UNIT 10

SIMPLE HARMONIC MOTION AND WAVES

10.1 SIMPLE HARMONIC MOTION (SHM)

LONG QUESTIONS

Q.1 Define SHM. Also prove that motion of mass attached with spring have simple harmonic motion. **(K.B + U.B + A.B)**
(LHR-G1),(SGD-G2),(DGK-G2),(RWP-G1),(GRW-G2)-2015 / (MTN-G1)-2016 / (SGD-G1), (SWL-G1),(FSD-G1),(RWP-G1),(DGK-G1)-2017

Ans: **SIMPLE HARMONIC MOTION**

Definition:

"Simple Harmonic Motion occurs when the **net force** is **directly proportional** to the **displacement** from the mean position and is always directed towards the mean position**"**.

Mathematical Expression: $\mathbf{F \propto -x}$

OR

Definition:

"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**"**.

Mathematical Expression: $\mathbf{a \propto -x}$

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

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 figure). If the spring is stretched or compressed through a small displacement **x** from its mean position due to external force '$\mathbf{F_{ext.}}$' on the mass.

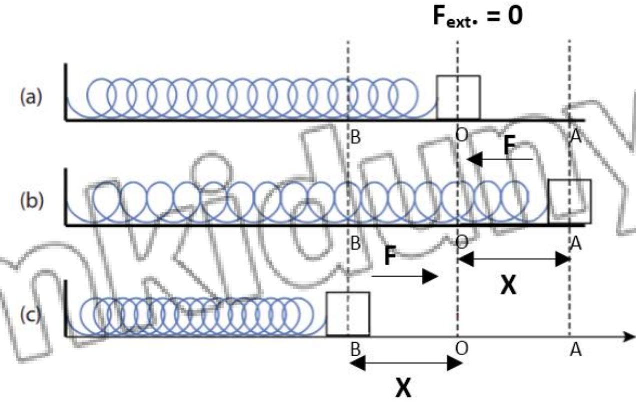


Figure: SHM of Mass-Spring System

According to Hooke's law this force is directly proportional to the change in length x of the spring within the elastic limit.

$$F_{ext.} \propto x$$

$$F_{ext.} = kx \ldots (i)$$

Where x is the displacement of the mass from its mean position O, and k is a constant called the **Spring Constant**.

$$k = \frac{F}{x} \quad ...(ii)$$

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}**.

When external force removed from mass attached to the spring then restoring force exert on the body and move it towards its mean position. This restoring force is exerted by spring on the mass

Restoring Force:

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

$$F = -F_{ext.}$$

Putting value of F_{ext}. from equation (i)

Therefore,

$$F = -kx \quad ....(iii)$$

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

$$F = ma \quad \text{Putting the value of 'F' in eq. ....(iii)}$$

$$ma = -kx$$

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

or $$a = -\text{constant } x \qquad \left(\text{Where } \frac{k}{m} = \text{constant}\right)$$

$$\Rightarrow \quad a \propto -x$$

It means acceleration of mass attached to a spring is directly proportional to its displacement from the mean position. Hence, the horizontal motion of a mass-spring system is an example of simple harmonic motion.

The **negative sign** in **eq. (iii)** shows that the force exerted by the spring is always directed opposite to the displacement of the mass.

At Mean Position 'O':

Initially the mass m is at rest in mean position O and the resultant force on the mass is zero. Hence at this position **P.E = 0, K.E = 0, V = 0 and a = 0**

From Position 'O' to 'A':

Suppose the mass is pulled through a **distance** x up to extreme position A at this position **P.E** is **maximum**, **K.E** is **minimum**, **Velocity** is **minimum** and **Acceleration** is **maximum.** Then the body released from exchange position and the restoring force exerted by the spring on the mass will pull it towards mean position O. Due to restoring force the mass moves back, towards the mean position O.

At Mean Position 'O':

The magnitude of restoring force decreases with the distance from the mean position and becomes zero at O. However, the mass gains speed as it moves towards the mean position and its speed becomes maximum at mean position O, **K.E** is also **maximum**, **P.E** is **minimum** and **Acceleration** is **zero** because **displacement** "X" is equal to **zero**. Due to inertia the mass does not stop at mean position O but continues its motion and reaches the extreme position B.

From Position 'O' to 'B':

As the mass moves from the mean position O to the extreme position B, the restoring force acting on it towards the mean position steadily increases in strength. At position B, **P.E** is **maximum K.E** is **minimum**, Velocity become is **minimum** and **Acceleration** is **maximum** because **displacement** is **maximum** at this position.

Effect on Speed:
The speed of the mass decreases as it moves towards the extreme position B. The mass finally comes briefly to rest at extreme position B as shown in Figure-(c). Ultimately the mass returns to the mean position O due to the restoring force.

Conclusion:

This process is repeated, and the mass continues to oscillate back and forth about the mean position O. Such motion of a mass attached to a spring on a horizontal frictionless surface is known as "Simple Harmonic Motion" (SHM).

Time Period (T):
The time period T of the simple harmonic motion of a mass m attached to a spring is given by the followi

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

Q.2 Prove that motion of ball placed in a bowl executing simple harmonic motion when displaced from its mean position. **(K.B + A.B)**
(BWP-G1),(DGK-G1),(GRW-G1)-2016 / (SWL-G1),(LHR-G2)-2017

Ans:

BALL AND BOWL SYSTEM
SIMPLE HARMONIC MOTION

Definition:
"Simple Harmonic Motion occurs when the **net force** is **directly proportional** to the **displacement** from the mean position and is always directed towards the mean position**"**.

Mathematical Expression: $\mathbf{F \propto -x}$

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

When ball is at rest (At mean position O):
When the ball is at the mean position O, that is, at the center 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.

At Extreme Position A:
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 Mean Position O:
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.

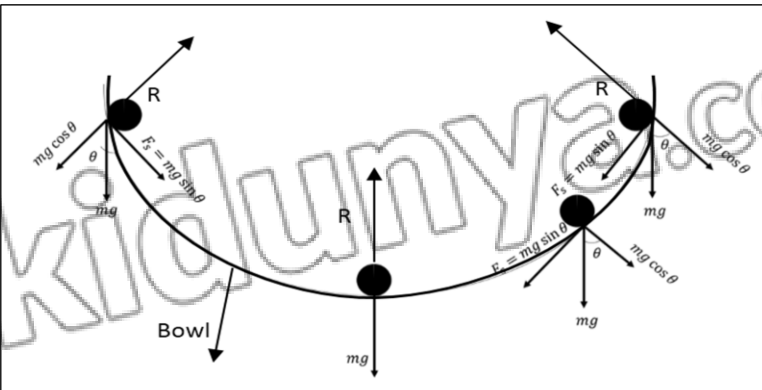


Figure: When a ball is gently displaced from the centre of a bowl it starts oscillating about the centre due to force of gravity which acts as a restoring force

At Extreme Position B:
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.

Q3. Prove that motion of simple pendulum is simple harmonic. (K.B + U.B+A.B)
(LHR-G1),(MTN-G2),(GRW-G2),(BWP-G1)(SGD-G2),(SWL-G2)-2014 / (BWP-G1),(DGK-G2),(MTN-G2), (SWL-G1/G2)-2015 / (BWP-G1),(DGK-G1),(GRW-G1)-2016 / (SWL-G1),(LHR-G2)-2017

Ans: **MOTION OF A SIMPLE PENDULUM**
SIMPLE HARMONIC MOTION

Definition:
"Simple Harmonic Motion occurs when the **net force** is **directly proportional** to the **displacement** from the mean position and is always directed towards the mean position**"**.

Mathematical Expression: $\mathbf{F \propto -x}$

A simple pendulum also exhibits **SHM**. It consists of a small bob of **mass** 'm' suspended from a light string of **length** $'\ell'$ fixed at the upper end.

In Equilibrium Position O (at mean position O):
In the equilibrium position O, the net force on the bob is zero and bob is stationary.

Weight = Tension

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

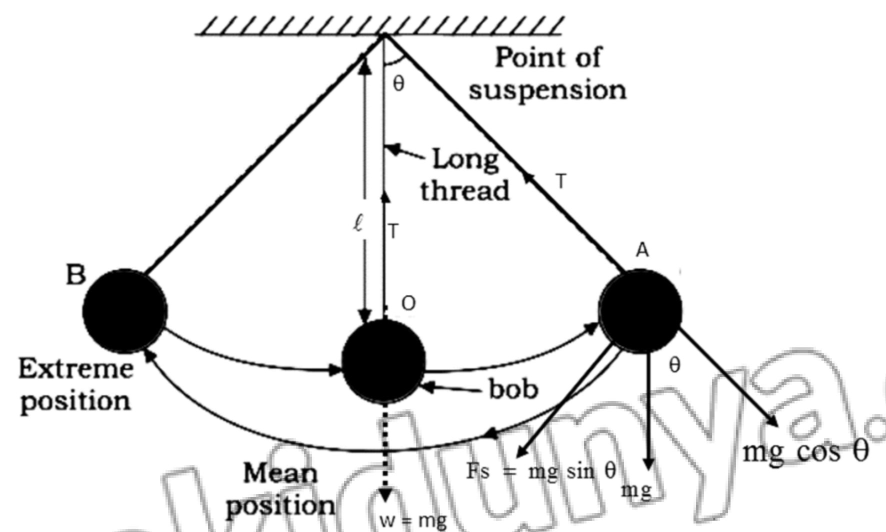


Figure: Forces acting on a displaced pendulum. The restoring force that causes the pendulum to undergo simple harmonic motion is the component of gravitational force mg sinθ tangent to the path of motion

Hence there is no motion along this direction. The component of the weight mg sinθ 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**.

$$T = mg\cos\theta,\ Fs = mg\sin\theta$$

At 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.

At Extreme Position B:

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.

Speed of bob Between Position A&B:

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.

