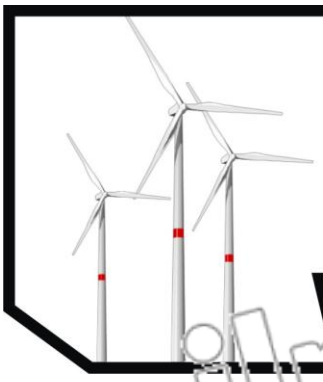

UNIT 6

WORK AND ENERGY

6.1 WORK

LONG QUESTIONS

Q.1 Define work. Derive its mathematical formula. *(K.B+U.B-A.B)*
When does a force do work? **(Ex. 6.3, GRW 2017)**

Ans: **WORK**

Definition:

"Work is done when a **force** acting on a body **displaces** it in the **direction of a force**".

Mathematically:

Work is equal to the product of force **F** and displacement **S** covered in the direction of force.

$$W = FS$$

Explanation:

Suppose a force **'F'** is acting on a body. It makes the body to move from point **'A'** to **'B'**. If the distance between these two points is **'S'** then we say that force has done some work as shown in the figure:

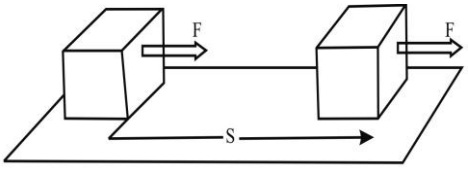

Figure: Work Done in Displacing a Body in the Direction of Force

If 'W' stands for work, 'F' for force and 'S' for distance.
Then,

$$\text{Work} = \text{Force} \times \text{Displacement}$$
$$W = FS$$

Unit of Work: **(LHR 2017)**

In System International, its unit is Nm that is also called as joule (J).

Joule:

"The amount of Work done is **one joule** if a force of **one newton** displaces a body through **one meter** in the **direction of the force."**
Thus,

$$1J = 1N \times 1m$$

Bigger Units:

Joule is a smaller unit of work. Commonly bigger units of work are also in use.

1 kilo joule (kJ) = 1000 J = 10^3 J
1 Mega Joule (MJ) =1000000J = 10^6J

Quantity:

Work is a scalar and derived quantity.

Conditions:

For work, the following two conditions must be fulfilled:

- A **force should** act on a body.

- The body should **cover some distance** under the action of this force in the direction of force.

Work Done on a Body When a Force Makes an Angle:

Sometimes force and displacement do not have same direction. Here the force **F** is making an angle **θ** with the surface on which the body is moved. Resolving **F** into its perpendicular components **'F_x'** and **'F_y'** as shown in the figure:

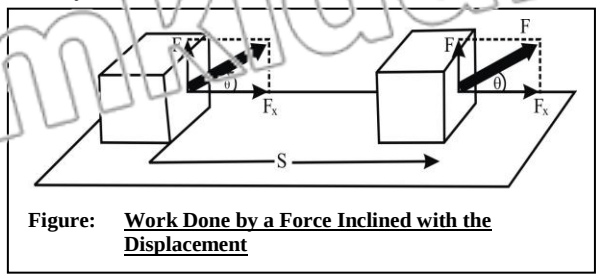

Figure: **Work Done by a Force Inclined with the Displacement**

$$F_x = F \cos \theta$$
$$F_y = F \sin \theta$$

In case when force and displacement are not parallel **then x-component F_x** parallel to the surface causes the body to move on the surface and not **y-component F_y.**

Hence $W = F_x S$
$W = (F\cos \theta) S$
$W = FS \cos \theta$

Dependence:

Work depends upon following factors:

- **Force:** Greater the force greater will be the work done.
- **Displacement of The Body:** Greater the distance covered in the direction of the force greater will be the work done on the body.
- **Angle:** Work done also depends upon angle between force and displacement covered by the body.

6.1 SHORT QUESTIONS

Q.1 Write conditions for work to be done. ***(K.B+U.B)***

Ans: **CONDITIONS FOR WORK**

Following are the conditions for work to be done:

- A force should act on a body.
- The body should cover some distance under the action of this force.
- Work also depends on angle between applied force and displacement covered by the body. For work to be done both applied force and displacement covered should not be perpendicular to each other.

Q.2 How much work is done when a body moves with uniform velocity? ***(K.B+U.B)***

Ans: **UNIFORM VELOCITY AND WORK DONE**

When a body moves with uniform velocity means moving with zero acceleration then work done will be zero because according to Newton's second law of motion if a = 0 then the net resultant force acting on the body is zero.

As we know that $W = FS$
if $F = 0$ then $W = 0 \times S = 0$

Q.3 Write some conditions for the work done will be zero. ***(K.B+U.B)***

Ans: **ZERO WORK DONE**

We know,

$W = FS$

$W = FS \cos \theta$

These equations show that the work done on a body will be zero if:

- **No net force will act on the body**
  As
  $W = FS$
  $W = (0)\ S = 0$
- **Body will not cover any distance under the action of a force**
  As
  $W = FS$
  $W = F\ (0) = 0$
- **If applied force and distance covered by the body are perpendicular to each other**
  $W = FS \cos \theta$
  If force and displacement are perpendicular then $\theta = 90°$ so
  $W = FS\cos 90^0$
  $\therefore \cos 90^0 = 0$
  So, $W = FS(0) = 0$

Q.4 Write some conditions for the work done to be maximum. ***(K.B+U.B)***

Ans:

MAXIMUM WORK DONE

We know,

$W = FS$

$W = FS \cos \theta$

These equations show that the work done on a body will be maximum if:

- The force acting on the body will be maximum
- Body covers maximum displacement under the action of maximum applied force.
- Applied force and displacement covered by the body are parallel to each other as:
  $W = FS \cos \theta$

If force and displacement are parallel then $\theta = 0°$ so

$W = FS\cos 0^0$

$\therefore \cos 0^0 = 1$

So $W = FS(1)$

$W = FS$ --------(Indicates maximum work done)

Q.5 Can a work done be negative? ***(A.B+U.B)***

Ans:

NEGATIVE WORK

Yes work done on the body will be negative if applied force and displacement covered by the body are anti-parallel to each other as:

$W = FS \cos \theta$

If force and displacement are anti-parallel then $\theta = 180°$ so

$W = FS\cos 0^0$

$\therefore \cos 180^0 = -1$

So

$W = FS\ (-1)$

$W = -FS$ --------(Indicates negative work done)

Q.6 A crate is moved by pulling the rope attached to it. It moves 10m on a straight horizontal road by a force of 100 N. How much work will be done if: *(U.B+A.B)*

(Mini Exercise Pg. # 120)

1. <u>The rope is parallel to the road</u>:

Ans. As we know that $W = FS\cos\theta$.

If the rope is parallel to the road then $\theta = 0^o$.

So

$W = 100 \times 10 \times \cos 0^o$

$= 100 \times 10 \times 1$ (as $\cos 0^o = 1$)

$= 1000$ J

If the rope is parallel the work done will be 100J

2. <u>The rope is making angle of 30^o with road</u>:

Ans. As we know that $W = FS\cos\theta$.

If the rope is parallel to the road then $\theta = 30^o$.

So

$W = 100 \times 10 \times \cos 30^o$

$= 100 \times 10 \times 0.866$ (as $\cos 0 = 0.866$)

$= 866$ J

If the rope is making angle of 30^o with road the work done will be 866J

<u>Result</u>:

- **If the rope is parallel the work done will be 100J**
- **If the rope is making angle of 30^o with road the work done will be 866J**

EXAMPLES 6.1

A girl carries a 10 kg bag upstairs to a height of 18 steps, each 20 cm high. Calculate the amount of work she has done to carry the bag. (Take g =10 ms^{-2}). *(U.B+A.B)*

<u>Solution</u>:

<u>Given Data</u>:

Mass of the bag = m = 10 kg

No of steps = n = 18

Height of each step = h_1= 20 cm = 0.2 m

<u>To Find</u>:

Work done by the girl to carry the bag = W =?

