EXERCISE- 2 (A)

Question 1:
Define work. Is work a scalar or a vector?
Solution 1:
Work is said to be done only when the force applied on a body makes the body move. It is a scalar quantity.

Question 2:
How is the work done by a force measured when (i) force is in direction of displacement, (ii) force is at an angle to the direction of displacement?
Solution 2:
(i) When force is in direction of displacement, then work done , $W = F \times S$
(ii) When force is at an angle θ to the direction of displacement, then work done,
$W = F S \cos^{\theta}$

Question 3:
A force F acts on a body and displaces it by a distance S in a direction at an angle θ with the direction of force. (a) Write the expression for the work done by the force. (b) what should be the angle between the force and displacement to get the (i) zero work (ii) maximum work?
Solution 3:
(a) When force is at an angle θ to the direction of displacement, then work done, $W = F S \cos \theta$
(b)
(i) For zero work done, the angle between force and displacement should be 90^o as $\cos 90^o = 0$
$W = FS\cos 90^o = FS \times 0 = 0$
(ii) For maximum work done, the angle between force and displacement should be 0^o as $\cos 0^o = 1$
Hence, $W = FS\cos 0^o = FS$

Question 4:
A body is acted upon by a force. State two condition when the work done is zero.

Solution 4:

Two conditions when the work done is zero are:

(i) When there is no displacement (S=0) and,

(ii) When the displacement is normal to the direction of the force ($\theta=90^{o}$).

Question 5:

State the condition when the work done by a force is (i) positive, (ii) negative. Explain with the help of examples.

Solution 5:

(i) If the displacement of the body is in the direction of force, then work done is positive.
Hence, W= F x S
For example: A coolie does work on the load when he raises it up against the force of gravity. The force exerted by coolie (=mg) and displacement, both are in upward direction.

(ii) If the displacement of the body is in the direction opposite to the force, then work done is negative.
Hence, $W = -F \times S$

For example: When a body moves on a surface, the force of friction between the body and the surface is in direction opposite to the motion of the body and so the work done by the force of friction is negative.

Question 6:

A body is moved in a direction opposite to the direction of force acting on it. State whether the work is done by the force or work is done against the force.

Solution 6:

Work is done against the force.

Question 7:

When a body moves in a circular path, how much work is done by the body? Give reason.

Solution 7:

When a body moves in a circular path, no work is done since the force on the body is directed towards the centre of circular path (the body is acted upon by the centripetal force), while the displacement at all instants is along the tangent to the circular path, i.e., normal to the direction of force

Question 8:
A satellite revolves around the earth in a circular orbit. What is the work done by the force of gravity? Give reason.
Solution 8:
Work done by the force of gravity (which provides the centripetal force) is zero as the force of gravity acting on the satellite is normal to the displacement of the satellite.

Question 9:
In which of the following cases, is work being done?
(i) A man pushing a wall.
(ii) a coolie standing with a load of 12 kgf on his head.
(iii) A boy climbing up a staircase.
Solution 9:
Work is done only in case of a boy climbing up a stair case.

Question 10:
A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work. Explain the reason.
Solution 10:
When a coolie carrying some load on his head moves, no work is done by him against the force of gravity because the displacement of load being horizontal, is normal to the direction of force of gravity.

Question 11:
The work done by a fielder when he takes a catch in a cricket match, is negative Explain.
Solution 11:
Force applied by the fielder on the ball is in opposite direction of displacement of ball. So, work done by the fielder on the ball is negative.

Question 12:
Give an example when work done by the force of gravity acting on a body is zero even though the body gets displaces from its initial position.

Solution 12:
When a coolie carries a load while moving on a ground, the displacement is in the horizontal direction while the force of gravity acts vertically downward. So the work done by the force of gravity is zero.

Question 13:
What are the S.I. and C.G.S units of work? How are they related? Establish the relationship.