Conclusion:

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.

Time Period (T):

We have the following formula for the time period of simple pendulum

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

Q.4 Write down important features of Simple Harmonic Motion. ***(K.B)***

(LHR-G1),(MTN-G2),(GRW-G2),(BWP-G1)(SGD-G2),(SWL-G2)-2014 / (BWP-G1),(DGK-G2),(MTN-G2), (SWL-G1/G2)-2015 / (DGK-G1),(GRW-G1)-2016 / (SWL-G1),(LHR-G2)-2017

Ans: **IMPORTANT FEATURES OF SHM**

Important features of SHM are summarized as:

- A body executing SHM always vibrates about a fixed position.
- Its acceleration is always directed towards the mean position.
- 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.

  Mathematical Expression: $a \propto -x$
- Its velocity is maximum at the mean position and zero at the extreme positions.

Q.5 Define following terms which characterize simple harmonic motion. ***(K.B)***

- **Vibration**
- **Time period**
- **Frequency**
- **Amplitude**
- **Displacement**

(GRW-G1) (DGK-G2)-2014 / (RWP-G1) (BWP-G1) (SGD-2) (LHR-G1)-2016 / (LHR-G1)-2016 / (RWP-G2) (SGD-G1) (DGK-G1) (LHR-G1) MTN-G1)-2017

Ans: **VIBRATION**

Definition:

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

TIME PERIOD

Definition:

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

Symbol: Time period is represented by 'T'.

Unit: SI unit of time period is second (s).

Formula: Time period is reciprocal of frequency i.e. $T = \frac{1}{f}$

FREQUENCY

Definition:

"The number of vibrations or cycles of a vibrating body in one second is called its frequency".

Symbol: Frequency is represented by 'f'.

Unit: SI unit of frequency is Hertz (Hz).

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

AMPLITUDE

Definition:

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

Symbol: Amplitude is represented by 'A'.

Unit: SI unit of amplitude is meter (m).

DISPLACEMENT

Definition:

"Distance of a vibrating body from its mean position at any instant during the vibration".

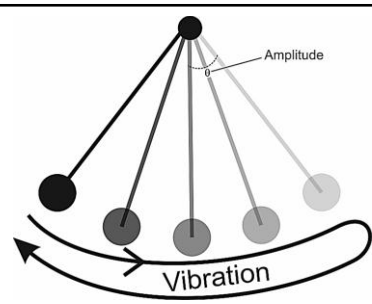


Figure: SHM of Simple Pendulum

10.1 SHORT QUESTIONS

Q.1 What do you know about restoring force? OR Define restoring force. ***(K.B)***
(MTN-G1)-2014, (FSD-G2)-2015, (SGD-G1/G2),(RWP-G1),(DGK-G2),(BWP-G2)-2016 / (SGD-G2),(RWP-G1),(BWP-G1)-2017

Ans: **RESTORING FORCE**

Definition:

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

$$F = -F_{ext.}$$
$$F = -kx$$

The negative sign in above equation shows 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. The unit of restoring force Newton (N).

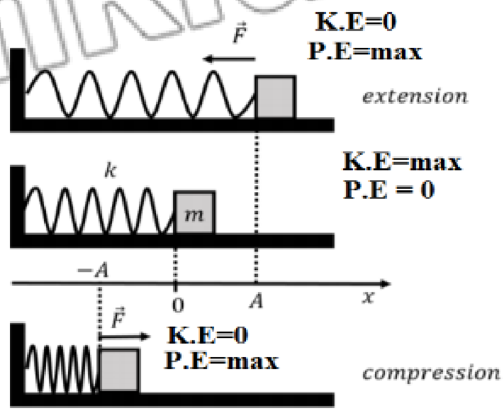
Q.2 How a spider detects its prey? ***(A.B)***

Ans: **A SPIDER DETECTS ITS PREY**

A spider detects its prey due to the vibration produced in the web.

Q.3 Draw a figure to show the Kinetic and Potential energy at different positions in a mass-spring syste

Ans: Kinetic and potential energy at different positions in a mass-spring system.



Q.4 How many times in one second a human eardrum can vibrate? ***(K.B)***

Ans: A human eardrum can oscillate back and forth up to 20,000 times in one second.

Q.5 In case of ball and bowl system and in case of simple pendulum, which force acts as restoring force

Ans:

RESTORING FORCE IN BALL & BOWL SYSTEM

When a ball is gently displaced from a centre of a bowl its starts oscillating about the centre due to force of gravity which acts as restoring force.

RESTORING FORCE IN PENDULUM

When pendulum is displaced from its extreme position, the component of gravitational force "$mg\ \sin\theta$" act as restoring force because $mg\ \cos\theta$ is balanced by tension in the string.

Q.6 Define simple pendulum and time period of simple pendulum. ***(K.B)***

(FSD-G1),(DGK-G2)-2014 / (BWP-G1)-2016 / (LHR-G2),(BWP-G2)-2017

Ans:

SIMPLE PENDULUM

Definition:

"A simple pendulum consists of a small bob of **mass** 'm' suspended from a light string of **length** 'ℓ' fixed at the upper end".

TIME PERIOD

Definition:

"Time period of a pendulum is the time to complete one cycle." It is denoted by **'T'**.

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

Q.7 Differentiate between time period and frequency in case of vibratory motion. ***(K.B)***

(GRW-G1)-14, (LHR-16), (SGD-G1/G2)-17, (RWL-G2)-17

Ans: *Given on Pg. # 6 and 7.*

Q.8 What is meant by spring constant? ***(K.B)*** **(MTN-G1)-2015 / (AJK-G1)-2016 / (SWL-G2**

Ans:

Spring Constant

Definition:

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

Mathematical Equation:

$$k = \frac{F_{ext.}}{x}$$

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.

Unit:

It is measured in **Nm^{-1}**.

Q.9 How the atoms vibrate in solids? OR Which type of motion solid molecules performed? *(K.B)*

Ans: MOTION OF ATOMS IN SOLIDS

The atoms in the solids are held together. But they can still move and vibrate as though connected by string. Solid molecules perform vibratory motion only.

Q.10 Define vibratory motion. OR What is meant by oscillation? (K.B) (RWP-GI)-2017

Ans: VIBORATORY OR OSCILLATORY MOTION

Definition:

"A body is said to be vibrating if it moves back and forth or to and fro about a point**"**.

Another term for vibration is oscillation. A special kind of vibratory or oscillatory motion is "Simple Harmonic Motion".

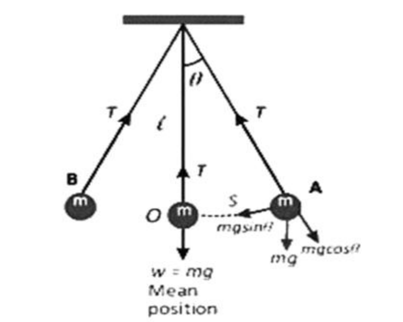


Figure: Vibratory or Oscillatory Motion of Simple Pendulum

Examples:

- Motion of mass attached to a spring.
- Motion of ball placed in a bowl.
- Motion of a Simple pendulum.
- Motion of a swing.

Q.11 Define Simple Harmonic Motion. Write conditions for SHM. (Exercise Question)
(LHR-G1),(MTN-G2),(GRW-G2),(BWP-G1)(SGD-G2),(SWL-G2)-2014 / (BWP-G1),(DGK-G2), (MTNG2),(SWL-G1/G2)-2015 / (BWP-G1),(DGK-G1),(GRW-G1)-2016 / (SWL-G1),(LHR-G2)-2017

Ans: SIMPLE HARMONIC MOTION (K.B) (given on previous page # 2)

Conditions/Requirements for SHM:

The conditions/requirements for a system executing SHM are summarized as:

- The oscillating system must have inertia.
- The oscillating system must have restoring force.
- The oscillating system must obey the Hook's law.
- The system should be frictionless.

Q.12 State Hooke's Law. Give its expression. *(K.B)*

Ans: HOOK's LAW

Statement:

"Within the elastic limit of the body. The applied force is directly proportional to the displacement**"**.

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

Mathematical Expression:

$$\mathbf{F \propto -x}$$

$$F = -kx$$

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

Q.13 Is it possible for a body to execute SHM when due to applied force spring crosses its elastic limit? *(Conceptual Base + A.B)*

Ans: It is not possible for a body to execute SHM because when body crosses its elastic limit then Hook's Law does not apply on a body and spring will permanently deformed.

Q.14 Is it possible for a simple pendulum to oscillate about its mean position forever? *(Conceptual Base +A.B)*

Ans: No, it is not possible to a simple pendulum to oscillate forever because the amplitude of oscillation will damped due to frictional force of air and other factors.

Q.15 What is the displacement of an object in SHM when kinetic and potential energies are equal? *(K.B*

Ans: **DISPLACEMENT IN SHM WHEN K.E & P.E ARE EQUAL**

The energy conservation graph in SHM is not a straight line graph (as shown in figure), it's a (parabolic) curved line graph, at intersecting point of kinetic and potential energies, the displacement on horizontal axis is 0.7 which is 70% of amplitude. Hence, in SHM kinetic & potential energies are equal when the displacement of oscillator will be 70% of its amplitude (as shown in figure).