<u>Calculations</u>:

As we know

$W = FS$

First we find force F = weight = mg

$F = (10)(10) = 100$ N

Total distance covered by the girl = S = no of steps x height of each step

$S = 18 \times 0.2 = 3.6$m

Now $W = FS$

Putting values

$W = 100(3.6) = 360$ J

<u>Result</u>:

360 J work is done by the girl for taking bag to 20 cm.

6.1 MULTIPLE CHOICE QUESTIONS

1. Product of force and distance covered in the direction of force is: *(K.B)*

(A) Acceleration (B) Resistance
(C) Work (D) Specific heat

2. Work done will be maximum when the angle between F and S is: *(K.B)* **(LHR 2017)**

(A) 90^0 (B) 45^0
(C) 30^0 (D) 0^0

3. Work is quantity: *(K.B)*

(A) Scalar (B) Vector
(C) Base (D) None of above

4. Unit of work is: *(K.B)*

(A) N (B) Nm
(C) J (D) Both b & c

5. What will be the work done if no force acts on the body: *(K.B)*

(A) Maximum (B) Minimum
(C) Zero (D) All of above

6. Work done will be maximum if displacement and force are: *(K.B)*

(A) Parallel (B) Perpendicular
(C) Tangent (D) Normal

7. Work done will be zero if displacement and force are: *(K.B)* **(LHR 2016)**

(A) Parallel (B) Perpendicular
(C) Tangent (D) Normal

8. If a force of one Newton acts on the body and it covers the distance of 1 meter in the direction of force. What will be the work done? *(A.B)*

(A) watt (B) One joule
(C) newton (D) coulomb

9. One Mega joule is equal to: *(K.B)* **(LHR 2011)**

(A) 10^6 J (B) 10^3 J
(C) 10^9 J (D) 10^2 J

10. What will be the magnitude of work if a force of 25 N pulls a stone through a distance of 5 m in its direction: *(K.B)*

(A) 25 J (B) 50 J
(C) 75 J (D) 125 J

11. Which unit is equal to kgm^2s^{-2} among the units given below: *(K.B)*

(A) joule (B) newton
(C) watt (D) meter

6.2 ENERGY
6.3 KINETIC ENERGY
6.4 POTENTIAL ENERGY

LONG QUESTIONS

Q.1 Define kinetic energy and derive its relation. *(K.B+U.B+A.B)* (Ex. 6.6, LHR 2011, 12, GRW 2011)

Ans:

KINETIC ENERGY

Definition

"The **energy possessed** by a body due to **its motion** is called kinetic energy**"**

Formula:

It is denoted by K.E. and its formula is given below:

$$K.E = \frac{1}{2}mv^2$$

Examples:

Following are important examples of Kinetic energy.

- Moving air is called wind. Wind has kinetic energy. We can use wind energy for doing various things. It drives windmills and pushes sailing boats.
- Moving water in a river has kinetic energy that can carry wooden logs through large distances and can also be used to drive turbines for generating electricity.

Mathematical Derivation:

Let a body of **mass** m is moving with velocity **v**. An opposing **force F** such as force of friction acting through a **distance** S brings it to rest. The body possesses kinetic energy and is capable to do work against opposing force **F** until all of its kinetic energy used up.

K.E of the body = Work done by it due to motion

$$K.E = FS$$

$$v_i = v$$

$$v_f = 0$$

$$\text{As} \quad F = ma$$

$$\therefore \quad a = -F/m$$

Since motion is opposed, hence, acceleration "**a"** is negative.

Using 3rd equation of motion:

$$2aS = v_f^2 - v_i^2$$

$$2\left(-\frac{F}{m}\right)S = (0)^2 - (v)^2$$

$$FS = \frac{1}{2}mv^2$$

As we know that K.E is equal to the work done,

So,

$$K.E = \frac{1}{2}mv^2$$

The above equation gives the K.E. possessed by a body of mass m moving with velocity v.

Conclusion:

$$K.E = \frac{1}{2}mv^2$$

Above equation shows that if we double the speed of a body its kinetic energy will become four times.

Q.2 Define Potential Energy and derive its relation. ***(K.B+U.B+A.B)*** **(Ex. 6.7)**

Ans:

POTENTIAL ENERGY

Definition:

"The energy possessed by a body due to its position is known as potential energy."

Formula:

Potential energy is denoted by P.E. and its formula is given below:

$$P.E. = m\ g\ h$$

Examples:

Following are important examples of Potential energy.

- Energy stored in water in dam at certain height.
- Energy possessed in raised hammer.
- An apple on a tree is capable to do work as it falls thus it possess energy due to its position that is Potential energy.

Types of Potential Energy:

- **Elastic Potential Energy:**
  The energy possessed by a body due to its compressed or stretched condition is known as elastic potential energy.
  Stretched bow and stretched catapult has elastic potential energy in it.
- **Gravitational Potential Energy:**
  The potential energy of a body due to its **specific height** from the **surface** of the **earth** is called its gravitational potential energy.
  Mathematical Derivation:
  Let a body of mass **m** be raised up through height **h** from the ground. The body will acquire potential energy equal to the work done in lifting it to height **h** as shown in the figure:

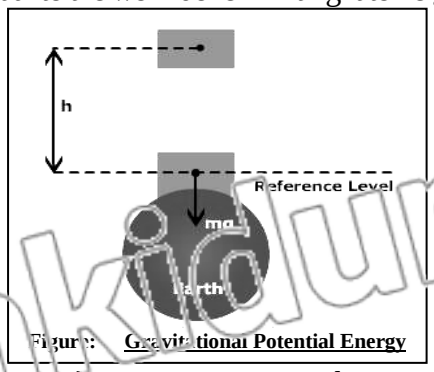

Figure: Gravitational Potential Energy

Thus, Potential Energy = F x h
= w x h

As we know that weight of the body = w = mg

So P.E. = w h = m g h

Conclusion:

Thus, the potential energy possessed by the body with respect to the ground is mgh and is equal to the work done in lifting it to a height h.

6.2,6.3,6.4 SHORT QUESTIONS

Q.1 Define Energy and write down its unit. *(K.B)* **(LHR 2012, GRW 2013)**

Ans:

ENERGY

Definition:

"A body possesses energy if it is capable to do work".

OR

Ability of a body to do work is known as energy.

Quantity:

It is a scalar quantity

Unit:

Joule (Nm) is the unit of energy same as that of work.

Types of Energy:

Energy exists in various forms such as mechanical energy, heat energy, light energy, sound energy, electrical energy, chemical energy and nuclear energy etc.

Example:

Water running down the stream has Kinetic energy in it.

Q.2 Define Elastic Potential Energy. *(K.B)*

Ans: Given on page # 212

Q.3 Define Gravitational Potential Energy. *(K.B)*

Ans:

GRAVITATIONAL POTENTIAL ENERGY

Definition:

"The potential energy of a body due to its specific height from the surface of the earth is called its gravitational potential energy".

Examples:

Energy in a ball placed at height "h" from the surface of the earth.

Q.4 The kinetic energy of a body of mass 2 kg is 25 J. What will be its speed? *(U.B+A.B)*

Solution:

Given Data:

Kinetic energy of the body =K.E. = 25J

Mass of the body = m = 2kg

To Find:

Speed of the body= v =?

Calculations:

We know

$K.E. = \frac{1}{2}mv^2$ and

$2\ K.E. = mv^2$

$$v^2 = \frac{2K.E.}{m}$$

$$v^2 = \frac{2(25)J}{2}$$

$$\sqrt{v^2} = \sqrt{25}$$

$$v = 5ms^{-1}$$

Result:

The speed of the body will be $5ms^{-1}$

EXAMPLE 6.2

A stone of mass 500 g strikes the ground with a velocity of 20ms^{-1}. How much is the kinetic energy of the stone at the time it strikes the ground? *(U.B+A.B)*

Solution:

Given Data:

Mass of the stone = m = 500g = 0.5kg

Velocity with which the stone strikes with ground = v = 20ms^{-1}

To Find:

Kinetic energy of the stone = K.E. = ?

Calculations:

We know,

$$K.E = \frac{1}{2}mv^2$$

Putting values,

$$K.E = ½ (0.5) (20)^2$$

$$K.E = 100J$$

Result:

The K.E. of the stone with which it will hit the ground is 100 J

EXAMPLE 6.3

A body of mass 50 kg is raised to a height of 3 m. What is its potential energy? $\left(g = 10\ ms^{-2}\right)$ ***(U.B+A.B)*** **(LHR 2017)**

Solution:

Given Data:

Mass of the body = m = 50 kg

Height of the body = h = 3m

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

To Find:

Potential energy of the body=P.E. = ?

Calculations:

We know

P.E. =mgh

Putting values

P.E.= (50)(10)(3)

P.E. = 1500 J

Result:

Hence, the potential energy of the body will be 1500 J.

EXAMPLE 6.4

A force of 200 N acts on a body of mass 20 kg. The force accelerates the body from rest until it attains a velocity of 50 ms^{-1}. Through what distance the force acts? *(U.B+A.B)*

Solution:

Given Data:

Force acting on the body = F= 200N

Mass of the body = m = 20kg

Velocity of the body = v = $50ms^{-1}$

To Find:

Distance through which the force acts = S=?

Calculations:

In this case the work done on the body will be equal to its K.E. as

Work done on the body = K.E. gained by the body

$$F.S = \frac{1}{2} m v^2$$

Putting values

$$(200)\ S = \frac{1}{2}\ (20)(50)^2$$

$$(200)S = 25000$$

$$S = \frac{25000}{200} = 125m$$

Result:

Hence, the distance moved by the body wil be 125 m.