Solution 13:
S.I unit of work is Joule.
C.G.S unit of work is erg.
Relation between joule and erg :
1 joule = 1N x 1m
But 1N = 10^5 dyne
And 1m=100 cm = 10^2 cm
Hence, 1 joule = 10^5dyne × 10^2cm
= 10^7dyne × cm =10^7erg
Thus, 1 Joule = 10^7 erg

Question 14:
State and define the S.I. unit of work.

Solution 14:
S.I unit of work is Joule.
1 joule of work is said to be done when a force of 1 newton displaces a body through a distance of 1 meter in its own direction.

Question 15:
Express joule in terms of erg.

Solution 15:
Relation between joule and erg :
1 joule = 1N × 1m
But 1N = 10^5 dyne
And 1m =100 cm = 10^2 cm
Hence, 1 joule = 10^5 dyne × 10^2cm
= 10^7dyne x cm = 10^7erg

Thus, 1 Joule = 10^7 erg

Question 16:

A body of mass m falls down through a height h. Obtain an expression for the work done by the force of gravity.

Solution 16:

Let a body of mass m fall down through a vertical height h either directly or through an inclined plane e.g. a hill, slope or staircase. The force of gravity on the body is F = mg acting vertically downwards and the displacement in the direction of force (i.e., vertical) is S = h.

Therefore the work done by the force of gravity is W = FS = mgh

Question 17:

A boy of mass m climbs up a staircase of vertical height h.

(a) What is the work done by the boy against the force of gravity?

(b) What would have been the work done if he uses a lift in climbing the same vertical height?

Solution 17:

Let a boy of mass m climb up through a vertical height h either through staircase of using a lift. The force of gravity on the boy is F = mg acting vertically downwards and the displacement in the direction opposite to force (i.e., vertical) is S = −h. Therefore the work done by the force of gravity on the boy is

W = FS = − mgh

or, the work W = mgh is done by the boy against the force of gravity.

Question 18:

Define the term energy and state its S.I. unit.

Solution 18:

The energy of a body is its capacity to do work. Its S.I unit is Joule (J).

Question 19:

What physical quantity does the electron volt (eV) measure? How is it related to the S.I. unit of that quality?

Solution 19:
eV measures the energy of atomic particles.
$1eV = 1.6 \times 10^{-19}J$

Question 20:
Complete the following sentence:
1 J = Calorie
Solution 20:
1 J = 0.24 calorie

Question 21:
Name the physical quantity which is measured in calorie. How is it related to the S.I. unit of the quality?
Solution 21:
Calorie measures heat energy.
1calorie = 4.18 J

Question 22:
Define a kilowatt hour. How is it related to joule?
Solution 22:
1kWh is the energy spent (or work done) by a source of power 1kW in 1 h.
$1kWh = 3.6 \times 10^6 J$

Question 23:
Define the term power. State its S.I. unit.
Solution 23:
The rate of doing work is called power. The S.I. unit of power is watt (W).

Question 24:
State two factors on which power spent by a source depends. Explain your answer with examples.

Solution 24:

Power spent by a source depends on two factors:

(i) The amount of work done by the source, and

(ii) The time taken by the source to do the said work.

Example: If a coolie A takes 1 minute to lift a load to the roof of a bus, while another coolie B takes 2 minutes to lift the same load to the roof of the same bus, the work done by both the coolies is the same, but the power spent by the coolie A is twice the power spent by the coolie B because the coolie A does work at a faster rate.

Question 25:

Differentiate between work and power.

Solution 25:

Work	Power
1. Work done by a force is equal to the product of force and the displacement in the direction of force.	1. Power of a source is the rate of doing work by it.
2. Work done does not depend on time.	2. 2. Power spent depends on the time in which work is done.
3. S.I unit of work is joule (J).	4. S.I unit of power is watt (W).

Question 26:

Differentiate between energy and power.

Solution 26:

Energy	Power
1. Energy of a body is its capacity to do work.	(i) Power of a source is the energy spent by it in 1s.
2. Energy spent does not depend on time.	(ii) Power spent depends on the time in which energy is spent.
3. S.I unit of energy is joule (J).	(iii)S.I unit of power is watt (W).

