hear a sound only if its frequency lies between 20Hz and 20, 000 Hz, in other words, a human ear neither hears a sound of frequency less than 20Hz nor a sound of frequency more than 20,000 Hz. Different people have different range of audibility. It also decreases with age. Young children can hear sound of 20,000 Hz but old people

Cannot hear sounds even above 15,000Hz.

11.7 Ultrasound:

Q.15 What are ultrasonic? And write some of the uses of ultrasonic?

Ans:- Ultrasound:

Sound of frequency higher than 20,000 Hz which are inaudible to normal human ear are called ultrasound or ultrasonic.

Why do we use ultrasonic in medical and technical field?

It has been seen that ultrasonic waves carry more energy that audible sound waves. Moreover, according to the relation $v = f\lambda$, the wavelength of ultrasonic waves is very small. Due to these characteristics they are usefully utilized in medical and technical fields. Some of the uses of ultrasonic are given as under:

A. Uses In Medical Field

For treatment of different diseases

Ultrasonic waves are being used to diagnose and treat different ailments. For diagnosis of different diseases ultrasonic waves are made to enter the human body. These waves are reflected differently by different organs, tissues, benign or malignant tumors. The reflected ultrasonic waves are then amplified and fed to a monitor which form an image of internal organs of the body which helps to detect the defects of these organs.

For diagnose purposes

Ultrasound can also be used to get the pictures of thyroid gland for diagnosis purposes.

Removal of Blood clots

Powerful ultrasonic are now being used to remove blood clots formed in the arteries.

Removal of Dirt from teeth

Ultrasonic waves are used for the scaling of teeth as their vibrations are so intense they remove easily the dirt and plaque sticking to the teeth.

Killing of Bacteria

Germs and bacteria in the liquids can be destroyed by using high intensity ultrasonics.

Removal of Kidney Stone

The kidney stones can be crushed and removed out through urine with the help of ultrasonics waves without any surgery

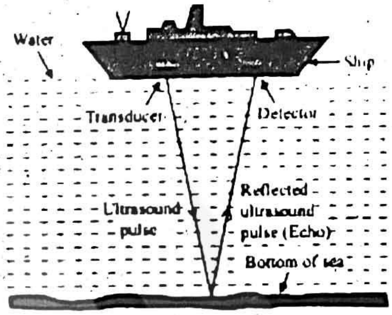
B. Use in Technical Fields

Searching of Oil and Gas

The source of oil and gas inside earth are searched by using ultrasonics.

Finding the Depth of water

Ultrasound is used to locate underwater depths or is used for locating objects lying deep on the ocean floor, etc. The technique is called SONAR, (sound navigation and ranging),. The sound waves are sent form a transmitter, and a receiver collects the reflected sound (Fig. 1 a). The time lapse is calculated, knowing the speed of sound in water, the distance of the object form the ocean surface can be estimated



Ultrasonic are used to measure depth of water by echo method (fig 1.a)

SONAR (sound navigation and ranging)

SONAR ranging is also used to see the shape and the size of the object.

Detection of Cracks

Cracks appear in the interior of moving parts of high speed heavy machines such as turbines, engines of ships and airplanes due to excessive use. These cracks are not visible form outside but they can be very dangerous. Such cracks can be detected by ultrasonic. A powerful beam of ultrasound is made to pass through these defective parts. While passing. These waves are reflected by the surface of these cracks and flaws. The comparison of the ultrasonic waves reflected form cracks and form the surfaces of these parts can give a clue of the existence of the cracks.

NUMERICAL PROBLEMS

11.1 A normal conversation sound intensities of about 3.0 x 10^{-6} Wm^{-2}. What is the decibel level for this intensity? What is the intensity of the sound for 100 dB?

(a) **Given Data**

Intensity of sound = $I = 3.0\times10^{-6} wm^{-2}$

Intensity of faintest sound = $I_o = 10^{-12} wm^{-2}$

Required

Intensity level = $L - L_o = ?$

Solution

As we know that

$$L - L_o = 10 \log \frac{I}{I_o} dB$$

$$= 10 \log \frac{3\times10^{-6}\ \cancel{wm^{-2}}}{10^{-12}\ \cancel{wm^{-2}}} dB$$

$$L - L_o = 10\log\left(\frac{3\times10^{-6}}{10^{-12}}\right)$$

$$= 10\log\left(3\times10^{-6+12}\right) dB$$

$$= 10\log\left(3\times10^{6}\right) dB$$

$$= 10\times6.47 dB$$

$$= 64.7 \text{ dB}$$

(b) **Given Data**

Intensity level $L - L_o = 100$ dB

Intensity of faintest audible sound = $I_o = 10^{-12} wm^{-2}$

Required

Intensity of given sound = $I = ?$

Solution

We know that

$$L - L_o = 10 \log \frac{I}{I_o} \, dB$$

$$100 \cancel{dB} = 10 \log \frac{I}{10^{-12} \, wm^{-2}} \cancel{dB}$$

$$\Rightarrow \quad \frac{100}{10} = \log \frac{I}{10^{-12} \, wm^{-2}}$$

$$10 = \log \frac{I}{10^{-12}}$$

$$10 = \log 10^{12} \times I$$

Taking antilog on both sides

$$\text{Antilog } 10 = \text{Antilog } \left[\log\left(10^{12} \times I\right)\right]$$

$$1 \times 10^{10} = 10^{12} I$$

$$\frac{1 \times 10^{10}}{10^{12}} = I$$

$$I = 1 \times 10^{-2}$$

$$I = 0.01 Wm^{-2}$$

11.2 If at Anarkali bazaar Lahore, the sound level is 80 dB, what will be the intensity level of sound there?

Given Data

Sound level = $L - L_o = 80$ dB

Intensity of faintest audible sound = $I_o = 10^{-12} wm^{-2}$

Required Intensity of sound = I = ?

Solution We know that

$$L - L_o = 10 \log \frac{I}{I_o} \, dB$$

$$80 \cancel{dB} = 10 \log \frac{I}{10^{-12} \, wm^{-2}} \cancel{dB}$$

$$\frac{80}{10} = \log \frac{I}{10^{-12} \, wm^{-2}}$$

$$8 = \log\left(10^{12} \times I\right)$$

Taking antilog on both sides

$$\text{Antilog } 8 = \text{Antilog } \left[\log\left(10^{12} \times I\right)\right]$$

$$10^{8} = 10^{12} \times I$$

$$\frac{10^{8}}{10^{12}} = I$$

$$I = 10^{8-12}$$

$$I = 10^{-4} Wm^{-2}$$

11.3 At a particular temperature, the speed of sound in air is $330ms^{-1}$. If the wavelength of a note is 5cm, calculate the frequency of the sound wave. Is this frequency lies in the audible range of the human ear?

Given Data

Speed of sound = $v = 330\ ms^{-1}$

Wavelength = λ = 5cm

$$= \frac{5}{100}m = 0.05m$$

Required

Frequency = f = ?

Solution

We know that

$$v = f\lambda$$

$$\Rightarrow \quad f = \frac{v}{\lambda}$$

$$= \frac{330\,ms^{-1}}{0.05\,m}$$

$$= 6600s^{-1} \qquad s^{-1} = Hz$$

$$f = 6.6\times10^{3}\ Hz$$

$\because$ yes this frequency lies in the range of human ear.

11.4 **A doctor counts 72 heartbeats in 1 min. Calculate the frequency and period of the heartbeats.**

Given Data

No of heartbeats = n = 72

Time = t = 1 min

= 1 × 60sec = 60sec

Required

Frequency = f = ?

Time period = T = ?

Solution

We know that

$$f = \frac{n}{t}$$

$$= \frac{72}{60\,sec}$$

$$= 1.2\ s^{-1} \qquad s^{-1} = Hz$$

$$= 1.2\ Hz$$

As

$$T = \frac{1}{f}$$

$$= \frac{1}{1.2\,s^{-1}}$$

$$T = 0.833\ sec.$$

11.5 A marine survey ship sends a sound wave straight to the sea bed. It receives an echo 1.5s later. The speed of sound in a sea water is 1500 ms^{-1}. Find the depth of the sea at this position.

Given Data:

Time taken = t = 1.5 s

Speed = v = 1500ms^{-1}

Required:

Depth of sea water = h =

Solution:

As we know that

S = vt

= (1500) (1.5)

= 2250m

For hearing echo, the minimum depth from sea bed to ship must be half of this depth (2250m)

$$h = \frac{S}{2}$$

$$= \frac{2250}{2}$$

$$= h = 1125m$$

11.6 A student clapped his hands near a cliff and heard the echo after 5s. What is the distance of the cliff from the student if the speed of the sound, v is taken as 346 ms^{-1}?

Given data:

Time taken = t = 5s

Speed = v = 346 ms^{-1}

Required:

Distance = d = ?

Solution:

As we know that

S = vt

= 346 x 5

S = 1730 m

For hearing echo, the minimum distance from obstacle to the source of sound must be half of this distance (1730m).

$$d = \frac{S}{2}$$

$$d = \frac{1730}{2}$$

d = 865 m

11.7 A ship sends out ultrasound that returns from the seabed and is detected afte 3.42s. If the speed of ultrasound through seawater is 1531 ms^{-1}, what is the distance of the seabed from ship?

Given data:

Time taken = t = 3.42S

Speed = v = 1531 ms^{-1}

Required:

Depth of sea water = h = ?

Solution:

As we know that

S = vt

= 1531 x 3.42

= 5236.02 m

For hearing echo, the minimum depth from sea ship must be half of this distance (5236.02m)

$$h = \frac{S}{2}$$

$$= \frac{5236.02}{2}$$

$$h = 2618m$$

11.8 The highest frequency sound humans can hear is about 20,000 Hz. What is the wavelength of sound in air at this frequency at temperature of 20°C? What is the wavelength of the lowest sounds we can hear of about 20 Hz? Assume the speed of sound in air at 20°'C is 343 ms^{-1}.

Given Data

Highest frequency = f_1 = 20,000 Hz

Lowest frequency = f_2 = 20 Hz

Speed of sound = v = 343 ms^{-1}

Required

Wavelength of highest frequency = λ_1 = ?

Wavelength of lowest frequency = λ_2 = ?

Solution:

We know that $v_1 = f_1\lambda_1$

$$\Rightarrow \lambda_1 = \frac{v}{f_2}$$

$$= \frac{343\,ms^{-1}}{20,000\,s^{-1}}$$

$$\lambda_1 = 0.01715 \text{ m} = 1.7 \times 10^{-2} \text{ m}$$

As

$$V = f_2 \lambda_2$$

$$\Rightarrow \quad \lambda_2 = \frac{v}{f_2}$$

$$= \frac{343\,ms^{-1}}{20\,s^{-1}}$$

$$= 17.15 \text{ m}$$

$$\boldsymbol{\lambda_2 = 17.15 \text{ m}}$$

11.9 A sound wave has frequency of 2 kHz and wavelength 35cm. How long will it take to travel 1.5 km?

Given Data:

Frequency = f = 2 KHz

$= 2 \times 10^3$ Hz

Wavelength = λ = 35 cm = $\frac{35}{100}$ m = 0.35m

Distance = s = 1.5 Km = 1.5 × 1000m = 1500 Km

Required:

Time = t = ?

Solution:

We know that

$$V = f\lambda$$

$$= 2 \times 10^3 \text{ Hz} \times 0.35 \text{ m} \qquad \text{Hz} = s^{-1}$$

$$= 700 \text{ ms}^{-1}$$

As

$$S = v \times t$$

$$1500 \text{ m} = 700 \text{ ms}^{-1} \times t$$

$$t = \frac{1500\,m}{700\,ms^{-1}}$$

$$= 2.1 \text{ sec}$$

REVIEW QUESTIONS

12.1 What do you understand by reflection of light? Draw a diagram to illustrate reflection at a plane surface.

Ans. See Question No. 1

12.2 Describe the following terms used in reflection (i) Normal (ii) Angle of incidence Angle of reflection

Ans. **Normal:** The perpendicular to a reflecting or refracting surface at the point of incidence of the ray concerned is called normal

Angle of incidence:

The angle between the incident ray and the normal is called angle of incidence.

Angle of reflection

The angle between the normal and the reflected fray is called angle of reflection.

12.3 State laws of reflection. Describe how they can e verified graphically.

Ans. See Question No. 1

12.4 Define refection of light. Describe he passage of light through parallel-sided transparent material.,

Ans. See Question No. 4

12.5 Define the following terms used in refraction : (i) Angle of incident (ii) Angle of refraction

Ans. **Angle of incidence:**

The angle made by the incident ray with the normal is called angle of incidence.

Angle of refraction:

The angle made by the refracted ray with the normal is called angle of refraction.

12.6 What is meant by refractive index of a material? How would you determine the refractive index of a rectangular glass slab?

Ans. **Refractive index:**

The refractive index of a medium is the ratio of the speed of light in a vacuum to the speed of light in the medium.

$$\text{Refractive index} = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$$

If refractive index is denoted by n, speed of light in a vacuum by c and speed of light in the medium by v, then.

$$n = \frac{c}{v} \quad \ldots\ldots\ldots\ldots(12.2)$$

12.7 State the laws of refraction of light and show how they may be verified using rectangular glass slab and pins.

Ans. **Laws of refraction of light:**

(i) The incident ray, the refracted ray, and the normal at the point of incidence all lie in the same plane.

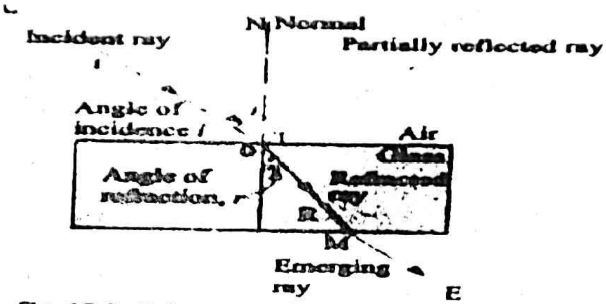


Fig. 12.9: Refraction of light by a glass block

(ii) The ratio of the sine of the angle of incidence I to the sin of the angle of refraction r is always equal to a constant.

i.e $\frac{\sin i}{\sin r}$ = constant

Where the ratio sin i/sin r is known as the refractive index of the second medium with respect to the first medium. So, we have

$$\frac{\sin i}{\sin r} = n = \frac{n_2}{n_1}$$

It is called Snell's law:

12.8 What is meant by the term total interval reflection?

Ans. See Question No. 5

12.9 State the conditions for total internal reflection.

Ans. See Question No. 5

12.10 What is critical angle Derive a relationship between the critical angle and the refractive index of a substance?

Ans. See Question No. 5

12.11 What are optical fibres? Describe how total internal reflection is used in light propagating trough optical fibres.

Ans. See Question No. 11

12.12 Define the following terms applied to a lens:

Ans. See Question No. 7

12.13 What is meant by the principal focus of a (a) convex lens (b) a concave lens illustrate you answer with ray diagram.

Ans. See Question No. 7

12.14 Describe how light is refracted through convex lens.

Ans. See Question No. 7

12.15 With the help of a ray diagram, how you can show the use of thin converging lens as a magnifying glass.

Ans. See Question No. 8.

12.16 A coin is placed at a focal point of a converging lens. Is an image formed? What is its nature?

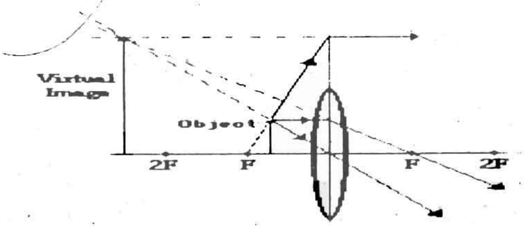
Ans. When a coin is placed at the focal point of the principal focus, no mage is formed because the refracted rays are parallel and never meet.

12.17 What are differences between real and virtual images?

Real Image	Virtual Image
1. It is formed by concave mirror only.	It can be formed by convex as well as concave mirror.
2. It is always inverted expiation.	It is always erect sun snpall.
3. It is formed at real principal focus (F) of a real object i.e light rays actually p ass the angle F.	It is formed at virtual principal focus (F) of a virtual object i.e lith rays appear the diverge from F.
4. It has positive sign convention.	It has negative sign convention.
5. It is formed infront of the mirror.	It is formed behind the mirror.
6. Focal length of real image is taken positive.	Focal length of virtual image is taken negative.

12.18 How does a converging lens form a virtual image of a real object? How does a diverging lens can form a real image of a real object?

Ans. When the object is placed between the convex lens and F, the image will be virtual. The ray diagram is shown in the figure given below.



Ray Diagram for Object Located in Front of F

A concave lens cannot form a real image of a real object in the air. If the concave lens is placed in a medium of refractive index greater than that of glass, then it will form real image of a real object.

12.19 Define power of a lens and its units.

Ans. See Question No. 7

12.20 Describe the passage of light through a glass prism and measure the angle of deviation.

Ans. See Question No. 4

12.21 Define the terms resolving power and magnifying power.

Ans. See Question No. 13

12.22 Draw the ray diagrams of (i) Simple microscope (ii) Compound microscope (iii) Refracting telescope

Ans. See Question No. 13 , 14 and 15

12.23 Draw ray diagrams to show the formation of images in the normal human eye.

Ans. See Question No. 16

12.24 What is meant by the terms nearsightedness and farsightedness? How can these defects can be corrected?

Ans. See Question No. 17

CONCEPTUAL QUESTIONS

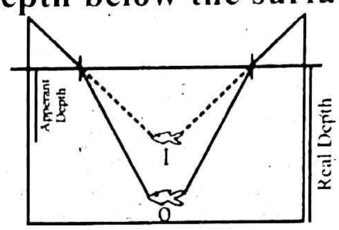
12.1 A man raises his left hand in a plane mirror; the image facing him is raising his right hand. Explain why.

Ans: A man raises his left hand in a plane mirror; the image facing him is raising his right hand. Because light rays are reflected in mirror causing us to see an inverted image.

12.2 In your own words, explain why light waves are refracted at a boundary between two materials.

Ans: Light waves are reflected at a boundary between two material due to change of speed of light while traveling form one medium to another. This change of speed of light at the boundary is caused by the change in the refractive indices of the two materials.

12.3 Explain why a fish under water appears to be at a different depth below the surface than actually is. Does it appear deeper or shallower?



Ans: A fish under water appear to the shallower that it really is, because of apparent depth, as a virtual image is formed at I above O, where image seem to be formed due to refraction of light.

12.4 Why or why not concave mirrors are suitable for make up?

Ans: Concave mirrors are suitable for makeup as they act as magnifier to form large size erect images of objects. When a person stand between principle focus and pole of mirror.

12.5 Why is the driver's side mirror in many cars convex rather than plane or concave?

Ans: Diver's side mirror is convex mirror as it gives an upright, erect although small image, it provider a wider field of view as it is curved outwards.

12.6 When an optician's testing room is small, he uses a mirror to help him test the eye sight of his patients. Explain why?

To increase the distance of alphabets form the patient, the optcianuses palen mirror if his testing room is small.

12.7 How does the thickness of lens affect its focal length?

If the thickness of a lens is increased, the power of the lens is also increased. Hence the focal length of the lens is decreased.

12.8 Under what conditions will a converging lens form a virtual image?

Ans: Converging lens forms a virtual image when object is placed between optical center and its focal point. The image formed will be eract and larger than the object.

12.9 Under what conditions will a converging lens form a real image that is the same size as the object?

Ans: When object is placed at 2F form the converging lens it forms a real and inverted image that has the same size as the object.

12.10 Why do we use refracting telescope with large objective lens of large focal length?

In refracting telescope we use objective lens of larger focal length so as to gather more light form weak distant sources. It not only makes them more visible but also increases the resolving power of the telescope.

SOLVED BOX INFORMATION

Point to ponder (Page 42)

Q.1 In large shopping centres, convex mirrors are used for security purposes. Do you know why?

Ans. In large shopping centres, convex mirrors are used to see hidden areas or places, it helps to avoid any stealing or theft and for better supervision.

Point to ponder (Page 42)

Q.2 why the position of fish inside the water seems to be at less depth than that of its actual positon?

Ans. Position of fish inside the water seems to be at less depth due to refraction of light at the surface or water.

Self assessment (Page 45)

Q.3 Will the bending of the light be more or less for a medium with high refractive index?

Ans. Bending of light is more for a medium with high refractive index.

Self Assessment (Page 55)

Q.4 Where a pen is placed in front of a convex lens if the image is equal to the size of the pen? What will be the power of the lens in dioptres?

Ans. To obtain an image of the pin where its size is equal to the size of the pen, the pen must be placed at 2F from the convex lens.

Quick Quiz (Page 62)

Q.5 how the size of the pupil of our eye will change: (a) in dim light (b) in bright light.

Ans. (a) In dim light, the size of the pupil of our eye increases.

(b) In bright light, the size of the pupil of our eye decrease.

EXERCISE

MULTIPLE CHOICE QUESTIONS

(1) Which of the following quantities is not changed during refraction of light?
(a) Its direction (b) Its speed (c) Its frequency (d) Is wavelength

(2) A converging mirror with a radius of 20cm creates a real image 30 cm from the mirror. What is the object distance?
(a) 5.0cm (b) 7.5cm (c) 15cm (d) 20cm

(3) An object is placed at the centre of curvature of a concave mirror. The imge produced by the mirror is located
(a) Out beyond the centre of the curvature
(b) At the centre of curvature
(c) Between the centre of curvature and the focal point
(d) At the focal point

(4) An object 14cm in front of a convex mirror. The image is 5.8 cm behind the mirror. What is the focal length of the mirror?
(a) 4.1cm (b) 8.2cm (c) 9.9cm (d) 20cm

(5) The index of refraction depends on
(a) The focal length (b) The speed of light (c) The image distance (d) The object distance

(6) Which type of image is formed by a concave lens on a screen?
(a) Inverted and real (b) Inverted and virtual (c) Upright and real (d) Upright and virtual

(7) Which type of image is produced by the converging lens of human eye if it views a distant object?
(a) Real, erect, same size (b) Real, inverted, diminished
(c) Virtual, erect, diminished (d) Virtual, inverted, magnified

(8) Image formed on a camera is
(a) Real, invited, and diminished (b) Real, inverted, diminished
(c) Virtual, erect, diminished (d) Virtual, inverted, magnified

(9) If a ray of light in glass is incident on a n air surface at an angle greater than the critical angel, the ray will
(a) Refract only (b) Reflect only
(c) Partially refract and partially reflect (d) Diffract only

(10) The critical angle for a beam of light passing form water into air is 48.8 digress. This means that all light rays with an angle of incidence greater than this angle will be
(a) Absorbed
(b) Totally reflected
(c) Partially reflected and partially transmitted
(d) Totally transmitted

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
c	b	b	c	b	d	b	a	b	b

CHAPTER 12

GEOMETRICAL OPTICS

CONCEPT MAP

LIGHT

Light rays and reflection

Two laws of reflection:

The incident ray, reflected ray and the normal at the point of incidence all lie in the same plane

(ii) $i = r$

Characteristics of an image formed by a plane mirror:

- Same size as object
- Inverted front-to-back
- Upright
- Virtual
- As far behind the mirror as the object is in front of the mirror

Some applications of plane mirrors:

- Optical testing
- Periscope
- Blind corner
- Instrument scales

Ray diagrams

Refractive index n

is defined as

$n = \frac{\sin i}{\sin r}$ where i is the angle of incidence in air

For the special case of the refracted ray in air:

$\sin c = \frac{1}{n}$

Where c is the critical angle

Total internal reflection occurs when:

- A ray of light travels from an optically denser to a less dense medium
- The angle of incidence in the optically denser medium is greater than the critical angle c

some applications of total internal reflection:

- Prisms in binoculars and periscopes
- optical fibres in telecommunications and the medical industry

Light rays and refraction

Two laws of refraction:

The incident ray, refracted ray and the normal all lie in the same plane.

Snell's Law: $\frac{\sin i}{\sin r}$=constant

Two laws of refraction:

The incident ray, refracted ray and the normal all lie in the same plane.

Snell's Law: $\frac{\sin i}{\sin r}$=constant

Real and inverted

- Real images are formed when object distance is $p < f$
- Virtual and upright images are formed when $p \leq f$

Some applications of thin converging lenses

- Magnifying glass
- projector
- Camera
- Visual correction for long-sightedness

TOPICAL MULTIPLE CHOICE QUESTIONS

12.1 Reflection:

(1) **Plank suggested that light consists of small packets of energy called:**
(a) Electrons (b) Neutrons (c) Photons (d) Positrons

(2) **The angle between incident ray and normal N is;**
(a) Angle of reflection (b) Angle of incidence (c) Angle of refraction (d) Normal angle

(3) **Angle of incidence is represented by**
(a) i (b) e (c) R (d) p

(4) **The angle between the normal and the reflected ray is called angle of**
(a) Reflection (b) Refraction (c) Incidence (d) Diffraction

(5) **The incident ray, the normal, and the reflected ray at the point of incidence all lie in the**
(a) Opposite direction (b) Same plane (c) x and y axis (d) y & z - axis

(6) **According to law of reflection**
(a) $i > r$ (b) $i < r$ (c) $r > i$ (d) $i = r$

(7) **Regular reflection is reflection by the**
(a) Rough surface (b) Smooth surface
(c) Irregular surface (d) Smooth and rough surfaces

(8) **The rough surfaces of object reflect the rays of light in many directions is called**
(a) Regular reflection (b) Irregular reflection (c) Refraction (d) Interference

12.2 Spherical Mirrors

(9) **In concave mirror the surface is reflecting;**
(a) Outer surface (b) Outer curved (c) Inner curved surface (d) Side of the mirror

(10) **Which statement is incorrect about concave mirror?**
(a) Size of image depends upon position of the object
(b) Both virtual and real images can form
(c) Inner surface of spherical mirror is reflecting
(d) Only virtual images are formed

(11) **A spherical mirror whose outer curved surface is reflecting is called**
(a) concave mirror (b) convex mirror (c) Concave lens (d) Convex lens

(12) **Which statement is correct about convex mirror?**
(a) Size of image is smaller than object (b) Only virtual erect image is formed
(c) Outer curved surface is reflecting (d) All of the given statements are true

(13) **Vertex is the midpoint of the curved surface of spherical mirror is also called**
(a) Radius of curvature (b) Principal axis
(c) Pole (d) Principal focus

(14) **A line joining centre of curvature and pole of the spherical mirror is**
(a) Principal axis (b) principal focus (c) Centre of curvature (d) Pole

(15) **The distance from the pole to the principal focus measured along the principal axis is**
(a) Principal focus (b) Radius of curvature (c) Focal length (d) Diameter

12.3 Image location by spherical mirror formula
12.4 Refraction of light

(16) **The relationship between object distance p, image distance q from the mirror and focal length of the mirror is called;**

(a) Mirror focal length (b) Distance from mirror
(c) Mirror formula (d) Lens formula

(17) **Mirror formula is**

(a) $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$ (b) $\frac{1}{f}=\frac{1}{p}-\frac{1}{q}$ (c) $\frac{1}{f}=\frac{1}{p}-\frac{q}{p}$ (d) $\frac{1}{f}=\frac{1}{q}+\frac{p}{q}$

(18) **Focal length of spherical mirror is**

(a) $\frac{R}{4}$ (b) $\frac{R}{2}$ (c) $\frac{R}{3}$ (d) $\frac{R}{9}$

(19) **Convex mirror produce images**

(a) Larger than object (b) Smaller than object (c) Equal to object (d) Very large in size

(20) **The bending of light as it passes from one transparent medium into another is**

(a) Reflection (b) Refraction (c) Reverberation (d) Incidence

(21) **According to law of refraction**

(a) $\frac{\sin i}{\sin r}>i$ (b) $\frac{\sin r}{\sin i}>r$ (c) $\frac{\sin i}{\sin r}=constant$ (d) $\frac{\sin r}{\sin i}>n$

(22) $\frac{\sin i}{\sin r}=n=\frac{n_2}{n_1}$ **is called**

(a) Boyl's-law (b) Charless's law (c) Snell's law (d) Newton's law

(23) **Speed of light in air is approximately**

(a) $3.0\times10^{8}\ ms^{-1}$ (b) $4\times10^{9}\ ms^{-1}$ (c) $4\times10^{14}\ ms^{-1}$ (d) $3\times10^{7}\ ms^{-1}$

(24) **The speed of light is greater in**

(a) Air (b) Water (c) Solid (d) Glass

(25) **The speed of light in water is approximately**

(a) $2.0\times10^{8}\ ms^{-1}$ (b) $2.3\times10^{8}\ ms^{-1}$ (c) $3\times10^{8}\ ms^{-1}$ (d) $3\times10^{7}\ ms^{-1}$

(26) $? = \frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$

(a) Reflective index (b) Snell's law (c) Refractive index (d) Critical angle

12.5 Total internal reflection
12.6 Refraction through prism
12.7 Lenses

(27) **When a ray of light enters from a denser medium to a rarer medium**

(a) It bends toward the normal (b) It bends away from the normal
(c) It bends towards inside (d) None of these

(28) **The angle of incidence that causes the refracted ray in the rarer medium to bend through 90° is called**

(a) Critical angle (b) Angle of incidence (c) Angle of reflection (d) Angle of refraction

(29) **No refraction occurs when the angle of incidence is**

(a) Smaller than the critical angle (b) Larger than the critical angle
(c) Equal to the critical angle (d) Very small than the critical angle

(30) **The line passing through the two centres of curvatures of the lens is called**
(a) Principal focus (b) Optical centre (c) Principal axis (d) Focal length

(31) **Optical centre is represented by**
(a) A (b) f (c) F (d) C

(32) **For a concave lens, the parallel rays appear to come from a point behind the lens is called;**
(a) Principal focus (b) Principal axis (c) Focal length (d) Optical length

(33) **The distance between the optical centre and the principal focus is.**
(a) Principal focus (b) Principal axis (c) Focal length (d) Optical length

(34) **It is a transparent body (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted;**
(a) prism (b) camera (c) lens (d) mirror

(35) **In lens number of curved surfaces at least;**
(a) two (b) three (c) one (d) four

(36) **Lenses are used in optical devices;**
(a) camera (b) eyeglasses (c) microscope (d) all given

(37) **The lens which causes incident parallel rays to converge at a point is;**
(a) convex lens (b) converging lens (c) both a & b (d) concave lens

(38) **Lens thick at the centre but thin at the edges is;**
(a) concave (b) convex (c) diverging (d) plane

(39) **SI unit of power of lens is:**
(a) meter (b) dioptre (c) centimeter (d) millimeter

(40) **1D = ?**
(a) $1m^{-1}$ (b) m^{-2} (c) m^{-3} (d) cm^{-1}

(41) **It has positive focal length;**
(a) simple lens (b) concave lens (c) convex lens (d) none of above

12.8 Refraction through lenses
12.9 Image Location by lens equation

(42) **In mirrors images are formed through reflection, but lenses form images through;**
(a) refraction (b) incidence (c) diffraction (d) reflection

(43) **In case of convex lens when object is placed beyond 2F,the image is formed;**
(a) between F and 2F (b) real, inverted (c) smaller than object(d) all of these

(44) **The image with convex lens is formed at 2F, real , inverted, the same size as the object when the object is placed at:**
(a) 2F (b) between F and 2F (c) F (d) C

(45) **When object is at F the image is;**
(a) inverted (b) real (c) small (d) not formed

(46) **Lens formula is**
(a) $\frac{1}{p}=\frac{1}{f}+\frac{1}{q}$ (b) $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$ (c) $\frac{1}{f}=\frac{q}{p}+\frac{1}{q}$ (d) $\frac{1}{f}=\frac{1}{p}-\frac{1}{q}$

(47) **For a converging lens f is;**
(a) negative (b) positive
(c) some time negative and some time positive(d) smaller

(48) **The study of behaviour of light is called;**
(a) optics (b) geometry (c) plasma (d) geometrical optics

(49) **If the object is on the right side of the lens then p is;**
(a) positive (b) negative (c) smaller (d) larger

(50) **Optical device is;**
(a) camera (b) slide projector (c) photograph enlarger (d) all of given

(51) **Which statement is correct about image formed by camera?**
(a) Real image is formed (b) Inverted image is formed
(c) Diminished image is formed (d) All options are true

(52) **In case of photograph enlarger the object is placed at distance;**
(a) more than F (b) less than 2F (c) both A and B (d) more than 3F

(53) **The working principle of photograph enlarger is the same as;**
(a) Slide projector (b) camera (c) Telescope (d) Endoscope

(54) **Which pipe is a bundle of thousand of optical fibres bounded together?**
(a) light pipe (b) Telescope (c) Microscope (d) Projector

(55) **It is used to explore the interior organs of the body?**
(a) Telescope (b) Endoscope (c) Microscope (d) Projector

(56) **Endoscope used to diagnose the stomach is;**
(a) Cystoscope (b) Gastroscope (c) Bronchoscope (d) Pancreoscope

(57) **Endoscope which is used to diagnose throat is;**
(a) Gastroscope (b) Cystoscope (c) Bronschoscope (d) None of these

12.11 Simple Microscope
12.12 Compound Microscope

(58) **A magnifying glass is a convex lens which is used to produce magnified images of small objects. It is also called;**
(a) Compound microscope (b) Simple microscope
(c) Electron microscope (d) Light microscope

(59) **For seeing tiny objects we use microscope of;**
(a) low resolving power (b) high resolving power
(c) Electron microscope (d) Light microscope

(60) **Which statement is correct about compound microscope?**
(a) Focal length of objective lens is smaller than eyepiece.
(b) Distance between objective lens and eyepiece is greater than $f_0 + f_e$.
(c) It is used to see very small object
(d) All given statements are true

(61) **The magnification of compound microscope is;**
(a) $M = \frac{L}{f_0}\left(1+\frac{d}{f_e}\right)$ (b) $M = \frac{L}{f_0}$ (c) $M = \left(1+\frac{d}{f_e}\right)$ (d) $M = \frac{L}{f_e}\left(1+\frac{d}{f_e}\right)$

12.13 Telescope
12.14 The Human Eye
12.15 Defects of Vision

(62) **It is an optical instrument which is used to observe distant objects using lens or mirror;**
(a) microscope (b) Kaledoscope (c) Telescope (d) Light microscope

(63) **Magnification of telescope can be determined by using formula;**
(a) $M = \frac{f_0}{f_e}$ (b) $M = \frac{f_0}{f_0}$ (c) $M = \frac{F}{L}$ (d) $M = \frac{L_0}{f_0}$

(64) **Human eye acts like;**
(a) Camera (b) Telescope (c) Kaledoscope (d) Microscope

(65) **Light enters the eye through transparent membrane called;**
(a) Retina (b) Cornea (c) Iris (d) Pupil

(66) **The coloured portion of eye controls the amount of light reaching the retina.**
(a) Iris (b) Pupil (c) Cornea (d) eye lens

(67) **The variation of focal length of eye lens is called;**
(a) Variation (b) Accommodation (c) Magnification (d) Resolution

(68) **When people cannot see distant objects clearly without the aid of spectacles the defect of vision is;**
(a) Short-sighted (b) near-sightedness (c) both A & B (d) Farsightedness

(69) **Short sighted may be due to eyeball being**
(a) too long (b) too short (c) too thick (d) too thin

(70) **Have ability to move eye lens forward or backward.**
(a) Fish (b) Human (c) Birds (d) Dog

(71) **The nearsighted eye can be corrected by using;**
(a) diverging lens (b) converging lens (c) both A & B (d) Concave mirror

(72) **The disability of the eye to form distinct images of nearby object on retina is called forsightedness or:**
(a) Short sightedness (b) isometropia (c) hypermetropia (d) Myopia

(73) **Farsightedness is corrected by using;**
(a) Converging lens (b) diverging lens (c) concave mirror (d) convex mirror

(74) **Power of concave lens is:**
(a) Greater (b) Less (c) Positive (d) Negative

(75) **Long sightedness is caused due to ---------- eye ball:**
(a) Thick (b) Thin (c) small (d) Both a & c

(76) **Near point of a normal human being is:**
(a) 25 cm (b) 50 cm (c) 100 cm (d) Infinity

(77) **Long sightedness is removed by:**
(a) Convex mirror (b) Concave mirror (c) Convex lens (d) Concave lens

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q	Ans	Q	Ans	Q.	Ans
1	c	11	b	21	c	31	d	41	c	51	d	61	a	71	a
2	b	12	d	22	c	32	a	42	a	52	c	62	c	72	c
3	a	13	c	23	a	33	c	43	d	53	a	63	a	73	a
4	a	14	a	24	a	34	a	44	a	54	a	64	a	74	d
5	b	15	c	25	b	35	c	45	d	55	b	65	b	75	b
6	d	16	c	26	c	36	d	46	b	56	b	66	a	76	a
7	b	17	a	27	b	37	c	47	b	57	c	67	b	77	c
8	b	18	b	28	a	38	b	48	a	58	b	68	c		
9	c	19	b	29	b	39	b	49	b	59	b	69	a		
10	d	20	b	30	c	40	a	50	d	60	d	70	a		

SHORT QUESTIONS

12.1 Reflection of light

Q.1. What is reflection?

Ans: Reflection of light:

When light traveling in a certain medium falls on the surface of another medium, a part of it turns back in the same medium. This is called reflection of light.

OR

The bouncing back of light in first medium after striking with any reflecting surface.

Q.2. Define regular reflection and irregular reflection ?

Regular Reflection:

The reflection by smooth surface in which all the reflected rays are parallel to each other is called regular reflection.

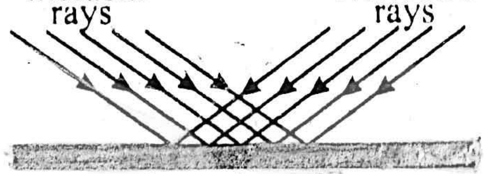


Fig. 12.3 Regular reflection

Irregular Reflection:

The reflection of light rays are not parallel to each other.

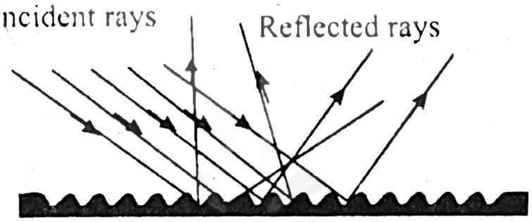


Fig. 12.4: Irregular reflection

Q.3. Write the conditions for regular and irregular reflection.

Ans: Conditions for Regular Reflection:

- The reflecting surface should be plane surface.
- The reflecting surface should be flat.
- The reflected rays of light should be parallel to each other and equal-space.

Conditions for Irregular Reflection:

- The reflecting surface should be rough.
- The reflecting rays of light are not parallel to each other.

Q.4. What are the laws of reflection of Light?

Ans: A ray of light obeys the following laws of reflection:

(i) The angle of incidence is equal to the angle of reflection.

(ii) The incident ray, the reflected ray and normal at the point of incidence, all lie in the same plane.

Q.5. Define the following terms
(i) Incident ray (ii) reflected ray (iii) normal (iv) angle of incidence (v) angle of reflection(vi) ray of light (vii) beam of light.

Ans:

(i) **Incident Ray:**
The ray of light coming form source of light is known as incident ray.

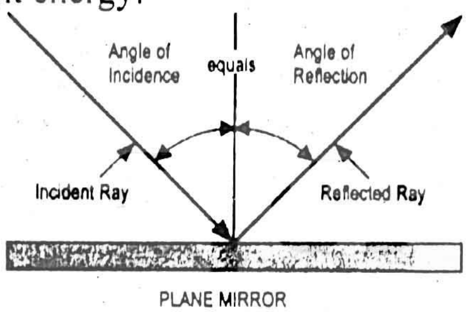
(ii) **Reflected Ray:**
The light ray which is thrown back, when incident ray hit the reflecting surface.

(iii) **Normal:**
A line (imaginary) at the right angle to the plane (surface) is called normal to surface.

(iv) **Angle of incidence:**
The angle between the incident ray and normal

(v) **Ray of light:**
The direction of path taken by light is known as ray of light.

(vi) **Beam of light:**
A beam is a stream of light energy.



12.2 Spherical Mirrors
12.3 Image location by spherical mirror formula

Q.6. What are the spherical mirrors? How light is reflected from spherical mirrors? Give the uses of spherical mirrors?

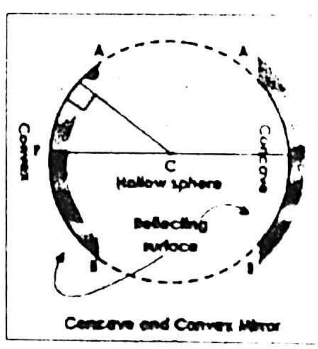
Ans: A spherical mirror, in fact, is a portion of the reflecting surface of a hollow sphere. Spherical mirrors are of two types:

(i) Concave Mirror

(ii) Convex Mirror

(i) **Concave Mirror**

The mirror whose inner curved surface is reflecting is called the concave mirror as shown in figure (a).



Concave and Convex Mirror

(ii) **Convex Mirror**

The mirror whose outer curved surface is reflecting is called the convex mirror as shown in figure (b).

Q.7. Write down Uses of spherical mirrors

Now-a-days spherical mirrors have a large number of scientific and practical uses. A few uses are given below:

1. Doctors use concave mirrors for examination of ear, nose, throat and eyes.
2. Concave mirrors with a parabolic shape are used in searchlight to throw an intense beam of light to a large distance.

3. Some people use a concave mirror for shaving because when a man stands between the principal focus and pole of a concave mirror, he sees an enlarged, erect and virtual image of his face. This is the reason why a concave mirror of large focal length is used for shaving.
4. Concave mirrors are used to throw light on the slides of microscope so that the slides can be viewed more clearly.
5. Now-a-days America and other developed countries use giant concave mirrors in their huge telescopes.
6. Convex mirrors are used in motorcycles and automobiles which enables the driver to see the automobiles coming behind him.
7. In huge shopping centers, convex mirrors are used for security purposes.

Q.8. Define the center of curvature, Radius of curvature, aperture, pole and principal axis.

Ans: **Center of curvature**

The centre of the sphere, of which a concave mirror or convex mirror is a part is known as the "Centre of Curvature" of the spherical mirror. In the figure, the point C is the center of curvature.

Radius of curvature

The radius of the sphere, of which a concave mirror or convex mirror is a part is known as the "Radius of Curvature" of the spherical mirror. In the figure, R is the radius of sphere or radius of curvature.

Aperture

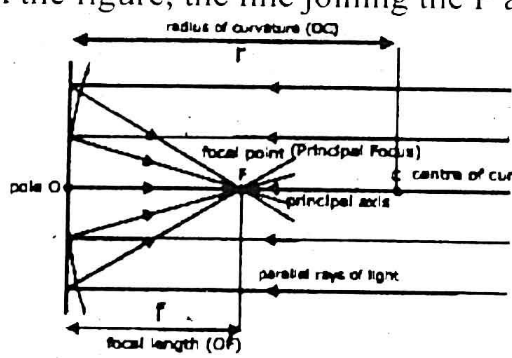
The front section of spherical mirror is circular one and its diameter is known as the "Aperture".

Pole

The centre of the concave or convex mirror is called the pole of the mirror. In the figure P is the pole of the mirror.

Principal Axis

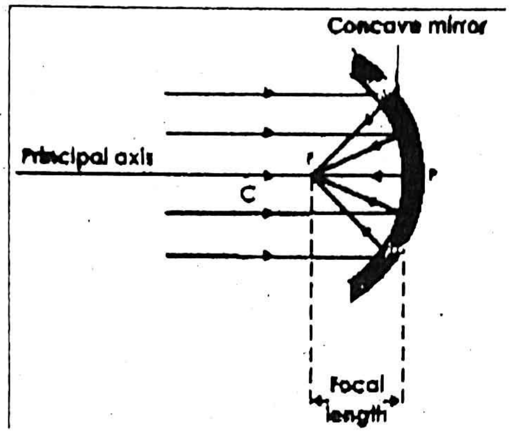
A line joining the pole of the mirror and the centre of curvature is called the "Principal Axis" of the mirror. In the figure, the line joining the P and the C is the principal axis.



Q.9. Define principal focus for concave and convex mirror and why they are called real and virtual focus?

Ans: **Real Focus for Concave mirror**

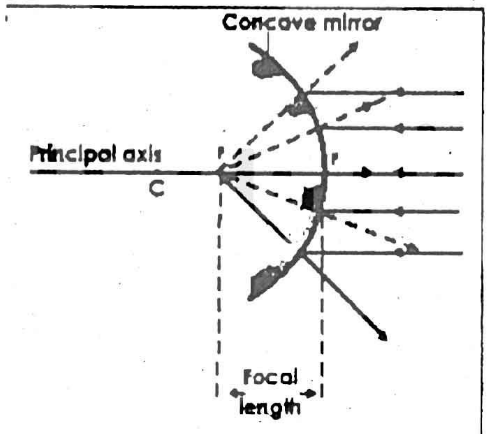
Rays of light parallel to the principal axis after reflection from a concave mirror converge to a point F. This point is called the "Principal Focus" of the mirror. Since rays, in fact, pass through this point, therefore, it is called real focus.



Virtual Focus for Convex mirror

In the case of a convex mirror, rays parallel to the principal axis after reflection appear to come from a point F situated behind the mirror. This point is called the principal focus of the convex mirror.

The principal focus of a convex mirror is virtual focus because the reflected rays do not actually pass through it but appear to do so. Therefore, its focus is called virtual focus.



Q.10. Define focal length and write down its relation with radius of curvature.

Ans: The distance between the pole and the principal focus of a spherical mirror (concave as well as convex) is called the "Focal Length". It is denoted by f.

Relation between Radius of curvature and focal length

The radius of curvature of a spherical mirror is twice of its focal length. i.e; $R = 2f$ or $f = R/2$

Q.11. Define linear magnification.

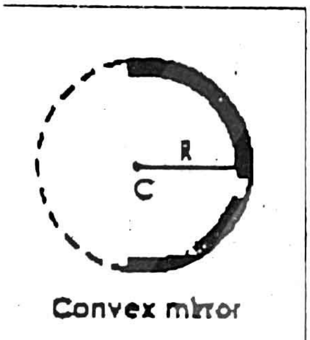
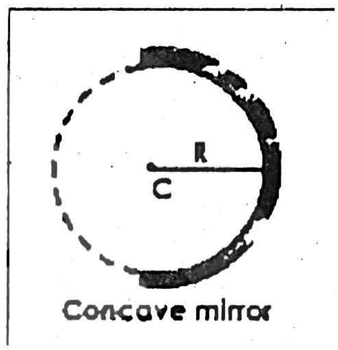
Ans: The ratio of the height of the image to that of the object is called as linear magnification or simply magnification and is denoted by the letter m. Thus

$$m = \frac{\text{Size of Image}}{\text{Size of Object}} = \frac{\text{Image distance}}{\text{Object distance}}$$

$$m = \frac{I}{O} = \frac{q}{p}$$

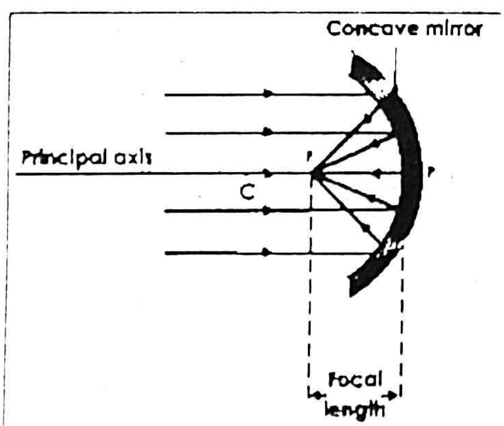
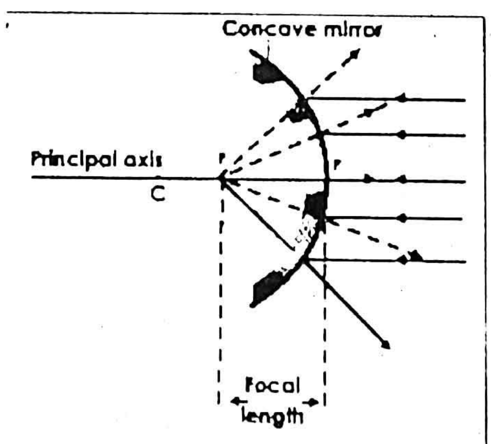
Q.12. Write the characteristics of focus of concave and convex mirror.

Ans: Characteristics of focus of concave and convex mirror:

Convex Mirror	Concave Mirror
• The mirror whose outer curve surface is reflecting is called convex mirror • Focus lie behind the mirror	• The mirror whose inner curve surface is refleacting is called concave mirror • Focus is in-front of the mirror.
• The focus is virtual as the reflected rays appear to come from focus.	• The focus is real as the rays of light after reflection converge at the focus.
• The focus of convex mirror is a diverging point of reflected rays. 	• The focus of concave mirror is a converging point of reflected rays. 

Q.13. Differentiate between real and virtual principal focus.

Ans:

DIFFERENCE BETWEEN REAL AND VIRTUAL FOCUS	
Real Focus	**Virtual Focus**
In concave mirror, the reflected rays actually pass through its principal focus. So it is real focus. 	In convex mirror, the reflected rays do not pass through the focus but appears to do so. So it is virtual focus. 

Q.14. Difference between Real Image and Virtual Image

Real Image	Virtual Image
1. Real image is formed when rays after reflection actually meet at a point.	1. Virtual image is formed when rays do not actually meet but appear to diverge from a point.
2. Real image is inverted and can be seen on a screen.	2. Virtual image is erect and cannot be seen on a screen.
3. It has a physical existence.	3. It does not have a physical existence.

Q.15. Why convex mirror are fixed on blind turns on the roads in hill areas?

Ans: Convex mirrors are fixed on blind turns on the road in hill areas because driver from one side of turn can see the automobiles coming from other side of mountain. So chances of accidents can be minimized.

Q.16. Why concave mirrors are used for examination of nose, ear, throat and eye?

Ans: Concave mirrors are used for examination of nose, ear, throat and eye to view a big and clear image of these organs.

Q.17. Why concave mirror is used for make up or shave?

Ans: Concave mirror is used for make up or shave because when a man/woman stands between the principal focus and pole of the concave mirror, he sees an enlarged image of his/her face. This is the reason why a concave mirror of large focal length is used for shaving and make up.

Q.18. Explain with help of activity whether the image is smaller or large, erect or inverted, real or virtual in a convex mirror.

Ans: Take a convex mirror or a well polished spoon (using out side of the spoon) and hold it in one hand and a pencil in other hand with its tip in upright position. Now look at the image in mirror. The image in convex mirror.

- Appears smaller
- Upright
- Behind the mirror
- Virtual

Now an object moves closer to convex mirror the image in convex mirror.

- Moves closer to the mirror
- Becomes larger
- Upright
- Stays virtual

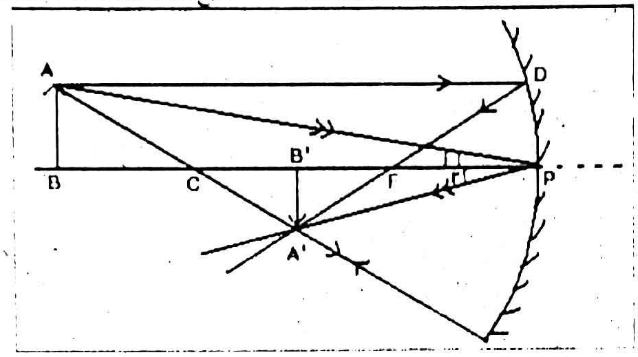
Q.19. How we can locate image by spherical mirrors? How we can tell the nature of image an size of image.

Ans: The location of the image, nature of image and the size of image calculated by he mirror formula which can be written as $\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \rightarrow (1)$

f = focal length of mirror
p = distance between the pole and object
q =distance between mirror and image
The equation can be used for both concave and convex mirrors.

Q.20. **Define mirror formula/mirror equation? Also write signs of convention.**

Ans: Curved mirror formula is the relationship between object distance 'p' image distance 'q' from the mirror and the focal length 'f' of the mirror.



Mathematically it can be written as:

$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}\rightarrow(2)$$

This equation is true for both type concave and convex mirror. But we already seen that the image is formed sometimes in the front of curved mirror and sometimes behind it. This make it necessary to have a signs convection so that we may distinguish between the two cases and obtain the correct answer when substituting in the formula.

Explain showing the use of the two signs conventions in common use are given below.

1. All distances are measured from the pole of mirror.
2. Distances measured against the incident light are negative.
3. Distances measured in the same direction as incident of light are positive.

If the object is placed to the left of the mirror, the ordinary graphical convention of signs comes into operation, i.e., distance measured to the let are negative,; those to the right, positive.

Signs of convection:

The focal length of concave mirror is positive and the negative of convex mirror. Sign of convections are given as following.

Quantity	**When positive (+)**	**when negative (-)**
1. Object distance 'p'	1. Real object	**1. Virtual object**
2. Image distance 'q'	2. Real image	**2. Virtual image**
3. Focal length 'f'	**3. Concave mirror**	**3. Convex mirror**

Q.21. **Explain with the help of activity whether the image is smaller or larger, erect or inverted in a concave mirror.**

Ans: Take a concave mirror or a well polished speed with a concave surface hold it in one hand and pencil in other hand with the tip in upright. The image formed by concave mirror is

- Real image
- Inverted

For all object positions outside the principal focus. But when the object is placed between focus and pole then the image is

- Virtual
- Upright

Q.22. What do you know about mirage?

Ans: In hot summer days, reflection of motor cars is seen on the roads and the image of an aeroplane is seen on runway, infact there is no water on the runway. It is due to total internal reflection and this phenomenon is known as mirage.

12.4 Refraction of light

Q.23. Write down the law of refraction.

Ans: The refraction of light takes place according to the following two laws:

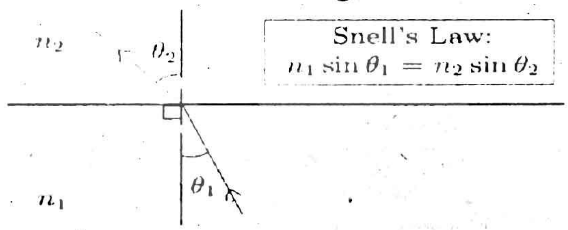
(i) The incident ray, the refracted ray and normal all lie in the same plane.

(ii) When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant.

This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It can be mathematically written as:

$$n = \frac{\sin i}{\sin r}$$

It is called Snell's law. A ray of light entering the second medium perpendicularly through the surface of separation shows no change of direction.



Q.24. What is Snell's law?

Ans: When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant. This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It is called Snell's law.

It can mathematically be written as:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} = n$$

It is called Snell's law. A ray of light entering the second medium perpendicularly through the surface of separation shows no change of direction.

Q.25. What is refractive index? Write down the methods to calculate the refractive index.

Ans: When a ray of light passes from one particular medium to another, the ratio of the sine of the angle of incidence (i) to the sine of angle of refraction (r) is constant. This constant ratio is called the "Refractive Index" of the second medium with respect to the first and it is denoted by the letter 'n'. It can mathematically be written as:

$$n = \frac{\sin i}{\sin r}$$

Second method

The refractive index of a medium can also be calculated by dividing the speed of light in vacuum by the speed of light in that medium. As the speed of light in vacuum is almost equal to the speed of light in air, therefore, we use the speed of light in air instead of vacuum, while calculating the refractive index of a medium.

Refractive index of medium with respect to air = $\dfrac{\textit{Speed of light in air}}{\textit{Speed of light in a medium}}$

$$n = \frac{C}{V}$$

Q.26. The speed of light in glass is 2 x 10^8 ms^{-1} and that in air is approximately 3 x 10^8 ms^{-1}, calculate refractive index of glass.

Ans: Refractive index of glass with respect to air = $\dfrac{\textit{Speed of light in air}}{\textit{Speed of light in glass}}$

$$n = \frac{C}{V}$$

By putting the values, we have

$$n = \frac{3 \times 10^8}{2 \times 10^8}$$

$$= 1.5$$

So refractive index of glass with respect to air is 1.5.

Q.27. Explain when does the light change its path, when pass through two different medium.

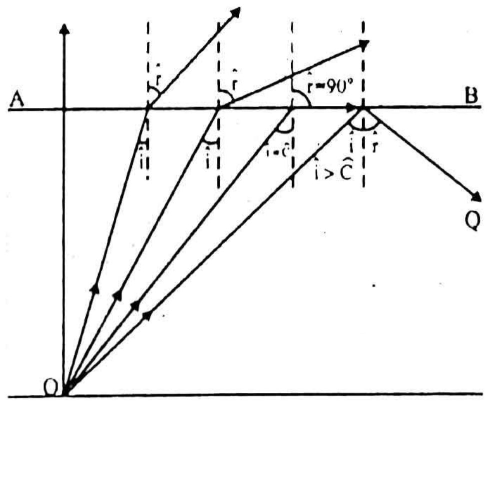
Ans:

1. During refraction light bends towards normal as the light enters from rate to denser medium.
2. During refraction light bends away as light enters from the denser to rare medium.
3. The angel of incidence is greater than angel of refraction. When light enters from rate to denser medium.
4. The angle of incidence is smaller than angle of refraction when light enters from denser to rare medium
5. If the light ray (incident ray) is along the normal (i.e. 90^o) to the interface between the two medium, the ray pass through without deviation.
6. No refraction take place in the same medium.

12.5 Total internal reflection

Q.28. Define total internal reflection. What is meant by critical angle? Explain total internal reflection and conditions necessary for it.

Ans: "When a ray of light from a denser medium enters a rarer medium in such a way that angle of incidence is greater than critical angle, then the ray is reflected totally inside and does not emerge out from the denser medium. This phenomenon is called total internal reflection".



Q.29. What is meant by critical angle

"The angle of incidence in the denser medium for which corresponding angle of refraction is 90° in the rarer medium is called the critical angle. This angle of incidence is denoted by C."

Q.30. Write Conditions for total internal reflection

(i) The ray of light should travel from a denser medium to a rare medium.

(ii) The angle of incidence should be greater than the critical angle

Q.31. What should be angle of incidence for total internal reflection?

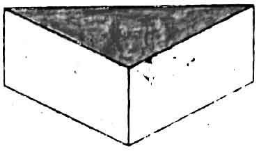
Ans: The angle of incidence for total internal reflection should be greater than the critical angle

12.6 Refraction though prism

12.7 Lenses

Q.32. What is prism ?

Ans: Prism



Prism is a transparent body having three rectangular and two triangular surfaces ~~as shown in Figure (a).~~

Angle of Prism

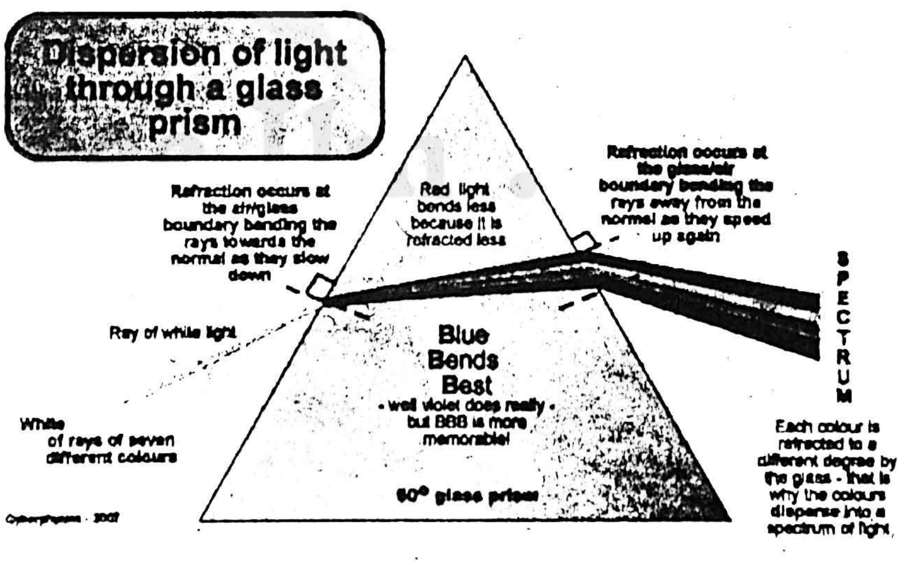
The angle of the triangular surface opposite to its base is known as "Angle of Prism".

Q.33. What is meant by Dispersion of Light

Ans: The refraction of waves depends on their wavelength. Since the sunlight consists of different colors, the waves of different wavelengths, thus when it passes through a prism then the waves of different wavelengths deviate on different paths, due to this white light disperses in different colors, which is called dispersion,

Solar spectrum

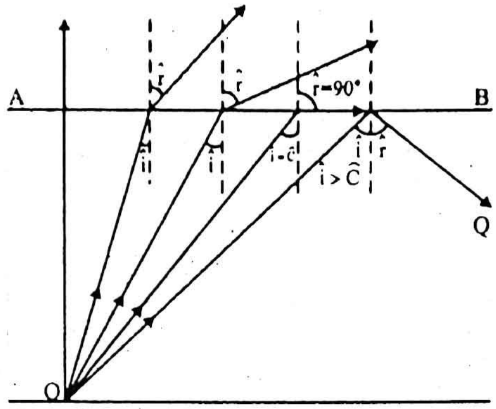
The band of colors which is seen after dispersion of white light on the screen is called solar spectrum.



Q.34. Define critical angle?

Ans: **Critical angle**

Critical angle is the angle of incidences in the denser medium to which the corresponding angle of refraction in the rarer medium is 90°



Q.35. What is totally reflecting prism?

Ans: A totally reflecting prism is that which has one of its angle equal to 90^o and each of the remaining two angles equal to 45^o.

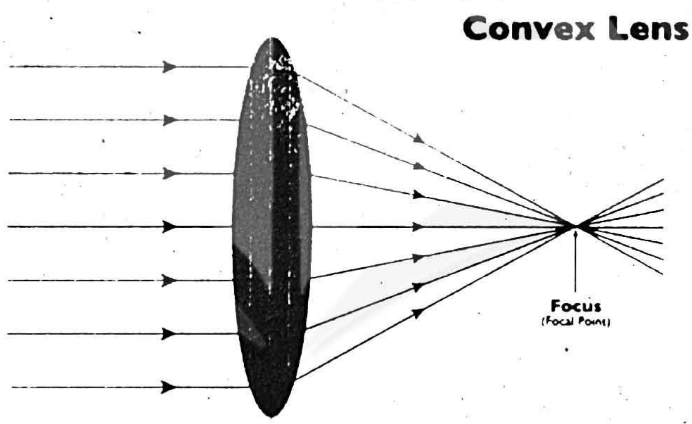
Q.36. What is meant by Angle of Deviation?

Ans: "The angle between the original path of incident ray and path of refracted ray through a prism is known as angle of deviation. "It is represented by 'D'.

Q.37. Define lenses.

Ans: "A transparent body having two surfaces of which at least one is curved. **OR**

Lens is piece of transparent medium bounded by two surfaces at least one of which is curved".



Q.38. How many types of lenses? Describe briefly.

Ans: Lenses are classified into two categories.

1. **Convex or Converging Lens:**

The lens which converge the all parallel incident rays after refraction is called convex or converging lens. **OR**

The lens which is thicker at middle and thinner at the edges.

Concave or Diverging Lens:

"The lens which diverge the light at point from all incident parallel rays. **OR**

The lenses which are thinner in middle than at the edges."

Type of Curved Lenses

No	Convex Lens	Shape	Concave Lens	Shape
1	Double convex OR bi convex		**Double Concave OR Bi-concave**	
2	Plano – Convex		**Plano Concave**	
3	Concavo – convex OR Convex meniscus		Convexo – concave OR Concave meniscus	

Q.39. What are the sign conventions adopted in case of Lenses?

Ans: The following sign conventions are adopted in case of lenses.

(i) All the distances are measured from the optical centre of the lens.

(ii) The distance of the real objects and real images are taken as positive and those of virtual objects and virtual images are taken as negative.

(iii) The focal length is taken as positive for convex lens and negative for concave lens.

Q.40. Define power and its unit.

"If the focal length of a lens is f then its reciprocal $\left(\frac{1}{f}\right)$ is called the power of the lens.

Dioptre

The unit of power "Dioptre" is defined as the power of a lens of focal length of one meter. Its symbol is 'D'.

Positive Power

Because the focal length of a convex lens is positive (+f) therefore the power of a lens is also positive.

Negative Power

Whereas the focal length of a concave lens is negative therefore the power of a concave lens is negative.

Opticians and eye specialist refer to the power of a lens instead of its focal length for their patients.

Q.41. Which lens has greater power, the lens of less focal length or of greater focal length?

Ans: The power of a lens is given by the formula: $p = 1/f$

Where 'f' is the focal length in meters. Hence for a lens of large power, the focal length will be small.

12.8 Refraction though Lenses
12.9 Image location by lens Equation

Q.42. To get a greater and clear image at what distance lens should be placed from the object?

Ans:- To get a greater and clear image, the object should be placed within the principal focus from the lens so that a clear, enlarged and erected image is obtained.

Q.43. How image formation from convex lens can be explained?

Ans. Image formation in convex lens can be explained with three rays.

(i) The ray parallel to the principal axis passes through the focal point after refraction by the lens

(ii) The ray passing through the optical centre passes straight through the lens and passes undeviated.

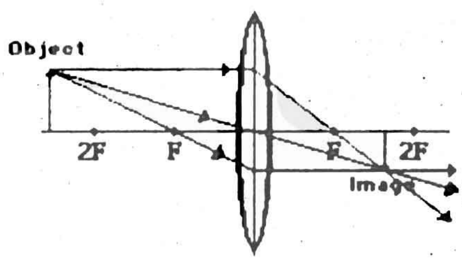
(iii) The ray passing through the focal point becomes parallel to the principal axis after refraction by the lens.

Q.44. When object is beyond 2F form converging lens, which type of image is formed?

Ans. When object is beyond 2F form converging lens, the image is between F and 2F, real, inverted, smaller than the object.

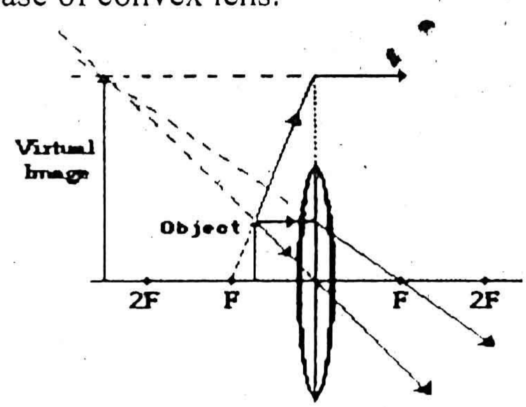
Q.45. When object is present at 2F which type of image is formed in case of convex lens?

Ans. The image is at 2F real inverted and of the same size as the object in case of convex lens.



Q.46. When object is present between lens and f then what is nature of image formed by convex lens?

Ans. When object is between lens and F the image is formed behind the object, virtual, erect and larger than the object in case of convex lens.



Ray Diagram for Object Located in Front of F

Q.47. What is meant by lens formula?

Ans. The relation between the object and image distance form the lens in term of the focal length of the lens is called lens formula and is given by: $\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$

12.10 Applications of Lenses

Q.48. What do you know about periscope?

Ans: Periscope is a long tube at the two ends of which are adjusted two totally reflecting prisms. The rays of light from an object are totally reflected through an angle of 90^0 by each prism. Thus light from a viewed object enters the observer's eye. Periscope is normally used in tanks and submarines. With the help of periscope, the commander of the submarine sitting in his cabin can see the objects on the surface of the sea. Similarly a soldier sitting inside a tank can see the objects outside the tank.

Q.49. How the power is lost in optical fibre through dispersion? Explain.

Ans: When a light signal travels along fibres by multiple refraction, some of light is absorbed by the impurities in the glass. Some of it is scattered by the group of atoms formed at the places such as joints when fibres are joined together.

Note: Careful manufacturing can reduce the power loss by scatting and absorption.

Q.50. What do you understand form linear and angular magnification.

Ans: Linear Magnification

"The ratio of the size of image to the size of object is called linear magnification."

Angular Magnification

"The ratio of the angle subtended by the image as seen through device to that subtended by the object at unaided eye is know as angular magnification"

Q.51. What do you know about totally reflecting prism? Also write its uses.

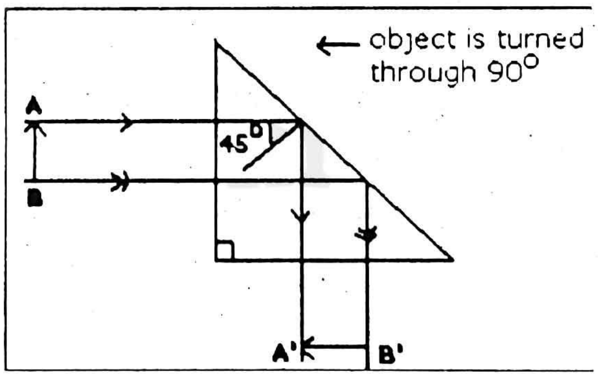
Ans: A transparent body, whose three sides are rectangular and two sides are right-angled triangular is called totally reflecting prism.

Totally reflecting prism:

The prism which has one angle 90° is called totally reflecting prism.

Principal of totally reflecting prism

The total reflecting prism works on the principal of total internal reflection. The totally reflecting prism reflect a beam of light through 90° or 180°. One angle of the right angle and other two 45° each. When light falls perpendicular to the one side it enter in the prism without deviation. These light rays strike with hypotenous of prism. The hypotenuse at the angle of 45°.



This angle is greater then the critical angle of glass which is 42°. So the angle of incidence is greater than critical angel the lights totally reflect through prism at an angle of 90°.

Uses of totally reflecting Prism

- The totally reflecting prism is used in periscope.
- It is used in binocular.
- It is used in textile engineering for designing.
- It is used in projectors.

Q.52. How the light signal is transmitted through optical fibre?

Ans: The light signal is transmitted through the optical fibre in the form of 1 and 0. The digit 1 represents the presence of light while the digit 0 represents the absence of light.

Note: Usually the light signal is produced by "LASER" or "LED" which travel through the optical fibre.

Q.53. Explain the difference between the angular magnification and resolving power of an optical instrument?

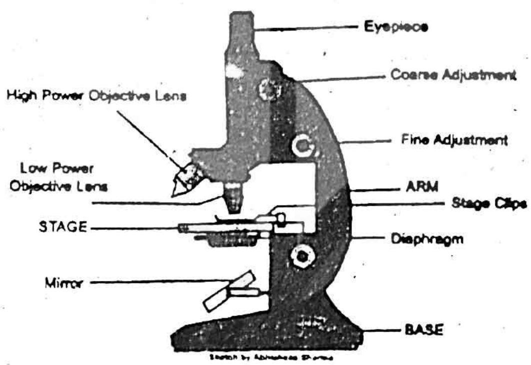
Ans:

Angular Magnification	Resolving Power
• Angular magnification simply increases the apparent size of image of an object when seen through an optical devices.	• The resolving power of an optical instrument is its at to reveal the minor details of an object under exam.
• It can be made as, large as, we wish, by using the lenses of suitable focal length.	• It is minimum angle between the point sources then allow the image to resolved as the distinct points of light rather than.

12.11 Simple Microscope
12.12 Compound Microscope

Q.54. What is simple microscope?

Ans. A magnifying glass is a convex lens which is used to produced magnified images of small objects. Hence it is called simple microscope.



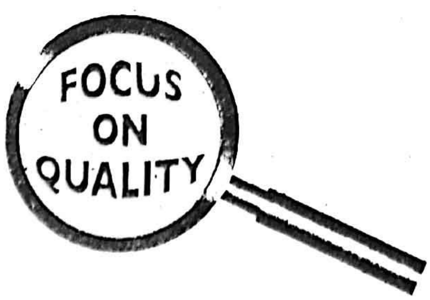
Labeled Microscope Diagram

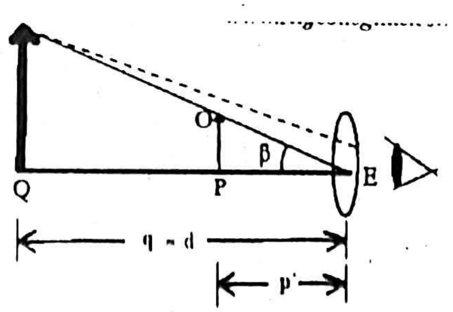
Q.55. What is meant by resolving power of instrument?

Ans. The resolving power of an instrument is fits ability to distinguish between two closely placed objects or point sources

Q.56. What is magnifying glass?

Ans. Magnifying glass is a lens that forms a virtual image that is larger than object and appears behind the lens.





Q.57. What is compound microscope? Also write its three features.

Ans. Compound microscope has two converging sets of lenses, the objective and the eyepiece and is used to investigate structure of small objects.

Features:

(i) It gives greater magnification than a single lens.

(ii) The objective lens has a short focal length, $f_o < 1cm$.

(iii) The eyepiece has a focal length, f_e of a few cm.

Q.58. Which formula is used to determine magnification of compound microscope?

Ans. The magnification of compound microscope is given by.

$$M = \frac{L}{f_0}\left(1+\frac{d}{f_e}\right)$$

Q.59. Write uses of compound microscope.

Ans: A compound microscope is used to study bacteria and other micro-objects. It is also used for research in several fields of sciences like Microbiology, Botany, Geology and Genetics.

Q.60. Why would it be advantageous to us when blue light is used with a compound microscope?

Ans: The blue light of short wavelength produces less diffraction are increases its resolving power. Hence, it allows more details to be seen

Q.61. What is least distance of distinct vision. How it is affected with increase of age?

Ans: The minimum distance of an object from the eye at which it produces a sharp image on eye is called least distance of distinct or near point.

Its volume is normally 25 cm with the increase in age its value usually increases

Q.62. The object of telescope is of 20 and eye piece of 50cm focal length. What is the magnifying power and length of telescope?

Ans:

Given Data:

Focal length of objective = f_o = 20cm

Focal length of eye piece = fc = 5.0 cm

Required:

Magnifying power = M =?

Length of telescope = L = ?

Solution:

As, we know that

$$M = \frac{f_o}{f_e}$$

By substituting the values

$$M = \frac{20}{50}$$

M = 4

Now, length of the telescope is given the

$$L = f_o + f_e$$

$$L = 20 + 5$$

$$L = 70 \text{ cm}$$

Q.63. Why objective of short focal length is preferred in microscope?

Ans: The magnification of microscope can be expressed as

$$M = \frac{L}{f_o}\left(1 + \frac{d}{f_e}\right)$$

It is chair from the above equation that

$$M \propto \frac{1}{f_o}$$

i.e smaller to focal length of objective greater will be its magnifying power and vice versa. Therefore, to increase the magnification power the value of focal lneght of objective must be smaller.

12.13 Telescope
12.14 The Human eye
12.15 Defects of Vision

Q.64. Define telescope. What do you know about refracting telescope?

Ans. Telescope is an optical instrument which is used to observe distant objects using lenses or mirrors. A telescope that uses two converging lenses is called refracting telescope.

Q.65. How terrestrial telescope is different form a telescope?

Ans. Terrestrial telescope has an extra lens between objective and eye piece.

Q.66. What is magnification of refracting telescope?

Ans. Magnification of refracting telescope can be determined by using formula;

$$M = \frac{f_o}{f_e}$$

Q.67. What should be the length of telescope of $f_o = 20cm$ and $f_e = 4cm$?

Ans: **Given Data:**

$f_o = 20cm$

$fe = 4cm$

Required:

Length of Telescope = L = ?

Solution:

As we know that

$L = f_o + F_e$

$L = 20 + 4$

$L = 24cm$

Q.68. Which human organ works like camera?

Ans: Human eye works like camera.

Q.69. What is pupil?

Ans: Iris has an opening at its centre is called pupil.

Q.70. What is meant by defect of vision? What are its types?

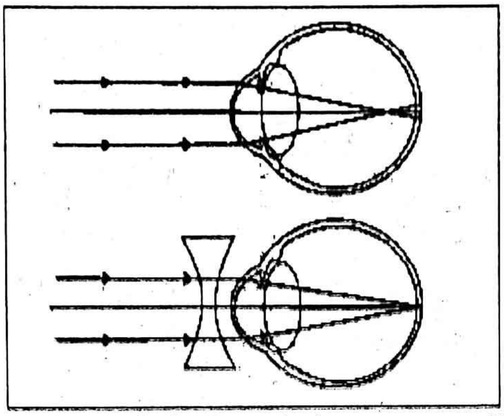
Ans: The inability of the eye to see the image of objects clearly is called defect of vision. The defect of vision are.

(i) Nearsightedness (Myopia)

(ii) Farsightedness(Hypermetropia)

Q.71. What is reason of short sightedness? How it is corrected?

Ans: Shortsightedness is due to eyeball being too long. Light rays form a distant object ar focused in front of the retina and a blurred image is produced. It is corrected by using, diverging lens.

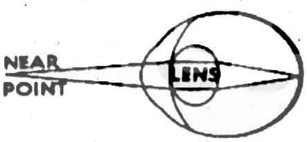


Q.72. What is meant by hypermetropia? How is it corrected?