6.2,6.3,6.4 MULTIPLE CHOICE QUESTIONS

1. Ability of a body to do work is known as: *(K.B)* **(LHR 2011)**

(A) Force (B) Momentum

(C) Power (D) Energy

2. Basic kinds of mechanical energy: *(K.B)*

(A) 1 (B) 2

(C) 3 (D) 4

3. Energy is quantity: *(K.B)*

(A) Vector (B) Scalar

(C) Base (D) None of above

4. Unit of Energy in System International is: *(K.B)*

(A) Watt (B) Joule

(C) Newton (D) Coulomb

5. Energy possessed by a body due to its motion is called? *(K.B)*

(A) Kinetic energy (B) Potential energy

(C) Mechanical energy (D) All of above

6. A bowler during playing cricket throws a ball of mass 200 g with a velocity of 20 ms^{-1}. Its kinetic energy will be: *(A.B)*

(A) 4 J (B) 40 J

(C) 400 J (D) 4000 J

7. What will be the kinetic energy of a body if its velocity is doubled? ***(A.B)*** **(GRW 2011)**
(A) Doubled (B) Four times
(C) Eight times (D) Half

8. What will be the kinetic energy of a body if its mass is doubled?
(A) Doubled (B) Four times
(C) Eight times (D) Half

9. What will be the kinetic energy of a car of mass 1000 kg moving with a velocity of 20 ms^{-1}?
(A) 2 $x10^2$ J (B) 2 $x10^3$ J
(C) 2 $x10^5$ J (D) 2 $x10^7$ J

10. Ability of a body to do work due to its position is called: **(LHR 2011)**
(A) Kinetic energy (B) Potential
(C) Weight (D) All of above

11. Ability of a body to do work due to its height from the surface of earth is called:
(A) Gravitational Potential energy (B) Elastic Potential energy
(C) Chemical Potential energy (D) Attraction energy

12. Energy possessed by a ball when it is lifted to a height 'h' from the ground:
(A) Kinetic (B) Gravitational potential
(C) Elastic potential (D) Mechanical

13. Energy of the water stored in the dam is: **(GRW 2015, 2017)**
(A) Elastic potential energy (B) Gravitational potential energy
(C) Kinetic energy (D) Mechanical energy

6.5 FORMS OF ENERGY
6.6 INTERCONVERSION OF ENERGY

LONG QUESTIONS

Q.1 Explain different Forms of Energy. ***(K.B+A.B)***

Ans: **FORMS OF ENERGY**

Energy exists in various forms. Some of the main forms of energy are explained below:

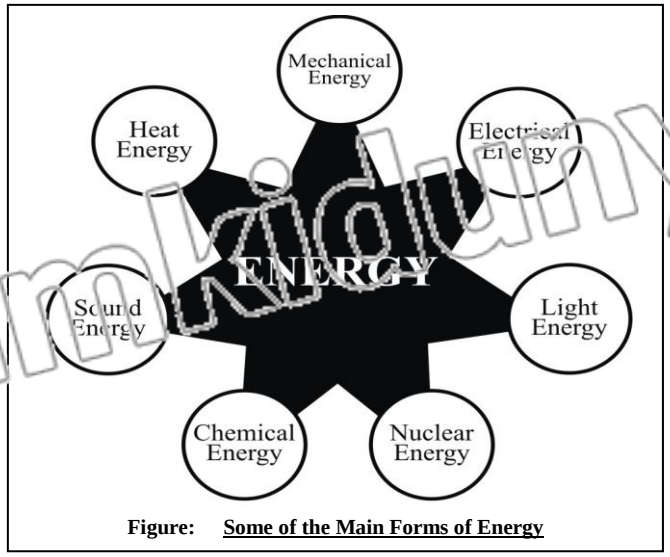

Figure: Some of the Main Forms of Energy

1) Mechanical Energy:

"The **energy possessed** by a body both due to its **motion** or **position** is called mechanical energy**"**.

Examples:

Following possess mechanical energy:

- Water running down a stream
- Wind
- A moving car
- A lifted hammer
- A stretched bow
- A catapult or a compressed spring

Types of Mechanical Energy:

Mechanical energy possessed by a body is of two types:

- **Kinetic Energy**
- **Potential Energy**

2) Heat Energy:

Heat is a form of energy given out by **hot bodies**. Large amount of heat is obtained by burning fuel. Heat is also produced when motion is opposed by frictional forces. The foods we take provide us heat energy. The Sun is the main source of heat energy.

3) Electrical Energy: **(GRW 2015)**

Electricity is one of the widely used forms of energy. Electrical energy can be supplied easily to any desired place through wires.

Sources:

We get electrical energy from **batteries** and **electrical generators**. These electric generators are run by hydro power, thermal or nuclear power.

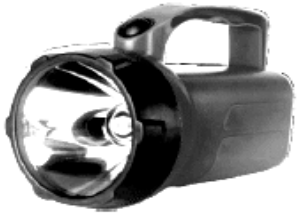

Figure: Most of the Things Use Electrical Energy for Their Operation

4) Sound Energy: **(GRW 2015)**

Sound is a form of energy. It is produced when a **body vibrates**.

Examples:

Sound is produced by:

- By knocking at the door
- By vibrating diaphragm of a drum
- By vibrating strings of a sitar
- By vibrating air column of wind instruments as flute pipe

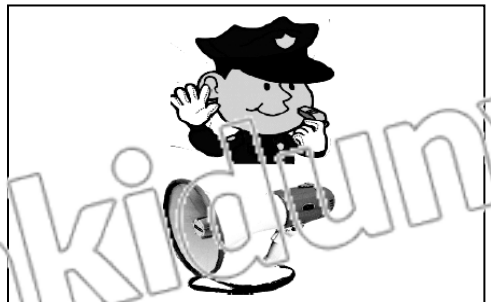

Figure: Sound Energy

5) Light Energy:

Light is an important form of energy. Plants produce food in the presence of light. We also need light to see things.

Sources:

We get light from candles, electric bulbs, and fluorescent tubes and also by burning fuel. However, most of the light comes from the Sun.

Figure: Heat Energy Coming From the Sun

6) Chemical Energy:

Chemical energy is present in **food**, **fuels** and in **other substances**. We get other forms energy these substances during chemical reactions.

Examples:

- The burning of food, coal or natural gas in air is a chemical reaction which releases energy as heat and light.
- Electric energy is obtained from electric cells and batteries as a result of chemical substances present in them.
- Animals get heat and muscular energy from the food they eat.

Figure: Our Body Gets Heat Energy From Chemical Energy Stored in Food

7) Nuclear Energy:

Nuclear energy is the energy released in the form of **nuclear radiations** in addition to **heat** and **light** during **nuclear reactions** such as **fission** and **fusion reactions**. Heat energy released in nuclear reactors is converted into electrical energy. A nuclear power plant uses the energy released in nuclear reactor such as Fission to generate electric power.

Usually we carried fission and fusion reactions in nuclear reactors.

- In fission reaction a heavy nuclei splits into smaller nuclei with the emission of large amount of nuclear energy
- In fusion reaction small nuclei combine to form a heavy nucleus with the emission of tremendous amount of nuclear energy. This reaction is taking place in the Sun.

Biggest Source of Energy:

The energy coming from the Sun for the last billions of years is the result of nuclear reactions taking place on the Sun. Sun is the biggest source of energy.

Q.2 Explain inter conversion of Energy.

OR Explain inter-conversion of energy *(U.B+A.B+K.B)*

Ans.

INTER CONSERSION OF ENERGY

Introduction:

In order to explain conversion of energy from one form to another form a law has been presented that is called **law of conservation of energy.**

According to law of conservation of energy:

"During the inter conversion of energy from one form to other forms, the total energy at any time remains constant.**"**

Energy cannot be destroyed however it can be converted into some other forms.

Example:

Rub your hands together quickly. You will feel them warm. You have used your muscular energy in rubbing hands as a result heat is produced. In the process of rubbing hands, **mechanical energy** is **converted** into **heat energy**.

Explanation:

Processes in nature are the results of energy changes. For example, some of the heat energy form the Sun is taken up by water in the oceans. This increases the thermal energy. Thermal energy causes water to evaporate from the surface to form water vapours. These vapours rise and form clouds. As they cool down, they form water drops and fall down as rain. Potential energy changes to kinetic energy as the rain falls. This rain water may reach a lake or a dam. As the rain water flows down, its kinetic energy changes into thermal energy while parts of the kinetic energy flowing water is used to wash away soil particles of rocks known as **soil erosion**.

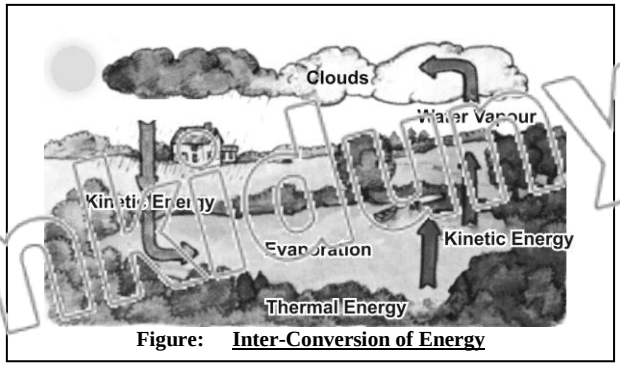

Figure: Inter-Conversion of Energy

Conclusion:

During the inter conversion of energy from one form to other forms, the total energy at any time remains constant.

6.5,6.6 SHORT QUESTIONS

Q.1 Define Mechanical Energy, Write its types. ***(K.B)*** **(LHR 2017)**

Ans: Given on Page # 117

Q.2 Give some examples of energies used in our body? ***(K.B)***

Ans: **ENERGIES USED IN DAILY LIFE**

There are many kinds of energies are used in our body. Some of them are given below:

Mechanical Energy:

For the moving of our body.

Chemical Energy:

For making body molecules.

Electrical Energy:

For the propagation of electrical signals in the body.

Heat Energy:

For maintaining the body temperature

Q.3 State law of conservation of energy.