Question 27:

State and define the S.I. unit of power.

Solution 27:
S.I unit of power is watt (W).
If 1 joule of work is done in 1 second, the power spent is said to be 1 watt.

Question 28:
What is horse power (H.P)? How is it related to the S.I. unit of power?
Solution 28:
Horse power is another unit of power, largely used in mechanical engineering. It is related to the S.I unit watt as : 1 H.P = 746 W

Question 29:
Differentiate between watt and watt hour.
Solution 29:
Watt (W) is the unit of power, while watt hour (Wh) is the unit of work, since power × time = work.

Question 30:
Name the quality which is measured in
(a) kWh (b) kW (c) Wh (d) eV
Solution 30:
a. Energy is measured in kWh
b. Power is measure in kW
c. Energy is measured in Wh
d. Energy is meaused in eV

Concept insight: Energy has bigger units like kWh (kilowatt hour) and Wh (watt hour). Similarly bigger unit of power is kW (kilo watt).
The energy of atomic particles is very small, and hence, it is measured in eV (electron volt).

MULTIPLE CHOICE TYPE:

Question 1:
One horse power is equal to:
(a) 1000 W
(b) 500 W
(c) 764 W
(d) 746 W
Solution 1:
746 W

Question 2:
kWh is the unit of:
(a) power
(b) force
(c) energy
(d) none of these
Solution 2:
The unit kWh is the unit of energy.

NUMERICALS:

Question 1:
A body, when acted upon by a force of 10 kgf, gets displaced by 0.5 m. Calculate the work done by the force, when the displacement is (i) in the direction of force, (ii) at an angle of 60° with the force, and (iii) normal to the force. ($g = 10\ N\ kg^{-1}$)
Solution 1:
Force acting on the body = 10 kgf = 10×10 N = 100 N
Displacement, S = 0.5 m
Work done = force x displacement in the direction of force
(i) $W = F \times S$
$W = 100 \times 0.5 = 50$ J
(ii) Work = force x displacement in the direction of force
$W = F \times S \cos^{\theta}$
$W = 100 \times 0.5 \cos 60^\circ$
$W = 100 \times 0.5 \times 0.5 (\cos 60^\circ = 0.5)$

$W = 25$ J

(iii) Normal to the force:

Work = force x displacement in the direction of force

$W = F \times S \cos^{\theta}$

$W = 100 \times 0.5 \cos 90^{o}$

$W = 100 \times 0.5 \times 0 = 0$ J($\cos 90^{o} = 0$)

Question 2:

A boy of mass kg runs upstairs and reaches the 8 m high floor in 5 s Calculate:

the force of gravity acting on the boy.

(i) the work done by him against gravity.

(ii) the power spent by boy.

(Take $g = 10$ m s^{-2})

Solution 2:

Mass of boy = 40 kg

Vertical height moved, h = 8m

Time taken, t = 5s.

(i) Force of gravity on the boy

$F = mg = 40 \times 10 = 400N$

(ii) While climbing, the boy has to do work against the force of gravity.

Work done by the boy in climbing= Force × distance moved in the direction of force

Or, W = F x S= 400 x 8= 3200 J

Power spent = $\frac{\text{work done}}{\text{time taken}} = \frac{3200}{5} = 640W$

Question 3:

It takes 20 s for a person A to climb up the stairs, while another person B does the same in 15 s. Compare the (i) Work done and (ii) power developed by the persons A and B.

Solution 3:

(i) The work done by persons A and B is independent of time. Hence both A and B will do the same amount of work. Hence,

$$\frac{\textbf{work done by A}}{\textbf{work done by B}} = \frac{\mathbf{1}}{\mathbf{1}} = \mathbf{1:1}$$

(ii)

Power developed by the person A and B is calculated as follows:

A takes 20 s to climb the stairs while B takes 15 s, to do the same. Hence B does work at a much faster rate than A; more power is spent by B.