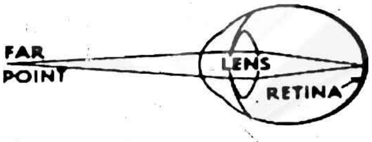
Ans: The disability of the eye to form distinct images of nearby objects on its retina is known as farsightedness or hypermetropia. This defect can be corrected with the aid of a suitable converging lens.

Q.73. What are the near and far points of the normal eye?

Ans: **Near Point:** A normal eye can see near objects clearly at distance of about 25cm from the eye. This is near point of normal eye.

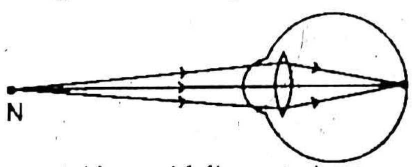


Far Point: A normal eye can see far off objects clearly. So we can say that far point of a normal eye will be at infinite distance.

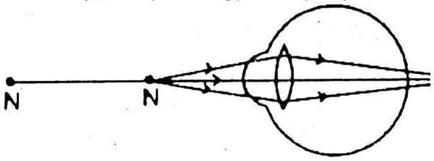


Q.74. Which lens is used for the long sightedness?

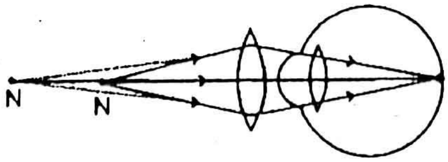
Ans: Long sightedness is corrected by wearing spectacles having convex lens of such focal length which forms a virtual image of the object placed at normal 25 cm, at the near point O of the eye. Hence a clear image of the object is formed on the retina.



(a) near point of hypermetropic eye



(b) Hypermetropia eye



(c) correction of hypermetropia eye

Q.75. What is different between compound microscope and astronomical telescope?

Compound microscope	Astronomical telescope
• **Objective lens has smaller focal length, than the eyepiece**	• Objective lens has larger focal length than the eyepiece
• **Distance between the objective lens and the eyepiece is greater than f_0+f_e**	• Distance between the objective lens and the eyepiece is equal to f_0+f_e
• **It is used to see very small objects**	• It is used to see distant astronomical objects

LONG QUESTIONS

12.1 Reflection of light

Q.1 What is reflection? Also explain the laws and types of reflection.

Ans: **Reflection of light:**

When light traveling in a certain medium falls on he surface of another medium, a part of it turns back in the same medium. This is called reflection of light. **OR**

The bouncing back of light in first medium after striking with any reflecting surface.

OR

The property of light wave being thrown back from reflecting surface such as mirror.

Explanation:

Consider a light ray along the path 'AO' falls on a plane mirror M. This light ray known as incident ray. When this incident ray 'AO' strike to mirror M at point 'O'. This incident ray will be reflected back in first medium along with the path 'OB". The ray 'OB' is known as reflected ray. Now take a 'N' normal at a point 'O'. The angle between 'AO' incident ray and normal 'N' $'N'\angle AON = i$ is known as angle of incidence is represented by $\angle AON$. The angle between reflected ray 'OB' and normal 'N' is known as angle of reflection . In diagram it is represented by $\angle NOB = r$.

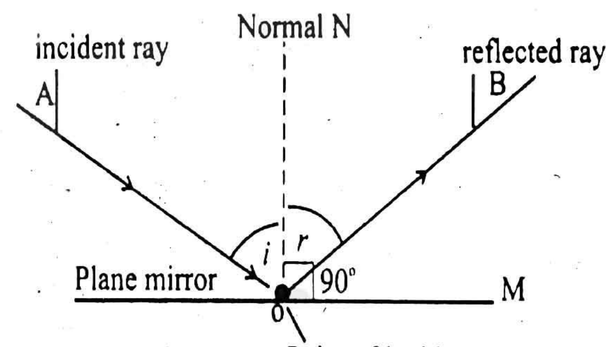


Fig. 12.2 Reflection of light

Law of Reflection

When a ray of light strikes a flate reflecting surface at a point the angle of incidence is equal to the angel of reflection and the incident ray, reflected ray and normal lie at single point. So the laws of reflection can be written as:

(i) Incident ray, normal and reflected ray at the point of incidence lie in the same plane.

(ii) Always the angle of incidence is equal to the angle of reflection i.e. $\angle i = \angle r$.

Types of Reflection:

The direction of reflected ray depends upon the smoothness of the surface on which incident ray strike. So, there are two type of reflection.

(i) Regular Reflection

(ii) Irregular Reflection

(i) **Regular Reflection:**

The reflection by smooth surface in which all the reflected rays the parallel to each other is called regular reflection.

For example a smooth surface reflects the rays of light in one direction only For regular reflection of light, the angle of incidence is equal to the angle of reflection i.e. $\angle i = \angle r$.

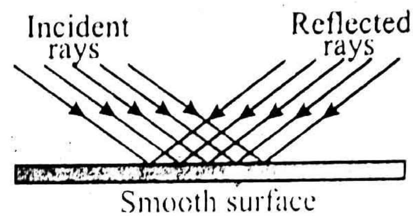


Fig. 12.3 Regular reflection

Conditions for Regular Reflection:

- The reflecting surface should be plane surface.
- The reflecting surface should be flate.
- The reflected rays of light should be parallel to each other and have equal-space between them.

(ii) **Irregular Reflection:**

The reflection by the rough surface in which all the reflected rays not parallel to each other is called irregular reflection.

For example, a rough surface reflects the light rays in many directions as shown fig.

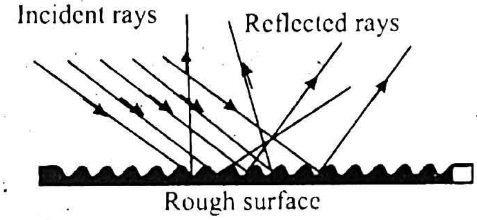


Fig. 12.4: Irregular reflection

Conditions for Irregular Reflection:

- The reflecting surface should be rough.
- The reflecting rays of light are not parallel to each other.

Q.2: What are spherical mirrors? Describe types for spherical mirrors.

An: Spherical Mirrors:

"The kind we use generally made by a silvering a piece of glass which is part of shell of hollow sphere. "OR.

"A mirror which is a part of a hollow sphere of glass or plastic is called spherical mirrors." In spherical mirrors one surface from of its two surfaces is coated with thin silver layer which is covered by a read lead oxide paint. Therefore, one side of spherical mirror is opaque and other side highly polished, that is know as reflecting surface. Spherical mirrors are classified in two categories on the basis of reflecting surface.

1. Concave or Converging mirror.
2. Convex or Diverging mirror.

Concave or Converging Mirror:

The mirror whose reflecting surface is on the inside of the curved shape.

Characteristics of Concave Mirror:

In concave mirror

- Size of image depend upon the position of object.
- Virtual or real image can be formed.

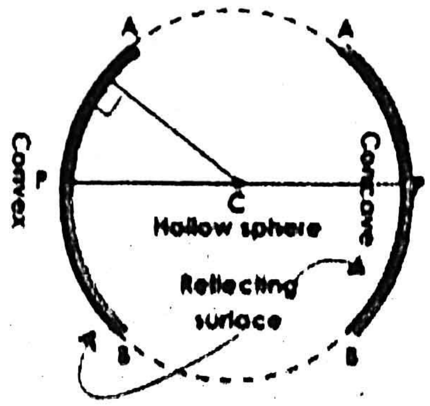
Convex or Diverging Mirror

The mirror whose reflecting surface is one the outside of the curved shape.

Characteristics of Convex Mirror

In convex mirror.

- Size of image is always smaller then the size of object.
- Virtual and erect image can be formed.



Q.3 Define the following terms associated with spherical mirrors? Pole, centre of curvature, radius of curvature, principal axis, principal focus, focal length, real focus, virtual focus.

Ans: **Pole OR Vertex:**

The midpoint of the curved surface of a spherical mirror is knows as pole or vertex.

Center of Curvature (C):

The center of sphere from which concave or convex mirror is formed, that is known as center of curvature.

OR

Spherical mirror is a part of sphere. The center of that sphere is known as center of curvature.

Radius of Curvature (R):

The radius of sphere of which spherical mirror is a part.

$$R = 2f$$

Principal axis:

The line joining center of curvature and pole of spherical mirror.

OR

The principal axis of curved mirror is line at right angles to the curved surface which meets the mirror at its center or pole.

Principal Focus (F):

The light rays which are parallel to the principal axis, after reflection the light rays pass through a single point on principal axis, that point is known as "principal focus" of spherical mirrors.

OR

The incident rays are parallel to the principal axis, after reflection the rays pass through a point on principal axis which lies just midway between the pole and the center of curvature is called principal focus.

Real Focus:

In concave or converging mirror, the reflected rays actually pass t through the focus point therefore it is called real focus.

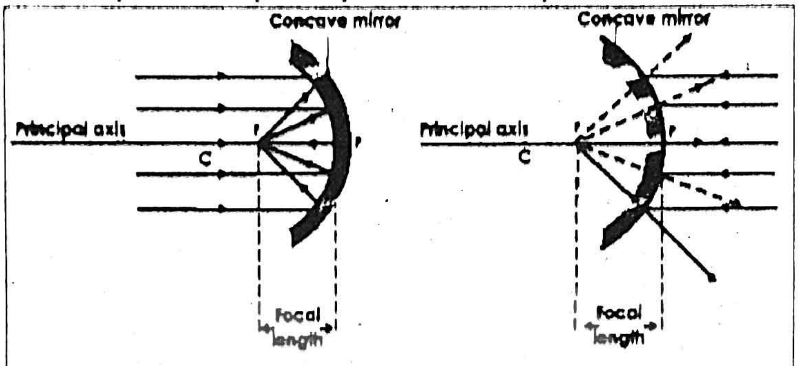
Virtual focus:

In convex or diverging mirror, the rays parallel to principal axis, after reflection appear to come from point 'F' situated behind the mirror.

"The principal focus of convex mirror is known as virtual focus because reflected rays do not actually pass through it but appear to do so."

Focal Length:

The distance between pole and principal focus of spherical mirrors is called focal length.



Principal Focus or Focus

Q.4 Define refraction of light. Describe the passage of light through parallel – sided transparent material.

OR

How the refraction of light can be verified using glass slab and pins.

Ans: **Refraction:**

"When light enter from one transparent medium to another medium then it changes its path. This is known as refraction of light..

OR

"The deviation in path of light when it enter from one medium to another medium is known as refraction."

Glass-slab experiment

Take a rectangular glass block (slab), a ray which is defined by the line connecting pins. The ray IO hit the glass-slab at point 'O'. This ray is known as incident ray. The normal 'N' is also at point 'O'. The angle $\angle ION$ between the incident ray and normal is known as angle of incident. The ray OR inside the glass-slab. This ray is known as refracted ray. The angle between the refracted ray and normal is known as angle of refraction. When ray 'OR' leaves the glass-slab, it moves away from the normal along with path ME. This 'ME' ray is known as emergent ray. So, the refraction of light is process in which light rays change its direction as it enter in other transparent medium which has different optical density.

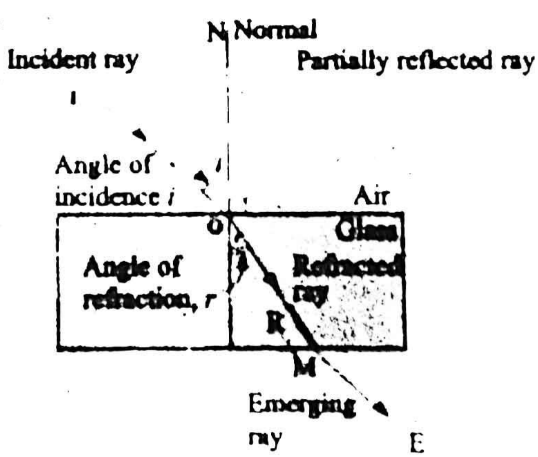


Fig. 12.9: Refraction of light by a glass block

Dependence of Refraction

This refraction depends on

1. The nature of two materials and speed of light in each material
2. The angle at which the ray strikes the surface.

Q.5 what is meant by total internal reflection? Also describe critical angle Derive relation of critical angle and refractive index.

Ans: The wave changes direction when passing from one medium to other due to change in the speed. This phenomenon is called as refraction. The change in direction of the wave can be quantified using the refractive indexes of the two materials. When a ray passes from denser medium (medium with higher refractive index) to rarer medium it bends or refracts away from the imaginary line, called normal, perpendicular to the surface. As the angle of incidence in denser medium becomes greater with respect to normal, the refracted ray bends further away from it.

At one particular angle, called critical angle, the refracted light does not enter rarer medium but instead travels along the surface between the two media.

Critical Angle

"The angle of incident that causes the refracted ray in rare medium to bend through 90° called critical angle."

OR

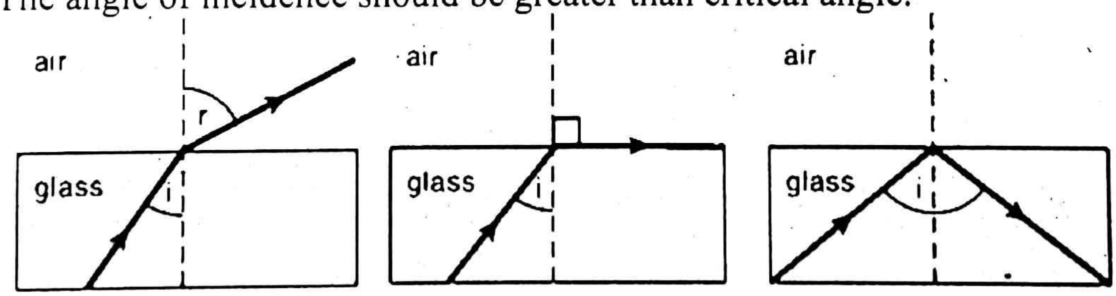
"The angle of incidence, whose corresponding angle of refraction is 90° is known as critical angle. The critical angle is denoted by c. "When the angle of incidence is greater then critical angle 'c. then light does not refract in second medium but reflects back in first (denser) medium.

Total Internal Reflection

When angle of incidence is greater than critical angle then no refraction occurs in second medium but light reflected back in first (denser) medium. This reflection is known as total internal reflection.

Conditions for total internal reflection

- The light should enter from denser medium to rare medium.
- The angle of incidence should be greater than critical angle.



if the angle of incidence is less than the critical angle, the light refracts away from the normal

if the angle of incidence is equal to the critical angle, the light refracts at 90 to the normal

if the angle of incidence is greater than the critical angle, total internal reflection occurs

Relation for critical angle and refractive index

Consider light enter from glass to air. The Snell's law $\frac{1}{n} = \frac{\sin i}{\sin r}$.

Which can also written as

$$n = \frac{\sin r}{\sin i} = \frac{\sin 90}{\sin \hat{c}} \qquad \frac{\hat{i} = c}{\hat{r} = 90} \qquad (\because \sin 90^o = 1)$$

$$n = \frac{1}{Sin\hat{C}}$$

Q.6 What is Prism? How refraction occurs through prism?

Ans: **Prism:** "Prism is transparent body with at least two polished plane faces inclined toward each other from which light is refracted." **OR**

"Optical transparent body having three rectangular sides and two triangular sides is known as prism.

Types of Prism:

There are two types of prism in general

(i) Simple Prism (ii). Totally Reflecting Prism.

(i) **Simple Prism**

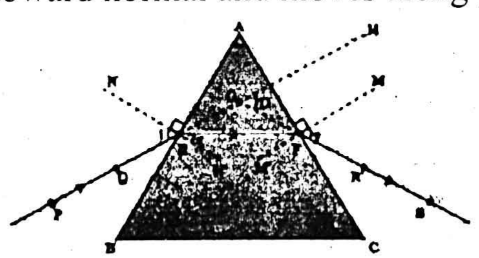
The prism whose triangular sides are equal in length and angles at vertices of triangular faces are also equal.

(ii) **Totally Reflecting Prism**

A totally reflecting prism is that which has one angle of 90° an each of the remaining two angles equal to 45° at its triangular faces.

Refraction through Prism

In triangular prism light ray 'PQ' hit the side. AB of prism at point 'E. The angle $\angle QEN$ is angle of incidence 'I'. The light ray should move along with path E,G to H. But when light enter in prism it bends toward normal and moves along path 'EF'.



PE – Incident ray
EF – Refracted ray
FS – Emergent ray
∠A – Angle of the prism
∠i – Angle of incidence
∠r – Angle of refraction
∠e – Angle of emergence
∠D – Angle of deviation

According to law of refraction $n = \frac{Sin\hat{i}}{Sin\hat{r}}$. The emergent ray is 'FS'. We can observe that incident ray 'PE' is not parallel to emergent ray 'FS'. This means that, when light pass through a prism, it is deviated from its original path. The original path is 'PEH' and deviated path GFS. The angel 'D' is the angle of deviation.

Angle of Deviation:

"The angle between the original path of incident ray and path of refracted ray through a prism is known as angle of deviation. "It is represented by 'D'.

Q.7 Define lenses. How many types of lenses? Describe briefly explain the following terms:

(1) Principal Axis **(2) Optical Center** **(3) Principal Focus**

(4) Focal Length **(5) Power of Lens.**

Ans: Lens:

"A transparent body having two surfaces of which at least one is curved.

OR

Lens is piece of transparent medium bounded by two surfaces at least one of which is curved".

Types of lenses:

Lenses are classified into two categories.

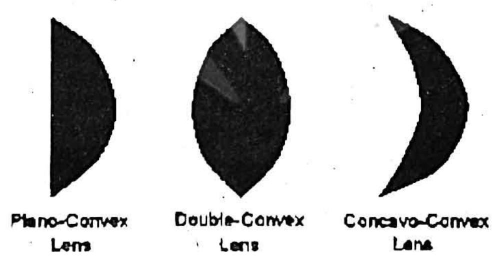
1. Convex or Converging Lens:

The lens which converge all parallel incident rays after refraction is called convex or converging lens.

OR

The lens which is thicker at middle and thinner at the edges.

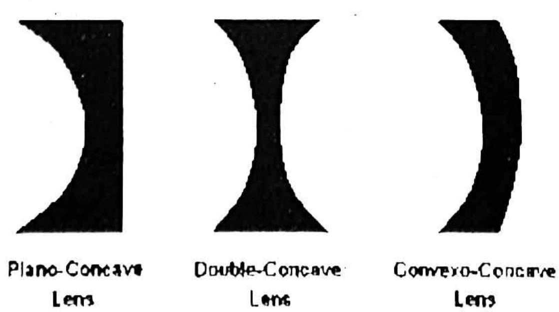
Type of Convex Lenses



Concave or Diverging Lens:

"The lens which diverge the light at point from all incident parallel rays. "OR" The lenses which are thinner in middle than at the edges."

Type of Concave Lenses



(1) **Principal Axis:**

"The each surface of the spherical lens are section of sphere, the line passing through the center of curvatures of two spheres is called the principal axis of lens."

"OR"

The line joining the two center of curvatures of the spheres is called principal axis, but this line also passes through the optical center and foci of lens."

(2) **Optical Center**

"A point on principal axis at the center of lens is called optical center." OR. "Optical center is a point inside the body of lens through which light rays pass, undeviated."

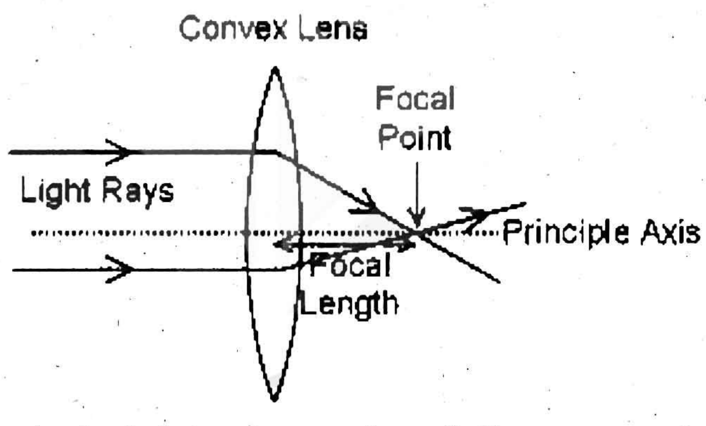
(3) **Principal Focus**

The light rays traveling parallel to the principal axis, passes through the lens. After refraction light converge at a point or appears to be diverge from the appoint. That co converging or diverging point is known as principle focus."

OR

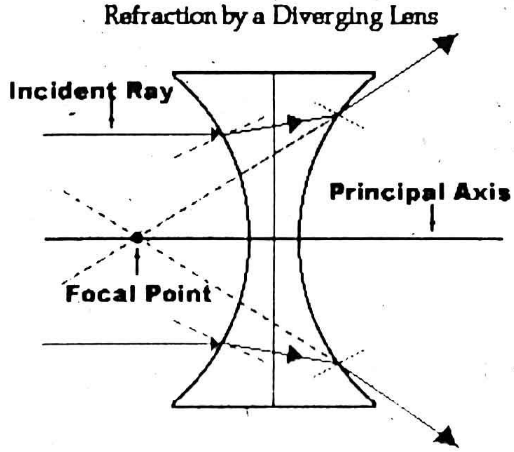
The principal focus of curved lens is the point 'F'. Where incoming rays which are parallel to principal axis come to a focus.

(a) For convex lens, principal focus is a point of convergence of refracted rays. It is a real point.



(b) For concave lens, principal focus is a point of divergence of refracted rays. It is imaginary point.

Refraction by a Diverging Lens



Incident rays traveling parallel to the principal axis will refract through the lens and diverge, never intersecting.

(4) **Focal Length:**

The distance between principal focus and optical center is called forcal length its is denoted by 'f'.

(5) **Power of Lens:**

The power or strength of lens is the reciprocal of the focal length.

OR

Power of lens is its ability to deviate light ray from its original path.

$$P = \frac{I}{f}$$

Where 'f' is the focal length in meter. SI unit of power of lens is "dioptre" and it is denoted by D. the dioptre 'D' is reciprocal of meter (m^{-1})

- Power of convex lens is positive, because its focal length is positive.
- Power of concave lens is negative because its focal length is negative.

Q.8 How is image formed by lens? Explain with ray diagram? Also explain ray diagram.

Ans: The image is formed through lenses by means of refraction.

Ray Diagram:

A graphical method of locating the image formed by spherical lens is called ray diagram. We will investigate the method for drawing ray diagrams for objects placed at various locations in front of a double convex lens. To draw these ray diagrams, we will have to recall the three ***rules*** of refraction for a double convex lens:

(i) Any incident ray traveling parallel to the principal axis of a converging lens will refract through the lens and travel through the focal point on the opposite side of the lens.

(ii) Any incident ray traveling through the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.

(iii) An incident ray that passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.

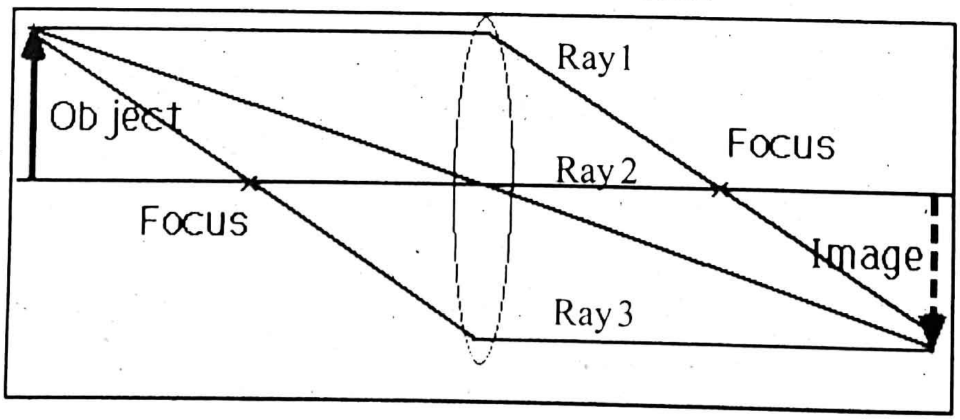
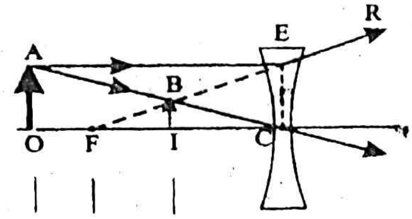


Image Formation through Concave Lens:

The ray diagram for concave lens is shown in fig



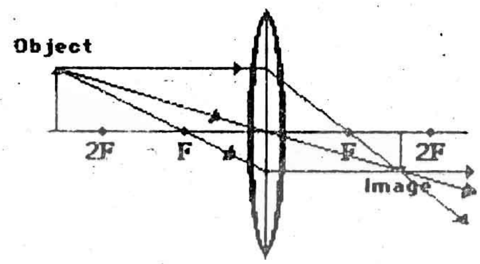
The Image is , Virtual, Erect, small in size and formed at Same side of lens .

Image Formation through Convex Lens

The following diagram illustrating the path of light from an object through a lens to an eye placed at various locations is as shown.

1. **Object Beyond 2F:**

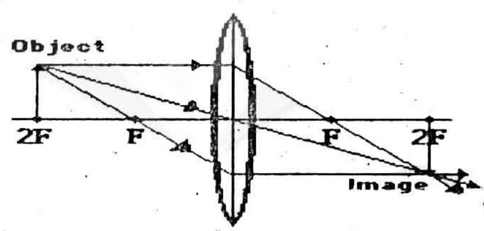
When object is placed at some distance from 2F then image is formed between the focus and center of curvature (2F).



The Image is formed Between F and 2F Opposite side of Lens, Real, Inverted and Small in size

2. **Object at 2F:**

When object placed at center of curvature, image is formed at center of curvature at the opposite side.

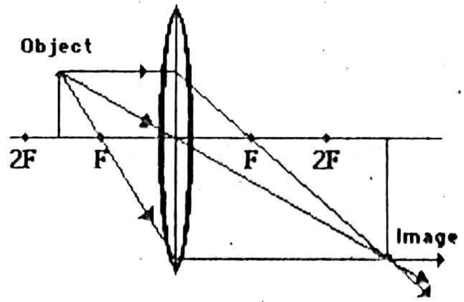


Ray Diagram for Object Located at 2F

The Image, Real, Inverted, at 2F , Same in size and At the opposite side of the Lens

3. **Object between F and 2F:**

When object is placed between the focus and center of curvature then the image is formed on opposite side beyond the center of curvature.

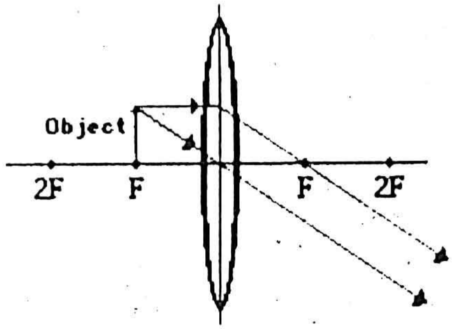


Ray Diagram for Object Located Between F and 2F

The Image, Real, Inverted, Large in size, Opposite side of lens and Beyond 2F

4. **Object at F:**

When object is placed at focus the refracted rays are parallel to each other and meet at infinity.

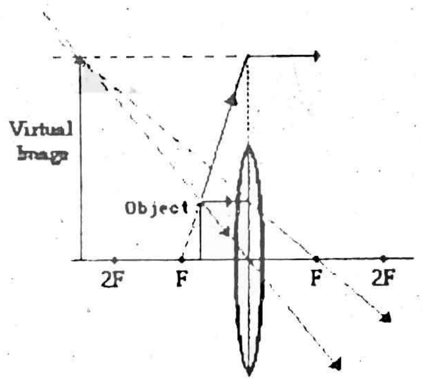


Ray Diagram for Object Located at F
(an image is not formed)

No image form because refracted rays are parallel and they never meet.

5. **Object between F and O**

When object is placed between the lens and principal focus, then the refracted rays does not meet at opposite side but image is formed at the same side where the object is placed.



Ray Diagram for Object Located in Front of F

The Image is Virtual, Erect, Large, Same side of lens and Beyond the object. We can also draw the ray diagram for object placed different position from a convex lens. Position and nature of image for convex lens given in following table.

Position of Object	Position of Image	Nature of Image
Beyond the 2F	Between F and 2F	Rea, inverted, small
At 2F	At 2F	Real, inverted, equal
Between F and 2F	Beyond 2F	Real, inverted, enlarged
At F	At infinity	No image is formed
Inside F	Behind the object	Virtual, erect, enlarged
At infinity	At F	Real, inverted, small

Q.9 How image location can be found using lens equation?

Ans: Consider, an object OP is placed in the front of convex lens. A 'PR' ray is parallel to the principal axis. According to ray diagram rules, it will pass through the focus point after refraction. An other ray 'PC' will pass through the optical center of lens. The ray PC pass through directly without deviation and intersect the ray RP' at point P' a real image O' P' is formed at distance 'q' where the distance of object from lens denoted by 'p'. To find the nature and the distance of image from lens, we use lens equation. Def: 'The relationship between the object and image distance from the lens in the term of focal length of the lens is called lens equation. "Lens equation can be written as:

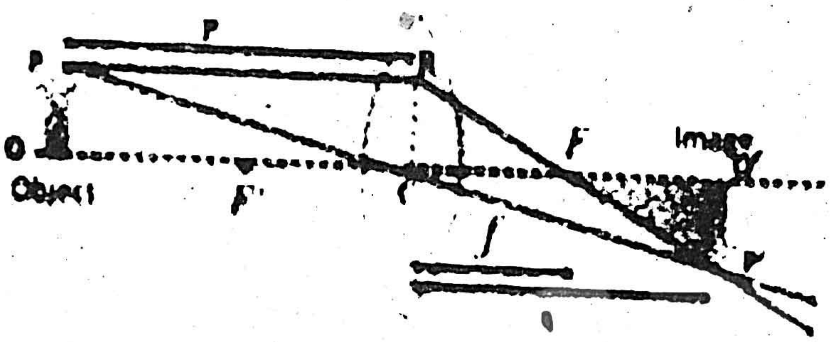


Fig.12.20

$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$$

This curved lens equation is applicable for convex and concave lens but following sign of convections be followed

Sigh of Convections for Lenses

Focal Length (f):

- 'f' is positive for converging lens (convex lens).
- 'f' is negative for diverging lens (concave lens).

Object distance (p)

- 'p' distance is taken as positive, if the object is at left of lens. It is called real object.
- 'p' is taken as negative distance if the object is on the right sides of lens. It is called virtual object.

Image Distance (q)

- The image distance 'q' is taken as positive for a real image made on the right side of lens by the real object.
- The image distance 'q' is taken as negative for a virtual image made on the left side of the lens by real object.

Q.10 Write a note on the following application of lenses.

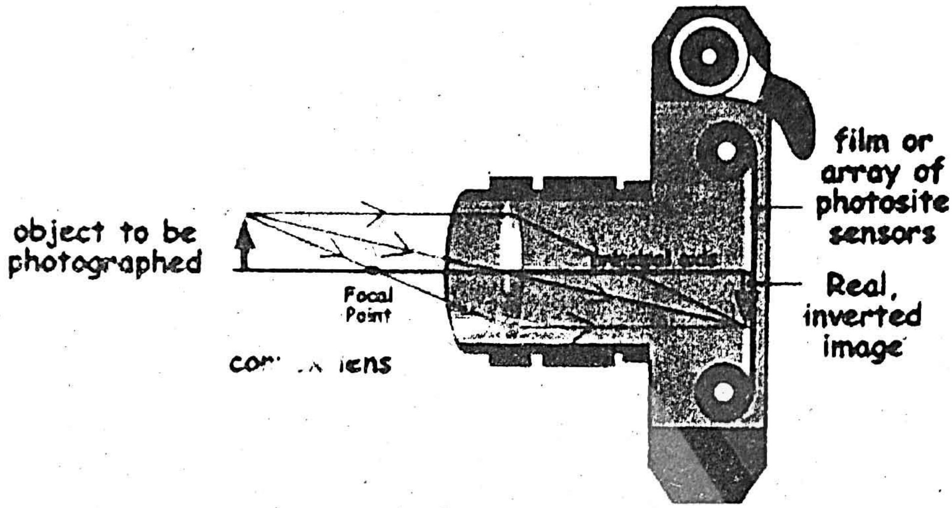
(1) Camera (2) Projector (3) Photographed enlarger.

Ans: (1) Camera

Definition: A camera is an optical device for obtaining still photographs, or for exposing cinematic films.

Construction and working:

It is light-proof box. The whole interior surface is normally matt black. A converging lens is adjusted in the front of camara. A shutter of variable speed and diaphragm of variable aperture, regulate the amount of light admitted though the lens. A sensitive film or plate fixed behind the lens at the focus point of lens. The image formed by simple camera is real, inverted (vertically and laterally diminished or magnified.)



(2) Slide Projector:

A slide projector is an upto-mechanical device to view photographic slides. A projector has four main elements:

CONSTRUCTION:

Slide projector consists on concave mirror, light source condenser (two palno convex) lenses, slide and projection lens. A light source (quartz iodine lamp) is placed at the center of curvature). Concave mirror reflect the light in the form of parallel rays. A condenser consisting of two plano-convex lens collect the parallel light rays.

WORKING:

The parallel light rays which passes from condenser falls on the slide and illuminated it. A projection lens is adjusted next to slide in such a way that the slide should in between the F and 2f of projection of lens. The projection lens refract the rays and real inverted (vertically and lateral) image is formed on screen. The slide placed upside down and flipped 180o. So that the image will be projected right way.

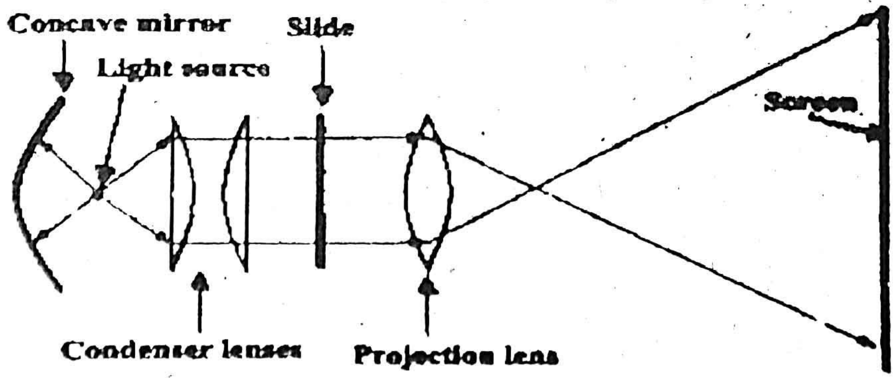


Fig.12.22: Diagram of slide projector

Photograph Enlarger:

An enlarger is a specialized transparency projector used to produce photographic prints from film or glass negatives using the gelatin silver process, or from transparencies.

Construction and Working:

A photograph enlarger is basically same as that slide projector. A light bulbs produce light and fall on condenser. Condenser consisting of two plano-convex lenses which collect the light rays. The light rays becomes parallel when pass through condenser and fall on film .A projection lens is placed next to film in such a way that the film should in between the F and 2F. The projection convex lens produces are magnified and inverted image of from on the photographic paper.

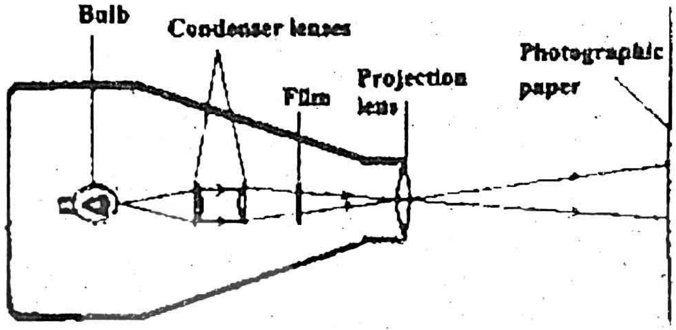


Fig.12.23: Diagram of photograph enlarger

Q.11 What is optical fiber? Describe how total internal reflection is used in light propagating through optical fiber.

What are the optical fibers? On which principal they work? Describe their few uses. (14.6)

Ans: Optical Fiber:

An optical fiber is made of a highly transparent fine strand of glass or plastic coated or cladded with another type of glass whose refractive index is less than the inner tube is called optical fiber

Principal

In recent years an important and interesting application of principal of total internal reflection is used in optical fibers.

Construction

A thin hair like rod of glass having central portion of light refractive index called core, which is surrounded by a glass layer having low refractive index called cladding." The central part of fiber is made of plastic or glass with high refractive index. The core is surrounded by an other layer of glass or plastic or low refraction index From figure, an optical fiber is made of a highly transparent fine strand of glass or plastic coated or cladded with another type of glass whose refractive index is less than the inner tube. Generally the refractive index of inner tube is 1.52 and that of outer coating is 1.48.

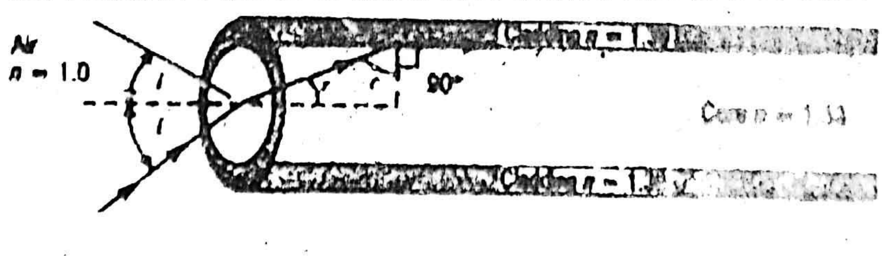


Fig.12.28: Passage of light through optical fibre

Transmission of Light/Data

If light rays enter at one end of an optical fiber at an angle of incidence greater than the critical angle then these rays undergo total internal reflection repeatedly at the walls and come out at the other end without any loss of intensity core and covers the distance of 30km. That s why the repeaters used at 30Km distance in optical fiber network. The simplest optical fiber, operates 14000 telephones calls and 14 TV channels at a time Thus, light travels along the fiber no matter how it may be curved and comes out with the same intensity

Q.12 What is light pipe? How it is used in daily life? What is Endoscope and Endoscopy? Describe the type of endoscope?

Ans: **Light Pipe:**

The light pipe is bundle of thousands optical fibers bounded together through a flexible pipe jacket. The light pipes are used by doctors are engineers to illuminate those inaccessible places which otherwise are not possible to examine. Light pipes also used to transmit data (image, calls, movies) from one plane to another.

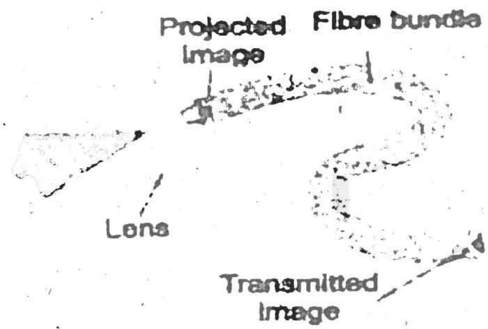


Fig.12.29: A lens and light pipe can be used together to produce a magnified transmitted image of an object

Endoscope

Endoscope is a medical instrument used for viewing and photographing internal structure of human body. Due to small size the endoscope is inserted through the mouth and illuminates the internal parts viewed by another bundle of optical fiber. A video camera is fitted outside of this bundle and it makes the interior parts visible to doctors which helps them to diagnose easily.

Endoscopy

A medical procedure in which any type of endoscope is used called endoscopy.

Types of Endoscope

The endoscope is divided into different type on the bases of use in medical filed.

1) Gastroscope 2) Cytoscope 3) Bronchosope

1) **Gastroscope:**
Gastroscope is an instrument used to diagnose the stomach.

2) **Cytoscope:**
Cytoscope is an instrument used to diagnose the bladder.

3) **Bronchoscope:**
Bronchoscope is an instrument used to diagnose sore throat.

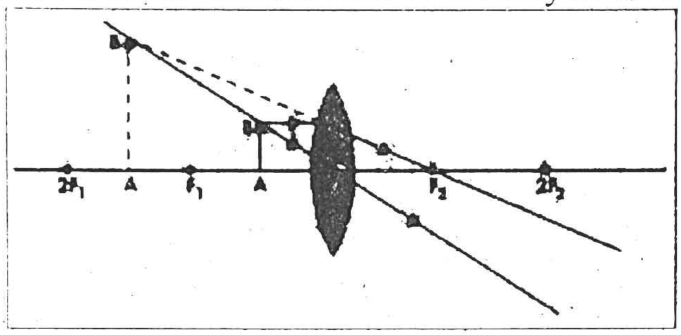
Q.13 What is simple microscope? Draw the diagram of simple microscope. Write the formula of its magnifying power.

Ans: Simple Microscope (Magnifier)

It is a simple convex (bi – convex) lens which is used to produce magnified (large) image of small object.

Principal

When object is placed within focal length of convex lens, then the magnified virtual and erect image is formed at least distance 'd'. It is observed clearly in the maximum possible size.

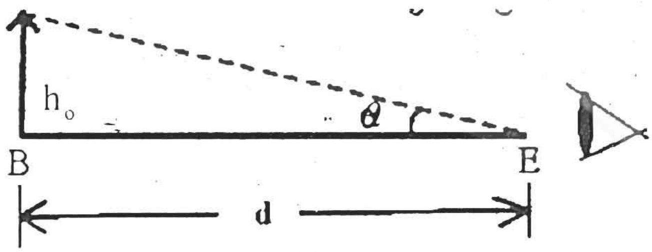


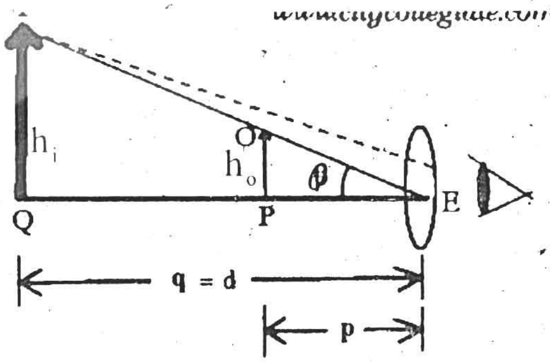
Magnifying Power

The angular magnification (or magnifying power) M is the angular size θ of the final image produced by the magnified glass divided by angular size θ of the object seen without magnifying glass.

Expatiation:

Let θ is the angle subtended at the eye by the object, when its placed before the eye at least distance. The 'θ' is angle subtended by the final image at eye when object is placed close to eye at distance less than 'f'.





$$M = \frac{\text{Angular size of final imge produced by magnfying glass}}{\text{Angular size of object seen without magnifying glass}}$$

$M = \frac{\theta'}{\theta}$ "The ratio of angles subtended by image as seen through the optical device (by using lens) to that subtended by object at unaided eye (without using lens) is called magnifying power."

So, enlarge virtual image is formed which is upright with respect to object. Magnifying power can be calculated by formula.

$$M \approx \left(\frac{d}{f}\right) + 1$$

Where 'd' is the near distance of object form eye which 25cm.

Resolving power of optical device

"The ability of an optical device to reveal (show) the minor detail of an object under the examination is called resolving power.

OR

"The ability of an optical device to reveal (show) the mirror detail of an object under the examinations is called resolving power.

OR

"The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources."

Q.14 Write a note compound microscope. Draw the ray diagram. Also explain its magnifying power.

Ans: **Compound Microscope:**

An optical device which consists on two converging lens, (objective and eyepiece) is used to get the minor detail of the structure of small objects.

Construction

It consists of two convex lenses placed parallel and co-axial with each other. One lens is called is called objective "because it is set towards the object to be viewed. The focal length of objective is very small. Second lens is called eyepiece because it is set towards the observer eye. The focal length of eyepiece is large. This microscope give greater magnification that a single lens.

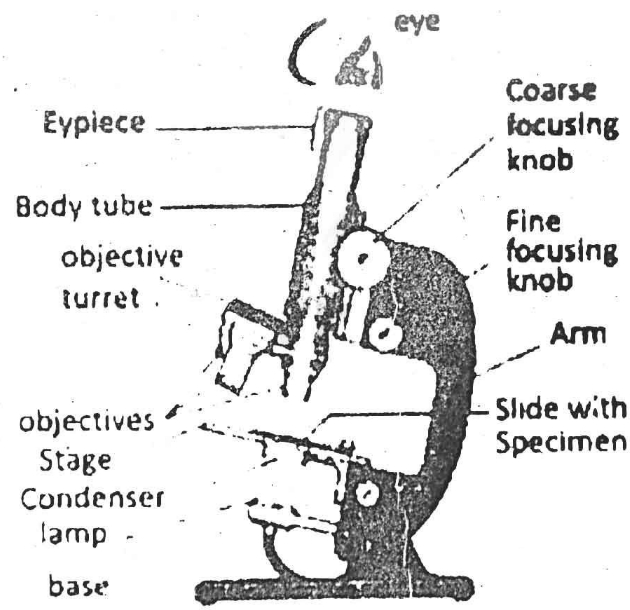
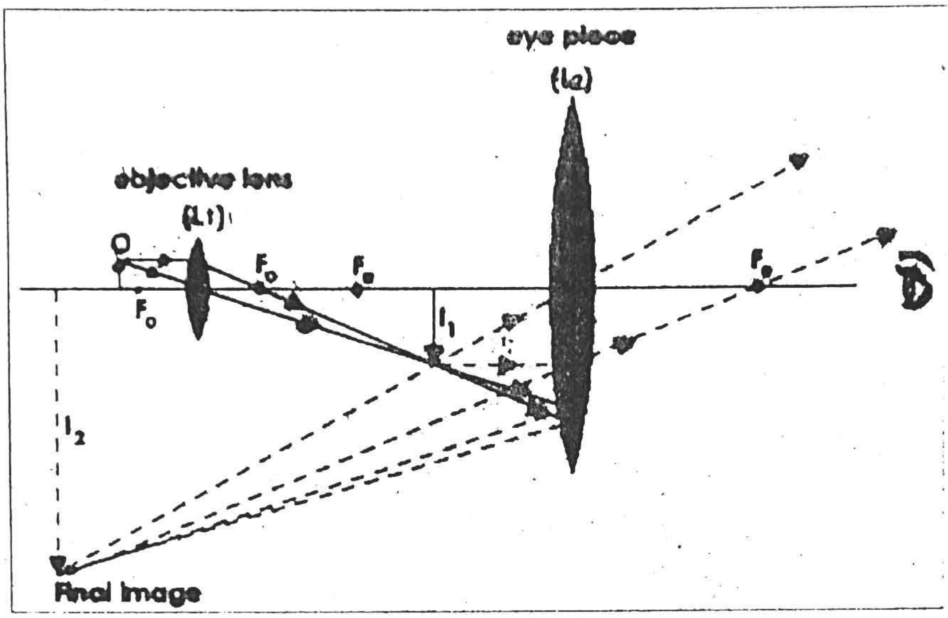


Fig. 12.32. Compound microscope

Magnifying power of compound microscope

The object 'op' is just placed beyond the principal focus'f' of the objective. This produce a real inverted and magnified image I, beyond the double focus of objective lens. The position of eyepiece is adjusted that image I, lies with in the focus 'f' of the eye-piece. The eye piece acts as magnifying glass and forms virtual erect and magnified image I, formed outside the focal point of objective.



The magnifying of compound microscope is given by:

$$M=\frac{L}{f_o}(1+\frac{d}{f})$$

When 'L' is the length of compound microscope, which is equal to the distance between objective and eyepiece, d is near distance of object from eye, f_o and f_e are the focal length of objective and eye-piece respectively.

Used of compound microscope

A compound microscope is used to study bacteria and other micro objectives. It is also used in different fields of science like microbiology, botany, geology and genetics.

Q.15 **What is refracting telescope? Draw its ray diagram and mention its magnifying power.**

Ans: **Telescope:**

"Telescope is an optical device which is used to see the distant object clearly and distinctly. '

OR

"Telescope is an optical device, which enables the observer to see the fine details of a far off object."

Construction: **A** refracting telescope consists of two convex lenses.

(i) Objective

(ii) Eyepiece

Objective: It is convex lens which is near the observer's eye and has short focal length (f_o)and larger aperture.

Eyepiece: It is a convex lens which is near the observer's eye and has short focal length(f_e) and small aperture.

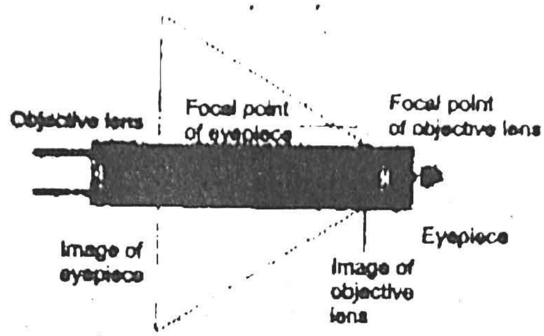


Fig. 12.34: An astronomical refracting telescope creates a virtual image that is inverted compared to the object.

Working of refracting telescope

The rays of light coming from object are considered to parallel are converged by objective lens to form a real diminished and inverted image 'I' is formed at the focus f_o of objective. This image acts as object for the eyepiece. The eyepiece magnifies I' thus the final image 'I'_2 see through the eyepiece, is virtual enlarge and inverted. This image makes an angle '0' at the eyepiece.

Magnification of telescope

Magnifying power of the telescope is defined as the ratio of the angle made by the image at eye as seen through the telescope to the angle made by the objective at the naked eye when the object and the image are at infinity.

But magnifying power of refracting telescope an be determined through ray diagram and given by:

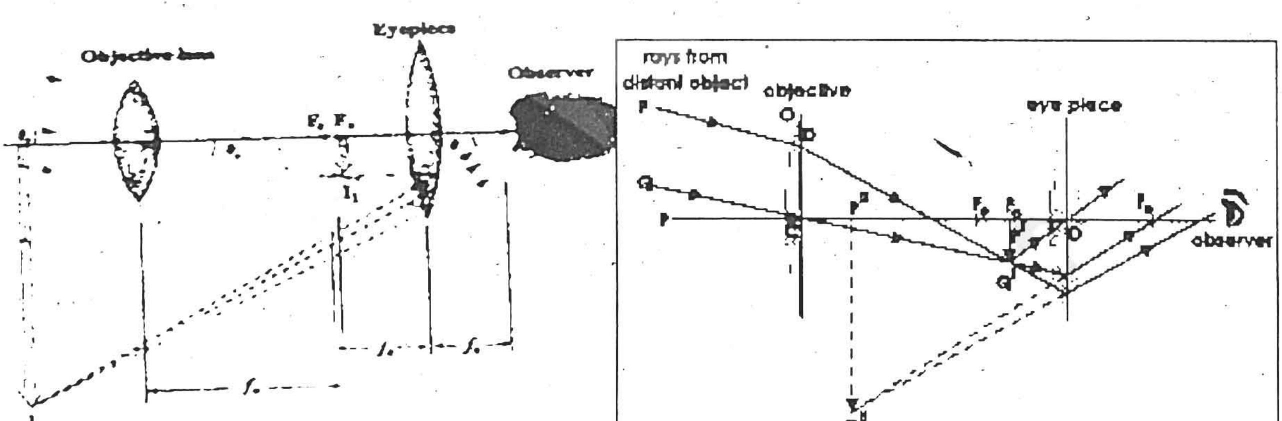


Fig.12.35: Ray diagram of refracting telescope

Q.16: Draw ray diagrams to show the formation of images in the normal human eye. Also explain the accommodation of eye.

Ans: **human eye:** in many respects the human eye is similar to camera. It has white wall called sclerotic in the front of eye there is a lens.

Parts of human eye

Retina: the light passing through the lens cross the vitreous humour to form an image an specific wall which is called retinal. Retina records the picture and work as film in camera.

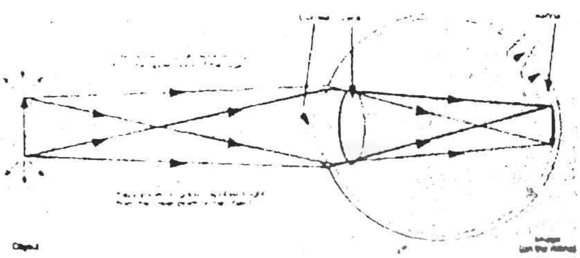
Lens: There is converging lens in the front of eye; naturally, this lens has ability to change the focal length.

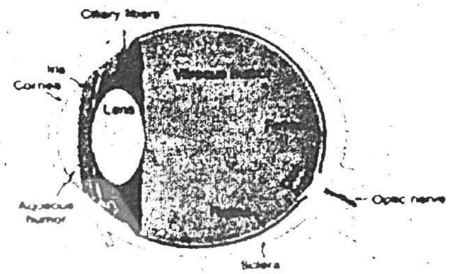
Iris: The iris is the coloured part of eye which automatically adjust the size of pupil and controls the amount of light reaching the retinal.

Pupil: pupil is circular in the center according to intensity of light falling on it. When white light passes, the iris contracts the size of pupil while in dim light pupil is enlarged.

Cornea: the light enters the eye through transparent membrane called corea.

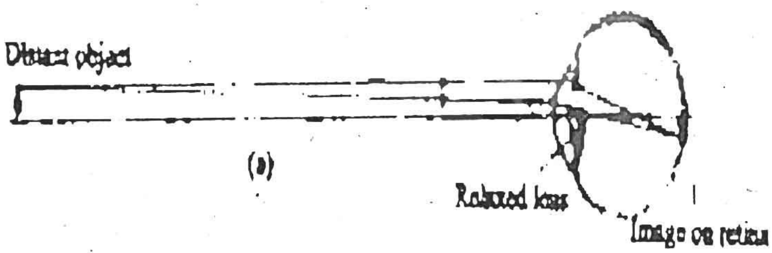
Formation of image: the camera focuses the image of an object at given distance form it by moving the lens towards or away from the film. The eye has another mechanism to focus the image on retina of object. The 'ciliary muscles control the size of lens. In this way the focal length of lens can be increased or decreased.





Far object: if the object is far away from eye, to deviation of light through lens must be lens. In this situation, The ciliary muscles relax. The curvature of lens is decreased. The focal length decreased.

The divergent rays from mean object are thus bent more and come to focus on retinal.



Nearer object: if an object is close to eye, The ciliary muscles contracts. The curvature of lens increased. The focal length decreased.

The divergent rays from near object are thus bent more and come to focus on retina.

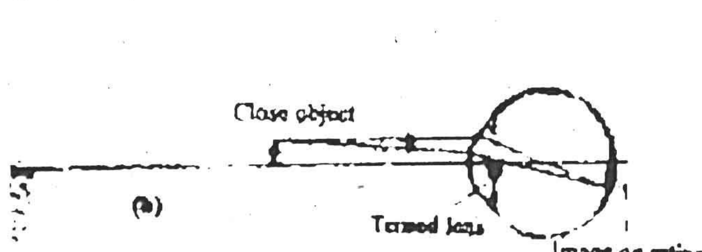


Fig.12.37: Human eye accommodation

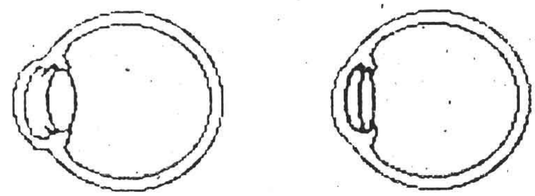
Accommodation:

The variation of the focal length of eye lens is called accommodation. "OR

"The sharpness of image formed in retina for objects at different distances from the eye is controlled by an alternation in the focal length of eye lens. This is called accommodation."

Accommodation is larger of healthy eye in young people while it goes on decreasing with increasing the age.

Accomodation



Q. 17: What is meant by the near sightedness and far sightedness? How these defects can be corrected? Define the defect of vision.

Ans. **Defect of Vision:** The inability of the eye to see the image of objects clearly is called defect of vision.

The defects of vision arise when the eye lens is unable to accommodate effectively. Therefore, the image formed at retina is blurred. There are two main defects of human eye.

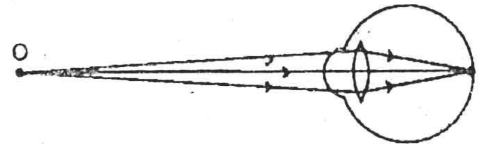
1. Nearsightedness (myopia)
2. Far sightedness (hypermetropia)

1. **Nearsightedness:**

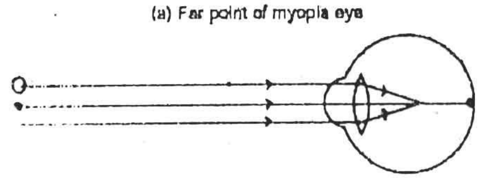
A person suffering from nearsightedness or shortsightedness cannot see distant object clearly. This defect is due to that either the lens of eye ball is thick with short focal length or the eye-ball is too long so that effectively parallel rays from a point for such an eye on a very distant object are focused in front of the retina instead to focus on retina. That is why blurred image is formed.

Correction of nearsightedness

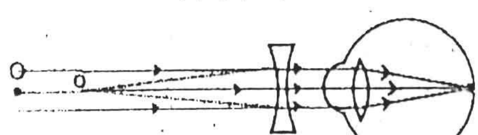
The nearsightedness can be corrected with suitable concave lens. The light rays coming from distant object are diverged by diverging lens so that they appear to be coming from eyes own far point. Therefore the rays focused on retina and sharp image is formed.



(a) Far point of myopia eye



(b) myopia eye



(c) Correction of myopia

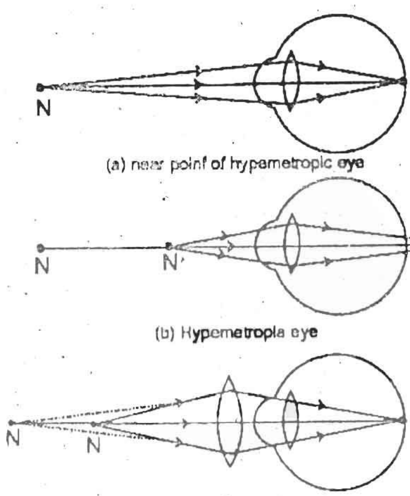
2. **Farsightedness (hypermetropia)**

The disability of the eye to form distinct image of nearby objects on its retina known as farsightedness.

This defect can be caused by the eye-ball which is shorter than the normal size of eye-ball or due thinner eye-lens which has less converging ability. This means that the image is not focused on retina but behind the retina. A man suffering from farsightedness or long-sightedness is unable to read the book which is placed at normal near point 25cm from such eye. Because the near point of such eye is greater than 25 cm.

Correction of far-sightedness

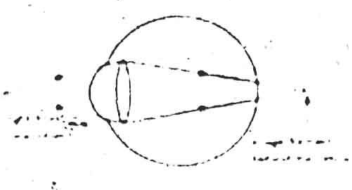
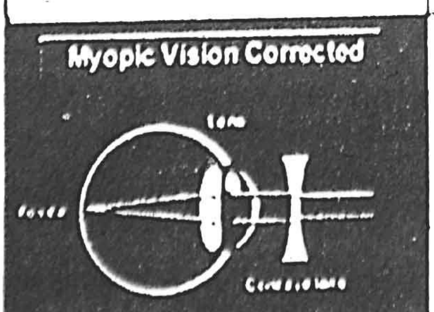
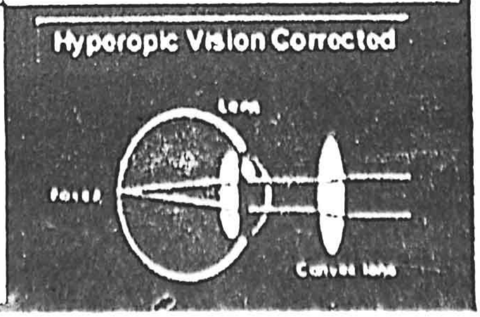
The farsightedness can be corrected with suitable convex lens focused the image on retina. In this way the refracted rays appears to come from near point. Than a sharp virtual image is formed on retina.



(a) near point of hypemetropic eye

(b) Hypemetropia eye

(c) correction of hypametropia eye

Myopia	Aspects	Hypermetropia
•See near object clearly •Can't focus far object	Condition	•Sees distant object clearly •Can't focus near object
•Eye lens too thick •Eyeball too long	Causes	•Eye lens too thin •Eyeball too short
Image form in front retina 	Focus.	Image form behind retina 
	Correction	

NUMERICAL PROBLEMS

12.1 An object 10.0 cm in front of a convex mirror forms an image 5.0 cm behind the mirror. What is the focal length of the mirror?

Solution:

Given that:

Distance of object $p = 10$ cm

Distance of image $q = -5$ cm (For convex mirror)

To Find:

Focal length f = ?

Calculations: Using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By putting the values

$$\frac{1}{f} = \frac{1}{10\text{cm}} - \frac{1}{5\text{cm}}$$

$$= \frac{1-2}{10\text{cm}}$$

$$\frac{1}{f} = \frac{-1}{10\text{cm}}$$

$f = -10$ cm **Ans.**

12.2 An object 30.0 cm tall is located 10.5 cm from a concave mirror with focal length 16.0cm. (a) Where is the image located) (b) How high is it?

Solution: Given that,

Object height $h_o = 30$ cm

Distance of object $p = 10.5$ cm

Focal length $f = 16$ cm

To Find

(a) Distance of image $q = ?$

(b) Image height $h_i = ?$

Calculations: (a) Using the formula

$$\text{Or } \frac{1}{f} = \frac{1}{q} + \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{16\,cm} - \frac{1}{10.5\,cm}$$

Or $$\frac{1}{q} = \frac{1}{16\,cm} - \frac{10}{105\,cm}$$

$$= \frac{105-160}{(16)(105)\,cm}$$

$$= \frac{-55}{(16)(105)\,cm}$$

q= 30.54 cm **Ans.**

(b) we know that

$$\frac{image\ hegith}{object\ height} = \frac{q}{p}$$

or $$\frac{h_i}{h_o} = \frac{q}{p}$$

by putting the values

$$\frac{h_i}{30\,cm} = \frac{30.54\,cm}{10.5\,cm}$$

$$h_i = \frac{30.54\,cm}{10.5\,cm} \times 30\,cm$$

h_i = 87.26 cm Ans.

12.3 An object and its image in a concave mirror are of the same height, yet inverted, when the object is 20.0 cm form the mirror. What is the focal length of the mirror?

Solution: given that,

Distance of object p = 20 cm

Distance of image q =20 cm

To find: focal length f =?

Calculations: using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

By putting the values

$$\frac{1}{f} = \frac{1}{20cm} + \frac{1}{20cm}$$

$$= \frac{1+1}{20\,cm}$$

$$= \frac{2}{20\,cm}$$

$$f = \frac{20\,cm}{2}$$

$f = 10$ cm **Ans.**

12.4 Find the focal length of a mirror that form an image 5.66 cm behind a mirror of an object placed at 34.4 cm in front of the mirror

Solution **Given Data:**

Distance of the image form the mirror = q = 5.66

Distance of object form the mirror = q = 34.4 cm

Required Data:

Find out the focal length of the mirror = ?

Formula: $$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Calculations: By using the above formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

As the image is formed behind the mirror, so it would be convex mirror, so q and f are all negative.

q = - 5. 66 cm

p = + 34 .4 cm

By substituting values in above equation, we get;

$$\frac{1}{f} = -\frac{1}{5.66} + \frac{1}{34.4}$$

$$\frac{1}{f} = -0.177 + 0.029$$

$$\frac{1}{f} = -0.148$$

$$f = -6.77cm$$

12.5 An image of a statue appears to be 11.5 cm behind a convex mirror with focal length 13.5 cm. find the distance form the statue to the mirror.

Solution: Given that,

Distance of image q = -11.5 cm (For convex mirror)

Focal length f = 13.5 c

To Find: Distance of object $p = ?$

Calculations: Using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Or $$\frac{1}{p} = \frac{1}{f} + \frac{1}{q}$$

By putting the values

$$\frac{1}{p} = \frac{1}{13.5\,cm} + \frac{1}{11.5\,cm}$$

$$= \frac{11.5 + 13.5}{(13.5)(11.5)\,cm}$$

$$= \frac{25}{155.25\,cm}$$

$$p = \frac{155.25\,cm}{25}$$

$p = 6.21$ cm **Ans.**

12.6 An image is produced by a concave mirror of focal length 8.70cm. The object is 13.2 cm tall and at a distance 19.3 cm from the mirror. (a) Find the location and height of the image. (b) Find the height of the image produced by the mirror if the object is twice as far from the mirror.

Solution: Given that,

Focal length $f = 8.70$ cm

Object height $h_o = 13.2$ cm

Distance of object $p = 19.3$ cm

To Find:

(a) (i) Location of image $q = ?$

(ii) Height of image $h_o = ?$

Calculation: (i) Using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

Or $$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$= \frac{1}{8.7\,cm} + \frac{1}{19.3\,cm}$$

13.1.7 A capacitor holds 0.06 coulombs of charge when fully charged by a 9 volt battery. Calculate capacitance of the capacitor.

Solution: Given that,

Charge $Q = 0.06\ C$

Voltage $V = 9V$

To Find: Capacitance $C = ?$

Calculations: Using the formula

$$Q = CV$$

Or $$C = \frac{Q}{V}$$

By putting the values

$$C = \frac{0.06C}{9v}$$

$$C = 6.67 \times 10^{-3}\ F$$ **Ans.**

13.1.8 A capacitor holds 0.03 coulombs of charge when fully charged by a 6 volt battery. How much voltage would be required for it to hold 2 coulombs of charge?

Solutions: Given that

Charge $= Q = 0.03\ C$

Voltage $V = 6V$

To Find: Voltage to hold 2C of charge $V = ?$

Calculations: Since

$$0.03\ C = 6V$$

Or $$1C = \frac{6V}{0.03}$$

Therefore,

$$2C = \frac{6V}{0.03} \times 2$$

$$= \frac{1200V}{3}$$

$$V = 400\ V$$ **Ans.**

12.7 **Nabeela uses a concave mirror when applying makeup. The mirror has a radius of curvature of 38.0 cm. (a) what is the focal length of the mirror? (b) Nabeela is located 50cm from the mirror. Where will her image appear? (c) Will the image be upright or invited?**

Solution: Given that,

Radius of curvature R = 38 cm

Distance of object p = 50 cm

To Find

(a) Focal length $f = ?$

(b) Distance of image $q = ?$

(c) Nature of image $= ?$

Calculation (a) Using the formula

$$f = \frac{R}{2}$$

or

$$f = \frac{38\,\text{cm}}{2}$$

$$f = 19\ \text{cm} \quad \textbf{Ans}$$

(b) Using the formula

$$\frac{1}{f} = \frac{1}{q} + \frac{1}{p}$$

Or

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{19\,\text{cm}} - \frac{1}{50\,\text{cm}}$$

$$= \frac{50 - 19}{(19)\,(50)\,\text{cm}}$$

$$= \frac{31}{950\,\text{cm}}$$

$$q = \frac{950\,\text{cm}}{31}$$

$$q = 30.64\ \text{cm} \quad \textbf{Ans}$$

(c) Because magnification $m = \frac{q}{p}$ is positive, so image will be upright.

12.8 An object 4cm high is placed at a distance of 12cm form a convex lens of focal length 8cm. Calculate the position and size of the image. Also state the nature of the image.

Solution: Given that,

Height of object $h_o = 4cm$

Distance of object $p = 12\ cm$

Focal length $f = 8\ cm$

To Find

(i) Position of image $q = ?$

(ii) Size of image $h_i = ?$

(iii) Nature f the image $= ?$

Calculations: (i) Using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

or

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{8\ cm} - \frac{1}{12\ cm}$$

$$= \frac{12 - 8}{(8)(12)cm}$$

$$= \frac{4}{96\ cm}$$

$$q = \frac{96\ cm}{4}$$

$$q = 24\ cm$$ **Ans.**

(ii) We know that

$$\frac{h_i}{h_o} = \frac{q}{p}$$

Or

$$h_i = \frac{q}{p} \times h_o$$

By putting the values

$$h_i = \frac{24\ cm}{12\ cm} \times 4cm$$

$$h_i = 8\ cm$$ **Ans**

(iii) Since the lens in convex and size of image is larger than the size of the object, therefore, image formed is real, inverted and magnified

12.9 An object 10cm high is placed at a distance of 20cm from a concave lens of focal length 15cm high is placed at a instance of 20 cm from a concave lens of focal length 15cm. Calculate the position and size of the image. Also state the nature of the image.

Solution: Given that.

Size of object	h_o	= 10 cm
Distance of object	p	= 20 cm
Focal length	f	= -15 cm (for concave lens)

To Find

(i)	Politico of image	q = ?
(ii)	Size of image	h_i = ?
(iii)	Nature of image	= ?

Calculations: (i) Using the formula

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

or

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

By putting the values

$$\frac{1}{q} = \frac{1}{15\,cm} - \frac{1}{20\,cm}$$

$$= \frac{-4-3}{60\,cm}$$

$$= \frac{-7}{60\,cm}$$

$$q = -\frac{60}{7}cm$$

$$= -.57 \text{ cm} \quad \textbf{Ans.}$$

(ii) We know that

$$\frac{h_i}{h_o} = \frac{q}{p}$$

Or $$h_i = \frac{q}{p} \times h_o$$

By putting the values

$$h_i = \frac{-8.57\,cm}{20\,cm} \times 10cm$$

$$h_i = 4.28 \text{ cm} \quad \textbf{Ans}$$

(iii) Since the lens is concave and object is larger in size than the size of the image, therefore, the image in virtual, eract and diminished.

12.10 A convex lens of focal length 6cm is to be used to form a virtual image three times the size of the object. Where must the lens be placed?

Solution: Given that,

Focal length	f = 6 cm	(For virtual image)
Distance of image	q = 3p	

To Find: Distance of object p = ?

Calculations: Using the formula

$$\frac{1}{f}=\frac{1}{p}+\frac{1}{q}$$

By putting the valuses

$$\frac{1}{6\,cm}=\frac{1}{p}+\frac{1}{3p}$$

$$\frac{1}{6\,cm}=\frac{3-1}{3p}$$

$$\frac{1}{6\,cm}=\frac{2}{3p}$$

Or $3p = 12\,cm$

$$p = \frac{12\,cm}{3}$$

$p = 4cm$ **Ans.**

12.11 A ray of light from air is incident on a liquid surface at an angle of incidence 35°. Calculate the angle refraction if the refractive index of the liquid is 12.5. Also calculate the critical angle between the liquid air inter-face.

Solution: Given that,

Angle of incidence $i = 35^{0}$

Refractive index $n = 1.25$

To Find

(i) Angle of refraction r = ?

(ii) Critical angle C = ?

Calculation: (i) Using Snell's law

$$\frac{\sin i}{f} = n$$

$$\text{Or } \sin r = \frac{\sin i}{n}$$

By putting the values

$$\sin r = \frac{\sin(35^{0})}{1.25}$$

$$\sin r = \frac{0.57}{1.25}$$

$$= 0.456$$

$$r = \sin^{-1}(0.456)$$

$$r = 27.13^{0}$$

(ii) For critical angle. We know that

$$\sin C = \left(\frac{1}{n}\right)$$

or $\quad C = \sin^{-1}\left(\frac{1}{n}\right)$

By putting the values

$$C = \sin^{-1}\left(\frac{1}{1.25}\right)$$

$$= \sin^{-1}(0.8)$$

$$C = 52.13^{\circ} \quad \textbf{Ans}$$

12.12 The power of a convex lens is 5D. At whit distance the object should be placed from the lens so that its real and 2 times larger image is formed.

Solution: Given that

Power of the lens p = 5D

Size of image $\quad q = 2p$

To Find: Distance of object p = ?

Calculations: Using the formula

Power of lens $p = \frac{1}{f}$

or $\quad 5 = \frac{1}{f}$

or $\quad f = \frac{1}{5}$

or $\quad f = 0.2m$

$$= \frac{2}{10} \times 100 \text{ cm} = 20 \text{ cm}$$

Now using the formula

$$\frac{1}{f} = \frac{1}{q} + \frac{1}{p'}$$

By putting the values

$$\frac{1}{20\,\text{cm}} = \frac{1}{p} + \frac{1}{2p}$$

$$\frac{1}{20\,\text{cm}} = \frac{2+1}{2p}$$

$$\frac{1}{20\,\text{cm}} = \frac{3}{2p}$$

$$2p = 60 \text{ cm}$$

$$p = \frac{60\,\text{cm}}{2}$$

$$p = 30 \text{ cm} \quad \textbf{Ans.}$$

REVIEW QUESTIONS

15.1 Demonstrate by an experiment that a magnetic field is produced around a straight current carrying conductor.

See Q. No. 2

15.2 State and explain the rule by which the direction of the lines of force of magnetic field around a current carrying conductor can be determined.

See Q. No. 5

15.3 Your are given an unmarked magnetized steel bar and bar magnet its north and south ends marked N and S respectively. State how would you determine the polarity at each and the unmarked bar?

When one end of unmarked magnet bring close to end 'N' of marked magnet. If marked magnet attract the unmarked then this show that there is south pole on unmarked and if 'N' pole of marked magnet repel the end of unmarked, this show that there is also north 'N' pole of unmarked magnet.

15.4 When a straight current carrying conductor is placed in a magnetic field, it experiences a force. State the rule by which the direction of this force can be found out.

See Q. No. 5

15.5 State that a current carrying coil in a magnetic field experiences a torque.

See Q.No. 6

15.6 What is an electric motor? Explain the working principle of D.C motor?

See Q. No. 7

15. 7 Describe a simple experiment to demonstrate that a changing magnetic field can induce e.m.f in a circuit.

See Q. No. 8

15.8 What are the factors which affect the magnitude of the e.m.f induced in a circuit by a changing magnetic field?

See Q. No. 9

15.9 Describe the direction of an induced e.m.f in a circuit? How this phenomenon is related to the conservation of energy?

See Q.No. 10

15. 10 Draw a labeled diagram to illustrate the structure and working of A.C. generator.

See Q.No. 11

15.11 What do you understand by the term mutual induction? Name and define SI unit of mutual inductance.

See Q.No. 12

15.12 What is transformer Explain the working of transformer in connection with mutual induction.

See Q.No. 13

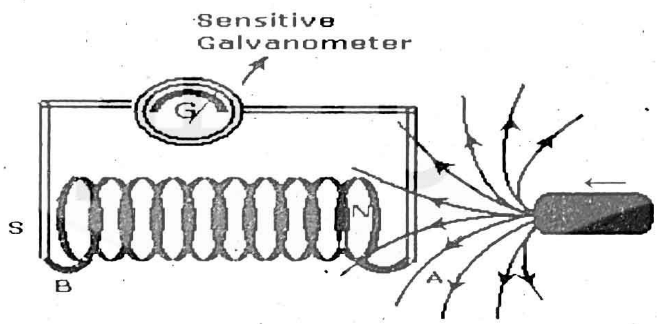
CONCEPTUAL QUESTOINS

15.1 **Suppose someone handed you three similar iron bars and told you one was not magnet but the other two were. How would you find the iron bar that was not the magnet.**

Ans: Take two bars at a time and test the nature of force between their ends. This can be done by bringing two bars close together. If changing the ends of two bars also changes the nature (attraction or repulsion) of force, it means both bars are magnet. If there exists a force of attraction (even on charging the ends) between the bars, it means one of the bars is not magnet. To test which one is not magnet bring each bar close to the third bar. In case of attraction between bars (even by changing their ends), the first (or second) bar will not be magnet while the third bar will be magnet.

15.2 **Suppose you have coil of wire and a bar magnet. Describe how you could use them to generate and electric current.**

Ans By moving a magnet and coil towards each other or away form each other would induce voltage in the coil. This induce voltage will cause current in the coil. You can also induce current in the coil by moving magnet and keeping the coil fixed and vice versa.



15.3 **Which devise is used for converting electrical energy into mechanical energy?**

Ans: Motor is an electrical device which can be used to convert electrical energy into mechanical energy as in fans.

15.4 **Suppose we hang a loop of wire so that it can swing easily. If we now put a magnet into the coil, the coil will start swinging. Which way will it swing relative to the magnet and why?**

Ans: The coil will swing opposite to the direction of motion of the magnet according the lenz's law. It is due to the fact that current in the coil is always induced in such a way so as to cancel the cause which induces it.

15.5 **A conductor wire generates a voltage while moving through a magnetic field. In what direction should the wire be moved, relative to the field to generate the maximum voltage?**

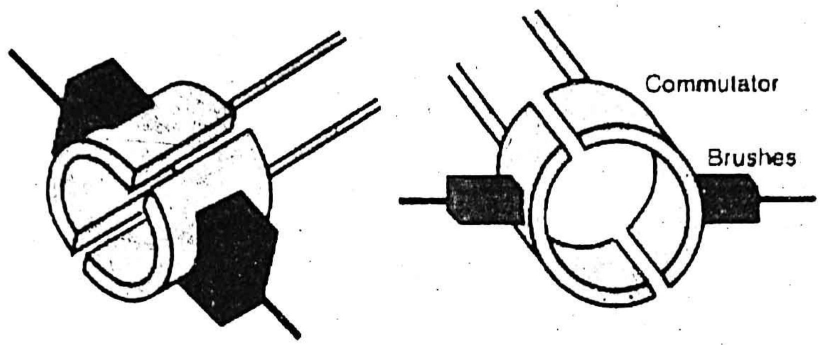
Ans: To generate maximum voltage through the conductor, it must be moving perpendicular to the direction of magnetic field in this case maximum magnetic force will act upon the conductor.