Ans: **LAW OF CONSERVATION OF ENERGY**

Statement:

According to law of conservation of energy:

"During the **inter conversion** of **energy from** one **form** to other **forms**, the **total energy** at any time **remains constant**.**"**

Example:

Rub your hands together quickly. You will feel them warm. You have used your muscular energy in rubbing hands as a result heat is produced. In the process of rubbing hands, mechanical energy is converted into heat energy.

Q.4 Write about chemical energy and its sources. ***(K.B)***

Ans Given on Page # 118

Q.5 With the help of a figure just show inter-conversion of Kinetic and Potential energy. ***(K.B)***

Ans: **INTERCONVERSION OF ENERGY**

Inter-conversion of Kinetic energy and Potential energy is shown below.

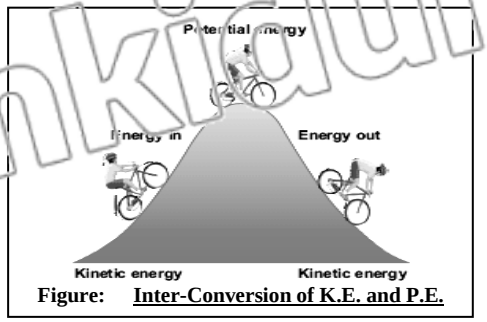

Figure: Inter-Conversion of K.E. and P.E.

6.5,6.6 MULTIPLE CHOICE QUESTIONS

1. Which kind of energy is used for movement of our body? ***(K.B+A.B)***
(A) Heat (B) Electrical
(C) Chemical (D) Mechanical

2. Which kind of energy is used for the propagation of signals in our body? ***(K.B+A.B)***
(A) Heat (B) Electrical
(C) Chemical (D) Mechanical

3. For maintaining the body temperature we use: ***(K.B+A.B)***
(A) Heat energy (B) Electrical energy
(C) Chemical energy (D) Mechanical energy

4. Increase in K.E is equal to: ***(K.B+U.B)***
(A) Increase in P.E (B) Decrease in P.E
(C) No effect (D) Both a & b

5. Increase in P.E is equal to: ***(U.B)***
(A) Increase in K.E (B) Decrease in K.E
(C) No effect (D) Both a & b

6. Decrease in K.E is equal to: ***(U.B)***
(A) Increase in P.E (B) Decrease in P.E
(C) No effect (D) Both a & b

7. Decrease in P.E is equal to: ***(U.B)***
(A) Increase in K.E (B) Decrease in K.E
(C) No effect (D) Both a & b

8. How many types of mechanical energy are? ***(K.B)***
(A) 1 (B) 2
(C) 3 (D) 4

6.7 MAJOR SOURCES OF ENERGY

LONG QUESTIONS

Q.1 Explain some non-renewable sources of Energy. ***(K.B+A.B)***

Ans:

NONRENEWABLE SOURCES OF ENERGY

Definition:

"The sources of energy that take **billions of years to reproduce** and have chances to **run-out in future** are called non-renewable energy sources**"**.

Some nonrenewable sources of energy are given below:

1) Fossil Fuels:

We use fossil fuels such as coal, oil and gas to heat our houses and run industry and transport. They are usually **hydrocarbons** (compounds of carbon and hydrogen).

Chemical Reaction:

When they are burnt, they combine with oxygen from the air. The carbon becomes **carbon dioxide**, **hydrogen** becomes **hydrogen oxide** called water; while energy is released as heat. In case of coal;

Carbon + Oxygen ⟶ carbon dioxide + heat energy

Hydrocarbon + Oxygen ⟶ carbon dioxide + water + heat energy

Fossil Fuels are Non-renewable:

The fossil fuels took **millions of years** for their formation. They are known as non-renewable resources. We are using fossil fuels at a very fast rate. Their use is increasing day by day to meet our energy needs. If we continue to use them at present rate, they will soon be **exhausted**. Once their supply is **exhausted**, the world would face **serious energy crises.**

Future Crises of Energy:

Thus, fossil fuels would not be able to meet our future energy needs. This would cause serious social and economical problems for countries like us. Therefore, we must use them wisely and at the same time, develop new energy sources for our future survival.

Harmful Effects Produced By Burning Fossil Fuels: **(LHR 2017)**

Moreover, fossil fuels release harmful waste products. These wastes include carbon **mono-oxide** and other **harmful gases**, which **pollute environment**. This causes serious health problems such as **headache**, **tension**, **nausea**, **allergic reactions**, and **irritation** of **eyes**, **nose** and **throat**. Long exposure of these harmful gases may cause **asthma**, **lungs cancer**, **heart diseases** and even **damage to brain**, **nerves** and other organs of our body.

Figure: Pollution Due to Burning of Fossil Fuels

2) Nuclear Fuels:

In nuclear power plants, we get energy as a result of fission reactions. During fission reaction, heavy atoms, such as **uranium atoms**, split up into smaller parts releasing a large amount of energy. Nuclear power plants give out a lot of nuclear radiations and vast amount of heat. A part of this heat is used to run power plants while lot of heat goes waste into the environment.

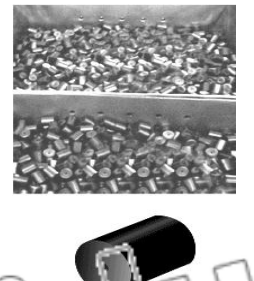

Figure: Nuclear Fuel Pallets Used in Nuclear Reactor

Q.2 Explain some renewable sources of energy. ***(K.B+A.B)***

Ans: **RENEWABLE SOURCES OF ENERGY**

Definition:

"The sources of energy that **reproduce quickly** and do not have chances to **run-out** in future are called renewable energy sources**."**

Example:

Sun light and water power are the renewable sources of energy. The will not run out like coal, oil and gas.

Sources of Renewable Energy:

Some renewable sources of energy are given below:

1) Energy Form Water:

Energy from water power is very cheap. Dams are being constructed at suitable locations in different parts of the world. Dams serve many purposes. They help to control floods by storing water. The water stored in dams is used for irrigation and also to generate electric energy without creating much environmental problems. Energy stored in the water of dams is used to run power plants.

2) Energy From Sun:

Solar energy is the energy coming from the sun and is used directly and indirectly. Sunlight does not pollute the environment in any way. The sunrays are the ultimate source of life on the Earth. We are dependent on the Sun for all our food and fuels. If we find a suitable method to use a fraction of the solar energy reaching the Earth, then it would be enough to fulfill our energy requirements.

Solar energy is most preferred form of energy due to following reasons:

- It is easily available and it is the most cheapest form of energy
- It can easily be converted into other forms of energy
- It is pollution free form of energy.

3) Wind Energy:

Wind has been used as a source of energy for centuries. It has powered sailing ships across the oceans. It has been used by wind mills to **grind grain** and **pump water**.

Wind Turbines:

More recently, wind power is used to turn wind turbines. When many wind machines are grouped together on **wind farms**, they can generate enough power to operate a power plant. In the United States, some wind farms generate more than **1300 MW** of electricity a day. In Europe, many wind farms routinely generate **hundred megawatts** or more electricity a day.

Figure: Wind Turbines

4) Geothermal Energy: (GRW 2017)

In some parts of the world, the earth provides us hot water from **geysers** and hot springs. There is **hot molten** part, deep in the Earth called **magma**. Water reaching close to the magma changes to steam due to high temperature of magma. This energy is called geothermal energy.

Electricity From Geothermal Energy:

Geothermal well can be built by **drilling deep** near hot rocks at places, where magma is not very deep. Water is then pushed down into the well. The rocks quickly heat the water and change it into steam. It expands and moves up to the surface. The steam can be pipes directly into houses and offices for heating purposes or it can be used to generate electricity.

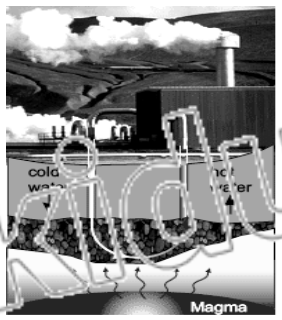

Figure: A Geothermal Power Station

5) **Energy From Biomass:** **(GRW 2015, 2017)**

Biomass is plant or **wastes** that can be burnt as fuel. Other forms of biomass are **garbage**, **farm wastes**, **sugarcane** and **other plants**. These wastes are used to run power plants. Many industries that use of forest products get half of their electricity by **burning bark** and other wood wastes. Biomass can serve as another energy source, but problems are there in its use.

Electricity From Biomass:

When animal dung, dead plants are dead animals decompose, they give off a mixture of methane and carbon dioxide. Electricity can be generated by burning methane.

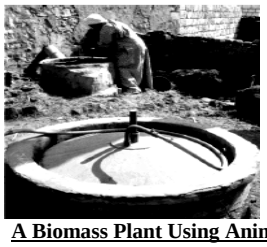

Figure: A Biomass Plant Using Animal Dung

Q.3 What is solar house heating system? Write its construction and working.
(LHR 2014) ***(K.B+A.B+U.B)***

Ans: **SOLAR HOUSE HEATING SYSTEM**

Introduction:

The use of solar energy is not new. However, it's use in houses and offices as well as for commercial industrial purposes is quite recent. Complete solar house heating system are successfully used in area with a minimum amount of sunshine in winter.