Power developed $\propto \frac{1}{\text{time}}$ (and amount of work done is same)

$$\frac{\textbf{power developed by A}}{\textbf{power developed by B}} = \frac{\mathbf{15}}{\mathbf{20}} = \mathbf{3:4}$$

Question 4:

A boy weighing 350 N runs up a flight of 30 steps, each 20 cm high in 1 minute, Calculate:

(i) the work done and

(ii) power spent.

Solution 4:

Total distance covered in 30 steps , S= 30 x 20 cm = 600 cm = 6 m

Work done by the boy in climbing= Force x distance moved in direction of force

Work, W= F x S= 350 x 6 =2100 J

Power developed = $\frac{\text{work done}}{\text{time taken}} = \frac{2100\text{J}}{60\text{s}} = 35\text{W}$

Question 5:

A man spends 6.4 KJ energy in displacing a body by 64 m in the direction in which he applies force, in 2.5 s Calculate:

(i) the force applied and

(ii) the power Spent (in H.P) by the man.

Solution 5:

Work done by man = 6.4kJ

Distance moved, S = 64m

(i) Work done by the man= Force x distance moved in direction of force

Work, W = F × S

6.4×10^3 =F × 64

$F = \frac{6.4 \times 10^3}{64} = 100$ N

(ii) Power spent $= \frac{6.4 \times 10^3}{2.5} = 2560$ W

1 H.P= 746 W

$1W = \frac{1}{746}$ H.P

$2560\ W = \frac{2560}{746}$ H.P = 3.43H.P

Question 6:

A weight lifter a load of 200 kgf to a height of 2.5 m in 5 s. Calculate: (i) the work done, and (ii) the power developed by him. Take g = 10 N kg^{-1}

Solution 6:

Force= mg = 200 × 10 = 2000 N

Distance, S = 2.5m

Time , t = 5 s

(i) Work done, W= F S

W = 2000 × 2.5m = 5000J

Power developed $= \frac{\text{work done}}{\text{time taken}} = \frac{5000J}{5s} = 1000W$

Question 7:

A machine raises a load of 750 N through a height of 16 m in 5 s. calculate:

(i) energy spent by machine,

(ii) power at which the machine works.

Solution 7:

(i) Energy spent by machine or work done = F S

Work, W = 750 × 16 = 12000J

(ii) Power spent $= \frac{\text{work done}}{\text{time taken}} = \frac{12000J}{5s} = 2400W$

Question 8:

An electric heater of power 3 KW is used for 10 h. How much energy does it consume? Express your answer in (i) kWh, (ii) joule.

Solution 8:

Energy consumed = power x time

(i) Energy = 3 kW × 10 h = 30 kWh

(ii) 1 kilowatt hour (kWh) = 3.6×10^6 J

30kWh = $30 \times 3.6 \times 10^6$ J

= 1.08×10^8 J

Question 9:

A boy of mass 40 kg runs up a flight of 15 steps each 15 cm high in 10 s. Find:

(i) the work done and

(ii) the power developed by him

Take g = 10 N kg^{-1}

Solution 9:

Force of gravity on boy

F= mg = 40 × 10 = 400N

Total distance covered in 15 steps ,

S = 15 × 15cm = 225cm = 2.25m

Work done by the boy in climbing = Force x distance moved in direction of force

Work, W = F × S = 400 × 2.25 = 900J

Power developed = $\frac{\text{work done}}{\text{time taken}} = \frac{900\text{J}}{10\text{s}} = 90\text{W}$

Question 10:

A water pump raises 50 litres of water through a height of 25 m in 5 s. Calculate the power which the pump supplies.

(Take g = 10 N kg^{-1} and density of water = 1000 kg m^{-3})

Solution 10:

Volume of water = 50 L = 50×10^{-3} m^3

Density of water = 1000 kgm^{-3}

Mass of water = Volume of water × density of water

= $50 \times 10^{-3} \times 1000$ = 50kg

Work done in raising 50kg water to a height of 25m against the force of gravity is:

W = mg × h = mgh

Power P = $\frac{\text{work done}}{\text{time taken}} = \frac{\text{mgh}}{\text{t}} = \frac{50\times10\times25\text{J}}{5\text{s}} = 2500\text{W}$

Question 11:

A man raises a box of mass 50 kg to a height of 2 m in 2 minutes, while another man raises the same box to the same height in 5 minutes. Compare:

(i) the work done and

(ii) the power developed by them.