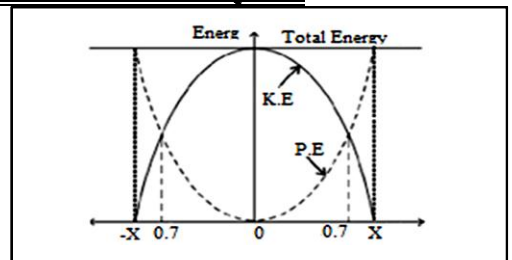
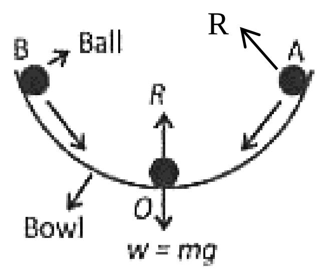


Figure: Energy-Displacement Graph in SHM

Q.16 Why in ball and bowl system weight is not balanced by the normal force of surface at extrem

Ans: At extreme position weight is not balanced by normal force of the surface because weight and normal force ar sition they have



Q.17 What are the factors upon which the time period of simple pendulum depends? *(K.B)*

Ans: **TIME PERIOD OF SIMPLE PENDULUM**

The relation for time period of simple pendulum is given by

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

The time period of simple pendulum depends upon:

- The length of string
- The value of acceleration due to gravity
- The time period of simple pendulum is **independent** of its **mass**.

Q.18 Tell whether or not these motions are examples of simple harmonic motion. *(U.B)*

(Check Your Understanding Text Book Pg. # 5)

Ans: **SHM & NON-SHM MOTIONS**

(a) Up and down motion of a leaf in a pond **(SHM)**
(b) Motion of a ceiling fan **(Not SHM)**
(c) Motion of hands of clock **(Not SHM)**
(d) Motion of a plucked string fixed at both its ends **(SHM)**
(e) Movement of honey bee **(Not SHM)**

Q.19 Why does the pendulum lose time in summer and gains time in winter? ***(Conceptual Base + U.B)***

Ans: **VARIATION OF TIME PERIOD**

As the time period of a simple pendulum is directly proportional to the square root of its length

- In summer due to increase in temperature, the length of simple pendulum increases and hence the time period of simple pendulum also increases.
- In winter due to decrease in length its time period also decreases.

Q.20 What happens to the frequency of pendulum, as its oscillations dies down from large amplitude to small? *(K.B+U.B+A.B + Conceptual Base)*

Ans: **VARIATION IN FREQUENCY**

The dissipation effect in the oscillations of simple pendulum is due to the frictional forces. The amplitude of motion of bob gradually becomes smaller and smaller due to air friction. Hence the friction has also an effect in reducing the frequency slightly.

Q.21 What is second pendulum? *(K.B+U.B)*

Ans: **SECOND PENDULUM**

Definition:

"A pendulum which completes one vibration in two seconds is called second pendulum". Thus time period of second pendulum is 2 seconds.

Q.22 What is the frequency of second pendulum? *(K.B+U.B+A.B)*

Ans: **FREQUENCY OF SECOND PENDULUM**

In SHM, the frequency and time period are related as

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

As the time period of second pendulum is 2 sec. Therefore, its frequency will be

$$f = \frac{1}{2} = 0.5 \text{ Hz}$$

Q.23 What will be the time period of simple pendulum at the center of the Earth? *(KB+U.B)*

Ans: **TIME PERIOD AT THE CENTER OF EARTH**

When the length of the pendulum is adjusted such that L=R, the bob will be at the center of the Earth. We know that at this position the value of 'g' is zero i.e g = 0.

Thus when length of simple pendulum is adjusted such that the bob is at the center the Earth, the time period of simple pendulum will be **infinity**.

Q.24 Can we realize an ideal simple pendulum? *(K.B)*

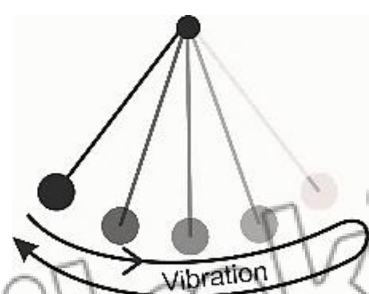
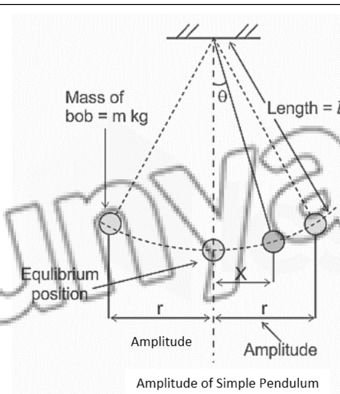
Ans: **AN IDEAL SIMPLE PENDULUM**

We cannot realize an ideal simple pendulum. An ideal simple pendulum consists of a heavy but small metallic bob suspended from a rigid frictionless support by means of long weightless and inextensible string.

Q.25 With respect to simple pendulum, what is the difference between vibration and amplitude? *(K.B+U.B)* **(LHR-G1)-2014**

Ans: **DIFFERENTIATION**

The differences between time period and frequency in case of vibratory motion are as follows:

Vibration	Amplitude
Definition	
• One complete round trip of a vibrating body about its mean position is called one vibration.	• The maximum displacement of a vibrating body on either side from its mean position is called its amplitude.
Figure	
	

Q.26 Who invented the pendulum clock and when? *(K.B)*

Ans: **INVENTION OF PENDULUM CLOCK**

Christian Huygens invented the pendulum clock in 1656. He was inspired by the work of Galileo who had discovered that all pendulums of the same length took the same amount of time to complete one full swing. Huygens developed the first clock that could accurately measure time.

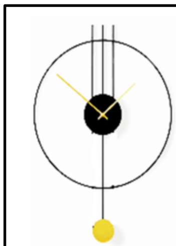


Figure: **Pendulum Clock**

10.1 MULTIPLE CHOICE QUESTIONS

1. **The maximum P.E of a vibrating mass attached to a spring is at: *(K.B+U.B)***
(A) Equilibrium position (B) Extreme position
(C) Between equilibrium and extreme positions (D) All the above

2. **In F = -kx , k indicates: *(K.B)***
(A) Force constant (B) Spring constant
(C) Constant (D) Displacement

3. **The value of k depends upon: *(K.B)***
(A) Length of spring (B) Width of spring
(C) Elasticity of spring (D) Stiffness of spring

4. **The value of spring constant in case of soft springs is: *(K.B)***
(A) Small (B) Large
(C) Mild (D) None

5. **In SHM displacement of mass and force exerted on the body is always directed: *(K.B)***
(A) Towards (B) Opposite to
(C) At same position (D) Away from

6. **With the distance from the mean position, the magnitude of the restoring force: *(K.B)***
(A) Decreases (B) Increases
(C) Not change (D) Both (A) & (B)

7. **In SHM, the mass does not stop at the mean position but continues its motion due to: *(K.B)***
(A) Restoring force (B) Inertia
(C) Reaction force (D) Gravitational force

8. **In SHM, as the mass moves towards extreme position its speed: *(K.B)***
(A) Remains some (B) Increases
(C) Decreases (D) None of these

9. **The ratio of exerted force to displacement is called: *(K.B)***
(A) Hooke's Law (B) Spring constant
(C) Restoring force (D) All of these

10. **A human eardrum can oscillate in one second back and forth up to: *(K.B)***
(A) 20,000 times (B) 2,000 times
(C) 200,000 times (D) 200 times

11. **The displacement of an object in SHM when the kinetic and potential energies are equal is: *(K.B+U.B)***
(A) Equilibrium position
(B) Extreme position
(C) In the middle of equilibrium and extreme positions
(D) 70% of its amplitude

12. **The restoring force in case of ball and bowl system is: *(K.B)***
(A) Gravitational force (B) Applied force
(C) Reaction force (D) None of these

13. **The to and fro motion of ball about mean position continues till all its energy is lost due to: *(K.B)***
(A) Gravitational (B) Reaction force
(C) Friction (D) Weight

14. **The period of a pendulum is independent of its: *(K.B)***
(A) Length (B) Mass
(C) Amplitude (D) Both (B) and (C)

15. **The time period T of simple harmonic motion of a mass m attached to a spring is given by: *(U.B+A.B)*** **(GRW)-2014**

(A) $T = 4\pi\sqrt{\frac{\ell}{g}}$ (B) $T = 2\pi\sqrt{\frac{\ell}{g}}$
(C) $T = 2\pi\sqrt{\frac{m}{k}}$ (D) $T = 2\pi\sqrt{\frac{\ell}{k}}$

16. If the mass of bob of a simple pendulum is doubled, its time period: *(U.B)*
(A) Is doubled (B) Becomes four times
(C) Remains the same (D) None of the above

17. If the length of a simple pendulum is halved, its time period T will become: *(U.B + A.B)* (LHR-15)
(A) $\frac{T}{2}$ (B) $\frac{T}{\sqrt{2}}$
(C) $\sqrt{2}T$ (D) $2T$

18. Frequency and time period are: *(U.B)* (GRW-16)
(A) Reciprocal (B) Inversely proportional
(C) Directly proportional (D) None of these

19. The product of frequency and time period is equal to: *(U.B)* (GRW-16)
(A) V (B) 1
(C) 0 (D) λ

20. Christian Huygen invented the pendulum clock in: *(K.B)*
(A) 1658 (B) 1657
(C) 1656 (D) 1654

21. In case of simple pendulum which component of weight acts as restoring force? *(K.B+U.B+A.B)*
(A) mg sinθ (B) mg cosθ
(C) mg (D) None of these

22. Mathematically, S.H.M is represented as: *(K.B+U.B)*
(A) $a \propto x$ (B) $a \propto -x$
(C) $a \propto -x^2$ (D) $a = x$

23. If length of simple pendulum become double, its time period becomes: *(U.B+A.B)*
(A) $\frac{T}{2}$ (B) $\frac{T}{\sqrt{2}}$
(C) $\frac{1}{\sqrt{2T}}$ (D) $\sqrt{2}T$

24. Time period of simple pendulum is independent of: *(K.B)*
(A) Mass (B) Amplitude
(C) Length (D) Both a and b

25. Who developed first pendulum clock that could accurately measure time? *(K.B)*
(A) Galileo (B) Archimedes
(C) Einstein (D) Huygens

EXAMPLE 10.1 (U.B + A.B)

Find the time period and frequency of a simple pendulum 1.0 m long at a location where g = 10.0 ms^{-2}. (AJK-G2)-2014 / (FSD-G2)-2015 / (FSD-G1)-2017

Solution:

Given Data:
Length of simple pendulum = l = 1.0 m
Gravitational acceleration = g = 10.0 ms^{-2}

To Find:
(i) Time period is simple pendulum = T = ?
(ii) Frequency of simple pendulum = f = ?