Construction:

A house heating system consists of:

- A collector
- A storage device
- A distribution system

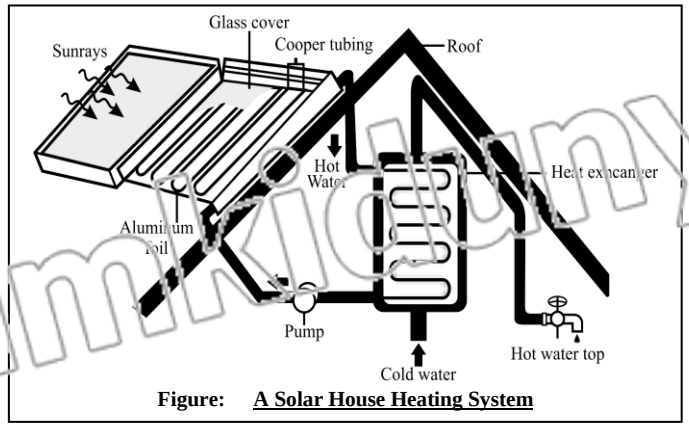

Figure: A Solar House Heating System

Working:

The above figure shows a solar collector made of glass panels over blank metal plates. The plates absorb the sun energy which heats a liquid flowing in the pipes at the back of the collector. The hot water can be used for cooking, washing and heating the buildings.

Solar energy collected through this system is used in solar cookers, solar distillation plants, and solar power plants.

Q.4 What are solar cells and solar panels? Write their use. ***(K.B)***

Ans: **SOLAR CELLS AND SOLAR PANELS**

Solar Cell:

Solar energy can also be converted directly into electricity by solar cells. A solar cell also called photo cell is made from silicon wafer. When sunlight falls on the solar cell, it converts the light directly into electrical energy.

Use:

- Solar cells are used in calculators, watches and toys.

Solar Panels:

Large number of solar cells are wired together to form a solar panel.

Uses:

- Solar panels can provide power to telephone booths, light houses and scientific research centers.
- Solar panels are also used to power satellites.

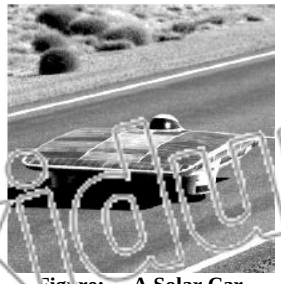

Figure: A Solar Car

Several other methods to trap sunrays are under way. If scientists could find an efficient and inexpensive method to use solar energy, then the people would get clean, limitless energy as long as the Sun continues to shine.

Q.5 Explain Mass – Energy Equation. ***(K.B+A.B+U.B)*** **(GRW 2015)**

Ans: **MASS ENERGY EQUATION**

Einstein predicted the Inter-conversion of **matter** and **energy**. According to him, a loss in the mass of a body provides us a lot **of energy**. This happens in nuclear reactions.

Equation:

The relation between mass m and energy E is given by Einstein mass – energy equation.

$$E = m c^2$$

Here c is the speed of light (3×10^8 ms^{-1}). The above equation shows that tremendous amount of energy can be obtained from small quantity of matter. It appears that matter is highly concentrated form of energy.

Energy on Sun and Stars

This process of getting energy from our nuclear power plants is based on the above equation. This process is taking place on the sun and stars for the last millions of years. Only a very small fraction of the sun energy reaches the earth. This very small fraction of the sun energy is responsible for life on the earth.

Q.6 Explain the electricity from fossil fuels with block diagram. ***(K.B+U.B)***

Ans:

ELECTRICITY FROM FOSSIL FUELS

We are using electricity in houses, offices, schools, business centers, factories and in farms. We have different ways of generating electricity. Most of the electricity is obtained using fossil fuels such as oil, gas and coal. Fossil fuels are burnt in thermal power stations to produce electricity. Various energy conversion process involved in producing electricity from coal are described in Block diagram.

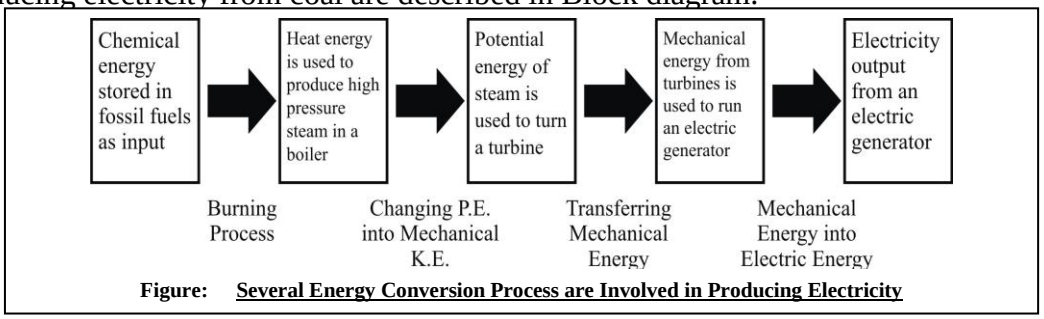

Figure: Several Energy Conversion Process are Involved in Producing Electricity

Q.7 Explain the effect of consumption of Energy on Environment. ***(K.B)***

Ans:

ENERGY AND ENVIRONMENT

Environmental problems such as pollution that consists of noise, air pollution and water pollution may arise by using different sources of energy such as fossil fuels and nuclear energy.

Pollution:

"Pollution is the change in the quality of environment that can be harmful and unpleasant for living things.**"**

Pollutants:

All things, chemicals or substances that cause pollution in our environment are called Pollutants e.g. Co_2 and So_2 are air pollutants.

Thermal Pollution:

A temperature rise in the environment that disturbs life is called thermal pollution. Thermal pollution upsets the balance of life and endangers the survival of many species.

Air Pollution:

Air pollutants are unwanted and harmful. Natural processes such as volcanic eruptions, forest fires and dust storms add pollutant to the air. These pollutant, rarely build up to harmful levels. On the other hand, the burning of fuel and solid wastes in homes automobiles, and factories releases harmful amount of air pollutants.

Nuclear Pollution:

All power plants produce waste heat, but fission plants produce the most. The heat released into a lake, a river or an ocean upsets the balance of life in them. Unlike other power plants, nuclear power plants do not produce carbon dioxide. But they produce dangerous radioactive waste.

Q.8 How can we control environmental pollution? ***(K.B)***

Ans:

CONTROLLING POLLUTION

It is not easy to control environmental pollution; however mutual efforts can reduce its rate as:

Government Laws:

In many countries, governments have passes laws to control air pollution. Some of these laws limit the amount of pollution level that power plants, factories and automobiles are allowed to give off. To meet these conditions for automobiles, new cars have catalytic converters these devices convert some polluting gases. The use of lead free petrol has greatly reduced the amount of lead in air. Engineers are working to improve new kinds of cars that use electricity or energy sources other than petrol and diesel.

Individual Efforts:

Many individual communities have laws which protect their areas from pollution. Individuals can help to control air pollutions simply by reducing the use of cars and other machines that burnt fuel. Sharing rides and using public transportation are the ways to reduce the number of automobiles in use.

6.7 SHORT QUESTIONS

Q.1 Differentiate renewable and nonrenewable sources of energy. ***(K.B)***

Ans:

DIFFERENTIATION

Renewable and nonrenewable energy sources can be differentiated as:

RENEWABLE SOURCES	NON-RENEWABLE SOURCES
Definition	
• The sources of energy that reproduce quickly and do not have chances to run-out in future are called renewable energy sources.**"**	• The sources of energy that do not reproduce quickly and have chances to run-out in future are called nonrenewable energy sources**"**.
Natural Recycling	
• They have natural recycling cycle	• They do not have natural recycling cycle.
Examples	
• Water • Sun light • Wind energy	• Coal • Gas • Oil

Q.2 Write some functions of dams. ***(K.B)***

Ans:

FUNCTIONS OF TIMES

Dams serve many purposes.

- They help to control floods by storing water.
- The water stored in dams is used for irrigation and also to generate electric energy without creating much environmental problems.
- Energy stored in the water of dams is used to run power plants.

Q.3 How can we produce electricity from geothermal energy? ***(K.B)***

Ans: Given on Page # 223

Q.4 How does a pole vaulter attain the height? ***(K.B)*** **(Do you know Pg. # 128)**

Ans:

POLE VAULTER

A pole vaulter uses a flexible vaulting pole made of special material. It is capable to store all the vaulter's kinetic energy while bending in the form of potential energy. The vaulter runs as fast as possible to gain speed. The kinetic energy gained by the pole vaulter due to speed helps him/her to rise up as the vaulter straightens. Thus he attains height as the pole returns the potential energy stored by the vaulter in the pole.

Figure A Pole Vaulter

Q.5 Draw the Flow Diagram of An Energy Converter. ***(K.B)*** **(GRW 2015)**

Ans:

FLOW DIAGRAMS

In an energy converter, a part of energy taken (used up) by the system is converted into useful work. Remaining part of the energy is dissipated as heat energy, sound energy (noise) into the environment. Energy flow diagram given below shows the energy taken up by an energy converter to transform it into other forms of energy.