Solution 11:

(i) Work done in raising a 50kg mass to a height 2m against the force of gravity is:

W = mg × h = mgh

Hence both men will do the same amount of work. Hence,

$$\frac{work\ done\ by\ A}{work\ done\ by\ B} = \frac{mgh}{mgh} = \frac{50\times10\times2}{50\times10\times2} = \frac{1}{1} = 1:1$$

(ii) First man A takes 2 minutes to raise 50 kg mass

Second man B takes 5 minutes to raise 50 kg mass.

Power developed by man A $= \frac{work\ done}{Time\ taken} = \frac{mgh}{t} = \frac{50\times10\times2J}{120S} = \frac{25}{3}W$

Power developed by man B $= \frac{work\ done}{Time\ taken} = \frac{mgh}{t} = \frac{50\times10\times2J}{5\times60s} = \frac{10}{3}W$

Power developed $\alpha\ \frac{1}{time\ taken}$

$$\frac{\text{Power developed by A}}{\text{Power developed by B}} = \frac{\frac{25}{3}}{\frac{10}{3}} = \frac{25}{10} = \frac{5}{2} = 5:2$$

Question 12:

A pump is used to lift 500 kg of water from a depth of 80 m in 10 s. calculate:

(a) the work done by the pump

(b) the power a which the pump works,

(c) the power rating of the pump if its efficiency is 40% (Take g = 10 m s^{-2})

Solution 12:

Work done in raising a 500kg mass to a height of 80m against the force of gravity is:

(a) W = mg × h = mgh

W = 500 × 10 × 80 = 4 × 10^5J

(b) Power at which pump works $= \frac{\text{work done}}{\text{Time taken}} = \frac{\text{mgh}}{\text{t}} = \frac{50\times10\times80\text{J}}{10\text{S}} = \frac{4\times10^5}{10} = 40\ \text{KW}$

(c) Efficiency $= \frac{\text{useful power}}{\text{power input}}$

Efficiency = 40 % = 0.4

$0.4 = \frac{40\ \text{KW}}{\text{Power inout}}$

Power input $= \frac{40KW}{0.4} = 100\text{kw}$

Question 13 :

An ox can apply a maximum force of 1000 N. It is taking part in a cart race and is able to pull the cart at a constant speed of 30 M S^{-1} while making its best effort. Calculate the power developed by the ox.

Solution 13:

Given, force = 1000N, velocity = 30m/s

Power, P = force × velocity

P = 1000 × 30 = 30,000W = 30kW

Question 14:

If the power of a motor is 40 kw, at what speed can it raise a load of 20,000 N?

Solution 14:

Power = 40kW

Force = 20,000N

Power = force × velocity

Velocity = $\frac{\text{Power}}{\text{Force}} = \frac{40\text{ KW}}{20{,}000} = \frac{40{,}000}{20{,}000} = 2\text{ m/s}$

EXERCISE 2(B)

Question 1:

What are the two forms of mechanical energy?

Solution 1:

Two forms of mechanical energy are:

(i) Kinetic energy

(ii) Potential energy

Question 2:

Name the forms of energy which a wound-up watch spring possesses.

Solution 2:

Elastic potential energy is possessed by wound up watch spring

Question 3:
Name the type of energy (kinetic energy K or potential energy U) possessed in the following cases:
(a) A moving cricket ball
(b) A compressed spring
(c) A moving bus
(d) The bob of a simple pendulum at its extreme position.
(e) The bob of a simple pendulum at its mean position.
(f) A piece of stone places on the roof.

Solution 3:
(a) Kinetic energy (K)
(b) Potential energy (U)
(c) Kinetic energy (K)
(d) Potential energy (U)
(e) Kinetic energy (K)
(f) Potential energy (U)

Question 4:
When an arrow is shot from a bow, it has kinetic energy in it. Explain briefly from where does it get its kinetic energy?