Formula:

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

Calculation:

By using formula, we have

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

$$T = 2\times3.14\times\sqrt{\frac{1.0\,m}{10.0\,ms^{-2}}}$$

$$T = 2\times3.14\times\sqrt{0.1}$$

$$T = 2\times3.14\times0.316$$

$$T = 1.99s$$

(ii) By using formula, we have

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

$$f = \frac{1}{1.99} = 0.50\,Hz$$

Result:

Hence, the time period and frequency of simple pendulum will be 1.99s and 0.50 Hz.

10.2 DAMPED OSCILLATIONS

LONG QUESTION

Q.1 What are damped oscillations? How damping progressively reduces the amplitude of oscillation? Describe its one application. ***(K.B +A.B)***

(LHR-G1)-2016 / (SGD-G2)-2017

Ans:

DAMPED OSCILLATIONS

Definition:

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

Explanation:

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 figure).

Application:

The practical application of damped motion is 'shock absorbers' used in automobiles.

Shock Absorbers:

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

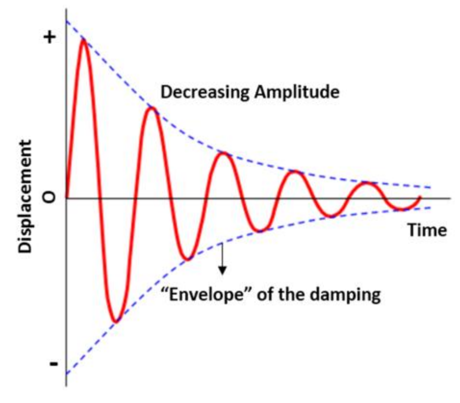


Figure: The variation of amplitude with time of damping system bump on the road, the car may vibrate violently. The shock absorbers damp these vibrations and convert their energy into heat energy of the oil.

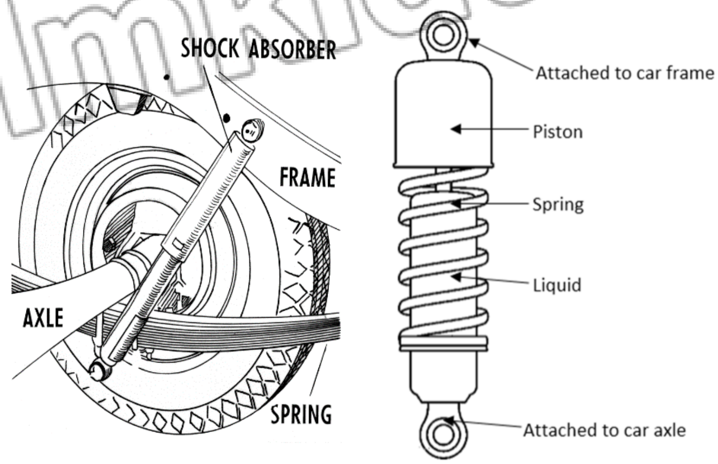


Figure: **Shock Absorber in Automobiles**

10.2 SHORT QUESTIONS

Q.1 Define damped oscillations. Give its two examples for daily life. ***(K.B +A.B)***

(AJK-G1)-2014 / (GRW-G2), (MTN-G2)-2017

Ans: *Given on Page # 14*

Q.2 Why the amplitude of damped oscillator decrease with the time? ***(K.B)***

Ans: The amplitude of oscillator decrease because it moves in resistance medium. If we remove all the resistance which damped the motion of oscillator. It will move for infinite time because its amplitude will remain same.

10.2 MULTIPLE CHOICE QUESTIONS

1. **Vibratory motion of ideal systems in the absence of any friction or resistance continues:** ***(K.B)***
   (A) Indefinitely (B) Directly
   (C) Definitely (D) All of these
2. **Shock absorbers damp vibrations and convert their energy into:** ***(A.B)***
   (A) Kinetic energy of oil (B) Potential energy of oil
   (C) Solar energy of oil (D) Heat energy of oil

10.3 WAVE MOTION

LONG QUESTION

Q.1 Define wave justify the particles of the wave always vibrate about their mean position. ***(K.B+A.B)***

Ans: **WAVE**

Definition:

"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".

Importance of waves:

Waves play an important role in our daily life. It is because waves are carrier of energy and information over large distances. Waves require some oscillating or vibrating source. Here we demonstrate the production and propagation of different waves with the help of vibratory motion of objects experimentally.

Experiment 1:

Dip one end of a pencil into a tub of water, and move it up and down vertically as shown in fig. The disturbance in the form of ripples produces water waves, which move away from the source. When the wave reaches a small piece of cork floating near the disturbance, it moves up and down about its original position while the wave will travel outwards. The net displacement of the cork is zero. The cork repeats its vibratory motion about its mean position.

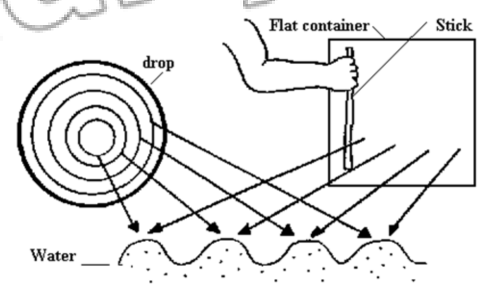


Figure: Waves Produced by Dipping a Pencil in a Water Tub

Experiment 2:

Take a rope and mark a point P on it. Tie one end of the rope with a support and stretch the rope by holding its other and in your hand as shown in fig. Now, flipping the rope up and down regularly will set up a wave in the rope which will travel towards the fixed end. The point P on the rope will start vibrating up and down as the wave passes across it.

The motion of point P will be perpendicular to the direction of the motion of wave.

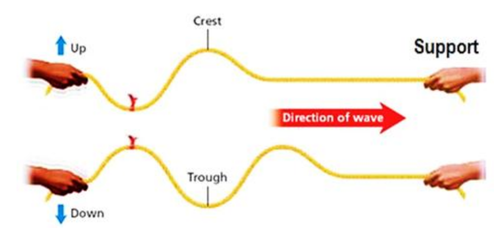


Figure: Waves Produced in a Rope

Conclusion:

From above experiments we can conclude that:

- **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.**
- **The up and down motion by flipping the rope produces a disturbance in the constituent molecules of the rope, due to which they start exhibiting vibratory motion about their mean position. Thus, this disturbance is transferred along with the wave, and a visible wave produced in a rope can be observed.**

Q.2 State and explain types of waves? **(MTN-G2)-2016 / (SGD-G2)-2017**

There are two basic categories of waves

- Mechanical waves
- Electromagnetic waves

MECHANICAL WAVES

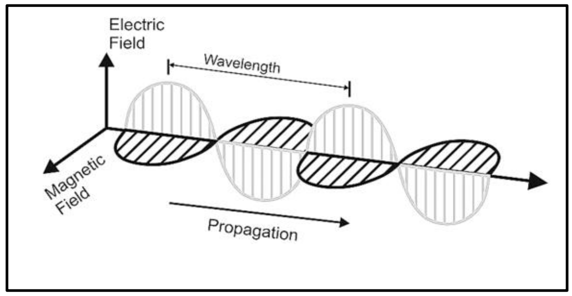
Definition:

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

Examples:

- Waves produced on water surface
- Sound waves
- Waves produced in strings and spring etc.

ELECTROMAGNETIC WAVE



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

Note: Electromagnetic waves consist of electric and magnetic fields oscillating perpendicular to each other.

10.3 SHORT QUESTIONS

Q.1 Define Mechanical and Electromagnetic waves with example? *(K.B)*
(SWL-G1)-2014 / (FSD-G1)-2016 / (MTN-G1)-2016 / (GRW-G2)-2017 / (SWL-G1)-2014 / (FSD-G1)-2016 (MTN-G1)-2016 / (BWP-G1), (FSD-G2)- (GRW-G2)-2017

Ans: *Given on page # 17*

Q.2 Do the mechanical waves pass through a space? *(K.B)* (Quick Quiz Text Book Pg. # 8)

Ans: **MECHANICAL WAVES IN SPACE**

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

10.3 MULTIPLE CHOICE QUESTIONS

1. A travelling disturbance is called: *(K.B)*

(A) Wave (B) Power
(C) Frequency (D) Time

2. Wave transfer: *(K.B+A.B)* **(GRW-2015)**

(A) Energy (B) Power
(C) Frequency (D) Disturbance

3. Such waves which require medium for their production and propagation are called: *(K.B)*

(A) Radio waves (B) Electromagnetic waves
(C) Mechanical waves (D) X-rays

4. Electromagnetic waves consist of electric and magnetic fields oscillating: *(K.B)*

(A) Opposite to each other (B) Perpendicular to each other
(C) Parallel to each other (D) Both a and b

5. Heat and light waves are: *(K.B+U.B)*

(A) Electromagnetic (B) Damped
(C) Mechanical (D) None

6. Electromagnetic waves consist of: *(K.B)*

(A) Electric field (B) Magnetic field
(C) Electric field and magnetic field (D) None of these

7. Upon which, the amount of energy carried by the wave of stretched string from its rest position depends: *(K.B)*

(A) Amplitude (B) Wave length
(C) Distance (D) Frequency

8. **Energy is transferred from one place of medium to the other in the form of: *(K.B)*** **(LHR 2016)**
(A) Heat (B) Particles
(C) Waves (D) None of these

9. **High frequency wave carries: *(K.B+A.B)***
(A) Less energy (B) More energy
(C) Both a and b (D) None of these

10.4 TYPES OF MECHANICAL WAVES

LONG QUESTIONS

Q. 1 Explain the types of mechanical waves with suitable examples. *(K.B+A.B)*
(MTN-G2),(DGK-GI),(BWP-G2)-2016 / (LHR-G1),(RWL-G2),(MTN-G2)(DGK-G1),(FSDG1/2)-2017

Ans. **TYPES OF MECHANICAL WAVES**

Depending upon the direction of displacement of medium with respect to the direction of propagation of wave itself, mechanical waves may be classified as:

- Longitudinal waves
- Transverse waves

LONGITUDINAL WAVES

Definition:

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

Examples:

- Sound Waves
- Waves produced in a spring

Explanation:

Waves produced in a slinky are longitudinal in nature, 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.