Some flow diagrams of energy converters are given below:

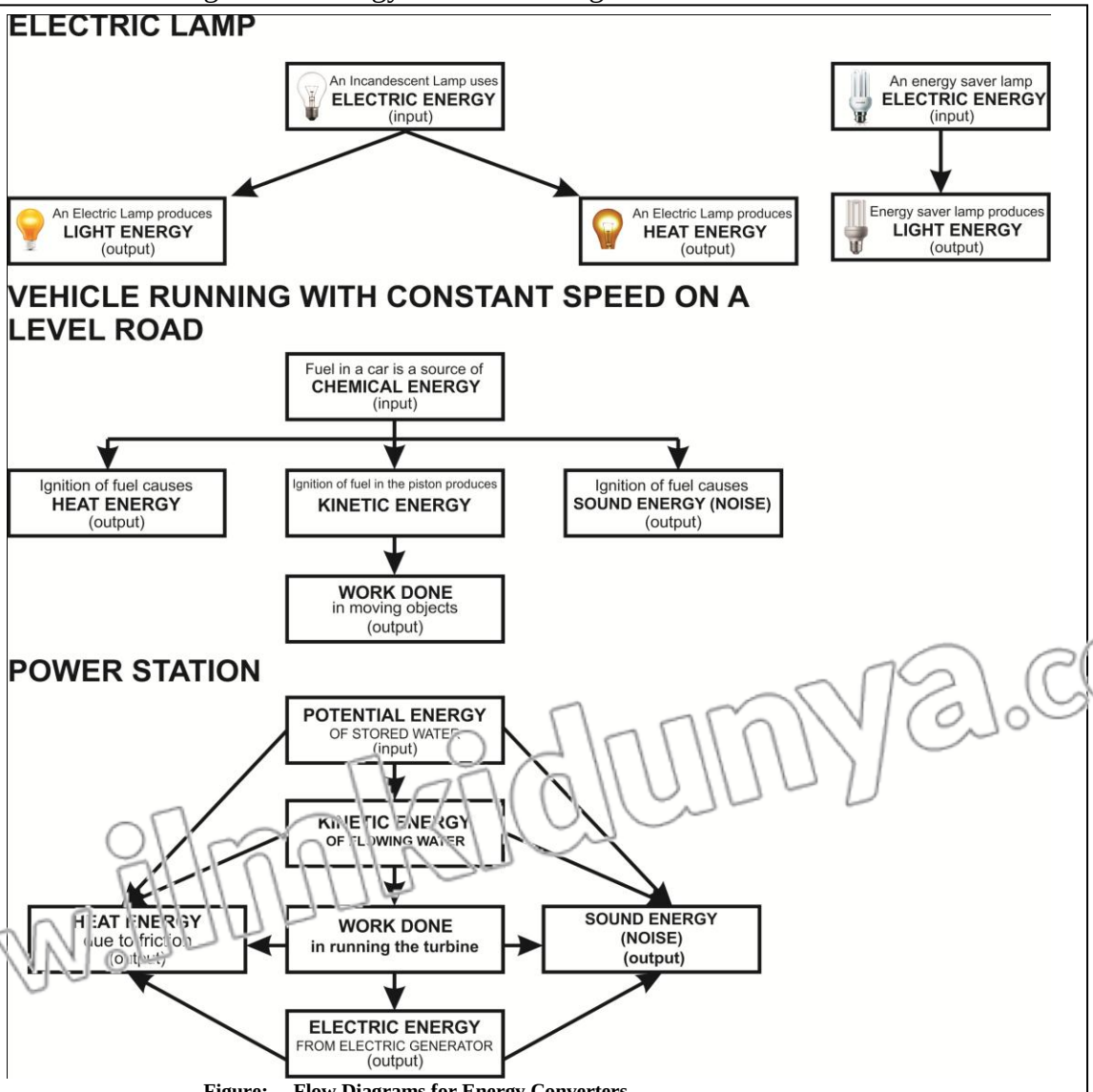

Figure: Flow Diagrams for Energy Converters

6.7 MULTIPLE CHOICE QUESTIONS

1. From following, which one is a renewable source? ***(K.B)***

(A) Coal (B) Gas

(C) Sunlight (D) Petroleum

2. The energy stored in a dam is: ***(K.B)***

(A) Electric energy (B) Potential energy

(C) Kinetic energy (D) Thermal energy

3. How many components are there of a solar heating system? ***(K.B)***

(A) 2 (B) 3

(C) 4 (D) 5

4. Solar cells are also known as: ***(K.B)***

(A) Electric cell (B) Photo cells

(C) Sun cells (D) Nuclear Cells

5. A solar cell is made up of wafers of: ***(K.B)***

(A) Silicon (B) Aluminum

(C) Nickel (D) Brass

6. In Unites State how much electricity per day is produced from wing energy: ***(K.B)***

(A) 13MW (B) 1300MW

(C) 1000MW (D) 1500MW

7. Hot molten part deep in the Earth is called: ***(K.B)***

(A) Coal (B) Gas

(C) magma (D) Petroleum

8. Mass-energy equation was given by: ***(K.B)***

(A) Newton (B) Einstein

(C) Joule (D) Pascal

9. A temperature rise in the environment disturbs life is called: ***(K.B)***

(A) Air pollution (B) Land pollution

(C) Noise pollution (D) Thermal pollution

10. What kind of waste is produced by nuclear power plant? ***(K.B)***

(A) Carbon dioxide (B) Radio active

(C) Fuels (D) Toxic material

11. Fossil fuels are usually: ***(K.B)***

(A) Carbon dioxide (B) Hydrogen

(C) Hydrocarbons (D) Carbon monoxide

12. Einstein's mass-energy equation relation is: ***(K.B)***

(A) $E = \frac{1}{2}mc^2$ (B) $E = mc^2$

(C) $E = m^2c$ (D) $E = 2mc^2$

6.8 EFFICIENCY
6.9 POWER

SHORT QUESTIONS

Q.1 What is Efficiency? Write its formula and unit (if any) *(K.B+U.B+A.B)*

Ans:

EFFICIENCY

Definition:

"Efficiency of a system is the **ratio** of required form of **energy obtained from** a system as **output** to the **total energy** given to it as **input"**.

Example:

Electric motors may be used to pump water, to blow air, to wash clothes, to drill holes, etc. for that they use electric energy. How good a machine is, depends how much output we obtain from it by giving certain input. The ratio of useful output to input energy is very important to judge the working of machine.

Mathematical Form:

$$\text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}}$$

Or

$$\% \text{ Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

Unit:

Efficiency is a ratio between two similar quantities so it has no unit. It is measured in percentage.

Q.2 Define the ideal system. Why is it not possible to construct 100% efficient system? *(K.B)*

Ans:

IDEAL SYATEM

Definition:

An ideal system is that which gives an output equal to the total energy used by it. In other words, its efficiency is **100 %**. People have tried to design a working system that would be 100 % efficient. But practically such system does not exist.

Reason For Not Existing 100% Efficient System:

Every system meets energy losses due to friction that causes heat, noise etc. These are not the useful forms of energy and go waste. This means we cannot utilize all the energy given to working system. The energy in the required form obtained from working system always less than the energy given to it as input.

Q.3 What is Power? Write down its unit and define it. (LHR 2017, GRW 2017) *(K.B+U.B+A.B)*

Ans:

POWER

Definition:

"Rate of doing work with respect to time is called the power.**"**

Formula:

Formula for power is given below:

$$\text{Thus Power} = \frac{\text{Work done}}{\text{Time taken}}$$

If we represent power by 'P', work by 'W' and time by 't', then

$$P = \frac{W}{t}$$

Quantity:

Since work is scalar quantity so power is also a scalar quantity.

Unit of Power:

In System International, the unit of power is watt (W).

Watt:

"The power of a body is **one watt** if it does work at the **rate of 1 joule per second** ($1Js^{-1}$)".

Bigger Units:

Bigger units of power are kilowatt (kW), megawatt (MW) etc.

$$1\ KW = 1000W = 10^3\ W$$
$$1\ MW = 1000000 = 10^6\ W$$
$$1\ horsepower = 1hp = 746\ W$$

Q.4 How much power is used by a 40 kg athlete by climbing 10m high ladder in 10s? *(U.B)*

Solution:

Given Data:

Mass of athlete = m = 40 kg

Time taken by athlete to climb= t = 10 s

Height of ladder = h = S = 10 m

To Find:

Power of athlete used for climbing = P = ?

Calculations:

As we know that Force = weight = w = mg = 40 x 10 = 400N

Work = W = FS = 400 x 10 = 4000 J

As we know that Power = P = W/t

So, Power = P = 4000/10 = 400 W

Result:

Power used by athlete is 400W

EXAMPLE 6.5

A cyclist does 12 joules of useful work while pedaling his bike from every 100 joules of food energy which he takes. What is his efficiency? (U.B+A.B)

Solution:

Given Data:

Useful work done by the cyclist = Output = 12J

Energy used by the cyclist = Input = 100J

To Find:

Efficiency of cyclist = ?

Calculations:

We know efficiency is measured in percentage as:

$$\%\text{efficiency} = \frac{\text{required form of out put}}{\text{total input energy}} \times 100$$

Putting the values,

$$\%\text{efficiency} = \frac{12}{100} \times 100 = 12\%$$

Result:

Hence, the efficiency of the cyclist will be 12%.