Solution 4:
When the string of a bow is pulled, some work is done which is stored in the deformed state of the bow in the form of its elastic potential energy. On releasing the string to shoot an arrow, the potential energy of the bow changes into the kinetic energy of the arrow which makes it move

Question 5:
Define the term potential energy of a body. State its different forms and give one example of each.

Solution 5:
Potential energy: The energy possessed by a body by virtue of its specific position (or changed configuration) is called the potential energy.
Different forms of P.E. are as listed below:
(i) Gravitational potential energy: The potential energy possessed by a body due to its position relative to the centre of Earth is called its gravitational potential energy.
Example: A stone at a height has gravitational potential energy due to its raised height.

(ii) Elastic potential energy: The potential energy possessed by a body in the deformed state due to change in its configuration is called its elastic potential energy.

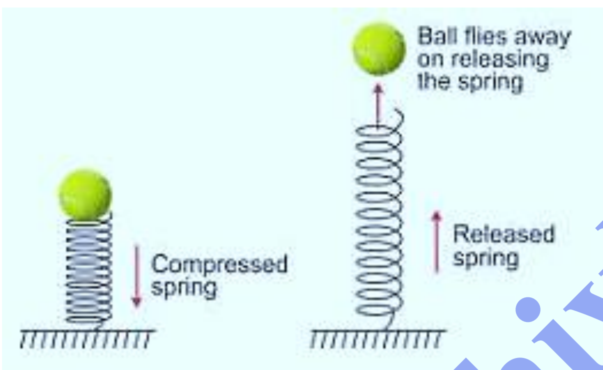
Example: A compressed spring has elastic potential energy due to its compressed state.

Question 6:

A ball is placed on a compressed spring. What form of energy does the spring possess? On releasing the spring, the ball flies away. Give a reason.

Solution 6:

The compressed spring has elastic potential energy due to its compressed state. When it is released, the potential energy of the spring changes into kinetic energy which does work on the ball if placed on it and changes into kinetic energy of the ball due to which it flies away.



Question 7:

What is meant by the gravitational potential energy? Derive expression for it.

Solution 7:

Gravitational potential energy is the potential energy possessed by a body due to its position relative to the centre of earth.

For a body placed at a height above the ground, the gravitational potential energy is measured by the amount of work done in lifting it up to that height against the force of gravity.

Let a body of mass m be lifted from the ground to a vertical height h. The least upward force F required to lift the body (without acceleration) must be equal to the force of gravity (=mg) on the body acting vertically downwards. The work done W on the body in lifting it to a height h is

W = force of gravity (mg) × displacement (h) =mgh

This work is stored in the body when it is at a height h in the form of its gravitational potential energy.

Gravitational potential energy U = mgh

Question 8:

Write an expression for the potential energy of a body of mass m places at a height h above the earth's surface.

Solution 8:

The work done W on the body in lifting it to a height h is

W= force of gravity (mg) × displacement (h) = mgh

This work is stored in the body when it is at a height h in the form of its gravitational potential energy.

Gravitational potential energy U = mgh

Question 9:

Name the form of energy which a body may possess even when it is not in motion. Give an example to support your answer.

Solution 9:

Potential energy is possessed by the body even when it is not in motion. For example: a stone at a height has the gravitational potential energy due to its raised position.

Question 10:

What do you understand by the kinetic energy of a body?

Solution 10:

A body in motion is said to possess the kinetic energy. The energy possessed by a body by virtue of its state of motion is called the kinetic energy.

Question 11:

A body of mass m is moving with a velocity v. Write the expression for its kinetic energy.

Solution 11:

Kinetic energy = $\frac{1}{2} \times mass \times (velocity)^2 = \frac{1}{2} mv^2$

Question 12:

State the work energy theorem.

Solution 12:

According to the work-energy theorem, the work done by a force on a moving body is equal to the increase in its kinetic energy.