15.5 **What is the difference between a generator and a motor?**

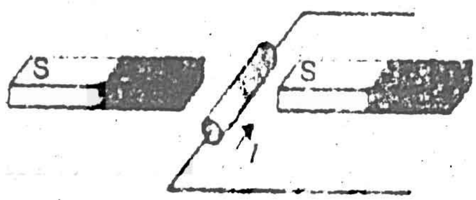
Ans: A motor is essentially an electrical inventor that operates in reverse. A generator converts electrical energy into mechanical energy. Where as a motor converts electrical energy into mechanical energy.

15.7 What reverses the direction of electric current in the armature coil of D.C. motor?

Ans: To reverse the direction of current the connection to coil is made through an arrangement of brushes and a ring that is split into two halves, called splitting commutator. The split ring is ranged so that each half of the commutative changes the brushes just as the coil reaches the vertical position. Changing brushes reverse the current in the loop.



15.8 A wire lying perpendicular to an external magnetic field carries a current in the direction shown in the diagram below. In what direction will the wire move due to the resulting magnetic force?



Ans: According to Fleming's left hand rule it will move downward direction.

15.9 Can a transformer operate on direct current?

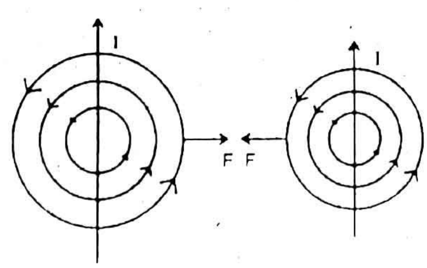
Ans: No, the cycle doesn't change in D,C. that is why there is not change in magnetic flux in core of transformer, that is why, there is no change of flux in secondary coil and current is not induced.

INFORMATION BASED QUESTIONS AND THEIR ANSWERS

Activity (Page 129)

Q.1 Suppose the direction of current passing through two straight wires is same. Draw the pattern of magnetic field of current due to each wire. Would the wires attract or repel each other?

Ans. When current flows through wires in the upward direction, the magnetic field lines around each wire are in the form of concentric circles as shown in fig.



The magnetic field lines of two wires cancel the effect of each the in the space between them. Hence, the two wires attract each other due to weak magnetic field between them and the stronger magnetic field on the other sides of the wires.

EXERCISE
MULTIPLE CHOICE QUESTION

(1) Which statement is true about the magnetic poles?
(a) Opposite poles repel
(b) Like poles attract
(c) Magnetic poles do not effect each other.
(d) A single magnetic pole does not exist

(2) What is direction of the magnetic field lines inside a bar magnet?
(a) From the pole of south pole
(b) From south pole to north pole
(c) From side to side
(d) There are no magnetic field lines

(3) The presence of a magnetic field can be detected by a
(a) Small mass
(b) Stationary positive charge
(c) Stationary negative charge
(d) Magnetic campus

(4) If the current in a wire which is placed perpendicular to a magnetic field increases, the force on the wire
(a) Increase
(b) Decrease
(c) Remain the same
(d) Be zero

(5) A D.C motor converts
(a) Mechanical energy into electrical energy
(b) Mechanical energy into chemical energy
(c) Electrical energy into mechanical energy
(d) Electrical energy into chemical energy

(6) Which part of a D.C motor reverses the direction of current through the coil every half cycle?
(a) The armature
(b) The commutator
(c) The brushes
(d) The slip rings

(7) The direction of induced e.m.f in a circuit in accordance with conservation of
(a) mass
(b) charge
(c) momentum
(d) energy

(8) The step-up transformer
(a) Increase the input current
(b) Increases the input voltage
(c) Has more turns in the primary
(d) Has less turns in the secondary

(9) The turn ratios of a transformer is 10. It means
(a) $I_s = 10I_p$
(b) $N_s = N_p/10$
(c) $N_s = 10N_p$
(d) $V_s = V_p/10$

ANSWER KEY

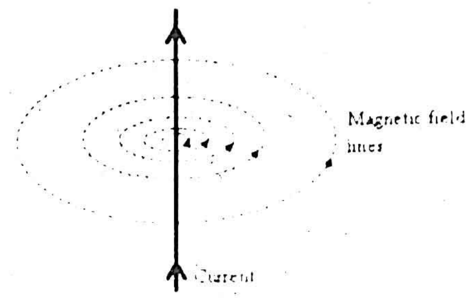
Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1.	d	2.	b	3.	d	4.	a	5.	c
6	b	7.	d	8.	b	9.	c	d	

SHORT QUESTIONS

15.2and 15.2 Magnetic Effects of a Steady Current and Force on a Current – Carrying Conductor Placed in Magnetic Filed

(1) **How magnetic lines of force are formed in the straight current carrying conductor?**

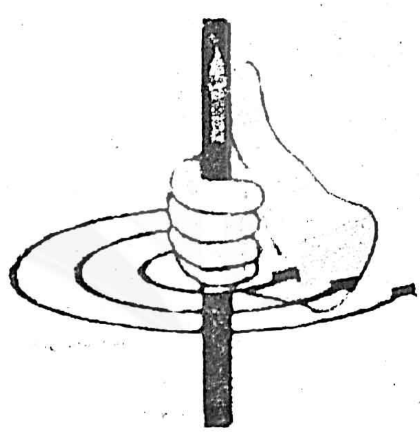
Ans: When current passes through a conductor, a magnetic field is produced in the space around it. If the conductor is a straight wire, the lines of force of this magnetic field would be in the form of concentric circles . These lines of force can be traced on a piece of cardboard with the help of a compass needle.



(2) **What is Right Hand Grip Rule?**

The **Right Hand Grip Rule:**

"Grasp a wire with your right hand such that your thumb pointed in the direction of the conventional (positive) current. Then curling fingers of your hand will point in the direction of the magnetic field



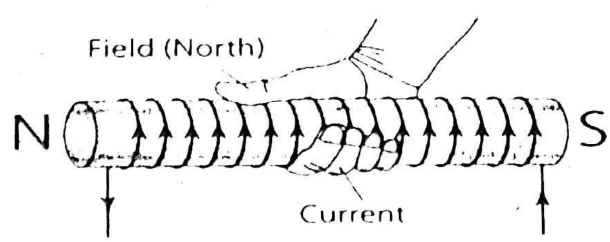
(3) **What do the cross (x) and dot (•) stand for?**

Ans: A dot (•) indicates that the current is directed out of the plane of the paper i.e. it is flowing towards us where as a sign of cross (x) would mean that the current is directed into the paper i.e. it is flowing away from us.

(4) **Write down the rules to find the polarity of solenoid.**

Ans: **Right Hand Grip Rule:**

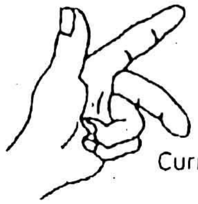
If we grip the coil with our right hand by curling our fingers in the direction of the conventional current, our thumb will indicate the north of the coil.



(5) State Fleming's Left Hand Rule.

Ans: The direction of the force acting on the wire can be determined by Fleming's left hand rule.

"According to this rule, stretch the thumb, forefinger and the middle finger of the left hand mutually at right angle to each other. If the forefinger points in the direction of the magnetic field, the middle finger in the direction of the current, then the thumb would indicate the direction of the force acting on the conductor".



(6) When the force on the current carrying conductor in a magnetic field is maximum and when it is minimum?

Ans: When the current carrying conductor makes an angle of 90^0 with the magnetic field or it is perpendicular to the field, force on it is maximum. If the conductor is placed along or parallel to the magnetic field, no force acts on the conductor.

15.3 and 15.4 Turning effect on current carrying coil in magnetic field and D.C motor

(7) What is D.C. Motor?

Ans: "D.C. motor is a device that converts the electrical energy into mechanical energy, which is utilized for different types of work".

(8) Describe working Principles of D.C Motor.

Working Principles

When a current-carrying coil is placed in magnetic field, it experiences a couple due to which the coil begins to rotate. A D.C motor operates on this principle.

(9) How can we make the coil of D.C Motor rotate continuously

The coil can be rotate continuously by reversing the direction of the current just as the coil reaches its vertical position. This reversal of current will allow the coil to rotate continuously. To reverse direction of current, the connection to coil is made through an arrangement of brushes and a ring that is split into two halves, called a split ring commutator as shown in figure. Brushes, which are usually pieces of graphite, make contact with the commutator and allow current to flow into the loop. As the loop rotates, so does the commutator. The split ring is arranged so that each half of the commutator changes brushes just as the coil reaches the vertical position. Changing brushes reverse the current in the loop. As a result, the direction of the force on each side of the coil is reversed and it continues to rotate.

(10) What is the function of split rings in D.C. motor?

Ans: Split rings connect the coil to the battery through carbon brushes. When coil rotates between the pole pieces of a magnet, split rings keep the current in the same direction in the rotating coil. Split rings change the direction of current in the sides of coil after every half cycle, so the direction of force is changed after every half cycle.

(11) **How the total force acting on the armature can be increased?**

Ans: The total force acting on the armature can be increased by

- ♣ Increasing the number of turns on the coil
- ♣ Increasing the current in the coil
- ♣ Increasing the strength of the magnetic field
- ♣ Increasing the area of the coil

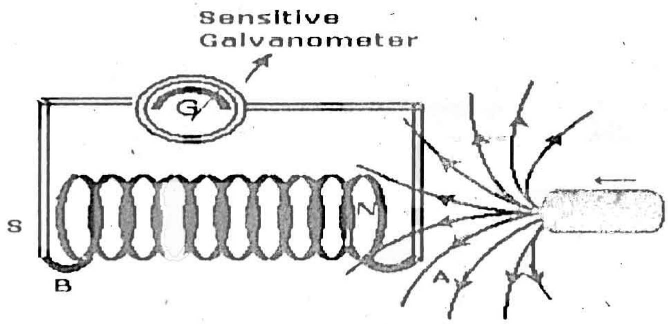
(12) **What is the function of carbon brushes in D.C. motor?**

Ans: Two carbon brushes are used to press slightly against the split rings by means of springs and give continuous passage of current to the coil.

Ans: 15.5, 15.6 and 15.7 Electromagnetic Induction, Direction of Induce e.m.f – Lenz's Law and A.C generator

(13) **Define electromagnetic induction.**

Ans: The process of generating an induced current in a circuit by changing the number of magnetic lines of force passing through it is called electromagnetic induction.



(14) **State Faraday law of Electromagnetic Induction.**

Ans: "The value of the induced e.m.f is directly proportional to the rate of change of flux".

Mathematically:

$$e.m.f = rate\ of\ change\ of\ magnetic\ flux\left(\frac{d\phi}{dt}\right)$$

(15) **Define A.C. Generator.**

Ans: "A device which produces or generates an alternating e.m.f is called A.C. generator". A.C. generator converts mechanical energy into electrical energy.

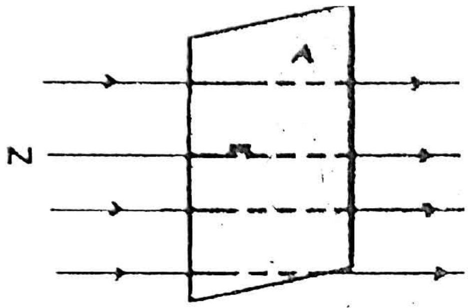
(16) **Write down the principle of A.C. generator.**

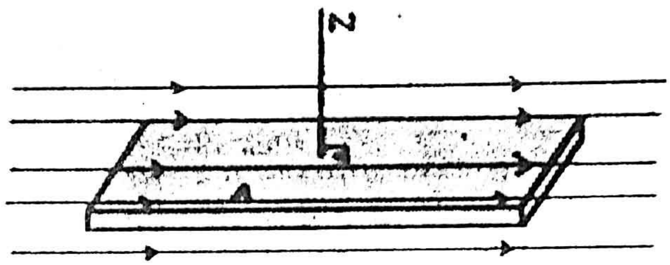
Ans: When a coil rotates in a magnetic field, the flux passing through it continuously changes. This change of flux induces an e.m.f in the coil. This is the principle on which an A.C generator works.

(17) **What is meant by magnetic flux? When it is maximum and minimum?**

Ans: "The number of magnetic lines of force passing through a certain surface is known as magnetic flux passing through that surface"

It is maximum when the area is held perpendicular to the direction of magnetic lines and minimum when the area is held parallel to the direction of magnetic lines of force.





(18) **Is it possible that a constant current flowing in a coil produces an induced current in another coil?**

Ans: No, a constant current flowing in one coil cannot produce induced current in another coil. In order to produce induced current in another coil, the current in first coil must be changing continuously so that magnetic flux may pass through another coil

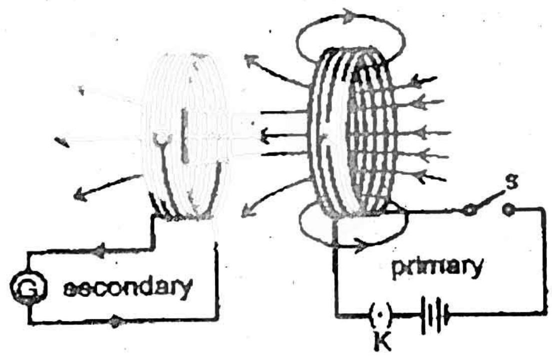
15.8 and 15.9 Mutual induction and Transformer

(19) **Define Mutual induction.**

Ans: "If a current is induced in a circuit due to a change of current in another circuit, this phenomenon is-known as mutual induction"

Unit:

S.I unit of mutual induction is Henry

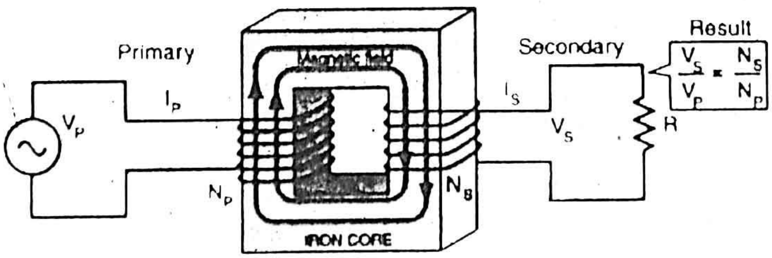


(20) **Define Self Induction.**

Ans: "If the current through a coil or a circuit changes and this change induces an e.m.f in the circuit itself, the phenomenon is known as self induction"

(21) **Define Transformer.**

Ans: "This is an electrical device which is used to increase or decrease the value of alternating voltage".



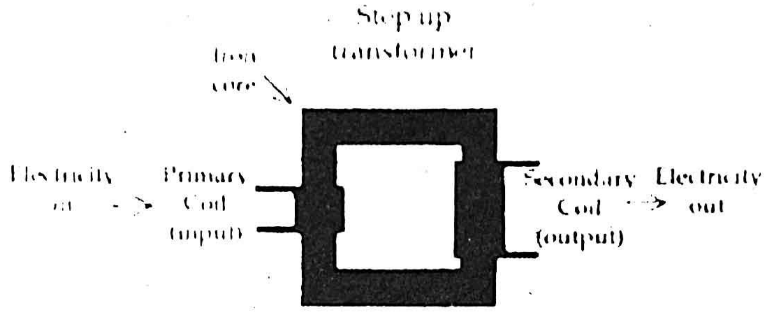
(22) **What do you know about Primary coil and Secondary coil?**

Primary coil

Ans: "The coil of transformer in which the change in current produces induced current in another coil is known as primary coil".

Secondary coil

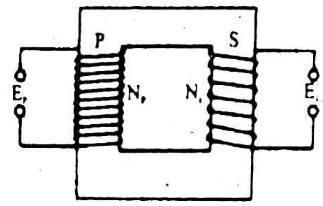
"The second coil of transformer in which current is induced is known as a secondary coil".



(23) Define Step Down Transformer and Step Up transformer.

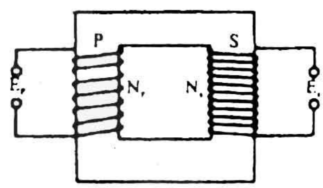
Ans: Step Down Transformer

If the number of turns in the secondary coil is less than the number of turns in primary coil ($N_s < N_p$), then such transformer is called step down transformer. It is used to decrease the A.C. voltage.



Step Up Transformer

If the voltage applied to the primary coil is to be increased, the number of turns in the secondary would be larger as compared to number of turns in the primary. $(N_p < N_s)$ Such a transformer is known as a step up transformer.



(24) What is the function of core in the transformer?

Ans: The iron core enhances the magnetic flux produced in the primary coil and the magnetic flux linked to the secondary coil through iron core.

(25) State Lenz's law?

"The direction of an induced current in a circuit is always such that it opposes the cause that produces it".

(a)

(26) Prove that Lenz law is a manifestation of the law of conservation of energy.

or

How does Induce e.m.f relate to conservation of energy?

Ans : Induce e.m.f and conservation of energy

If we apply the law of conservation of energy to electromagnetic induction, we realize that the electrical energy induce in a conductor appears from the kinetic energy of the moving magnet. We do some work on the magnet to bring it close to the solenoid. This work done consequently appears as electrical energy is the conductor. Thus mechanical energy of our hand used to push the magnet towards or away from the coil results into electrical energy. Hence **Lenz law** is a manifestation of the **law of conservation of energy.**

(27) **Why alternating voltage is stepped up at the generating station?**

Ans: Electric power is usually generated at places which are far from the places where it is consumed. The power is transmitted over long distances at high voltage to minimize the loss of energy in the form of heat during transmission. As heat dissipated in the transmission cable of resistance R is $I^2 Rt$. Hence by reducing the current through the cable, power loss in the form of heat dissipation can also be reduced. So the alternating voltage is stepped up at the generating station.

(28) **How voltages are stepped down?**

High voltages are transmitted to the main sub-station. This voltage is stepped down and is transmitted to the switching transformer station or the city sub-station. At the city sub-station it is further stepped down to 20V and supplied to the consumer.

(29) **Why mains power is supplied as alternating current?**

Transformers play an essential part in power distribution. Transformer work only with AC. This is one reason why mains power is supplied as alternating current.

(30) **What is an electromagnet?**

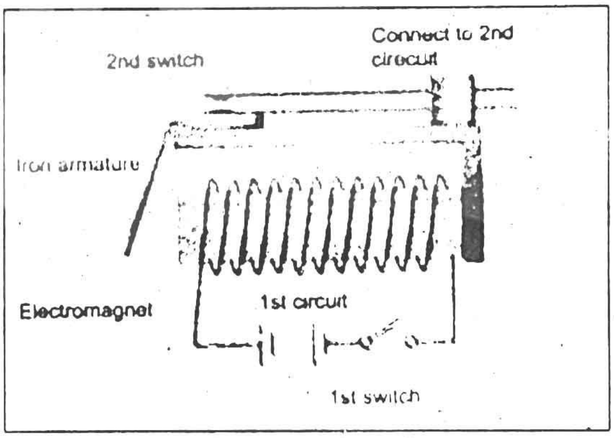
Electromagnet

"Magnetic effect of current is called electromagnet".

(31) **What is Relay Circuit ?**

Relay Circuit

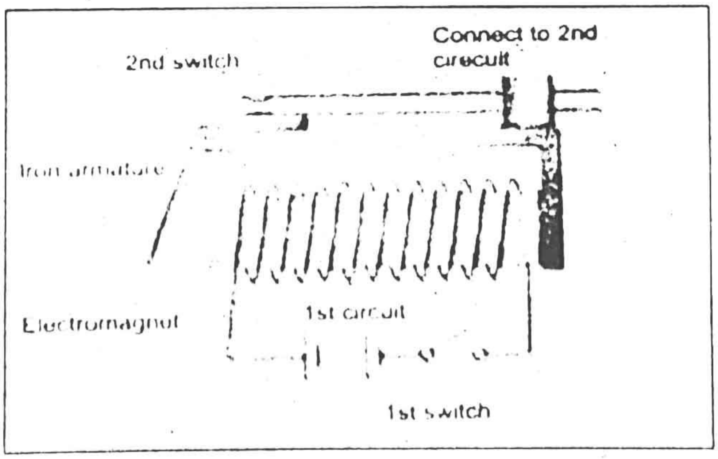
"A relay is an electrical switch that opens and closes under the control of another electrical circuit". The relay is used to control a large current with the help of small current as shown in fig.



(32) **Explain Working principle of relay circuit .**

Working principle of relay circuit

The 1^{st} circuit (input circuit) supplies current to the electromagnet. The electromagnet is magnetized and attracts one end of the iron armature. The armature is then closes the contacts (2^{nd} switch) and allows current to the electromagnet stops. Now electromagnet looses its magnetism and the 2^{nd} switch is opened. Thus the flow of current stops in the 2^{nd} circuit.



LONG QUESTIONS

Q.1: What is meant by electromagnetism?

Electromagnetism

"Electromagnetism is the study of magnetic effects of current."

Q.2: Demonstrate by an experiment that a magnetic field is produced around a straight current carrying conductor also state the rule by which direction of the lines of force of magnetic field around a current carrying conductor can be determined?

Magnetic Effects of a Steady Current

Ampere discovered that when a current passes through a conductor it produces magnetic filed around it.

Experiment:

To demonstrate this, we take straight, conductor wire and pass it vertically through a cardboard. Now connect the two ends of the conductor wire with the terminals of the battery so that current flows through the circuit in the clock wise direction. The lines of force of the magnetic field produced around the wire would be in the form of concentric circles. As shown fig 1 (a).

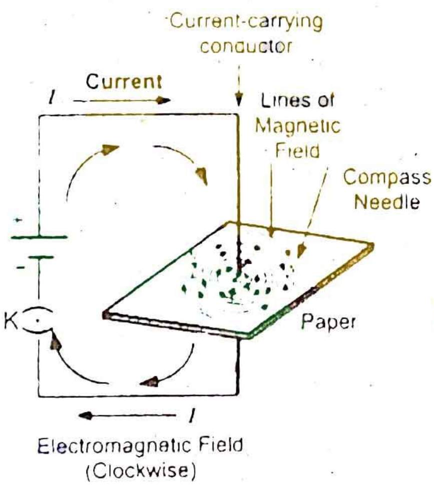


Fig. 15.1(a)

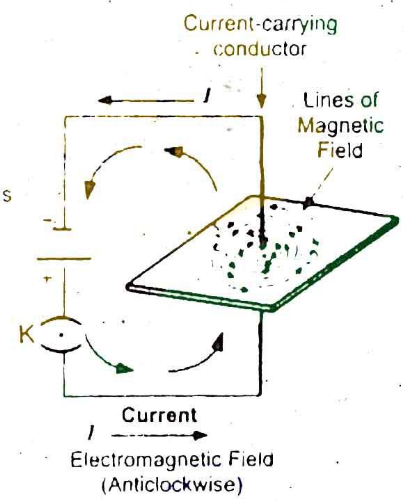


Fig. 15.1(b)

If we place compass needle at different points in the region of magnetic field, it will align along the direction of magnetic field. Also if we sprinkle some iron filings on the cardboard around the wire, they will align themselves in concentric circles in the clockwise direction.

If we reverse the direction of the current by reversing the terminals of the battery, the compass needle also reverses its direction. Now the magnetic field lines will align in the anticlockwise direction.

The magnetic field produced is stronger near the centre of the current – carrying conductor and weaker father away from it. As shown fig 1 (b).

Direction of Magnetic Field

The direction of the magnetic field is governed by the direction of the current flowing through the conductor. A simple method of finding the direction of magnetic field around the conductor is the Right Hand Grip Rule.

Right Hand Grip Rule:

"Grasp a wire with your right hand such that, your thumb pointed in the direction of the conventional (positive) current. Then curling fingers of your hand will point in the direction of the magnetic field."

Q. 4: What is solenoid? Explain magnetic field produced in current carrying solenoid.

OR

Explain magnetic field produced solenoid in resents to bar magnet.

Solenoid:

A long coil of wire consisting of many loops is called a solenoid.

Magnetic Field of a solenoid:

The field from each loop in a solenoid adds to the fields of the other loops and creates greater total field strength as shown in fig. Electric current in the coil of wire produces magnetic field which is similar to the magnetic field of a permanent bar magnet. When this current – carrying coil is brought close to a suspended bar magnet, one end of the coil repels the north pole of the magnet. Thus, the current – carrying coil has a north and a south pole and use itself a magnet.

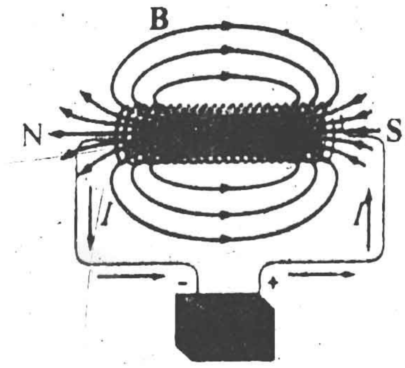


Fig. 15.4: Magnetic field due to a coil

Electromagnet:

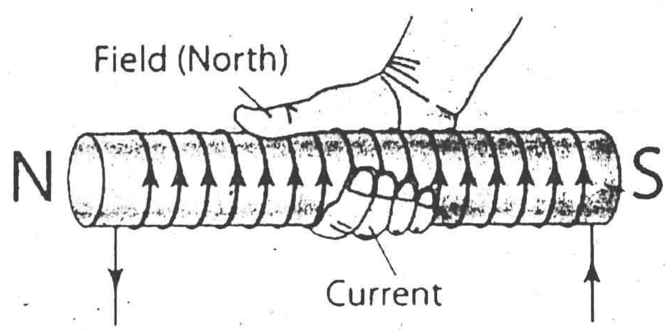
"The type of temporary magnet, which is created when current flows through a coil, is called an electromagnet."

Direction of the magnetic field:

The direction of the field produced by a coil due to the flow of conventional current can be found with the help of right hand grip rule stated as

Right Hand Grip Rule:

If we grip the coil with our right hand by curling our fingers in the direction of the conventional current, our thumb will indicate the north of the coil.



FORCE ON A CURRENT-CARRYYING CONDUCTOR PLACED IN A MAGNETIC FIELD

Q. 5: Explain When a straight current-carrying conductor is placed in a magnetic field, it experiences a force. State the rule by which the direction of this force can be found out.

Force on a current-caryying conductor placed in a magnetic field:

We know that electric current produces a magnetic field similar to that of a permanent magnet. Since a magnetic field exerts a force on a permanent magnet, it implies that current-carrying wire should also experience a force when placed in a magnetic field.

Explanation:

The force on a wire in a magnetic field can be demonstrated using the arrangement. A battery produces current in a wire placed inside the magnetic field of a permanent magnet. Current-carrying wire produces its own magnetic field which interacts with the field of the magnet. As a result a force is exerted on the wire. Depending on the direction of the current, the force on the wire either pushes or pulls it towards left as shown in fig 1(a) and 1(b).

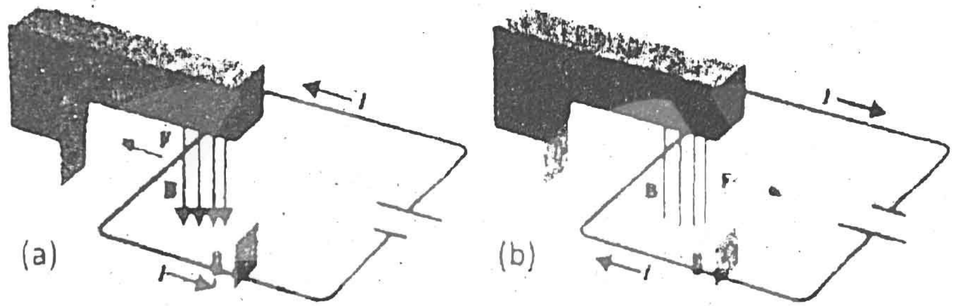


Fig. 15.6 Force on a current-carrying wire in magnetic field

Michael Faraday discovered that the force on the wire is at right angles to both the direction of the magnetic field and the direction of the current.

Factor affecting the force:

The force is increased if

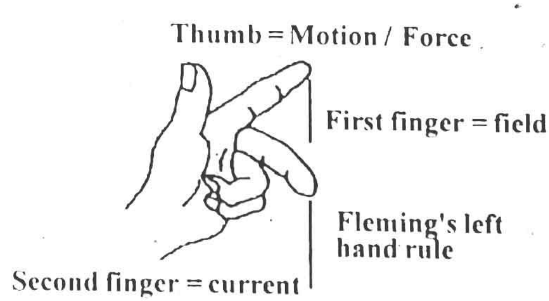
- The current in the wire is increased
- Strength of magnetic field is increased
- The length of the wire inside the magnetic field is increased

Determining the direction of force

Faraday's description of the force on a current-carrying wire does wire does not completely specify the direction of force because the force can be towards left or towards right. The direction of the force on a current – carrying wire in a magnetic field can be found by using Fleming's left hand rule started as:

Fleming's Left Hand Rule

Stretch the thumb, forefinger and the middle finger of the left hand mutually perpendicular to each other. If the forefinger points in the direction of the magnetic field, the middle finger in the direction of the magnetic field, the middle finger in the direction of the current, then the thumb would indicate the direction of the force acting on the conductor.

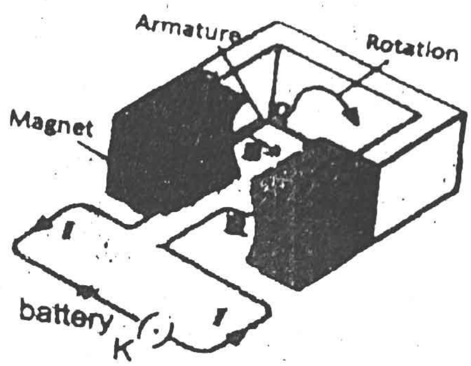


Q.6: State that a current carrying coil in a magnetic field experiences a torque.

TURNING EFFECT ON A CURRENT – CARRYING COIL IN A MAGNETIC FIELD

If instead of a straight conductor, we place a current, carrying loops inside the magnetic field, the loop will rotate due to the torque acting on the coil. This is also the working principle of electric motors.

Explanation:



Consider a rectangular coil of wire with sides PQ and RS, lying perpendicular to the field, placed between the two poles of a payment magnet as shown in fig. Now if the ends of the coil are connected with the positive and negative terminals of battery, a current would start flowing through the coil. The current passing through the loop enters from one end of the loop and leaves from the other end.

Now apply Fleming's left hand rule to each side of the coil as shown in the fig. We can see the PQ side of the loop force arts upward, while on the RS side of the loop force acts downward. It is because the direction of the current through the two sides of the loop facing the two poles is at right angles to the field but opposite to each other. The two forces which are equal in magnitude but opposite in direction form a couple. The resulting torque due to this couple rotates the loop, and the magnitude of the torque acting on the loop is proportional to the magnitude of the current passing through the loop. If we increase the number of loops, the turning effect is greatly increased. This is the principle involved in electric motors.

15.4 D.C Motor

Q.7 What is electric motor? Explain its construction and working principle.

Electric Motor

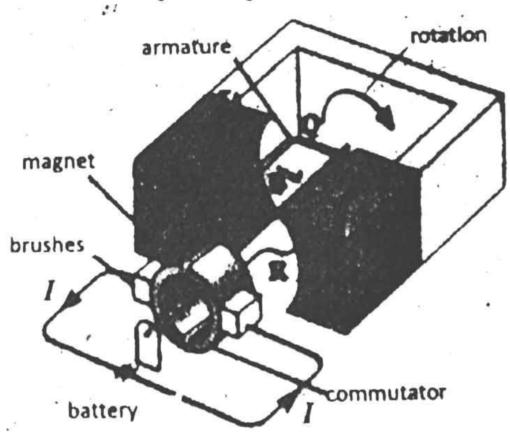
"It is an electrical apparatus (device) that converts electrical energy into rotational kinetic energy".

Working Principles

When a current-carrying coil is placed in magnetic field, it experiences a couple due to which the coil begins to rotate. A D.C motor operates on this principle.

Construction of D.C Motor

D.C motor consists of a rectangular coil PQSR mounted on a shaft or axle. Coil is placed in a field of permanent magnet or in a field which is produced by an electromagnet, called a field of coil. There are two carbon brushes which are usually pieces of graphite, These brushes are made the contact with copper ring. This ring is split into two halves, called a split ring commentators show in fig.1.



(Fig 1.)

Working of D.C Motor

When the coil of the motor is connected to the battery, the current starts flowing through it. The simple coil placed in a magnet cannot rotate more than 90°. The forces push the PQ side of the coil up and the RS side of the loop down until the loop reaches the vertical position. In this situation, plane of the loop is perpendicular t o the magnetic field and the net force on the coil is zero. So the loop will not continue to turn because of the forces are still up and down and balanced.

i. **Function of Commutator**

The coil can be rotate continuously by reversing the direction of the current just as the coil reaches its vertical position. This reversal of current will allow the coil to rotate continuously. To reverse direction of current, the connection to coil is made through an arrangement of brushes and a ring that is split into two halves, called a split ring commutator. Brushes, which are usually pieces of graphite, make contact with the commutator and allow current to flow into the loop. As the loop rotates, so does the commutator. The split ring is arranged so that each half of the commutator changes brushes just as the coil reaches the vertical position. Changing brushes reverse the current in the loop.

As a result, the direction of the force on each side of the coil is reversed and it continues to rotate. This process repeats at each half-turn, causing coil to rotate in the magnetic field continuously. The result is an electric motor, which is an apparatus that converts electric energy into rotational kinetic energy.

In a practual electric motor the coil, called a armature, is made of many loops mounted on a shaft or axle. The magnetic field is produced either by permanent magnets or by an electromagnet, called a field coil. The torque on the armature, and as a result, the speed of the motor, is controlled by varying the current through the motor.

Factors effecting on force

The total force acting on the armature can be increased by

- Increasing the number of turns on the coil
- Increasing the current in the coil
- Increasing the strength of the magnetic field
- Increasing the area of the coil

15.5 Electromagnetic Induction

Q.8 Describe by an experiment to demonstrate that changing magnetic field can induced e.m.f in a circuit?

OR

What is electromagnetic induction? Explain with experiment that a changing magnetic field can induce an e.m.f in circuit?

Electromagnetic Induction

"The process of generating an induce current in a circuit by changing the number of magnetic lines of force passing through it is called electromagnetic induction".

Explanation

Hans Christian oersted and Ampere discovered that an electric current through a conductor produces a magnetic field around it. Michael Faraday described that change of magnetic field in any circuit must produce an electric current in it.

Honery also showed that a changing magnetic field could produce electric current.

Magnetic flux

The number of magnetic lines of force passing through any surface is known as strength of magnetic field (magnetic flux).

How e.m.f. is induce in the coil?

Strength of the magnetic field is maximum when the surface is held perpendicular to the magnetic lines of force.

Strength of the field is minimum when surface is held parallel to the magnetic lines of force.

Magnetic field of a bar magnet through coil

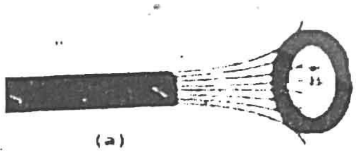
In case of a bar magnet the lines of force are emerging from north pole of a magnet. If we place a coil in the magnetic field of a bar magnet, some of the magnetic lines of force will pass through it.

When the coil is far away from the magnet

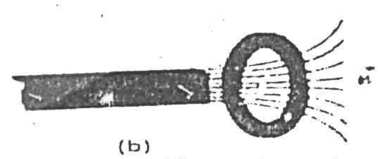
If the coil is far away from the magnet, only a few lines of force will pass through the coil.as shown in fig a.

When the coil is closed to the magnet

If the coil is close to the magnet, a large number of lines of force will pass through it, In this way we can change the number of magnetic lines of force through a coil by moving it in the magnetic field. This change in the number of magnetic field lines will induce and e.m.f in the coil as shown in fig b.



(a)



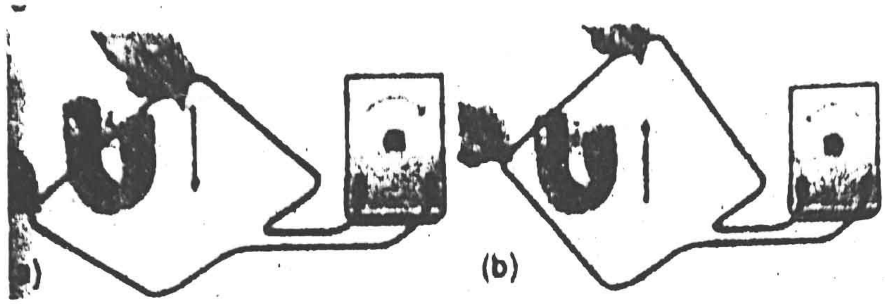
(b)

Note: This is the basic principle of production of electricity and working of transformer.

Experiment:

Take a rectangular loop of wire and connect its two ends with a galvanometer. Now hold the wire stationary or move it parallel to the magnetic field of a strong u-shaped magnet. Galvanometer shows no deflection and hence there is no current. Galvanometer shows no deflection and hence there is no current. Now move the wire downward through the field, current is induced in one direction as shown by the deflection of the galvanometer (Fig. 15.3-b). Now move the wire upward though the field, current is induced in the opposite direction.

It implies that an electric current is generated in a wire only when the wire cuts magnetic field lines. This induced current is generated by induced e.m.f. in the circuit. Faraday found that to generate current, either the conductor must move thorugh a magnetic field or a magnetic field must pass through the conductor.



(b)

Conclusion:

It is concluded that an electric current is generated in a wire only when the wire cuts magnetic field lines. This induced current is generate by the induced e.m.f in the circuit.

Q. 9 Sates Faraday's law of electromagnetic induction. Explain with experiment how current is induced in a solenoid? Write factors.

Faraday's law of electromagnetic induction

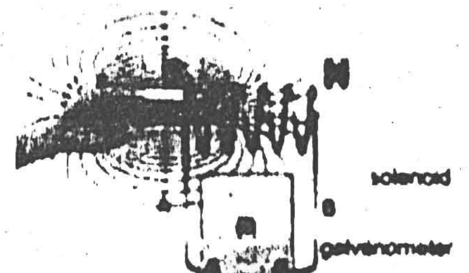
"The value of induced e.m.f in a circuit is directly proportional to the rate of change of number of magnetic lines of force through it."

Induce current in solenoid

Faraday perform experiments in which a current is induced by moving a magnetic into the solenoid or out of the solenoid.

(a)

When the magnet is stationary, no current is induced. When the magnet is moved towards the solenoid, the needle of galvanometer defects towards right, indicating that current is being induced in the solenoid. As shown fig (a).



(b)

When the magnet is pulled away from the solenoid, the galvanometer deflects towards left, indicating that the induced current in the solenoid d is in the opposite direction as

shown in fig.(b)

Conclusion

From the experiments it is concluded that an e.m.f in induced in the coil when there is a relative motion between the coil and the magnet.

Electromagnetic Induction

The phenomenon in which an e.m.f is induced due to the relative motion between the coil and the magnet is called electromagnetic induction.

Factors affecting induced e.m.f

The magnitude of induced e.m.f in a circuit depends on the following factors:

i. Speed of relative motion of coil and magnet

ii. Number of turns of coil.

iii. Amount of current passing through coil.

15.6 Direction of Induced e.m.f ------- Lenz's Law

Q.10 State Lenz's law? Describe the direction of an induced e.m.f in a circuit. How does this phenomenon relate to conservation of energy?

Lenze's Law

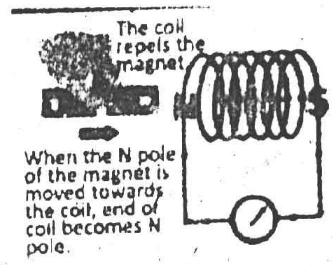
"The direction of an induced current in a circuit is always such that it opposes the cause that produces it".

Direction of induced e.m.f

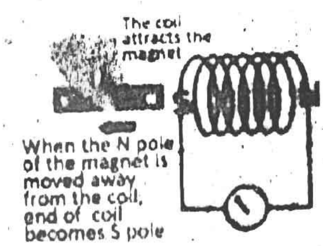
Lenz devised a rule to find out the direction of a current induced in a circuit.

Experiment

If we bring a north pole of a bar magnet near a solenoid, an e.m.f will be induced in the solenoid by electromagnetic induction.



The direction of the induced current in the solenoid by the induced e.m.f will be such that it will repel the north pole of the magnet. This is only possible if the right end the solenoid becomes North Pole. Hence according to right hand grip rule the direction of the induced current in the solenoid will the counter clockwise.



Similarly, when we move the north pole of the magnet away from the solenoid the direction of the induced current will be clockwise.

Induce e.m.f and conservation of energy

If we apply the law of conservation of energy to electromagnetic induction, we realize that the electrical energy induce in a conductor appears from the kinetic energy of the moving magnet. We do some work on the magnet to bring it close to the solenoid. This work done consequently appears as electrical energy is the conductor. Thus mechanical energy of our hand used to push the magnet towards or away from the coil results into electrical energy. Hence **Lenz law** is a manifestation of the **law of conservation of energy.**

15.7 A.C Generator

Q.1. What is A.C. Generator? How is it constructed? How current is induced in it?

A.C Generator

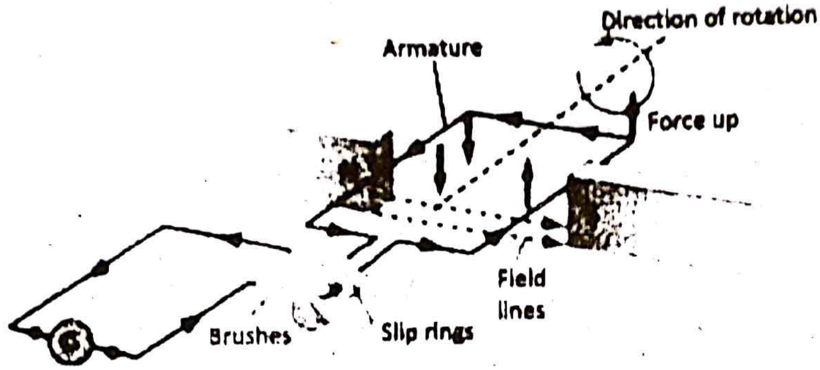
"A device which generates an alternating e.m.f is called A.C. generator". A generator converts mechanical energy into electrical energy.

Principle of working

An A.C generator consists of a coil and magnet. When this coil is made to rotate in a magnetic field, the magnetic flux through it continuously changes due to which an alternating voltage is induced in it. Thus A.C. generator converts mechanical energy into electrical energy.

Construction and Working

A simple generator consists of a rectangular coil, which is rotated between the poles of a permanent magnet. Both the ends of the coil are soldered to the two slip rings fixed on the arm of the coil as shown in figure.

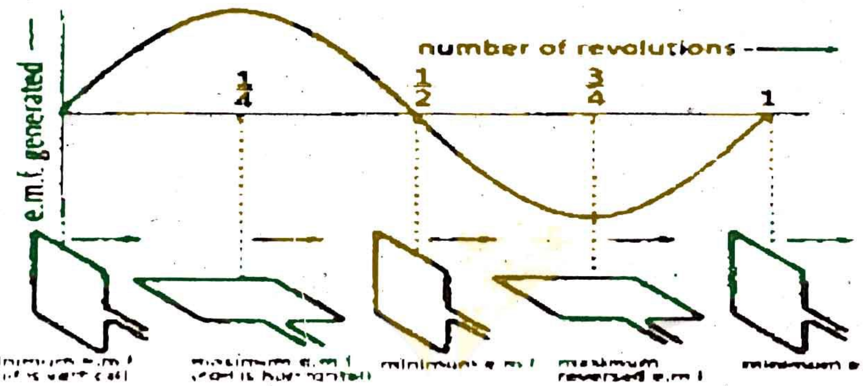


Two carbon brushes are kept in contact with these slip rings with the help of two springs. Current is drawn from the coil through these brushes.

The armature is arranged so that it can rotate freely in the magnetic field. As the armature turns, the wire loops cut through the magnetic field lines and induces an e.m.f. The e.m.f. developed by the generator depends on the length of the wire rotating in the field. Increasing the number of loops in the armature increases the wire length, thereby increasing the induced e.m.f. .

Current from a generator

When a generator is connected in a closed circuit, the induced e.m.f generates an electric current. As the loop rotates the strength and the direction of the current changes as shown in fig.



Position of coil with respect to direction of magnetic field

The current is minimum when the plane of the loop is parallel to the magnetic field; that is, when the loop is in the vertical position. As the loop rotates from the vertical to the horizontal position, it cuts through large magnetic field lines per unit of time, thus the e.m.f and the current increase. When the loop is perpendicular to the field, so the e.m.f and the current reaches their maximum values. As the loop continues to turn, the segment that was moving up begins to move down and reverses the direction of the e.m.f and the current in the loop. This change in direction takes place each time the loop turns through 180°. Thus, the e.m.f and the current change smoothly from zero to some maximum values and back to zero during each half-turn of the loop.

Q.12 What is meant by mutual induction? Name and define SI unit of mutual inductance.

Mutual Induction:

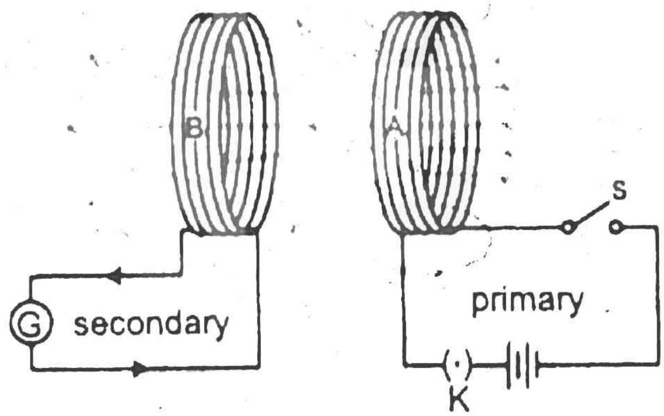
"The phenomenon of production of induced current in one coil due to change of current in a neighboring coil is called mutual induction".

Circuit:

Suppose a system of two coils A and B placed closed to each other. The coil A is connected to a battery and a switch, while a sensitive galvanometer is connected to the coil B. We observe that as soon as the switch of the coil A is closed, the galvanometer shows a momentary deflection. Similarly when the switch is opened the galvanometer again shows a deflection but this time its direction is opposite to that of the previous case.

Explanation

We can explain these observation using Faraday's law of electromagnetic induction. When the switch of coil A is closed, a current is induced in the coil due to which magnetic field id developed across the coil. Some of the magnetic lines of forces of this field start passing through the coil B. Since current is changing in the coil A, hence number of magnetic lines of force across the coil B also changes due to which a current is induced in the coil B in accordance with Faraday's law. When current in the coil A becomes steady, number of magnetic lines of force across the coil A also becomes constant. Therefore there is no more change in number of magnetic lines of force through the coil B due to which induced current in B reduces to zero.



Similarly when the switch of the coil A is opened, the flow of current through it stops and in few moments its magnetic field reaches to zero. The number of magnetic lines of force through the coil B decreases to zero due to which current is again induced in it but in opposite direction to that in the previous case.

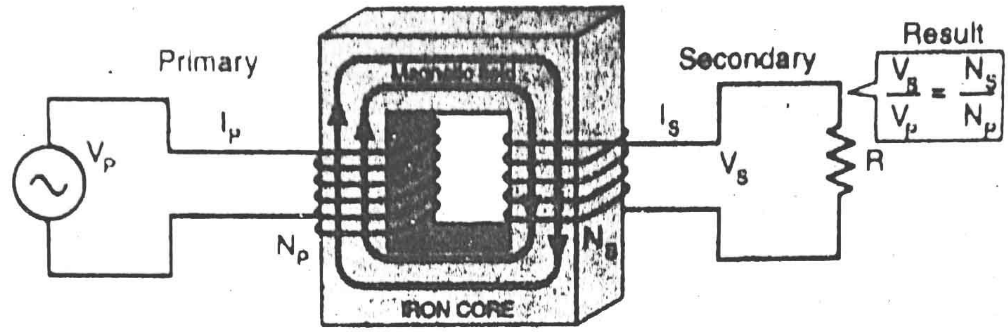
Q.13 What is transformer? Explain its construction, working principle and types.

Transformer

"Transformer is an electrical device which is used to increase or decrease the value of alternating voltage".

Construction

A transformer has two coils, electrically insulated from each other, but wound around the same iron core. One coil is called the primary coil The other coil is called the secondary coil. Number of turns on the primary and the secondary coils are represented by N_P and N_S respectively



Working Principle

When the primary coil is connected to a source of A.C, voltage, the changing current creates a changing magnetic field, which is carried through the core to the secondary coil. In the secondary coil, the changing field induces a varying e.m.f. This effect is called mutual inductance.

Voltages and number of turns of coil

The e.m.f induced in the secondary coil, called the secondary voltage V is proportional to the primary voltage V_p. The secondary voltage also depends on the ratio of the number of turns on the secondary coil to the number of turns on the primary coil, as shown by the following expressions,

$$\frac{V_S}{V_p} = \frac{N_S}{N_p}$$

Types

There are two types of transformer

i. Step – up transformer

ii. Step-down transformer

i. **Step – up transformer:**

If Ns>Np, then secondary voltage is larger than the primary voltage, then the transformer is called a step-up transformer.

ii. **Step-down transformer:**

If Np > Ns then the secondary voltage is smaller than the primary voltage, then transformer is called a step-down transformer.

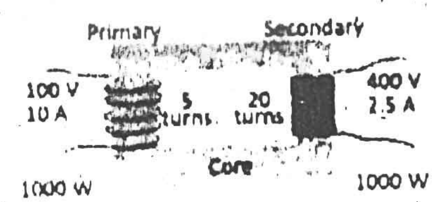


Fig (1.b) Step Up Transformer

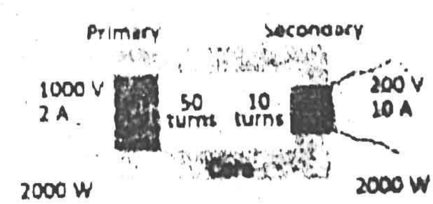


Fig (1.c) Step Down Transformer

An Ideal Transformer

In an ideal transformer, the electric power delivered to the secondary circuit equals the power supplied to the primary circuit. An ideal transformer dissipates not power itself and for such a transformer we can write:

$$P_P = P_S$$

$$V_pI_p = V_sI_s$$

Uses of transformer

Transformer are used to increase or decrease AC voltages. Usage of transformers is common because they change voltages with relatively little loss of energy. In fact, many of the devices in our homes, such as game systems, printers and stereos have transformers in side their casings or as part of their connecting cords.

Q.14 How high voltage transmission reach from power station to consumer?

OR

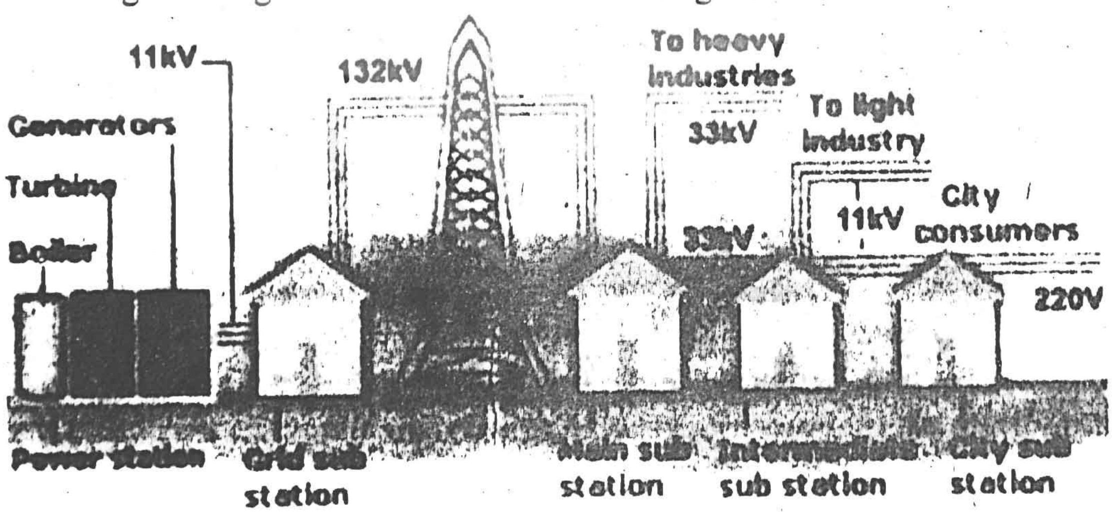
Why alternating voltage is stepped up at the generating station?

Why heat dissipates in transmission?

Electric power is usually generated at places which are far from the places where it is consumed. The power is transmitted over long distances at high voltage to minimize the loss of energy in the form of heat during transmission. As heat dissipated in the transmission cable of resistance R is I^2Rt. Hence by reducing the current through the cable, power loss in the form of heat dissipation can also be reduced. So the alternating voltage is stepped up at the generating station.

How voltages are stepped down?

High voltages are transmitted to the main sub-station. This voltage is stepped down and is transmitted to the switching transformer station or the city sub-station. At the city sub-station it is further stepped down to 20V and supplied to the consumer. A schematic diagram of height voltage transmission is shown in fig.



Main power is supplied as alternating current.

Transformers play an essential part in power distribution. Transformer work only with AC. This is one reason why mains power is supplied as alternating current.

Q.15 What is an electromagnetic? Explain its uses giving one practical example

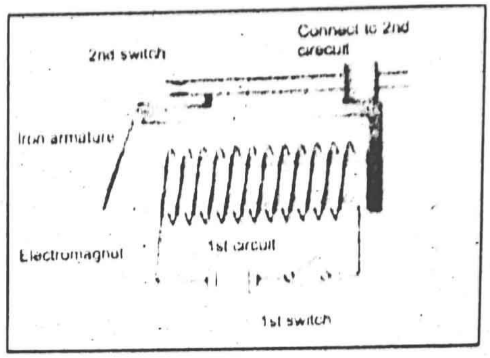
Electromagnet

"Magnetic effect of current is called electromagnet".

Application:

This affect is used in many devices like relay, electric bell etc. soft iron gains and looses magnetism easily in such devices.

Relay Circuit



"A relay is an electrical switch that opens and closes under the control of another electrical circuit". The relay is used to control a large current with the help of small current as shown in fig.

Working principle of relay circuit

The 1st circuit (input circuit) supplies current to the electromagnet. The electromagnet is magnetized and attracts one end of the iron armature. The armature is then closes the contacts (2nd switch) and allows current to the electromagnet stops. Now electromagnet looses its magnetism and the 2nd switch is opened. Thus the flow of current stops in the 2nd circuit.

NUMERICAL PROBLEMS

15.1 **A transformer is needed to convert a mains 240 V supply into a 12V supply. If there are 2000 turns on the primary coil, then find the number of turns on the secondary coil.**

Solution:

Given Data:

$V_p = 240$ V

$V_s = 12V$

$N_p = 2000$

Required: $N_s = ?$

Formula:

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$\mathbf{Ns = \frac{Vs \times Np}{Vp} = \frac{12 \times 2000}{240} = 100}$$

15.2 **A step-up transformer has a turn ratios of 1:100.An alternating supply of 20V is connected across the primary coil. What is secondary voltage?**

Solution:

Given Data:

$N_p : N_s = 1:100$

$V_p = 20V$

Required :

$\mathbf{V_s = ?}$

Formula

$$\frac{N_p}{N_s} = \frac{1}{100}$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$Vs = \frac{N_s \times V_p}{N_p} = \frac{100}{1} \times 20$$

$V_s = 2000$ Volt Ans

15.3 A step – down transformer has a turns ratio of 1:100. An ac voltage of amplitude 170V is applied to the primary. If the current in the primary is 10 mA, what is the current in the secondary?

Solution:

Given Data:

$$N_s : N_p = 1:100$$

$$\frac{N_s}{N_p} = \frac{1}{100}$$

$$V_p = 170v$$

$$I_p = 1mA = 1 \times 10^{-3} A$$

Required

$$I_s = ?$$

Formula

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

$$V_s = \frac{N_s}{N_p} \times V_p$$

$$= \frac{1}{100} \times 170 = 1.7V$$

For an ideal transformer

Power of primary =Power of secondary

$$P_p = P_s$$

$$I_p V_p = I_s V_s$$

$$\frac{I_p V_p}{V_s} = I_s$$

$$\frac{1 \times 10^{-3} \times 170}{1.7} = I_s$$

$$0.1 \text{ A} = I_s \Rightarrow I_s = 0.1\text{A Ans}$$

15.4 A transformer, designed to convert the voltage from 240 V a.c. mains to 12V, has 4000 turns on the primary coil. How may turns should be on the secondary coil? If the transformer were 100% efficient, what current would flow through the primary coil when the current in the secondary coil was 0.4A?

Solution:

Given Data:

$$V_p = 240V$$

$$V_s = 12V$$

$$N_p = 4000$$

Required: $N_s = ?$

Formula:

$$\frac{N_s}{N_p} = \frac{V_s}{V_p}$$

$$Ns = \frac{V_s \times N_p}{v_p} = \frac{12 \times 4000}{240}$$

$N_s = 200$ Ans

$I_p = ?$

$I_s = 0.4A$

$P_p = P_s$

$I_p V_p = I_s V_s$

$$Ip = \frac{I_s V_s}{V_p} = \frac{0.4 \times 12}{240}$$

$\mathbf{I_p = 0.02\ A}$

15.5 **A power station generates 500 MW of electrical power which is fed to a transmission line. What current would flow in the transmission line if the input voltage is 250 kV?**

Solution:

Given Data:

$V = 250 \times 10^3 V$

Power = $P = 500 \times 10^6 W$

Required: $I = ?$

Formula: $P = IV$

$$\frac{P}{V} = I$$

$$\frac{500 \times 10^6}{250 \times 10^3} = I$$

$2 \times 10^3 A = I$ $\Rightarrow I = 2KA$ **Ans**

15.6 **The diagram shows a wind turbine which a 150 kW generator with an output voltage of 1000V. The voltage is increased by transformer T_1 to 10 000 V for transmission to a town 5 km away through power lines with a total resistance of 2Ω. Another transformer, T, at the town reduces the voltage to 250V. Assume that the transformers are 'Ideal' when the system is running at full power: (Figure from the textbook page 143)**

Solution:

Given Data:

Power = P = 150 k W

$P = 150 \times 10^3 W$

At T_1 $Vp = 10000$ V

$R = 2\Omega$

At T_2 $Vs = 250$

REVIEW QUESTIONS

16.1.1 Describe, using one simple diagram in each case, what happens when a narrow beam of electrons is passed through (a) a uniform electric field)b a uniform magnetic field. What do these results indicate about the charge on electron?

Ans. **See Q No 2 & 3**

16.2 Explain the working of different parts of oscilloscope.

16.3 Name some uses of oscilloscope.

16.4 Considering an oscilloscope explain.

(i) How the filament is heated

Ans: Filament is heated electrically by a battery (6V Supply).

(ii) Why the filament is heated

Ans: By heating filament a fine beam of electrons is obtained.

(iii) **Why the anode potential is positive with respect to the cathode potential.**

Ans: To accelerate the electrons emitted form heated filament positive potential of anode is used. In this way the electrons are focused into a fine beam as they pass through the anode.

(iv) **Why a large potential is applied between anode and cathode.**

Ans: After leaving the electron gun, electron beam passes between pair of horizontal. A large potential difference is applied between anode and cathode, due to this potential electrons are directed in specific direction. Higher voltage in short time produced and excellent displaying wave forms height voltage supply also heat the filament quickly and increased the rate of thermo ionic emission.

(v) **Why the tube evacuated?**

Ans: Ionization of gases present in tube occur due to height voltage applied across tube, so it must be evacuated. Due to ionization of gases a fine beam of electrons cold not be produced and accelerate in specific direction.

16.5 **What is electron gun? Describe the process of the thermionic emission.**

Ans. See Q. No 2 & 3

16.6 **What do you understand by digital and analog quantifies?**

Ans. See Q. No 4

16.7 **Differentiate between analog electronics and digital electrons. Write down names of five analogue and five digital devices that are commonly used in every day.**

Ans. See Q. No 4

16.8 **State and explain for each case whether the information given by the following devices is in analogue or a digital form.**

Ans: **(i) A moving coil voltmeter measuring the e.m.f of a cell**

A moving coil voltmeter measuring the e.m.f of a cell provide information in the form of analogue form.

(ii) A microphone generating an electric current.

A microphone generating an electric voltage is also in the form of analogue form.

(iii) A central heating thermostat controlling the water pump.

Central heating thermostats controlling the water pump in the form of analogue signal.

(iv) Automatic traffic lights controlling the flow of traffic.

Automatic traffic lights also work on the basis of analogue quantities.

16.9 Write down some benefits of using digital electronics over analogue electronics.

Ans: The big advantage of digital electronics is quality.

There is no interference or loss of strength in digit signal traveling in an optical fibre. Digit technology in TV gives excellent view and alloy you to be interactive.

Smart ID cards are being developed. A single card can be passport, national insurance card and driving license all in one. The card could also hold biometric data like an eye retina scene and voice scene for unique identification and security. All of this data would be held digitally in the tiny chip. Now, today everything is going digital like digital cameras are fast replacing traditional film equipment. You can download an image into a PC and edit the picture.

16.10 What are the three universal Logic Gates? Give their symbols and truth tables.

Ans. **See Q. No. 13-14-15**

CONCEPTUAL QUESTIONS

16.1 Name two factors which can enhance thermionic emission.

Ans:Rate of thermionic emission depends upon the nature of the metal used, temperature and surface area of the metal. By increasing the temperature and surface area of the cathode, rte of therminonic emission can be increased.

16.2 Give three reasons to support the evidence that cathode rays are negatively charged electrons.

Ans: IN the beginning, no one was sure about the nature of cathode-rays. It was J.J. Thomson who carried out many experiments and concluded that cathode-rays are negatively charged electrons. The three reasons to support this evidence are as follows.

- They are attracted towards positively charged plate.
- They are deflected in magnetic field opposite to the direction of positive charge.
- Their charge to mass ratio (e/m) is equal to e/m of electrons.

Q. 16.3 When electrons pass through two parallel plates having opposite charges they are deflected towards the positively charged plate. What important characteristics of the electron can be inferred form this?

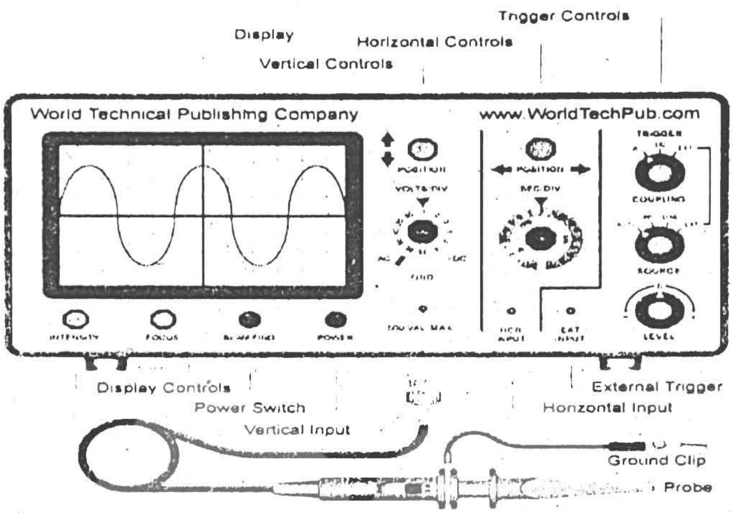
Ans: From the deflection of electrons towards the positively charged plate, we can easily conclude that electrons carry negative charge.

Q. 16.4 When a moving electron enters the magnetic field it is deflected from its straight path. Name two factors which can enhance electron deflection.

Ans: Two factors which enhance the deflection of electrons in a magnetic field are the strength of magnetic field and speed of electron.

16.5 **In what ways is an oscilloscope a voltmeter?**

In order to use oscilloscope as a voltmeter, switch OFF the time base and connect the voltage to be measured to the Y-input terminals. In this way the deflection of the spot would be vertically. The deflections is proportional to potential difference, which is to be measured. In this way the input of CRO (i.e. internal resistance between Y-inputs terminals) is very height, typically several million ohms. This makes an oscilloscope very nearly an ideal voltmeter.



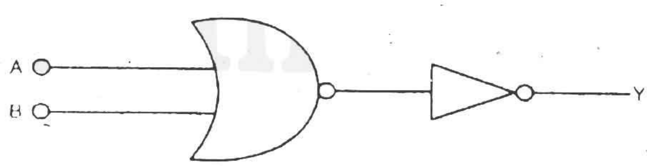
16.6 **How can you compare the logic operation X = A.B with usual operation of multiplication**

Ans: From the truth table of AND operation it is clear that behave as multiplicative inverse. Each time result is zero when is multiplied with any Boolean variable. Hence logic operation X = A.B behave as operation of multiplication

16.7 **NAND gate is the reciprocal of AND gate. Discuss. .**

Ans: In NAND gate the value of AND gate is inverted by NOT gate. From the sets of inputs and output given in truth table of NAND gate, its is clear that it is the reciprocal of AND gate i.e. every time the value of output of AND gate is

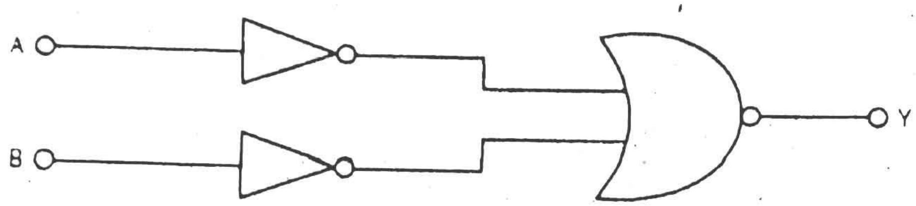
16.8 **Show that the circuit given as below acts as OR gate.**



Ans: The electronic circuit which implements the OR operation is **known as OR gate. It has** two or more than two inputs and has only one output. The values of output of OR gate are always in accordance with the truth table of OR operation.. It means, the value of output of OR gate will be '1' when one of its inputs is at '1'. The output will be '0', when both inputs are at '0'.

A	B	X = A + B	$X = \overline{A+B}$	$X = \overline{\overline{A+B}}$
0	0	0	1	0
1	0	1	0	1
0	1	1	0	1
1	1	1	0	1

Q. 16.9 **Show that the circuit given as below acts as AND gate.**



Ans: The circuit which implements the AND operation is known as AND gate. AND gate has two or more than two inputs and only one output. The value of output of NAND gate is always in accordance with the truth table of AND operation. It means output of AND gate will be '1' only when both of its inputs are at logic '1', for all other situations output of AND gate will be '0'.

A	B	$\overline{A}$	$\overline{B}$a	$\overline{A}.\overline{B}$	$\overline{\overline{A}.\overline{B}}$
0	0	1	1	1	0
0	1	1	0	1	0
1	0	0	1	1	0
1	1	0	0	0	1

INFROMATION BASED QUESTIONS AND THEIR ANSWERS

Point to Ponder (Page 147)

Q.1 **When a magnet is brought near to the screen of a television tube picture on the screen is distorted. Do you know why?**

Ans. Electromagnets are used to deflect electrons to the desired positions of the screen of a television tube to produce clear picture. When a magnet is brought near to the screen of the television tube, the spot of the electrons beam on the screen is distorted.

Quick Quiz (Page 156)

Q.2 **Assume you have an Or gate with two inputs, A and B. Determine the output C, for the following cases:**

(a) A = 1, B = 0 (b) A = 0, B = 1

If either input is one, what is the output?

Ans. The value of the output of Or gate will '1' when either of its inputs is '1'. Thus, in this case, the output C will be '1'.

EXERCISE

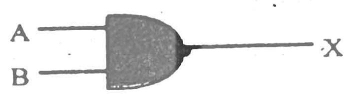
MULTIPLE CHOICE QUESTIONS

(1) **The process by which electrons are emitted by a hot metal surface is known as**

(a) Boiling (b) Evaporation
(c) Conduction (d) Thermionic emission

(2) **The particles emitted from a hot cathode surface are**

(a) Positive ions (b) Negative ions (c) Protons (d) Electrons



(3) **The logical operation performed by this gate is**

(a) AND (b) NOR (c) NAND (d) OR

(4) **AND gate can be formed by using two**

(a) NOT gates (b) OR gates (c) NOR gates (d) OR gates

(5) **The output of a two-input NOR gate is 1 when**

(a) A is 1 and B is 0 (b) A is 0 and B is (c) Both A and B are 0 (d) Both A and B are 1

(6) **If X = A. B, then X is 1 when:**

(a) A and B are 1 (b) A or B is 0 (c) A is 0 and B is 1 (d) A is 1 and B is 0

(7) **The output of a NAND gate is 0 when**

(a) Both of its inputs are 0 (b) Both of its inputs are 1
(c) Any of its inputs is 0 (d) Any of its inputs is 1

ANSWER KEY

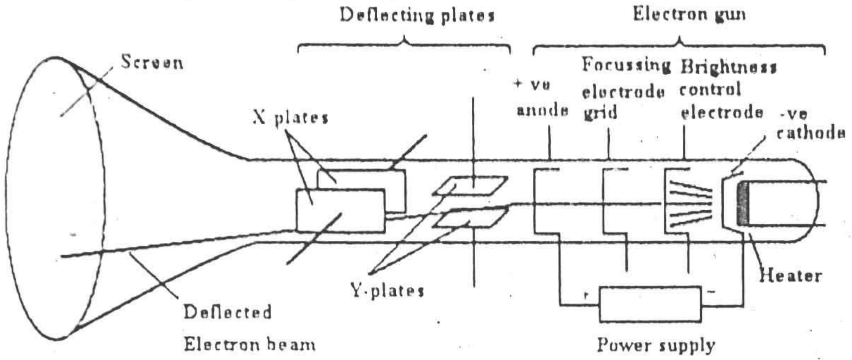
1	2	3	4	5	6	7
d	d	c	c	c	a	b

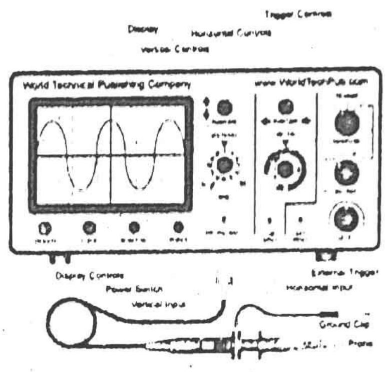
CHAPTER 16

BASIC ELECTRONICS

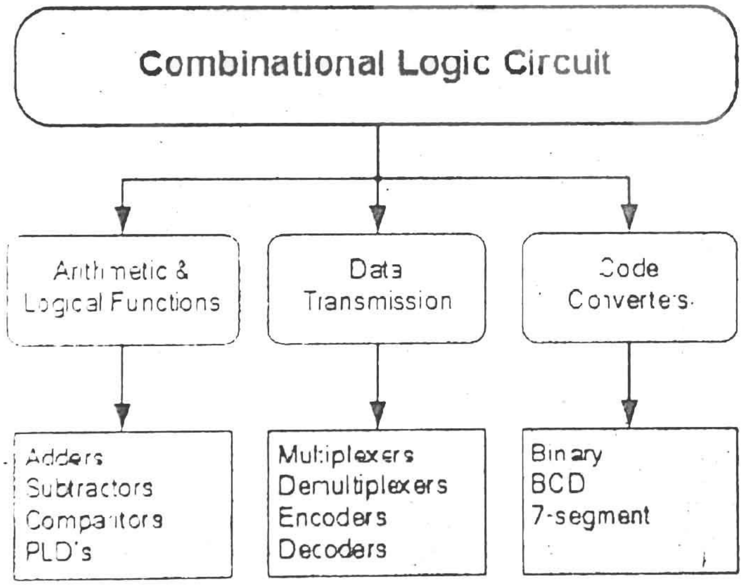
CATHODE RAY OSCILLIOSCOPES

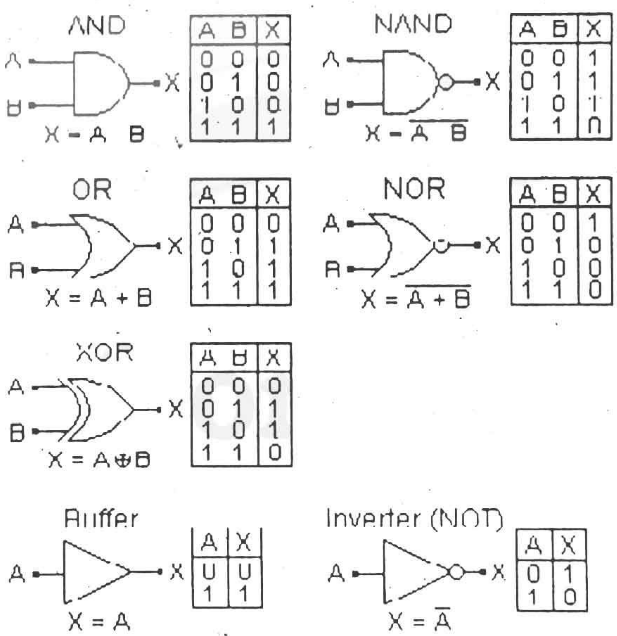
28.1.11 Cathode ray oscilloscope





DIGITAL ELECTRONICS AND LOGIC GATES





AND

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

NAND

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

OR

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

NOR

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

XOR

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Buffer

A	X
0	0
1	1

Inverter (NOT)

A	X
0	1
1	0

MULTIPLE CHOICE QUESTIONS

16.1 Thermionic Emission
1.6.2 Investigating the properties of Electrons
16.3 Cathode-Ray Oscilloscope (C.R.O)

(1) **The branch of applied physics which deals with the behaviour of electrons using different devices for various useful purposes is**
(a) light (b) mechanics (c) thermodynamics (d) electronics

(2) **Who observed the deflection of cathode rays by both electric and magnetic fields?**
(a) Newton (b) J.J Thomson (c) Plank (d) Charles

(3) **Cathode rays contain negatively charged particles called:**
(a) Neutrons (b) protons (c) electrons (d) positrons

(4) **The process of emission of electrons from the hot metal surface is called;**
(a) dynamic emission (b) electronic emission
(c) thermionic emission (d) static emission

(5) **Metals contain large number of:**
(a) free electrons (b) Free protons (c) free neutrons (d) bound electrons

(6) **For thermionic emission typical values of voltage and current used are:**
(a) 3v, 0.4A (b) 6V, 0.3A (c) 5V, 0.3A (d) 6V, 0.1A

(7) **Electron gun is used to investigate the properties of;**
(a) electron beam (b) nucleus (c) neutron (d) proton

(8) **The degree of deflection of electrons from their original direction is proportional to;**
(a) the speed of electrons (b) the strength of the electric field applied
(c) the amount of current (d) the potential difference

(9) **A component of cathode-ray oscilloscope (C.R.O) is;**
(a) the electron gun (b) the deflecting plates
(c) a fluorescent screen (d) all of given

(10) **Electron gun has an electrode for controlling the flow of electron in the beam;**
(a) grid C (b) grid A (c) grid B (d) grid G

(11) **The screen of a cathode-ray tube consists of a thin layer of;**
(a) aluminium (b) potassium (c) phosphor (d) sulphur

(12) **Cathode-ray oscilloscope (C.R.O) is used in many field of science for;**
(a) displaying waveforms (b) measuring voltages
(c) range-finding (d) all given are true

(13) **To find the depth of sea-beds, C.R.O is used as:**
(a) echo-sounding (b) displaying waveforms
(c) measuring voltage (d) range finding

16.4 Analogue and Digital Electronics
16.5 Basic Operations of Electronic-Logic Gates

(14) **Analogue quantities are;**
(a) whose values vary continuously (b) whose values remain cosntatn
(c) e.g. temperature of air (d) all of given are true

(15) **Time , pressure, distance are all:**
(a) analogue quantities (b) variable quantiites
(c) nominal quantities (d) digital quantities

(16) **Which is an analogue circuit which amplifies the singals without chaninging its shape to such an extent that it can operatre a loudspeaker?**
(a) Galvanometer (b) Manometer (c) amplifier (d) Optical fiber

(17) **The quantities whose value vary in non –continuous manner are called;**
(a) analogue quantities (b) digital quantities
(c) statistic quantities (d) continuous quantiies

(18) **Those quantities whose value vary continuously or remain constant:**
(a) Analogue (b) Digital (c) Hybrid (d) All of them

(19) **Which of the following is an analogue device?**
(a) Electric fan (b) Electric iron (c) Radio receiver (d) All of them

(20) **Electronics which provides the data in the form of maximum and minimum voltage signals:**
(a) Analogue (b) Digital (c) Hybrid (d) All of them

(21) **Which of the following are digital devices?**
(a) Computer (b) Mobile phone (c) Digital camera (d) All of them

(22) **Circuits which convert the digital signal into analogue signals:**
(a) ADC (b) DAC (c) CAD (d) None of them

(23) **Circuits which convert the analogue signal into digital signal:**
(a) ADC (b) DAC (c) CAD (d) None of them

(24) **Digital electronics uses two digits.**
(a) 0,2 (b) 0,3 (c) 0,1 (d) 0,4

(25) **A switch has only possible states.**
(a) Two (b) Three (c) Four (d) Five

(26) **The states of binary variables are usually represented by the digits;**
(a) 1,2 (b) 0,2 (c) 0,3 (d) 0,1

(27) **George Boolean invented a special algebra known as algebra of logics or ________.**
(a) Boolean algebra (b) Geometry (c) Ratios (d) Trigonometry

(28) **Boolean algebra operates with two logic states represented by two distinct voltage level.**
(a) 0,2 (b) 0,3 (c) 1,0 (d) 1,1

(29) **The number of operations of Boolean algebra are:**
(a) 1 (b) 2 (c) 3 (d) 4

(30) **In Boolean Algebra zero represents:**
(a) Zero potential (b) Ground potential (c) Low potential (d) Both a & b

(31) **In Boolean Algebra 1 represents:**
(a) 5V (b) 1V (c) Both a & b (d) None of above

16.6 AND Operation
16.7 OR Operation

(32) **The logical operation, whose output will only be one if its all inputs are 1:**
(a) AND (b) OR (c) NOT (d) All of above

(33) **The logical operation, whose output will only be zero if its all inputs are zero:**
(a) AND (b) OR (c) NOT (d) All of above

(34) **AND operation is just like --------- combinations of resistors:**
(a) Series (b) Parallel (c) Both (d) None of above

(35) **AND operations is represented by:**
(a) Dot (•) (b) Multiplication sign (c) Any sign (d) Both a & b

(36) **OR operation is just like --------- combinations of resistors:**
(a) Serial (b) Parallel (c) Both (d) None of above

(37) **OR operations is represented by:**
(a) Dot (•) (b) Multiplication sign (c) '+' sign (d) Both a & b

(38) **The various operations of Boolean variables are also called:**
(a) Boolean constants (b) Algebraic operations (c) Logic operations (d) Both b & c

(39) **The circuit which implements the AND operation is called:**
(a) AND gate (b) AND circuit (c) OR gate (d) Both a & b

(40) **The circuit which implements the OR operation is called:**
(a) AND gate (b) OR circuit (c) OR gate (d) Both b & c

(41) **The word "truth" that is used in Boolean algebra is borrowed from:**
(a) Mathematics (b) Italian (c) Geometry (d) Subject of Logic

(42) **If switches S_1 and S_2 both are open the lamp is:**
(a) ON (b) OFF
(c) sometime ON and sometime OFF (d) Neither ON nor OFF

(43) **In case of OR operation the lamp is Off when:**
(a) S_1 and S_2 are open (b) S_1 is open and S_2 is closed
(c) S_1 is closed and S_2 is open (d) S_1 and S_2 are closed

(44) **OR operation is represented by the symbol of (+) and Boolean expression for OR is:**
(a) $x = A + B$ (b) $x = A - B$ (c) $x + A = A$ (d) $X = \overline{A+B}$

16.8 NOT Operation
16.9 NAND Gate

(45) **NOT operation is represented by:**
(a) line (b) bar over the symbol
(c) both A & B (d) (.) dot

(46) **Value of a Boolean variable 1 after NOT operation is;**
(a) 0 (b) +1 (c) -1 (d) -2

(47) **After NOT operation the value of Boolean variable 0 is;**
(a) 0 (b) +1 (c) -1 (d) 1

(48) **NOT gate is also called;**
(a) converter (b) inverter (c) adder (d) substractor

(49) **NAND operation is simply an AND operation followed by a;**
(a) NOR operation (b) OR operation (c) NOT operation (d) AND operation

(50) **NOT operation is also known as:**
(a) Gate (b) Inverter (c) Converse (d) All of above

(51) **Number of input(s) of NOT operation are:**
(a) 1 (b) 2 (c) 3 (d) 4

(52) **The circuit which is used to implement NOT operation:**
(a) AND gate (b) NOT gate (c) OR gate (d) Both a & b

(53) **NAND gate is the combination of:**
(a) AND & OR (b) AND & NOT (c) NOT & OR (d) None of them

(54) **A and B are two inputs of NAND gate. Its output would be zero when**
(a) A=0, B=0 (b) A=1, B=0 (c) A=0, B=1 (d) A=1, B=1

(55) **NOR gate is the combination of:**
(a) AND & OR (b) AND & NOT (c) NOT & OR (d) None of them

(56) **A and B are the two input of NOR gate. Its output would be 1 when:**
(a) A=0, B=0 (b) A=1, B=0 (c) A=0, B=1 (d) A=1, B=1

(57) **The output of the NAND is written as;**
(a) $x = A + B$ (b) $X = A \cdot B$ (c) $x = A.B$ (d) $X = \overline{A.B}$

16.10 NOR Gate

16.11 Uses Of Logic Gates

(58) **The NOR operation is simply an OR operation followed by a;**
(a) NOT operation (b) AND operation (c) NAND operation (d) OR operation

(59) **The Boolean expression for NOR operation is;**
(a) $X = \overline{A+B}$ (b) $X = A - B$ (c) $X = A + B$ (d) $X = \overline{A.B}$

(60) **To make burglar alarm, we use:**
(a) NAND gate (b) OR gate (c) NOT gate (d) NOR gate

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	d	11	c	21	d	[illegible]	a	41	d	51	a
2	b	12	d	22	b	[illegible]	a	42	a	52	b
3	c	13	a	23	a	33	b	43	a	53	b
4	c	14	d	24	c	34	a	44	a	54	d
5	a	15	a	25	a	35	a	45	b	55	c
6	b	16	c	26	d	36	b	46	a	56	a
7	a	17	b	27	a	37	c	47	d	57	d
8	b	18	a	28	c	38	c	48	b	58	a
9	d	19	d	29	c	39	a	49	c	59	a
10	d	20	b	30	d	40	c	50	b	60	a

SHORT QUESTIONS

16.1 Thermionic Emission
16.2 Investigating the properties of Electrons
16.3 Cathode-Ray Oscilloscope (C.R.O)

(1) Define electronics.