EXAMPLE 6.6

A man M_1 takes 80 s in lifting a load of 200 N through a height of 10 m. While another man M_2 takes 10 s in doing the same job. Find the power of each.(U.B+A.B)

Solution:

Given Data:

Force used in lifting the load = F =200N
Time taken by M_1 to do the job = t_1 = 80 s
Distance covered by the body = S = 10m
Time taken by M_2 to do the job = t_2 = 10 s

To Find:

Power of M_1 = P_1 = ?
Power of M_2 = P_2 = ?

Calculations:

As the work done by both men is same i.e.

$$W = FS$$

Putting values

$$W = (200)(10)$$
$$W = 2000J$$

Now we find power of M_1 as

$$P_1 = \frac{Work}{t_1}$$

Putting the values

$$P_1 = \frac{200}{80} = 25\,Watts$$

Now we find power of M_2 as

$$P_2 = \frac{Work}{t_2}$$

Putting the values

$$P_2 = \frac{2000}{10} = 200\ watts$$

Result:

The power of man M_1 is 25 watts and that of man M_2 is 200 watts.

EXAMPLE 6.7

Calculate the power of a pump which can lift 70 kg of water through a vertical height of 16 metres in 10 seconds. Also find the power in horse power(U.B+A.B)

Solution:

Given Data:

Mass of water = m = 70 kg
Height at which the water has been lifted = h =16 m
Time taken in lifting the water = t = 10 s

To Find:

Power of the pump (hp) = ?

Calculations:

We know,

$$\text{Power} = \frac{\text{Work}}{\text{time}}$$

In this case work done will be converted into P.E. of the body so

$$\text{Power} = \frac{mgh}{t}$$

Putting the values

$$\text{Power} = \frac{(70)(10)(16)}{10} = 1120 \text{ watts}$$

Conversion in hp:

We know

1hp = 746 watts

$$\text{Power} = \frac{1120}{17460} = 1.5 \text{ hp}$$

Result:

Hence, the power of the pump will be 1.5 hp.

6.8, 6.9 MULTIPLE CHOICE QUESTIONS

1. Rate of doing work with respect to time is known as: ***(K.B)*** **(LHR 2016)**

(A) Energy (B) Power
(C) Momentum (D) None of above

2. Unit of power is: ***(K.B)***

(A) Watt (B) Joule
(C) Newton (D) Coulomb

3. How much power is used by a 40 kg athlete by climbing 10m high ladder in 10 s: ***(A.B)***

(A) 4 W (B) 40 W
(C) 400 W (D) 4000 W

4. What will be the power of a machine doing 10 J work in 5 seconds? ***(A.B)***

(A) 2 W (B) 10 W
(C) 25 W (D) 50 W

5. Total energy of the system: ***(K.B)***

(A) Increases (B) Decreases
(C) Remains same (D) All of above

6. 1 hp = ***(K.B)***

(A) 726 W (B) 736 W
(C) 746 W (D) 756 W

7. A motor lift a weight of 5N up to the height of 2m in 4s. What will be the power of the motor? ***(A.B)***

(A) 2.5 W (B) 5 W
(C) 20 W (D) 10 W

8. What is efficiency of electric fan? ***(K.B)***

(A) 25 % (B) 80 %
(C) 55 % (D) 3 %

9. What is efficiency of Petrol engine? *(K.B)*
(A) 25 % (B) 80 %
(C) 55 % (D) 3 %

10. What is efficiency of electric motor? *(K.B)*
(A) 25 % (B) 80 %
(C) 55 % (D) 3 %

11. What will be efficiency if input is 100 J and output is 55 J? *(A.B)*
(A) 25 % (B) 80 %
(C) 55 % (D) 3 %

12. What is efficiency of solar cell? *(K.B)*
(A) 25 % (B) 80 %
(C) 55 % (D) 3 %

13. 1120 watts are equal to: *(K.B)* **(GRW 2017)**
(A) hp (B) 2.5 hp
(C) 1.5 hp (D) 2.7 hp

MCQ'S ANSWER KEY (TOPIC WISE)

6.1 WORK

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

6.2 ENERGY

6.3 KINETIC ENERGY

6.4 POTENTIAL ENERGY

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

13
B

6.5 FORMS OF ENERGY

6.6 INTERCONVERSION OF ENERGY

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

6.7 MAJOR SOURCES OF ENERGY

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

6.8 EFFICIENCY

6.9 POWER

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

13
C

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

6.1 Encircle the correct answer from the given choices.

i. The work done will be zero when the angle between force and distance is: (GRW 2014) ***(K.B)***

(a) 45^o (b) 60^o
(c) 90^o (d) 180^o

ii. If the direction of motion of the force is perpendicular to the direction of motion of the body, then work done will be: ***(K.B)***

(a) maximum (b) minimum
(c) zero (d) none of above

iii. If the velocity of a body becomes double, then its kinetic energy will: ***(A.B)***

(a) remains the same (b) becomes double
(c) becomes four times (d) become half

iv. The work done in lifting a brick of mass 2 kg through a height of 5 m above the ground will be: ***(A.B)*** **(LHR 2014)**

(a) 2.5 J (b) 10 J
(c) 50 J (d) 100 J

v. The kinetic energy of a body of mass 2 kg is 25 J. Its speed is: ***(A.B)***

(a) 5 ms^{-1} (b) 1.5 ms^{-1}
(c) 12.5 ms^{-1} (d) 50 ms^{-1}

vi. Which one of the following converts light energy into electrical energy? **(LHR 2014)** ***(K.B)***

(a) electric bulb (b) electrical generator
(c) photocell (d) electric cell

vii. When a body is lifted through a height 'h', the work done on it appears in the form of its: ***(K.B)***

(a) kinetic energy (b) potential energy
(c) elastic potential energy (d) geothermal energy

viii. The energy stored in coal is: ***(K.B)*** **(GRW 2013)**

(a) heat energy (b) kinetic energy
(c) chemical energy (d) nuclear energy

ix. The energy stored in a dam is: ***(K.B)*** **(GRW 2015)**

(a) electrical energy (b) potential energy
(c) kinetic energy (d) thermal energy

x. In Einstein's mass-energy equation, c is the: ***(K.B)*** **(LHR 2015)**

(a) speed of sound (b) speed of light
(c) speed of electron (d) speed of Earth

xi. Rate of doing work is called: ***(K.B)***

(a) energy (b) torque
(c) power (d) momentum

ANSWER KEY

i	ii	iii	iv	v	Vi	vii	viii	ix	x	xi
c	c	c	d	a	c	b	b	b	b	c

6.2 Define work. What is its SI unit? *(K.B)* **(LHR 2014)**

Ans: Given on Page # 206

6.3 When does a force do work? Explain. *(K.B)*

Ans: Given on Page # 207

6.4 Why do we need energy? *(K.B)*

Ans:

NEED OF ENERGY

We need energy to do different types of work in our daily life. When we say that body has energy, we mean that it has the ability to do work.

Examples:

- Energy is required to move.
- Energy is required to stop the moving objects.

6.5 Define energy; give two types of mechanical energy. *(K.B)*

Ans: Given on Page # 117

6.6 Define K.E. and derive its relation. *(K.B+U.B+A.B)*

Ans: See Q. no.1 Long Question TOPIC 6.2

6.7 Define potential energy and drive its relation. *(K.B+U.B+A.B)* **(LHR 2013)**

Ans: See Q. no.2 Long Question TOPIC 6.3

6.8 Why fossils fuels are called non - renewable form energy? *(K.B)* **(LHR 2013)**

Ans:

NONRENEWABLE ENERGY SOURCE

The fossil fuels took millions of years for their formation. They are known as non-renewable resources. We are using fossil fuels at a very fast rate. Their use is increasing day by day to meet them at present rate, they will soon be exhausted. Once their supply is exhausted, the world would face serious energy crises.

6.9 Which form of energy is most preferred and why? *(K.B)*

Ans:

MOST PREFERRED FORM OF ENERGY

Solar energy is most preferred form of energy due to following reasons:

- It is easily available and it is the most cheapest form of energy
- It can easily be converted into other forms of energy
- It is comparatively pollution free form of energy.

6.10 How is energy converted from one form to another? Explain. *(K.B)*

Ans: See Q. no.2 Long Question TOPIC 6.6

6.11 Name the five devices that convert electrical energy into mechanical energy. *(K.B)*

Ans:

DEVICES NAMES

Following devices convert electrical energy into mechanical energy:

- Electric Motor
- Electric Fan
- Elevator
- Drill machine
- Grinder
- Electric sewing machine

6.12 Name device that converts mechanical energy into electrical energy. (LHR 2016) *(K.B)*

Ans:

DEVICE NAME

Electric Generator is a device which is used to convert mechanical energy into electrical energy.

6.13 What is meant by efficiency of a system? *(K.B)*

Ans:

EFFICIENCY

Definition:

"Efficiency of a system is the ratio of required form of energy obtained from a system as output to the total energy given to it as input.**"**

Example:

Electric motors may be used to pump water, to blow air, to wash clothes, to drill holes, etc. for that they use electric energy. How good a machine is, depends how much output we obtain from it by giving certain input. The ratio of useful output to input energy is very important to judge the working of machine.

Mathematical Form:

$$\text{Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}}$$

Or $$\%\text{ Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

Unit:

Efficiency is a ratio between two similar quantities so it has no unit. It is measured in percentage.