Question 13:

A body of mass m is moving with a uniform velocity u. A force is applied on the body due to which its velocity changes from u to v. How much work is being done by the force.

Solution 13:

Body of mass m is moving with a uniform velocity u. A force is applied on the body due to which its velocity changes from u to v and produces an acceleration a in moving a distance S. Then,

Work done by the force= force × displacement

W = F × S ---------(i)

From relation : $v^2 = u^2 + 2\,a\,S$

Displacement, $S = \frac{v^2 - u^2}{2a}$

And force, F = ma

From equation (i), $W = ma \times \left(\frac{v^2 - u^2}{2a}\right)$

$= \frac{1}{2} m\,(v^2 - u^2)$

$= k_i - K_l$

Where K_1 is the initial kinetic energy $= \frac{1}{2}\,mu^2$

And K_1 is the final kinetic energy $= \frac{1}{2}\,mv^2$

Thus work done on the body = increase in kinetic energy

$W = \frac{1}{2}\,m\,(v^2 - u^2)$

Question 14:

A light mass and a heavy mass have equal momentum. Which will have more kinetic energy? (Hint : Kinetic energy $K = P^2/2m$ where P is the momentum)

Solution 14:

Kinetic energy, $k = \frac{p^2}{2m}$ where p is the momentum.

Both the masses have same momentum p. The kinetic energy, K is inversely proportional to mass of the body.

Hence light mass body has more kinetic energy because smaller the mass, larger is the kinetic energy.

Question 15:
Name the three forms of kinetic energy and give on example of each.
Solution 15:
The three forms of kinetic energy are:
(i) Translational kinetic energy- example: a freely falling body
(ii) Rotational kinetic energy-example: A spinning top.
(iii)Vibrational kinetic energy-example: atoms in a solid vibrating about their mean position.

Question 16:
Differentiate between the potential energy (U) and the kinetic energy (K)
Solution 16:

Potential energy (U)	Kinetic energy (K)
1. The energy possessed by a body by virtue of its specific position or changed configuration is called potential energy.	1. The energy possessed by a body by virtue of its state of motion is called the kinetic energy.
2. Two forms of potential energy are gravitational potential energy and elastic potential energy.	2. Forms of kinetic energy are translational, rotational and vibrational kinetic energy.
3. Example: A wound up watch spring has potential energy.	3. For example: a moving car has kinetic energy.

Question 17:
Complete the following sentences:
(a) The kinetic energy of a body is the energy by virtue of its…………
(b) The potential energy of a body is the energy by virtue of its ………………
Solution 17:
(a) Motion.
(b) Position.

Question 18:
Is it possible that no transfer of energy may take place even when a force is applied to a body?
Solution 18:
Yes, when force is normal to displacement, no transfer of energy takes place.

Question 19:
Name the form of mechanical energy, which is put to use.
Solution 19:
Kinetic energy.

Question 20:
In what way does the temperature of water at the bottom of a waterfall differ from the temperature at the top? Explain the reason.
Solution 20:
When water falls from a height, the potential energy stored in water at a height changes into the kinetic energy of water during the fall. On striking the ground, a part of the kinetic energy of water changes into the heat energy due to which the temperature of water rises.

Question 21:
Name six different forms of energy?
Solution 21:
The six different forms of energy are:
1. Solar energy
2. Heat energy
3. Light energy
4. Chemical or fuel energy
5. Hydro energy
6. Nuclear energy

Question 22:
Energy can exist in several forms and may change from one form to another. For each of the following, state the energy changes that occur in:
(a) the unwinding of a watch spring

(b) a loaded truck when started and set in motion.
(c) a car going uphill
(d) photosynthesis in green leaves
(e) Charging of a battery,
(f) respiration,
(g) burning of a match stick
(h) explosion of crackers.