Ans: The branch of applied physics which deals with the behaviour of electrons using different devise for various useful purposes is known as electronics

(2) What do you understand by thermionic emission?

Ans: **Thermionic Emission**

The process of emission of electrons form the hot metal surfaces is called thermionic emission.

(3) What happens when a narrow beam of electrons is passed through a uniform electric field? What is its reason?

Ans: We can set up electric field by applying a potential difference across two parallel metal plates placed horizontally separated with some distance. When an electron beam passes between the two plates. It can be seen that the electrons are deflected towards the positive plate (Fig. 16.1). The reason for this is that electrons are attracted by the positive charges and repelled by the negative charges due to force $F = qE$. The degree of deflection of electrons form their original direction is proportional to the strength of the electric field applied.

(4) What is the function of electromagnetism in television?

Ans: Electromagnets are used to deflect electrons to the desired positions on the screen of a television tube.

(5) What happens when a narrow beam of electrons is passed through a uniform magnetic field.

Ans: Deflection of Electrons by Magnetic Field

We apply magnetic filed at right angle to the beam of electrons by using a hoarse-shoe magnet as shown in fig. W e will notice that the spot of the electrons beam on he screen is getting deflected form its original direction. Now charge the direction of horse-shoe magnet. We will see that spot on the fluorescent screen is getting deflected in the opposite direction.

(6) When and who discovered electrons?

Ans: In the 1950's physicists stared to examine the passage of electricity through on vacuum tube. Some kind of rays was emitted from the cathode or the negative electrode, the rays were called cathode rays. J.J Jhomson in 1897 observed the deflection of cathode rays by both electric and magnetic field. From these deflection experiments he concluded that cathode rays must carry a negative charge. These negatively charged particles were given the name of electrons.

(7) What is meant by thermionic emission?

Ans: **Definition:**

"The process of emission of electrons from the hot metal surfaces is called thermionic emission."

(8) **How thermionic emission is produced?**

Ans: Metals contain a large number of free elections. At room temperature electrons cannot escape the metal surface due to attractive forces of atomic nucleus. When the metal is heated to a high temperature. Some of the free electrons may gain sufficient energy to escape the metal surface.

(9) **What is Cathode – Rays Oscilloscope (C.R.O)?**

Ans: The Cathode – ray oscilloscope is an instrument which is used to display the magnitudes of changing electric currents or potentials as shown in fig.

The information is displaced on the screen of a "cathode ray tube." This screen appears a circular or rectangular window usually with a centimeter graph.

Examples:

Picture tube in our TV set and the display terminal for most computers are cathode ray tubes.

(10) **Describe function of the electron gun**

Ans: The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons. Flow of the electrons in the beam is controlled by an electrode called grid 'G'. The grid is connected to the negative potential. The more negative this potential. The more electrons will be repelled form the grid and hence fewer electrons will reach the anode and the screen. The number of the electrons reaching the screen determines. The brightness on the screen light. Hence the negative potential of the grid can be used as a brightness control. The anode is connected to the positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

(11) **Write down uses of CRO**

The CRO is used in many fields of science, some uses are given below:

i. Displaying wave forms.

ii. Measuring voltages.

iii. Range finding (as in radar)

iv. Echo – sounding (to find the depth of sea – beds).

v. To display heart beats.

(12) **How glow is produced in the tube?**

Ans: The glow in the tube is due to the circular motion of electrons in the magnetic field. The glow comes from the light emitted from the excitations of the gas atoms in the tube.

16.4 Analogue and Digital Electronics
16.5 Basic Operations of Electronic-Logic Gates

(13) **Explain the difference between analogue and digital electronics.**

Ans:

Analogue electronics	Digital electronics
The branch of electronics consisting of such circuits which process the analogue quantities (continuously vary) is called analogue electronics. **Examples:** • Amplifier • Electric iron • Refrigerator	The branch of electronics consisting of circuits which process the data being provided in the form of maximum and minimum voltage signals is known as digital electronics. **Examples:** • Computer • Digital camera • Mobile phone

(14) **Name five analogue and five digital devices that are commonly used in everyday life.**

Ans:

Analogue devices	Digital devices
(i) Electric iron	(i) Computer
(ii) Electric fan	(ii) Calculator
(iii) Radio receiver	(iii) Digital camera
(iv) Refrigerator	(iv) Mobile phone
(v) Washing machine	(v) Security system
(vi) Microphone	(vi) Fire alarm

(15) **Name five analogue and five digital devices that are commonly used in everyday life?**

Ans: **Analogue devices**

Analogue devices used in our everyday life are:

i. Radio receiver
ii. Washing machine
iii. Public address system
iv. Electric lamp
vi. Refrigerator
vii. Electric motor

Digital devices

Digital devices used to everyday life are

i. Burglar alarm
ii. Mobile phones
iii. Digital camera
iv. Radar
v. Computer

(16) **Write the brief importance of digital electronics?**

Ans: Most of today's technologies fall under the classification of digital electronics. Digital electronics device store and process bits electrically which help user fastly.

(17) **What is bit and byte?**

Ans: A bit represents data using 1' and 0's.

8 bits is equal to 1 byte.

(18) **What is digitization?**

Ans: Digitization is the process of information into 1's and 0's.

(19) **Define logic operation and logic gates**

Logic operation

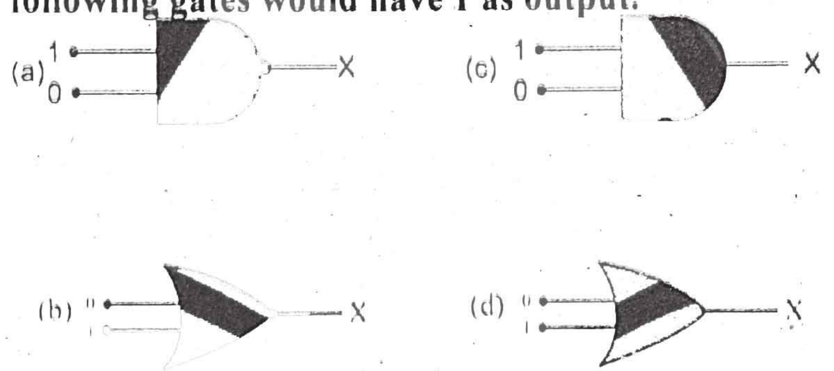
The various operations of Boolean variables are called as logic operations because the various variables used in subject of logic also possess two values. The word "truth" has also been borrowed from this subject.

Logic gates

In digital electronics, the 0 and 1 values of the variables are simulated by two different levels of the potential. Usually 0 is represented as zero or ground potential and 1 by 5 volts or by any other suitable voltage. Then such circuits have been designed which implement the various logic operations. These circuits are known as logic gates.

16.6 AND Operation
16.7 OR Operation

(20) **Which of the following gates would have 1 as output.**



Answer: **a and d**

(21) **Define OR operation.**

"OR operation to be that in which the output has a value 1 when at least one of its inputs is at 1. The output is 0 only when all the inputs are 0".

(22) **Write down Truth table of OR gate**

Truth table of OR operation

B	A	X = A +B
0	0	0
0	1	1
1	0	1
1	1	1

(23) **Define AND operation**

AND operation is such a logic operation that its output is 1 only when all the values of its inputs are 1."

(24) **Write down Truth table of OR gate**

Truth table of AND operation

Truth table shows all the values of the input variables and the value of output for each set of the values of the inputs. By using the sign of AND operation, the various lines of the truth table are shown in table.

B	A	X
0	0	0
0	1	0
1	0	0
1	1	1

16.8 NOT Operation
16.9 NAND Gate

(25) **Define NOT Gate**

"An operation after which the Boolean variable changes its state and acquires the second possible state is known as NOT operation".

(26) **Write down Truth table of NAND gate**

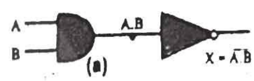
Truth table

Truth table of NOT operation is given in table.

A	$\overline{A}$
0	1
1	0

(27) **Define NAND Gate**

A NAND gate is formed by coupling a NOT gate with the output terminal of an AND gate. NAND gate is shown in Figure. The NOT gate inverts the output of the AND gate.



(28) **Write down Truth table of NAND gate**

Truth table of NAND gate

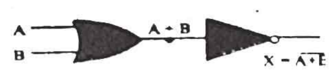
Table given is the truth table of NAND gate. In each line of this table, the value of the output has been obtained by inverting the value of the output of the AND gate corresponding to that line.

B	A	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

16.10 NOR Gate
16.11 Uses Of Logic Gates

(29) **Define NOR Gate.**

Ans:



A NOR gate is formed by coupling the output of OR gate with a NOT gate. NOR gate is shown in Figure. This NOT gate inverts the output A+B of the OR gate.

(30) **Write down Truth table of NOR gate**

Truth table of NOR gate

Given table is the truth table of NOR gate. In this table, the value of output has been written by inverting the output of OR gate.

B	A	$X = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

LONG QUESTIONS

Q.1 Define electronics.

Ans: Electronics

The branch of applied physics which deals with the behaviour of electrons using different devise for various useful purposes is known as electronics

Q.2 What is meant by thermionic emission? How thermionic emission is produced?

Ans: **Definition:**

"The process of emission of electrons from the hot metal surfaces is called thermionic emission."

How thermionic emission is produced?

Metals contain a large number of free electron. At room temperature electrons cannot escape the metal surface due to attractive forces of atomic nucleus. When the metal is heated to a height temperature. Some of the free electrons may gain sufficient energy to escape the metal surface.

Thermionic emission from tungsten filament:

Thermionic emission can be produced by electrically heating a fine tungsten filament. Typical values of the voltage and current used are 6V and 0.3 A respectively.

Q.3 How electron beam is obtained? Explain the effect of electric and magnetic field on electron beam.

Ans: **Electron beam:**

Electrons are produced by the thermionic emission from a tungsten filament heated by 6V supply. A fine filament is fitted in electron gun as shown in fig.

A high positive potential is applied to a cylindrical anode (+). The electrons are accelerated to a high speed and pass through the hole of the anode in the form of a find beam of electrons. The whole setup is fitted in and evacuated glass tube.

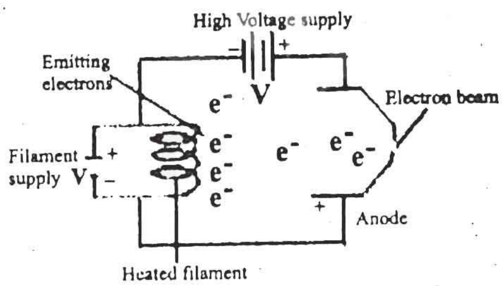
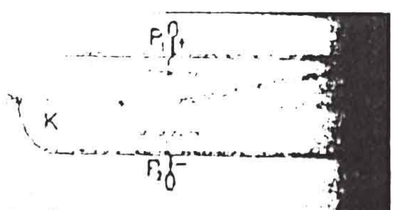


Fig. 16.1: Electron gun

Deflection of electrons by electric field

We can setup electric field by applying a potential difference across two parallel metal plates placed horizontally separated with some distance. When an electron beam passes between the plates, it can be seen that the electrons are deflected toward the positive plate as shown in fig.



Deflection of cathode ray an electric field

Reason

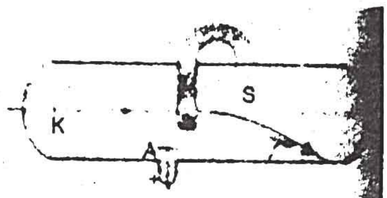
Deflection of electrons in electric filed is due to the attraction of positive pole (Plate) and repulsion of negative plate. The electric force acting on the electron in electric field will be

$$F = qE$$

Where 'q' the charge of electron and 'E' is the electric field intensity due to plates. The degree of deflection of electrons from their original direction is proportional to the strength of the electric field applied.

Deflection of electrons by magnetic field

Magnetic field is applied at right angle to the beam of electrons by using horse shoe magnet as shown in fig.



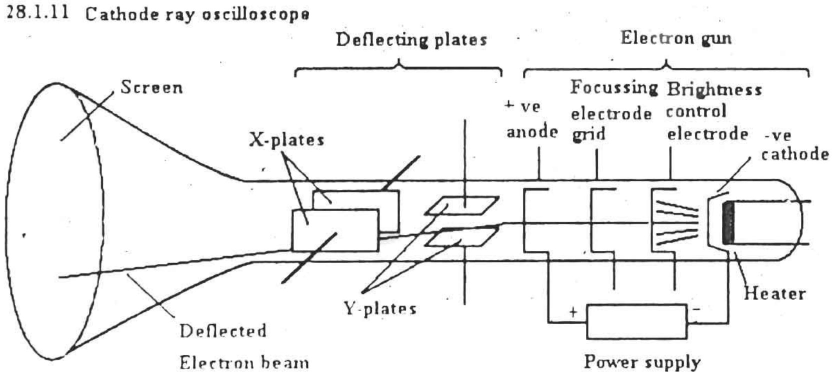
Deflection of cathode rays by a magnetic field

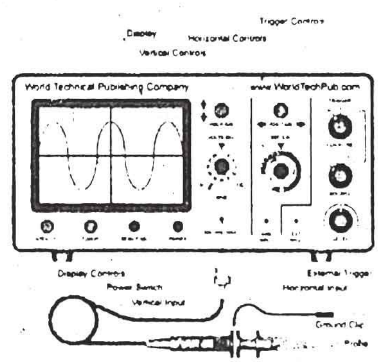
A spot of electron beam will be noticed on the screen due to the deflection of beam from its original path (direction). Now change the direction of the horse shoe magnet. We will see the spot on the fluorescent screen is getting deflected in the opposite direction.

Q.4 What is Cathode – Rays Oscilloscope (C.R.O)? Explain the working of different parts of oscilloscope?

Ans: The Cathode – ray oscilloscope is an instrument which is used to display the magnitudes of changing electric currents or potentials as shown in fig.

28.1.11 Cathode ray oscilloscope





The information is displaced on the screen of a "cathode ray tube." This screen appears a circular or rectangular window usually with a centimeter graph.

Examples:

Picture tube in our TV set and the display terminal for most computers are cathode ray tubes.

Construction and Working:

The cathode-ray oscilloscope (C.R.O) consists of the following components:

1. The electron gun
2. The deflecting plates
3. A fluorescent screen

The electron gun:

The electron gun consists of an electron source which is an electrically heated cathode that ejects electrons.

Flow of the electrons in the beam is controlled by an electrode called grid 'G'. The grid is connected to the negative potential. The more negative this potential. The more electrons will be repelled form the grid and hence fewer electrons will reach the anode and the screen. The number of the electrons reaching the screen determines. The brightness on the screen light. Hence the negative potential of the grid can be used as a brightness control.

The anode is connoted to the positive potential and hence is used to accelerate the electrons. The electrons are focused into a fine beam as they pass through the anode.

2. The deflecting plates

After leaving electron gun, the electron beam passes between a pair of horizontal plates. A potential difference applied between these plates deflects the beam in a vertical plane. This pair of plates provides the Y-axis or vertical movement of the spot on the screen. A pair of vertical plates provides the x-axis or horizontal movement of the spot on the screen.

3. The fluorescent screen

The screen of cathode – ray tube consists of a thin layer of phosphor, which a material that gives light as a result of bombardment b y fast moving electrons.

Uses of C.R.O

The CRO is used in many fields of science, some uses are given below:.

i. Displaying wave forms.

ii. Measuring voltages.

iii. Range finding (as in radar)

iv. Echo – sounding (to find the depth of sea – beds).

v. To display heart beats.

Q;4 Write a note on analogue and digital electronics.

Ans: **Analogue quantities**

Those quantities whose values vary continuously or remain constant are known as analogue quantities.

Example

The temperature of air varies continuously during 24 hours of a day. If we plot a graph between time and temperature recorded at different times, we get a graph as shown in Figure.

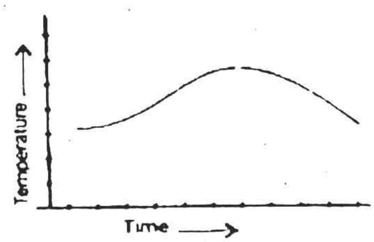


Fig. 19 1

This graph shows that the temperature varies continuously with time. Therefore temperature is an analogue quantity. Similarly time, pressure, distance etc., are analogue quantities.

Analogue Electronics

The part of electronics consisting of such circuits which processes analogue quantities is called analogue electronics.

Example

For example the public address system is an analogue system in which the microphone converts sound into a continuously varying electric potential. This potential is an analogue signal which is fed into an amplifier. Amplifier is an analogue circuit which amplifies the signal without changing its shape to such an extent that it can operate a loudspeaker. In this way loud sound is produced out of the speaker.

Digital Electronics

"The part of electronics which processes the data provided in the form of digits is known as digital electronics".

For this purpose digital electronics uses only two digits 0(zero) and 1 (one) and the whole data is provided in binary system due to which processing of data becomes easy.

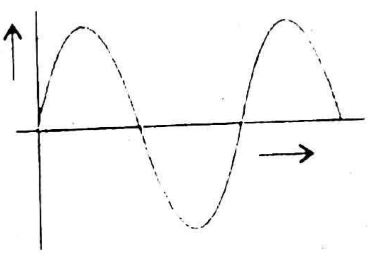
Examples

For quite a long period the use of digital electronics was limited to computers only but now-a-days its application is very wide spread Modern telephone system, radar system, naval and other systems of military importance, devices to control the operation of industrial machines, medical equipments and many household appliances are all using digital technology

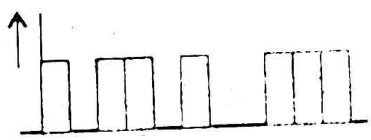
Representation of analogue and digital signals

Figure given below shows an analogue and digital signals. It can be seen that digital signal provides the data by a maximum and minimum voltage level. In it the changes are not continuous.

(a) Analogue Voltage Signals



(a) Analogue Voltage Signals



(b) Digital Voltage Signals

Fig. 19.3

Analogue to Digital converter (ADC)

"A circuit has been designed which converts the analogue signal into a digital one in the form of digits. This circuit is known as analogue to digital converter, i.e., ADC".

When we get an analogue signal in the form of digits, we can process it with digital circuit, the output of which is also in digital form.

Digital to Analogue converter (DAC)

"A circuit that is designed to convert digital output into analogue form by a circuit known as digital to analogue converter (DAC)".

As the output of DAC is an analogue signal, it can be readily sensed by us. Thus electronic systems used at present consist of both analogue and digital type circuits

Q.9 What is use of ADC and DAC? Briefly explain?

Ans: In our daily life the quantities that we perceive by our senses are usually analogue quantities which can not be processed by digital circuits. To resolve this difficulty different circuits has been designed which convert analogue quantities into digital quantities and digital quantities into analogue quantities are per required. There circuits are known as ADC and DAC.

i. Analogue Digital Converter (ADC)

A circuit which is designed to convert analogue signal into a digital one in the form of digits is known as analogue to digital converter. (ADC).

ii. Digital Analogue Converter (DAC)

When we get an analogue signal in the form of digits we can process it with digital circuit the output of which is also in digital form. This digital output is converted into analogue circuit known as digital to analogue converter i.e DAC.

As the output of DAC is an analogue signal it can readily be sensed by us. Thus electronic system used at present consists of both analogue and digital type circuits.

Q.10 What is meant by binary (Boolean) variables? Explain with example.

"The variables which have only two possible states are knows as binary variables".

Ans: **Explanation:**

There are many things which have two possible sates e.g.

i. A switch could be either open or closed.

ii. A circuit may be either ON or OFF.

iii. A statement would be either true or false.

iv. The answer of a question could be right .

All three things which have only two possible states are called binary (Boolean) variables.

Representation of Binary variables

The state of binary variables are usually represented by the digits '0' and '1'.

Example:

Suppose we form a circuit by connecting a lamp to battery using a switch 'S' as shown in fig. We call the state of switch as input and state of current or lamp as output.

Switch and lamp are binary variables

When the switch is open no current passes through the circuit and lamp is OFF. In other words when input is Zero (O) output is also Zero (O).

When the switch is closed current passes through the circuit and the lamp is ON. Both switch and lamp have value '1'. Hence switch and lamp (Current) both have two possible states Zero (O) and one 1. therefore they are considered as binary variables. This is also explain in table given in front.

S	Lamp
Open	Off
Closed	On

Q.11 What is meant by Boolean Algebra? Explain its importance.

Ans: "The algebra used to describe logic operations by symbols is called Boolean Algebra'.

Importance:

"George Boolean invented Boolean Algebra".

By using Boolean algebra the values of output variables are determined when the values of input variables of ca circuit or system are known. Boolean Algebra is a branch of mathematics which deals with the relationship of logic variables. Boolean Algebra handles variables that represent two types of logic propositions.

Importance:

Boolean algebra has become the main cornerstone of digital electronic.

- It operates with two logic states '1' and '0'.
- It interpret the logical operators AND, OR and NOT.
- It develop a systematic complex digital systems.
- Simple logic gates perform the simple mathematical as well as intricate logical operations.
- Logic operations are considered as combination of switches.

Q.12 What do you mean by logic gate?

Ans: Logic gate is a switch (digital circuit), its outputs can have only one of the two possible states, i.e either a higher voltage (1) or a low voltage (0) – it the either ON or OFF. Output voltage of the logic gate depend upon the condition of its input. It may be high (1) or low (0) according to the condition of input.

Q.13 What is AND operation? Explain in possible states. Write its symbol, Expression and gate?

Ans: **AND operation**

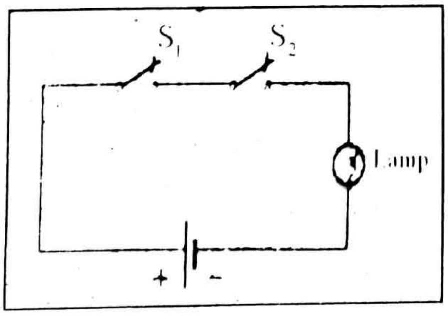
"AND operation is such a logic operation that its output is 1 only when all the values of its inputs are 1".

Explanation:

In order to understand the logic AND operation, we consider a circuit in which a lamp is connected to a battery using two switches S_1 an S_2 connected in series as shown in fig. These switches are considered as inputs and lamp is an output, this circuit is given as

Possible states

There are four possible states of two switches are given as
i) When S_1 and S_2 are both open, the lamp is OFF.
ii) When S_1 is open and S_2 is closed, the lamp is OFF.
iii) When S_1 is closed and S_2 is open, the lamp is ON.
iv) When both S_1 and S_2 are closed, the lamp is On.
These states of switches and lamp are shown in table. It is clear from table that when either of the switches (S_1 and S_2) or both are open, the lamp is OFF. When both switches are closed, the lamp is ON.



S_1	S_2	Lamp
Open	Open	Off
Open	Closed	Off
Closed	Open	Off
Closed	Closed	ON

Symbol and AND operation:

Symbol for AND operation is dot (.)

Expression:

Boolean expression of AND operation is

$X = A.B$

This expression is read as

"X equals to A AND B

Truth table:

"Set of inputs and outputs in binary from is called truth table".

In binary language, when either of the inputs or both the inputs are low (0,, the output is slow (0). When both the inputs are high (1), the output is high (1).

These relationship are shown in table. Where 'X' represent the output. Hence AND operation may be represented by switches concede in series and each switch represents an input.

B	A	X = A.B
0	0	0
0	1	0
1	0	0
1	1	1

Important results:

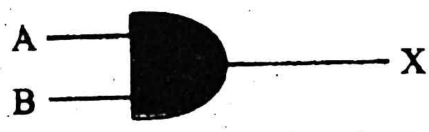
- When two switches are close i.e. the inputs of the AND operation are at logic '1', The output and AND operation will be at logic '1'.
- When two switches are open i.e. the in puts of AND operation are at logic 'O', the output of AND operation will be at logic 'O'.

AND gate:

"The circuit which implements the AND operation is known as AND gate".

Symbol and AND gate:

Symbol of AND operation is given as AND gate has two or more than two inputs and only one output. The value of output of AND gate will be '1' only when both of its inputs are at logic '1' and for all other situations output and AND gate will be 'O'.



Q.14 **What is OR operation? Explain its possible states. Write its symbol, expression and gate?**

Ans: **OR operation**

"The logical operation in which the value of output variable is equal to '1' when any one of the both input variables have value equal to '1'.

Explanation:

In order to under the logic OR operation we consider a circuit in which a lamp is connected to a battery using two switches, S_1 and S_2 connected in parallel considered as two inputs.

Possible states

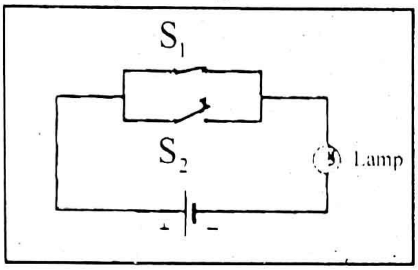
There are four possible states which are given as:

i) When S_1 and S_2 are open the lamp is OFF.

ii) When S_1 is open and S_2 closed the lamp is ON.

iii) When S_1 is closed and S_2 open the lamp is On.

iv) When both S_1 and S_2 are closed the lamp ON.



S_1	S_2	Lamp
Open	Open	OFF
Open	Closed	ON
Closed	Open	ON
Closed	Closed	ON

All possible states of the lamp and switches are shown on the table given below.

It is clear from table that the lamp will glow if at least one of the switch i.e. S_1 and S_2 is closed (at logic '1')

Symbol of OR operation

OR operation is represented by the symbol of plus (+).

Expression:

Boolean expression for OR operation is given as

$$X = A + B$$

This expression is read as:

"X equals to A OR B"

Truth Table:

"Set of inputs and outputs in binary form is called truth table".

Truth table of OR operation is shown as:

B	A	X
0	0	0
0	1	1
1	0	1
1	1	1

Hence OR operation may be represented by switches connected in parallel, since only one of these parallel switches need to turn on in order to flow current in the circuit.

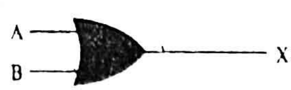
OR gate

The electronic circuits which implements the OR operation is known as OR gate".

Symbol of OR gate:

Symbol of 'OR' gate is given in fig

OR gate has two or more than two inputs and has only one output. The values of output of OR gate are always in accordance with the truth table of OR operation. It means value of output of OR gate will be '1' when one of its inputs is at '1' the value of output will be 'O'. when both inputs are at 'O'.



Q.15 What is meant by NOT operation? Explain its possible states, write its symbol, Expression and gate.

Ans: NOT operation

"A logical operation which changes the state of binary (Boolean) variable".

OR

"Not operation inverts the value of Boolean variable".

Explanation:

In order to understand NOT operation, we consider a circuit in which a lamp is connected to a battery with a switch 'S in parallel way.

Possible states

NOT operation has only one input and only one output.

There are two possible sates.

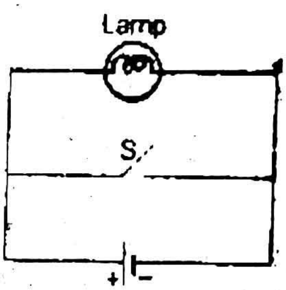


Fig. 16.12

i) When the switch "S' is open , the current will pass through the lamp and it will glow.

ii) When the switch is closed, no current will pass through the lamp due to large resistance of its filament and it will not glow.

The states of NOT operation are shown in table.

S	LAMP
OFF	ON
ON	OFF

Symbol of NOT operation

NOT operation is represented by a line or bar over the Boolean variable i.e : $\overline{A}$.

Expression:

Boolean expression for NOT operation is given as:

$$X = \overline{A}$$

This is read as:

"*X equals A NOT*".

Truth Table

"A set of inputs and outputs in binary form is called truth table". Truth table of NOT operation is shown in table given below: Hence, it is clear from the table. If the Boolean variable is 'O', then after NOT operation its value before NOT operation is '1', then after NOT operation it would change to 'O'.

A	$\overline{A}$
0	1
1	0

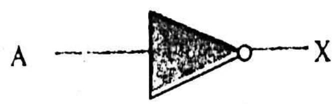
"Thus NOT operation inverts the state of Boolean variable".

NOT gate

The electronic circuit which implements NOT operation is known as NOT gate.

Symbol of NOT gate

The symbol of NOT gate is given as NOT gate has only one input and one output terminal NOT gate works in such a way that if its input is 'O' is output would be '1'. It its input is '1' the nits output would be 'O'. Not gate performs the basic logical function called inversion of complementation. Not gate is also called inverter.



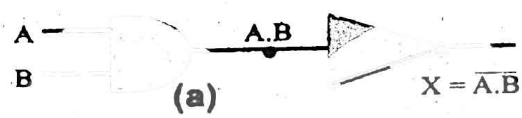
Q.16 What is NAND gate? Explain its symbol. Express and Truth table?

Ans: NAND gate:

NAND operation is simply AND operation followed by a NOT operation. "the NAND gate is obtained by coupling a NOT gate with the output terminal of the AND gate".

Symbol of NAND gate

Symbol of NAND gate is given as:
The NOT gate inverts the output of the AND gate.



Short symbol of NAND gate

In this symbol the NOT gate has been replaced with a small circle. this small Circle attached to a the output of NAND gate shows NOT o eration, its fig is given below:

Expression:

Boolean expression for NAND operation is described as:
The output of the NAND gate equals A.B and is written as:

$$X = \overline{A.B}$$

It is read as

"X equals A AND B NOT".

Truth Table

B	A	X = $\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Hence it is clear form table that inverts the output of the NAND gate.

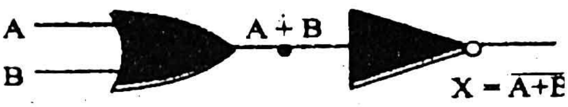
Q.17 **What is NOR gate? Explain its symbol, expression and truth table?**

Ans: **NOR gate:**

The NOR operation is simply an OR operation followed by a Not operation. " The NOR gate is obtained by coupling the output of the OR gate with NOT gate".

Symbol of NOR gate

The symbol of NOR gate is given as: For the same combination of inputs, the output of a NOR gate will be opposite to that of an OR gate.



Short symbol of NOR gate:

In this symbol the NOT gate has been replaced with a small circle. In the symbol If NOR gate, this small circle attached at the output of OR gate shows NOT operation, its fig is given as

Expression:

Boolean expression for NOR operation is describes as:

$$X = \overline{A + B}$$

It is read as:

"X equals A OR B NOT".

Truth Table

B	A	$X = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

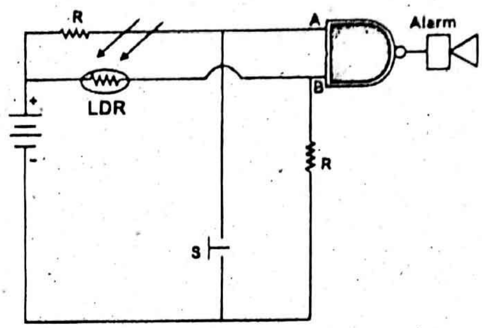
" A set of inputs and outputs in binary form is called truth table".

Q.18 **What is the use of logic gates? Explain with one example.**

Ans: We can use logic gates in electronic circuits to do useful tasks. These circuits usually use light depending resistors (LDRs) to keep inputs low. An LDR can act as a switch that is closed when illuminated by light and open in the dark.

House safety Alarm

We can use single NAND gate to make burglar alarm. This can be done by using NAND gate, an LDR, a push – button switch S and an alarm. Connect LDR between NAND gate input B and the positive terminal of the battery. the LDR will cause a height level input (1) at B when in light because of its low resistance. The LDR will cause a low level input (0) at B when light is interrupted and causes high resistance in LDR. A low level signal is also caused at A when burglar steps on switch S. So this burglar alarm sounds when either burglar interrupts light falling on LDR or steps on switch S.



(Burglar alarm schematic circuit)

REVIEW QUESTIONS

13.1 How can you show by simple experiments that there are two types of electric charges?

Ans: See Questions 1

13.2 What is the method of charging bodies by electrostatic induction?

See Questions 2

13.3 How does electrostatic induction differ from charging by friction?

Ans. During the process of charging by friction, we rub a neutral body with another neutral body. But in the process of electrostatic induction. We charge a conductor without making any contact with the charging body.

13.4 What is gold leaf electroscope? Discuss its working principle with a label diagram.

Ans. See Questions 3

13.5 Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope (i) negatively (ii) Positively.

Ans. See Questions 3

13.6 With the help of electroscope how you can find presence of charge on a body.

Ans. See Questions 3

13.7 Describe how you would determine the nature of the charge on a body by using electroscope.

Ans. See Questions 3

13.8 Explain Coulomb's law of electrostatic and write its mathematical from?

Ans: See Questions 4

13.9 What is meant by electric field and electric intensity?

Ans. See Questions 5

13.10 Is electric intensity a vector Quantity? What will be its direction?

Ans. See Questions 5

13.11 Find the electric intensity due to a point charge q.

Ans. See Questions 5

13.12 How would you define potential difference between two points? Define its unit.

Ans. See Questions 7

13.13 Show that potential difference can be described as energy transfer per unit charge between the two points.

Ans. See Questions 7

13.14 Describe capacitor as an energy strong device?

Ans. See Questions 9

13.15 What do you men by the capacitance of a capacitor? Define units of capacitance.

Ans. See Questions 8

13.16 Derive the formula for the effective capacitance for a series combination of a number of capacitors.

Ans. See Questions 11

13.17 Discuss different types of capacitors.

Ans. See Questions 12

13.18 What is difference between variable and fixed type capacitor?

Ans. See Questions 12

13.19 Enlist some uses of capacitors.

Ans. See Questions 13

13.20 Discuss one application of static electricity.

Ans. See Questions 14

13.21 What are hazards of static electricity?

Ans. See Questions 15

CONCEPTUAL QUESTIONS

13.1 An electrified rod attracts pieces of paper. After a while these pieces fly away! Why?

Ans. When a glass rod is rubbed with a silk cloth, it is positively charged. This electrified rod attracts pieces of paper. When the pieces of paper touch the rod, they give up some electrons to the glass rod and become positively charged. They are then flown away by the rod due to force of repulsion form the positive charge remaining on the rod.

13.2 How much negative charge has been removed from a positively charged electroscope if it has a charge of 7.5×10^{-11}C?

Ans. A charge of -75×10^{-11} C has been removed from a positively charged electroscope which has a charge of 7.5×10^{-11}C.

13.3 In what direction will a positively charged particle move in an electric field?

Ans. A positive charge released in an electric field will move along the direction electric field i.e. from higher potential to the lower potential.

13.4 Does each capacitor carry equal charge in series combination? Explain.

Ans. As in series combination each capacitor is connected side by side, so each capacitor carries equal magnitude of charge due to electrostatic induction.

13.5 Each capacitor in parallel combination has equal potential difference between its two plates. Justify the statement.

Ans. In a parallel combination of capacitors, two plates of each capacitor are connected to the positive and negative terminals of a battery between the same two points. Hence potential difference between two plates of each capacitor is equal i.e equal to the potential difference of the battery.

13.6 Is the presence of charge necessary for the existence of electrostatic potential?

Ans. Electrostatic potential is a characteristic of the field charge and independent of the existence of test charge

13.7 Rubber tires get charged from friction with the road. What is the polarity of the charge?

Ans. During the process of rubbing, electrons form road surface (make of black pitch) are transferred to rubber tyres to make them negatively charged.

13.8 Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What purpose does the chain serve?

Ans. This metal charging is used of the purpose of earthling. The static charge accumulated on the body of truck during transportation are discharged to the ground through this metal chain. This may avoid any chance of explosion or fire during filling or otherwise.

13.9 If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car?

Ans. Similar to Faraday's cage, inside the car you are safe from the influence of external field. The charge is evenly distributed on the surface of the car and the electric field inside the car is zero. But if we touch the ground. While coming out of the car, the charge will be discharged to the ground through our body. Hence it may be fatal.

13.10 Explain why, a glass rod can be charged by rubbing when held by hand but an iron rod cannot be charged by rubbing, if held by hand?

Ans. Because glass rod is an insulator, so charge developed on it during rubbing does not flow to the ground through the hand holding it. However, iron rod is a conductor and charge developed on it during rubbing can easily flow to the ground through the hand holding it. For this reason all metal objects used in electrostatic have insulating handles or stands.

Information based Questions and their Answers

Point to Ponder (Page 77)

Q.1 Why leaves of charged electroscope diverge if we touch its disk with a metal rod but they do not diverge if we touch the disk with a rubber rod?

Ans. If we touch the disk of a charged electroscope with a conductor, electrons will flow from electroscope to the ground or from ground or the electroscope. It depends upon the type charge on the disk of the electroscope. Due to this transfer of charges, divergence of leaves will decrease or increase accordingly. As in case of an insulator, there is not any flow of charges (as insulators are bad conductors) , so there is not any change in the position of leaves of the electroscope.

Point to Ponder (Page 78)

Q.2 In a dry day, if we walk in a carpeted room and then touch some conductor, we will get a small electric shock! Can you tell why does it happen?

Ans. It is caused by static electric charges accumulated on our body due to friction while walking on a carpet.

Quick Quiz (Page 80)

Q.3 If we double the distance between the two charges, what will be the change in the force between the charges:

Ans. If we double the distance between two charges, force between them decreases by a factor of $\frac{1}{4}$ according to Coulomb's law.

$$F = \frac{kq_1q_2}{r^2} \quad \text{where } r = 2r$$

Then, $F' = \frac{kq_1q_2}{(2r)^2}$ or $F' = \frac{kq_1q_2}{4r^2} = \frac{1}{4}F$

Point Ponder (Page 81)

Q.4 A strong electric field exists in the vicinity of the "Faraday cage". Yet the person inside the cage is not affected. Can you tell why?

Ans. A Faraday's cage is an enclosure made of a conducting material to block internal electric fields. In the presence of internal electric field, the electric charges on the surface of cage are redistributed in such a way so that electric field becomes zero inside the interior of Faraday's cage.

Quick Quiz (Page 85)

Q.5 is the equivalent capacitance of parallel capacitors larger or smaller than the capacitance of any individual capacitor in the combination?

Ans. In parallel combination of capacitors, equivalent capacitance is the sum of the individual capacitances. Hence, equivalent capacitance will be larger than the capacitance of any individual capacitor in the combination.

Quick Quiz (Page 86)

Q.6 Is the equivalent capacitance of series capacitors larger or smaller than the capacitance of any individual capacitor in the combination?

Ans. In series combination of capacitors, The equivalent capacitance is equal the sum of the reciprocal of the individual capacitances. Hence, equivalent capacitance is smaller than the capacitance of any individual capacitor in the combination.

Point to Ponder (Page 89)

Q.7 Capacitor blocks d.c current but allows a.c. current to pass through a circuit. How does this happen?

Ans. D.C, current flows only in one direction. When capacitor connected' to any D.C source (e.g battery) is fully charged there is no further flow of current in the circuit. In case of A.C the polarity of A.C. source changes again and again due to which charge polarity on the plates of capacitor also changes. Due to this reason. A.C. is not stopped or blocked through the circuit.

MULTIPLE CHOICE QUESTIONS

(i) A Positive electric charge

(a) attracts other positive charge (b) repels other positive charge

(c) attracts a neutral charge (d) repels a neutral charge

(ii) An object gains excess negative charge after being rubbed against another object

(a) neutral (b) negatively charged (c) positively charged (d) either a, b or c

(iii) Two uncharged objects A and B are rubbed against each other when object B is placed near a negatively charged object C, the two objects repel each other which of the following statements is true about object A?

(a) remains uncharged (b) becomes positively charged

(c) becomes negatively charged (d) unpredictable

(iv) When you rub a plastic rod against your hair several times and put it near some bits of paper the pieces of papers are attracted towards it. What does this observation indicates?

(a) the rod and the paper are oppositely charged

(b) the rod acquires a positive charge

(c) the rod and the paper have the same charges

(d) the rod acquires a negative charge

(v) According to coulomb's law, what happens to the attraction of two oppositely charged objects as their distance of separation increases?

(a) increase (b) decreases

(c) remains unchanged (d) cannot be determined

(vi) The coulomb's law is valid for the charges which are

(a) moving and point charges (b) moving and non-point charges

(c) stationary and point charges (d) stationary and large size charges

(vii) A positive and a negative charge are initially 4 cm apart. When they are moved closer together so that they are now only 1 cm apart, the force between them is

(a) 4 times smaller than before (b) 4 times larger than before

(c) 8 times larger than before (d) 16 times larger than before

(viii) Five joules of work is needed to shift 10C is charge form one place to antoher. The potential difference between the places is

(a) 0.5 V (b) 2 V (c) 5V (d) 10V

(ix) Two charged spheres are separated by 2mm. Which of the following would produce the greatest attractive force?

(a) +1q and +4q (b) – 1q and – 4q (c) +2q and +2q (d) +2q and -2q

(x) Electric field lines

(a) always cross each other (b) never cross each other

(c) cross each other in the region of strong field

(d) cross each other in the region of weak field

(xi) Capacitance is defined as

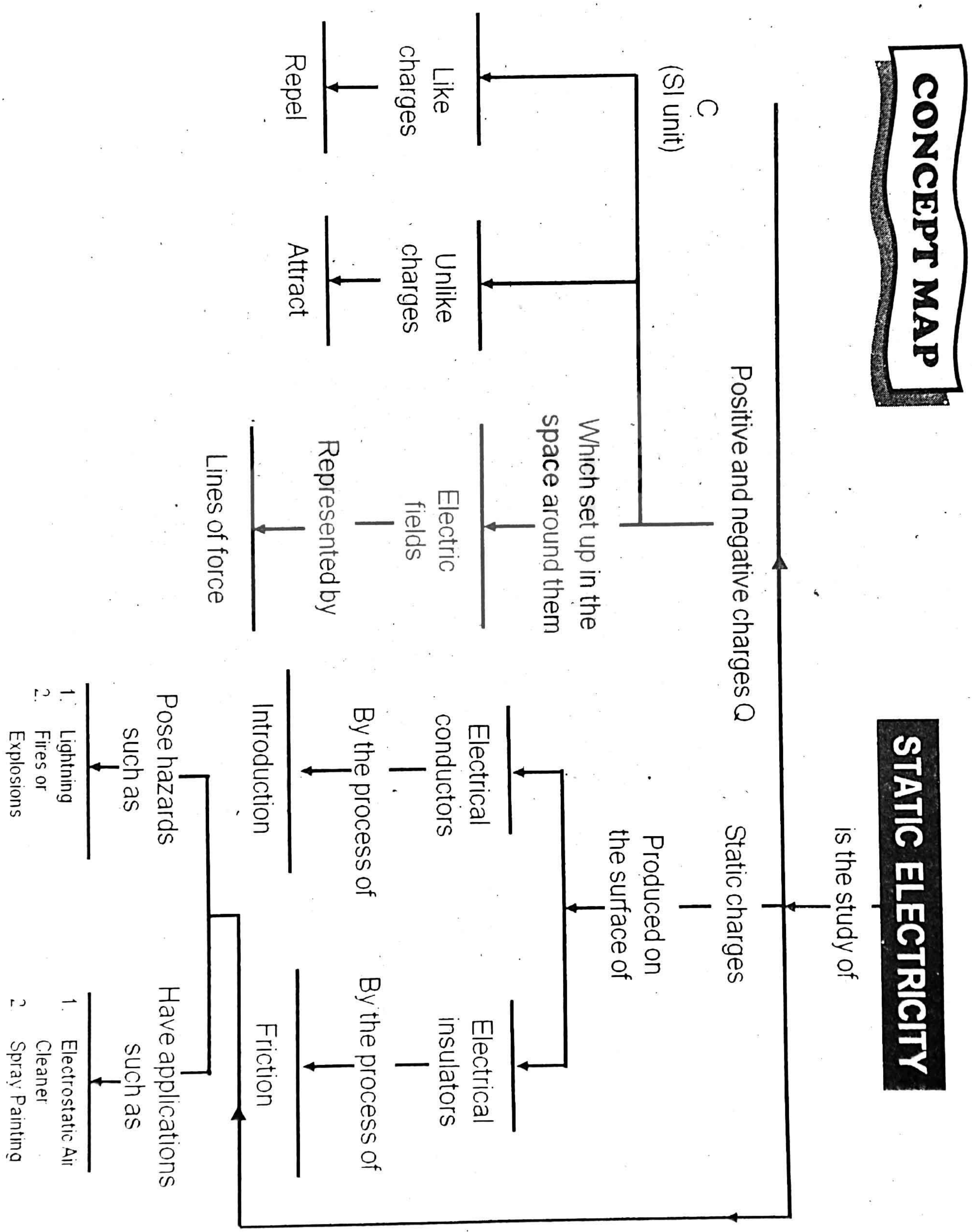
(a) VC (b) Q/V (c) QV (d) V/Q

1	2	3	4	5	6	7	8	9	10	11
b	a	b	a	c	c	d	a	d	b	b

CHAPTER 13

ELECTROSTATICS

CONCEPT MAP



TOPICAL MULTIPLE CHOICE QUESTIONS

13.1 and 13.2 Production of Electric Charges and Electrostatic Induction

1. **Study of charges at rest is called __________**
   (a) Electrostatics (b) Magnetism (c) Electrochemistry (d) Electric Current
2. **An insulating rod is charged positively by rubbing. This is due to**
   (a) Deficiency of protons (b) Excess of protons
   (c) Deficiency of electrons (d) Excess of electrons
3. **When an insulating rod is charged negatively, this is due to**
   (a) Deficiency of protons (b) Excess of protons
   (c) Deficiency of electrons (d) Excess of electrons
4. **If we run a plastic comb through hair and then bring it near shell pieces of paper. The comb __________**
   (a) Attract them (b) repel them (c) Both a and b (d) None of these
5. **Electric charges can be produced by rubbing a neutral body with**
   (a) Charged body (b) Another neutral body (c) Both a and b (d) None of these
6. **SI unit of electric charge is __________**
   (a) Coulomb (b) Ampere (c) Volt (d) Watt
7. **A positive charge**
   (a) Attract other positive (b) Repel other positive charge
   (c) Attract the natural charge (d) Repels a neutral charge
8. **An object gain excess negative charge after being rubbed against another object**
   (a) Neutral (b) Negative charged (c) positively charge (d) Object
9. **A body can be charged by**
   (a) Rubbing with another body (b) Conduction
   (c) Electrostatic induction (d) All of these
10. **Only __________ type charges exist**
    (a) One (b) Two (c) Three (d) Four
11. **When a glass rod is rubbed with a silk cloth, then**
    (a) Glass rod acquires negative charge while silk acquires positive charge
    (b) Glass rod acquires positive charge while silk acquires negative charge
    (c) Both glass rod and silk acquire negative charge
    (d) Both glass rod and silk acquire positive charge
12. **If a glass rod is rubbed with a silk cloth, it receives charge by the process of:**
    (a) Heating (b) Separation of change
    (c) Rubbing (d) electric force
13. **Which one of the following statements is correct?**
    (a) Similar charges attract each other
    (b) Similar charges repel each other
    (c) Similar charges attract and repel each other
    (d) Similar charges hither attract nor repel each other
14. **Which one of the following statements is correct?**
    (a) Opposite charges attract each other
    (b) Opposite charges repel each other
    (c) Opposite charges attract and repel each other
    (d) Opposite charges neither attract nor repel each other.

15. **Metals are good conductors of electricity, because they have**
(a) Large number of bounded electrons (b) Small number of bounded electrons
(c) Large number of free electrons (d) Small number of free electrons

16. **Free electrons are**
(a) Tightly bound (b) Fixed
(c) Loosely bound (d) strongly fixed

17. **The number of electrons in one coulomb charge is equal to**
(a) 6.25×10^{19} (b) 1.6×10^{-19}
(c) Zero (d) 6.2×10^{21}

18. **Like charges always __________ each other.**
(a) Attract (b) Repel (c) Attract and repel (d) None of these

19. **In the presence of a charged body an insulated inductor develops positive charge at one end and negative charges at other end, this process is called the __________**
(a) Electrostatic induction (b) Conduction (c) Friction (d) All of these

13.2,13.3 and 13.4 Electroscope ,Coulomb's Law and Electric Field

20. **Electroscope is an instrument used for**
(a) Detecting presence of charge (b) To detect the type of charges
(c) To identify conductor and insulator (d) All of these

21. **Force of attraction or repulsion acts between**
(a) Two charged bodies (b) Neutral bodies (c) Non charged bodies (d) All of these

22. **Who established fundamental law of electric force between two stationary charged particles?**
(a) Planks (b) Faraday (c) Quantum (d) Coulomb

23. **According to Coulomb's law**
(a) $F=K\frac{q_1r^2}{q_2}$ (b) $F=\frac{kr_1r_2}{(q)^2}$ (c) $F=\frac{kq_1q_2}{r^2}$ (d) $F=k\frac{q_1q_2}{r}$

24. **K is constant of proportionality given by**
(a) $K=\frac{1}{4\pi \in_o}$ (b) $K=\frac{\in}{4\pi}$ (c) $K=\frac{4\pi}{\in_o}$ (d) None of these

25. **SI unit of K**
(a) Nm^2C (b) Nm^2C^{-2} (c) $N^2m^2C^{-1}$ (d)

26. **The value of K**
(a) $8.85 \times 10^9\ Nm^2C^{-2}$ (b) $9 \times 10^9\ Nm^2C^{-2}$ (c) $6.67 \times 10^9\ Nm^2C^{-2}$ (d)none of these

27. **A region around the charge in which it exerts electrostatic force on another charge is called**
(a) Gravitational field (b) Magnetic field (c) Electric field (d) All of these

28. **SI unit of electric intensity is**
(a) Nm^{-1} (b) NC^{-1} (c) Nm^{-2} (d) Nm

29. **The spacing between the field lines shows the**
(a) Strength of electric field (b) Direction of electric field
(c) Both a and b (d) None of these

30. **Electroscope can be charge by the process**
(a) Magnetism (b) Internal reflection
(c) Electrostatic induction (d) Electromagnetic tension

31. **The value of Coulomb's constant K depends upon**
(a) The system of units used
(b) Medium between the charges
(c) Quantity of the charges
(d) The system of units and the medium between the charges

32. **If the distance between the two charged bodies is halved, the force between them becomes**
(a) Doubled (b) Half
(c) Four times (d) One half

33. **If the distance between two charges is doubled, the electric force between them will become**
(a) Four times (b) Twice
(c) Half (d) One fourth

34. **Electric charge of 100μC is 13 m apart from another charge 16.9μC. The force between them in Newton is**
(a) 9×10^7 (b) 0.09
(c) 90 (d) 9×10^5

35. **The electric force of repulsion between two electrons at a distance of 1 m is**
(a) 1.8 N (b) 1.5×10^{-9}N
(c) 2.30×10^{-27}N (d) 2.30×10^{-27}N

36. **The magnitude of the charge on the electron is**
(a) 1.2×10^{-19}C (b) 1.6×10^{-19}C
(c) 2.6×10^{-19}C (d) 1.81×10^{-19}C

37. **The space around the charge within which other charges are influenced by it is called**
(a) electric intensity (b) Electric field
(c) Electric flux (d) Electric potential

38. **Force experienced by a unit positive charge placed at a point in the electric field is known as**
(a) Electric field intensity (b) Magnetic field intensity
(c) Electric potential (d) Capacity

39. **The force per unit charge is known as**
(a) Electric flux (b) Electric intensity
(c) Electric potential (d) Electric volt

40. **SI unit of electric field intensity is**
(a) Coulomb (b) Volt
(c) Newton/coulomb (d) Ampere

41. **Electric field intensity is a vector quantity and its direction is**
(a) Perpendicular to the direction of field (b) Opposite to the direction of force
(c) Along the direction of force (d) At a certain angle

42. **The electric intensity at infinite distance from the point charge is**
(a) Zero (b) Infinite
(c) 1 Volt – m^{-1} (d) Positive

13.6 and 13.7 Electric potential, capacitor and capacitance :

43. **Work done in bringing a unit positive charge from infinity to that point in an electric field is called**
(a) potential difference (b) Resistance
(c) Capacitance (d) Electric potential

44. **Electric field is strong when liens are**
(a) Separated (b) Closer (c) Smaller (d) Larger

45. __________ **at a point in an electric field is equal to amount of work done in bringing unit positive charge from infinity to that point**
(a) Electric intensity (b) Potential difference (c) Electric potential (d) Volt

46. **Which statement is true about electrical potential**
(a) Its SI unit is volt (b) It is scalar quantity (c) At any point $v = \frac{w}{q}$ (d) all of these

47. **In order to store the charge a device is used which is called**
(a) Potential (b) Capacitor (c) Momentum (d) Voltage

48. **SI unit of capacitance**
(a) Farad (F) (b) Coulomb (c) Newton (d) Voltage

49. **Parallel plate capacitor consist of two metal plates separated by**
(a) Metal (b) Insulator (c) Conductor (d) all of these

50. **Which is incorrect for parallel capacitor?**
(a) $v_1 = v_2 = v_3 = v$ (b) $Q = Q_1 + Q_2 + Q_3$ (c) $C_e = C_1 + C_2 + C_3$ (d) $Q_1 = Q_2 = Q_3 = Q$

51. **The work done in moving a unit positive charge form one point to another against the eclectic field is a measure of**
(a) Intensity of electric field (b) Resistance between two points
(c) Capacitance (d) Potential difference between two points

52. **The potential difference between two points is one volt. The amount of work done in moving a charge of one coulomb from one point to another is**
(a) One erg (b) One Joule
(c) One electron volt (d) one coulomb

53. **Electron volt is the unit of**
(a) Potential difference (b) Electric energy
(c) Electric current (d) Capacitance

54. **The electron energy is one electron – volt when it is accelerated through a potential difference of**
(a) One volt (b) One joule
(c) One Coulomb (d) One erg

55. **Electric potential is a**
(a) Vector quantity (b) Scalar quantity
(c) Neither scalar nor vector (d) Sometimes scalar and sometimes vector

56. **One electron volt is equal to**
(a) 1.6×10^{-19}J (b) 1.6×10^{19}J
(c) 6.25×10^{-18}J (d) 6.25×10^{18}J

57. **The capacitance C of a capacitor is given by the relation**
(a) C = QV/2 (b) C = QV
(c) C = Q/V (d) C = V/Q

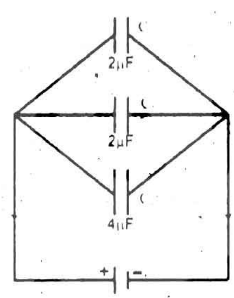
58. **A capacitor is a perfect insulator for**
(a) Direct current (b) Alternating current
(c) Both for the direct and alternating current (d) Electric charge

59. **Which one of the following is correct?**
(a) $1\ \mu F = 10^{-6} F$ (b) $1 pF = 10^{-13} F$
(c) $1 pF = 10^{-6} \mu F$ (d) All of the above

60. **When capacitors are connected in parallel, their equivalent capacitance is equal to**
(a) The product of their individual capacitances
(b) The sum of their individual capacitances
(c) The product of their individual reciprocal capacitances
(d) The sum of the reciprocals of the individual capacitances

61. **When capacitors are connected in series, their equivalent capacitance is equal to**
(a) The product of their individual capacitances
(b) The sum of their individual capacitance
(c) The sum of the reciprocals of the individual capacitances
(d) The product of their individual reciprocal capacitances

62. **Three capacitors C_1, C_2 and C_3 are connected in parallel as in the Fig. Their equivalent capacitance will be**



(a) 8μF (b) 0.8μF
(c) 1μF (d) 16μF

63. **Tick the correct statement**
(a) Capacitance decreases in parallel combination
(b) Capacitance decreases in series combination
(c) Capacitance is the same in both combinations
(d) All of the above

64. **If 4μF and 2μF capacitors are connected in series, the equivalent capacitance is given by**
(a) 6μF (b) 2μf
(c) 1.3μF (d) 8Fμ

65. **Two 50μF capacitors are connected in parallel. The equivalent capacitance of the combination is**
(a) 1μF (b) 100μF
(c) 50μF (d) 25μF

13.9 and 13.10 Types of capacitor and some hazards of electricity:

66. **In variable capacitors**
(a) Both the sets of plates are fixed
(b) Both the sets of plates are moveable
(c) One set of plates is fixed and the other is moveable
(d) Both the sets of plates are neither fixed not moveable

67. **Variable capacitors are used in**
(a) Radio only (b) Television only
(c) Radio and television (d) None of the above

68. **A radio tuning capacitor is a**
(a) Variable parallel plate capacitor (b) Variable cylindrical capacitor
(c) Spherical capacitor (d) Tubular capacitor

69. **Which of the following is commercial type capacitor**
(a) Tubular capacitor (b) Electrolytic capacitor
(c) Miniature capacitors (d) All of the above

70. **The equivalent capacitance is greater than individual capacitance in**
(a)Series combination (b) Parallel combination
(c) Series and parallel combination (d) All of them

71. **Farad is defined as**
(a) Coulomb/Volt (b) Ampere/Volt
(c) Coulomb/Joule (d) Joule/coulomb

72. **Capacitor have different types depending upon**
(a) Their construction (b) Nature of dielectric(c) Both A and B (d) None of above

73. **In variable capacitors, the value of capacitance can be**
(a) Decrease (b) Increased (c) Both a and B (d) Fixed

74. **In fixed type of capacitors, the value of capacitance**
(a) Increase (b) Decrease (c) Can not be changed (d) All given ture

75. **It is a fixed capacitor**
(a) Paper capacitor (b) Mica capacitor (c) Both a and b (d) Capacitors in radio sets

76. **In Mica capacitors the dielectric is**
(a) Aluminum foils (b) Mica (c) Copper (d) Polythene paper

77. **Capacitors are used in**
(a) Tuning Transmitters (b) Receiver (c) Transistor radio (d) All of these

78. **Capacitors are used in resonant circuit that tune radios to particular frequency**
(a) Electrostatic air cleaner (b) Spray painting (c) Car washing (d) None of these

79. **Application of electrostatic is**
(a) Photocopying (b) Car painting (c) Extracting Dust (d) All of these

ANSWER KEY

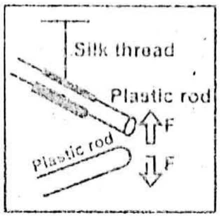
Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	a	11	b	21	a	31	d	41	c	51	d	61	c	71	a
2	c	12	c	22	d	32	c	42	a	52	b	62	a	72	c
3	d	13	b	23	c	33	d	43	d	53	b	63	b	73	c
4	a	14	a	24	a	34	b	44	b	54	a	64	c	74	c
5	b	15	c	25	b	35	c	45	c	55	a	65	b	75	c
6	a	16	c	26	b	36	b	46	d	56	a	66	c	76	b
7	b	17	a	27	c	37	b	47	b	57	c	67	c	77	d
8	b	18	b	28	b	38	a	48	a	58	c	68	a	78	d
9	d	19	a	29	a	39	b	49	b	59	a	69	d	79	d
10	b	20	d	30	c	40	c	50	d	60	b	70	b		

SHORT QUESTIONS

13.1 And 13.2 Production of Electric Charges and Electrostatic Induction

(1) **How can we produce a charge in neutral body?**

Ans: We can produce a charge in neutral body by rubbing it with another neutral body e.g plastic rod rub with per or silk.



(2) **What is electrostatics?**

Ans: Study of charges at rest is called electrostatics or static electricity.

(3) **What is meant by electrostatic induction, for which purpose it is used?**

Ans: In the presence of a charged body, an insulated conductor develops positive charge at one end and negative charge at the other end. This process is called the electrostatic induction. This method is used for charging body.

(4) **Why is electric charge produced in bodies by friction?**

Ans: When we rub two bodies, we provide external force by rubbing. Then the loosely bound electrons in one body are transferred to the other body. As electrons carry negative charge, therefore, a negative charge is developed on the body which gets electrons and positive charge is developed on that body which looses electrons.

(5) **What is purpose electrostatic used?**

Ans: Electrostatic is used in everyday lives which includes photocopying, car painting extracting dust from carpets and form chimneys of industrial machinery.

13.3,13.4 and 13.5 Electroscope, Coulom's Law and Electric Field

(6) **How electroscope can be charged?**

Ans: Electroscope can be charge by the process of electrostatic induction. It can also be chare by process of conduction.

(7) **Which type of instrument gold leaf electroscope is?**

Ans: The gold leaf electroscope is sensitive instrument for detecting charges. It consists of a brass rod with a brass disk at the top and two thin leaves of gold foil hanging at the bottom. The rod passes through an insulator that keep the rod in place and also remains the charges. Charges can move freely from the disk to leaves through the rod. A thin aluminum foil is attached on the lower portion of the inside of the jar.

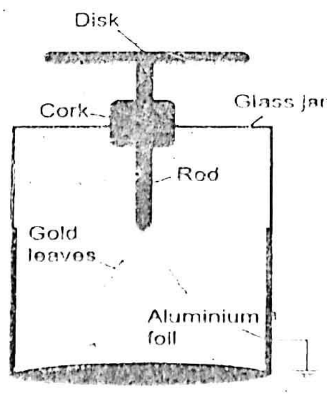


Fig. 1 Uncharged electroscope

(8) How can we detect with electroscope that body is conductor or insulator?

Ans: Electroscope can also be used to distinguish between insulator and conductors. Touch the disk of a charged electroscope with martial under test. If the leaves collapse from their diverged position the body would be a good conductor. If thee is no change in the divergence of the leaves, it will show that the body under test is insulator.

(9) Defined electric field intensity?

Ans: "The strength of electric field at any point in space is known as electric field intensity"

Formula:

$$E = \frac{F}{q^{o}}$$

Thus the electric field intensity at any point is defined as the force acting on a unit positive charge place at that point.

Unit:

Its SI unit is NC^{-1}

(10) State the Coulomb's law.

Ans: The force of attraction or repulsion between two points charges is directly proportional to the product of the quantity of charges and inversely proportional to the square of the distance between them

Mathematically:

$$F \propto q_1 q_2$$

$$F \propto \frac{1}{r^2}$$

$$F = k\frac{q_1 q_2}{r^2}$$

Where F is coulomb's force, q_1, q_2, are charges and K is called coulomb's constant

(11) Who introduce the electric lines of force?

Ans: The direction of electric liens filed intensity in an electric field can also be represented by drawing lines these lines are known as electric lines of force introduced by Michael Faraday.

(12) What is meant by point charges?

Ans: If the distance between two charged bodies is much greater as compared to their size. the bodies are considered as point charges.

(13) What will happen to Coulomb's force, if the distance between two point charges becomes double?

Ans: According to coulomb's law

$$F = k\frac{q_1 q_2}{r^2}$$

When r = 2r

Then $F' = k\frac{q_1 q_2}{(2r)^2}$ Or $F' = k\frac{q_1 q_2}{4r^2} = \frac{1}{4}$

Thus if the distance between two point charges is doubled, the coulomb's force between them reduces to one fourth.

(14) **In which direction Coulomb's force act between the two charges?**

Ans: The Coulomb's forces have equal magnitude but always act in opposite directions.

(15) **What is SI unit of electric intensity?**

Ans: SI unit of electric intensity is NC^{-1}.

(16) **What is work of Charles Coulomb?**

Ans: A French scientist Charles Coulomb (1736 – 1806) in 1785 experimentally established the fundamentals law of electric force between two stationary charged particles.

(17) **What is direction of electric intensity?**

Ans: Electric intensity being a force is a vector quantity. Its direction is the same as that of the force acting on the positive test charge.

(18) **On which factors the value of K depends?**

Ans: The value of the k depends upon the medium between the two charges and the system of units in which F, q and r are measured ϵ_o is the permittivity of free space.

13.6,13.7 and 13.8 Electric potential , capacitor and capacitance, difference types of capacitors:

(19) **What is meant by electric potential?**

Ans: Electric potential at a point in an electric field is equal to the amount of work done in bringing a unit positive charge form infinity to that point

Formula:

$$V = \frac{W}{q}$$

Unit:

Its unit is volt.

(20) **Defined fared?**

Ans: If one Coulomb of charge given to the plates of a capacitor produces a potential difference of one volt between the plates of the capacitor then its capacitance would be one farad.

$$1F = \frac{1C}{1V}$$

(21) **What is meant by Capacitance?**

Ans: Capacitance is the ability of the capacitor to store charge. It is given by the ratio of charge and the electric potential as

Formula:

$$C = \frac{Q}{V}$$

Unit:

SI unit of capacitance is fared (F) fared is a large unit, usually we use a smaller unit called micro fared (μF) and pico forced (pF).

(22) **Define potential difference between two points.**

Ans: "The potential difference between two points can be defined as the energy supplied by a unit charge as it moves from one point to the other."

(23) **What is electron volt? Also find its energy in joules.**

Ans: Electron volt [eV] is the unit of energy used to measure the energy supplied by the movement of charges. This is a small unit of energy and is often used in atomic and nuclear physics. It is defined as under:

Definition

"It is equal to the amount of energy supplied by an electron as it moves between two points having a potential difference of one volt."

Mathematically

Charge on an electron = $q = 1.6 \times 10^{-19}$ C.

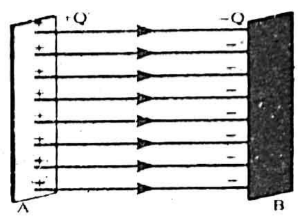
Potential difference = $V_A - V_B = 1$ V

$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ C} \times 1 \text{ V}$$

$$= 1.6 \times 10^{-19} \text{ J}$$

(24) How does capacitor store charge?

Ans:



If +Q amount of charge is transferred to its one plate, due to electrostatic induction it would induce -Q charge on the inner surface of other plate. There exists a force of attraction between the charges +Q stored on the first plate and the charge -Q induced on the inner surface of other plate.

Due to this force of attraction, the charges are bound with the plate and remain stored for long periods.

(25) Why charge can not be stored on capacitor for a long time?

Ans: Charge cannot be stored on a conductor for a long period of time because the stored charges mutually repel each other due to which they spread on the whole surface of the conductor and also tend to leak out from there.

13.8 and 13.9 Types of capacitor and some hazards of electricity:

(26) How static electricity can be generated?

Ans: Static electricity can be generated by the frictions of the gasoline being pumped into a vehicle or container. It can also be produced when we get out of the car or remove an article of clothing static electric charge build up during transport.

(27) What do you know about paper capacitor?

Ans: Paper capacitor is an example of fixed capacitors. The paper capacitor has a cylindrical shape. Usually an oiled or greased paper or a thin plastic sheet is used as a dielectric between two aluminum foils. The papers or plastic sheet is firmly rolled in the form of a cylinder and is then enclosed into a plastic case.

(28) How the phenomenon of lightening occurs?

Ans: The phenomenon of lightening occurs due to a large quantity of electric charge which builds up in the heavy thunder clouds. The thunderclouds are charged by friction between the water molecules in the thunder clouds and the air molecules. When the charge on the thunder clouds is sufficiently high, it can produce positive and negative charges in the air. The huge amount of negative charge is discharged to the highest object on the ground and can harm them.

(29) How static charges are dangerous?

Ans: If static charges are allowed to discharge through the area where there is petrol vapour a fire can occur. The results are frightening and may be devastating.

(30) What is difference between variable and fixed capacitors?

Ans: Capacitors are either variable or fixed. In variable capacitors the value of capacitance can be increased or decreased. In fixed type capacitors, the value of capacitance cannot be changed.

(31) How electrolytic capacitor is important?

Ans: An electrolytic capacitors in important because it is often used to store large amounts of charge at relatively law voltages.

(32) Why parallel plate capacitors are not commonly used.

Ans: Parallel plate capacitors are not commonly used in most devices because in order to store enough charger, their size must be large which is not desirable.

(33) Why it is very dangerous to swim in the open sea, play in an open field or hide under a tree during a thunderstorm?

Ans :The phenomenon of lightening occurs due to a large quantity of electric charge which builds up in the heavy thunderclouds. The thunderclouds are charged by friction between the water molecules in the thunderclouds and the air molecules. When the charge on the thunderclouds is sufficiently high, it can produce positive and negative charges in the air. The he amount of negative charge is discharged to the highest object on the ground and can harm them.

This explains why it is very dangerous to swim in the open sea, play in an open field or hide under a tree during a thunderstorm.

(34) How is Static electricity a major cause of fires and explosions at many places

Ans Static electricity is a major cause of fires and explosions at many places. A fire or an explosion may occur due to excessive build-up of electric charges produced by friction.

(35) What is capacitor and at what principle it work?

Ans: Capacitor is a device that is used to store charges. It works on the principle of electrostatic induction.

(36) What is the purpose of parallel combination of capacitors?

Ans: If 'n' capacitors are combined in parallel, then their equivalent capacitance is given by:

$$C_e = C_1 + C_2 + C_3 + \ldots\ldots + C_n$$

Generally capacitors are connected in parallel combination to increase the value of capacitance.

(37) How can we determine that an electric field is strong or weak in a certain region?

Ans: The number of lines of force is related with the strength of the field. If in a certain region, lines of force are close to each other, the field is strong there. And if lines of force are far apart from each other, the field is weaker there. Thus by seeing the lines of force, we can get information about the magnitude and direction of electric field intensity.

(38) Enlist few uses of capacitors.

Ans: They are used in:

(i) tuning transmitters (2) receiver and transistor radios

(3) table fans, exhaust fans (4) Coolers, air conditioners (5) motors, washing machines

(39) For what purpose electrostatics is used in everyday life?

Ans: Electrostatics is used in everyday lives which includes photocopying, car painting, extracting dust from dirty carpets and from chimneys of industrial machinery.

(40) How automobile manufactures use statics electricity to paint new cars?

Ans: The body of car is charged and then the paint is given the opposite charge by charging the nozzle of the sprayer. Due to mutual repulsion charge particles coming out of the nozzle form a fine mist and are evenly distributed on the surface of the object.

(41) How the phenomenon of lightening occurs?

Ans: The phenomenon of lightening occurs due to a large quantity of electric charge which builds up in the heavy thunderclouds. The thunderclouds are charged by friction between the water molecules in the thunderclouds and the air molecules. When the charge on the thunderclouds is sufficiently high, it can produce positive and negative charges in the air. The huge amount of negative charge is discharged to the highest object on the ground and can harm it.

(42) Why lightening conductors are used in tall buildings?

Ans: The purpose of the lightening conductor is to provide a steady discharge path for the large amount of negative charge in the air to flow form the top of the building to the earth. In this way, the chances of lightening damage due to sudden discharge can be minimized.

(43) How static electricity can be generated?

Ans: Static electricity can be generated by the friction of the gasoline being pumped into a vehicle or container. It can also be produced when we get out of the car or remove an article of clothing. Portable oil containers can also build up a static electric charge during transport.

(44) How static charges are dangerous?

Ans: If static charges are allowed to discharge though the areas where there is petrol vapour a fire can occur. The results are frightening and may be devastating.

(45) Write any two examples of practical application of electrostatic induction?