6.14 What is meant by the term power? **(GRW 2013, LHR 2012, 2016)**

Ans: Given on Page # 230

6.15 Define watt. **(LHR 2011, 2014, 2016, 17)**

Ans: Given on Page # 230

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

6.1 A man has pulled a cart through 35 m applying a force of 300 N. Find the work done by the man. **(GRW 2013, 2017)**

Solution:

Given Data:

Force applied = F = 300 N

Distance moved by cart = S = 35 m

To Find:

Work done by the man = W =?

Calculations:

As we know that,

$$W = F \times S$$

By putting the values, we have

$$W = 300 \times 35$$

$$W = 10500\ J$$

Result:

Hence, the work done by the man on the cart will be 10500 J.

6.2 A block weighing 20 N is lifted 6 m vertically upward. Calculate the potential energy stored in it.

Solution:

Given Data:

Weight of the block = W = 20 N

Distance moved vertically upward = h = 6 m

To Find:

Potential energy of the block = P.E = ?

Calculations:

As we know that

$W = F \times S$

By putting the values, we have

$W = 20 \times 6$

$W = 120$ J

Result:

Hence, the potential energy of the block will be 120 J.

6.3 A car weighing 12 kN has speed of 20 ms-1. Find its kinetic energy stored in it.

(LHR 2015)

Solution:

Given Data

Weight of car = w = 12 kN

Speed of car = v = 20 ms^{-1}

To Find:

Kinetic energy stored in car = K.E = ?

Calculations:

As we know that

$K.E = \frac{1}{2} mv^2$

By putting the values, we have

$K.E. = \frac{1}{2} \times 1200 \times (20)^2$

$K.E. = \frac{1}{2} \times 1200 \times 400$

K.E. = 240000 J

K.E = 240 KJ

Result:

Hence, the kinetic energy stored in car will be 240 kJ.

6.4 A 500 g stone is thrown up with a velocity of 15 ms^{-1}. Find its
i) P.E. at its maximum height
ii) K.E. when it hits the ground

Solution:

Given Data:

Mass of the stone = m = 500 g = 0.5 kg
Velocity of the stone = v = 15 ms^{-1}

To Find:

P.E. at its maximum height = P.E. = ?
K.E. when it hits the ground = K.E. = ?

Calculations:

As we know that

Potential energy at maximum height = kinetic energy while throwing
Potential energy at maximum height = ½ mv^2

By putting the values, we have

Potential energy at maximum height = ½ x 0.5 x $(15)^2$
Potential energy at maximum height = ½ x 0.5 x 225
Potential energy at maximum height = 56.25 J

Potential energy of the stone at maximum height is 56.25 J

Also we know that

Kinetic energy while hitting the ground = Potential energy at maximum height
As Potential energy at maximum height = 56.25 J
So Kinetic energy while hitting the ground = 56.25 J

Kinetic energy of the stone while hitting the ground is 56.25 J

Result:

Hence, the P.E. at its maximum height will be 56.56 J and K.E. when it hits the ground will be 56.56 J.

6.5 On reaching the top of a slope 6 m high from its bottom, a cyclist has a speed of 1.5 ms^{-1}. Find the kinetic energy and the potential energy of the cyclist. The mass of the cyclist and his bicycle is 40 kg.

Solution:

Given Data:

Speed of the cyclist = v = 1.5 m^{s-1}
Height of slope = h = 6 m
Mass of cyclist and bicycle = m = 40 kg

To Find:

Kinetic energy of the cyclist = K.E. = ?
Potential energy of the cyclist = P.E = ?

Calculations:

As we know that

P.E. = mgh

By putting the values, we have

P.E. = 40 x 10 x 6
P.E. = 2400 J

Also we know that

$K.E. = \frac{1}{2} mv^2$

By putting the values, we have

$K.E. = \frac{1}{2} \times 40 \times (1.5)^2$

$K.E = \frac{1}{2} \times 40 \times 2.25$

$K.E. = 45$ J

Result:

Hence, the kinetic energy of the cyclist will be 45 J and Potential energy of the cyclist will be 2400 J.

6.6 A motor boat moves at a steady speed of 4 ms^{-1}. Water resistance acting on it is 4000 N. Calculate the power of its engine. **(LHR 2017)**

Solution:

Given Data:

Speed of the motor boat = $v = 4\ ms^{-1}$

Water resistance acting on boat = 4000 N

To Find:

Power of the engine of motor boat = P = ?

Calculations:

As we know that

$$P = \frac{W}{t}$$

$$= \frac{FS}{t} = F\left(\frac{S}{t}\right)$$

$P = F \times v$

By putting the values, we have

$P = 4000 \times 4$

$P = 16000$ W $\quad (\because 1000 = 1 \text{ kilo})$

$P = 16$ KW

Result:

Hence, the Power of the engine of motor boat will be 16 kW.

6.7 A man pulls a block with a force of 300 N through 50 m in 60 s. Find the power used by him to pull the block. **(LHR 2015)**

Solution:

Given Data:

Force applied on block = F = 300 N

Distance covered by the block = S = 50 m

Time taken = t = 60 s

To Find:

Power used to pull the block = P = ?

Calculations:

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{3000 \times 50}{60}$$

$$P = \frac{150000}{60}$$

$$P = 250W$$

Result:

Hence, the power used to pull the block will be 250 W.

6.8 A 50 kg man moved 25 steps up in 20 seconds. Find his power, if each step is 16 cm high. (GRW 2014)

Solution:

Given Data:

Mass of man = m = 50 kg
Height of each step = h = 16 cm = 0.16 m
Number of steps = n = 25
Time taken = t = 20 s

To Find:

Power of the man = P = ?

Calculations:

Since

$$F = w$$
$$= mg$$
$$= (50)(10)$$
$$= 500\ N$$

Height reached by man = h = 0.16 × 25
= 4 m

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{500 \times 4}{20}$$

$$P = \frac{2000}{20}$$

$$P = 100W$$

Result:

Hence the power of the man will be 100 W.

6.9 Calculate the power of a pump which can lift 200 kg of water through a height of 6m in 10 seconds. **(LHR 2013, 2017, GRW 2013, 2014)**

Solution:

Given Data:

Mass of the water = m = 200 kg

Height attained = h = 6 m

Time taken = t = 10 s

To Find:

Power of the pump = P = ?

Calculations:

Since

$$F = w$$
$$= mg$$
$$= 200 \times 10$$
$$= 2000 \text{ N}$$

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{2000 \times 6}{10} \Rightarrow P = \frac{12000}{10}$$
$$P = 1200 \text{W}$$

Result:

Hence, the power of the pump will be 1200 W.

6.10 An electric motor of 1 hp is used to run water pump. The water pump takes 10 minutes to fill an overhead tank. The tank has a capacity of 800 liters and height of 15 m. find the actual work done by the electric motor to fill the tank. Also find the efficiency of the system. (Density of water = 1000 kgm^{-3})(Mass of 1 litre of water = 1kg)

Solution:

Given Data:

Power of the motor = P = 1 hp

Time taken by pump = t = 10 mins = 600 s

Capacity of the tank = v = 800 liters

Height of the tank = h = 15 m

To Find:

Work done by the motor = W = ?

Efficiency of the system = ?

Calculations:

As we know that

$$P = \frac{W}{t} \qquad \text{So} \qquad W = P \times t$$

By putting the values, we have

$W = 1\ hp \times 600s$

Or $W = 746\ w \times 600s = 447600\ J$

The actual work done by the electric motor is 447600J

Now Output = W = mgh

By putting the values, we have

Output = 800 x 10 x 15

Output = 120000 J

We also know that

$$\% \text{ Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

By putting the values, we have

$$\% \text{ Efficiency} = \frac{120000\ J}{447600\ J} \times 100$$

% Efficiency = 0.268 x 100

So, % Efficiency = 26.8%

Efficiency of the electric motor is 26.8%

Result:

Hence, the work done by the motor will be 447600 J and Efficiency of the system will be 26.8%.

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. To convert heat energy into electrical energy, which reaction occurs in nuclear reactors?

(A) Chemical (B) Fusion
(C) Fission (D) Both fission and fusion

2. Energy stored in coal is:

(A) Heat energy (B) Kinetic energy
(C) Chemical energy (D) None of these

3. K.E of a stationary body is:

(A) Maximum (B) Zero
(C) Negative (D) None

4. 1hp = ?

(A) 600 W (B) 700 W
(C) 746 W (D) 1000 W

5. A 50 kg man moved 25 steps up in 20 seconds. If height of each steps is 16 cm then power consumed is:

(A) 100 W (B) 25 W
(C) 250 W (D) 50 W

6. The kinetic energy of a body of mass 2 kg is 25 J. Its speed is:

(A) 5 ms^{-1} (B) 12.5 ms^{-1}
(C) 25 ms^{-1} (D) 50 ms^{-1}

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

i. Why LED light is preferred to traditional electric bulb?
ii. How much energy can be produced by 4 kg of matter?
iii. Write three conditions for work to be zero.
iv. What will be the effect on kinetic energy of a body if its speed is doubled?
v. Why fossil fuels are called non-renewable energy sources?

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

a) What is an ideal system? Why is it not possible construct and ideal system practically?
b) Calculate the power of a pump which can lift 200 kg of water through a height of 6 m in 10 seconds.

Note:

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