Production:

Longitudinal waves can be produced on a spring (slinky) placed on a smooth floor or a long bench. 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 figure).

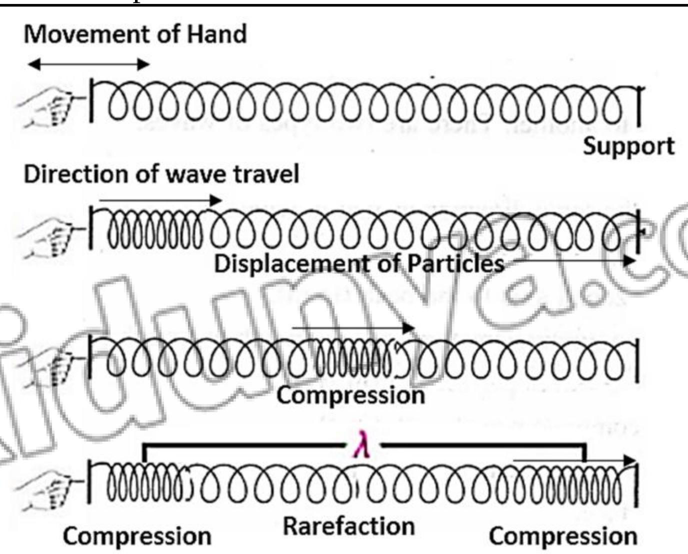


Figure: Longitudinal Wave on a Slinky

A series of disturbances will start moving along the length of the slinky such waves consist of regions called compression and rarefaction.

The compression and rarefactions move back and forth along the direction of motion of the wave.

Compression:

"The regions where the loops of the spring are close together and particles of the medium are closed together are called as compressions".

Rarefactions:

"The regions where the loops are spaced apart and particles of the medium spaced apart are called **rarefactions** (expansions)".

Wavelength:

"The distance between two consecutive compressions is called wavelengths".

TRANSVERSE WAVES

Definition:

"In the case of transverse waves, the vibratory motion of particles of the medium is perpendicular to the direction of propagation of wave".

Examples:

- Waves produced on water surface
- Waves produced in a string
- Light Waves

Production:

We can produce transvers waves 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 figure)

A wave in the form of alternative crests and troughs will start traveling towards fixed end. The crests and troughs move perpendicular to the direction of the wave.

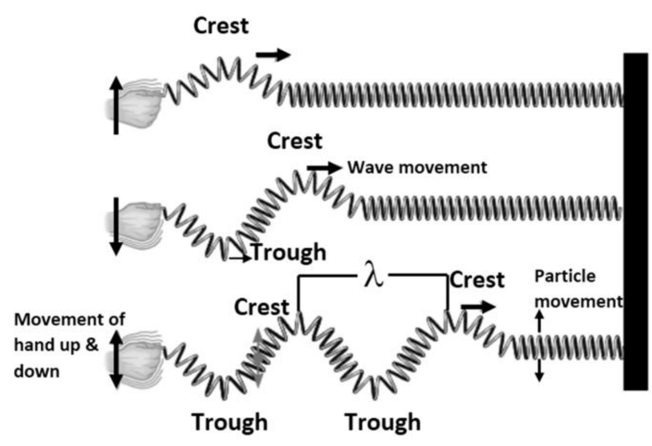


Figure: Longitudinal Wave on a Slinky

The Crests:

"The Crests are the highest points of the particles of the medium from the mean position".

The Troughs:

"The Troughs are the lowest points of the particles of the medium from the mean position".

Wavelength:

"The distance between two consecutive crests or troughs is called wavelengths".

Q.2 Describe waves as a carrier of energy in detail. ***(K.B+A.B)***

OR Waves are means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment. (Exercise Question) (BWP-G2)-2015

Ans: **WAVES AS CARRIERS OF ENERGY**

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

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.

The amount of energy carried by the wave depends on the distance of the stretched string from its rest position. That is the energy in a wave depends on the amplitude of the wave. If we shake the string faster, we give more energy per second to produce wave of higher frequency, and the wave delivers more energy per second to the particles of the string as it moves forward.

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.

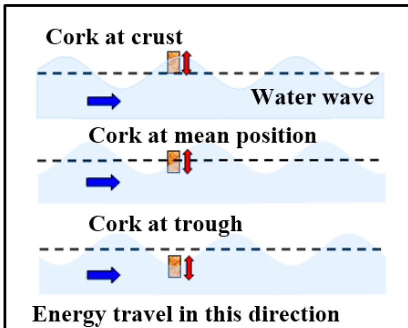


Figure: Waves as a Carrier of Energy

Conclusion

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

Q.3 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. ***(A.B)***

(Exercise Question)

(LHR-G-2)-2015 / (SGD-G2)-20116 / (MTN-G1)-2017

Ans: **RELATION BETWEEN SPEED, FREQUENCY AND WAVELENGTH**

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

Formula Derivation:

Wave is 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. $T = \frac{1}{f}$ therefore,

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

Conclusion:

Above equation is called the wave equation it is true for all type of waves i.e. longitudinal, transverse etc. The above equation shows the relation between Speed, frequency and wavelength of a wave.

10.4 SHORT QUESTIONS

Q.1 Relate the speed of longitudinal and transvers waves through solid, liquid and gas. ***(K.B+U.B)*** *For Y*

Ans: **Speed of longitudinal and transvers waves**

Longitudinal waves move faster through solids than through gases or liquids. Transvers waves move through solids at a speed of less than half of the speed 0f longitudinal waves. Reason: it is because the restoring force exerted during this up and down motion of particles of the medium is less than the restoring force exerted by a back and forth motion of particles of medium in case of longitudinal waves.

Q.2 Which wave requires more energy for generation? ***(K.B)***

For Your Information Text Book Pg. # 11

Ans: **HIGH AND LOW FREQUENCY WAVES**

Generating a high frequency wave, require more energy per second than to generate to low frequency wave. Thus, a high frequency wave carries more energy than a low frequency waves of the same amplitude.

Q.3 What do you know about seismic waves? ***(K.B)*** Do You Know Text Book Pg. # 11

Ans: **SEISMIC WAVES**

Earthquake produces waves through the curst of the earth in the form of seismic waves. By studying such waves, the geophysicist learns about the internal structure of the Earth and information about the occurrence of future Earth activity.

Q.4 Differentiate between compression and rarefaction? ***(K.B)*** **(SWL-G1)-2017**

Ans: *Given on the page # 18.*

Q.5 Differentiate between crest and trough? ***(K.B)*** **(BWP-G1)-2014**

Ans: *Given on the page # 19.*

Q.6 Differentiate between transverse waves and compressional or longitudinal waves. ***(K.B)***

Ans: *Given on the page # 18+19.*

Q.7 How can you define term wave? Elaborate difference between mechanical and electromagnetic wave. ***(K.B)*** **(**

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. Mechanical and electromagnetic wave are given on page # 17

10.4 MULTIPLE CHOICE QUESTIONS

1. The parts of longitudinal wave where loops of spring are far apart from each other: ***(K.B)***

(A) Compressions (B) Rarefactions
(C) Crest (D) Troughs

2. The speed of transverse waves as compared to the speed of longitudinal waves through solids, is: ***(K.B+U.B)***

(A) More than half (B) Half
(C) Less than half (D) Equal

3. The distance between two consecutive crests and troughs is called: ***(K.B)***

(A) Wave motion (B) Wave frequency
(C) Wave amplitude (D) Wave length

4. **Highest points are: *(K.B)***
(A) Crest (B) Through
(C) Amplitude (D) None of these

5. **Lowest points are: *(K.B)***
(A) Crest (B) Trough
(C) Amplitude (D) None of these

6. **Water and light waves are: *(K.B)***
(A) Transverse waves (B) Longitudinal wave
(C) Electromagnetic waves (D) None of these

7. **The relation between the velocity frequency and wavelength of the wave is known as: *(K.B+U.B+A.B)***
(A) Spring constant (B) Amplitude
(C) Wave equation (D) Spring constant

8. **Earthquake produces waves through the body of the Earth in form of: *(K.B)***
(A) Transverse wave (B) Longitudinal waves
(C) Seismic waves (D) None of these

9. **The region where pressure on the layer of air is more than surroundings: *(K.B)***
(A) Compression (B) Rarefaction
(C) Diffraction (D) Interference

10. **The region where pressure on the layer of the air is less than surrounding: *(K.B)***
(A) Compression (B) Rarefaction
(C) Diffraction (D) Interference

11. **The relation between velocity, wavelength and time period is: *(A.B+U.B)* (GRW 2014, LHR 2016)**
(A) $\lambda = \frac{v}{T}$ (B) $v = \lambda T$
(C) $\lambda = vf$ (D) $T = \frac{\lambda}{v}$

12. **Wave equation is true for: *(K.B+U.B)***
(A) Transverse waves (B) Longitudinal waves
(C) Both a and b (D) None of these

EXAMPLE 10.2

A wave moves on a slinky with frequency of 4 Hz and wavelength of 0.4 m. What is the speed of the wave? *(U.B+A.B)*

Solution:

Given Data:

Frequency of wave = f = 4 Hz

Wavelength = λ = 0.4 m

To Find:

Speed of wave = v = ?