Ans: The applications of electrostatic induction are given as under:

i. Separation of particles from smoke

ii. Electro painting

LONG QUESTIONS

13.1 Production of electric charges:

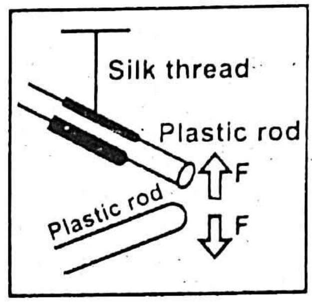
Q.1What is electrostatic? How electric charges be produced? Explain it with activities.

Electrostatics:

"Study of charges at rest is called electrostatics or static electricity."

Production of electric charges:

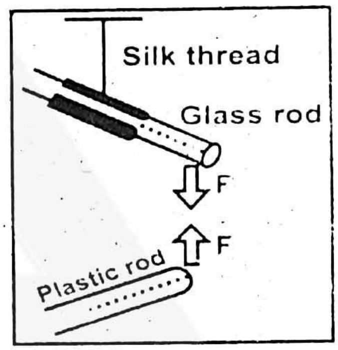
We can produce electric charge by rubbing a neutral body with another neutral body. The following activates show that we can produce two types of electric charges through the process of rubbing.



Activity 1: Take a plastic rod. Rub it with fur and suspend it horizontally by a silk thread (as shown Fig. 1). Now take another plastic rod and rub it with fur and bring near to the suspended rod

Observation:

We will observation that both the rods will repel each other. It means during the rubbing both the rods were charged both rods have same charge.



Activity 2: Now take a glass rod and rub it with slide and suspend it horizontally. When we bring the plastic rod rubbed with fur near to the suspended glass rod as shown fig. 2.

Observation:

We observe that both the rods attract each other.

Conclusions:

- In the above activity, rods are unlike and their attraction imply that charge on the two rods are not of the same kind but of opposite nature.

These apposite charges are conventionally called positive and negative charge. During the process of rubbing negative charge is transferred from one object to another object from these activities we conclude that:

Conclusion:

1. Charge is a basic property of a material body due to which it attracts or repels another object.
2. Friction produces two different types of charge on different material 9such as glass and plastic).
3. Like charges always repel each other.
4. Unlike charges always attract each other.
5. Repulsion is the sure test of charge on a body.

13.2 Electrostatic Induction:

Q.2 What is meant by electrostatic induction? Explain it with the help of experiments or activities.

Definition:

In the presence of a charged body, an insulated conductor develops positive charge at one end and negative charge at the other end. This process is called the electrostatic induction.

Explanation with the help of the activities

Activity 1:

If we bring charged plastic rod near neutral aluminium rod, both rods attract each other as shown in Fig. 13.4. This attraction between the charged and uncharged rods shows as if both rods have different charged. But this is not true. Charged plastic rod produces displacement of positive and negative charges on the neutral aluminium rod which is the cause of attraction between them. But total charge on aluminium rod is still zero. It implies that attraction is not the sure test of charge on a body.

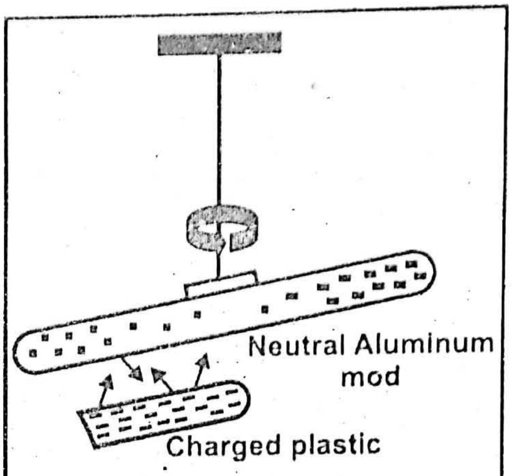


Fig. 13.4

It also shows that electrostatic induction is another method of charging a body and is described below.

Method of Charging a bodies by electrostatic induction

Consider a metallic sphere placed on an insulated stand Fig. (13.5a), The sphere is neutral as it carries equal number of positive and negative charges. Now bring a negatively charged rubber rod near the conducting sphere. As shown in Fig. (13.5.b) left part of the sphere that is close to the rod becomes positively charged while the right part that is away form the rod becomes negatively charged. Negative charge in the rod repels the negative charge of the sphere and shifts it to the opposite region of the sphere that is away form the rod. Thus there is excess of positive charge in the region of sphere close to the rod while there is excess of negative charge in the region of the sphere away form the rod. But as a whole the sphere is still neutral, since no charge has been added or subtracted.

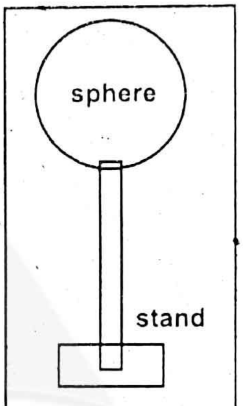


Fig. 13.5 (a)

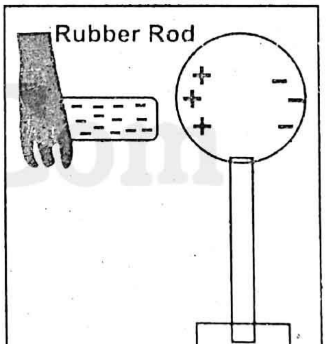


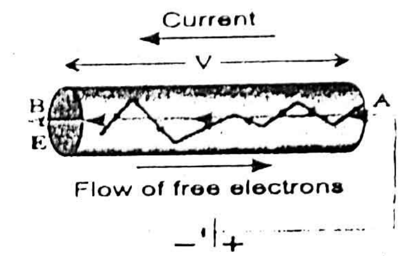
Fig. 13.5 (b)

Now if we remove the rod away form the sphere, the charged again will spread uniformly on the whole surface of the sphere.

Now earth the sphere through a conducting wire in the presence of the rod (Fig. 13.6-a) The negative charge will flow to the earth an leaves the sphere with net positive charge Now if we first break the earth connection and then remove the rod form the sphere it will get positive charge permanently (Fig. 13.6-b).

Explanation

When the ends of a copper wire are at different temperatures, heat energy flows from one end of higher temperature to the end of lower temperature. The flow stops when both ends reach the same temperature. Water in pipe also flows in a pipe from high level to low level. Similarly when a conductor is connected to a battery, it pushes positive charges to flow current from high potential to low potential as shown in fig.



The flow of current continues as long as there is a potential difference. Conventional current produces the same effect as the current flowing from negative terminal to the positive terminal due to flow of negative charges.

Q.4 How we can detect and measure the electric current (14.1)?

Ans: We use different electrical instruments which can detect and measure the current in the circuit.

1. **Galvanometer:**

"Galvanometer is a device which is used to detect the presence of electric current in any circuit."

ii. **Ammeter:**

"Ammeter is a device which is used to measure the current in any circuit."

Importance of Galvanometer

Galvanometer is very sensitive instruments and can detect small current. A current of few milli amperes is sufficient in it. Ideal galvanometer should have very small resistance to pass the maximum current in the circuit.

Polarity of galvanometer

While making the connections polarity of the terminals of the galvanometer should be taken into consideration. Generally the terminal of the galvanometer with red colour shows the positive polarity while that of with black colour shows negative polarity.

How Ammeter is formed?

After suitable modification galvanometer can converted into an ammeter. A suitable but small resistance is connected in parallel to the galvanometer, this circuit is called ammeter. A large current of the range such as 1A or 10 A can be measured by means of ammeter, like galvanometer ammeter is also connected in series, so that the current flowing in the circuit also passes through the ammeter.

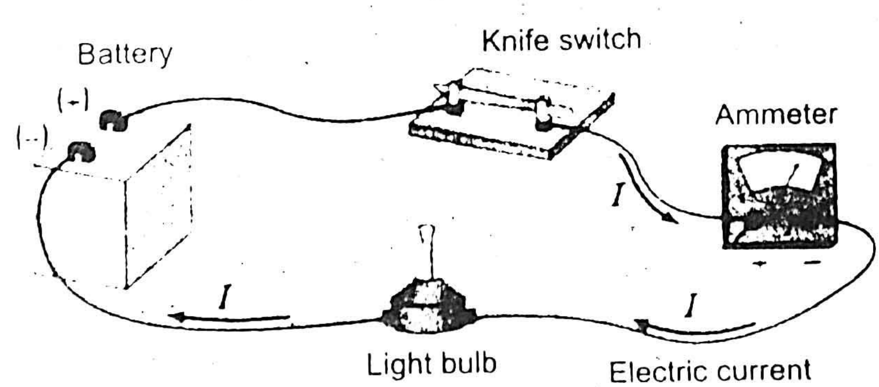


Fig. 14.5: Schematic diagram showing the measurement of current

14.2 and 14.3 Potential Difference and e.m.f

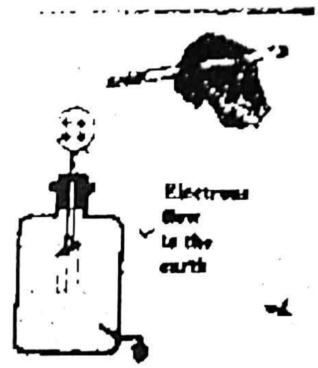
Q.5: Define and explain the potential difference (14.2).

Ans: **Definition:**

"Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as charges flow through the circuit.

Charging the Electroscope by Electrostatic induction:

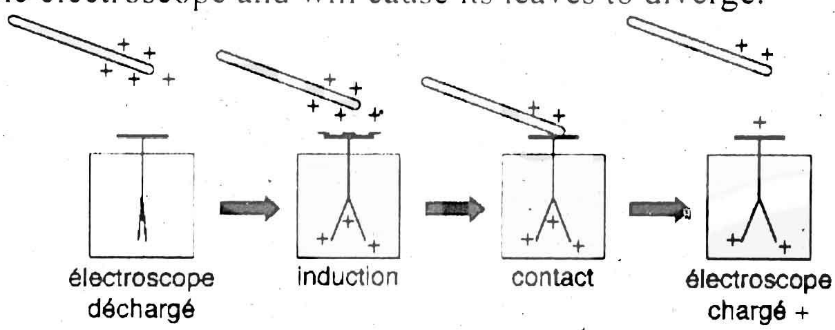
Electroscope can be charged by the process of electrostatic induction. In order to produce positive charge on the electroscope, bring a negatively charged body near the disk of the electroscope (Fig. 3-a). Positive charge will appear on the disk of the electroscope while negative charges will shift to the leaves. Now connect the disk of electroscope to the earthed aluminium foil by a conducting wire (Fig. 3-b). Charge of the leaves will flow to the earth through the wire. Now if we first beak the earth connection and then remove the rod the electroscope will be left with positive charge. Similarly electroscope can be charged negatively with the help of a positively charged rod.



Charging the electroscope positively

By Conduction:

Electroscope can also be charged by the process of conduction. Touch a negatively charged rod with the disk of a neutral electroscope. Negative charge from the rod will transfer to the electroscope and will cause its leaves to diverge.



(ii)

Detecting the Type of Charge:

For the detection of type of charge on a body, electroscope is first charged either positively or negatively. Suppose the electroscope is positively charged as explained before. Now in order to detect the type of charge on a body. Bring the charged body near the disk of the positively charged electroscope. If the divergence of the leaves increases, the body carries positive charge (Fig. 4-a). On the other hand if the divergence decreases, the body has negative charge (Fig 4-b)

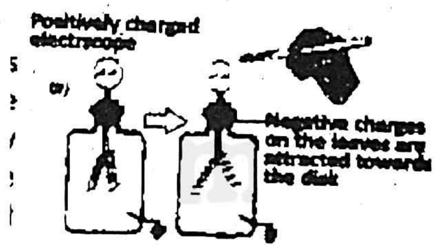


Fig. 4-a detecting positive charge on body

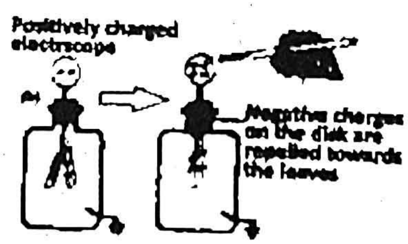


Fig. 4-b detecting negative charge on body

(iii) **Identifying conductors and insulators:**

Electroscope can also be used to distinguish between insulators and conductors. Touch the disk of a charged electroscope with material under test. If the leaves collapse from their diverged position the body would be a good conductor. If there is no change in the divergence of the leaves. It will show that the body under test is an insulator.

13.4 Coulomb's Law:

Q.4 State and explain Coulomb's law and write its mathematical form.

Introduction:

We know that a force of attraction or repulsion acts between two charged bodies. How is this force affected when the quantity of the charge on the two bodies or the distance between them is changed?. In order to find the answers of these question, a French scientist charges coulomb (1736-1806) in 1785 experimentally established the fundamental law of electric force between two stationary charged particles.

Coulomb's Law:

Statement:

"The force of attraction or repulsion between two point charges is directly proportional to the product of the quantity of charges and inversely proportional to the square of the distance between them."

Mathematically:

$$F \propto q_1 q_2 \quad \text{.......................... (i)}$$

$$F \propto \frac{1}{T^2} \quad \text{.......................... (ii)}$$

Combining Eqs. (i) and (ii) we get

$$F = k\frac{q_1 q_2}{r^2} \quad \text{.......................... (iii)}$$

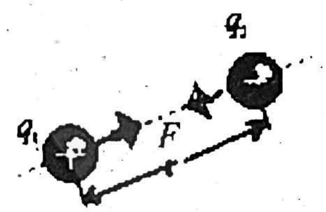


Fig. 1-a attraction between oppsite charges

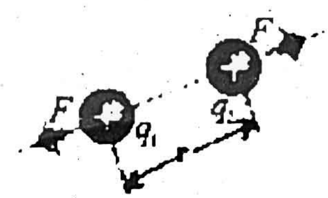


Fig. 1-b Repulasion between similar charges

Equation (iii) is known as coulomb's law. Where F is the force between the two charges and is called the coulomb force, q_1 and q_2 are the quantities of two charges and r is the distance between the centre of two charges (Fig. 1-a-b) K is the constant of proportionality given by

$$K = 1/4\pi\,\varepsilon_0$$

Dependence of value of K

The value of K depends upon the medium between the two charges and the system of units in which F, q, and r are measured, ε_0 is the permittivity of free space.

Now if the medium between the two charges is air then the value of K in SI units will be $9 \times 10^9 Nm^2C^{-2}$.

Final form of Coulomb's force is

$$F = \frac{1}{4\pi\epsilon_0} \times \frac{q_1 q_2}{(r)^2}$$

Point Charges:

Coulomb's law is true only for point charges whose sizes are very smallest compared to the distance between them. Like other forces, electric forces also obey Newton's third law.

13.5 Electric Field And Electric Field Intensity:

Q.5 Define electric field and electric intensity also explain electric intensity?

OR

What is meant by electric field and electric intensity? Find the electric intensity due to point charge

Electric field

Definition:

"The region of space surrounding the charge q in which it exerts a force on the charge q_0 is known as electric field of the charge q."

OR

"The electric field is a region around a charge in which it exerts electrostatic force on another charges."

Explanation:

According to Coulomb's law if a unit positive charge q_o (call it the test charge) is brought near a charge q (call it the field charge) placed in space, the charge q_o will experience a force. The value of this force would depend upon the distance between the two charges. If the charge q_o is moved away form q this force would decrease till at a certain distance the force would practically reduce to zero. Now the charge q_o is out of the influence of charge q.

Electric Filed Intensity

"The strength of electric field at any point in space is known as electric field intensity"

Explanation:

In order to find the value of electric intensity at a point in the field, of charge + q, we place a test charge q_o at that point Fig. 13.13. If F is the force acting on the test charge q_o the electric field intensity would be given by

$$E \frac{F}{q_0} \text{ .... } (13.4)$$

Thus the electric field intensity at any point is defined as the force acting on a unit positive charge place at that point.

SI Unit:

SI unit of electric intensity is NC^{-1}

If the electric field due to a given arrangement of charges is known at some point, the force on any particle with charge q placed that point can be calculated by using the formula

$F = qE$ ....(13.5)

Quantity:

Electric intensity being a force is a vector quantity. It direction is the same as that of the force acting on the positive test charge. If the test charge is free to move, it will always move in the direction of electric intensity.

Q.6 What is meant by electric lines of force? Explain

Electric Filed Lines:

Definition:

The direction of electric field intensity in an electric field can also be represented by drawing lines. These lines are known as electric lines of force.

Explanation:

These lines were introduced by Michael Faraday. The field lines are imaginary line around a field charge with an arrow head indicating the direction of force. Field lines always move away form positive charge but toward negative charge. The spacing between the field lines shows the strength of electric field (Fig 1)

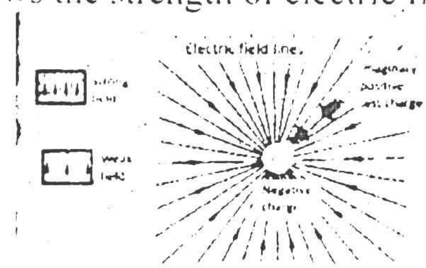
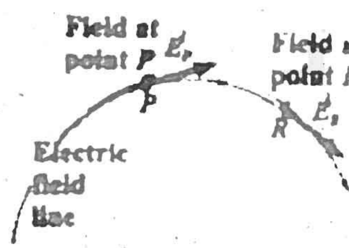


Fig. 1

Relation of field line with the electric field intensity

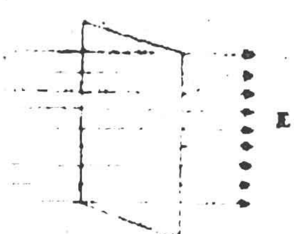
Field lines are related to the electric field intensity in any region of space in the following way

1. The electric field intensity is tangent to the electric field lines at each point (Fig. 2-a).



(Fig. 2-a)

2. The number of lines per unit area through a surface perpendicular to the lines is proportional to the electric field strength in a given region (Fig. 2-b)

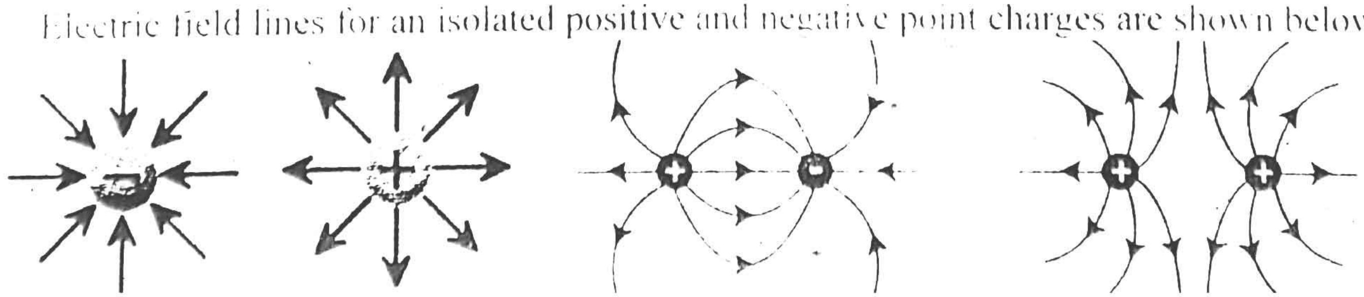


(Fig. 2-b)

3. Electric field is strong when the field lines are close together and weak when the lines are for apart.

4. No, two field lines cross each other.

Electric field lines for an isolated positive and negative point charges are shown below:



13.6 Electrostatic Potential:

Q.7 What is meant by electric potential? Explain

Electric potential:

"Electric potential at a point in an electric field is equal to the amount of work done in bringing a unit positive charge form infinity to that point."

Mathematically:

If W is the work done in moving a unit positive charge from infinity to a certain point in the field, the electric potential V at this point would be given by

$$V = \frac{W}{q} \quad ....(13.6)$$

It implies that electric potential is measured relative to some reference point and like potential energy we can measure only the change in potential between two points.

Quantity:

Electric potential is a scalar quantity.

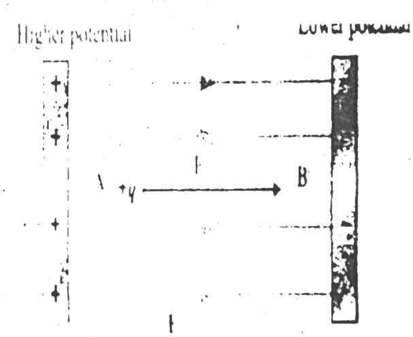
Unit:

It SI unit is volt which is equal to JC^{-1}

Definition of volt:

If one joule of work is done against the electric field in bringing one coulomb positive charge form infinity to a point in the electric field then the potential at that point will be one volt. Or if the potential energy of one coulomb of charge at a point in the electric field is one joule, the potential of the point will be one volt.

Potential Difference:



A body in gravitational field always tends to move form a point of higher potential energy to a point of lower potential energy. Similarly, when a charge is released in a electric field, it moves form a point of higher potential say A to appoint a lower potential say B(Fig. 13.16). If the potential of point A is V_a and that of point B is V_b the potential energy of the charge at these points will be qv_a and qv_b respectively. The change in potential energy of the charge when it moves from point A to B will be equal to $qv_a - qv_b$. This energy is utilized in doing some useful work.

Thus Energy supplied by the charge $= q(v_a - V_b)$ .... (13.7)

If q is equal to one unit, then the potential difference between two points becomes equal to the energy supplied by the charge. Thus, we define potential difference between two points as

Potential difference:

"The energy supplied by a unit charge as it moves form one point to the other in the direction of the field."

- If a positive charge is transferred form a point of lower potential to a point of higher potential i.e. against the field direction, energy would have to be supplied to it.
- When we release a negative charge in an electric field, its behaviour will be opposite to that of positive charge. A more useful unit for the electrical energy is electron volt (eV).

13.7 Capacitors and Capacitance:

Q.8 What is meant by capacitance of the conductor? Explain.

Capacitance:

"The ability of a capacitor to store charge is known as capacitance. It is the ratio of charge and electric potential".

Explanation:

When we charge a conductor, some work has to be done during the process of transferring the charge to the conductor. This raises the potential of the conductor. Experiments show that the charge Q on the conductor is directly proportional to its potential V,

$$Q \propto V$$

Or

$$Q = CV \quad \ldots\ldots\ldots\ldots\ (1)$$

$$C = Q/V$$

Where C is a constant whose value depends upon the size of the conductor. It is known as capacitance of the conductor. In Equation [1], if V= 1 volt, then Q = C i.e., the capacitance of a conductor is equal to the amount of charge which raises the potential of the conductor by one volt.

Unit

The unit of capacitance is known as farad. It can be defined as:

Farad

"It is the capacity of that conductor the potential of which rises by one volt when one coulomb charge is given to it."

Q.9 Describe a capacitor. How does it store charge?

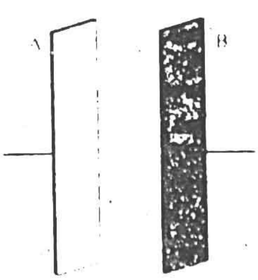
OR

Describe capacitor as an energy storing device?

Ans: "The device that is used to store electric charge is known as Capacitor"

Construction

It consists of two thin metal plates, parallel to each other with a very small distance between them. The medium between the two plates is air or a sheet of some insulator. This medium is known as dielectric. A plane parallel plate capacitor has been shown in Figure.



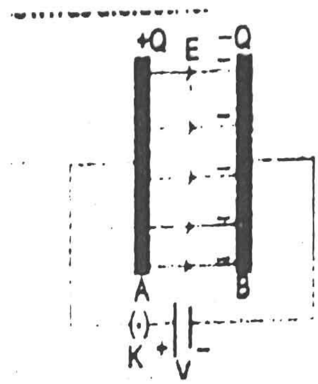
Parallel plate capacitor

Storage of charge on metals

Charge cannot be stored on a conductor for a long period of time because the stored charges mutually repel each other due to which they spread on the whole surface of the conductor and also tend to leak out from there.

Process of storing charges on capacitor

If +Q amount of charge is transferred to its plate A, due to electrostatic induction it would induce -Q charge on the inner surface of the plate B and +Q charge on its outer plate as shown in the figure. The lines offered between the plates have been shown. There exists a force of attraction between the charges +Q stored on the plate and the charge -Q induced on the inner surface of plate B. Due to this force of attraction, the charges are bound with the plate and remain stored for long periods.



Mathematical form

Due to presence of the charges on the plate, a potential difference V is created between them which is directly proportional to the charge Q given to the plate 'A'.

$$Q \propto V$$

Or

$$Q = CV$$

Here C is the constant of proportionality, known as the capacitance of the capacitor.

Combination of Capacitors

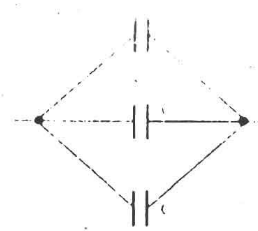
Q.10 How are the capacitors are connected in parallel? Describe the characteristics features of this combination.

OR

Derive the formula for the effective capacitance for a parallel combination of a number of capacitors.

Ans:

In this method the left plate of each capacitor is connected to the positime terminal of battery by a connecting wire. In the same way the right plate of each capacitor is connected to negative terminal of the battery.



Characteristics of parallel combination

1. Each capacitor connected to a battery of voltage V has the same potential difference V across it.
   i.e $V_1 = V_1 = V_2 = V$
2. The charge developed across the plates of each capacitor will be different due to different value of capacitances.
3. The total charge Q supplied by the battery is divided among the various capacitors. Hence

   $$Q = Q_1 + Q_2 + Q_3$$

   $$\text{or } Q = C_1V + C_2V + C_3V$$

   $$\text{or } \frac{Q}{V} = V_1 + V_2 + C_3$$

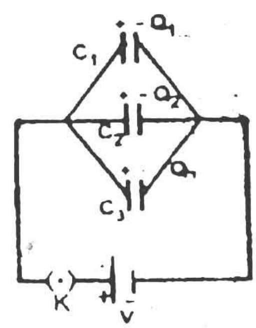


Fig 13.18 Capacitors in parallel combination

4. Thus, we can replace the parallel combination of capacitors with one equivalent capacitor having capacitance C_{eq} (Fig. 13.19), such that

   $$C_{eq} = C_1 + C_2 + C_3$$

   In the case of n capacitors connected in parallel, the equivalent capacitance is given by

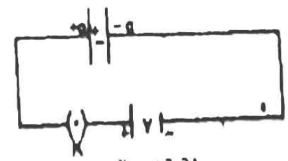


Fig 13.21

$$C_{eq} = C_1 + C_2 + C_3 + \dots\dots\dots\dots + C_n$$

5. The equivalent capacitance of a parallel combination of capacitors is greater than any of the individual capacitances.

Q.11 How are the capacitors are connected in series? Describe the characteristics features of this combination.

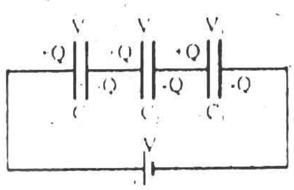
OR

Derive the formula for the effective capacitance for a series combination of a number of capacitors.

Ans:

In this method the capacitors are connected side by side. The right plate of one capacitor is connected to the left plate the next capacitor as shown in figure.

Characteristics of series combination



1. Each capacitor has the same charge across it. IF the battery supplies + Q charge to the left plate of the capacitor C_1 due to induction $-Q$ charge is induced on the right plate of the capacitor and + Q charge on the left plate of the capacitor C_2 i.e.

$Q_1 = Q_2 = Q_3 = Q$

2. The potential difference across each capacitor is different due to different values of capacitances.

3. The voltage of the battery has been divided among the various capacitors. Hence

$$V = V_1 + V_2 + V_3$$

$$= \frac{Q}{C_1} + \frac{Q}{C_2} + \frac{Q}{C_3}$$

$$= Q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\frac{V}{Q} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right).$$

4. Thus, we can replace series combination of capacitors wit one equivalent capacitor having capacitance C eq i.e.,

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

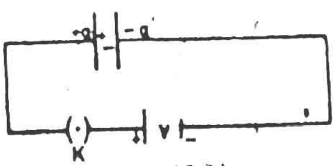


Fig 13.21

5. In the case of n capacitors connected in series. We have

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots\dots\dots + \frac{1}{C_n}$$

13.8 Different Types Of Capacitors:

Q.12 Discuss the different types of capacitors.

Parallel plate capacitors are not commonly used in most devices because in order to store enough charge their size must be large which is not desirable. A parallel plate capacitor has a dielectric between its plates and is made of a flexible material that can be rolled into the shape of a cylinder. In this way, we can increase the area of each plate while the capacitor can fit into a small space. Some other types of capacitors use chemical reactions to store charge, like tiny batteries.

Types of capacitor:

Capacitors have different types depending upon their construction and the nature of dielectric used in them. Capacitors are either variable or fixed. In variable capacitors,

Definition:

Fixed capacitor

If the capacitor is such that its plates are immovable, it is known as a fixed capacitor. Its value does not change.

TYPES OF FIXED CAPACITOR:

- Paper capacitor
- Mica capacitor

Paper capacitors:

The paper capacitor has a cylindrical shape. Usually an oiled or greased paper or a thin plastic sheet is used as a dielectric between two aluminium foils. The paper or plastic sheet firmly rolled in the form of a cylinder and is then enclosed into a plastic case.

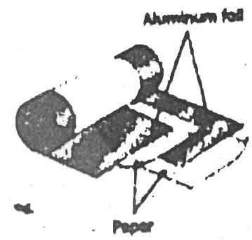
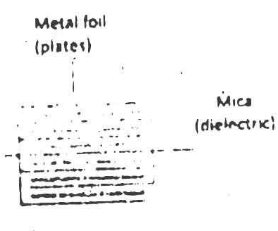
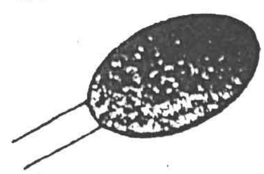


Fig. 13.22: Paper capacitor

Mica capacitor:

Capacitor another example of fixed capacitors. In these capacitors, mica is used as dielectric between the two metal plates (Fig. 13.23-a). For convenience and safety purposes it is enclosed in a plastic case or in a case of some insulator. Wires attached to plates project out of the case for making connections (Fig. 13.23-b).





If the capacitance is to be increased, large number of plates is piled up, one over the other with layers of dielectric in between and alternative plates are connected with each other.

Variable capacitor:

In variable type of capacitors some arrangement is made to change the area of the plates facing each other (Fig. 13.24). It is generally a combination of many capacitors with air as electric. It consists of two sets of plates.

One set remains fixed while the other set can rotate so the distance between the plates does not change and they do not touch each other . The common area of the plates of the two sets which faces each other, determines the value of capacitance. Thus the capacitance of the capacitor can be increased or decreased by turning the rotatable plates in or out of the space between the static plates such capacitors are usually utilized for tuning in radio sets.

AN ELECTROLYTIC

An electrolytic capacitor is often used to store large amounts of charge at relatively low voltages (Fig. 13.25). It consists of a metal foil in contact with an electrolyte –a solution that conducts charge by virtue of the motion of the ions contained In it.

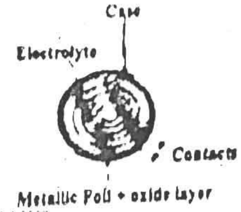


Fig 13.25 Electrolytic capacitor

When a voltage is applied between the foil and the electrolyte, a thin layer of metal oxide (an insulator) is formed on the foil, and this layer serves as the dielectric. Enormous capacitances can be attained because the dielectric layer is very thin.

Q.13 Write down few uses of capacitors.

Uses of Capacitors:

Capacitors have wide range of applications in different electrical and electronic circuits.

For Tuning some appliance:

They are used for turning transmitters, receivers and transistor radios.

For Home appliance:

They are also used for table fans, celling fans, exhaust fans, fan motors in air conditioners; coolers, motors washing machines, air conditioners and many other appliances for their smooth working.

In electronic circuses:

Capacitors are also used in electronic circuits of computers etc.

To differentiate between Low and high frequency:

Capacitors can be used to differentiate between high frequency and low frequency signal which make them useful in electronic circuits.

A so filter circuit:

Capacitors are used in the resonant circuits that tune radios to particular frequencies. Such circuits are called filter circuit.

Ceramic:

Capacitors are generally superior to other types and therefore can be used in vast ranges of application.

13.9 Applications of Electrostatics:

Q.14 Discuss in detail important application of electrostatic.

OR

Write a note on the following

(a) Electrostatic air cleaner

(b) Spray Painting

Static electricity has an important place in our everyday lives which include photocopying, car painting, extracting dust from dirty carpets and from chimneys of industrial machinery.

Electrostatic Air Cleaner:

An electrostatic air cleaner is used in homes to relieve that discomfort of allergy sufferers.

Working of electric static Air cleaner:

Air mixed with dust and pollen enters the device across a positively charged mesh screen. The airborne particles become positively charged when they make contact with the screen. Then they pass through a second, negatively charged mesh screen. The electrostatic force of attraction between the positively charged particles in the air and the negatively charged screen cases the particles to precipitate out on the surface of the screen.

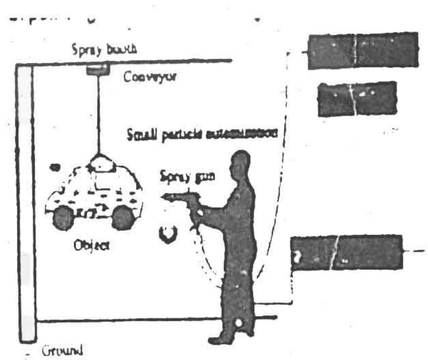
Through this process we can removes a very high percentage of contaminants form the air stream.

Spray painting;

Automobile manufacturers use static electricity to paint new cars.

Working of electrostatic spray painting:

The body of car is charged and then the paint is given the opposite charge by charging the nozzle of the sprayer (Fig.13.26) Due to mutual repulsion charge particles coming out of the nozzle form a fine mist and are evenly distributed on the surface of the object. The charged paint particles are attracted to the car and stick to the body, just like a charged balloon sticks to a wall. Once the paint dries, sticks much better to the car and is smoother because is the uniformly distributed. This is a very effective, efficient and economical way of painting automobiles on large scale.



13.26 Schematic [illegible] of electrostatic spray painting system [illegible] charged and spray gun is positively charged [illegible] charge they repel and give a fine [illegible] spray

13.10 Some Hazards of Static Electricity Lightening:

Q.15 What are the hazards of static electricity? Explain them.

There are so many hazards of static electricity. We are discussing only two of them.

(i) Lightening (ii) Fires or Explosions

(i) **Lightening**

The phenomenon of lightening occurs due to a large quantity of electric charge which builds up in the heavy thunderclouds. The thunderclouds are charged by friction between the water molecules in the thunderclouds and the air molecules. When the charge on the thunderclouds is sufficiently high, it can produce positive and negative charges in the air. The he amount of negative charge is discharged to the highest object on the ground and can harm them.

This explains why it is very dangerous to swim in the open sea, play in an open filed or hide under a tree during a thunderstorm.

Precaution or prevention:

To prevent lightening from damaging tall buildings, lightening conductors are used. The purpose of the lightening conductor is to provide a steady discharge path for the large amount of negative charge in the air to flow form the top of the building to the Earth. In this way the chances of lightening damage due to sudden discharge can be minimized.

(ii) **Fires or Explosions:**

Static electricity is a major cause of fires and explosions at many places. A fire or an explosion may occur due to excessive build-up of electric charges produced by friction.

Production of static electricity:

Static electricity can be generated by the friction of the gasoline being pumped into a vehicle or container. It can also be produced when we get out of the car or remove an article of clothing. Static charge are dangerous. If static charges are allowed to discharge though the areas where there is petrol vapour a fire can occur.

The results are frightening and may be devastating.

Portable oil containers can build up a static electric charge during transport. Consequently, when the container is not placed on the ground for filling, its static electricity could be discharged and result in a fire when filling begins.

Precaution or prevention

Precaution or prevention containers should be placed on the ground during filling and the nozzle should be kept in contact with the container. Containers should not to be filled while inside a vehicle.

NUMERICAL PROBLMES

13.1.1 The charge of how many negatively charged particles would be equal to $100\mu C$. Assume charge on one negative particle is $1.6\times10^{-19}C$?

Solution: Given that,

Total Charge Q = 100 μC = 100×10^{-6} C

Charge on an electron e = 1.6×10^{-19} C

To find: No. of negatively charged particles n = ?

Calculations: Using the formula

$$Q = ne$$

Or $$n = \frac{Q}{e}$$

By putting the values

$$n = \frac{100\times10^{-6}C}{1.6\times10^{-19}C}$$

$$= \frac{10^{2}\times10^{-6}\times10^{19}}{1.6}$$

$$= \frac{10^{-6} \times 10^{21}}{1.6}$$

$$= \frac{1}{1.6} \times 10^{15}$$

$$= \frac{1}{16} \times 10^{16} = 0.0625 \times 10^{16}$$

$n = 6.25 \times 10^{13}$ **Ans**

13.1.2 Two point charges $q_1 = 10\mu C$ and $q_2 = 5\mu C$ are placed at a distance of 150 cm. What will be the Coulomb's force between them? Also find the direction of the force.

Solution: Given that

First point charge = $q_1 = 10\mu C = 10 \times 10^{-6} = 1 \times 10^{-5} C$

Second point charge = $q_2 = 5\ \mu C = 5 \times 10^{-6}\ C$

Distance $r = 150\ cm = \frac{150 cm}{100} = 1.5\ m$

Proportionality constant = $k = 9 \times 10^{9}\ Nm^2\ C^{-2}$

To Find

(i) Magnitude of Coulomb's force F = ?

(ii) Direction of Coulomb's force = ?

Calculations: According to Coulomb's law

$$F = k\frac{q_1 q_2}{r^2}$$

By putting the values

$$F = \frac{9 \times 10^{9} Nm^2 C^{-2} \times 1 \times 10^{-5} C \times 5 \times 10^{-6} C}{(1.5m)^2}$$

$$= \frac{9 \times 10^{9} Nm^2 \times 10^{-5} \times 5 \times 10^{-6}}{2.25m^2}$$

$$= \frac{45 \times 10^{-2} N}{2.25}$$

$$= \frac{45}{225} N$$

$F = 0.2$ N **Ans**

The direction of coulomb's force is direction of repulsion

13.1.3 The force of repulsion between two identical positive charges is 0.8 N, when the charges are 0.1 m part. Find the value of each charge.

Solution: Given that,

Force = F = 0.8 N

Distance between the charges r = 0.1 m

Proportionality constant = $k = 9 \times 10^9\ Nm^2C^{-2}$

To Find: Value of each charger = q = ?

Calculations: Using Coulomb's law

$$F = \frac{kq_1q_2}{r^2}$$

Since the charges are identical, therefore, $q_1 = q_2 = q$, thus

$$F = k\frac{q^2}{r^2}$$

Or $\quad F \times r^2 = 9 \times 10^9\ Nm^2\ C^{-2} \times q^2$

Or $\quad q^2 = \dfrac{F \times r^2}{9 \times 10^9\ Nm^2C^{-2}}$

By putting the values

$$q^2 = \frac{0.8N \times (0.1m)^2}{9 \times 10^9\ Nm^2C^{-2}}$$

$$= \frac{0.8 \times 0.01}{9 \times 10^9}C^2$$

$$= \frac{0.008}{9 \times 10^9}C^2$$

$$q = \sqrt{\frac{0.008 \times 10^{-9}}{9}}\ C$$

$q = 9.4 \times 10^{-7}$ C Ans

13.1.4 Two charges repel each other with a force of 0.1 N when they are 5cm apart. Find the forces between the same charges when they are 2 cm apart.

Solution: Given that,

Force F = 0.1 N

Distance between the charges $r = 5\ cm = \frac{5}{100}m = 0.05\ m$

To Find: Forces between the charge when they are 2 cm or 0.02 m apart F = ?

Calculations: According to coulomb's law.

$$F = K\frac{q.q}{r^2}$$

By putting the values

$$0.1\ N = 9 \times Nm^2\ C^{-2} \times \frac{q.q}{(0.05m)^2}$$

Or $$q_1q_2 = \frac{0.1\times(0.05)^2}{9\times10^9}C^2$$

Now force between the charges

$$F = k\frac{q_1q_2}{r^2}$$

By putting the values

$$F = 9 \times 10^9\ Nm^2C^{-2} \times \frac{(0.1)\times(0.05)^2 C^2}{9\times10^9}\times\frac{1}{(0.02m)^2}$$

$$= \frac{(0.1)\times(0.05)^2}{(0.02)^2}N$$

$F = 0.62$ N **Ans.**

13.1.5 The potential lat a point in an electric field is 10^4 V. If a charge of $+100\mu C$ is brought from infinity to this point. What would be the amount of work done on it?

Solution: Given that,

Electric potential V $= 10^4$ V

Charge q $= +100\ \mu C = 100 \times 10^{-6}\ C = 1 \times 10^{-4}\ C$

To Find: Work done W = ?

Calculations: Using the formula

$$V = \frac{W}{q}$$

Or $W = qV$

By putting the values

$W = 10^{-4}\ C \times 10^4\ C$

$W = 1J$ **Ans.**

13.1.6 A point charge of +2C is transferred from a point at potential 100V to a point at potential 50V, what would be the energy supplied by the charge?

Solution: Given that,

Charge q $= +2C$

Potential at point A V_A $= 100$ V

Potential at point B V_B $= 50$ V

To Find: Energy supplied by the charge E = ?

Calculations

Using the formula

$$E = q(V_A - V_B)$$

By putting the values

$E = 2C(100V - 50V)$

$E = 100$ J **Ans.**

13.1.7 A capacitor holds 0.06 coulombs of charge when fully charged by a 9 volt battery. Calculate capacitance of the capacitor.

Solution: Given that,

Charge $Q = 0.06\ C$

Voltage $V = 9V$

To Find: Capacitance $C = ?$

Calculations: Using the formula

$$Q = CV$$

Or $$C = \frac{Q}{V}$$

By putting the values

$$C = \frac{0.06C}{9v}$$

$$C = 6.67 \times 10^{-3}\ F \textbf{ Ans.}$$

13.1.8 A capacitor holds 0.03 coulombs of charge when fully charged by a 6 volt battery. How much voltage would be required for it to hold 2 coulombs of charge?

Solutions: Given that

Charge $= Q = 0.03\ C$

Voltage $V = 6V$

To Find: Voltage to hold 2C of charge $V = ?$

Calculations: Since

$$0.03\ C = 6V$$

Or $$1C = \frac{6V}{0.03}$$

Therefore,

$$2C = \frac{6V}{0.03} \times 2$$

$$= \frac{1200V}{3}$$

$$V = 400\ V \textbf{ Ans.}$$

13.1.9 Two capacitors of $6\mu F$ and $12\mu F$ are connected in series with 12V battery. Find the equivalent capacitance of the combination. Find the charge and potential difference across each capacitor.

Solution: Given that,

Capacitance = $C_1 = 6\ \mu F = 6 \times 10^{-6} F$

Capacitance = $C_2 = 12\ \mu F = 12 \times 10^{-6} F$

Voltage = V = 12 V

To Find

(i) Equivalent capacitance $C_{eq} = ?$

(ii) Charge on each capacitor $Q = ?$

(iii) Potential difference across one capacitor $V_1 = ?$

Potential difference across second capacitor = $V_2 = ?$

Calculations: (i) Since the capacitors are connected in series, therefore, equivalent capacitance will be

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

By putting the values

$$\frac{1}{C_{eq}} = \frac{1}{6\mu F} + \frac{1}{12\mu F} = \frac{2+1}{\mu F}$$

$$\frac{1}{C_{eq}} = \frac{3}{12\mu F}$$

Or $$C_{eq} = \frac{12\mu F}{3}$$

$$C_{eq} = 4\mu F \textbf{ Ans.}$$

(ii) Since the capacitor are connected in series, therefore, charge on capacitor will be

$$Q = CV$$

Or $$Q = 4 \times 10^{-6} F \times 12V$$

$$Q = 48 \times 10^{-6} FV$$

$$Q = 48\ \mu C \textbf{ Ans.}$$

(iii) Potential difference across capacitor of capacitance C_1 will be

$$Q = C_1 V_1$$

Or $$V_1 = \frac{Q}{C_1}$$

Or $V_1 = \frac{48\mu C}{6\mu F} = 8V$ **Ans.**

Similarly, potential difference across capacitor of capacitance C_2 will be

$$Q = C_2V_2$$

Or $V_2 = \frac{Q}{C_2}$

Or $V_2 = \frac{48\mu C}{12\mu F} = 4V$ **Ans.**

13.1.10 Tow capacitors of capacitances $6\mu F$ and $12\mu F$ are connected in parallel with a 12V battery. Find the equivalent capacitance of the combination. Find the charge and the potential difference across each capacitor.

Solution: Given that,

Capacitance = $C_1 = 6\mu F$

Capacitance = $C_2 = 12\mu F$

Voltage = V = 12V

To Find

(i) Equivalent capacitance $C_{eq} = ?$

(ii) Charge on one capacitor $Q_1 = ?$

(iii) Charge on second capacitor = $Q_2 = ?$

(iv) Potential difference across each capacitor V = ?

Calculations: (i) Since the capacitors are connected in parallel, therefore, equivalent capacitance will be

$$C_{eq} = C_1 + C_2$$

$$= 6\mu F + 12\mu F$$

$C_{eq} = 18\mu F$ **Ans.**

(ii) Charge on capacitor C_1 will be

$$Q_1 = C_1V$$

Or $Q_1 = 6\mu F \times 12V$

$Q_1 = 72\mu C$ **Ans.**

(iii) Charge on capacitor C_2 will be

$$Q_2 = C_2V$$

$$Q_2 = 12\ \mu F \times 12\ V$$

$Q_2 = 144\mu C$ Ans.

(iv) Since the capacitors are connected in parallel, therefore, potential difference across each capacitor will be 12V.

CHAPTER 17

INFORMATION AND COMMUNICATION TECHNOLOGY

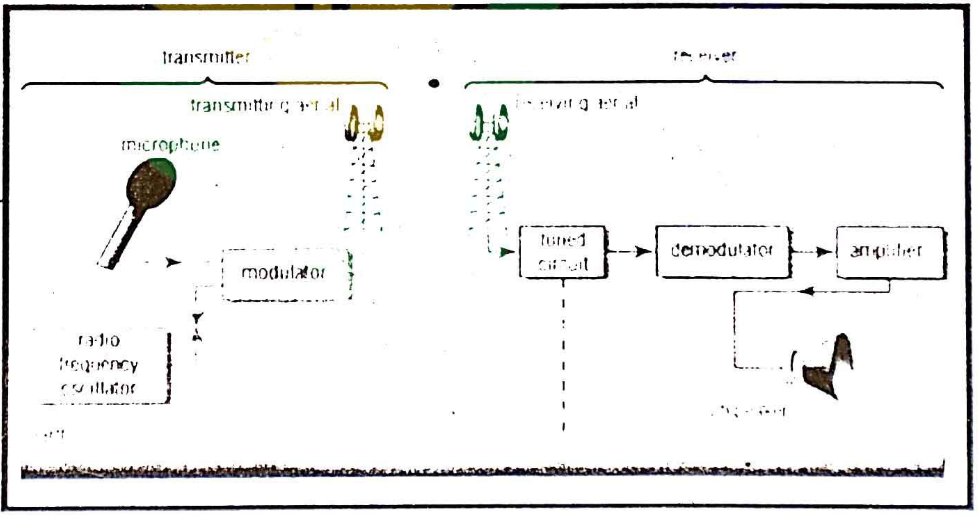
CONCEPT MAP

INFORMATION AND COMMUNICATION TECHNOLOGY

Transmission
- Through wire
- Through Radiowave
- Through optical fibre

Information storage devices
- Primary storage devices (RAM)
- Secondary storage devices
  - (i) Audio and video cassettes
  - (ii) Magnetic disc
  - (iii) Hard disc
  - (iv) Compact disc
  - (v) Flash derive

Application of computer
- Word processing
- Data management
- Internet
- Internet device
- E-mail



MULTIPLE CHOICE QUESTIONS

17.1 and 17.2 Information and Communication Technology, Component of Computer Based Information

(1) Which source has shortened the distances and has brought in contact the whole world?
(a) Telephone (b) Mobile phone (c) Fax machine (d) all given

(2) In computer terminology, processed data is called
(a) Output (b) Information (c) Input (d) Procedure

(3) Which is basically an electronic based system of information transmission, reception, processing and retrieval?
(a) ICT (b) IDT or OR (c) CRO (d) ADC or DAC

(4) The method used to communicate information to far off places instantly is called
(a) Telecommunication (b) Information (c) Transfer of data (d) Production

(5) The term refers to machinery in computer terminology is
(a) Software (b) Hardware (c) Data (d) Procedures

(6) Supports equipments of hardware are
(a) Storage devices (b) Out put devices (c) Communication devices (d) All given

(7) Which refers to computer programs and the manuals that support them?
(a) Software (b) Hardware (c) Data (d) Information

(8) Which are facts that are used by programs to produce useful information?
(a) Data (b) Software (c) Hardware (d) Programs

(9) Which technology is used in mobile phone?
(a) Computer (b) Internet (c) Radio (d) Fax machine

(10) Which technology is used in videophone?
(a) 2G (b) 3G (c) 5G (d) None

17.3 and 17.4 Flow of Information and Transmission of Electrical signal through wire

(11) The transfer of information from one place to another through different electronic and optical equipment is
(a) Flow of information (b) Information storage
(c) Information collection (d) Cheque information

(12) In telephone, information is sent in the form of signals through
(a) Wires (b) Plastic (c) Spring (d) Threads

(13) The essential part of any communication system is
(a) Transmitter (b) Transmission channel (c) Receiver (d) All given

(14) Alexander Graham Bell in 1876 made a :
(a) Machine (b) Computer (c) Telephone (d) Cell

(15) Telephones sent voice in the form of
(a) Waves (b) Electrical signals (c) Mechanical signals (d) Magnetic signals

(16) Who design and operate the software and feed input data, build the hardware for the smooth running of any CBIS?
(a) Software (b) Hardware (c) People (d) Data

(17) Major Components of CBIS are?
(a) 2 (b) 3 (c) 5 (d) 7

(18) **Cell phone transmission are made with __________**
(a) Microwaves (b) Radio waves (c) Visible waves (d) All

(19) **The most important of hardware of computer system is?**
(a) Monitor (b) CPU (c) Hard Disk (d) Processor

(20) **The mouthpiece of telephone contains thin metal diaphragm and granules of**
(a) Carbon (b) Aluminium (c) Sulphur (d) Copper

(21) **The speed of sound in air is**
(a) 1850 km per hour (b) 1200km per hour (c) 1550km per hour (d) 1246km per hour

17.5 Transmission of Radio Waves through space

17.6 Transmission of Light Signal through optical fiber

(22) **Information in the form of audio frequency (AF) signals may be transmitted directly by**
(a) Wire (b) Computer (c) Cable (d) TV

(23) **For sending information over a long distance it has to be superimposed on;**
(a) Mechanical waves (b) Electromagnetic waves (c) Sound waves (d) Kinetic waves

(24) **At the radio station, sound waves produced are changed into electrical signals through**
(a) Microphone (b) Modem (c) Speaker (d) Head phone

(25) **Which device basically scans a page to convert its text and graphic into electronics signal and transmit it?**
(a) Cell phone (b) Photo phone (c) Fax machine (d) Text machine

(26) **Cell phone is a type of ____________ having two way communication:**
(a) T.V (b) Computer (c) Radio (d) Microwave oven

(27) **Cell phone sends and receives the message in the form of**
(a) Electronic waves (b) Radio waves (c) Mechanical waves (d) Magnetic waves

(28) **Cell phone network system consists of**
(a) Base stations (b) Mobile switching center (c) Cells (d) All given

(29) **Which is an electronic computing machine used for adding, subtracting and multiplying?**
(a) Mobile (b) Computer (c) Cell phone (d) Photo phone

(30) **The most important piece of hardware is**
(a) Monitor (b) Keyboard (c) Printer (d) CPU

(31) **Microprocessor is tiny rectangular chip present in**
(a) CPU (b) Monitor (c) Printer (d) Keyboard

(32) **Which refers to the instructions or programs?**
(a) Hardware (b) Software (c) Monitor (d) Keyboard

(33) **Which are more compact and portable**
(a) Desktop (b) Computers (c) Laptops (d) All of these

17.7 Information Storage Devices

(34) **Which statement is incorrect for primary memory?**
(a) It consists of integrated circuit
(b) It vanishes when computer is switched off
(c) Read only memory
(d) Random access memory

(35) **Which statement is correct about secondary memory?**
(a) Data storage devices are secondary memory
(b) Store data permanently in computer
(c) Audio-video cassettes are secondary storage devices
(d) All given are true

(36) **Which is small magnetically sensitive, flexible, plastic wafer housed in plastic case?**
(a) Floppy (b) Cassette (c) Video-disk (d) Audio disk

(37) **Floppy is coated with**
(a) Magnetic oxide (b) Sulphuric oxide (c) Potassium oxide (d) Silver oxide

(38) **Which is rigid, magnetically sensitive disk that spins rapidly and continuously inside the computer chassis?**
(a) Floppy (b) Hard disk (c) Cassette (d) Compact disk

(39) **A typical floppy has a storage capacity between**
(a) 1 and 3 MB (b) 2 and 4MB (c) 3 and 5MB (d) 6

(40) **A CD can store computer data**
(a) 680 megabyte (b) 660 megabyte (c) 620 megabyte (d) 610 megabyte

(41) **Which is small storage device that can be used to transport files from one computer to another?**
(a) Compact disk (b) Hard disk (c) Flash drive (d) Floppy disk

(42) **Use of computer through which we can write a letter, article, book or prepare a report, is called;**
(a) Word processing (b) Internet (c) Data management (d) Browser

(43) **Which function allows uses to view web pages?**
(a) Web-browsing (b) E-mail (c) E-commerce (d) All given

(44) **The advantage of e-mail is**
(a) Fast communication (b) Fast free service (c) Simple to use (d) All given

(45) **1024 bytes are equal to __________**
(a) 1Mb (b) 1kB (c) 1GB (d) 1mB

(46) **1GB is equal to __________**
(a) 1024 bytes (b) 1024 kilobytes (c) 1024 mega bytes (d) None

(47) **1MB equal to __________**
(a) 1024 bytes (b) 1024 kilobytes (c) 1024 mega bytes (d) All

(48) **Which one is short-term storage devices?**
(a) Hard Disk (b) Floppy Disk (c) Magnetic Disk (d)

(49) **The areas between pits are called?**
(a) Panel (b) Spiral (c) Lands (d) Flate

(50) **Which device is slightly larger than a gum-stick?**
(a) CD (b) Floppy Disk (c) Flash Drive (d) Hard disk

(51) **Internet is a global web of more than one million nets in which more than __________ computers are operating?**
(a) 50 million (b) 20 million (c) 10 billion (d) 20 billion

(52) **Which one is an example of browsers?**
(a) Opera (b) Motor (c) Pipette (d) Gyroscope

(53) **The most common form of crime in internet using is?**
(a) Over use (b) Theft (c) Hacking (d) None

(54) **Which of the following are electromagnetic waves?**
(a) Radio waves (b) Compress ional waves
(c) Sound waves (d) None

(55) **What is floppy disk made of?**

(a) Nonmetal (b) Metal (c) Soft Plastic (d) None of these

(56) **Storage devices work on what principle?**

(a) Heat (b) Electricity (c) Sound (d) Magnetism

(57) **Which waves are the radio waves?**

(a) Mechanical waves (b) Electronic waves
(c) Electromagnetic waves (d) None of these

(58) **Who invent radio?**

(a) Graham bell (b) Newton (c) Marconi (d) Faraday

(59) **Who transmitted the first radio signal in the air?**

(a) Graham bell (b) Newton (c) Marconi (d) Faraday

(60) **The process to draw the required line or pictures on a computer screen using, mouse or key board is called**

(a) Graphic designing (b) Line designing (c) Data designing (d) Picture designing

(61) **To collect information for a special purpose and to store it in the computer in more than one interlinked files is called**

(a) Data base (b) Data Storing (c) Data managing (d) Data processing

(62) **A program which helps to create written document and lets you go back and make corrections as necessary**

(a) Home row keys (b) Tool bar (c) Folder (d) Word processor

(63) **What type of software is used for creating letters, papers and other documents?**

(a) Database (b) Word Processor (c) Spread sheet (d)Operating Program

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	d	11	a	21	d	31	a	41	d	51	a	61	c
2	b	12	a	22	c	32	b	42	a	52	a	62	d
3	a	13	d	23	b	33	c	43	a	53	b	63	b
4	a	14	c	24	a	34	b	44	d	54	a		
5	b	15	b	25	c	35	d	45	b	55	c		
6	d	16	c	26	c	36	a	46	c	56	d		
7	a	17	c	27	b	37	a	47	a	57	c		
8	a	18	d	28	d	38	a	48	b	58	c		
9	c	19	b	29	b	39	c	49	c	59	c		
10	b	20	a	30	b	40	a	50	c	60	a		

CONCEPTUAL QUESTOINS

17.1 Why optical fiber is more useful tool for the communication process.

Ans: Waves of visible light have a much more frequency than that of radiowaves, Therefore, rate of sending information in the form of light signals using optical fibre is larger than that with radio waves or microwaves though space or electrical signals though wires..

17.2 Which is more reliable floppy or hard disk?

Floppies are inexpensive, convenient but are not much reliable as they lack the storage capacity and drive speed form many large jobs. There is also a risk of data loss stored on floppy. We do not face such problems in the care of hard disk Which is , therefore, more reliable than a floppy.

17.3 What is difference between RAM and ROM memories?

RAM:

The main difference between the RAM and ROM is their use to store data. When a computer is tuned ON and programs are being run the program information is stored in RAM for better efficiency and see. When the computer is turned OFF any information stored in RAM is lost. So RAM is used for the storage of memory temporarily. In the ROM, data is stored permanently and retains there even when computer is tuned OFF. RAM is the primarily memory device while the ROM is secondary memory device.

ROM

ROM stands for read only memory. It is type of internal that normally can be read. ROM is used in a computer system to hold information. That is either permanent or does not change frequently.

REVIEW QUESTIONS

17.1 What is difference between data and information?

Ans: See Q.NO 1

17.2 What do you understand by information and communication technology (ICT)?

Ans: See Q.No.2

17.3 What are the components of information technology?

Ans: See Q.No.4

17.4 Differentiate between the primary memory and the secondary memory.

Ans: See Q.No.15

17.5 Named different information storage devices and describe their uses.

Ans: See Q.No.16

17.6 How light signals are set through optical fiber.

Ans: See Q.No.12

17.7 How light signals are sent through optical fiber.

Ans: See Q.No.12

17.8 What is computer? What is the role of computer in everyday life?

Ans: See Q.No.13

17.9 What is the difference between hardware and software? Name different softwares?

Ans: See Q.No.

17.10 What do understand by the term word processing and data managing?

Ans: See Q.No.17

17.11 What is internet? Internet is useful source of knowledge and information, Discuss.

Ans: See Q.No.18

17.12 Discuss the role of information technology in school education.

Ans. See Q.No.18

SHORT QUESTIONS
INFRMATION AND COMMUNICATION TECHNOLOGY

17.1 Information and Communication Technology

(1) **What is difference between data and information?**

Ans:

DATA	INFORMATION
"A representation of facts, concepts or instructions in the formalized manner suitable for communication, interpretation or processing by humans or machines is called data." **OR** "Data is a collection of facts. It is raw material of information." **Examples:** • Numeric data • Alphabetic data	The raw facts arranged in suitable manner provide information. OR "Processed data is known as information." **Example:** • Text • Graphics • Figures etc.

(2) **Define the terms.**

(i) Information technology **(ii) Telecommunication**

i. **Information Technology**

The scientific method used to store information, to arrange it for proper use and to communicate it to others is called information technology.

ii. **Telecommunication**

The method that is used to communicate information to far off places instantly is called telecommunication.

(3) **What do you understand by information and communication technology?**

Information and communication technology is scientific and technical methods and means to store, process and transmit vast amounts of information in seconds with help of electronic equipment.

17.2 Component of Computer Based Information

(4) **What are the components of information technology?**

Ans: (i) Hardware (ii) Software (iii) Data

(iv) Procedure (v) People

(5) **What is difference between Hardware and Software?**

Ans:

Hardware	Software
The hardware of computer system consists of physical components installed in main computer box and all associated equipments interconnected in an organized way. **Examples:** • Mouse • Monitor screen • Printers	The term software refers to computer programs and the manuals that give the set of instruction to the hardware of compute that tells the CBIS parts what to do. After instruction the hardware part of CBIS produce the useful information from raw data. **Examples** • Dos • Windows • Linux

17.3 Flow of Information

(6) **What is meant by flow of information?**

Flow of information

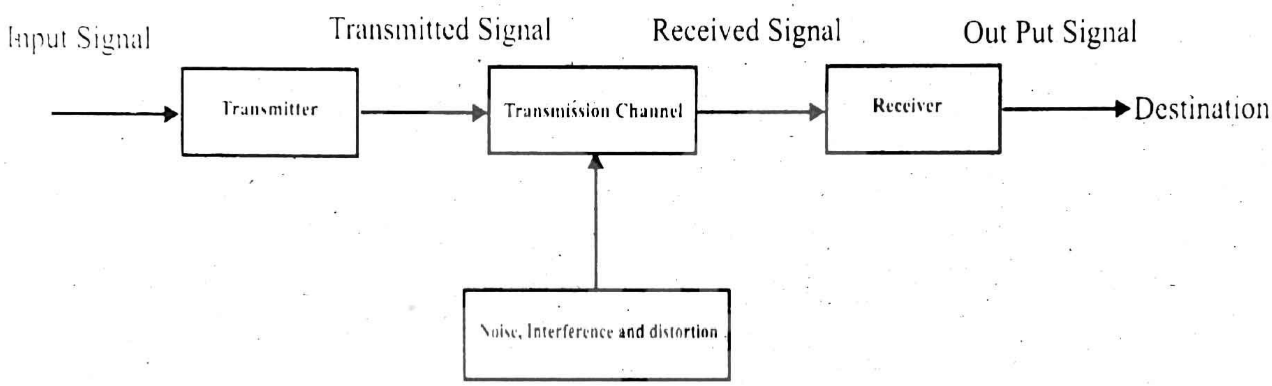
The transformation of information from one place to another place is known as flow of information. The information transferred in different way through telecommunication equipments.

(7) **Why satellite communication system is based on microwaves instead of radio waves.**

The radio waves are refracted by the different layers in the earth's atmospheric system. But the microwaves are not refracted. This does not lead weaken signal and easy to receive the information over long distance. That is micro-waves are used in satellitne communication system.

(8) **Draw flow chart of flow of information.**

Ans:



17.4 Transmission of Electrical Signals
17.5 Transmission of radio waves through space

(9) **What do you know about telephone? Describe its construction**

Ans: telephone also has diaphragm to turn voice into electrical signals by vibration which are transmitted over phone lines.

Telephone system has two main parts:

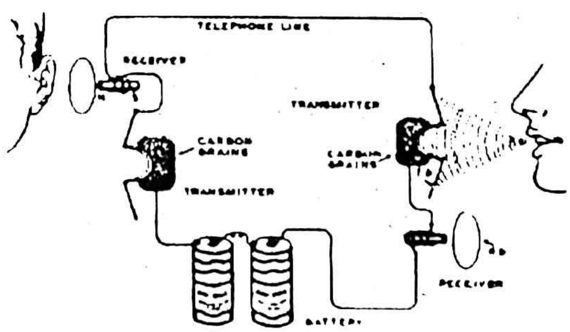
(i) Mouthpiece / Transmitter

(ii) Earpiece / Receiver

(10) **What is function of Mouthpiece and Earpiece**

Ans: **Mouthpiece**

When compressional waves of voice strike with diaphragm, the diaphragm also vibrated which compress the carbon and electrical signal produced. These electrical signals flow through the wire in the form of electrical current.



Earpiece

Receiver received electrical signal which flow through the electromagnet. The electromagnet produces a varying field cause the vibration in metal diaphragm. This vibration of the diaphragm produces sound waves.

(11) What is fax machine?

Ans: Fax machine is also known as 'Telefacsimile's'. Fax machine is used to send the copy of documents from on place to another place.

Fax machine scans the documents page and convert it into electrical signals and transmit it to another fax machine through telephone lines.

The receiving fax machine receive these electrical signals and converted these signals into copy with the help of printer

(12) What is cell phone? Describe its main parts.

Ans: Cell Phone:

A cell phone is device which consists on radio transmitter and radio receiver and used for two way communication. It send and receive the information with help of electromagnetic waves.

Construction and Working:

Main parts of cell phone network are as following

- Cells
- BS
- MSC

(13) What is meant by Modulation?

Ans: Modulation:

The process in which we superimpose information on electromagnetic waves called modulation.

(14) What do you know about photo phone?

Ans: In common telephone system, we can transfer and receiver sound only but in photo phone. We can send and receive sound the picture also. By using the photo and phone number of our friends or family members on this telephone you can call them by pressing pad with their photos. Thus we can communicative with our relatives or fiends on photo phone with the physical appearance of each other.

(15) How the desired station is picked through any radio station?

Ans: In a radio set, a variable capacitor is used to receive or pick the desire frequency of any radio signal. It is because the radio waves have broad spectrum of waves of different wavelengths and frequencies transmitted by different radio station simultaneously. A variable capacitor helps in picking the desired frequency of broadcasted radio waves.

(16) What is the difference between the mobile phone and the normal phone?

Ans: Mobile phone works on the basis of two way radio communication system. It is based on wireless systems. However in telephone, the signals are transmitted through telephone cables in the form of electrical pulses.

17.6 Transmission of Light Signals through optical fiber

(17) What is meant by optical fibre?

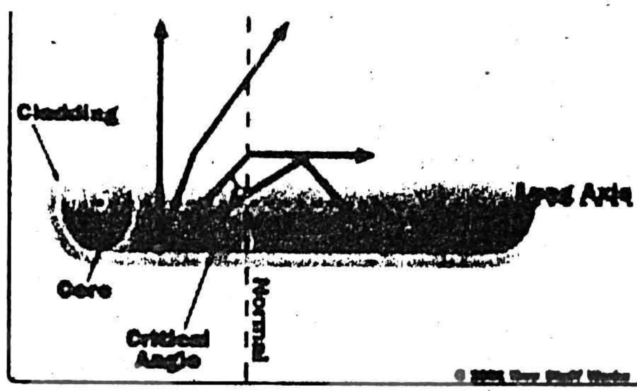
Ans: Optical Fiber:

An optical fiber or optical fibre is a flexible, transparent fiber made of high quality extruded glass or plastic, slightly thicker than a human hair. It can function as a waveguide, or "light pipe" to transmit light between the two ends of the fiber

(18) **Describe working principle of optical fiber?**

Ans: **Working Principle:**

The light enters the core at one end of optical fiber. These light beams hits the core-cladding interface and reflect back into the core. If the angle of incidence is less than critical angle the light beam escape form core which cause the data loss. If incidence angle is greater than of critical angle then the light beams totally reflect into the core. In this way large amount of data can be transferred form one place to another place in the form of light.



(19) **What do you know about multimode?**

Ans: **Multimode:**

When electrical signals are transmitted through wires, the signal lost increases with increasing data rate. This decreases the range of the signal. The optical fiber of multimode is 10 times bigger than fiber optics used in single mode cable. The light beams in core can travel by following different paths, that is why it is called multimode.

Advantage:

Multimode fibre optics are used to link the computer networks together and it can send information relatively short distances.

(20) **What is computer?**

Ans: Computer is machine that can be programmed to accept the data (input) process it (processing) to give useful information (output) and store it(storage) for further.

OR

"Computer is electronic machine which give useful processed data in short time after analyzing and arranging."

MAIN PARTS OF COMPUTER

The some main parts of computer are given below

a. Input devices

b. Central processing unit (CPU)

c. Output devices

(21) **Briefly describe the types of computer.**

Ans: **Types of Computer**

There are main types of computer.

1. Personal Computer:

It is general use. These are less powerfull machine as compared to micro-computer.

2. Minicomputer:

These low cost computers use integrated circuits. These yet surprisingly powerful computer find their application in business and education. Minicomputer got their names due to their small size and have less powerful then main frame computers.

3. Main Frame:

Mainframe are large scale computer together with their supporting equipment cost millions of dollars. It is usually used in large firms for different functions.

4. Super computer

Supercomputers are largest, fastest and most expensive computer for complicated problems. Fastest supercomputer can perform more than one trillion calculations in one second.

(22) What is difference between input and output devices?

Input Devices	Output Devices
The device which are used to give the instructions to computer are known as input devices. **Examples:** Keyboard, mouse, scanner, trackball, touchpad, pointing stick, touch screen, light pent etc are the examples of input devices	The device takes results from computer and presents it in human readable form is called output devices. There are number of output devices. **Examples:** Video display unit/ visual display device or monitor, printers, floppy drives, hard disk, CD writer and speaker etc.

17.7 Information storage devices and Application of computer

(23) What is meant by storing devices? Name the different storage devices?

The devices which are used to store any important data or information are called information storing devices.

For Example

Audio, video tap, compact disc (CD), Laser Disc, Floppy Disk and Hard Disk. The storage devices work on different principles using electronics, magnetism and laser technology.

(24) Differentiate between primary and secondary memory?

Ans: **Primary Memory**

- Main memory is computer's primary storage. It is extension of the central process unit (CPU) and directly accessible to it. Main memory accepts data and instructions from input unit, exchanges data supplies instructions to the other parts of CPU.
- It is based on electronics and consists of integrated circuits (Ics). It is random access memory (RAM). It vanishes when the computer is switched off.

Secondary Memory

- Secondary memory also referred as backing storage is used to supplement the capacity of main or primary memory.
- The data storage devices are generally known as secondary memory. It is used to store the data permanently in the computer. When we open any program, data is

(25) What are audio and video cassettes? How data is stored in these cassettes?

Ans: Audio cassettes consist of a tape of magnetic material, on which sound is saved in a particular form of a magnetic field.

Storing information

The electric pulses produced by microphone change with respect to sound waves. These electric pulses change the magnetic field produced by electromagnet. Because of this magnetic field the magnetic tap is magnetized in specific form according to rise and fall of electric pulses. In this way this way sound is stored in specific magnetic pattern on this magnetic tape.

(26) What is Floppy Disc?

Ans: The floppy disc are the most common from secondary storage devices. It is made up of a small magnetically sensitive, flexible plastic wafer which coated with ferromagnetic material and enclosed in a rigid plastic cover which protects it. Most personal computers included at least one disk drive that allow the computer to read write information from on floppy disk.

Compact Disc (Cds)

It is molded plastic disk on which digital data (binary numbers) is stored in the form of microscopic reflecting and non-reflecting spots. The reflecting spots are known as 'pits' and non-reflecting spot knows s "lands".

Pits: Pits are spiral tracks encoded on the top surfaces of CD.

Lands: Lands are the area between the spits.

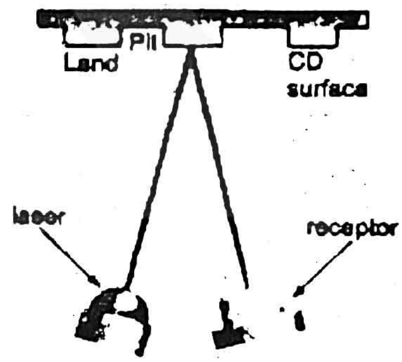


Fig. 17.18

Compact disc is laser based technology.

A fine laser beam sean the surface of rotating disk to read data. Pits and lands reflect different amount of laser light falling on the surface of CD. The reflected light from pits and lands converted into binary data. The presence of pit indicate '1' and absences of pit indicate '0'.

The data stored on CD is only readable data that cannot be altered or erased, therefore CD memory is called read only memory (ROM).

Storage Capacity

A CD can store over 680 megabyte data. A DVD the same size as traditional CD, is able to store up – to – 17 gigabyte of data.

Flash Drive

Flash drive is an electronic based device and consists of data storage ICs, and used to transfer data from one computer to another. It is small storage device which slightly larger than gum stick. Flash drive is easy to sue. We can simply plug flash drive in USB port and can copy past our created papers. Flash drive can separate from computer.

(27) Define program.

Ans: All the work is done by the computer in the light of those instructions which are called Program information in its memory as long as we desire.

(28) Define computer and enlist its different parts.

Ans: Computer is an electronic machine which after analyzing and arranging the given information, presents it in a very short time.

Parts of computer

The parts of computer are given below:

(i) Input devices
(ii) C.P.U
(iii)Output devices

(29) Why computer becomes so popular?

Ans: The reasons of popularity of computer are as under:

- Fast working of the computer
- Accurate solution of the given information
- Large memory
- Capability of deriving results

(30) What is protocol?

Ans: All computers linked with internet use uniform communication process and same code. In the internet terminology, it is called 'protocol' whose name is TCP / IP. It is the abbreviation of transmission control protocol / internet protocol.

(31) What is HTML?

Ans: The language which is used in the internet web is understood well by all the computers linked with it and this language is called HTML which is an abbreviation of Hypertext Markup Language. Computers linked with the internet can exchange their information or can use the data base.

(32) Define word processing?

Ans: "To type something by computer's keyboard, to correct, to arrange, to amend the document, to add and delete the written portion when required is called the word processing".

(33) Define graphic designing?

Ans: "The process to draw a required line or pictures on a computer screen using mouse or keyboard is called the graphic designing".

(34) Define data managing.

Ans: "The process of collecting information regarding a subject for any purpose and to store them in the computer in more than one inter linked files which may help when needed, is called data Managing".

(35) What is remote control system?

Ans: It is an extremely useful instrument. The function of a television and some other electronic machines can be controlled by it from a large distance without any cable connection.

(36) Which part of the computer is called the brain of computer?

Ans: The central processing unit of computer is called the brain of the computer because it accepts all the instructions or program given to it, which accordingly processed by a control and memory unit.

17.1 Information and Communication Technology

Q.1 What is difference between data and information?

"A representation of facts, concepts or instructions in the formalized manner suitable for communication, interpretation or processing by humans or machines is called data." OR "Data is a collection of facts. It is raw material of information."

Information

The raw facts arranged in suitable manner provide information. OR "Processed data is known as information."

Q.2 What do you understand by information and communication technology?

Information and communication technology is scientific and technical methods and means to store, process and transmit vast amounts of information in seconds with help of electronic equipment.

OR

"The technology developed by combining computing data with high speed and transmit it with the help of telecommunication links for carrying data is called information and communication technology."

Explanation

Information and communication technology is the combination of information technology and telecommunication. So, ICT is basically electronic (telecommunication) based systems which are used for transmission, reception, processing and retrieval of data."

Q.3 Define the terms.

(i) Information technology
(ii) Telecommunication

Information Technology

The scientific method used to store information, to arrange it for proper use and to communicate it to others is called information technology.

Telecommunication

The method that is used to communicate information to far off places instantly is called telecommunication.

17.2 Component of Computer Based Information

Q.4 What are the components of information technology? Clearly indicate the function of each component . OR Explain CBIS?

(i) Hardware (ii) Software (iii) Data
(iv) Procedure (v) People

Hardware

The hardware of computer system consists of physical components installed in main computer box and all associated equipments interconnected in an organized way. Main unit which consists of Central Processing Unit (CPU) and disk drives is called system unit. The supporting equipments are input and output devices. Storage devices and communication devices. That is why hardware of computer referred to machinery.

Software

The term software refers to computer programs and the manuals that give the set of instruction to the hardware of compute that tells the CBIS parts what to do. After instruction the hardware part of CBIS produce the useful information from raw data. Computer software further divide into system software and application software.

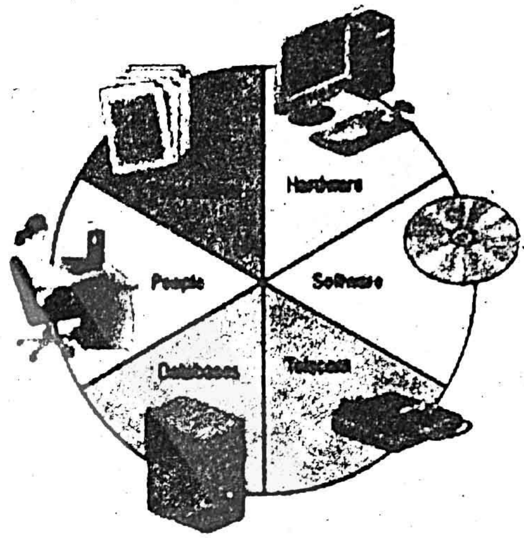
(i) **System software**

The software that control the working of the different parts of computer hardware.

(ii) **Application software**

The soft ware that help the user to perform a specific task on compute is called application software.

Data



Data is collection of facts used by user by entering it in computer to produce some useful and meaningful information.

The computer data can be classified into following types.

(i) Graphic (ii) Audio/video (iii) Text (numeric, alphabetic, alphanumeric).

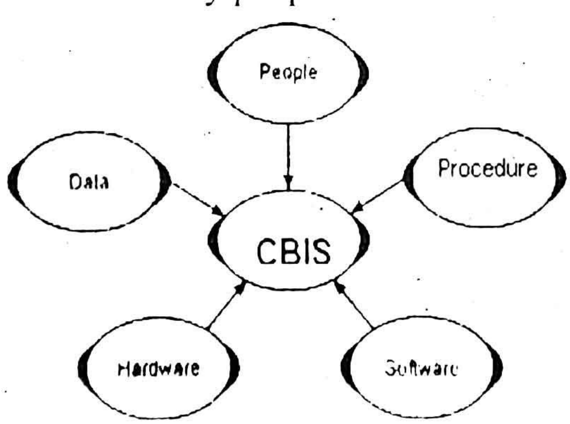
Like software programs, data generally stored in machine – readable form on disk or tape unit the computer needs them.

Procedures

The set of instructions and rules to design and use information system. These care in the dorm of manuals and documents. These rules methods may change from time to time and information system must be flexible to accept the new rules.

People (User)

A CIBS need people if it is to be useful. Who influence the success or failure of information system. People design and operate the software, they feed the input data, build the hardware for smooth running of nay CIBS. People write the procedures, instructions, rules and it is ultimately people who determine success or failure of CIBS.



Flow Chart of Component of CBIS

17.3 Flow of Information

Q.5 Write a note on flow of information briefly describes its main parts.

Flow of information

The transformation of information from one place to another place is known as flow of information. The information transferred in. different way through telecommunication equipments.

Information flow methods

Some of information flow methods are give as

Information flow through Telephone: In telephone system information sent through copper wires in the form of electrical signals.

Information flow through Radio, Television and Cell phone:

The information e sent either through the space in the form of electromagnetic waves in radio, TV and Cell phone system.

Information flow through Optical Fibers:

In optical fiber system, the information flow in the form of light.

The essential parts of communication system:

(i) Tranmitter

(ii) Tranmission Channel (medium)

(iii) Receiver

(i) Transmitter:

Transmitter is part of communication system which process the input signal and convert the input signal according to equipment of transmission channel.

(ii) Transmission Channel:

Its part of communication channel which sends the signal from source to destination. It is a medium which cause the transformation of information. Types of transmission channels are given below.

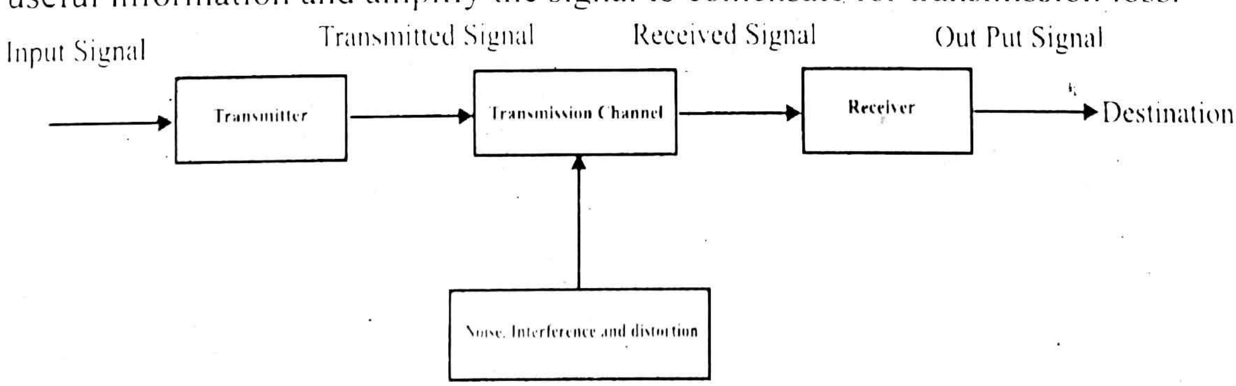
(a) Pair of Wires **(b)** Coaxial Cable

(c) Radio waves/ electromagnetic waves **(d)** Optical fiber cable

The power of signal decrease by increasing the distance between source and destination.

(iii) Receiver

In part of communication system, which receive the information from transmission channel and delivers to transducer. The transducer process the signal and convert it to useful information and amplify the signal to comensate for transmission loss.



Q.6 Why satellite communication system is based on microwaves instead of radio waves.

The radio waves are refracted by the different layers in the earth's atmospheric system. But the microwaves are not refracted. This does not lead weaken signal and easy to receive the information over long distance. That is micro-waves are used in satellitne communication system.

17.4 Transmission of Electrical Signals

Q.7 Briefly describe the transmission of electrical signal through wires.

OR

Write a note on telephone.

Telephone:

A single telephone system was made by Alexander Graham in 1876. In telephone system, sound transmitted from one place to another place.

Construction and Working:

It consist of Metal reed, Electrical coil and Diaphragm .Modern telephone also has diaphragm to turn voice into electrical signals by vibration which are transmitted over phone lines.

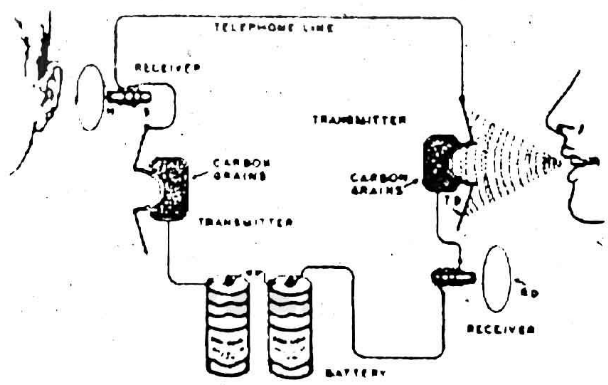
Telephone system has two main parts:

(i) Mouthpiece / Transmitter

(ii) Earpiece / Receiver

Mouthpiece

The mouthpiece has carbon granules and thin metal diaphragm. When compressional waves of voice strike with diaphragm, the diaphragm also vibrated which compress the carbon and electrical signal produced. These electrical signals flow through the wire in the form of electrical current.



Earpiece

The receiver also consists on carbon granules and the metal diaphragm. The reverse process is done in receiver. Receiver received electrical signal which flow through the electromagnet. The electromagnet produces a varying field cause the vibration in metal diaphragm. This vibration of the diaphragm produces sound waves.

17.5 Transmission of radiowaves through space

Q.8. Explain the transmission of radio waves through space.

Electrical signals represents the information. These signals produced by microphone T.V, camara or computer and sent from one place to another place via cables or radio waves. But for long distance communication, the information is superimposed on electromagnetic waves.

Modulation:

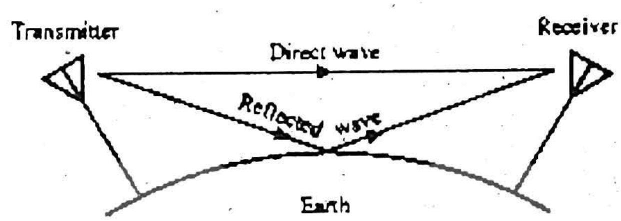
The process in which we superimpose information on electromagnetic waves called modulation.

The transmission radio waves consists on two parts.

(i) Radio station (ii) Receiver

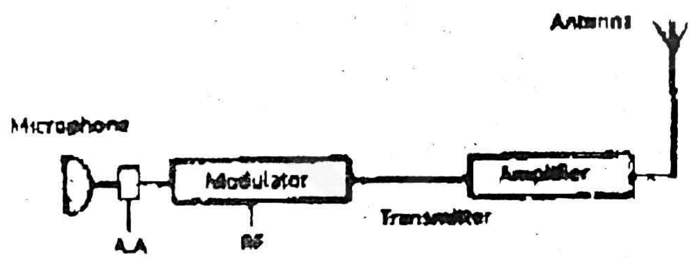
(i) Radio Station

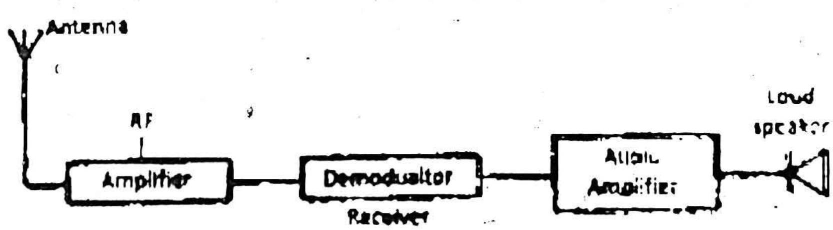
The information (sound) waves produce at radio station which is changed into electrical signals through microphone. These electrical signals are given to transmission antenna which consists on two metal rods. When electrical signals introduced to transmission antenna, its oscillate the electric charges in antenna which emits the electrical signals in the form of electromagnetic waves.



(ii) Receiver

At the receiving end, receiver receives the modulated signals. The demodulator in receiver demodulate the signals and extract information. This extracted information given to amplifier which amplify the information delivers into the receptor.





Q.9 What is fax machine?

Fax machine is also known as 'Telefacsimile's'. Fax machine is used to send the copy of documents from on place to another place.

Fax machine scans the documents page and convert it into electrical signals and transmit it to another fax machine through telephone lines.

The receiving fax machine receive these electrical signals and converted these signals into copy with the help of printer

Q.10 What is cellphone? How it works and describe its main parts.

Cell Phone:

A cellphone is device which consists on radio transmitter and radio receiver and used for two way communication. It send and receive the information with help of electromagnetic waves.

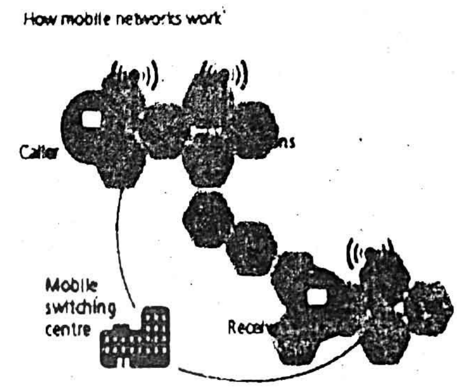
Construction and Working:

Main parts of cellphone network are as followin

(i) MSC (Mobile Switching Centre)

(ii) Bs (Base Stations)

(iii) BTS (Base transceiver system)



A 'BTS' is set up at particular geographical location. The BTS signal is known as cell. This cell is in hexagonal form. The large number of 'BTS' are connected with base station. So, a very large area is converted by base station. The group of cells forms a cluster. With in cluster all BSc are connect with MSC (Mobile Switching Center) through, optical fiber. In MSC, the data of subscriber is stored and up dated time by time. MSc also route the calls.

When caller calls another cell phone, sound waves of callers converted into radio waves. These radio signals of particular frequency is sent at local base station of the caller, where the signal is assigned a specific radio frequency. Then these signals sent to the base staton of receiver through MSC. Then the call is transferred to the cellphone of receiver. Mobile receiver radio waves and changes into sound.

Q.11 What do you know about photo phone?

In common telephone system, we can transfer and receiver sound only but in photo phone. We can send and receive sound the picture also. By using the photo and phone number of our friends or family members on this telephone you can call them by pressing pad with their photos. Thus we can communicative with our relatives or fiends on photo phone with the physical appearance of each other.

17.6 Transmission of Light Signals through optical fiber

Q.12 Describe the transmission of light signals through optical fibers. How light signals are sent through optical fiber.

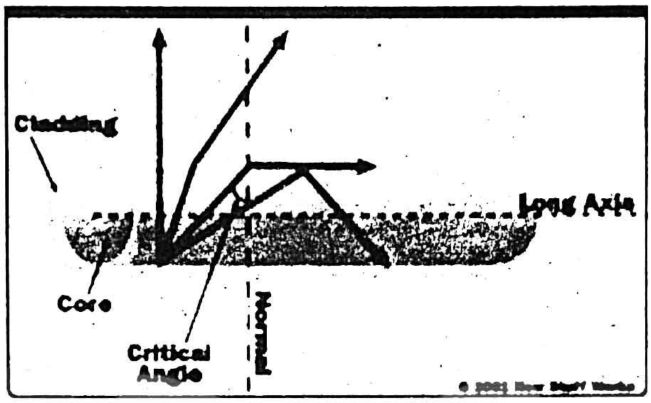
Optical Fibre:

An optical fiber or optical fibre is a flexible, transparent fiber made of high quality extruded glass or plastic, slightly thicker than a human hair. It can function as a waveguide, or "light pipe" to transmit light between the two ends of the fiber. The field of applied and engineering concerned with the design and application of optical fibers is known as fiber optics.

The frequency of visible light is greater than that of radio waves. That is why the large amount of information can be transmitted through visible light than that of microwaves and radio waves.

Working Principle:

The light enters the core at one end of optical fiber. These light beams hits the core-cladding interface and reflect back into the core. If the angle of incidence is less than critical angle the light beam escape form core which cause the data loss. If incidence angle is greater than of critical angle then the light beams totally reflect into the core. In this way large amount of data can be transferred form one place to another place in the form of light. This feature of fiber optic differentiate it form wires.



Multimode:

When electrical signals are transmitted through wires, the signal lost increases with increasing data rate. This decreases the range of the signal. The optical fiber of multimode is 10 times bigger than fiber optics used in single mode cable. The light beams in core can travel by following different paths, that is why it is called multimode.

Advantage:

Multimode fiber optics are used to link the computer networks together and it can send information relatively short distances.

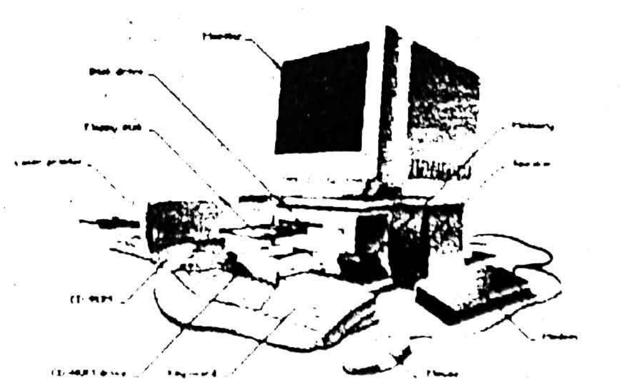
Q.13 What is computer? What is the role of computer in everyday life? Briefly describe the types of computer.

Computer

Computer is machine that can be programmed to accept the data (input) process it (processing) to give useful information (output) and store it(storage) for further.

OR

"Computer is electronic machine which give useful processed data in short time after analyzing and arranging."



Computer work through an instruction of hardware and software. The some main parts of computer are given below

(i) Input devices

(ii) Central processing unit (CPU)

(iii) Output devices

Input Devices

The device which are used to give the instructions to computer are known as input devices. Keyboard, mouse, scanner, trackball, touchpad, .pointing stick, touch screen, light pent etc are the examples of input devices.

Central Processing Unit (CPU)

The most important part of the computer, which consist on a box containing motherboard inside with a small chip (called microprocessor) in it is known as CPU.

This part of computer receive the instructions and translates them and perform specific task according to the given instruction. So, it performs all computational, logical and analytical functions. If is the brain of computer.

Output Devices

The device takes results from computer and presents it in human readable form is called output devices. There are number of output devices. For example:

Video display unit/ visual display device or monitor, printers, floppy drives, hard disk, CD writer and speaker etc.

Use of Computer in Everyday life

Computer becomes a necessary part of everyday life because its fast working, accurate solutions of information, large memory and capability for deriving results.

- Computer is used in offices for preparing letters, documents and reports.
- In hotels computers are used for advance booking of rooms, preparing bills and providing equity service.
- In railways, computers are used for rail reservation, printing of tickets and preparations of reservation charts.
- In medical field, doctors are computer for diagnosing illness and treatment of diseases.
- An architect engineer use computer for building designing and city planning.
- In meteorology department, computes are used for wheatear forecasting.

Types of Computer

There are main types of computer.

1. **Personal Computer:**

   It is general use. These are less powerful machine as compared to micro-computer.

2. **Minicomputer:**

   These low cost computers use integrated circuits. These yet surprisingly powerful computer find their application in business and education. Minicomputer got their names due to their small size and have less powerful then main frame computers.

3. **Main Frame:**

   Mainframe are large scale computer together with their supporting equipment cost millions of dollars. It is usually used in large firms for different functions.

4. **Super computer**

Supercomputers are largest, fastest and most expensive computer for complicated problems. Fastest supercomputer can perform more than one trillion calculations in one second.

Q.14 What is meant by storing devices? Name the different storage devices?

The devices which are used to store any important data or information are called information storing devices.

For Example

Audio, video tap, compact disc (CD), Laser Disc, Floppy Disk and Hard Disk. The storage devices work on different principles using electronics, magnetism and laser technology.

Q.15 Differentiate between primary and secondary memory?

Primary Memory

Main memory is computer's primary storage. It is extension of the central process unit (CPU) and directly accessible to it. Main memory accepts data and instructions from input unit, exchanges data supplies instructions to the other parts of CPU.

It is based on electronics and consists of integrated circuits (Ics). It is random access memory (RAM). It vanishes when the computer is switched off.

Secondary Memory

Secondary memory also referred as backing storage is used to supplement the capacity of main or primary memory.

The data storage devices are generally known as secondary memory. It is used to store the data permanently in the computer. When we open any program, data is moved from the secondary storage into the primary storage.

Q.16 Write a note on

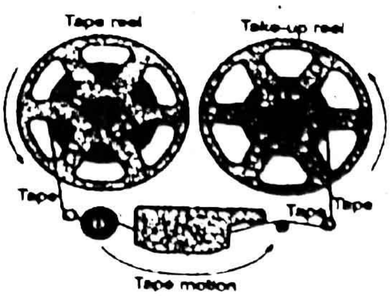
(i) Audio – Video Cassettes **(ii)** Magnetic Disks

(iii) Hard Disk **(iv)** Compact Disc (Cds) **(v)** Flash Drive

(i) **Audio – video cassettes**

Audio-video cassette is storage device, which store the audio-video data on magnetism base. It consists on a tape. Specific magnetic material spread over the tape. For recording the microphone changes sound waves into electrical pulse are made by an amplifier. Magnetic tape is moved across the head of audio cassette recorder which is in fact an electromagnet.

The electric pulses produced by microphone change with respect to sound waves. These electric pulses change the magnetic field produced by electromagnet. Because of this magnetic field the magnetic tap is magnetized in specific form according to rise and fall of electric pulses. In this way this way sound is stored in specific magnetic pattern on this magnetic tape.



A magnetic tape storage mechanism

Fig. 17.13

Now, to produce the recorded sound, the tape is moved past the play head. The current pulses induced in the coil of play back head because variation of magnetic field which was stored on magnetic tape. The loudspeaker reproduce and amplify the recorded sound.

In video tape pictures are recorded along with sound

(ii) **Magnetic Disk**

Magnetic disk is a metal or plastic disk coated with ferrous oxide. The read write head of discs are similar to recorded and play back head of type recorder. The information is stored on magnetic disk by magnetizing of parts on its surface. Magnetic disk is digital data storage medium.

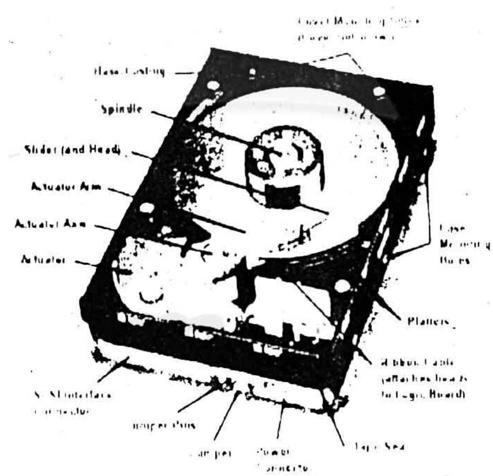
Floppy Disc:

The floppy disc are the most common from secondary storage devices. It is made up of a small magnetically sensitive, flexible plastic wafer which coated with ferromagnetic material and enclosed in a rigid plastic cover which protects it. Most personal computers included at least one disk drive that allow the computer to read write information from on floppy disk.

The read write had of disk drive contacts the diskettes which rotate at speed 300 rmp in plastic cover. Data stored on floppy disk is also subject to loss as result of stray magnetic field. The floppy disks over reliable for short-term storage and cannot be used longer nd no attempts should be made to save data for longer period.

(iii) **Hard Disk**

Hard disk is rigid usually made up of aluminum with surface coating easily magnetized elements, such as iron, cobalt. The hard disk is rigid magnetically sensitive disk the spins rapidly and continuously inside the computer chassis or ain separate box connected to the computer. A typical hard disk consists of several platters each accessed via read/write head on the moveable arm. While typical floppy disc has a storage capacity between 1 and 3MB. But the hard disk might hold hundred or thousands megabytes of information. The information can be transferred quickly to and fro a hard disk much faster than with a floppy.



(iv) **Compact Disc (Cds)**

It is molded plastic disk on which digital data (binary numbers) is stored in the form of microscopic reflecting and non-reflecting spots. The reflecting spots are known as 'pits' and non-reflecting spot knows s "lands".

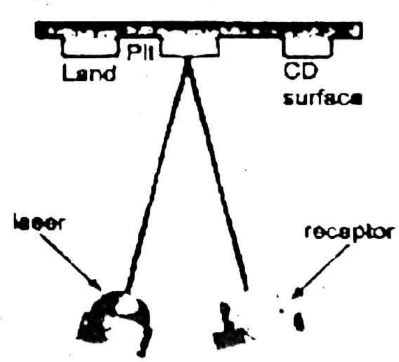


Fig. 17 18

Pits: Pits are spiral tracks e... on the top surfaces of CD.

Lands: Lands are the area betw e the spits.

Compact disc is laser based technology.

A fine laser beam Scan the surface of rotating disk to read data. Pits and lands reflect different amount of laser light falling on the surface of CD. The reflected light from pits and lands converted into binary data. The presence of pit indicate '1' and absences of pit indicate '0'.

The data stored on CD is only readable data that cannot be altered or erased, therefore CD memory is called read only memory (ROM).

Storage Capacity

A CD can store over 680 megabyte data. A DVD the same size as traditional CD, is able to store up – to – 17 gigabyte of data.

(v) **Flash Drive**

Flash drive is an electronic based device and consists of data storage ICs, and used to transfer data from one computer to another. It is small storage device which slightly larger than gum stick. Flash drive is easy to sue. We can simply plug flash drive in USB port and can copy past our created papers. Flash drive can separate from computer.

Q.17 What do you understand by the term word processing and data managing?

Word Processing

It is use of computer through specific software, through which we can write a letter, article, book or a paper report.

Explanation

Word processing is computer program which is use to develop any document, see it on the screen after typing. We can edit the documents, add some new text or delete the previous text or make amendments I n it. We can write in different styles and different colours. We can also use graphic in word processing. It also helps to point out mistakes in the text. We can move text frojm one page to another page, even from one documents to another documents. In these days word processing software are also used for designing purpose. The point of word processing documents can also be taken.

Uses of Data Management

The educational instructions, libraries, hospitals and industries store the concerned information by data management. According to requirement, the addition or deletions are made in data. This helps the improvement of the management of institutions. In big departmental store and super market the optical scanners are used to read, with the help of laser beam. The bar codes of product which indicates the number at which this product is recoded in the register.

In this way the detail about its price is obtained. The central computer monitors the bills and related recorded of sold goods. It also helps placing the order of goods being sold in a large quantity and decide about less selling good.

Q. 18 What is internet? Explain that internet is useful source of knowledge and information.

Internet:

"Internet is system in which many computer network all over the world are connected together to communicate with each other through communication medium. " OR" Internet is a network of computer networks which spread all over the world."

Useful source of Knowledge and Information:

- Internet technology is most useful in modern times that not only helps us in our daily lives, but also our personal development and professional lives. The Internet helps us to achieve this goal in several ways.
- For students and the educational goals of the Internet is widely used to gather information in order to do research or to add to the knowledge of any kind of subject they have. Even business meetings and professionals such as doctors, Internet access to filter information for their use. The Internet is the largest encyclopedia for everyone in all age categories.
- The Internet has served to be more useful in maintaining contact with friends and relatives who live abroad permanently. The easiest means of communication such as the Internet and email systems Chat are the best and most common way to maintain contact with people all over the world.
- Not to mention the Internet is useful for providing the major part of the fun today. Whether all games and conference networking or online movies, songs, plays and quizzes, the Internet has provided a great opportunity for users to eliminate boredom of their lives.
- Internet is also used to upgrade the Internet and use special software to work on projects and documentation work that allows Internet users to download a variety of different software for a variety of different purposes, this which makes it much easier than buying expensive software cds.

Q.19 Write a note on internet .

Internet is actually a process by using which people can contact one another through computer. This contact is usually made via telephone line or cable.

Introduction

Internet is a system with which we can know the global conditions within no time. Not only the information on internet about the whole world are available but it has revolutionized the communication techniques.

Connecting people together

This new invention has given a large projection to communication. One can not imagine a speed greater than that by pressing a button you can send your message anywhere in the world. This source of communication is said to be an E-mail. Internet users are provided the facility to send their messages or graphics and the receiver checks them in his spare time. Another important feature of the internet is world websites which is a wide storage of information.

Internet society

Internet is infect an interconnection of millions of computers. It is neither for one person, nor is the possession of one. It is beyond imagination that a person or a department individually may run the internet. Internet society is a group of many departments which controls the internet.

Connecting protocol (TCP/IP)

All computers linked with internet use uniform communication process and same code. In the internet terminology, it is called 'protocol' whose name is TCP / IP. It is the abbreviation of transmission control protocol / internet protocol. This protocol controls the transmission and transmits a small portion of the information at a time. This process is repeated millions of times per second.

Hypertext Markup Language (HTML)

The language which is used in the internet web is understood well by all the computers linked with it and this language is called HTML which is an abbreviation of Hypertext Markup Language. Computers linked with the internet can exchange their information or can use the data base.

Extended Communication facilities

In the beginning internet facility was limited to the government departments or big libraries, but the modern ways of communication have broadened this facility. Now-a-days, not only national but at the international level, internet is an important and fastest medium of information.

Medium of information

Students and teachers having contact with the internet can get information of any kind and about any subject. Businessmen can advertise their product by it. Doctors can exchange latest information about medical problems. In short, information concerned with any department can be obtained from the internet.

The main services used on the internet include.

The Internet is a worldwide network of computers connecting thousands and thousands of computers across the globe. It is formed by the joining of many smaller networks around the world to form the largest network in the world.

The computers of the Internet are connected through telephone lines, satellite links, modemand through many other means.

The Internet consists of following applications:

(i) E-Mail

(ii) World Wide Web

(iii) Chatting

(iv) Video Conferencing

(v) Searching for information

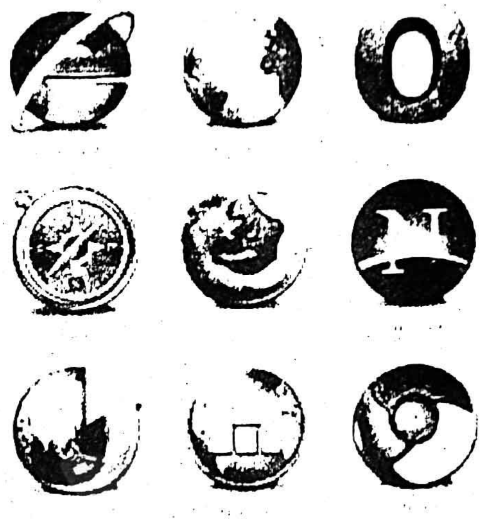
(vi) Online Shopping and Trade

(vii) Education and Research

Q.20 What are browsers? Also write the name of some internet browsers.

Browser:

A browser is a application which provides a window to the web. All the browsers are designed to display the page of information located at the websites around the world



Name of Browsers

The today's most population browsers are

(i) Internet explorer

(ii) The world

(iii) Opera

(iv) Safari

(v) Mozilla Fir fox

(vi) Chrome

Q.21 Write a note on e-mail.

Electronic Mail

Electronic mail (e-mail) is most widely used application of internet, which provides very fast delivery of messages to any enabled site on the internet.

In this way communication through e-mail is more quick and reliable.

Advantages of E-mail

Some advantages of e-mail are as follows.

Fast Communication

We can send messages or graphics anywhere in the world instantly. In this way e-mail is fast way of communication.

Cost free services:

If someone has internet connection. He can avail the e-mail service free of cost.

Simple to use:

After initial set-up e-mail account, it is very easy to use.

More Efficient:

We can send our message to many friends or people only in one action.

Versatile:

Pictures or other files can also be sent through e-mail.

Use of Internet:

Internet is very beneficial for us. Here is the list of use of internet.

(i) Fast communication

(ii) Big source information

(iii) Source of entertainment

(iv) Access of social media

(v) Access of online services.

(vi) E-commerce

(vii) E-learning

Q.22 Explain the risks of ICT to society and the environment

1. Health Problems

In new age we are expected to rely upon information technology. But blind faith in modern technology may be dangerous in many cases. Over use of computer is dangerous for our health.

2. Crime

In these days the computer crimes are also very common. Computer crime is defined as any crime accomplished through knowledge are use of computer technology.

3. Theft

There is also a word theft. Theft is most common from of crime. Computer are used to steal money, goods, information and computer resources. Privacy is another common issue in computer. Illegal duplication of copyright material like books, papers and software on internet is also crime.

4. Hacking

Hacking is still another illegal activity which is committed on computer systems of other person. Computer hackers can damage some organization by stealing their credit cards and valuable information.

Precaution:

One way to reduce the risk of security is to make sure that only authorized person have access to computer equipment. We may be granted access to computer based on passwords s described below.

We can use a key, an ID card with photo, an, ID number, a luck combination our voice or finger print as password to secure our computer.

Q.23 What is word processing? Explain its features.

Ans: "To type something by computer's keyboard, to correct, to arrange, to amend the document, to add and delete the written portion when required is called the word processing".

Word processing is such a use of computer through which we can write letters prepare reports and books. Word processing is a computer program.

Features of Word processing

By using word processing, following tasks can be performed.

- We can develop any document; see it on the screen after typing.
- Edit it, add some new text or delete the previous text or do the amendments in it.
- Document can he stored in memory and its print can also be taken.
- By means of modern word processing, we can write it in different styles and in different colors. We can also use graphics.
- In computers, a facility is also available which points out the spellings or grammatical mistakes.
- The content list and index etc. can also be made easily.

Q.24 What is graphic designing? And give its applications.

"The process to draw a required line or pictures on a computer screen using mouse or keyboard is called the graphic designing".

Applications

- Designs of the buildings or components can also be drawn with the help of computers. This process is named as computer aided designing (CAD).
- Three dimensional (3D) colored pictures can be drawn by this process which can be checked by rotating it at different angles. Moreover different colors can also be selected for the pictures. This process because of accuracy and comfort is very popular in industrial field.

Q.25 What do you know data managing and explain its applications.

Ans: "The process of collecting information regarding a subject for any purpose and to store them in the computer in more than one inter linked files which may help when needed, is called data Managing".

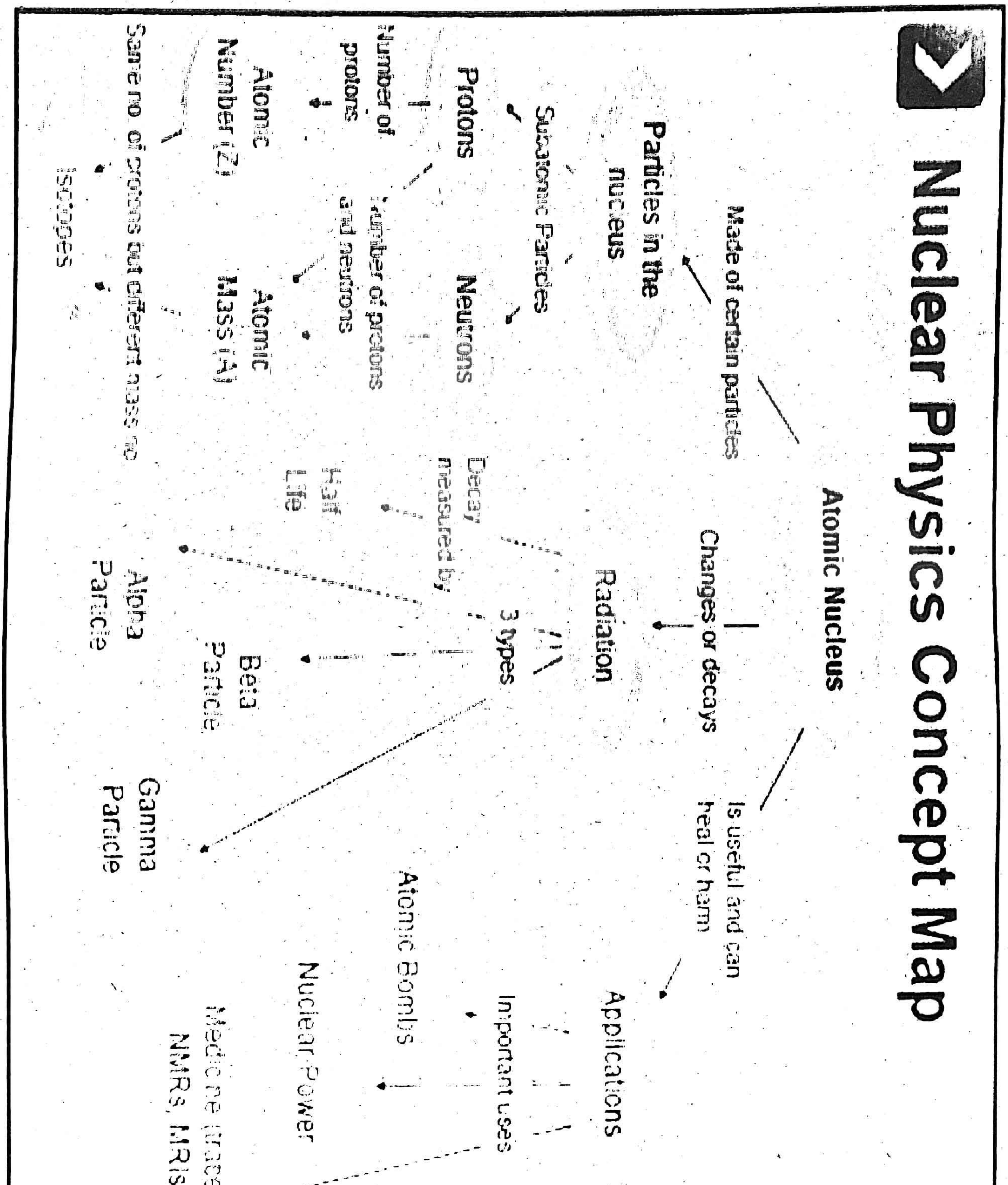
Applications in educational institutions, libraries, hospitals and industries

The educational institutions, libraries, hospitals and industries store the concerned information by data management. Additions and deletions are made in the data according to the requirement, which help in the improvement of the management of the institutions.

Applications of Bar Codes

In big departmental stores and super markets optical scanners are used to read, with the help of a Laser Beam, to read the Bar Codes of a product which indicates the number at which this product is recorded in the register. In this way the detail about its price is obtained and the central computer monitors the bills and the related record of the sold goods. It also helps placing the order for goods being sold in a large quantity and to decide about less selling goods.

ATOMIC AND NUCLEAR PHYSICS



MULTIPLE CHOICE QUESTIONS

18.1 Atom and Atomic Nucleus
18.2 Natural Radioactivity

(1) **Which statement is correct about isotopes?**
(a) Atoms of an element have same number of protons.
(b) Atoms of an element have different number of neutrons in their nuclei
(c) Protium, deuterium and tritium are isotopes of hydrogen
(d) All of above

(2) **The mass of the proton and neutron is nearly equal to:**
(a) 1.67×10^{-27} kg (b) 1.67×10^{-31} kg (c) 1.67×10^{-19} kg (d) 1.67×10^{-21} kg

(3) **A nucleon is ------------- times heavier than electron:**
(a) 1827 (b) 1836 (c) 1841 (d) 1832

(4) **The total number of nucleons in a nucleus is:**
(a) Atomic number (b) Atomic mass number (c) Isotope number (d) None of these

(5) **The total number of protons in a nucleus or total number of electrons in the orbits is:**
(a) Atomic number (b) Atomic mass number (c) Isotope number (d) None of these

(6) **The atomic number is represented by:**
(a) A (b) Z (c) N (d) None of them

(7) **The number of neutrons in a nucleus is represented by:**
(a) A (b) Z (c) N (d) None of them

(8) **The number of protons and neutrons in a nucleus or atomic mass is represented by:**
(a) A (b) Z (c) N (d) None of them

(9) **Atoms of the element which have same number of protons but different number of neutrons are:**
(a) Isotopes (b) Nuclide (c) Both a & b (d) None

(10) **Rutherford discovered that the positive charge in an atom was concentrated in a small region called;**
(a) atom (b) nucleus (c) molecule (d) shell

(11) **____________ are collectively called nucleons.**
(a) protons in nucleus (b) electrons in shell
(c) protons and neutrons in nucleus (d) neutrons in nucleus

(12) **In which simplest atom, nucleus has only one proton?**
(a) Helium (b) Carbon (c) Nitrogen (d) Hydrogen

(13) **Generally an atom is represented by the symbol;**
(a) $^{A}_{B}X$ (b) $^{A}_{Z}X$ (c) $^{Z}_{A}X$ (d) $^{A}_{0}X$

(14) **In nuclide $^{13}_{6}X$ the number of protons are;**
(a) 3 (b) 10 (c) 8 (d) 6

(15) **Isotopes of an element have the same:**

(a) Chemical properties (b) Atomic number (c) Atomic mass number (d) Colures

(16) **Tritium contains one proton, while protium and deuterium contains;**

(a) two protons (b) three protons (c) one proton (d) no proton

(17) **Who accidentally discovered that uranium salt crystals emit an invisible radiation that can darken a photographic plate;**

(a) Becquerel (b) Marie Curie (c) Pierre (d) Rutherford

18.3 Background Radiations

18.4 Nuclear Transmutations

18.5 Half-life and its Measurement

(18) **Transmutation is**

(a) unstable nuclei changes into stable nuclei

(b) spontaneous process

(c) Both A and B

(d) non spontaneous precess

(19) **The Earth and all living things receive radiation from outer space.**

(a) X- ryas (b) Cosmic rays (c) Radon gas (d) None of these

(20) **Complete the equation** $^{226}_{88}Ra \rightarrow ^{222}_{86}Rn + ?$ **+ energy;**

(a) [illegible] (b) $^{14}_{7}N$ (c) $^{4}_{2}H_e$ (d) $^{A}_{Z}Y$

(21) $^{14}_{6}C \rightarrow ? + ^{0}_{-1}e +$ **Energy**

(a) [illegible] (b) $^{4}_{2}He$ (c) $^{14}_{6}e$ (d) $^{14}_{7}N$

(22) $^{60}_{27}Co \rightarrow ^{60}_{27}CO + ^{0}_{0}\gamma$ **+ Energy this equation shows emission of:**

(a) β-particles (b) alpha particles (c) gamma particles (d) none of these

(23) **Charge on alpha particles is;**

(a) 2e (b) 3e (c) 4e (d) 5e

(24) **Stream of high energy electrons;**

(a) β-particles (b) α-particles (c) γ-particles (d) Σ-particles

(25) **Gamma rays are also called:**

(a) photons (b) electrons (c) protons (d) positrons

(26) **Which have the greatest power of ionization as compared to others?**

(a) β-particles (b) α-particles (c) γ-particles (d) x-rays

(27) **Penetrating power of γ rays as compared to α rays and β rays is:**

(a) Greater (b) Smaller (c) Equal (d) Anyone can be

(28) **The phenomenon by which radiations split matter into positive and negative ions is called;**

(a) ionization (b) penetration (c) sublimation (d) deflection

(29) **The rate of radioactive decay is proportional to the number of:**

(a) stable nuclei present (b) unstable nuclei present

(c) electrons present (d) protons present

(30) Radium-226 has a half-life of:

(a) 1820 years (b) 1920 years (c) 1620 years (d) 1600 years

18.6 Radioisotopes and their uses

(31) Stable nuclei have atomic number between:

(a) 1 – 82 (b) 2 – 89 (c) 2 – 88 (d) 2 – 85

(32) Elements are naturally unstable having atomic number greater than;

(a) 84 (b) 89 (c) 82 (d) 88

(33) ${}^{4}_{2}He + {}^{27}_{13}Al \rightarrow ? + {}^{1}_{0}n$

(a) ${}^{24}_{11}Na$ (b) ${}^{30}_{15}P$ (c) ${}^{23}_{11}Na$ (d) ${}^{24}_{13}Na$

(34) Which are chemical compounds containing some quantity of radioisotope?

(a) Radioactive tracer (b) Hard compounds

(c) High energy compounds (d) Soft compounds

(35) Which compound readily accumulates in the thyroid gland and can be used for monitoring of thyroid functioning?

(a) I – 131 (b) I – 130 (c) I – 132 (d) I – 129

(36) Which compound is used for diagnosis of brain tumor?

(a) Phosphorus -32 (b) iodine -131 (c) hydrogen-3 (d) neon -152

(37) Radioactive isotope is used for curing cancerous tumors and cells.

(a) P -32 (b) I-131 (c) C-14 (d) Co-60

(38) When a tree dies radioactive isotope present in plant starts decaying?

(a) C -14 (b) P - 32 (c) I - 131 (d) Co - 60

(39) The half –life of C-14 is;

(a) 5720 years (b) 5730 years (c) 5700 years (d) 5202 years

(40) The stable argon nuclide Ar-40 half-life:

(a) 2.4×10^{8} years (b) 2.9×10^{4} years (c) 2.5×10^{9} years (d) 2.4×10^{11} years

18.7 Fission Reaction

18.8 Nuclear Fusion

18.9 Hazards of Radiations and Safety Measures

(41) Mass energy equation and theory of relativity was given by:

(a) Newton (b) Quantum (c) Einstein (d) Volta

(42) Nuclear fission was first observed in 1939 by:

(a) Otto Hahn and Fritz Strassman (b) Otto Hahn and Curie

(c) Fritz and Curie (d) Otto Hahn and Rutherford

(43) In each fission reaction energy released;

(a) 210meV (b) 299mV (c) 200 MeV (d) 255meV

(44) During fission of 1kg of Uranium -235 energy released is;

(a) 67×10^{10}J (b) 65×10^{8}J (c) 60×10^{8}J (d) 66×10^{9}J

(45) **Half-life of plutonium $\left(^{236}_{96}Pu\right)$ is 2.85 years and $^{242}_{94}Pu$ is;**

(a) 3.79×10^{5} years (b) 7.1×10^{8} years (c) 2.85 years (d) 7.1×10^{10} years

(46) **Half-life of $^{60}_{27}Co$ is**

(a) 20 years (b) 40 years (c) 50 years (d) 30 years

(47) **When two light nuclei combine to form a heavier nucleus, this process is called;**

(a) nuclear fission (b) nuclear fusion (c) bombardment (d) disintegration

(48) **The temperature of the centre of sun is;**

(a) 20 million kelven (b) 2 million kelvin (c) 24 million kelvin (d) 29 million kelvin

(49) **Hazards of radiation for humans are;**

(a) Leukemia (b) Sterility (c) Blindness (d) all given

(50) **In order to find the intensity of radiations, which device (s) is/are used:**

(a) Film badge (b) Dosimeter (c) Radiometer (d) Both a & b

ANSWER KEY

Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	d	11	c	21	d	31	a	41	c
2	a	12	d	22	c	32	c	42	a
3	b	13	b	23	a	33	[illegible]	43	c
4	b	14	[illegible]	24	a	34	a	44	a
5	a	15	b	25	a	35	a	45	a
6	b	16	c	26	b	36	a	46	d
7	c	17	a	27	a	37	d	47	b
8	a	18	c	28	a	38	a	48	a
9	a	19	b	29	b	39	b	49	d
10	b	20	c	30	c	40	a	50	c

REVIEW QUESTIONS

(1) **What is difference between atomic number and atomic mass number? Give a symbolical representation of a nuclide.**

Ans: The difference between the atomic number and the mass number is that the atomic **number** is the number of protons in the nucleus of an atom of the element. The **mass number** is the total number of protons and neutrons in the atom.

Atomic number = number of protons

Mass number = total number of protons + neutrons

Symbolic representation of a nuclide:

If atomic number of an atom is A and its atomic mass number is Z, then this atom is represented by the symbol $^{A}_{Z}X$ which is called a nuclide.

Example: There is only one proton in the nucleus of hydrogen atom so its atomic number is I and its atomic mass number is also I. Hence it is denoted by $^{1}_{1}H$.

(2) **What do you mean by the term radioactivity? Why some elements are radioactive but some are not**

Ans: **Radioactivity:** Radioactivity is such a process in which the elements with the charge number greater than 82. Naturally keep on radiating. **OR**

The spontaneous emission of radiation by unstable unstable nuclei is called natural radioactivity.

Reason of radioactivity: An isotope will be radioactive if its nuclei are unstable. Large atomic nuclei with more than 82 protons and their associated complement of neutrons are inherently unstable uranium and plutonium are examples of such elements. Small atomic nuclei may also be radioactive if the ratio of neutrons to protons exceeds certain limits. Even tiny hydrogen, the smallest of atoms, has a radioactive isotope. If the atom is stable it will not emit radiations.

(3) **How can you make radioactive elements artificially? Describe with a suitable example.**

Ans:

Any stable element, besides the natural radioactive element, can be made radio-active for this purpose very high energy particles (protons, neutrons or alpha particles) are bombarded on the stable element. This bombardment excites the nuclei and the nuclei after becoming unstable become radioactive element. Such radioactive elements are called artificially produced radioactive elements.

Example: Rutherford was a Scottish scientist, who discovered artificial radioactivity. Through the bombardment of alpha particles against the nuclei of ^{14}N Rutherford produced ^{17}O and protons. Through this observation, Rutherford concluded that atoms of one specific element can be made into atoms of another element through this discovered process of artificial radioactivity

(4) **What are the three basic radioactive decay processes and how do they differ from each other?**

Ans: There are following basic radioactive decay processes.

1. **ALPHA(a) –decay**
2. **Beta (b) – decay**
3. **Gamma (y)-decay**

1. **Alpha (a) – decay**

General equation

$^{A}_{Z}X$ → $^{A-4}_{Z-2}Y$ + $^{4}_{2}He$ + Energy

Parent nuclide daughter nuclide alpha (a) – particle.

Example:

$^{226}_{88}Ra$ → $^{222}_{86}Rn$ + $^{4}_{2}He$ + Energy

In alpha decay, the proton number or atomic number Z of the parent buclide reduces by 2 and its mass number A decreases by 4.

2. **Beta (b) – decay**

General equation:

$^{A}_{Z}X$ → $^{A}_{Z+1}Y$ + $^{0}_{-1}e$ + Energy

Parent Nuclide **daughter nuclide** **alpha (B) particle**

Example: $^{14}_{6}C$ → $^{14}_{7}N$ + $^{0}_{-1}e$ + energy

Carbon **nitrogen** **beta (B)**

In beta (B)- decay, the parent nuclide has its proton number Z increased by I but its mass number or nucleon number A remains unchanged.

3. **Gamma (y) – decay:**

General equation:

$^{A}_{Z}X$ → $^{A}_{Z}X$ + γ

Parent nuclide daughter nuclide gamma rays

Example: $^{60}_{27}Co$ → $^{60}_{27}Co$ + $^{0}_{0}\gamma$ + Energy

Cobalt cobalt gamma- rays

y- rays are usually emitted at the same moment as either an alpha or a beta particle.

(5) **Write the alpha decay process for $^{234}_{91}Pa$. Identify the parent and daughter nuclei in this decay.**

Ans: **Alpha decay process for** $^{234}_{91}Pa$

$$^{234}_{91}Pa \rightarrow ^{230}_{89}Ac + ^{4}_{2}He + \text{Energy}$$

It means in alpha decay, the proton number or atomic number Z of the parent nuclide reduces by 2 and its mass number or nucleon number A decreases by 4.

$^{234}_{91}Pa \Rightarrow$ Parent nuclei

$^{230}_{89}Ac \Rightarrow$ Daughter nuclei

(6) **Explain whether the atomic number an increase during nuclear decay. Support your answer with an example.**

Ans: Yes, atomic number can increase during nuclear decay. During the β-decay atomic number of atom can be increased.

Beta (β) –decay:

General equation:

$^{A}_{Z}X$ → $^{A}_{Z+1}Y$ + $^{0}_{-1}e$ + Energy

Parent nuclide Daughter nuclide beta (β) -particle

Example: $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e +$ Energy

Carbon nitrogen beta (β) particle

In beta (β) –decay, the parent nuclide has its protean number Z increased by 1 but its mass number or nucleon number A remains unchanged.

(7) What do you understand by half-life of a radioactive element?

Ans: See Q # 6

(8) Is radioactivity a spontaneous process? Elaborate your answer with a simple experiment.

Ans: Radioactive decay involves the spontaneous transformation of one element into another. The only way that this can happen is by chaining the number of proteins in the nucleus. There are a number of ways that this can happen and when it does, the atom is forever changed. There is no going back.

For example, when U-238 (one of the radioactive isotopes of uranium) initially decays, it produces Th-234, which decays to Pa-234. The decay continues until, (finally, after a total of14 steps, pb-206 is produced. Pb-206 is stable, and the decay sequence, or series, stops)

(9) What is meant by background radiations? Enlist some sources of background radiations.

Ans: Back ground radiations:

Radiations present in atmosphere due to different radioactive substance are called background radiation. Every where in rocks, soil, water and air of our planet are traces of radioactive elements. This natural radioactivity is called the background radiation.

Sources of background radiation: (i) The cosmic rays entering the earth from the upper atmosphere along with sunlight. (ii) The presence of radioactive material in the atmosphere or the presence of radioactive wastes of nuclear reactor. There are a number of naturally occurring radioactive elements in the earth's crust. Uranium, radium, plutonium, and even some radio-isotopes of common elements like carbon and iodine. All of them will contribute to background radiations.

(10) Describe two uses of radioisotopes in medicine industry or research?

Ans: Use of radioactive isotope in medicine:

(1) Radioactive cobalt-60 is used for curing cancerous tumors and cells. The radiations kill the cells of the malignant tumor in the patient.

(2) Isotopes of Iodine-131 are used for diagnosis of goiter in thyroid gland.

Uses of radioisotope in industry or research:

(1) The radioisotopes are used in a chemical reaction to follow a radioactive element during the reaction and ultimately to determine the structure. For example, C-14 is used to label CO_2.

(2) Radioactive isotopes are used to generate electricity by carrying out controlled nuclear fission reaction in nuclear reactors. For example, when U-235 is bombarded with slow moving neutrons, the Uranium nucleus breaks up to produce Barium-139 and krypton-94 and three neutrons.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}ba + {}^{94}_{36}Kr + 3^{1}_{0} + \text{Energy}$$

A large amount of energy is released which is used to convert water into steam in boilers. The steam then drives the turbines to generate electricity.

(11) **What are two common radiation hazards? Briefly describe the precautions that are taken against them.**

Ans: **Common radiation Hazards:**

(1) Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.

(2) Blindness or formation of cataract in the eye.

Precautions:

1. The sources should only be handled with tongs and forceps.
2. The user should use rubber gloves and hands should be washed carefully after the experiment.
3. All radioactive sources should be stored in thick lead containers.
4. Never point a radioactive source towards a person.
5. Frequent visits to the radiation sensitive areas should be avoided.

(12) **Complete this nuclear reaction:** $^{235}_{92}U \rightarrow {}^{140}_{54}X + ? + 2^{1}_{0}n$. **Does this reaction involve fission or fusion? Justify your answer.**

Ans: **Complete reaction:** $^{235}_{92}U \rightarrow {}^{140}_{54}X + {}^{94}_{38}Sr = 2^{1}_{0}n + Q$ Energy

(Xenon) (Strontium) Neutron

Justification: It is a fission reaction. Because the process of breaking up of nucleus of a heavy atom such as Uranium into two nuclei nearly of the same size with the release of energy is called fission reaction.

(13) **Nuclear fusion reaction is more reliable and sustainable source of energy than nuclear fission chain reaction. Justify this statement with plausible arguments.**

Ans: Nuclear fusion reaction is more reliable and sustainable source of energy than nuclear fission chain reaction. In case of fusion reaction, fusion reactors cannot sustain a chain reaction so they never melt down like fission reactors. Fusion reaction produces very less or, if the right atoms are chosen, no radioactive waste. In case of nuclear fission large radioactive waste is produced and disposal of radioactive waste is a complicated problem. For nuclear power, fusion is the better choice.

(14) **A nitrogen nuclide $^{14}_{8}N$ decays to become an oxygen nuclide by emitting an electron. Show this process with an equation.**

Ans: **Equation:** $^{14}_{7}N + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$

(15) **Determine which of these radioactive decay processes are possible:**

(a) $^{214}_{84}P_{o} \rightarrow {}^{208}_{82}P_{b} + {}^{4}_{2}He$ **(b)** $^{230}_{90}Th \rightarrow {}^{226}_{88}R_{a} + {}^{4}_{2}He$

(c) $^{233}_{91}P_{a} \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$ **(d)** $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$

Ans: (a) $^{214}_{84}P_{o} \rightarrow {}^{208}_{82}P_{b} + {}^{4}_{2}He$ Not possible

(b) $^{230}_{90}Th \rightarrow {}^{226}_{88}R_{a} + {}^{4}_{2}He$ Possible

(c) $^{233}_{91}Pa \rightarrow {}^{233}_{92}U + {}^{0}_{-1}\beta$ Possible

(d) $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$ Possible

CONCEPTUAL QUESTOINS

18.1 Is it possible for an element to have different types of atoms? Explain.

Ans Usually an element has same types of atoms. However, certain elements have different types of atoms. These atoms have same atomic mass numbers, but different atomic number. For example, there are three different types of atoms of hydrogen elements ^1_1H, ^2_1H and ^3_1H. These different atoms of same element are known as isotopes.

18.2 Which nuclear reaction would release more energy, the fission reaction of the fusion reaction? Explain

Ans: Energy released in fusion reaction is large as compared to that of fission reaction. For example, in the proton-proton fusion reaction about 6.4. MeV energy is released which is much greater than the per nucleon energy released per nucleon for fission reaction which is about 1 MeV.

18.3 Which has more penetrating power, alpha particle or gamma ray photon? Explain.

Ans: Alpha particle is a massive particle as compared to a gamma-ray photon. Also photon is neutral out charge on alpha particle is +2e. Hence, alpha particle has greater ionization power and, therefore, has less penetrating power than that of gamma-ray photon.

18.4 What is the difference between natural and artificial radioactivity?

Ans: In natural radioactivity, some elements emit radiations by their own due to their unstable state. For example, $^{14}_{6}C$ is natural radioactive isotope of carbon. Some stable elements can also be transformed into radioactive elements. Such process is called artificial radioactivity. For example, when N-14 is bombarded with neutron, it changes into C – 14 ie.

$$^{14}_{7}N + ^{1}_{0}N \longrightarrow ^{12}_{6}C + ^{1}_{1}H$$

18.5 How long would you likely have to wait to watch any sample of radioactive atoms completely decay?

Ans: During one half-life, half of the parent nuclei of radioactivity element change into daughter nuclei. However, the total decay time of any radioactive element is indefinite. Thus, we have to wait for infinite amount of time to observe the complete decay.

18.6 Which type of natural radioactivity leavers the number of protons and the number of neutrons in the nucleus unchanged?

Ans. During gamma-decay process, the number of protons and the number of neutrons remains unchanged e.g.

$$^{60}_{27}Co \longrightarrow ^{60}_{27}Co + ^{0}_{0}\gamma + \text{Energy}$$

18.7 How much of 1-gram sample of pure radioactive matter would be left after four-half lives?

Ans. Using the formula;

$$\text{Remaining} = \text{Original} \times \frac{1}{2^{t}}$$

We get

$$\text{Amount of sample after 4 half-lives} = \frac{1}{2^{4}} g$$

$$= \frac{1}{16} g$$

18.8 Tritium, $^{3}_{1}H$ is radioactive isotope of hydrogen. It decays by emitting an electron. What is the daughter nucleus.

Ans. The decay process is

$$^{3}_{1}H \longrightarrow {}^{3}_{2}X + {}^{0}_{-1}e$$

Thus, the daughter nuclei $^{3}_{2}X$ is of helium element i.e. $^{3}_{2}He$

18.9 What information about the structure of the nitrogen atom can be obtained from its nuclide $^{14}_{7}N$? in what way atom in $^{14}_{7}N$ is different from the atom in $^{16}_{7}N$?

Ans. Form the nuclide $^{14}_{7}N$. We know that it is one of the isotopes of nitrogen. It has 7 protons. 7 electron and 7 neutrons. As compared to $^{14}_{7}N$, $^{16}_{7}N$ has two extra neutrons in its nucleus as its atomic mass number increases by 2.

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Ans. Using the formula;

$$\text{Remaining} = \text{Original} \times \frac{1}{2^t}$$

We get

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Ans. Form the nuclide $^{14}_7N$. We know that it is one of the isotopes of nitrogen. It has 7 protons. 7 electron and 7 neutrons. As compared to $^{14}_7N$, $^{16}_7N$ has two extra neutrons in its nucleus as its atomic mass number increases by 2.

EXERCISE
MULTIPLE CHOICE QUESTIONS

(1) **Isotopes are atoms of same element with different**
(a) Atomic mass (b) Atomic number (c) Number protons (d) Number of electrons

(2) **One of the isotopes of uranium is $^{238}_{92}U$. The number of neutrons in this isotope is**
(a) 238 (b) 92 (c) 330 (d) 146

(3) **Which among the following radiations has more penetrating power?**
(a) A beta particle (b) A gamma ray
(c) An alpha particle (d) All have the same penetrating capability

(4) **What happens to the atomic number of an element which emits 1 alpha particle?**
(a) Increases by 1 (b) Stays the same (c) decreases by 2 (d) decreases by 1

(5) **The half life of a certain isotope is 1 day. What is the quantity of the isotope after 2 days?**
(a) One half (b) One quarter (c) One eight (d) None of it

(6) **When Uranium (92 protons) ejects a beta particle, how many protons are let in the remaining nucleus?**
(a) 92 protons (b) 91 protons (c) 93 protons (d) 89 protons

(7) **Release of energy by the sun is due to**
(a) Nuclear fission (b) Nuclear fusion (c) Burnings of gases (d) Chemical reaction

(8) **When heavy nucleus splits into two lighter nuclei, the process would**
(a) Release nuclear energy (b) Absorb nuclear energy
(c) Release chemical energy (d) Absorb chemical energy

(9) **The reason carbon dating works is that**
(a) Plants and animals are such strong emitters of carbon-14
(b) After plant of animal dies, it stops taking in fresh carbon-14
(c) There is so much non-radioactive carbon dioxide in the air
(d) When a plant or an animal dies

ANSWER KEY

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	a	3	b	5	b	7	b	9	b
2	b	4	d	6	c	8	a		

SHORT QUESTIONS

18.1 Atom and Atomic Nucleus
18.2 Natural Radioactivity

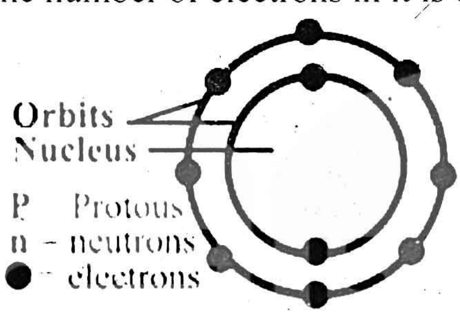
Q.1. Define atom and write down its parts.

Ans: The smallest part of an element is called an atom.

Parts of atom

(i) Atom consists of two parts and its central part is called nucleus. The nucleus consists of protons and neutrons. The proton is a positively charged particle and neutron has no charge so the nucleus carries a positive charge.

(ii) The electrons revolve around the nucleus in nearly circular orbits. Since an atom is a neutral particle, so the number of electrons in it is equal to the number of protons.



Q.2. What are Nucleons?

Ans: The mass of the proton & neutron is nearly the same i.e. 1.67×10^{27} kg. Since the protons and neutrons exist inside the nucleus so these are called nucleons.

Q.3. What is Atomic Mass Number?

Ans: A nucleon is nearly 1836 times heavier than an electron. So the mass of an atom is nearly equal to the total sum of the masses of all the protons and neutrons present in the nucleus of that atom.

"The total number of protons and neutrons in the nucleus is called the Atomic Mass Number and is denoted by the letter A".

Q.4. What is Atomic Number?

Ans: Since the number of protons in an atom of different elements is different so the number of protons in the nucleus indicates the charge on that nucleus.

"The number of protons in a nucleus is called the charge number or Atomic number and is denoted by the letter Z".

The number of neutrons in the nucleus is denoted by the letter N.

Q.5. What do you know about Nuclide?

Ans: If atomic number of an atom is Z and its Atomic Mass Number is A then this atom is represented by the symbol which is called a nuclide $\left(^{A}_{Z}X\right)$. For example there is only one proton in the nucleus of hydrogen atom so its atomic number is 1 and its atomic mass number is also 1. Hence it is denoted by $^{1}_{1}H$.

Q.6. What is the difference between Atomic number and Atomic Mass number?

Ans:

Atomic number	Atomic Mass number
• The total number of protons and neutrons in the nucleus is called the Atomic Mass Number. • It is denoted by the letter A.	• The number of protons in a nucleus is called the charge number or Atomic number. • It is denoted by the letter Z.

Q.7. What are radioactive isotopes?

Ans: The atoms of the same radioactive element whose atomic numbers are the same but have different atomic mass numbers are called Radioactive Isotopes.

Q.8. What are isotopes? What do they have in common and what are there differences.

Ans: Atoms of the same element having same atomic number but different mass number, are called isotope. They have same chemical properties but different physical properties. For example, Hydrogen has three isotopes

Protium $Z=1$ $A=1$ $N=A-Z=0$

Deutrium $Z=1$ $A=2$ $N=A-Z=1$

Tritium $Z=1$ $A=3$ $N=A-Z=2$

Hence, from above relations we conclude that the number of protons are same and number of neutrons are different in the isotopes of hydrogen.

Fig.18.2: Three Isotopes of hydrogen
Protium (^1_1H), Deutrium (^2_1H) and Tritium (^1_1H).

Q.9. Why Marie Curie and Pierre are famous?

The most significant investigations of the process of radioactivity were done by Marie Curie and the husband Pierre.

They discovered two new elements which emitted radiations. These were named **polonium** and **radium**. This process of emission of radiations by some elements was called natural radioactivity by Marie Curie.

Q.10. Why are heavy nuclei unstable?

Ans: Heavy nuclei are unstable due to large number of protons. The strong nuclear force cannot balance the repulsive Coulomb force which comes into play due to increase in size.

Q.11. Find the number of neutrons and protons in $^{238}_{92}U$

Ans: In $^{238}_{92}U$

A = 238 and Z = 92

N = ? No of protons = ?

or $\boxed{N = 146}$ Ans

and No. of protons = Z = 92

or $\boxed{Z = 92}$

18.3 Background Radiations
18.4 Nuclear Transmutations
18.5 Half-life and its Measurement

Q.12. What is meant by Background Radiations ?

Background Radiations

"Radiations present in atmosphere due to different radioactive substances are called background radiations".

Sources of background radiations

The back ground radiation present in the atmosphere is due to the following two possible causes.

(i) The presence of radioactive material under the earth

(ii) The cosmic rays entering the earth from the upper atmosphere along with the sun light

Q.13. What are cosmic radiation?

The earth and all living things on it also receive radiation from outer space. This radiation is called cosmic radiation which primarily consists of positively charged ions from protons to iron and large nuclei. The cosmic radiation interacts with atom in the atmosphere to create a shower of secondary radiation, including x-rays, muons, protons, alpha particles, electrons and neutrons.

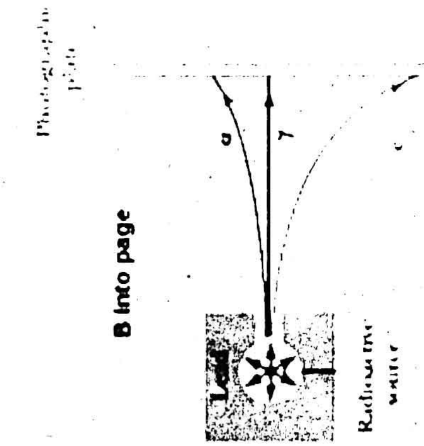
Q.14. Describe a brief account of Interaction of various types of radiations with matter.

Ans: **α-radiation:** It is a helium nuclei. When an alpha particle passes through a gas it interact with the atom of the gas and ionizes them. As its mass is comparatively more than β *and* γ so it has less penetrating power. Each ionization by an α-particle produces an ion pair and an average of about 3.5 electron volt energy is used to produce one ion pair. The range of α particle is around 7 cm and it can be stopped by a thick paper. α particle are capable of producing fluorescence in zinc sulphide or barium platinocyanide.

β-Radiations: These are negative charge particles they can penetrate 100 times more than α particles. The β-particle looses most its energy in a single collision. β Particle can also produce fluorescence in some materials like barium platinocyanide.

γ-Radiations: γ – rays have no charge that is why the cause very little ionization. The γ – ray photon can be absorbed by an atom and a photo electron can be ejected

(Photoelectric effect). When fast moving γ – ray photon is stopped it disintegrates into an electron positron pair (pair production). Material having large no of electron in a unit volume absorbs more γ – radiations. They have high penetration power than α & β particles and their intensity decreases exponentially with increase in depth of penetration into the material.



Q.15. Explain how α and β-particles may ionize an atom without directly hitting the electrons? What is the difference in the action of the two particles for producing ionization?

Ans: Since α and β-particles are electrically charged they can cause ionization without hitting an atom either by attracting or repelling the electrons of the target atom. α particle produces ionization by exerting electrostatic force of attraction while β-particles produce ionization by exerting electrostatic force of repulsion. α-particles cause ionization by attracting the electron while β-particles cause ionization by repelling the electron.

Q.16. A particle which produces more ionization is less penetrating why?

Ans: A particle which produces more ionization interacts strongly with the matter and loses its energy in a short distance and hence comes to rest soon, that's why it is less penetrating

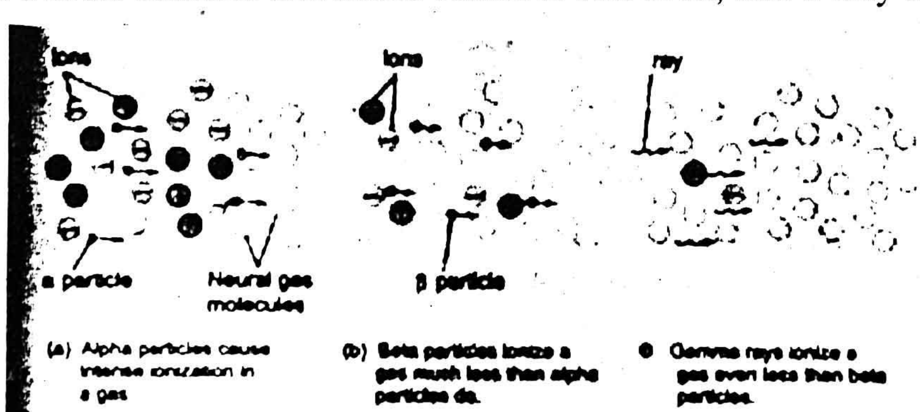


Fig. 18.5: Ionization effect of radiations in gas.

Q.17. If someone accidentally swallows an α-source and a β-source which would be the more dangerous to him? Explain why?

Ans: α-particles have greater ionizing power as compare to β-particles. So, they can cause more damage to tissues, if swallowed.

Q.18. Rn^{222} decays to a new element 'y' by two alpha and two β-emissions. What you can say about new element?

Ans: $_{86}Rn^{222} \longrightarrow {}_{82}Y^{214} + 2{}_2He^4$ (α -particles)

After two β-emissions

$_{82}Y^{214} \longrightarrow {}_{84}Y^{214} + 2{}_{-1}e^0$ (β-particle)

Hence, new element will be $_{84}Y^{214}$.

Q.19. Do α,β and γ radiations emit from the same element ? Why they are found in many radioactive elements?

Ans: α,β and γ rays emit from the same element . But, an element can not emit α and β rays simultaneously.

When a radioactive element emit α or β rays, it decays into new element and so on. Hence, we find all the three radiations in many radioactive element.

Q.20. Define nuclear transmutation?

"The spontaneous process in which a parent unstable nuclide changes into a more stable daughter nuclide with the emission of radiations is called nuclear transmutation".

Examples of radioactive decay

There are three processes given as

(i) Alpha (α) decay

$${}^{A}_{Z}X \rightarrow {}^{A-4}Y + {}^{4}_{2}H_e + \text{Energy}$$

$${}^{226}_{85}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}H_e + \text{Energy;}$$

(ii) Beta (β) decay

General Equation

$${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e + \text{Energy}$$

Parent nuclide — daughter nuclide — beta (β) -particle

Example

$${}^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e + \text{Energy}$$

carbon — nitrogen — beta (β) – particle

In (β) - decay, the parent nuclide has its proton number Z increased by 1 but is mass number or nucleon number a remains unchanged.

(iii) Gamma (γ) – decay

General Equation

$$^{A}_{Z}X \rightarrow \ ^{A}_{Z}X + (\gamma)$$

parent nuclide — daughter nuclide — gamma rays

Example:

$$^{60}_{27}C_0 \rightarrow \ ^{60}_{27}C_0 + \ ^{0}_{0}\gamma + \text{Energy}$$

γ – rays are usually emitted at the same moment as either an alpha or a beta particle.

Q.21. What is the use of α,β and γ-radiation?

Ans: α-particles

They are used to treat skin cancer because their penetrating power is small.

β-particles

They are used to treat the tumors under the skin due to their large penetration power

γ-particles

They are used to treat the infection in interior parts of the body clue to their longest penetration power.

Q.22. What is the difference between an electron and β-particles?

Ans: β-particle is negatively charged particle emitted from the nucleus of radioactive element. An electron is negatively charge particle which revolves around the nucleus.

Q.23. What do you know about half life?

Ans: "The half life of an element is that time during which the numbers of atoms of that element are reduced to one half".

Example

If the half life time of a radioactive element is T, then at the end of this time the number of atoms in this element remain one half, after a time 2T, the number of atoms remain 25% and after time 3T, the number of atoms are reduced to 12.5% of the initial number.

Q.24. What is meant by Penetrating ability?

Penetrating ability

"The strength of radiations to penetrate a certain material is called penetrating power".

All kind of radiations penetrate but penetrating range is different for each.

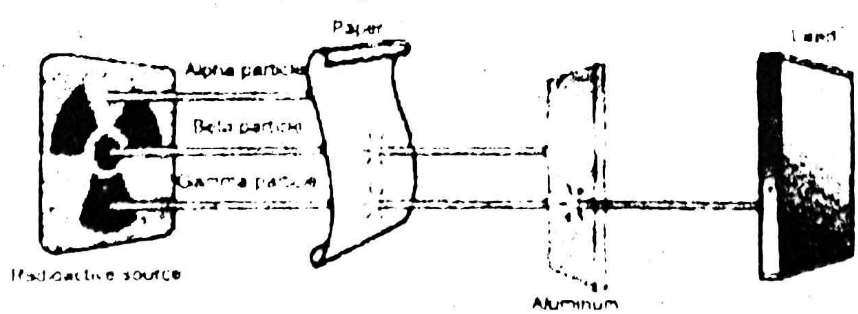


Fig 18.6 Penetrating power of radiations in different materials

18.6 Radioisotopes and their uses

Q.25. What are radioactive isotopes?

Ans: The atoms of the same radioactive element whose atomic numbers are the same but have different atomic mass numbers are called Radioactive Isotopes.

Q.26. What are stable nuclides?

Ans: Nuclei which do not emit radiations naturally are called stable nuclei. Most of the nuclei whose atomic number is from 1 to 82 are stable nuclei. They do not change from one type of element to another. The stable elements can also be changed into unstable form by bombarding them with neutrons. Such elements are called radio isotopes.

Q.27. What are unstable nuclides?

Ans: Nuclei which do not emit radiations naturally are called stable nuclei. Some elements, whose atomic number is greater than 82, are naturally unstable. These elements depending upon their characteristics, emit, all the time, different types of radiations and they continously change from one type of element to another.

Q.28. Differentiate between stable and unstable nuclides?

Ans:

Stable elements	Unstable elements
• Nuclei which do not emit radiations naturally are called stable nuclei.	• Nuclei which emit radiations naturally are called unstable nuclei.
• Most of the nuclei whose atomic number is from 1 to 82 are stable nuclei.	• The elements, whose atomic number is greater than 82, are naturally unstable.
• They do not change from one type of element to another.	• They continuously change from one type of element to another.

Q.29. What is a radioactive tracer? Describe one application each in medicine, agriculture and industry.

Ans: A definite quantity of radio isotope introduced into a mechanical or biological system to enable its route through the system.

(i) Tracers are widely used in medicine to detect malignant tumors, blockage in the blood vessels, e.g brain and thyroid tumors are detected using I-131. Radio sodium has been largely used in medical research to study the action of various medicines

(ii) Tracers are also used in agriculture to study the uptake of a fertilizer by a plant, e.g P^{32} is incorporated in fertilizer and added to the soil.

(iii) Tracer technique is also very useful in industry in detecting the cracks and leakage in the pipes and welding joints e.g Iridium 192- is used to test the welds.

Q.30. How can radioactivity help in the treatment of cancer?

Ans: Medical applications of radio isotopes can be divided into two parts (i) diagnostic and (ii) therapy. Radiotherapy with γ – rays from cobalt-60 is often used in the treatment of cancer. The γ – rays are carefully focused on to the malignant tissue.

Radioactive Iodine-131 is used to fight with cancer of the thyroid gland.

Skin Cancers: for skin cancers, phosphorus-32 or strontium-90 may be used. They produce β radiation.

Q.31. How can radioactivity help in the treatment of Cancer?

Ans: **Radioactivity & Treatment of Cancer:** Cancerous cells are always weak as compared to the normal cells, and hence are destroyed by firing β-radiation or γ-radiation from radioactive source. Some times encapsulated "seeds" made from radioactive source are implanted in the malignant tissues for local and short ranged treatment.

For example:

- γ-rays from Co-60 in general
- Iodine–131 for treatment of cancer of thyroid gland.
- Phosphorus–32 or strontium–90 may be used for skin-cancers.

Q.32. How a radioisotope be used to determine the effectiveness of fertilizer?

Ans: Radioactive phosphorus or nitrogen used as a tracer in agriculture, provide information about the best fertilizer to supply to a particular crop and soil. Due to their use, varieties of crops such as rice, wheat and cotton have improved. Moreover, plants have shown more resistance to disease and give better yield and grain quality.

18.7 Fission Reaction
18.8 Nuclear Fusion
18.9 Hazards of Radiations and Safety Measures

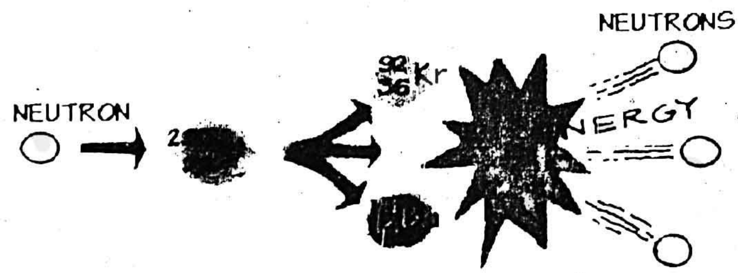
Q.33. What is positron?

Ans: Positron is a particle with mass equal to the mass of an electron having opposite and equal charge.

Q.34. What is by Nuclear fission

Nuclear fission

Nuclear fission takes place when a heavy nucleus, such as U-235, splits or fissions, into two smaller nuclear by bombarding a slow moving (low- energy) neutron represent in equation.



$$ {}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{92}^{236}U \rightarrow X + Y + \text{neutron} + \text{energy} $$

U-236 in an intermediate state that lasts only for few seconds before splitting into nuclei X and Y, called fission fragments.

Q.35. Briefly explain how heat is produced in a nuclear reactor?

Ans: The fission of U-235 may be represent as:

$$ {}_{92}U^{235} + {}_{0}n^{1} \longrightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\,{}_{0}n^{1} + Q $$

Where Q is the amount of energy released and it is nearly equal to 200 Mev. This energy is appeared in the form of heat.

Q.36. Why does water is used to slow down the neutrons rather than lead?

Ans: When neutrons collide with lead nuclei, they are bounced back. While lead atoms remain at rest due to their greater mass. But, in case of water, collision b/w neutrons and hydrogen nuclei, present in water is perfectly elastic. In this collision, neutrons are slowed down, while proton starts moving.

Hence, water may be used efficiently to slow down the neutrons rather than lead.

Q.37. Write a note on Einstein's mass energy equation.

Ans: In classical physics, the various forms of energy were related under the law of conservation of energy but no relationship was established between the energy and mass. In 1905, when Einstein gave his theory of relativity, it also contained the idea that the energy and matter are interchangeable. For this change an equation was also given which is known as Einstein's mass-energy equation. It is

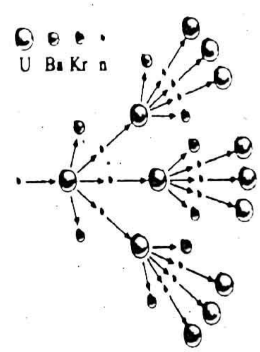
$$E=mc^2$$

Which means that if mass m of matter is converted into energy, then this will be equal to E, where in this mass-energy equation c is the speed of light that is $3 \times 10^8\ ms^{-1}$.