Formula:

$v = f\lambda$

Calculation:

By using formula, we have

$v = f\lambda$

$v = (4\text{Hz})(0.4\text{m})$

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

Result:

Hence, the speed of wave moves on a slinky will be 1.6 ms^{-1}.

10.5 RIPPLE TANK

LONG QUESTIONS

Q.1 What is ripple tank? Write the construction and working of ripple tank. ***(K.B+A.B)***

(GRW-G2)-2016 / (SWL-G2)-2017

Ans: **RIPPLE TANK**

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 figure) waves can be produced on the surface of water present in the tray by means of a vibrator (paddle).

Working:

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 water waves consisting of straight wave fronts. 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.

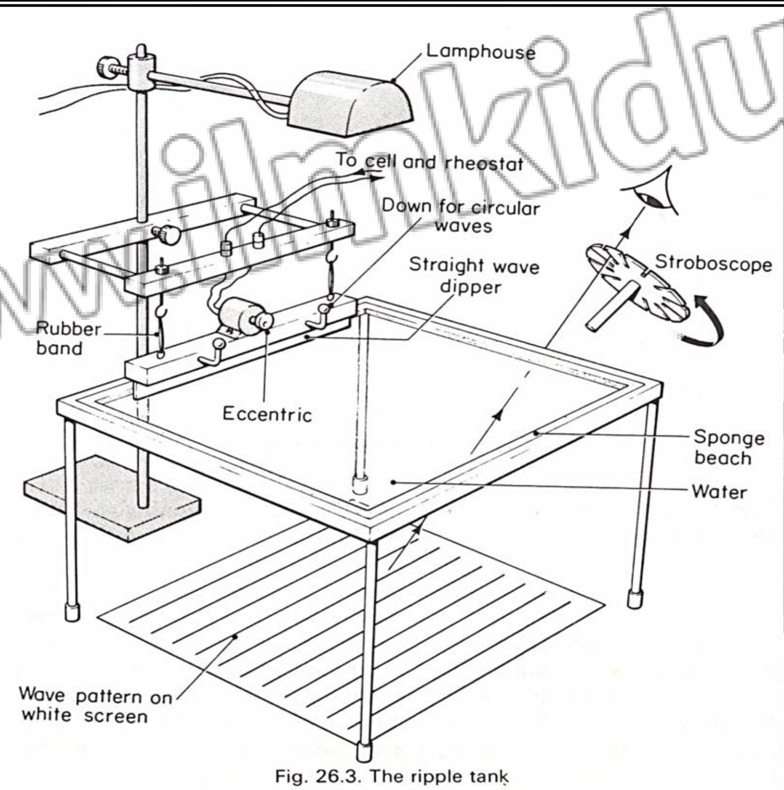


Figure: **Ripple Tank Apparatus**

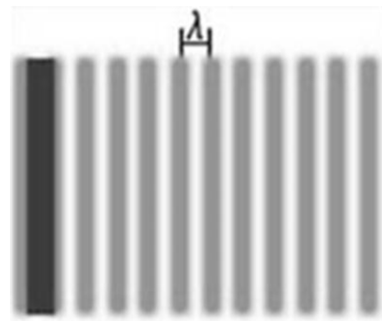


Figure: **Waves Consisting of Straight Wave fronts**

Q.2 Explain the properties of waves with reference to the ripple tank. ***(K.B+A.B)***
(Exercise Question) (RWL-G2), BWP-G1/G2)-2017

Ans: By using the ripple tank, we can produce the water waves to observe the properties of waves which are described below:

- Reflection
- Refraction
- Diffraction

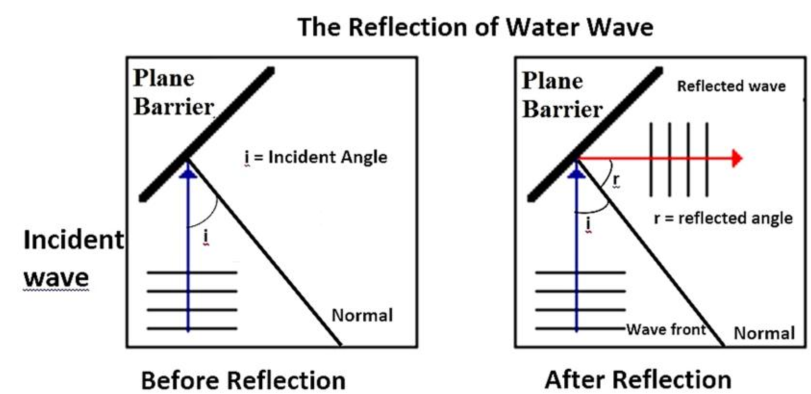
REFLECTION

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 figure).



$$\angle i = \angle r$$

Figure: Reflection of Water Waves from a Plane Barrier

REFRACTION

Definition:

"When a wave from one medium enters into the second medium at some angle, its direction of travel changes. 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 and its speed also 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 as shown in Fig. 10.14 ($V = f\lambda$).

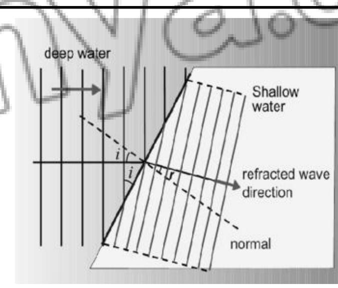


Figure: Refraction of Water Waves

In deep water the wave length of the water wave is greater as compared to wave length in shallow water due to increase in wave length its speed also increases and its frequency remain same because both types of waves in deep water and in shallow water are produced by same vibrator.

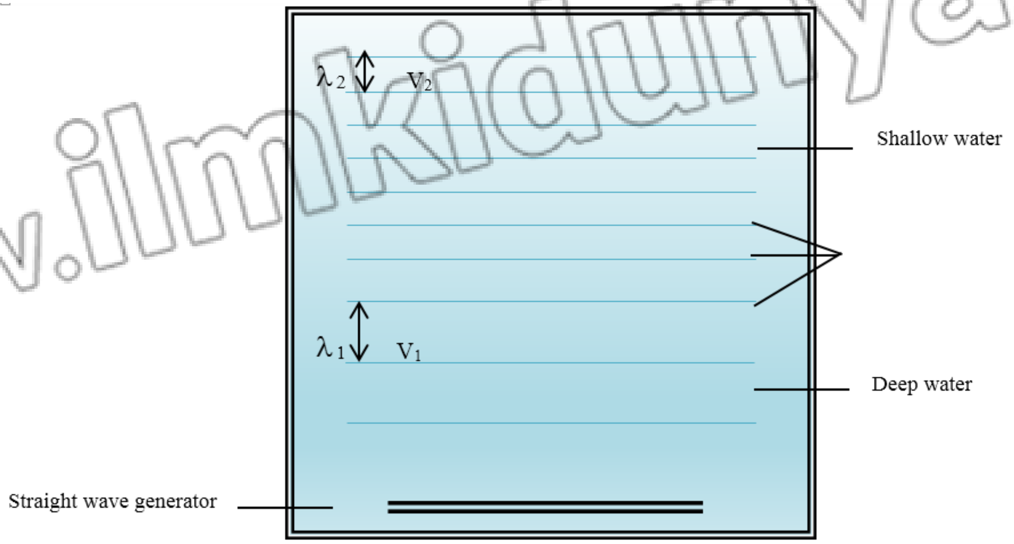


Fig. 10.14

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 (as shown in figure). 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.

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 or slits is called diffraction."

Explanation:

Now we observe the phenomena of diffraction of water waves. Generate straight 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 figure).

Figure: **Diffraction of Water Waves through a Small Slit**

(As shown in Figure) 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.

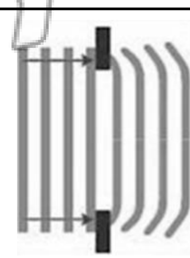


Figure: **Diffraction of Water Waves through a Large Slit**

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.

10.5 SHORT QUESTIONS

Q.1 What is the function of ripple tank? *(K.B+A.B)*
(DGK-G2)-2013

Ans: **FUNCTION OF RIPPLE TANK**

Ripple tank is a device used to produce **water waves** and to study their characteristics (Reflection, Refraction, Diffraction).

Q.2 Define refraction of wave. *(K.B+A.B)* **(LHR-G1),(GRW-G2)-2016**

Ans: *Given on Page # 24*

Q.3 Define diffraction of waves. *(K.B+A.B)* **(BWP-G2)-2014 / (SGD-G2)-2015 / (SGD-G1),(GRW-G2)-2017**

Ans: *Given on page # 25*

Q.4 What do the dark and bright fringes on the screen of ripple tank represent? *(K.B+U.B)*

(Quick Quiz Text Book Pg. # 13)

Ans: **DARK AND BRIGHT FRINGES**

Bright fringes represent crests whereas dark fringes represent troughs of the waves on the screen.

Q.5 What is the condition for diffraction? *(K.B)*

Ans: *Given on page # 25*

Q.6 What happens to the direction of wave when water wave pass from deep to shallow part of the water? Are the magnitude of angle of incidence and angle of refraction equal? Which will be greater? *(K.B+U.B+A.B+Conceptual Base)*

(ACTIVITY: Text Book Pg. # 14)

Ans: **DIRECTION OF WAVE**

When water wave enters from deep to shallow depth, wave changes its direction in addition to decrease in wavelength. It is clear that when water enters the shallow part, water wave bend towards the normal on line separating the two parts. Hence the angle of refraction becomes less than angle of incidence.