Q.38. What is do you know about Fission chain reaction

Fission chain reaction

When a neutron reacts with a uranium nucleus, two or three neutrons are released. Every one of these reacts with next nuclei producing two or three more neutrons and hence, the number of available neutrons and the fission goes on increasing. Such a reaction is called the chain reaction.



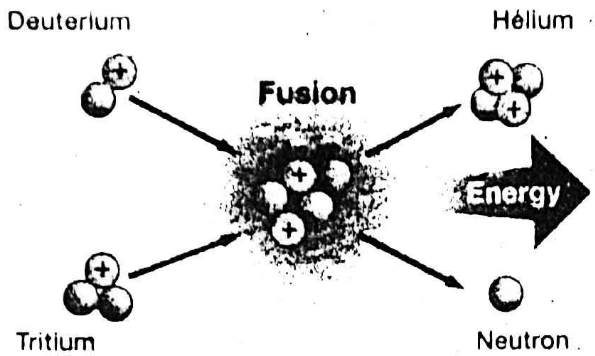
Q.39. Define Fusion Reaction.

Ans: "When two light nuclei combine to form a heavier nucleus, the process is called nuclear fusion".

Equation:

If an atom of Deuterium is fused with an atom of Tritium, the a Helium nucleus or alpha particle is formed as given by

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n + \text{energy}$$



Pictorially fusion reaction is shown in the following figure.

Q.40. Why it is more difficult to start a fusion reaction rather than fission reaction?

Ans: because, in bringing two nuclei closer to each other, great work has to be done against repulsive forces of nuclei. Hence, more energy is needed. On the other hand fission may be proceeded with slow neutrons.

Q.41. Differences between nuclear fission and nuclear fusion.

Nuclear Fission	Nuclear Fusion
1. A bigger heavier nucleus splits into smaller (lighter) nuclei.	1. Lighter nuclei fuse together to form the heavier nucleus.
2. It does not require temperature.	2. Extremely high temperature is require for fusion to take place.
3. A chain reaction sets in.	3. It is not a chain reaction.
4. It can be controlled and energy released can be used for peaceful purpose.	4. It cannot be controlled and energy released cannot be used properly.
5. The products of the reaction are radioactive in nature.	5. The products of a fusion reaction are non-radioactive in nature.
6. At the end of the reaction nuclear waste is left behind.	No nuclear waste is left at the end of fusions reaction.

Q.42. Discuss uses and the hazards of radiations

Some of harmful effects on human beings due to large doses or prolonged small doses of radiations.

1. Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.
2. Sterility (i.e. inability to produce children).
3. Genetic mutations in both human and plants. Some children are born with serious deformities.
4. Leukernia (Cancer of the blood cells)
5. Blindness or formation of cataract in the eye.

Q.43. Describe the precaution to minimize radiations dangers (safety measures)

Precautions to minimize radiation dangers

Because we cannot detect radiations directly, we should strictly follow safety precautions, even when the radioactive sources are very weak.

1. Sources should not be handled with tongs and forceps.
2. The user should use rubber gloves and hand should be washed carefully after the experiment.
3. All radioactive sources should be stored in thick lead containers.
4. Never point radioactive source towards a person.
5. Frequent visits to the radiation sensitive areas should be avoided.

LONG QUESIONS

Q.1 Describe the structure of an atom. Differentiate between atomic number and atomic mass number? Write the symbol of atom.

Structure of Atom

There are two main parts of an atom.

(i) Central part (Nucleus)
(ii) Circular part (Orbits)

Rutherford's concept of structure of atom

Nucleus:

Rutherford discovered that the positive charge in an atom was concentrated in a small region called nucleus.

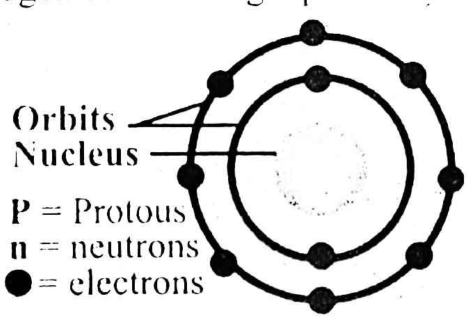
Nucleons:

"The nucleus contains protons and neutrons which are collectively called nucleons".

Circular Orbits:

Atom contains electrons which resolve in nearly circular orbits about nucleus.

Example: Simplest atom of hydrogen contain single proton.



Difference between atomic number and atomic mass number	
Atomic Number	**Atomic mass number**
1. The number of protons inside the nucleus is called the atomic number.	**1.** The sum of protons and neutrons present inside the nucleus of an atom is called its atomic mass number.
2. Atomic number depends upon the number of protons or electrons of atom.	**2.** Atomic mass number depends upon the number of neutrons.
3. Atomic number is represented by Z.	**3.** It is represented by 'A' which is written as: $A = Z + N$
4. It is written at the bottom left side of the symbol of an element. e.g. $^{4}_{2}He$	**4.** It is written at the top left side of the symbol of an element e.g $^{4}_{2}He$.

Comparison of the masses of the fundamental particles of atom

The mass neutron is nearly equal to the mass of proton. But proton is about 1836 times heaviour than an electron. Hence the mass of the atom is equal to the sum of the masses of protons and neutrons.

Symbol of atom (Nuclide)

Generally an atom is represented by the symbol $^{A}_{Z}X$, which is called nuclide.

Example:

Nuclide of hydrogen atom having only one proton is $^{1}_{1}H$.

Q.2 What is meant by isotopes? Give example.

Isotopes:

Isotopes are atom of an element which have same number of protons but different number of neutrons in their nuclei.

Example:

Hydrogen has three Isotopes.

(i) Protium $\left(^{1}_{1}H\right)$

Protium contains one proton and one electron

(ii) Deuterium $\left(^{2}_{1}H\right)$

Deuterium contain on proton, one neutron and one electron.

(iii) Tritium $\left(^{3}_{1}H\right)$

Tritium contains one proton, two neutrons and one electron.

Fig.18.2: Three isotopes of hydrogen
Protium ($^{1}_{1}H$), Deutrium ($^{2}_{1}H$) and Tritium ($^{3}_{1}H$)

Q.3 What is meant by natural radioactivity? Explain how it is discovered and how radiations are identified?

Natural Radioactivity

"The spontaneous emission of radiation by unstable nuclei is called natural radioactivity."

Radioactive elements

"The elements which emit radiations naturally are called radioactivity elements".

Explanation

In 1896, Becquerel accidentally discovered that uranium crystals emit an invisible radiation that can darken a photographic plate. He also observed that the radiation has the ability to ionize a gas.

Marie Curie

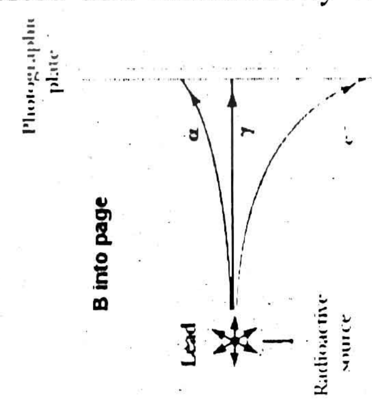
The most significant investigations of the process of radioactivity were done by Marie Curie and the husband Pierre.

They discovered two new elements which emitted radiations. These were named **polonium** and **radium**. This process of emission of radiations by some elements was called natural radioactivity by Marie Curie.

Henry Becquerel performed some experiments and suggested that radioactivity was the result of the decay unstable nuclei.

How these radiations are identified?

Three types of radiation are usually emitted by a radioactive element (substance). e.g.



(i) Alpha (α) particles.

(ii) Beta (β) particles.

(iii) Gamma (γ) rays.

These three forms of radiations were studied by the following scheme. The radioactive source is placed inside the lead block. The radiations emitting from the source allow to pass through the magnetic field. These radiations split into three components. Alpha (α) and Beta (β) radiations bend in opposite direction in magnetic field but gamma (γ) radiation does not change direction.

Q.4 What is meant by background radiations? Enlist some sources of background radiations.

Background Radiations

"Radiations present in atmosphere due to different radioactive substances are called background radiations".

Sources of background radiations

Everywhere in rocks, soil, water and air of our planet (Earth) there are traces of radioactive elements. They emit the radiation every time, this natural radioactivity is called the background radiation. It is as much part of our environment as sunshine and rain. Fortunately, our bodies can tolerate it. Only those places can be injurious to health where radiations are very height in magnitude.

The earth and all living things on it also receive radiation from outer space. This radiation is called cosmic radiation which primarily consists of positively charged ions from protons to iron and large nuclei. The cosmic radiation interacts with atom in the atmosphere to create a shower of secondary radiation, including x-rays, muons, protons, alpha particles, electrons and neutrons.

Q.5 Define nuclear transmutation? Explain the radioactive decay of nuclide.

"The spontaneous process in which a parent unstable nuclide changes into a more stable daughter nuclide with the emission of radiations is called nuclear transmutation".

Examples of radioactive decay

There are three processes given as

(i) Beta (β) decay

General Equation

${}^{A}_{Z}X$	$\rightarrow$	${}^{A}_{Z+1}Y$	+	${}^{0}_{-1}e$	+	Energy
Parent nuclide		daughter nuclide		beta (β) -particle		

Example

${}^{14}_{6}C$	$\rightarrow$	${}^{14}_{7}N$	+	${}^{0}_{-1}e$	+	Energy
carbon		nitrogen		beta (β) – particle		

In (β) - decay, the parent nuclide has its proton number Z increased by 1 but is mass number or nucleon number a remains unchanged.

(iii) Gamma (γ) – decay

General Equation

${}^{A}_{Z}X$	$\rightarrow$	${}^{A}_{Z}X$	+	(γ)
parent nuclide		daughter nuclide		gamma rays

γ - rays are usually emitted at the same moment as either an alpha or a beta particle.

Q.6 Discuss the nature and properties of radiation.

There are three types of radiations which show different properties.

(1) Nature of Radiations

(i) Alpha (α) particles

Alpha particle is a helium nucleus comprising two protons and two neutrons with a charge of +2. Alpha particles are emitted by the decay of unstable heavy nucleus, i.e

$$ {}^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn \quad + \quad {}^{4}_{2}He \ + \ Energy $$

Radium radon Alpha particle

(ii) Beta (β) particles

Beta radiation is a stream of high-energy electrons. An unstable nuclei with excess of neutrons any eject beta radiations. i.e

$$ {}^{214}_{82}Pb \rightarrow {}^{214}_{83}Bi + {}^{0}_{-1}B $$

In above example one neutron is converted into proton with the emission of Beta particles

$$ {}^{1}_{0}n \rightarrow {}^{1}_{1}H \rightarrow {}^{0}_{-1}B $$

iii. Gamma (γ) rays

Gamma radiations are fast moving light photons. They are electromagnetic radiations of very high frequency and short wavelength. These radiations are emitted by the unstable excited nuclei.

(2) Ionizing Effect

"The phenomena by which radiations split matter into positive and negative ions is called ionization". All three kinds of radiations ionize the matter but in different extent.

i. Alpha (α) particles:

Alpha particles have the greatest power of ionization of all. It is due to large positive charge and large mass of alpha particles.

ii. Beta (β) particles:

Beta particles ionize a gas much less than alpha particles do. It is due to high speed and negligible mass.

iii. Gamma $((\gamma)$ rays:

The ionization of power of gamma rays is even less than that of beta particles.

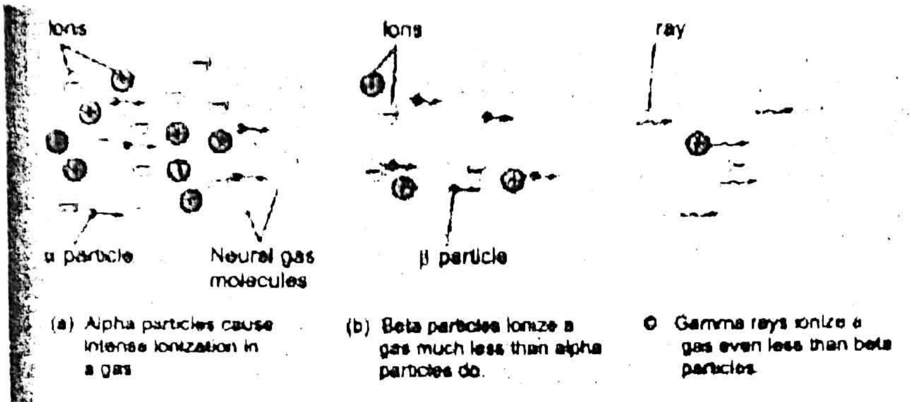


Fig. 18.5: Ionization effect of radiations in gas.

(3) **Penetrating ability**

"The strength of radiations to penetrate a certain material is called penetrating power".

All kind of radiations penetrate but penetrating range is different for each.

i. **Alpha (α) particles**

Alpha particles ahs the shortest range because of its strong interacting or ionizing power. Alpha particle has a rang of only a few centimetres in air.

ii. **Beta (β) p articles:**

Beta particle also penetrate to matter but their penetration is less than gamma rays and more than alpha particles. It is due to beta radiation strongly interacts with matter due to its charge. Beta particle has a range of several meters in air.

iii. **Gamma (γ) rays:**

The gamma ray can penetrate a considerable thickness of concrete. It is due to their large speed and neutral nature. Gamma radiations have a range of several hundred meters in air.

The three types of Radiation

Alpha particle	Beta particle	Gamma ray
Charge +2	Charge -1	No charge
Least penetration	Middle penetration	Highest penetration
Transmutes nucleus:		
$A \rightarrow A-4$	$A \rightarrow A$	$A \rightarrow A$
$Z \rightarrow Z-2$	$Z \rightarrow Z+1$	$Z \rightarrow Z$

Q.7 **What do you understand by the half life of a radioactive elements? Explain with one example.**

Half Life

"The time during which half of the unstable radioactive nuclei disintegrate is called the half life of the sample of radioactive element".

Explanation

Every radioactive element has its own characteristic half-life. For example, radium-226 has a half-life of 1620 years, which means that half of a radium-226 sample will be converted to other elements by the end of 1620 years (Fig. 18.7) In the next 1620 years, half of the remaining radium will decay, leaving only one-fourth the original amount of radium, and so on.

If the half-life of the radioactive element is $T_{1/2}$, then at the end of this time the number of atoms in the sample will become half i.e. 1/2. After a time $2T_{1/2}$. After second half-life period, the number of remaining atoms will become 1/2. 1/2 = $1/2^2$ = 1/4, after a time 3 $T_{1/2}$, the number of remaining atoms will be 1/2. 1/2. 1/2 = $1/2^3$ = 1/8, and at the end of t half lives number of atoms that remain will be $1/2^t$.

amount of radium, and so on.

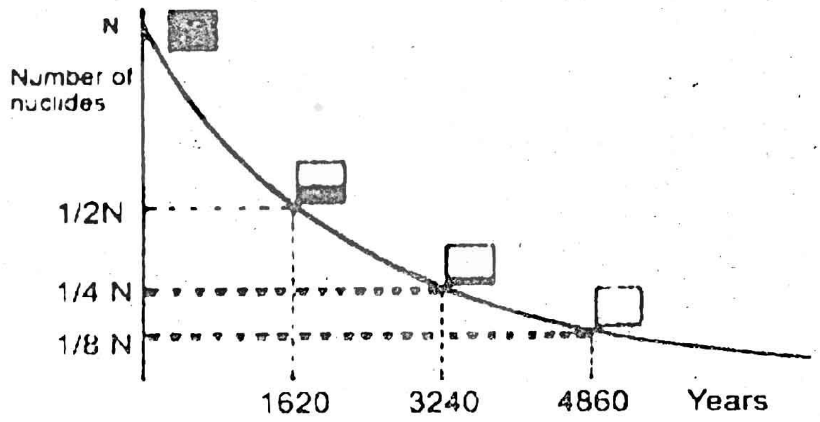


Fig.18.7 Radioactivity of radium

It means that if N_0 is the original number of atoms in the sample of radioactive element, then after t half lives number of atoms left in the sample can be determined by using the relation,

Remaining atoms = Original atoms 1/2

Or $\quad N = N_0 \times 1/2^t$

Radioactivity is a nuclear process

Radioactivity is a nuclear process because radiations are emitted by the disintegration of nucleus.

Conclusion

The process of radioactivity does not depend upon the chemical combinations or reactions. It also not affected by any change in physical conditions like temperature, pressure, electric or magnetic fields.

Q.8 Define stable and unstable nuclei? How radioisotopes are produced?

Stable nuclei:

Nuclei which do not emit radiations naturally are called stable nuclei. The elements with atomic number 1 to 82 are stable nuclei. E.g. Sodium; $^{23}_{11}Na, ^{40}_{20}Ca$ etc.

Unstable nuclei

The elements whose atomic number is greater than 82 are naturally radiating all the time called unstable nuclei. They emit different types of radiations and hence continuously change one type of element to another.

How radioisotopes are formed?

The stable and non-radioactive elements can also be change into radioactive elements by bombarding them with protons, neutrons or alpha particles are called radioactive isotopes or radio-isotopes.

Examples:

(1) $^{1}_{0}n$ +

$$^{1}_{0}n \quad + \quad ^{23}_{11}Na \quad \rightarrow \quad ^{24}_{11}Na \quad + \quad gamma(\gamma)$$

neutron stable sodium nuclide sodium radio isotope

(2)
$$^{4}_{2}He \quad + \quad ^{27}_{13}Al \quad \rightarrow \quad ^{30}_{15}Na \quad + \quad ^{1}_{0}n$$

particle aluminium nuclide a phosphorous radioisotope

Q.9 Describe the uses of radioisotopes in different fields?

Radioisotopes are frequently used in medicine, industry and agriculture for variety of useful purpose.

Important applications of radioisotopes

(1) Traces:

Radioactive tracers are chemical compounds containing some quantity of radioisotope.

Radioactive traces are used to explore the metabolism of chemical reactions inside the human body, animal or plant.

i. Tracers in medicine (Medical field)

Radio isotopes are used for the diagnosis and treatment of diseases in hospitals.

(a) Iodine - 131

Radio iodine – 131 is used in treating cancer of thyroid glands.

Iodine – 131 readily accumulates in the thyroid gland and can be used for the monitoring of thyroid functioning.

(b) Phosphorous -32

P-32 is used to diagnose the brain tumour and for the treatment of leukaemia. The malignant part of the body absorbs more quantity of isotopes and this helps in tracing the affected part of the body.

(c) Cobalt – 60

The gamma-rays from cobalt – 60 are used for treatment of cancer because this powerful radiation kills the cancerous cells.

(d) **Gallium - 67**

Ga-67 is used to identify tumours in the lymph region of the throat and neck.

ii. **Tracers is industry**

In industry tracers can be used to locate wear and tear of the moving parts of the machinery, e.g. Co-60. They can be used for the location of leaks in underground pipes. By introducing a suitable radioactivity tracer into the pipe, the leak can be conveniently traced from higher activity in the region of crack in the pipe.

γ -rays radiography is used in metals. It shows any flaw in metal castings any welded joints.

Traces of radio isotopes are used to monitor the flow of oil and gas through pipe. They are used to check and control the thickness or density of finished products.

iii. **Tracers in agriculture:**

In agriculture radio phosphorus – 32 is used as a tracer to find out how well the plants are absorbing the phosphate fertilizers which are crucial to their growth.

(2) **Medical Treatment**

Radio isotopes are also used in nuclear medicines for curing various diseases. For example, radioactive cobalt – 60 is used for curing cancerous tumors and cells. The radiations kill the cells of the malignant tumor in the patient.

(3) **Carbon Dating**

Radioactive carbon – 14 is present in small amount in the atmosphere. Live plants use carbon dioxide and therefore become slightly radioactive.

When a tree dies, the radio carbon – 14 present inside the plant starts decaying. Since the half-life of carbon – 14 – 5730 year, the age of dead tree can be calculated by comparing the activity of carbon-14 in the live and dead tree. The activity of the live tree remains almost constant as the carbon-14 is being replenished while the carbon 14 in the dead trees in no more replenished. Therefore, by measuring the activity in the ancient relic, scientists can estimate its age.

Other radio isotopes are also used to estimate the age of geological specimens. For example, some rocks contain the unstable potassium isotope K-40. This decays to the stable argon nuclide Ar-40 with half life of 2.4 x 10^8 years. The age of rock sample can be estimated by comparing the concentrations of K-40 and Ar-40.

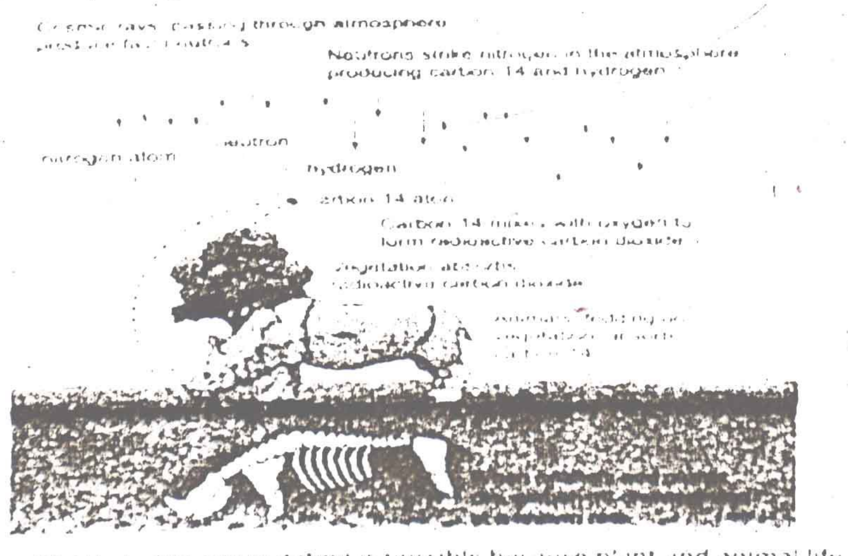


Fig. 18.10 Radiocarbon dating is possible because plant and animal life

Q.10 Define and explain the phenomenon of nuclear fission?

Nuclear fission

"The process of splitting of heavy nuclei into lighter nuclei is called fission reaction".

Natural Nuclear Transmutation

A nuclear transmutation in which an unstable nucleus changes into more stable nucleus is called natural nuclear transmutation.

Example

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}C$$

Artificial Transmutation

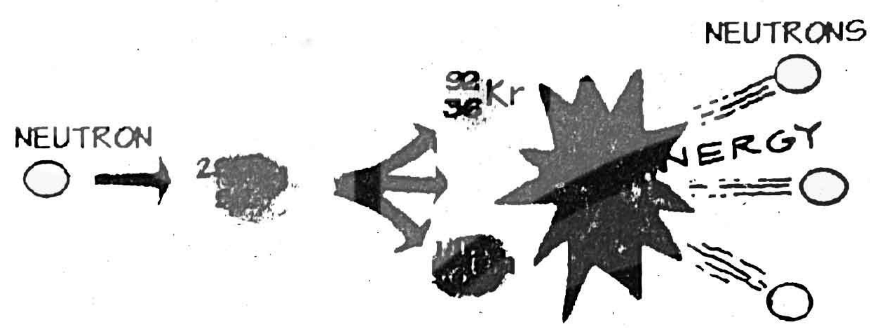
A nuclear transmutation reaction in which an unstable nucleus changes into more stable nucleus when it is bombarded with particle like neutron is called artificial transmutation.

Example:

Famous example of artificial transmutation is the nuclear fission reaction.

Nuclear fission

Nuclear fission takes place when a heavy nucleus, such as U-235, splits or fissions, into two smaller nuclear by bombarding a slow moving (low- energy) neutron represent in equation;



$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{236}_{92}U \rightarrow X + Y + \text{neutron} + \text{energy}$$

U-236 in an intermediate state that lasts only for few seconds before splitting into nuclei X and Y, called fission fragments.

When and who nuclear fission discovered

Nuclear fission was first observed in 1939 by Otto Han and Fritz Strassman.

How fission take place?

The uranium nucleus was split into two nearly equal fragments after absorbing a slow moving (low-energy) neutron. The process also resulted in the production of typically two or three neutrons per fission event. On average, 2.47 neutrons are released per event such as given below

$$^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + \text{Energy}$$

Enormous energy released

In nuclear fission, the total mass of the products is less than the original mass of the heavy nucleolus. From measurements it is showed that about 200 MeV of energy is released in each fission event. This is large amount of energy relative to the energy released in chemical processes.

Example:

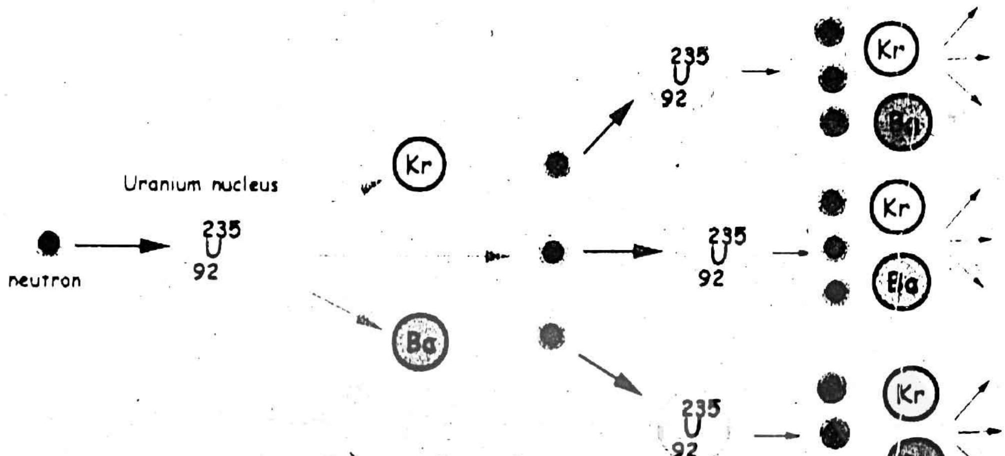
If we born one tonne of coal then about 36 x 10^9J of energy is released.

Chain Reaction

"A fission reaction where the neutrons from a previous step continue to propagate and repeat the reaction, tem as chain reaction".

Explanation of chain reaction

During fission reaction neutrons are emitted. These neutrons can in turn trigger other uranium nuclei to undergo fission with the possibility of a chain reaction.



Fission Chain Reaction
in Uranium 235

Explosion

Calculations show that if the chain reaction is controlled, it will proceed too rapidly and possibility result in the sudden release of an enormous amount of energy which is considered as an explosion.

How chain reaction in controlled?

The fission chain reaction is controlled in nuclear reactor. In nuclear reactor the extra neutrons liberated in fission reactions are absorbed using some material to stop chain reaction. e.g.

$$^{10}_{5}B \quad + \quad ^{1}_{0}n \quad \rightarrow \quad ^{7}_{3}Li \quad + \quad ^{4}_{2}He$$

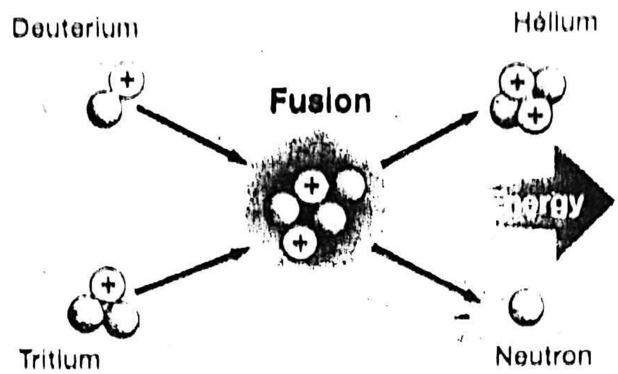
Thus chain reaction is prevented from going too fast. Hence their energy is controlled, so nuclear reactor provides energy for useful purposes.

Q.11 Nuclear Fusion

When two light nuclei combine to form a heavier nucleus, the process is called nuclear fusion. The mass of the final nucleus is always less than the masses of the original nuclei. According to mass energy relation this loss of mass converts into energy. If an atom of Deuterium is fused with an atom of Tritium, the a Helium nucleus or alpha particle is formed as given by

$$^{2}_{1}H \quad + \quad ^{3}_{1}H \quad \rightarrow \quad ^{4}_{2}He \quad + \quad ^{1}_{0}n \quad + \quad \text{energy}$$

Pictorially fusion reaction is shown in the following figure.



Source of Energy

Energy coming from the Sun and stars is supposed to be the result of fussion of hydrogen nuclei into Helium nucleus with release of energy. The temperature at the centre of the sum is nearly 20 million kelvin which makes the fusion favourable. According to this reaction four hydrogen nuclei fuse together to form a helium nucleus along with two positrons, three alpha particles and 25.7 MeV of energy.

Q.12 Differences between nuclear fission and nuclear fusion.

Nuclear Fission	Nuclear Fusion
1. A bigger heavier nucleus splits into smaller (lighter) nuclei.	1. Lighter nuclei fuse together to form the heavier nucleus.
2. It does not require temperature.	2. Extremely high temperature is require for fusion to take place.
3. A chain reaction sets in.	3. It is not a chain reaction.
4. It can be controlled and energy released can be used for peaceful purpose.	4. It cannot be controlled and energy released cannot be used properly.
5.The products of the reaction are radioactive in nature.	5. The products of a fusion reaction are non-radioactive in nature.
6. At the end of the reaction nuclear waste is left behind.	No nuclear waste is left at the end of fusions reaction.

Q.13 Describe the half-lives of some important isotopes? Also write the radiation produced by this decay process.

Element	Isotope	Half-Life	Radiation Produced
Hydrogen	${}^{3}_{1}H$	12.3 years	β
Carbon	${}^{14}_{6}C$	5730 years	β
Cobalt	${}^{60}_{27}Co$	30 years	$\beta-\gamma$
Iodine	${}^{131}_{53}I$	8.07 days	$\beta-\gamma$

Lead	${}^{212}_{82}Pb$	10.6 hours	β
Polonium	${}^{194}_{84}Po$	0.7 seconds	α
Polonium	${}^{210}_{84}Po$	138 days	$\alpha-\gamma$
Uranium	${}^{235}_{92}U$	7.1 x 10^8 years	$\alpha-\gamma$
Uranium	${}^{238}_{92}U$	4.51 x 10^8 years	$\alpha-\gamma$
Plutonium	${}^{236}_{94}Pu$	2.85 years	α
Plutonium	${}^{242}_{94}Pu$	3.79 x 10^5 years	$\alpha-\gamma$

Q.14 Discuss uses and the hazards of radiations? Describe the precaution to minimize radiations dangers (safety measures)

Important fields where radiations are uses as follow

Radiations are very useful in medicine, agriculture and industry, they can also cause considerable damage if not used with precautions. Radioactive, nuclear materials are now widely used in nuclear power plants, nuclear – powered submarines, intercontinental ballistic missiles etc.

Radiations Hazards

Some of harmful effects on human beings due to large doses or prolonged small doses of radiations.

6. Radiation burns, mainly due to beta and gamma radiations, which may cause redness and sores on the skin.
7. Sterility (i.e. inability to produce children).
8. Genetic mutations in both human and plants. Some children are born with serious deformities.
9. Leukernia (Cancer of the blood cells)
10. Blindness or formation of cataract in the eye.

Explosion of nuclear reactor at Chernogyl

During the nuclear accident at Chernobyl, Russia the explosion of the nuclear reactors melted through a few meters thick concrete housing. This caused a massive destruction of local community and also contaminated vegetation and livestock in the large surrounding area. Millions of dollars were lost as the contaminated vegetable and livestock had to be destroyed.

Precautions to minimize radiation dangers

Because we cannot detect radiations directly, we should strictly follow safety precautions, even when the radioactive sources are very weak.

6. Sources should not be handled with tongs and forceps.
7. The user should use rubber gloves and hand should be washed carefully after the experiment.
8. All radioactive sources should be stored in thick lead containers.
9. Never point radioactive source towards a person.
10. Frequent visits to the radiation sensitive areas should be avoided.

NUMERICAL PROBLEMS

18.1 The half-life of $^{16}_{7}N$ is 7.3s. A sample of this nuclide of nitrogen is observed for 29.2s. Calculate the fraction of the original radioactive isotopes remaining after this time.

Solution: Given that,

Half-life of $^{16}_{7}N$		= 7.3
Time	t	= 29.2 s

To Find: Remaining fraction of original radioactive isotope = ?

Solution: During 29.2 s, four half-lives are elapsed. If N_0 is the original fraction of the nuclide of nitrogen, then after four half-lives i.e., $4T_{1/2}$

$$\text{Remaining fraction} = \text{Original} \times \frac{1}{2^{1}}$$

Or

$$N = N_0 \times \frac{1}{2^{4}}$$

Or $$\frac{N}{N_0} = \frac{1}{16} \quad \textbf{Ans.}$$

Thus, the fraction of the original radioactive isotope remaining after 4 hal-lives will be $1/16^{th}$.

18.2 Cobalt-60 is a radioactive element with half-life of 5.25 years. What fraction of the original sample will be left after 26 years.

Solution: Given that,

Half-life of C – 14	$T_{1/2}$	= 5730 years
Time	t	= 26 years

To Find: Reaining fraction = ?

During the 26 years, five half-lives are elapsed so

$$\text{Remaining fraction} = \text{Original} \times \frac{1}{2^{t}}$$

Or $$N = N_0 \times \frac{1}{2^5}$$

Or $$\frac{N}{N_0} = \frac{1}{32} \quad \textbf{Ans.}$$

Thus, the fraction of the original isotope remaining after 5 half-lives will be $\frac{1}{32th}$.

18.3 Carbon-14 has a half-life of 5730 years. How long will it take for the quantity of carbon-14 in a sample to drop to one-eight of the intial quantity?

To Find: Time t = ?

Calculations: As quantity of C – 14 drops to $\frac{1}{8th}$ of the original quantity after 3 half-lives, therefore.

Time = No. of half-lives × half-life

Or Time = $3 \times T_{1/2}$

Or Time = 3 × 5730 years

Time = 1.72×10^4 years **Ans.**

18.4 Technetium-99 m is a radioactive element and is used to diagnose brain, thyroid, liver and kidney disease. This element has half-life of 36 hours. If there is 200 mg of this technetium present, how much will be left in six hours.

Solution: Given that,

Half-life	$T_{1/2}$	= 6 hours
Time	t	= 36 hours
Original quantity		= 200 mg

Since during 36 hours, 6 half-lives are elapsed, therefore,

$$\text{Remaining amount} = \text{Original} \times \frac{1}{2^{1}}$$

$$= 200 \text{ mg} \times \frac{1}{2^{6}}$$

$$= \frac{200 \text{ mg}}{64}$$

$$\text{Remaining amount} = 3.125 \text{ mg} \textbf{ Ans.}$$

18.5 Half-life of a radioactive element is 10 minutes. If the initial count rate is 368 counts per minute, find the time for which count rate reaches 23 counts per minutes.

Solution: Given that

Half-life $T_{1/2} = 10$ min.

Initial count rate = 368 counts per min.

Final count rate = 23 count per min.

To Find: Time taken $t = ?$

Calculations: For the count rate to decrease from 368 counts per min. to 23 counts per min., it takes 4 half-lives, therefore

$$\text{Time taken} = 4 \times T_{1/2}$$

$$= 4 \times 10 \text{ min}$$

$$t = 40 \text{ min} \textbf{ Ans.}$$

18.6 In an experiment to measure the half-life of a radioactive element, the following results were obtained:

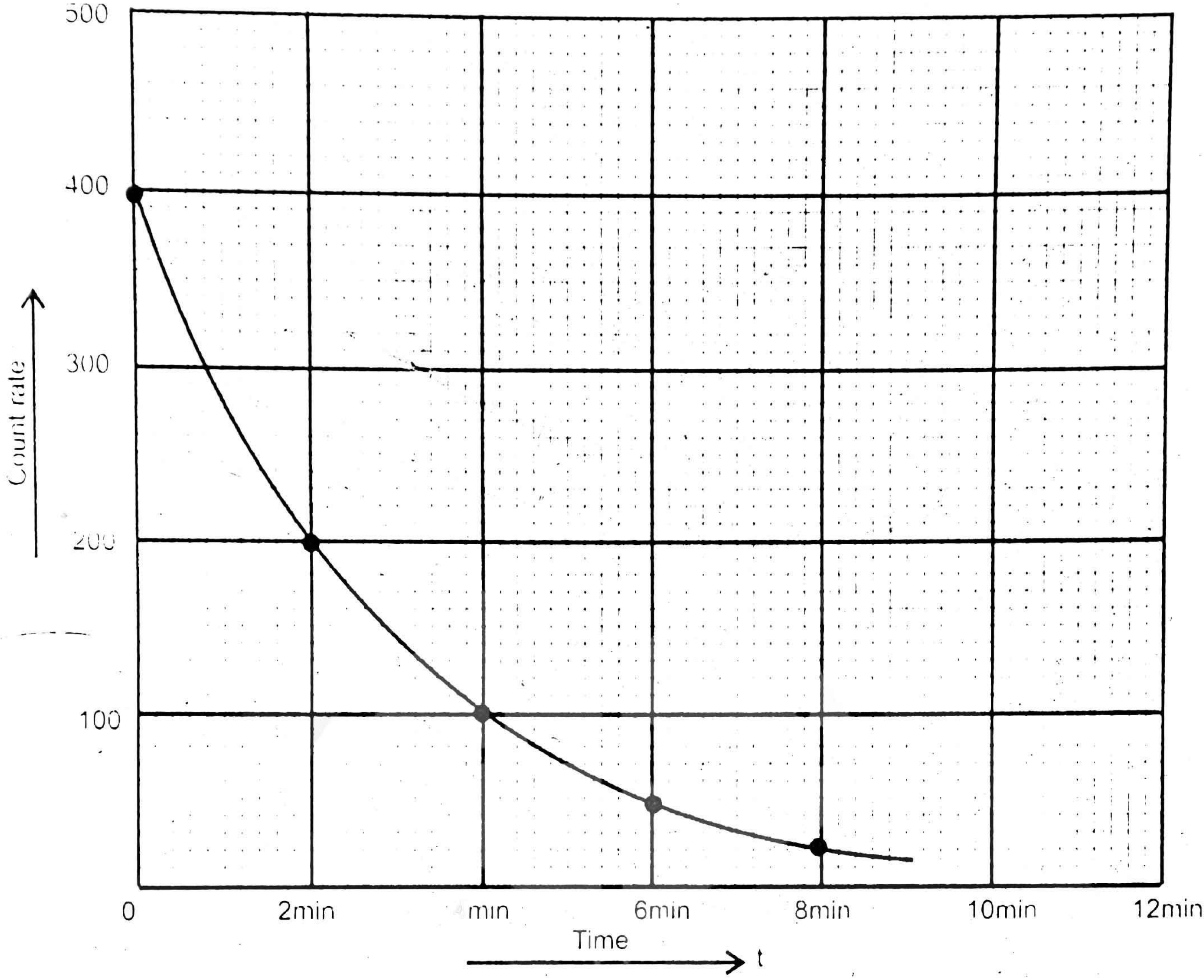
Count rate	400	200	100	50	25
Time (in minutes)	0	2	4	6	8

Plot a graph between the count rate and time in minutes. Measure the vaue for the half-life of the element from the graph.

Solution: Scale

One big division = 2 min. (along x-axis)

One big division = 100 counts (along y-axis)



From the graph, it is clear that half-life of the radioactive element is 2 mintues.

18.7 A sample of certain radioactive element has a half-life of 1500 years. If it has an activity of 32000 counts per hour at the present time, then plot a graph of the activity of this sample ovr the period in which it will reduce to 1/16 of its present value.

Solution:

Half-life $T_{1/2}$ = 1500 years

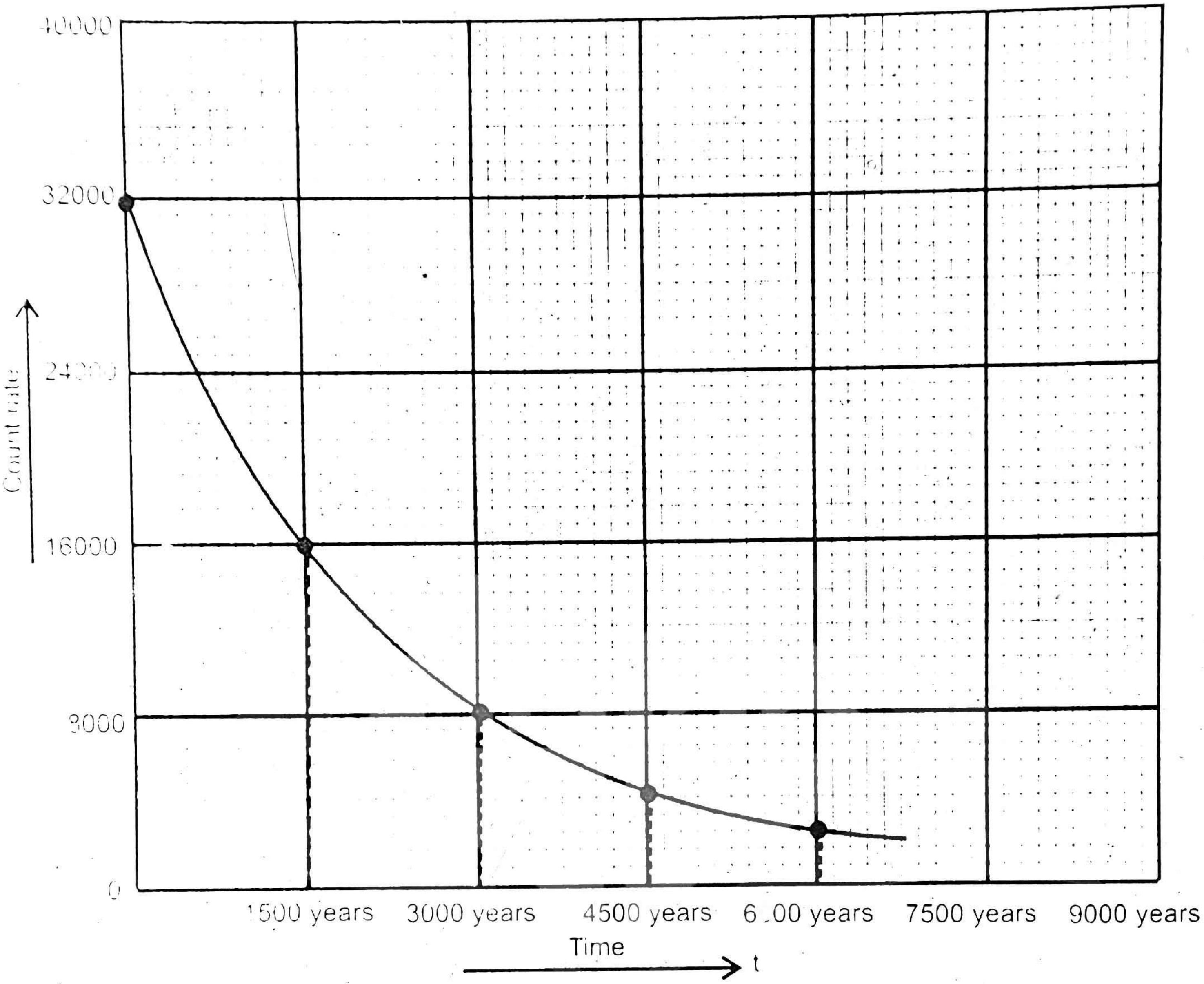
Activity = 32000 counts per hour

$\frac{1}{16}$ th of the activity $= \frac{32000}{16} = 2000$

Scale

One big division = 1500 years (along x-axis)

One big division = 4000 counts per hour

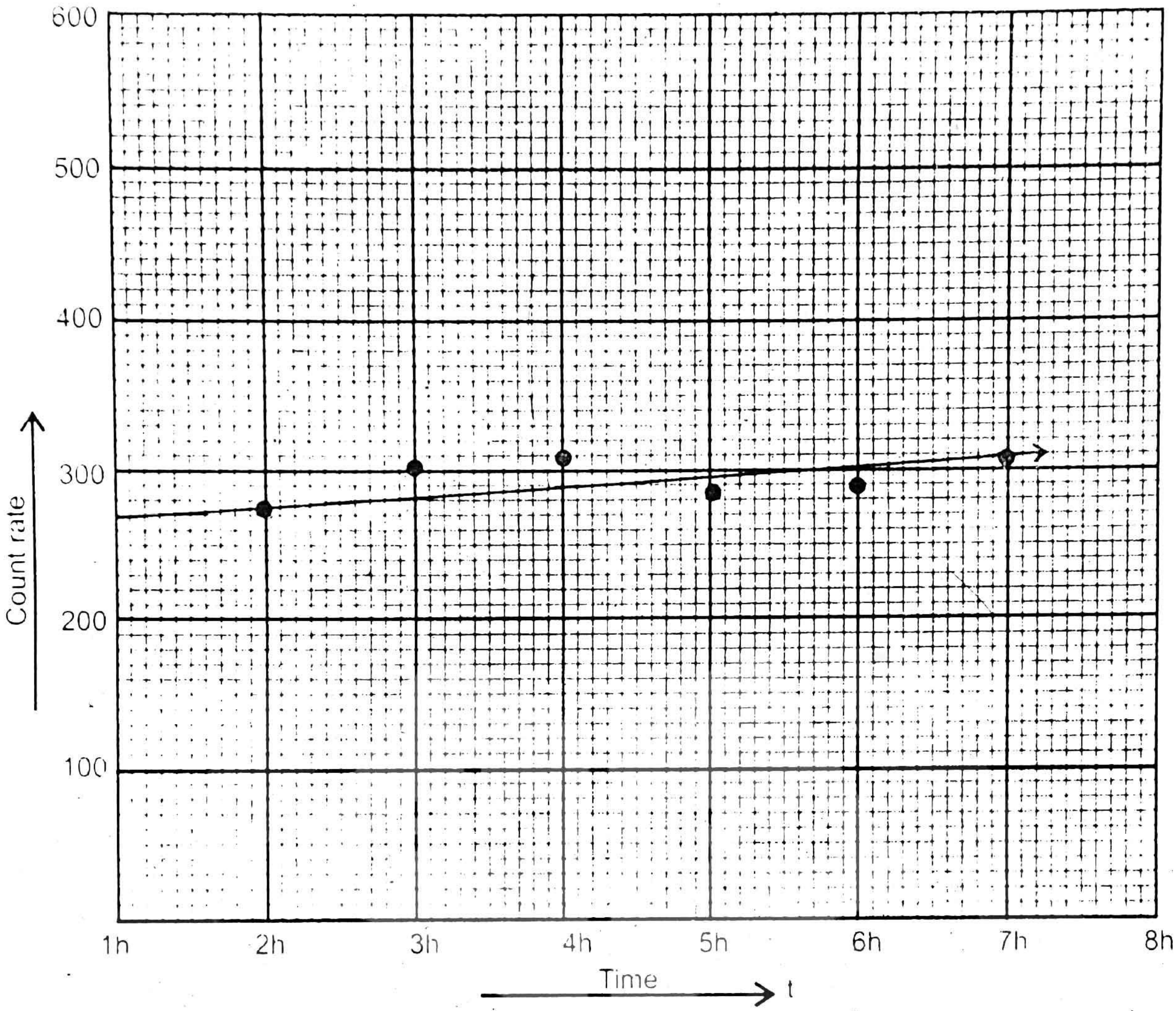


18.8 **Half-life of a radioactive element was found to be 4000 years. The count rates per minute for 8 successive hours were found to be 270, 280, 300, 310, 285, 290, 305, 312. What does the variation in count rates show? Plot a graph between the count rates and time in hours. Why the graph is a straight line rather than an exponential?**

Solution: Scale

One big division = 1 hour (along x-axis)

One big division = 100 counts (along y-axis)



Variation in count rates shows the random nature of radioactive decay, the graph is almost a horizontal line rather than an exponential curve, which is due to long half-life as compared to period of 8 hours

18.9 Asches from a campfire deep in a cave show carbon-14 acivity of only one-eighth the activity of fresh wood. How long ago was that camfire made?

Solution: Given that,

Activity of C – 14 from ashes $= \frac{1}{8}$th of fresh wood

Half life of C – 14 $\quad T_{1/2} = 5730$ years

To find: Time $\quad t = ?$

Calculations: Since activity of C – 14 from ashes is $\frac{1}{8}$th of fresh wood, hence 3 half-lives have been elapsed. Therefore,

Time $=$ No. of half-lives $\times T_{1/2}$

$t = 3 \times 5730$ years

$t = 17190$ years **Ans.**

REVIEW QUESTIONS

14.1 **Define and explain the term electric current.**

See Question no. 1

14.2 **What is the difference between electronic current and conventional current?**

Ans. Electronic current flows due to the motion of electrons (negative charges) from the negative terminal of the battery to the positive terminal. Whereas conventional current flows due to the motion of positive charges form the positive terminal of the battery to the negative terminal.

14.3 **What do we mean by the term e.m.f? Is it really a force? Explain.**

See Question no. 6

14.4 **How can we differentiate between e.m.f and potential difference?**

The electromotive force (emf) of a battery or a cell is the total energy supplied in driving one coulomb of charge round a complete circuit in which the cell is connected. The complete circuit includes the cell itself and an external circuit connected to the terminals. Whereas the potential difference determines the energy required between any two points of the circuit, in moving a charge form one point to another.

14.5 **Explain Ohm's law. What are its limitations?**

Ans: See Question no. 8

14.6 **Define resistance and its units.**

Ans: See Question no. 10

14.7 **What is the difference between conductors and insulators?**

Ans: See Question no. 12

14.8 **Explain the energy dissipation in a resistance. What is Joule's law?**

Ans: See Question no. 15

14.9 **What is difference between D.C. and A.C?**

Ans: See Question no. 18

14.10 **Discuss the main features of parallel combination of resistors.**

Ans: See Question no. 14

14.11 **Determine the equivalent resistance of series combination of resistors.**

Ans: See Question no. 13

14.12 **The voltage chosen for the transmission of electrical power over large distances is many times greater then the voltage of the domestic supply. State two reasons why electrical power is transmitted at high voltage.**

Ans: The reasons for transmission of high voltage are as under:

1. **Sending power at high voltage would reduce the power loss in the form of heat** dissipation i.e. $I^2 Rt$. For same power, high voltage means lower current and hence less power loss

2. **Sending power at high voltage means low current. It means we need thinner wires** and also less number of repeater step- up transformers to send power over long destinations.

14.13 **Why is the voltage used for the domestic supply much lower than the voltage at which the power is transmitted?**

Ans. Domestic appliances operate on low voltage because high voltage can damage these instruments. High voltage can also be dangerous for users as it can cause electric shock. It may also damage property and other valuables as a result of some serious electric shock.

14.14 **Describe briefly the hazards of household electricity?**

Ans: See Question no. 21

14.15 **Describe four safety measures that should be taken in connection with the household circuit.**

Ans: See Question No. 22, 23, 24,25

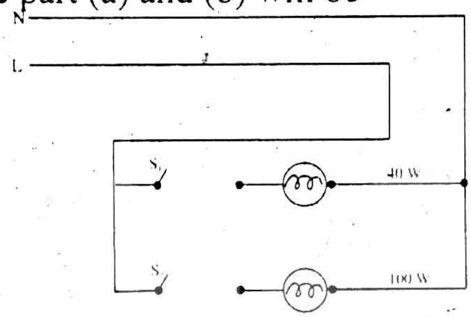
14.16 **Design a circuit diagram for a study room that needs the following equipment in parallel.**

(a) One 100 W lamp operated by one switch.

(b) One reading lamp fitted with a 40 W bulb which can be switched ON and OFF from two points.

(c) What is the advantage of connecting the equipment in parallel instead of in series combination.

Ans. The circuit diagram of the part (a) and (b) will be



(c) In a parallel circuit voltage remains the same (240V) across each equipment. On the other hand, I series circuit voltage across each equipment will not be 240V, but the sum of voltages will be 240 V. Therefore, in series circuit, the equipments will not work.

CONCEPTUAL QUESTIONS

14.1 **Why in conductors charge is transferred by free electrons rather than by positive charge?**

Ans. Heavy positively charged protons in conductors (metals) are bound in the nuclei of atoms. Therefore, they are not free to move inside the conductors. Electrons present at the larger distance form the nuclei of atoms of conductor are loosely bound. These electrons are called free electrons which can move freely inside the conductor and are means of charge transfer in conductors.

14.2 What is the difference between a cell and a battery?

Ans. Cells convert chemical energy into electrical energy. A cell consists of two metal electrodes (anode and cathode) dipped into an electrolyte. Groups of cells are known as batteries. Battery stores larger energy as compared to a single cell.

14.3 **Can current flow in a circuit without potential difference?**

Ans. According to Ohm's law ($v = IR$), current passing through a conductor is directly proportional to the potential difference across the two ends of the conductor. Hence, when potential difference in a circuit is zero no current will flow through it.

14.4 **Two points on an object are at different electric potential. Does charge necessarily flow between them?**

Ans. Consider two points A and B on an object having electric potential V_a and V_b. The charge will flow only when the two points are at different potential. It means the charge will flow when potential at one point is higher than the potential at the other point. Thus, charge flows due to the difference of electric potential.

14.5 In order to measure current in a circuit, why ammeter is always connected in series?

Ans. In order to measure current, ammeter is always connected in series with the circuit so that all the current to be measured must flow through it (due to its low resistance) . If it is connected in parallel, we cannot measure the actual current flowing through the circuit as some current will flow along the other parallel path.

14.6 In order to measure voltage in a circuit, voltmeter is always connected in parallel. Discuss.

Ans. In order to measure voltage in a circuit, voltmeter is always connected in parallel with the circuit. In this way, voltmeter does not disturb the current and hence the voltage of the circuit. Due to high resistance of voltmeter, no current passes through it and hence voltage of the circuit remains unaffected.

14.7 How many watt-hours are there in 1000 joules?

Ans. As we know,

$1 \text{ watt} \times 3600\text{s} = 1 \text{ watt-hour}$

$3600 \text{ Ws} = 1 \text{ watt-hours}$

$3600 \text{ Joules} = 1 \text{ watt-hours}$

$$1 \text{ joules} = \frac{1}{3600} \text{ watt-hours}$$

$$1000 \text{ joules} = \frac{1}{3600} \times 1000 \text{ watt-hours}$$

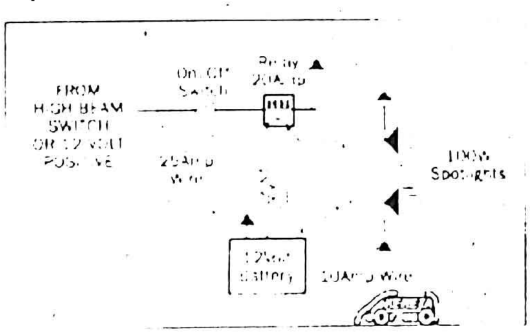
$1000 \text{ joules} = 0.28 \text{ watt -hours}$

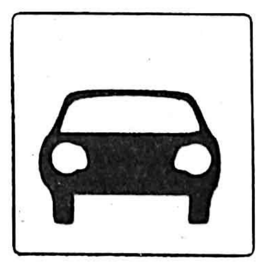
Hence there are 28×10^{-2} watt-hours in 100 joules

14.7 From your experience in watching cars on the roads at night, are automobile headlamps connected in series or in parallel?

Ans. Head lamps of automobiles are connected in parallel because of the following reasons

- The potential difference between headlamps remains same. (Both have same brightness)
- If one head-lamp is out of order the other lamps still glow. Also we can turn ON or OFF any individual head lamp independently, which is only possible if they are connected in parallel.





14.9 A certain flash-light can use a 10 ohm bulb or a 5 ohm bulb. Which bulb should be used to get the brighter light? Which bulb will discharge the battery first?

Ans. To get the brighter light and discharge the battery first, we have to use bulbs of resistance 5 ohm. Lower resistance of bulb means, larger current will pass through the filament of the bulb and hence it will flow more brightly as compared to that of 10 Ohm bulb. When larger current passes through the circuit, battery will be discharged quickly.

14.10 It is impracticable to connect an electric bulb and an electric heater in series. Why?

Ans. When appliances are connected in series, total resistance of circuit increases. This decreases the current and hence the power through each appliance. In order to avoid this loss of current and power, through bulb and heater, they are connected in parallel.

14.11 Does a fuse in a circuit control, the potential difference or the current?

Ans. Fuse in a circuit is used to control the current in the circuit. When current exceeds the limited value as allowed by the fuse, it burns out, stops the current and beaks the circuit.

INFORMATION BASED QUESTIONS AND THEIR SOLUTION

Quick Quiz (Page 97)

Q.1 How long does it take a current of 10mA to deliver 30 C of charge?

Ans. Solution Given that

$1 = 10$ mA $= 10 \times 10^{-3}$ A, $Q = 30C$

Using the formula

$$I = \frac{Q}{t} \text{ or } t = \frac{Q}{I} = \frac{30}{10 \times 10^{-3}} = 3 \times 10^{-3} \text{ s}$$

Quick Quiz (Page 106)

Q.2 Which metal is used as the filament of an electric bulb? Explain with reason.

Ans. A metal of high resistance (such as tungsten) is used as the filament of electric bulb. When electrons pass throught the filament, they feel larger resistance due to witch filament is heated and starts glowing.

Point to Ponder (Page 107)

Q.3 A bird can sit harmlessly on high tension wire. But it must not reach and grab neighboring wire. Do you know why?

Ans. A bird can sit harmlessly on high tension wire as no current passes through its body, since the potential of the wire is constant. However, if the bird grabs the neighbouring wire, then due to potential difference of two wires, current will flow through the body of the bird and con be fatal

Brain Teaser (Page 107)

Q.4 Connect a battery to a small 2.5V light bulb and observe the brightness of the bulb. Now add another light bulb in series with the first bulb. Observe the relative brightness of the bulbs compared to when only one bulb was lit. Pepeat the process with two or three additional bulbs in series. Using ohm's law. Explain what happened to the brightness of each bulb.

Ans. Connecting 2nd bulb in series with the 1st one, it decreases the brightness of two bulbs. Adding additional bulbs in series with these two bulbs will further reduce the glow and brightness of each bulb. In fact, adding more bulbs in series circuit increases the resistance of the circuit. Hence, according to ohm's law ($V = IR$), current through each bulb will be reduced which in turn decreases the brightness of eac bulb.

Connecting 2nd bulb in parallel with 1st bulb, the battery of 2.5V will not affect the brightness of the 1st bulb. Rather, both bulbs wil glow with same brightness as in parallel circuit, both bulbs have the sam e potential difference. Adding more bulbs wil also not affect the birthness of each bulb. How ever, brightness of each bulb in parallel circuit is large as compared to the brightness of bulbs in series circuit.

Self Assessment (Page 112)

Q.5 A ligh bulb is switched on for 40s. If the electrical energy consumed by the bulb during this time is 2400 J, find the power of the bulb

Ans. Given that,

$t = 40s,\ w = 2400\ J$ and $P = ?$

Using formula:

$$\text{Power} = \frac{\text{Electric energy}}{\text{time}}$$

$$P = \frac{2400\,J}{40\,s} = 60Js^{-1}\ 60W$$

Hence, power of the bulb is 60watt.

EXERCISE

14.1 **Choose the correct answer form the following choices:**

(i) **An electric current in conductors in due to the flow of**

(a) positive ions (b) negative ions (c) positive charges ✓(d) free electrons

(ii) **What is the voltage across a 6 Ω resistor when 3A of current passes through it?**

(a) 2V (b) 9V ✓(c) 18V (d) 36V

(iii) **What happens to the intensity or the brightness of the lamps connected in series as more** and more lamps are added?

(a) increases ✓(b) decreases (c) remains the same (d) cannot be predicted

(iv) **Why should household appliances be connected in parallel with the voltage source?**

(a) to increase the resistance of the circuit

(b) to decrease the resistance of the circuit

✓(c) to provide each appliance the same voltage as the power source

(d) to provide each appliance the same current as the power source

(v) **Electric potential and e.m.f**

✓(a) are the same terms (b) are the different terms

(c) have different units (d) both (b) and (c)

(vi) **When we double the voltage in a simple electric circuit, we double the**

(a) current (b) power (c) resistance ✓(d) both (a) and (b)

(vii) **If we double both the current and the voltage in a circuit while keeping its resistance** constant, the power

(a) remains unchanged (b) halves

✓(c) doubles (d) changes/replace

(viii) **What is the power rating of a lamp connected to a 12V source when it carries a current of 2.5A?**

(a) 4.8 W (b) 14.5 W ✓(c) 30 W (d) 60 W

(ix) **The combined resistance of two identical resistors, connected in series is 8Ω. Their combined resistance in a parallel arrangement will be**

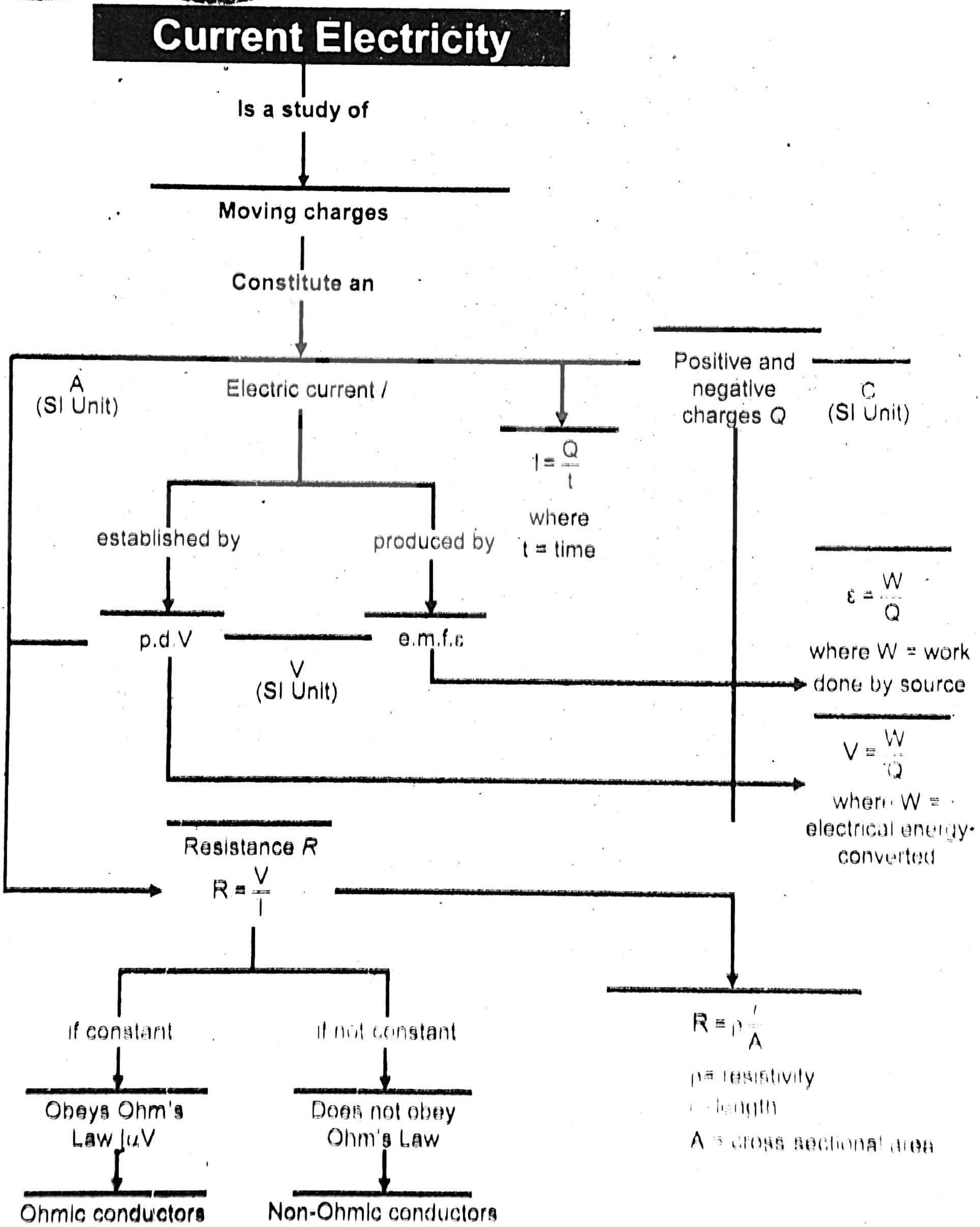
✓(a) 2Ω (b) 4Ω (c) 8Ω (d) 12 Ω

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1.	d	2.	c	3.	b	4.	c
5.	a	6.	d	7.	c	8.	c
9.	a						

CHAPTER 14

CURRENT ELECTRICITY

CONCEPT MAP



Practical Electricity

deals with the use of electric in

- Electric heating
- Electric lighting
- Electric motors

consumes power and energy given by

$P = IV$ where
P = power (W)
I = current (A)
V = potential difference (V)

$E = Pt$ where
E = energy (J)
P = power (W)
t = times (s)

Or expressed in units of electricity usage

Kilowatt [illegible]
kWh [illegible] or
[illegible] units
of electricity

can cause electric shocks or fires in situations such as

- Damaged insulation
- Overheating of cables
- Damp conditions

which can be prevented by using

Safety measure

such as

requires safety measures such as

1. Fuses or circuit breakers
2. Switches fitted on the live wire
3. Earthing
4. Double insulation

TOPICAL MULTIPLE CHOICE QUESTIONS

14.1 Electric Current

(1) In metals, current is produced only due to the flow of
(a) Protons (b) Electrons (c) Free electrons (d) Neutrons

(2) In electrolyte, current is produced due to the flow of
(a) Positive charge (b) Negative charges
(c) Both positive and negative charges (d) None of these

(3) The rate of flow of electric charge through any cross-sectional area is called
(a) Electrostatics (b) Electric current (c) e.m.f (d) Voltage

(4) The SI unit of electric current is
(a) Volt (b) Farad (c) Capacitance (d) Ampere

(5) The equivalent current of positive charges which flows through a conductor is known as
(a) Electronic current (b) Conventional current (c) Electrostatic (d) Ampere

(6) The current due to negative charges and an equivalent current due to positive charges always flow in the
(a) Opposite direction (b) Same direction
(c) Perpendicular to each other (d) None of these

(7) In electricity, we assume that electric current is always due to the flow of
(a) Negative charges (b) Neutral particles
(c) Positive charges (d) Both negative and positive charges

(8) The conventional current of positive charges flows from a point of
(a) Higher potential to a point of lower potential (b) Lower potential to a point of higher potential
(c) Lower potential to a point of lower potential (d) Higher potential to a point of higher potential

(9) The current constituted by negative charges flows from a point of
(a) Higher potential to a point of a lower potential
(b) Lower potential to a point of higher potential
(c) Lower potential to a point of lower potential
(d) Higher potential to a point of higher potential

(10) When we connect a battery across a conductor, the energy is provided to the charges in the conductor by the
(a) Magnetic field produced in the conductor
(b) Electromagnetic field produced in the conductor
(c) Electric field produced in the conductor
(d) None of the above

(11) Energy is produced to transfer the electrons from positive terminal of the battery to the negative terminal by the
(a) Electrical process (b) Chemical process (c) Thermal process (d) Magnetic process

(12) The current through a metallic conductor is due to the motion of
(a) Protons (b) Neutrons (c) Electrons (d) Free electrons

(13) In liquids and gases, the current is due to the motion of
(a) Negative charges (b) Positive charges
(c) Both negative and positive charges (d) Neutral particles

(14) Free electrons are
(a) Tightly bound (b) Fixed (c) Loosely bound (d) Tightly fixed

(15) **The direction of conventional current flowing in a circuit is**

(a) from negative to positive in the external circuit and from positive to negative within the source of potential difference (battery)

(b) from positive to negative in the external circuit and from negative to positive within the source of P.D.

(c) From positive to negative throughout the circuit.

(d) From negative to positive throughout the circuit.

(16) **The direction of the electronic current in the closed circuit is**

(a) along the flow of electrons

(b) opposite to the flow of electrons

(c) from positive to negative in the external circuit

(d) along the direction of positive charges.

(17) **If a charge 'Q' flows through any cross-section of the conductor in time 't' second, the current 'I' is given by**

(a) I = Qt (b) I = Q/t (c) I = t/Q (d) I = Q2/t

(18) **One coulomb per second is equal to**

(a) One volt (b) One Ampere (c) One watt (d) One Ohm

(19) **Which of the following represents an electric current?**

(a) Erg C^{-1} (b) Cs^{-1} (c) J S^{-1} (d) Dyne S^{-1}

(20) **If 1 ampere current flows through 2m long conductor, the charge flow through this in 1hour will be**

(a) 3600 C (b) 7200 C (c) 1C (d) 2C

(21) **Batteries convert**

(a) electrical energy into heat energy (b) electrical energy into chemical energy

(c) chemical energy into electrical energy (d) heat energy into chemical energy

(22) **The electronic current is due to the flow of**

(a) negative charge (b) positive charge (c) both (a) and (b) (d) none of the above

(23) **The conventional current is due to the flow of**

(a) negative charge carriers (b) neutral charge

(c) positive charge carriers (d) both negative and positive charges carriers.

14.2 Potentional Difference

14.3 E.M.F

(24) **The energy required to move a charge from one point to another in the circuit is called**

(a) e.m.f (b) Potential difference(c) Resistance (d) Volt

(25) **Volt is a unit of**

(a) Potential difference (b) e.m.f

(c) Potential difference and e.m.f. (d) None of these

(26) **The energy supplied in driving one coulomb of charge round a complete circuit in which the cell is connected is called**

(a) e.m.f (b) Potential difference (c) Resistance (d) Volt

(27) **The instrument with which we can detect the presence of current in a circuit is knows as**

(a) Voltmeter (b) Ammeter (c) Galvanometer (d) Ohm meter

(28) **In order to detect the current, galvanometer is connected**

(a) In parallel (b) In series

(c) May be parallel or in series (d) Any where in the circuit

(29) **If the needle of galvanometer shows some deflection, it would indicate the**

(a) Presence of current (b) Absence of current
(c) A large current (d) None of these

(30) **A galvanometer is a very**

(a) Large instrument (b) Small instrument
(c) Insensitive instrument (d) Sensitive instrument

(31) **A resistance which is connected with the galvanometer in order to convert it into ammeter should have**

(a) High resistance (b) Very high resistance
(c) Low resistance (d) Very low resistance

(32) **The resistance of an ammeter should be**

(a) Height (b) Very high (c) Low (d) Very low

(33) **In order to measure the current in a circuit, ammeter should be connected**

(a) Parallel to battery (b) In series in the circuit
(c) May be parallel or in series (d) None of these

(34) **When ammeter is connected in the circuit, the positive terminal of ammeter should be connected with the**

(a) Negative terminal of the battery (b) Positive terminal of the battery
(c) Any terminal of the battery (d) None of these

(35) **The potential difference can be directly measured by the instrument known as**

(a) Ammeter (b) Potentio-meter (c) Voltmeter (d) Ohm meter

(36) **The series resistance which is connected with galvanometer to convert it into voltmeter usually has value in**

(a) Ohms (b) Several hundred ohms
(c) Several thousand ohms (d) Hundred thousand ohms

(37) **Voltmeter is always connected in a circuit in**

(a) Series (b) Parallel
(c) May be in series or parallel (d) None of these

(38) **A good voltmeter is that which draws**

(a) No current (b) Small current (c) Large current (d) Very large current

14.4 Ohm's Law
14.5 V-I Characteristics of Ohmic and Non Ohmic Conductors

(39) **The relation V = IR represents**

(a) Ampere law (b) Coulomb's law
(c) Faraday's law (d) Ohm's law

(40) **Ohm's law is applicable to**

(a) Liquids only (b) Gases only
(c) Liquid conductors only (d) Metallic conductors only

(41) **Ohm is the unit of**

(a) Current (b) Capacitance (c) Electric intensity (d) Resistance

(42) **Ohm is defined as**

(a) Volt/Coulomb or VC^{-1} (b) Volt/Ampere or VA^{-1}
(c) Ampere/Volt or CV^{-1} (d) Ampere/Volt or AV

(43) **The resistance of a conductor through which a current of one ampere is flowing when the potential difference across its ends is one volt, is called**

(a) One volt (b) One coulomb (c) One Ohm (d) One ampere

(44) **Thermistor is**

(a) A heat sensitive resistor (b) potential divider

(c) constant resistor (d) An ordinary resistor

(45) **The graphical representation of Ohm's law is**

(a) Hyperbola (b) Ellipse (c) Parabola (d) Straight line

(46) **The value of current passing through a conductor is directly proportional to the**

(a) Resistance (b) Capacitance (c) Potential difference (d) None of these

(47) **The property of a substance which opposes the flow of current through it is called**

(a) Conductivity (b) Capacitance (c) Resistance (d) Conduction

(48) **If a potential of 220V is applied across a conductor and a current of 2A flows through it. What would be the resistance of the conductor?**

(a) 210Ω (b) 440Ω (c) 880Ω (d) 110 ohm

14.6 Specific Resistance (Resistivity)
14.7 and 14.8 Conductors and Insulators

(49) **The resistance of a meter cube of the substance is called**

(a) conductivity (b) permittivity (c) resistivity (d) susceptibility

(50) **At a certain temperature, the resistance of a wire is directly proportional to its**

(a) Length (b) Area of cross-section (c) Shape (d) Colour

(51) **At a certain temperature, the resistance of a wire is inversely proportional to its**

(a) Length (b) Area of cross-section (c) Temperature (d) Colour

(52) **If we increase the length of a wire to four times of its original length, what will be its resistance?**

(a) The same (b) Doubled (c) Four times (d) Eight times

(53) **If we increase the cross-sectional area of the wire to double of its original area, its resistance will become**

(a) The same (b) Halved (c) One fourth (d) Doubled

(54) **If L is the length and A is the cross-sectional area of a wire, then its resistance is gives by the relation**

(a) $R = \frac{1}{\rho}\frac{L}{A}$ (b) $R = \frac{1}{\rho}\frac{A}{L}$ (c) $R = \rho\frac{A}{L}$ (d) $R = \rho\frac{L}{A}$

(55) **The SI unit of specific resistance is**

(a) $\Omega - m$ (b) $\Omega - m$ (c) $\Omega - m^{-1}$ (d) $\Omega - m^{2}$

(56) **If we increase the temperature of a conductor, its resistance will**

(a) Increase (b) Decrease (c) Remains the same (d) None of these

(57) **The resistance of a conductor does not depend on its**

(a) Length (b) Cross sectional area (c) Resistivity (d) Mass

(58) **When the temperature of a conductor is raised, its resistance**

(a) Always decreases (b) Always increases

(c) Remains the same (d) First increases and then decrease

14.9 Combination of Resistors

(59) **The resistances are connected end to end and provide only one path for current in**

(a) Parallel circuit (b) Series circuit

(c) Both parallel and series circuit (d) None of these

(60) **The potential drop across each of resistors will be same in**

(a) Parallel circuit (b) Series circuit

(c) Both parallel and series circuit (d) None of these

(61) **In series circuit, the magnitude of current that flows through each resistor is**
(a) Very small (b) Very large (c) Same (d) Different

(62) **In parallel circuit, the magnitude of current that flows through each resistor will be**
(a) Very small (b) Very large (c) Same (d) Different

(63) **In series combination of resistors, the expression of equivalent voltage is given by**
(a) $V = V_1 + V_2 + V_3$ (b) $V = \frac{1}{V_1} + \frac{1}{V_2} + \frac{1}{V_3}$
(c) $V = V\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$ (d) $\frac{1}{V} = \frac{1}{V_1} + \frac{1}{V_2} + \frac{1}{V_3}$

(64) **The equivalent resistance for series combination of 3 resistors is given by**
(a) $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (b) $\frac{1}{R_e} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$
(c) $Re = R_1 + R_2 + R_3$ (d) $R_e = VR_1 + VR_2 + VR_3$

(65) **The equivalent resistance for parallel combination of 3 resistors is given by**
(a) $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (b) $\frac{1}{R_e} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$
(c) $Re = R_1 + R_2 + R_3$ (d) $R_e = VR_1 + VR_2 + VR_3$

(66) **The expression for total current through parallel combination is**
(a) $I - I_1 = I_2 - I_3$ (b) $I = I_1 + I_2 + I_3$
(c) $I - I_1 - I_2 - I_3$ (d) $I = 2_1 - 2I_2 - 2I_3$

(67) **If three resistances of 6Ω each are connected in series combination, what will be the equivalent resistance?**
(a) 6Ω (b) 12Ω (c) 18Ω (d) 24Ω

(68) **When resistors are connected in series, the equivalent resistance is equal to**
(a) Sum of the reciprocals of the individual resistance
(b) Product of the reciprocals of the individual resistances
(c) Sum of the individual resistances
(d) Product of the individual resistance

(69) **If the resistors are connected in parallel, then**
(a) The current through each is the same
(b) The total resistance is the sum of individual resistance
(c) The voltage across each is the same
(d) The total resistance is the product of individual resistance

(70) **If the resistance of 2 ohm and 4 ohm are connected in parallel, the equivalent resistance will be**
(a) 11.0 ohms (b) 1.33 ohms (c) 3.0 ohms (d) 5.0 ohms

(71) **Three resistance 5000, 500 and 50 ohms are connected in series across 555 volts mains. The current flowing through them will be**
(a) 1A (b) 100 mA (c) 10 mA (d) 10A

14.10 Electrical Energy and Joule's Law and
14.11 Electric Power

(72) **When Q coulomb of charge flows between the two points having potential difference of V volts then the energy in joules is represented by**
(a) $W = \frac{Q}{V}$ (b) $W = \frac{V}{Q}$ (c) $W = QV$ (d) W = F.S

(73) **If a current I ampere flows through a resistance R in time seconds, then the energy supplied will be**
(a) $W = IRt$ (b) $W = I^2Rt$ (c) $W = IR^2t$ (d) $W = IRt^2$

(74) **The energy supplied $W = I^2Rt$ is the mathematical expression for**
(a) Ohm's law (b) Fleming's law (c) Faraday's law (d) Joule's law

(75) **The amount of energy supplied by current in unit time is known as**
(a) Electrical energy (b) Electrical power (c) Electrical work (d) Potential difference

(76) **When current I is flowing through a resistance R the electrical power that generates heat in the resistance is given by**
(a) IR (b) I/R (c) I^2R (d) IR^2

(77) **The SI unit of electrical power is**
(a) Watt (b) Joule (c) Ampere (d) Volt

(78) **One watt is equal to**
(a) Js (b) Js^{-1} (c) J^2s (d) sJ^{-1}

(79) **Heat energy dissipated in a resistor R when connected to a battery of V volts and current I ampere flowing through it for time t is given by**
(a) I^2R (b) IRt (c) VIt (d) I^2Rt

(80) **How will you calculate power from current (I) and voltage (v)**
(a) power = I/V (b) power = VI (c) power = V^2I (d) power = VI^2

(81) **Electrical energy is measured in**
(a) watt (b) horse power (c) kilo watt (d) kilowatt hour

(82) **Which one of the following bulbs has least resistance?**
(a) 100 watt (b) 200 watt (c) 500 watt (d) 1000 watts

(83) **Electrical energy is commonly consumed in very large quantity and hence a large unit of energy is required which is know as**
(a) Watt-hour (b) Milli-watt hour (c) Killowatt-hour (d) Megawatt - hour

(84) **One kilowatt-hour is equal to**
(a) 13.6 MJ (b) 13.6 kJ (c) 3.6 kJ (d) 3.6 MJ

(85) **We can calculate the amount of electricity bill by the following formula**
(a) $\dfrac{\text{watt} \times \text{time (in hours)}}{1000} \times$ cost of one unit (b) $\dfrac{\text{watt} \times 1000}{\text{time (in hours)}} \times$ cost of one unit
(c) $\dfrac{1000 \times \text{time (in hours)}}{\text{Watt}} \times$ cost of one unit (d) $\dfrac{1000 \times \text{watt} \times \text{time (in hours)}}{\text{cost of one unit}}$

(86) **Kilowatt – hour is a unit of**
(a) Power (b) Work (c) Energy (d) Current

14.12 Direct Current and Alternating Current
14.13 Hazards of Electricity

(87) **The current which always flows in one direction is called**
(a) Alternating current (b) Direct current (c) Stationary current (d) Multi-directional

(88) **The current which changes its direction again and again is called**
(a) Alternating current (b) Direct current
(c) Multi-directional current (d) Uni - directional current

(89) **The time interval after which the voltage repeats its value is known as**
(a) Frequency (b) Wavelength (c) Time period (d) None of these

(90) **The number of cycles completed by current in one second is called its**
(a) Time period (b) Frequency (c) Wavelength (d) Amplitude

(91) **The frequency of a.c used in our houses is**
(a) 30 cycles / second (b) 50 cycles/second (c) 60 cycles/ second (d) 100cycles/ second

14.14 Safe Use Of Electricity In Homes

(92) All electrical appliances are connected in parallel to each other between the main live and neutral wire to get

(a) same current (b) same current and potential difference

(c) different currents and potential differences (d) same potential differences

(93) **Insulated covered wire is called:**

(a) Extension (b) Cable (c) Lead (d) None of these

(94) **The wire at certain potential is called:**

(a) Live wire (b) Neutral wire (c) Earth wire (d) Ground wire

(95) **The wire at zero potential is called:**

(a) Live wire (b) Neutral wire (c) Earth wire (d) Ground wire

(96) **The wire grounded in the earth is called:**

(a) Live wire (b) Neutral wire (c) Earth wire (d) Ground wire

(97) **A small wire connected in series with the live wire is called:**

(a) Neutral wire (b) Earth wire (c) Fuse (d) Circuit breaker

(98) **Safety device used in place of fuse is:**

(a) Socket (b) Earth wire (c) Plug (d) Circuit breaker

(99) **Circuit breaker works on the principle of:**

(a) Electric current (b) Joule's law (c) Electromagnetism (d) None of them

(100) **An additional wire used in devices having the metallic bodies is:**

(a) Live wire (b) Neutral wire (c) Earth wire (d) Ground wire

ANSWER KEY

Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans
1.	c	21.	c	41.	d	61.	c	81.	d
2.	c	22.	a	42.	b	62.	d	82.	a
3.	b	23.	c	43.	c	63.	a	83.	c
4.	d	24.	b	44.	a	64.	c	84.	d
5.	b	25.	c	45.	d	65.	a	85.	a
6.	a	26.	a	46.	c	66.	b	86.	c
7.	d	27.	c	47.	c	67.	c	87.	b
8.	a	28.	b	48.	d	68.	c	88.	a
9.	b	29.	a	49.	c	69.	c	89.	c
10.	c	30.	d	50.	a	70.	b	90.	b
11.	b	31.	d	51.	b	71.	b	91.	b
12.	d	32.	c	52.	c	72.	c	92.	d
13.	c	33.	b	53.	b	73.	b	93.	b
14.	c	34.	b	54.	d	74.	d	94.	a
15.	b	35.	c	55.	b	75.	b	95.	b
16.	a	36.	c	56.	a	76.	c	96.	c
17.	b	37.	b	57.	d	77.	a	97.	c
18.	b	38.	b	58.	b	78.	b	98.	d
19.	b	39.	d	59.	b	79.	d	99.	c
20.	a	40.	d	60.	a	80.	b	100.	c

SHORT QUESTIONS

14.1 Electric Current

Q.1. Define electric current.

Ans: The rate of flow of electric charge through any cross- sectional area is called, electric current. If the charge Q is passing through an area A in time t second, then the current flowing through it will be I, whereas

Mathematically

$$\text{Current} = \frac{\text{charge}}{\text{time}}$$

$$I = \frac{Q}{t}$$

Unit

In system International, the unit of current is known as ampere.

Q.2. What is meant by conventional current?

Ans: "A current produced due to flow of negative charges is equivalent to a current due to flow of an equal amount of positive charge in opposite direction. This equivalent current of positive charge is known as conventional current".

Q.3. Which type of charge is responsible for the flow of current in metallic conductors?

Ans: In metals or metallic conductors, the current is due to the flow of free electrons i.e. negative charges. For example, in a copper wire there are large number of free electrons which are in random motion. When we apply potential difference across the wire, these free electrons move through the wire.

Q.4. In electrolyte which charge are responsible for the flow of current?

Ans: The molecules of electrolytes are dissolved among positive and negative ions in a solution. Thus current in electrolytes is due to the flow of both positive and negative charges **as shown in fig.**

Q.5. How energy is obtained due to flow of charges?

Ans: When a positive charge moves from a point of higher potential to the point of lower potential, it gains the energy from the electric field. During flow of electric current, positive charges flow continuously from a high potential to a low potential point. Thus the electric current becomes a continuous source of energy.

14.2 Potentional Difference
14.3 E.M.F

Q.6. How a galvanometer is converted into voltmeter?

Ans: The galvanometer is converted into voltmeter by connecting suitable resistance in series with it. The value of the resistance depends upon the range of the voltmeter. Usually its value is several thousand ohms. Thus the resistance of a voltmeter is very high.

Q.7. How a galvanometer is converted into ammeter?

Ans: Galvanometer can be converted into an ammeter by connecting a small resistance parallel to it. This small resistance is known as "shunt". Shunt provides an alternative path for the current to flow. The major part of the current passes through the shunt and small fraction of it flows through the galvanometer.

Q.8. Why resistance of the ammeter is kept low?

Ans: If the resistance of the ammeter is kept high, then high amount of current flows through the galvanometer. When high amount of current will flow through the galvanometer then galvanometer can be burnt. That is why resistance of the ammeter is kept low

Q.9. Why resistance of the voltmeter is kept high?

Ans: If the resistance of the voltmeter is comparatively low, it will draw more current from the circuit. Due to this the potential difference across the resistance for the measurement, of which the voltmeter was connected, would drop.

Q.10. On what factor reliability of voltmeter depend?

Ans: Higher the resistance of the voltmeter, more reliable would be its readings. Therefore a good voltmeter should have such a high resistance so that no or very little current could pass through it.

Q.11. Differentiate between electromotive force and potential difference.

Ans:

Difference between electromotive force and potential difference.	
Electromotive force	**Potential difference**
The electromotive force of a battery or cell is the total energy supplied in driving one coulomb charge round a complete circuit in which cell is connected. The complete circuit includes the cell and external circuit connected to the terminals.	The potential difference determines the energy between any two points of the circuit which is required in moving a charge from one point to another.

14.4 Ohm's Law
14.5 V-I Characteristics of Ohmic and Non Ohmic Conductor

Q.12. State and explain Ohm's law. Write down its limitations. (16.4)

Ans: "The value of current I passing through a conductor is directly proportional to the potential difference V applied across its ends, provided the temperature and the physical state of the conductor does not change."

Mathematical form

$V \propto I$ Or $V = IR$ .... (1)

Limitations of Ohm's Law

Ohm's law is applicable only in case of metallic conductors when their temperature and physical state do not change.

Q.13. Define resistance and its unit.

Ans: "The property of a substance which opposes the flow of current through it is called its resistance."

Mathematically:

$$R = \frac{V}{I}$$

Where R is resistance, V is potential difference and I is current. S.I unit of resistance is Ohm. Which is define as

Ohm

"If a current of one ampere passes through it when a potential difference of one volt is applied across its ends then resistance would be one Ohm. Ohm is usually represented by the Greek letter Ω

Mathematically

$$1\Omega = \frac{IV}{IA}$$

14.6 Specific Resistance (Resistivity)
14.7 and 14.8 Conductors and Insulators

Q.14. What are the factors upon which the resistance of a conductor depends?

Ans: Resistance of the conductor depends upon the following factors:

- Length of the conductor (L)
- Area of cross-section of the conductor (A)
- Nature of the conductor
- Temperature

Q.15. Why does the resistance of a conductor increase with the rise of its temperature?

Ans: When the temperature of the conductor rises, average speed of the random motion of the free electrons increases which enhances the rate of collision of electrons and atoms. This causes an increase in the resistance of the conductor.

Q.16. Why do we always use metal wires for conduction of electricity?

Ans: Because, they are good conductors of electricity and offer less resistance to the flow of current. Metals like silver and copper have excess of free electrons which are not held strongly with any particular atom of metals. These free electrons move randomly in all direction inside metals. When we apply external electric field these electrons can easily move in a specific direction. This movement of free electrons in particular direction under the influence of external field causes flow of current in metal wires.

Q.17. What do you mean by Insulators?

Ans: The substances through which almost no current flow are called Insulators

<u>Examples</u>: The examples of insulators are as followings glass, wood, plastic, fur, silk etc.

14.9 Combination of Resistors
14.10 Electrical Energy and Joule's Law and
14.11 Electric Power

Q.18. State Joule's Law.

Ans: The amount of heat generated in a resistance due to flow of charges is equal to the product of square of current I, resistance R and the time duration t.

Mathematically:

$$W = I^2 Rt$$

Where W is work done (Energy), I is current, R is resistance and t is time duration.

Q.19. Define electric power.

Ans: The amount of energy supplied by current in unit time is known as electric power.

Mathematically:

$$\text{Power} = \frac{\text{Work}}{\text{Time}}, \qquad P = \frac{QV}{t} = IV = I^2 R$$

Q.20. Define kilowatt hour?

Ans: Kilowatt – Hour

The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt – hour.

Mathematically:

One kilowatt – hour 1kwh = 1000 w x 1 hour

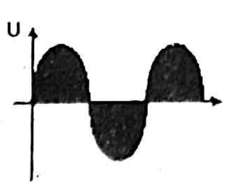
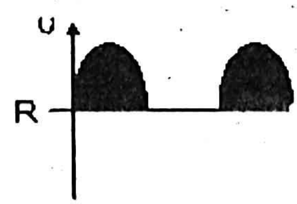
= 1000 w x (3600s)

= 36×10^5 J = 3.6 MJ

14.12 Direct Current and Alternating Current
14.13 Hazards of Electricity

Q.21. Differentiate between A.C and D.C.

Ans:

Difference between A.C. and D.C.	
Alternating current (A.C.)	**Direct current (D.C.)**
• The current which changes its direction again and again is called alternating current.	• A current which always flows only in one direction is called the direct current.
• A.C current can transfer electrical energy over the long distances and can provide more power.	• Voltage of D.C cannot travel very far until it begins to lose energy.
• The frequency of alternating current is 50Hz.	• The frequency of the D.C current is zero.
• A.C current is obtained from A.C generators and mains.	• D.C current is obtained from batteries and cells.
• **Wave form of A.C**  **AC Current**	• **Waveform of D.C**  **DC Current**
Example Current used in our houses.	**Example** Current from dry cells.

Q.22. What are live and neutral wires?

Ans: Electricity is distributed to various houses in a city from a power station by means of two wires.

Neutral wire

One wire is earthed at the power station, so it is at zero potential. This wire is called neutral wire. This wire provide the return path of current. It is a black or blue in colour.

Live wire

The other wire on power station is at some certain potential called the live wire. The potential difference between both wire is 220. It is red or brown in colour.

Q.23. How electricity is dangerous for us?

Ans: Our body is a good conductor of electricity through which current can easily pass. Therefore if a person holds live wire, then because of the presence of voltage in it, current will start flowing to ground through the human body which may prove fatal for the person.

14.14 Safe Use of Electricity In Homes

Q.24. What is cable? And how it should be used?

Ans: "An insulated covered wire is known as cable".

Cable should be used keeping the following things in mind:

- **Layer of insulation** in the cable is perfect and is not damaged.
- Sometimes a **heavy current** flow through the wire and it gets so hot that its insulation is burnt out and the wire becomes naked and it becomes dangerous.
- **Constant friction** also removes the insulation from the wire whereas too much moisture also damages the insulation. In such a situation it is advisable to use a cable with two layers of insulation.

Q.25. Define fuse and write down its principle.

Ans: "A small wire connected in series with the live wire is known as fuse wire or fuse".

Principle

A specified amount of current can safely pass through it. When the current following through it exceeds this limit, it gets so hot that it melts.

Q.26. What do you know about Fuse rating?

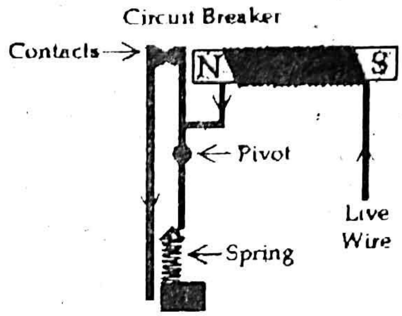
Ans: We can determine the required fuse rating for a circuit. Suppose we want to insert a fuse for an air-conditioner or heater of power 3000W. If voltage supply is of 240V, then according to relation $P = V \times I$, we get $I = 12.5A$. The available fuses in the market are usually of rating 5A, 10A, 13A, 30A etc. Hence, suitable fuse for this circuit would be of 13A.

Q.27. What is Circuit Breaker? Also write down its principle.

Ans: It is a safety device which is used in place of fuse. Due to any fault when the current exceeds the safety limit, then the button of the circuit breaker moves upward. Due to which the circuit breaks and the flow of the current is stopped in it.

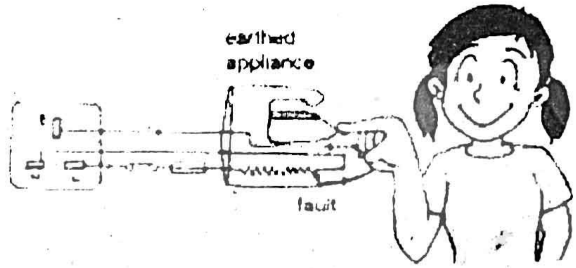
Principle

The current flowing through the electric circuit also flows through the coil of the circuit breaker due to which the coil becomes electromagnet. When the current is within its limits, the contact points of the circuit are connected to each other and the circuit is completed. As soon as the current exceeds the limit, the magnetic force of the electromagnet is so increased that it attracts the iron strip towards it. Hence the contact points are separated and the circuit breaks.



Q.28. What is the working principle of Earth wire?

Ans: Whenever the metal casing of the appliance, due to faulty insulation, gets connected with the live wire, the circuit shorts and a large current would immediately flow to ground through the earth wire and causes the fuse wire to melt or the circuit breaker breaks the circuit. Therefore, the person who is using the appliance is saved.

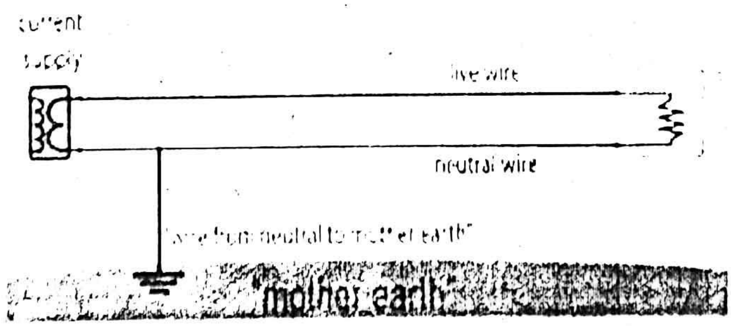


Q.29. On what principle circuit breaker work?

Ans: The current flowing through the electric circuit also flows through the coil of the circuit breaker due to which the coil becomes electromagnet. When the current is within its limits, the contact points of the circuit are connected to each other and the circuit is completed. As soon as the current exceeds the limit, the magnetic force of the electromagnetic is so increased that it attracts the iron strip towards it. Hence the contact points are separated and the circuit breaks.

Q.30. How earth wire is useful to us?

Ans: Whenever the metal casing of the appliance, due to faulty insulation, gets connected with the live wire, the circuit shorts and a large current would immediately flow to ground through the earth wire and causes the fuse wire to melt or the circuit breaker breaks the circuit. Therefore, the person who is using the appliance is saved.



14.1 Electric Current

Q.1 Define and explain the term electric current (14.1).

Ans: Definition:

"The rate of flow of electric charges through any cross-sectional area is called current."

Mathematically:

If charges 'Q' is passing through any area in time't' the current 'I' flowing through it will be given as"

$$\text{current} = \frac{\text{charge}}{\text{time}}$$

$$I = \frac{Q}{t}$$

Unit: SI unit of current is Ampere (A)

Ampere:

One ampere is the amount of electric current due to the flow of electric charge at the rate of one coulomb per second.

$$1A = \frac{1\text{COLOUMB}}{1\text{second}} = \frac{1c}{1s}$$

Flow of current through a conductor

Consider a conductor in form of a copper wire. It has a large number of free electrons which are in random motion just like the molecules of a gas confined in a container. Their movement does not obey any symmetry but they move in all directions.

Motion of free electrons in absence of electric field

In absence of an electric field, rate at which the free electrons cross any section of the wire from right to left is equal to the rate at which they cross from left to right with the result that the net rate is zero.

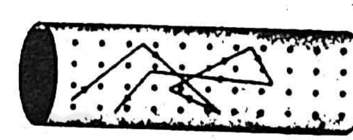


Fig. 16.3

So in-spite of the fact that electrons are in motion, no current flows through any section of the conductor.

Motion of free electrons in presence of electric field

If one end of the copper wire is connected with positive terminal of a battery and other with its negative terminal, an electric field E is established at each point of wire. Now the free electrons, because of their negative charge, experience a force in a direction opposite to the direction of electric field E.

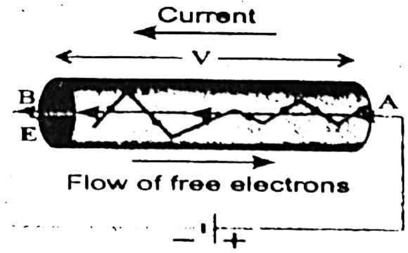


Fig. 16.4

Because of this force a net directed flow of free electrons takes place from the negative terminal of the battery towards its positive terminal and an electric current begins to flow through the wire from the positive terminal towards the negative terminal of the battery.

Direction of flow of current

The current flow due to negative charges has been changed with conventional current. This current flows in the wire from positive to negative terminal of the battery i.e., current flows from a point of higher potential to a point of lower potential

Current in solutions (electrolyte)

In case of electrolyte its molecules in aqueous solution dissociate among positive and negative ions. So current in electrolyte is produced due the flow of both positive and negative charges.

Q.2 Explain battery as source of energy (14.1)

Battery is one of the sources of current. The electrochemical reaction inside a battery separates positive and negative electric charges as shown in fig.

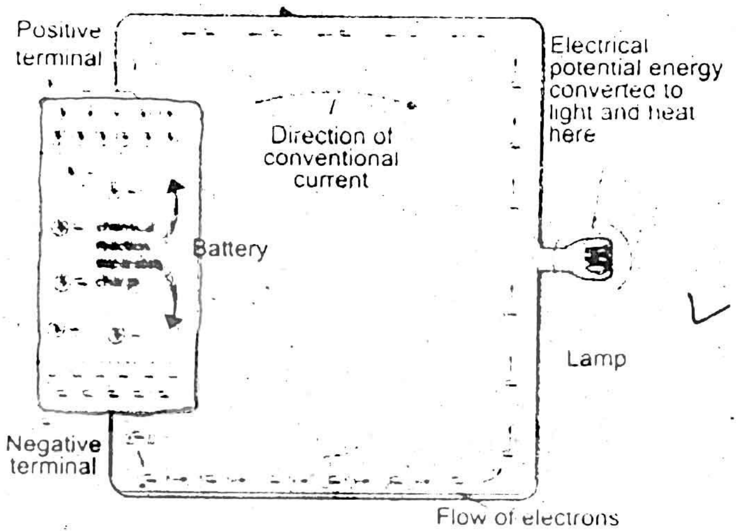


Fig.14.1: Schematic diagram of battery as a current source

This separation of charges set up potential difference between the terminals of the battery. When we connect a conducting wire across the terminals of the battery, the charges can move from one terminal to the other due to the potential difference.

Potential energy per unit charge:

The chemical energy of the battery changes to electrical potential energy. The electrical potential energy decreases as the charges move around the circuit. This electric potential energy can be converted to another useful forms of energy (heat, light, sound etc.) it is only the energy which changes form but the number of charge carriers and the charge on each carrier always remains the same (i.e. charge are not used up.) instead of electrical potential energy we use the term electrical potential which is potential energy per unit charge.

Q.3 Define and explain the term conventional current (14.1).

Ans: Definition

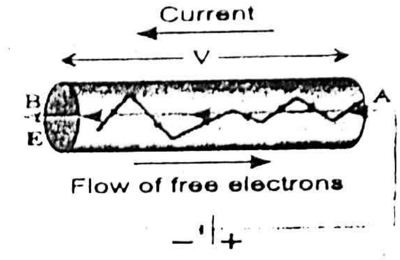
"Current flowing from positive to negative terminal of battery due to flow of positive charges is called conventional current."

Convential mean

Before the idea of free electrons which constitute in metals, it was thought that current in conductors flowed due to motion of positive charges. Therefore, this convention is still in used.

Explanation

When the ends of a copper wire are at different temperatures, heat energy flows from one end of higher temperature to the end of lower temperature. The flow stops when both ends reach the same temperature. Water in pipe also flows in a pipe from high level to low level. Similarly when a conductor is connected to a battery, it pushes positive charges to flow current from high potential to low potential as shown in fig.



The flow of current continues as long as there is a potential difference. Conventional current produces the same effect as the current flowing from negative terminal to the positive terminal due to flow of negative charges.

Q.4 How we can detect and measure the electric current (14.1)?

Ans: We use different electrical instruments which can detect and measure the current in the circuit.

1. **Galvanometer:**

"Galvanometer is a device which is used to detect the presence of electric current in any circuit."

ii. **Ammeter:**

"Ammeter is a device which is used to measure the current in any circuit."

Importance of Galvanometer

Galvanometer is very sensitive instruments and can detect small current. A current of few milli amperes is sufficient in it. Ideal galvanometer should have very small resistance to pass the maximum current in the circuit.

Polarity of galvanometer

While making the connections polarity of the terminals of the galvanometer should be taken into consideration. Generally the terminal of the galvanometer with red colour shows the positive polarity while that of with black colour shows negative polarity.

How Ammeter is formed?

After suitable modification galvanometer can converted into an ammeter. A suitable but small resistance is connected in parallel to the galvanometer, this circuit is called ammeter. A large current of the range such as 1A or 10 A can be measured by means of ammeter, like galvanometer ammeter is also connected in series, so that the current flowing in the circuit also passes through the ammeter.

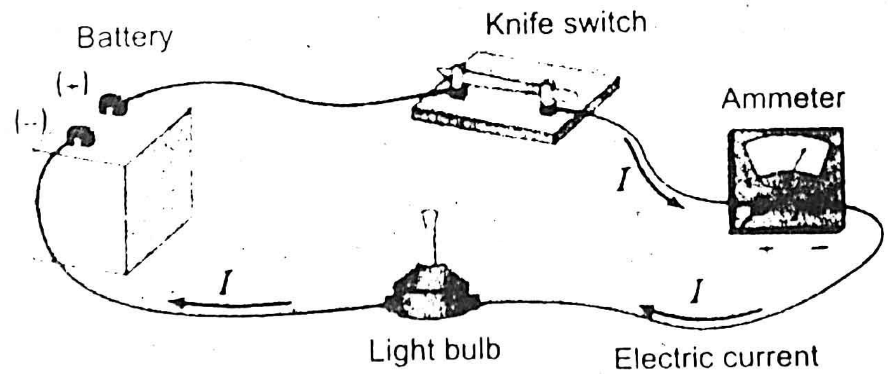


Fig. 14.5: Schematic diagram showing the measurement of current

14.2 and 14.3 Potential Difference and e.m.f

Q.5: Define and explain the potential difference (14.2).

Ans: **Definition:**

"Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as charges flow through the circuit.

Explanation:

When one end A of conductor is connected to the positive terminal and its other end B is connected to the negative terminal of the battery then the potential of A becomes higher than the potential of as shown in figure.

This cause a potential difference between the two ends of the conductor. The flow of current continues as long as there is a potential difference. The agent which provides the steady flow of current in the copper wire is the battery. As the current flows form higher potential to the lower potential through the conductor, the electrical energy (due to current) is converted into to other form i.e. heat and light etc.

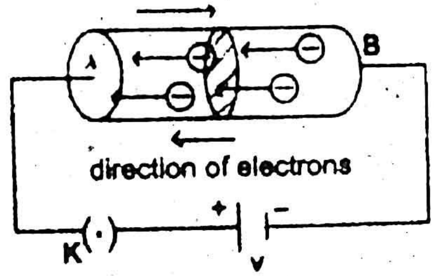


Fig.14.6

When current flows through the conductor, it experiences a resistance in the conductor. The energy supplied by the battery is utilized in overcoming this resistance and is dissipated as heat and other form of energy. The dissipation of this energy is accounted for by the potential difference across the two ends of the conductor (light bulb)

SI unit of potential difference is volt.

A potential difference of I volt across a bulb means that each coulomb of charge or 1 ampere of current that passes through the bulb consumers 1 joule of energy. When a bulb is lit, the energy is taken from the current and is transformed into light and heat energy.

Q.6 What is mean by electromotive force? Write its equation and explain its unit.(14.3)

Ans: Definition of e.m.f

"It is the energy converted form non-electrical form when one coulombs of positive charge passes through the battery".

OR

"it is the energy supplied by a battery to a unit charge when it flows through the closed circuit".

Equation:

$$emf = \frac{energy}{charge}$$

$$E = \frac{W}{Q}$$

Where 'W' is energy converted from non-electrical forms to electrical form and 'Q' is a positive charge.

Unit of e.m.f

SI units of energy and charge are Joule and coulomb, then the unit of em.f will be JC^{-1} i.e.

$$emf = \frac{energy}{charge}$$

$$= JC^{-1}$$

$$e.mf = volt$$

Hence if the e.m.f of the battery is 2V, the total energy supplied by the battery is 2 Joules when one coulombs of charge flows through the closed circuit.

Explanation

Sources of e.m.f

Batteries, thermocouples and generators are the best examples of the sources of e.m.f When a conductor is connected to battery current flows through it due to potential difference. A source of electromotive (e.m.f) converts non-electrical energy (chemical, thermal, mechanical into electrical energy.

How do charges move a circuit?

Battery supplies energy to the charges for continuous flow of current. The positive charges leave the positive terminal of the battery, pass through the conductor and reach the negative terminal of the battery. As this positive charge enters the battery at its lower potential point (negative terminal), the battery must supply energy, say W to the positive charge derive it to appoint of higher potential (positive terminal).

Q.7 How we measured the potential difference and e.m.f across a circuit?(14.3),

Ans: The Measurement of potential Difference

The potential difference across a circuit component (e.g., light bulb) can be measured by a voltmeter (Fig.) connected directly across the terminal of the component. The positive terminal of the cell is connected to the positive terminal of the voltmeter and the nega ve terminal of the cell is connected to the negative terminal of the voltmeter. An ideai voltmeter should have very large value of resistance so that no current passes through it, voltmeter is always connected in parallel with the device across which the potential difference is to be measured (Fig)

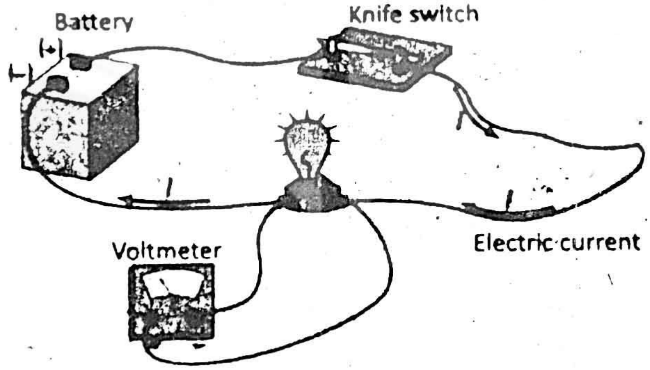


Fig. 14.8: Schematic diagram for measuring potential difference in a circuit.

The measurement of e.m.f

In general e.m.f refers to the potential difference across the terminals of the battery when it is not driving current in the external circuit. So in order to measure e.m.f of the battery we connect voltmeter directly with the terminals of the battery as shown in

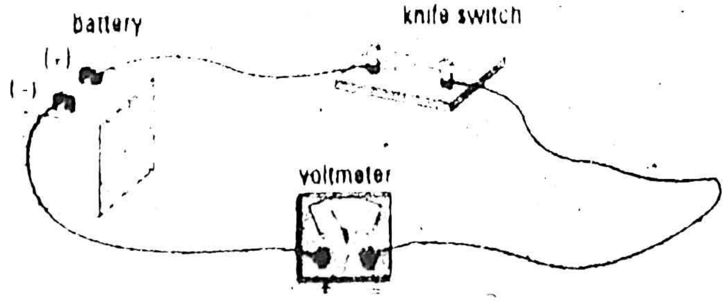


Fig. 14.9: Schematic diagram for measuring e.m.f. of the battery

14.4 Ohms's Law

Q.8 States and explain Ohm's law. What are its limitation?

Ans: Ohm's law:

The amount of current I passing through a conductor is directly proportional to the potential difference V applied across its ends, provided the temperature and the physical state of the conductor does not change.

Explanation:

If 'V' is the potential difference across the two ends of any conductor, then current I will flow through it. The value of the current 'I' changes with the changes in potential difference 'V', hence by the definition of Ohm's law.

$$V \propto I$$
$$V = (\text{Constant}) \quad (I)$$
$$V = (R)I$$
$$V = IR \ldots\ldots\ldots\ldots(1)$$

Where 'R' is the constant of proportionality, and is the resistance of the conductor. Its SI units is Ohm.

Resistance:

"The property of a substance which offers opposition to the flow of current through it is called its resistance".

Unit:

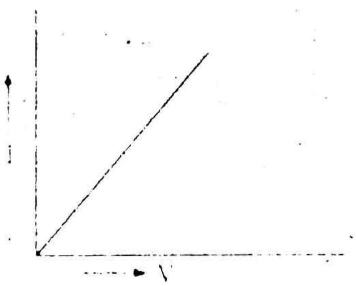
SI unit of the resistance 'R' is Ohm. It is denoted by the symbol, called Omega (Ω).

Definition of Ohm:

"When a potential difference of one volt is applied across the ends of a conductor and 1 ampere of current passes thorough it, then its resistance will be one ohm"

Graphically representation:

If a graph is plotted between the current 'I' and the potential difference 'V' a straight line will be obtained.



Limitations of Ohm's Law:

Ohm's law is applicable when temperature of conductor is kept constant. It has been observed that only good conductors obey ohm's law as long as the electric current through them is not very large and the physical state of the conductor also remains the same.

14.5 Characteristics of Ohmic and Non Ohmic conductors

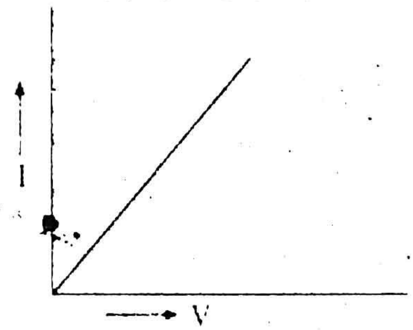
Q.9 Explain the V-I characteristics of Ohmic and non Ohmic conductor.(14.5)

Ans: Materials that obey Ohm's law, and hence have a constant resistance over a wide range of voltages, are said to be Ohmic."

Ohmic Conductor:

Ohmic conductors have a linear current-voltage relationship over a wide range of applied voltages as shown in figure:

The straight line shows a constant ratio between voltage and current, So Ohm's law is obeyed. For example most metals show Ohmic behavior.



(i) Ohmic

None-Ohmic Conductor

Non-Ohmic materials have a non-linear current-voltage relationship.

Example:

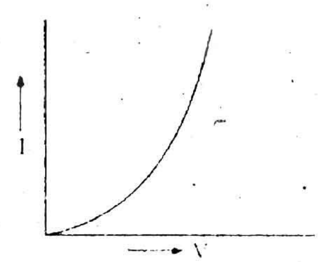
(i) Filament lamp

(ii) Thermister

(iii) Filament lamp

(i) **Filament lamp:**

The filament lamp shows the non-Ohmic materials properties. The resistance of filament rises (current decreases) as it gets hotter, which is shown by the gradient getting steeper as shown in fig.

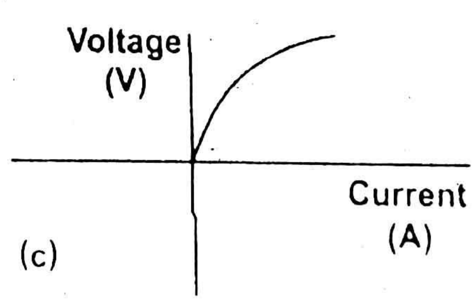


(ii) Non-ohmic

(ii) **Thermister:**

A thermister (a heat sensitive resistor) behaves in the opposite way as that of filament lamp. Its resistance decreases (current increases) as it gets hotter as shown in fig.

This is because on heating, more free electrons become available for conduction of current.



(c)

Q.10: Define resistance and its units.

Ans: **Resistance:**

"The property of a substance which offers opposition to the flow of current through it is called its resistance".

Reason:

Opposition to the flow of current is due to the collisions of the moving electrons with atoms of the substance.

Unit:

SI unit of the resistance 'R' is Ohm. It is denoted by the symbol, called Omega (Ω).

Definition of Ohm:

Since, $V = IR$

If we put $V = 1$ volt and $I = 1$ Ampere the value of 'R' will be 1 ohm, Thus, "When a potential difference of one volt is applied across the ends of a conductor and 1 ampere of current passes thorough it, then its resistance will be one ohm"

14.6 Specific Resistance (Resistively)

Q.11 Define and explain the term specific resistance. Discuss different factors which affect the resistance of conductors.(14.6)

Ans: Definition:

"The resistance of one meter cube of a substance is called its specific resistance".

Explanation:

A short pipe offers less resistance to water flow than a long pipe. A pipe with larger cross-sectional area offers less resistance than the pipe having smaller cross-sectional area.

Same is the case for resistance of wire that carry current .the resistance of wire depends both on the cross-sectional area and length of the wire, current flow also depends upon the nature of the material of the wire.

Factors:

At specific temperature resistance depends upon the following factors.

(a) Length of conductor:

Longer wires have more resistance than short wires.

(b) Cross-sectional area of conductor

Thick wires have less resistance than thin wires.

(c) Nature of the conductor:

Copper wire has less resistance than steel wire of the same size.

Note: Electrical resistance also depends on temperature.

MATHEMATICALLY EXPLANATION OF SPECIFIC RESISTANCE

At a certain temperature and for a particular substance;

(1) **Length and Resistance;**

The resistance 'R' of wire is directly proportional to the length of the wire i.e.

$$R \propto L \rightarrow (i)$$

It means if we double the length of wire its resistance will also be double and , if its length is halved its resistance would become one half.

(2) **Cross-sectional area and resistance**

The resistance 'R' of the wire is inversely proportional to the area of cross-section 'A' of the wire .i. c.

$$R \propto \frac{1}{A} \longrightarrow (ii)$$

It means that a thick wire would have smaller resistance than a thin wire.

By combining these above relations.

$$R \propto L\frac{1}{A}$$

$$R \propto \frac{L}{A}$$

$$R = \rho\frac{L}{A} \longrightarrow (iii)$$

Where 'ρ' is the constant of proportionality, known as specific resistance.

Nature of conductor (specific resistance)

Where ρ is the constant of proportionality known as specific resistance. Its value depends upon the nature of conductor i.e., copper, iron, tin and silver would each have a different values of ρ.

Unit of specific resistance

In above equation, if L = 1 m and A = $1m^2$ then R = ρ i.e., the resistance of one meter cube of a substance is equal to its specific resistance. According to above equation the unit of ρ is ohm-meter (Ωm)

14.7 and 14.8 Conductor and Insulators

Q.12: What is the difference between the conductors and insulators?(14.7 and 14.8)

Ans: **Conductors:**

Why do we always use metal wires for conduction of electricity? Because, they are good conductors of electricity and offer less resistance to the flow of current. But how can they conduct electricity with much ease? Metals like silver and copper have excess of free electrons which are not held strongly with any particular atom of metals. These free electrons move randomly in all direction inside metals. When we apply external electric field these electrons can easily move in a specific direction. This movement of free electrons in particular direction under the influence of external field causes flow of current in metal wires. The resistance of conductors increases with increase in temperature. This is due to increase in the number of collisions of electrons with the themselves and the atoms of metals.

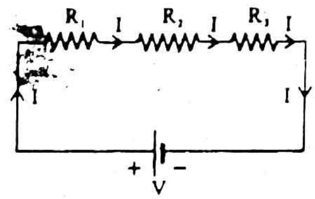
Insulators

All materials contain electrons. The electrons in insulators, like rubber, however, are not free to move they are tightly bound inside atoms. Hence, current cannot flow through an insulator because there are no free electrons for the flow of current. Insulators have very large value of resistance. Insulators can be easily charged by friction and the induced charge remains static on their surface. Other examples of insulators are glass, wood, plastic, fur, silk etc.

14.9 Combination of Resistors

Q.13: How are resistance are connected in series? Describe the characteristics features of this combination. What is meant by equivalent resistance of a series combination? Find its value.(14.9)

Ans: In this method resistance are connected end to end and the circuit thus formed provides only one path for the flow of current.1



Characteristics of series combination

(i) In this arrangement, the magnitude of current that flows through each individual resistor is same.

(ii) In series combination, the sum of voltages across each of the resistor is equal to the voltage of the battery connected across the combination. If the voltage of the battery is V and V_1, V_2, V_3 are the voltages across the resistors R_1, R_2, R_3 respectively, then

$$V = V_1 + V_2 + V_3$$

If the current passing through the resistors R1, R2, and R3 is I, then

$$V = IR_1 + IR_2 + IR_3$$

$$V = I(R_1 + R_2 + R_3) \quad \ldots\ldots\ldots \quad (1)$$

Equivalent resistance of series combination

The equivalent resistance R_e of a series combination is that resistance which is substituted in place of the combination, the same current would flow through the circuit. Figure shows the equivalent resistance Re. Note that the battery is sending the same current, which it was sending when the combination was connected in the circuit. By Ohm's law,

$$V = IR_e$$

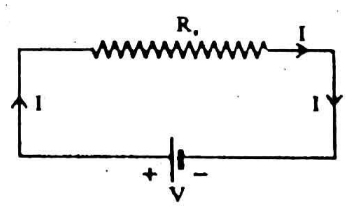
By substituting the value of V in equation (1), we have

$$IR_e = I(R_1 + R_2 + R_3)$$

$$R_e = R_1 + R_2 + R_3$$

Thus the equivalent resistance of a series combination is equal to the sum of the individual resistances of the combination.

If resistances R_1, R_2, R_3, ..., R_n are connected in series then their equivalent resistance can be determined by the following equation.



$$R_e = R_1 + R_2 + R_3 + \ldots\ldots + R_n$$

Q.14: How are resistance are connected in parallel? Describe the characteristics features of this combination. What is meant by equivalent resistance of a parallel combination? Find its value. (14.9)

Ans: In this combination, resistances are connected in such a way that one end of all the resistors is connected to one point, say 'A' and the other ends to another point 'B' as shown in the figure.

In the circuit formed, several paths are available for the flow of current. The total current is divided in these paths. The parallel combination has the following characteristics.

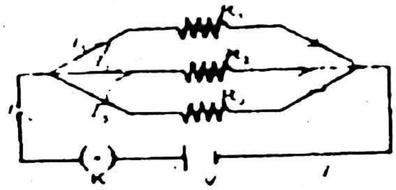


Fig 14.12: Three resistors in parallel combination

Features of Parallel combination

(i) In this combination, the potential drop across all the resistances is the same. The potential drop across each of the resistance in the figure will be V.

(ii) The sum of the current flowing through the various resistances of this combination is equal to the total of the circuit.

$$I = I_1 + I_2 + I_3 \quad \ldots\ldots\ldots \quad (1)$$

As the potential drop across each resistance is V. So by Ohm's law

$$I_1 = \frac{V}{R_1} \qquad I_2 = \frac{V}{R_2} \qquad I_3 = \frac{V}{R_3}$$

By substituting the values of I_1, I_2, I_3 in equation (1), we have

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Or

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \quad \ldots\ldots\ldots \quad (2)$$

(iii) The equivalent resistance R_e of the parallel combination is that resistance which when substituted in place of the parallel combination does not alter the total current of the circuit.

By Ohm's law $I = \frac{V}{R_e}$

By putting the value of I in equation (2), we have

$$\frac{V}{R_e} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

Or

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

If resistances R_1, R_2, R_3, ……, R_n are connected in parallel then their equivalent resistance can be determined by the following equation.

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}$$

Advantages of Parallel

Parallel circuits have two big advantages over series circuits.

(i) Each device in the circuit receives the full battery voltages.

(ii) Each device in the circuit may be turned off independently without stopping the current flowing to other devices in the circuit. This principle is used in our wiring.

14.10 Electrical energy and Joule's Law

Q. 15: State and explain joule's law. Derive its formula.(14.10)

Ans: Joule's law:

Statement:

"The amount of heat energy generated in a resistance due to flow of charges in equal to the product of square of current 'I' resistance 'R' and the time during 't'."

Explanation:

When water falls on turbine form higher gravitational. Potential to lower gravitational potential. Then electrical energy is produced by the running of generator.

Similarly when charge moves form a higher electrical potential to a lower potential it delivers electric current.

Hence the electric current, during when charges continuously move form a higher potential to a lower potential, becomes a continuous source of electrical energy.

Mathematics formula:

Consider two point with a potential difference 'V' volts. If one coulomb of charge passes between these points, the amount of energy delivers by the charge would be V joule, when 'Q' coulomb of charge flows between these two points, then we get QV joule of energy. It is represented by W.

$$\text{i.e. } W = QV \rightarrow \text{(i)}$$

When charge 'Q' flow in time 't' then by definition of current, we have.

$$I = \frac{Q}{t}$$

$$\Rightarrow Q = It \qquad \rightarrow \text{(ii)}$$

Put eq (ii) in eq (i)

$$W = It\,V \rightarrow \text{(iii)}$$

This electrical energy can be converted into heat and other forms in the circuit.

By Ohms law, we have

$$V = IR \rightarrow \text{(iv)}$$

Put eq.(iv) in eq (iii) we get.

$$W = It\,(IR)$$

So energy supplied by 'Q' charge in given as:

$$W = I^2 Rt$$

This equation is called joules law.

Importance:

The heat energy produced can be utilized for different useful purposes. E.g.

(i) Bulb converts this energy into light and heat.

(ii) Heater and Iron convert this heat energy into heat.

(iii) Electric fans convert into mechanical energy.

Note: When current pass through conductor (heater) we get heat

14.11 Electric Power:

Q. 16: What is electric power? How it is calculate and write its unit.(14.11)

Ans: **Electric power:**

"The amount of energy supplied by current in unit time is known as electric power

How power can be determined?

If the work done by the electric current in time 't' is 'W' then 'P' is determined by the formula.

$$\text{Electric power} = \frac{\text{electrical energy}}{\text{time}}$$

$$P = \frac{W}{t} \longrightarrow (i)$$

Where 'w' is the electrical energy given as:

$$W = QV \rightarrow (ii)$$

$$P = \frac{QV}{t} \rightarrow (iii)$$

By definition of current

$$\frac{Q}{t} = I$$

Hence eq. (iii) becomes

$$P = IV \rightarrow (iv)$$

By Ohm's law

$$V = IR \rightarrow (iv)$$

Hence equation (iv) can be written as:

Electrical power = $P = I(IR)$

Electrical power = $P = I^2R$

When current I is passing through resistor R, the electric power that generates heat in the resistance is given by I^2R.

Unit:

The unit of electric power is watt which is equal to one joule per second. It is represent by the symbol W.

Examples:

- Electric bulbs commonly used in houses consume 25w, 40w, 60w, 75w, and 1000 w of electric power.

Q.17 What is kilowatt hour? How the cost of electricity in a house can be a calculated?

Ans: "The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt hour."

Explanation:

Electric energy is commonly consumed in very large quantity for the measurement of which joule is a very small unit hence a very large unit of electric energy is needed which is called kilowatt hour.

$$\begin{aligned}\text{One kilowatt hour} &= \text{Kwh}\\ &= 1000\text{W} \times (3600\text{s})\\ &= 36 \times 10^5\ \text{Ws}\\ &= 3.6 \times 10^6\text{Ws}\end{aligned}$$

$$\therefore 10^6 = \text{Mega} = \text{M},\ \text{Ws} = \text{J}$$

Hence,

One kilowatt hour = 3.6MJ

Formula:

$$\text{The amount of energy in kwh} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000}$$

Or

$$\text{No. of units consumed} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000}$$

Calculation for cost of Electricity in House:

The electric meter installed in our houses measures the consumption of electric energy in units of kilowatt hour according to which we pay our electricity bills. If the cost of one kilowatt-hour i.e., one unit is known then cost of electricity is calculated as:

Formula:

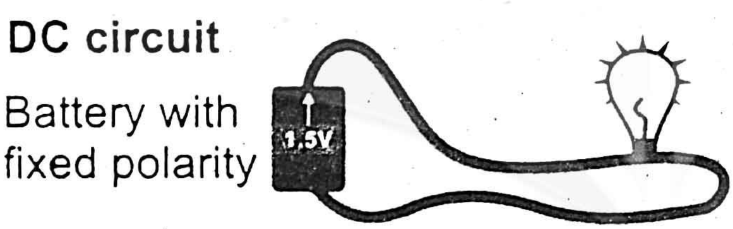
$$\text{Cost of electricity} = \text{number of units consumed} \times \text{cost of one unit}$$

$$\text{Cost of electricity} = \frac{\text{Power(watt)} \times \text{time of use in hours}}{1000} \times \text{cost of one unit}$$

14.12 Direct current and alternating current

Q.18: What is difference between D.C. and A.C.? OR Compare direct current (D.C) and alternating current (A.C)(14.12)

Ans: "The current which does not change its direction of flow is known as direct current or d.c."
The current derived from a cell or a battery is direct current (D.C.) since it is unidirectional. The positive and negative terminals of d.c. sources have fixed polarity, therefore, level of d.c. remains constant with time as shown in figure.



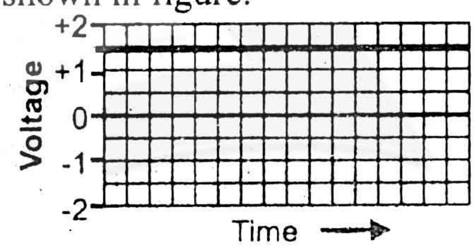
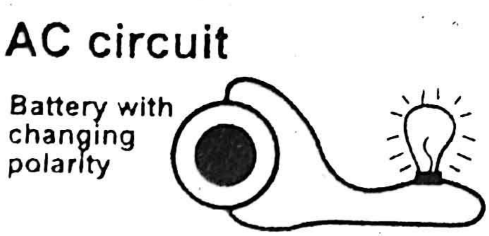
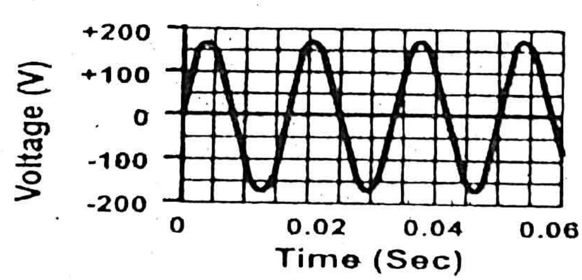


Fig. 14.13: Variation of D.C Current with time.

Alternating Current (A.C)

"The current which changes its direction of flow after regular intervals of time is known as alternating current or A.C." The current produce by A.C generators changes its polarity again and again as shown in fig:





Characteristics of A.C

Time period: The interval after which the A.C. voltage or current repeat its value is known as time period.

Cycle:

The set of all the value of current during one period is known as one cycle"

Frequency: The number of cycles completed by alternating current. in one second is called its frequency."

The change in the values of voltage and current corresponds to the frequency of the source. In Pakistan, alternating current oscillates 50 time every second. Thus, its frequency is 50Hz.

Importance of A.C:

Alternating current has advantages that make it more practical for use in transferring electrical energy. The current supplied to our homes by power companions is alternating current.

Q.19. How electricity is distributed in our house? How electrical appliances are connected in houses?(14.12)

Ans: **Supply to Houses:**

The electric power enters our house through three wires. One is called earth wire or ground wire (E). This caries no electricity. The earthy wire is connected to a large metal plate buried deep in the ground near the house the other wire is maintained as zero potential by connecting it to the earth at the power station itself and is called neutral wire (N). This wire provides the return path for the current. The third wire is at a high potential and is called live wire (L).

Potential difference between live wire and neutral wire:

The electric power enters our houses through wires, the potential difference between the live wire and neutral wire is 220V.

Dangers

Our body is a good conductor of electricity through which current can easily pass. Therefore, if a person holds live wire current will start flowing to the ground while passing through his body which may prove fatal for the person.

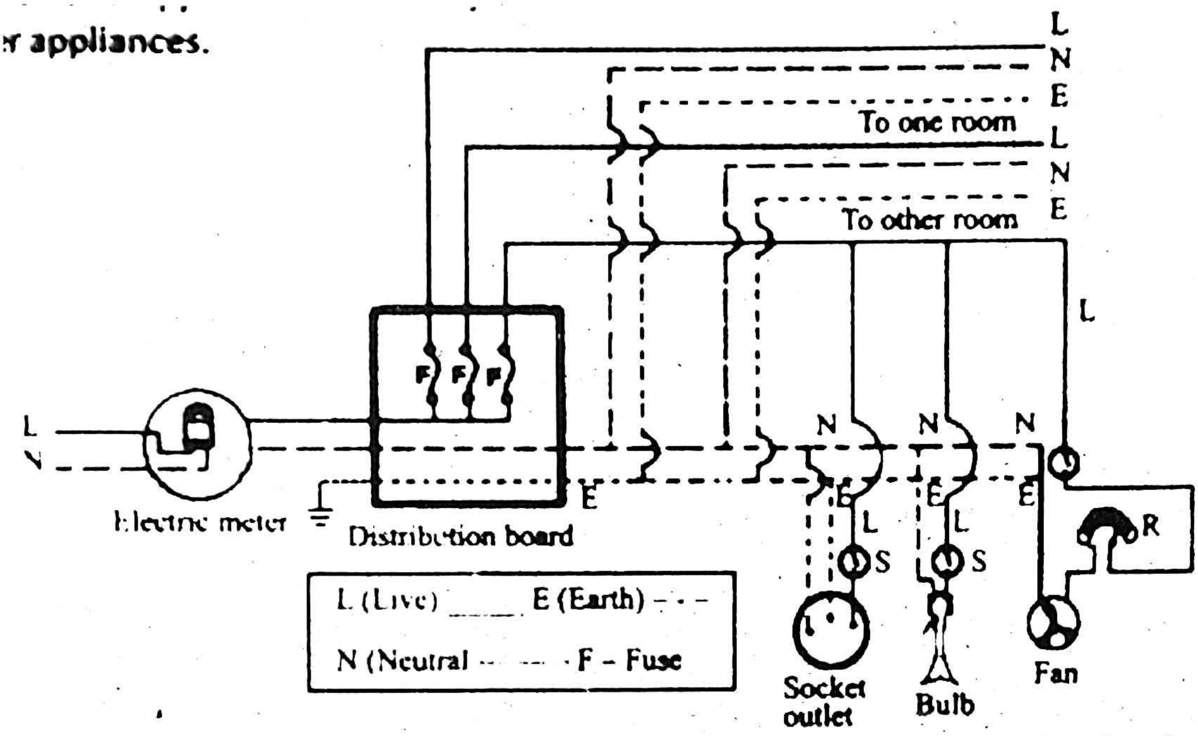
How electric appliances are connected?

All electrical appliances are connected across the neutral and live wires. The same potential difference is therefore applied to all of them and hence these are connected in parallel to the power source.

Q.20 Explain the circuit of house wiring.

Ans: The wires coming from power sub-station are connected to electricity meter installed in house. The output power from the electric meter is taken to the distribution board and then to the domestic electric circuit.

...r appliances.



The main box contains fuses of rating about 30A.A separate connection is taken from the live wire for each appliance. Terminal of the appliance is connected to the live wire through a separate fuse and a switch. If the fuse of the one appliance burns out, it does not affect the other appliances.

How all appliances are connected?

In house wiring all appliances are connected in parallel with each other. This means they get the full mains voltage and one can turn on any appliance without having to turn on another.

14.13 Hazards of electricity:

Q. 21: Discuss some faults in electrical circuits that may cause electricity hazards.(14.13)

Ans: Electricity has become part and parcel of our lives, care should be taken to save ourselves form its hazardous effects.

Major dangers:

Major dangers of electricity are:

(i) Electric shock.

(ii) Fire.

Some major faults in electrical Circuit:

These are the major faults in electrical circuits that may cause electrical hazards.

1. **Insulation Damage:**

How insulation damage:

(i) **Excess of current:** Electrical current exceeds the rated current carrying capacity of the conductor it can produce excess current that can damage insulation due to overheating of cables.

(ii) **Friction:** Constant friction may also remove the insulation from the wire.

(iii) **Moisture:** Too much moisture also damages the insulation because moisture decrease resistance and increase the rate of current.

How Circuit become short?

(i) A short circuit occurs when circuit with a very low resistance is formed. The low resistance causes the current to be very large.

(ii) When appliances are connected in parallel, each additional appliances placed in circuit reduces the equivalent resistance (Re) in the circuit increase the current through the wires. This additional current might produce enough thermal energy to melt the wiring's insulation, cause a short circuit, or even start a fire.

(iii) Short circuit can also occur when the live wire and the neutral wire come in direct contact.

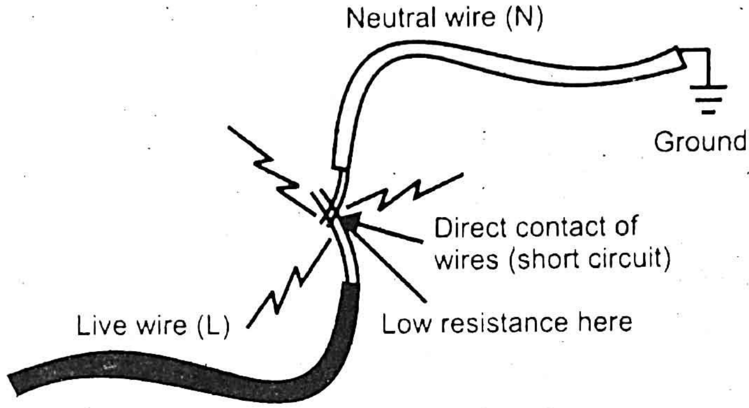


Fig. 14.16: Short circuit

Precautions:

Cable: All electrical wires are well insulated with plastic cover for the purpose of safety. Plastic is a good insulator. Such an insulation covered wire is called cable

i. In order to avoid dangerous situation it is advisable to use a cable with two layers of insulation.

ii. Don't use naked current carrying wires.

iii. Do not fly kites near electricity naked lines. It may cause some fatal accident.

2. Damp Conditions:

We environment is called damp conditions.

Dry human skin has a resistance of 1000,000 ohms or more. But under damp conditions resistance of human skin is reduced drastically to few hundred ohms. Therefore never operate any electrical appliance with wet hands. The switches, plugs, sockets and wires must be dry.

14.14 Safe Use of Electricity in Homes

Q. 22: Briefly describe the importance of safety devices.(14.14)

Ans: "The electrical devices which prevent the damage of electrical circuits appliances and property are called safety devices.

Examples:

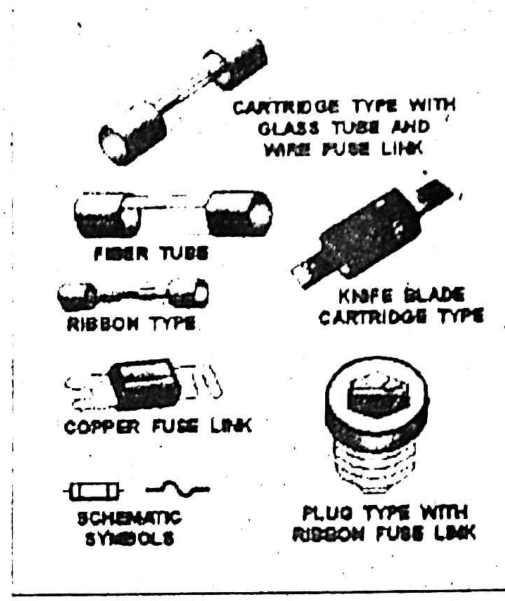
(i) Fuse
(ii) Circuit Breaker
(iii) Earth wire

Importance:

In order to protect persons, devices and property form the hazards of electricity. There is a need of extensive safety measures in household electricity. Safety devices prevent circuit form overloading that can occur when too many appliances are turned on at the same time or when a short circuit occurs in one appliance.

Q.23: Write a note on fuse:

Ans: Definitions: "A fuse is a safety device that is connected in series with the live wire in the circuit to protect the equipments when excess current flows."



Construction: Fuse is made of a short and thin piece of metal wire that melts when large current passes through it.

Working: If a large, unsafe current passes through the circuit, the fuse melts and breaks the circuits before the wires becomes very hot and cause fire.

Fuse rating: Fuse are normally rated as 5A, 10A, 13A and 30 A etc.

We can determine the fuse rating of circuit, let use determine the fuse rating of air conditions of power 3000W.

$P = 3000W.$

$V = 240 \text{ Volt}$

$I = ?$

$P = VI$

$$\Rightarrow \quad I = \frac{P}{V}$$

$$I = \frac{300}{240} = 12.5A$$

Hence suitable fuse for this circuit would be 13A.

Safety Measures:

Following safety measures should be taken while using fuses in house hold electrical circuits.

(i) fuses to be used should have slightly more rating than the current which the electrical appliance in will draw under conditions. For example, for a lightening choose a 5A fuse as the current drawn by each lamp is very small (about 0.4A) for a 100 W lamp. In such circuit 10 lamps of 100 W can be safely used because the total current drawn is only 9A which can be calculated using the formula P = VI

(ii) Fuses should be connect to the live wire so that the appliance will not become live after the fuse has blown.

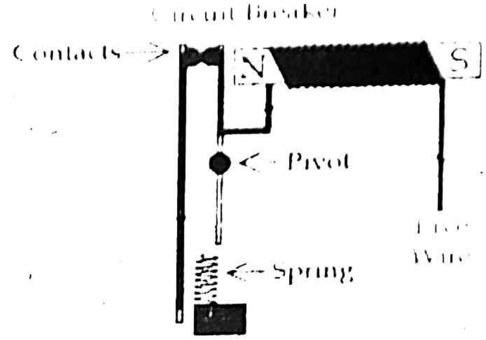
(iii) Switch off the main before changing any fuse.

Q. 24: What is the principle of circuit breaker?(14.14)

Ans: Circuit Breaker:

The circuit breaker acts as a safety device in the same way as a fuse. It disconnects the supply automatically if current exceeds the normal value.

Working principle: When the normal current passes through the live wire the electromagnet is not strong enough to separate the contacts. If something goes wrong with the appliance and large current flows through the live wire, the electromagnet will attract the iron strip to separate the contracts and break the circuit. The spring then keeps the contacts apart as shown in figure.



After the fault is repaired, the contacts can then be pushed back together by pressing a bottom on the outside of the circuit breaker box.

Q. 25: Explain the importance of Earth wire.(14.14)

Ans: Earth Wire:

Sometimes, even the fuse cannot capture the high currents coming from the live wire into the household appliance. Earthing further protects the user form electric shock by connecting the metal casing of the appliance to earth (a wired connection to the bare ground) many electrical appliances have metal cases, including cookers, washing machines and refrigerators, the earth wire provides a safe route for the current to flow through, if the live wire touches the cashing as shown in fig below.

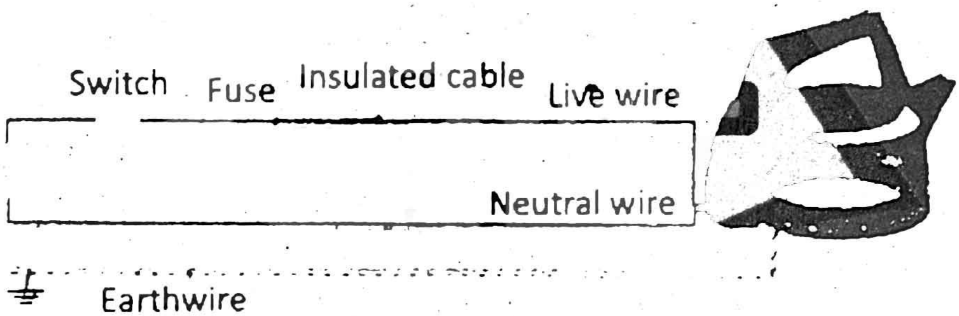


Fig. 14.20

We will get an electric shock if the live wire inside an appliance comes loose and touches the metal casing, However, the earth terminal is connected to the metal cashing, so the current goes though the earth wire instead of passing through our body and causing an electric shock, A strong current passes through the earth wire because it has a very low resistance. This breaks the fuse and disconnects the appliance.

Working principle of Earth wire

Whenever the metal casing of the appliance, due to faulty insulation, gets connected with the live wire, the circuit shorts and a large current would immediately flow to ground through the earth wire and causes the fuse wire to melt or the circuit breaker breaks the circuit. Therefore, the person who is using the appliance is saved.

UNSOLVED NUMERICAL PROBLEMS

Q.14.1 A current of 3mA is flowing through wire for 1 minute. What is the charge flowing through the wire?

Solution

Given Data

$$\text{Current} = I = 3mA$$
$$I = 3 \times 10^{-3}\ A \quad (\because \text{milli} = m = 10^{-3})$$
$$\text{Time} = t = 1\text{min}$$
$$T = 1 \times 60 = 60\ \text{sec.}$$

Required:

$$\text{Charge} = Q = ?$$

Formula

$$I = \frac{Q}{T}$$
$$\Rightarrow \quad Q = I \times t$$
$$Q = 3 \times 10^{-3} \times 60$$
$$Q = 180 \times 10^{-3}\ C \text{ Ans}$$

Q. 14.2 At 100,000 Ω how much current flows through your body if you touch the terminals of a 12-V battery? If your skin is wet, so that your resistance is only 1000 Ω, how much current would your receive form the same battery?

Solution:

Given Data

$$R_1 = 100,000$$
$$V = 12 \text{ volts}$$
$$R_2 = 1000\ \Omega$$

Required

(a) $I_1 = ?$

(b) $I_2 = ?$

(a) **Formula:**

$$V = IR$$

$$\Rightarrow \quad I = \frac{V}{R}$$

$$I_1 = \frac{V}{R_1}$$

$$I_1 = \frac{12}{100,000}$$

$$I_1 = \frac{12}{10^5}$$

$$I_1 = 12 \times 10^{-5} A$$

$$I_1 = 1.2 \times 10^{-4} A \text{ Ans}$$

(b) **Formula:**

$$V = IR$$

$$\Rightarrow \quad I = \frac{V}{R}$$

$$I_2 = \frac{V}{R_2}$$

$$I_2 = \frac{12}{1000}$$

$$I_2 = 12 \times 10^{-3} A$$

$$I_2 = 1.2 \times 10^{-2} A \text{ Ans}$$

Q.14.3 The resistance of a conductor wire is 10 MΩ. If a potential difference of 100 volt is applied across its ends. Then find the value of current passing through it in mA.

Solution:

Given Data

Resistance = $R = 10\ M\Omega = 10 \times 10^6 \Omega$ ($\because M = 10^6$)

Potential difference = V = 1000 volt

Required:

Current = I = ?

Formula

$$V = IR$$

$$\Rightarrow \quad I = \frac{V}{R}$$

$$I = \frac{100}{10 \times 10^6}$$

$$I = 10 \times 10^{-6}$$

$$I = 10^{-5} A$$

$$I = 10^{-2} \times 10^{-3} A$$

$$I = \frac{1}{10^2} mA$$

$$I = \frac{1}{100} mA$$

$$I = 0.01 \text{ mA}$$

Q.14.4 By applying potential difference of 10 V across a conductor a current of 1.5A passes through it. How much energy would be obtained from the current in 2 minutes?

Solution:

Given Data

$V = 10$ volt

$I = 1.5$ Amp

Time $= t = 2\text{min} = 2 \times 60 = 120$ sec.

Required:

Energy $= W = ?$

Formula:

$W = I^2Rt$

$W = I(IR)t$

$W = I(V)t$

$W = (1.5)(10)(120)$

$W = 1800J$ **Ans.**

Q.14.5 Two resistances of 2kΩ 8kΩ are joined in series, if a 10V battery is connected across the ends of this combination, find following quantities.

(a) The equivalent resistance of the series combination.

(b) Current passing through each of the resistances.

(c) The potential difference across each resistance.

Solution:

Given Data

Value of first resistance	=	R1	=	$2K\Omega = 2\times10^3\Omega$
Value of second resistance	=	R2	=	$8K\Omega = 8\times10^3\Omega$
Potential of battery	=	V	=	10V

Required:

(a) Equivalent resistance in series	=	Re	=	?
(b) Current through each resistance	=	I	=	?
(c) Potential difference across first resistance	=	V1	=	?
Potential difference across second resistance	=	V2	=	?

Formula:

(a) Equivalent resistance $= R_e = R_1 + R_2$

$Re = 2K\Omega + 8K\Omega$

$= 10K\Omega$

Hence equivalent resistance is 10KΩ

(b) As the circuits is in series so same value of current will pass through each resistance.

$I = I_1 = I_2$

$= V = IRe$

By putting value

$$I = \frac{10}{10 \times 10^3}$$

$$I = 1 \times 10^3$$

$$I = 1mA$$

(c) Potential difference across first resistance $= V_1 = IR_1 = 1 \times 10^{-3} \times 2 \times 10^3$

$$= 2V$$

Potential difference across second resistance $= V_2 = IR_2$

$$= 1 \times 10^{-3} \times 8 \times 10^3$$

$$= 8V$$

Hence current through each resistance is 1mA and potential difference across first resistance is 2V and potential difference across second resistance is 8V.

Q.14.6 Two resistance of 6kΩ and 12kΩ are connected in parallel. A 6V battery is connected across its ends, find the values of the following quantities:

(a) Equivalent resistance of the parallel combination.

(b) Current passing through each of the resistances.

(c) Potential difference across each of the resistance.

Solution

Given Data

$R_1 = 6K\Omega = 6 \times 10^3\Omega$

$R_2 = 12K\Omega = 12 \times 10^3\Omega$

$V = 6V$

(a) Equalvalent resistance $R_e = ?$

(b) Potential differnce across $R_1 = V_1 = ?$

Potential differce across $R_2 = V_2 = ?$

(c) Current through resistance $R_1 = I_1 = ?$

Current through resistancer $R_2 = I_2 = ?$

(a) **Formula:**

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_e} = \frac{1}{6 \times 10^3} + \frac{1}{12 \times 10^3}$$

$$= \frac{2+1}{12 \times 10^3}$$

$$= \frac{3}{12 \times 10^3}$$

$$\frac{1}{R_e} = \frac{1}{4 \times 10^3}$$

$$R_e = 4K\Omega$$

Hence equivalent resistance is 4KΩ

(b) As the circuit is parallel so potential difference across each resistance is equal to potential of battery,

$$V = V_1 = V_2 = 6V$$

(c) Quantity of current through first resistance $= I_1 = \frac{V_1}{R_1}$

$$= \frac{6}{6\times10^3}$$

$$= 1\times10^{-3}$$

$$I_1 = 1mA$$

Quantity of current though second resistance $I_2 = \frac{V_2}{R_2}$

$$= \frac{6}{12\times10^3}$$

$$= \frac{1}{2\times10^3}$$

$$= 0.5\times1^{-3}$$

$$I_2 = 0.5mA$$

Hence quantity of current is 1mA and 0.5 mA

Q.14.7 An electric bulb is marked with 220V, 100W. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in kilowatt-hour consumed by the bulb in one month (30 days).

Solution

Given Data

Voltage of bulb $= V = 220V$

Power of bulb $= P = 100W$

Daily use of bulb $= t = 5h$

No. of days for bulb $= 30days$

Required:

Resistance of bulb filament $= R = ?$

Energy consumed by bulb $E = ?$

Formula

$$P = I^2R$$

But according to Ohm's law

$$I = \frac{V}{R}$$

So

$$P = \left(\frac{V}{R}\right)^2\times R$$

$$P = \frac{V_2}{R_2} \times R$$

$$P = \frac{V_2}{R}$$

$$R = \frac{V_2}{P}$$

By putting values

$$R = \frac{(220)^2}{100}$$

$$R = \frac{48400}{100}$$

$$\mathbf{R = 484\Omega}$$

Time in 30 days $= 30 \times 5 = 150$ hours

Energy in kilowatt hour $= \frac{\text{Power (Watt)} \times \text{time (hour)}}{1000}$

$$= \frac{150 \times 100}{1000}$$

$$= 15\text{kWh}$$

$$= 15\text{kWh}$$

Q.14.8 An incandescent light bulb with an operating resistance of 95 Ω is labeled "150 W." Is this bulb designed for use in a 120-V circuit or a 220-V circuit? Explain with calculations. (it has been designed for 120 V as is evident form the power formula i.e.(P =VI). Ans.

Solutions:

Given Data

$R = 95\Omega$

Power $= P = 150$ W

Required:

For which voltage bulb is designed = ? (120V or 220V)

Formula:

$$P = I^2R$$

$$150 = I^2(95)$$

$$\Rightarrow I^2 = \frac{150}{95}$$

$$I^2 = 1.5784$$

$$\sqrt{I^2} = \sqrt{1.578}$$

$$I = 1.2565$$

$$V = IR$$

$$V = (1.2565)(95)$$

$$V = 119.37\text{volt}$$

$$V = 120\text{volt}$$

This bulb is designed for 120V

Q.14.9 A house is installed with

(a) 10 bulbs of 60 W each of which are used 5 hours daily.

(b) 4 fans of 75W each of which run 10 hours daily.

(c) One T.V. of 100 W which is used 2 hours daily.

(d) one electric iron of 1000 W which us used hours daily.

If the cost of one unit of electricity is Rs. 4. Find the monthly expenditure of electricity (one month = 30 days)

Solution

Given Data

Power of 10 bulbs	=	60×10	=	600 W
Power of 4 fans	=	75×4	=	300 W
Power of 1 iron	=	1000×1	=	1000W
Power of 1 T.V	=	100×1	=	100 W
Price of per unit	=	Rs. 4		

Required:

Monthly cost of electricity of house = ?

Formula:

Energy consumed by bulb $= \dfrac{\text{Power (Watt)} \times \text{time (hour)}}{1000}$

$= \dfrac{600 \times 5 \times 30}{1000} = \dfrac{90000}{1000}$

$=$ 90 unit

Energy consumed by fans $= \dfrac{\text{Power (Watt)} \times \text{time (hour)}}{1000}$

$= \dfrac{300 \times 10 \times 30}{1000} = \dfrac{60 \times 1000}{1000}$

$=$ 60 Units

Energy consumed by T.V $= \dfrac{100 \times 5 \times 30}{1000} = \dfrac{100 \times 150}{1000}$

= 15 units

Total consumed energy in units = $90 + 90 + 60 + 15$

= 255 Units

Price of electricity = $255 \times 4 = 1020$ Rs.

Hence total price of electricity is 1020 rupees.

Q. 14.10 A 100 W lamp bulb and a 4 kW water heater are connected to a 250 V supply.

Calculate

(a) The current which flows in each appliance and

(b) The resistance of each appliance when in use

Solution:

Given Data

Power = $P_1 = 100W$ (lamp)

Power = $P_2 = 4kW$ (heater)

$P_2 = 4 \times 10^3 W$

$V = 250$ Volts

Required:

(a) $I_1 = ?$

$I_2 = ?$

(b) $R_1 = ?$

$R_2 = ?$

Formula:

Current in Lamp; (I_1)

$P = VI_1$

$P_1 = VI_1$

$$\Rightarrow \quad I_1 = \frac{P_1}{V_1}$$

$$I_1 = \frac{100}{250}$$

$I_1 = 0.4A$ Ans.

(a) Current in heater; (I_2)

$P = VI$

$P_2 = VI_2$

$$\Rightarrow I_2 = \frac{P_2}{V}$$

$$I_2 = \frac{4 \times 10^3}{250}$$

$I_2 = 0.016 \times 10^3 A$

$I_2 = 16A$ Ans.

(b) Resistance of Lamp; (R_1)

$V = IR$

$V = I_1R_1$

$250 = (0.4)R_1$

$$\frac{250}{0.4} = R_1$$

$625\Omega = R_1$

$R1 = 625\Omega$ Ans.

(c) Resistance of heater; (R_2)

$$V = IR$$

$$V = I_2R_2$$

$$250 = 16(R_2)$$

$$\frac{250}{16} = R_2$$

$$15.625\Omega = R_2 \text{ Ans.}$$

Q.14.11 A resistor of resistance 5.6 Ω is connected across a battery of 3.0 V by means of wire of negligible resistance. Current of 0.5 A passes through the resistor. Calculate the

(a) power dissipated in the resistor

(b) total power produced by the battery

(c) Give the reason of difference between these two quantities.

Solution: Given that,

Resistance $R = 5.6\Omega$

Voltage $V = 3V$

Current $I = 0.5A$

Required:

(a) Power dissipated $P = ?$

(b) power produced by the battery $P = ?$

(c) Why these two quantities differ $= ?$

Calculations:

Using the formula

$$P = VI$$

We know that

$$V = IR$$

$$P = I^2R$$

By putting the values

$$P = (0.5A)^2 (5.6\Omega)$$

$$= 0.25A \times 5.6\Omega$$

$$P = 1.4W \text{ Ans.}$$

(b) Using the formula

$$P = VI$$

By putting the values

$$P = 3V \times 0.3A$$

$$P = 1.5 \text{ W Ans.}$$

(c) Because some power is lost by the internal resistance of the battery