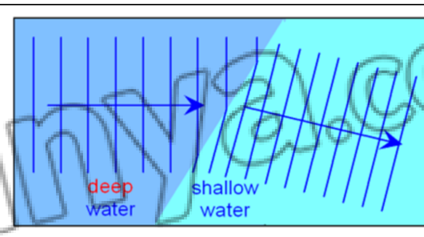
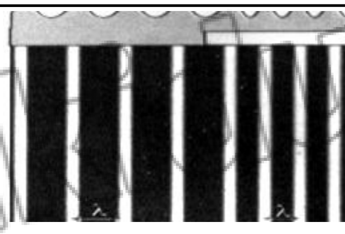


Figure: **Refraction of Water Waves**

Q.7 Why bright lines are seen on the screen of the ripple tank? *(K.B+U.B)*

Ans: **BRIGHT LINES ON SCREEN**

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 (as shown in figure below).



Q.8 Why dark lines are seen on the screen of the ripple tank? ***(K.B+U.B)***

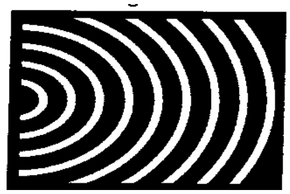
Ans: **DARK LINES ON SCREEN**

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 (as shown in figure below).

Q.9 How can we generate circular waves in a ripple tank? ***(K.B+A.B)***

Ans: **CIRCULAR WAVES IN A RIPPLE TANK**

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 (as shown in figure below).



Q.10 In relation $v = f\lambda$ which two quantities depend upon the properties of the medium and why does third one not? ***(K.B+A.B+U.B)***

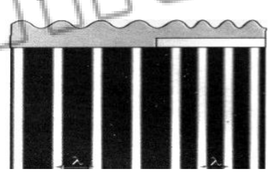
Ans: **DEPENDANCE OF *v*, λ and *f***

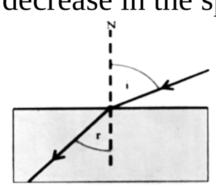
In relation $v = f\lambda$., v and λ depend on the properties of the medium while *f* does not depend on the properties of the medium because frequency (*f*) depends upon the frequency of the vibrator.

Q.11 Why does wavelength decrease in shallow part of water? ***(Conceptual Base+K.B+A.B)***

Ans: **DECREASE OF WAVELENGTH IN SHALLOW PART**

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.





Q.12 What are the factors which affect refraction? ***(K.B)***

Ans: **FACTORS AFFECTING REFRACTION**

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.

Q.13 What is the effect of diffraction on water waves? ***(K.B)***

Ans: **EFFECT OF DIFFRACTION**

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.

Q.14 What is the importance of diffraction in daily life? ***(A.B)***

Ans: **IMPORTANCE OF DIFFRACTION**

The importance of diffraction in our daily life is given as follow:

- Due to diffraction of radio waves, transmission can be heard in such areas where the waves cannot reach directly.
- The closely spaced tracks on a CD or DVD act as a diffraction grating to form the familiar rainbow pattern we see when looking at a disk.

Q.15 How do ocean waves cause destruction? ***(K.B+A.B)***

Ans: **OCEAN WAVES CAUSE DESTRUCTION**

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.

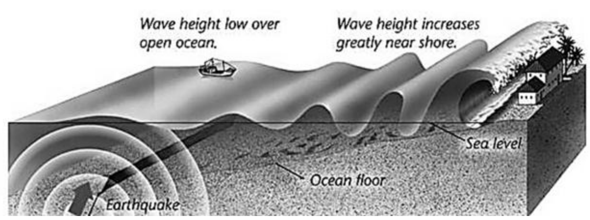


Figure: Ocean Waves Cause Destruction

10.5 MULTIPLE CHOICE QUESTIONS

1. **The apparatus used to study the properties of waves is:** ***(K.B+A.B)***
   (A) Ripple tank (B) Stroboscope
   (C) Stethoscope (D) Endoscope
2. **Vibrator is:** ***(K.B+A.B)***
   (A) Oscillating motor (B) Moving motor
   (C) Wave (D) None of these
3. **Crests and troughs appear as:** ***(K.B)***
   (A) Dark and light (B) Bright and dark
   (C) Dull and shining (D) Shining and dull
4. **Refraction of light rays depend upon:** ***(K.B)***
   (A) Speed (B) Frequency
   (C) Amplitude (D) Wavelength
5. **Refraction of water waves depend upon:** ***(K.B)***
   (A) Depth (B) Frequency
   (C) Amplitude (D) All of them

6. **Diffraction of waves can clearly be observed if size of the slit or obstacle is nearly equal to the: *(K.B)***
(A) Trough of wave (B) Crest of wave
(C) Amplitude of wave (D) Wavelength

7. **Transmission can be heard in such areas where the waves cannot reach directly due to: *(K.B + A.B)***
(A) Reflection (B) Refraction
(C) Interference (D) Diffraction

8. **The observe the diffraction properly the slit or obstacles must be equal to the: *(U.B)***
(A) Frequency (B) Amplitude
(C) Wavelength (D) Time period

9. **On screen crest appear as: *(K.B)***
(A) Bright line (B) Dark line
(C) Silver line (D) Golden line

EXAMPLE 10.3

A student performs an experiment with waves in water. The student measures the wavelength of a wave to be 10 cm. By using a stopwatch and observing the oscillations of a floating ball, the student measures a frequency of 2 Hz. If the student starts a wave in one part of a tank of water, how long will it take the wave to reach the opposite side of the tank 2 m away? (U.B + A.B)

Solution:

Given Data:

Wavelength = λ = 10 cm = 0.1 m
Frequency of wave = f = 2 Hz

To Find:

Time taken by wave = t = ?

Formula:

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

Calculation:

By using formula, we have
$$v = f\lambda$$
$$v = (2\,Hz)(0.1m)$$
$$v = 0.2\ ms^{-1}$$
Use this value to calculate the time:
$$t = \frac{2m}{0.2ms^{-1}} = 10s$$

Result:

Hence, the time taken by the wave to reach the opposite side of then tank2 m away will be 10 s.

MCQ'S ANSWER KEY (TOPIC WISE)

10.1 SIMPLE HARMONIC MOTION (SHM)

1	2	3	4	5	6	7	8	9	10	11	12
B	B	D	A	B	D	B	C	B	A	D	A
13	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
C	D	C	C	B	A	B	C	A	B	D	D
25	**D**										

10.2 DAMPED OSCILLATIONS

1	2
A	D

10.3 WAVE MOTION

1	2	3	4	5	6	7	8	9

A	A	C	B	A	C	C	C	B

10.4 TYPES OF MECHANICAL WAVES

1	2	3	4	5	6	7	8	9	10	11	12
B	C	D	A	B	A	C	C	A	B	D	C

10.5 RIPPLE TANK

1	2	3	4	5	6	7	8	9
A	A	B	A	A	D	D	C	A

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

i. **Which of the following is an example of simple harmonic motion? *(K.B)***
(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

ii. **If the mass of the bob of a pendulum is increased by a factor of 3, the period of the pendul**
(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

iii. **Which of the following devices can be used to produce both a transverse and longitu**
(a) a string (b) a ripple tank
(c) a helical spring (slinky) (d) a tuning fork

iv. **Waves transfer: *(K.B)* (SWL-G2)(LHR-G1)(RWP-G2)(GRW-G2)-2014 / (FSD-G1)(BWP-G2)(GRW-G1)-2015 / (R**
(a) energy (b) frequency
(c) wavelength (d) velocity

v. **Which of the following is a method of energy transfer? *(K.B)* (SGD-G1)(SWL-G1)(DGK-G1)-2014 / (FSD-G1**
(a) conduction (b) radiation
(c) wave motion (d) all of these

vi. **In a vacuum all electromagnetic waves have the same: *(K.B)***
(a) speed (b) frequency
(c) amplitude (d) wavelength

vii. **A large ripple tank with a vibrator working at a frequency of 30 Hz produces 25 complete waves in**
(BWP-G1)(LHR-G2)(SGD-G2)-2014 / (RWP-G1)-2016
(a) 53 cm^{-1} (b) 60cms^{-1}
(c) 750 cms^{-1} (d) 1500 cms^{-1}

viii. **Which of the following characteristics of a wave is independent of the others? *(K.B)***
(MTN-G1)(SGD-G1)-2014 / (RWP-G1)(FSD-G2)-2015 / (FSD-G2)(DGK-G1)-2016 / (LHR-G2)-2017
(a) speed (b) frequency
(c) amplitude (d) wavelength

ix. **The relation between v, f and λ of a wave is: *(U.B+A.B)***
(GRW-G1 / G2)(FSD-G1)-2014 / (MTN-G2)(LHR-G1)-2015 / (RWP-G1)(MTN-G1)(FSD-G1)(DGK-G2)-2016 / (SGD-G2)-2017
(a) $vf = \lambda$ (b) $f\lambda = v$
(c) $v\lambda = f$ (d) $v = \frac{\lambda}{f}$

ANSWER KEY

i	ii	iii	iv	v	vi	vii	viii	ix
a	b	c	a	d	a	b	c	b

REVIEW QUESTIONS

10.1 What is simple Harmonic Motion? What are the necessary conditions for a body to execute simple harmonic motion? *(K.B)*

Ans: (See Topic 10.1, Short Question-3)

10.2 Think of several examples in everyday life of motion that are simple harmonic. *(U.B)*

Ans: **<u>EXAMPLES OF SHM IN DAILY LIFE</u>**

Example of Simple Harmonic Motion (SHM) in everyday life are as follows:

- Motion of a body attached to one end of spring.
- Motion of bob of simple pendulum.
- Motion of ball in bowl system.
- Motion of the prong of the tuning Fork.

10.3 What are damped oscillations? How damping progressively reduces the amplitude of oscillation? *(K.B + U.B)*

Ans: (See Topic 10.2, Long Question-1)

10.4 How can you define term wave? Elaborate difference between mechanical and electromagnetic waves. *(K.B)*

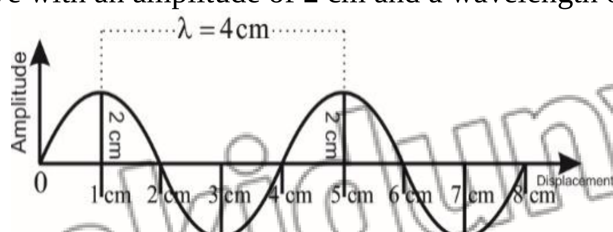
Ans: (See Topic 10.3, Short Question-3)

10.5 Distinguish between longitudinal and transverse waves with suitable examples. *(K.B)*

Ans: (See Topic 10.4, Short Questions-6)

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. *(U.B)*

Ans: A transverse wave with an amplitude of 2 cm and a wavelength of 4 cm is drawn below:



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. *(U.B + A.B)*

Ans: (See Topic 10.4, Long Question-3)

10.8 Waves are the means of energy transfer without transfer of matter. Justify this statement with the help of a simple experiment. *(K.B + U.B + A.B)*

Ans: (See Topic 10.4, Long Question-2)

10.9 Explain the following properties of waves with reference to ripple tank experiment.
a. Reflection b. Refraction c. Diffraction *(K.B + A.B)*

Ans: (See Topic 10.5, Long Question-2)

10.10 Does increasing the frequency of a wave also increase its wavelength? If not, how are these quantities related? *(K.B + U.B)*

Ans. **<u>RELATION BETWEEN FREQUENCY & WAVELENGTH</u>**

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 when speed kept constant 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 (A.B)

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

(LHR-G1)-2015 / (DGK-G2), (MTN-G1)-2017

Ans: **VARIATION IN 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 $\ell = 2\ell$

$$T' = 2\pi\sqrt{\frac{2\ell}{g}} = \sqrt{2}\left(2\pi\sqrt{\frac{\ell}{g}}\right) \Rightarrow T' = \sqrt{2}T$$

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.

Ans: **MOTION OF BALL**

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?

Ans: **EFFECT ON TIME PERIOD**

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

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?

Ans: *Given on the previous page.*

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?

Ans: 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 wavelength, 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.

NUMERICAL PROBLEMS

(U.B+A.B)

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 $g_e = 10 ms^{-2}$. **(FSD-G1)-2015**

Solution:

Given Data:

Time period of simple pendulum = T = 2 sec.

Value of 'g' on Earth = $g_e = 10\ ms^{-2}$

Value of 'g' on Moon = $g_m = \frac{g_e}{6} = \frac{10}{6} = 1.6\ ms^{-2}$

To Find:

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

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

Formula:

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

Calculation:

(i) For Earth

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

By taking square on both sides, we have

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

or

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

By putting the values, we have

$$\ell_e = \frac{(2)^2 \times 10}{4 \times (3.14)^2} = \frac{4 \times 10}{4 \times 9.86}$$

$$\boxed{\ell_e = 1.02\text{m}}$$

(ii) For Moon

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

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

By putting the values, we have

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

$$\boxed{\ell_m = 0.17\text{m}}$$

Result:

Hence, the length of pendulum on Earth and on Moon will be 1.02 m and 0.17 m respectively.

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? **(MTN-G2)-2015**

Solution:

Given Data:

Length of pendulum on Moon = ℓ_m = 0.99m

Time period of pendulum = T = 4. 9 s

To Find:

Value of g on moon = g = ?

Formula:

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

Calculation:

By using formula, we have

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

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

Squaring

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

g = 1.63 ms^{-2}

Result:

Hence, the value of 'g' of the surface of Moon will be 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 simple pendulum = ℓ = 1m

Value of 'g' on Earth = g_e = 10 ms^{-2}

Value of 'g' on Moon = g_m = 1.62 ms^{-2}

To Find:

Time period on earth = T_e = ?

Time period on moon = T_m = ?

Formula:

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

Calculation:

(i) For Earth:

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

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

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

T_e = (6.28) (0.316)

T_e = 1.985 sec.

T_e = 2sec. Ans

(ii) For Moon:

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

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

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

T = 4.9 sec

Result:

Hence, the time period of simple pendulum on Earth and Moon will be 2 s and 4.9 s respectively.

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 of second pendulum = T = 2sec

Gravitational acceleration = g = 10 ms^{-2}

To Find:

Length of simple pendulum = ℓ = ?

Calculation:

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

Squaring on both sides

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

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

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

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

ℓ = 1.02 m

Result:

Hence, the length of simple pendulum will be 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 passed through a point = n = 100

Time taken = t = 20s

Wavelength = λ = 6cm = 0.06 m

To Find:

(i) Frequency of wave = f = ?

(ii) Time period of wave = T = ?

(iii) Speed of wave = v = ?

Formula:

(i) f = n/t $\frac{\text{no. of waves passed}}{\text{Time taken}}$

(ii) Time period of wave $= T = \frac{1}{f}$

(iii) Speed of wave = v = fλ

Calculation:

(i) By using formula, we have

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

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

f = 5Hz

(ii) As, we know that

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

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

T = 0.2 sec

(iii) By using wave equation, we have

V = f λ

V = 5 $\times$ 0.06

V = 0.3 ms^{-1}

Result:

Hence, the frequency, time period and speed of the wave will be 5 Hz, 0.2 s and 0.3 ms^{-1} respectively.

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 of wooden bar = f = 12 Hz

Wavelength = λ = 3cm = 0.03 m

To Find:

Speed of wave = v = ?

Formula:

We know that

V = λ f

Calculations:

By using wave equation,

v = fλ

v = (0.03) (12)

v = 0.36 ms^{-1}

Hence, the speed of wave will be 0.36 ms^{-1}.

Result:

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 of wave = f = 190 Hz
Distance travelled by wave = d = 90 m
Time taken = t = 0.5s

To Find:

(i) Time period of wave = T = ?
(ii) Speed of wave = V = ?
(iii) Wavelength = λ = ?

Formula:

(i) $T = \frac{1}{f}$

(ii) $v = \frac{d}{t}$

(iv) $\lambda = \frac{v}{f}$

Calculations:

(i) Time period:

By using formula, we have

T = 1/f
T = 1/190
T = 0.005
T = 0.01s

(ii) Speed of wave:

By using formula, we have

V = d/t
V = 90/0.5
V = 180 m/s

(iii) Wavelength:

By using wave equation, we have

λ = v/f
λ = 180/190
λ = 0.95 m

Result:

Hence, the time period, speed and wavelength of the wave will be 0.01 s, 180 ms^{-1} and 0.05 m respectively.

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?

Solution:

Given Data:

Length of dish = d = 6.0 cm = 0.06 m
Frequency of wave = f = 4.8 Hz

To Find:

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

Formula:

(i) $v = \frac{d}{t}$

(ii) $T = \frac{1}{f}$

Calculations:

(i) Time period:
By using formula, we have
T = 1/f
T = 1/4.8
T = 0.21 s

(ii) Speed of waves:
By using formula, we have
V = d/t
V = 0.06/0.21
V = 0.29m/s

Result:

Hence, the speed and time period of water wave will be 0.29 ms^{-1} and 0.21 s respectively.

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:

Distance travelled = d = 80 cm = 0.8 m

Frequency = f = 5Hz

Wavelength = λ = 40mm = 0.04 m

To Find:

Time taken by the wave = t = ?

Formula:

(i) $v = \frac{d}{t}$

Calculation:

Using wave equation

$v = f\lambda$

v = (5) (0.04) = 0.2 m/s

Know by using formula, we have

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

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

t = 0.8/0.02

t = 4s

Hence, time taken by the wave to cross the tang will be 4s.

Result:

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 x $10^8 ms^{-1}$.

Solution:

Given Data:

Frequency of radio waves = f = 90 MHz

$f = 9\times10^7$ Hz

Speed of radio waves = v = $3 \times 10^8 ms^{-1}$

To Find:

Wave length of the radio waves = λ = ?

Formula:

According to the wave equation

$v = f\lambda$

$\lambda = v/f$

Calculation:

By wave equation,

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

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

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

λ = 3.333m

Result:

Hence, the wavelength of the radio waves transmitted by an FM station will be 3.33

SELF TEST

Time: 40 min. **Marks: 25**

Q.1 Four possible answers (A), (B), (C) & (D) to each question are given, mark the correct answer. **(6×1=6)**

1. When a body moves to and fro about a point its motion is called:

(A) Random motion (B) Linear motion
(C) Vibratory motion (D) Rotatory motion

2. What is the SI unit of frequency?

(A) Hz (B) Ampere
(C) Second (D) Coulomb

3. Which of the following quantities is not changed during refraction of light?

(A) Its speed (B) Its direction
(C) Its wavelength (D) Its frequency

4. If the length of a simple pendulum is halved its time period will become:

(A) $\frac{T}{2}$ (B) $T = \frac{T}{\sqrt{2}}$
(C) $\sqrt{2}T$ (D) $2T$

5. In which state of matter longitudinal waves move faster?

(A) Liquid (B) Solid
(C) Gas (D) Both A & B

6. Which of the following characteristics of a wave is independent of the others?

(A) Speed (B) Frequency
(C) Amplitude (D) Wavlength

Q.2 Give short answers to following questions. **(5×2=10)**

i. What do you mean by vibrating body?
ii. Define spring constant and give its unit.
iii. What is the relation between frequency and time period? Also write its unit.
iv. What is meant by damped oscillations?
v. What is meant by a crepst and trough?

Q.3 Answer the following questions in detail. **(4+5=9)**

a) Prove that the motion of a mass attached to a spring is SHM.
b) The time period of a simple pendulum is 2 s. What will be its length on Earth? What will be its length on the moon if $g_m = g_e / 6$? Where $g_e = 10ms^{-2}$.

<u>Note</u>:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.