Solution 22:

(a) Potential energy of wound up spring converts into kinetic energy.
(b) Chemical energy of petrol or diesel converts into mechanical energy (kinetic energy)
(c) Kinetic energy to potential energy
(d) Light energy changes into chemical energy
(e) Electrical energy changes into chemical energy
(f) Chemical energy changes into heat energy
(g) Chemical energy changes into heat and light energy
(h) Chemical energy changes into heat, light and sound energy

Question 23:

State the energy changes in the following cases while in use:
(a) loudspeaker
(b) a steam engine
(c) microphone
(d) washing machine
(e) an electric bulb
(f) burning coal
(g) a solar cell
(h) bio-gas burner
(i) an electric cell in a circuit
(j) a petrol engine of a running car
(k) an electric toaster
(l) a photovoltaic cell
(m) an electromagnet.

Solution 23:

(a) Electrical energy into sound energy
(b) Heat energy into mechanical energy
(c) Sound energy into electrical energy
(d) Electrical energy to mechanical energy
(e) Electrical energy into light energy

(f) Chemical energy to heat energy
(g) Light energy into electrical energy
(h) Chemical energy into heat energy
(i) Chemical energy into electrical energy
(j) Chemical energy to mechanical energy
(k) Electrical energy into heat energy
(l) Light energy into electrical energy
(m) Electrical energy into magnetic energy.

MULTIPLE CHOICE TYPE

Question 1:
A body at a height possesses:
(a) kinetic energy
(b) potential energy
(c) solar energy
(d) heat energy
Solution 1:
(b) Potential energy
Hint: P.E. is the energy possessed by a body by virtue of its position.

Question 2:
In an electric cell which in use, the change in energy is from:
(a) electrical to mechanical
(b) electrical to chemical
(c) chemical to mechanical
(d) chemical to electrical
Solution 2:
Chemical to electrical
Hint: When current is drawn from an electric cell, the chemical energy stored in it changes into electrical energy.

NUMERICALS:

Question 1:
Two bodies of equal masses are placed at heights h and 2h. Find the ration of their gravitational potential energies.
Solution 1:
Height $H_1 = h$
Height $H_2 = 2h$
Mass of body 1 = m
Mass of body 2 = m
Gravitational potential energy of body 1 = $mgH_1 = mgh$
Gravitational potential energy of Body 2 = $mgH_2 = mg(2h)$
Ratio of gravitational potential energies
$= \frac{mgh}{mg(2h)} = \frac{mgh}{2mgh} = \frac{1}{2} = 1:2$

Question 2:
Find the gravitational potential energy of 1 kg mass kept at a height of 5 m above the ground if $g = 10 \text{ m s}^{-2}$.
Solution 2:
Mass, m = 1kg
Height, h = 5m
Gravitational potential energy = mgh
$= 1 \times 10 \times 5 = 50\text{J}$

Question 3:
A box of weight 150 kgf has gravitational potential energy stored in it equal to 14700 J. Find the height of the box above the ground. (Take $g = 9.8 \text{ N kg}^{-1}$)
Solution 3:
Gravitational potential energy = 14700 J
Force of gravity = mg = 150×9.8N/kg = 1470N
Gravitational potential energy = mgh
14700 =1470 x h
h =10m

Question 4:

A body of mass 5 kg falls from a height of 10 m to 4 m. Calculate: (i) the loss in potential energy of the body, (ii) the total energy possessed by the body at any instant? (Take g = 10 m s^{-2})

Solution 4:

(i) Mass of the body = 5 kg

P.E. at height 10m = mgh = 5 × 10 × 10 = 500 J

P.E. at height 4 m = mgh = 5 × 10 × 4 = 200 J

Loss in P.E. = (500 – 200) J = 300 J

(ii) The total energy possessed by the body at

Any instant remains constant for free fall

It is equal to the sum of P.E. and K.E.

∴ At height 10m, i.e., at top most point, K.E. = 0

∴ Total energy = P.E. + K.E.

Total energy = 500 + 0 = 500J

Question 5:

Calculate the height through which a body of mass 0.5 kg is lifted if the energy spent in doing so is 1.0 J. Take g = 10 m s^{-2}

Solution 5:

Mass = 0.5 kg

Energy = 1 J

Gravitational potential energy = mgh

1 = 0.5 × 10 × h

1 = 5h

Height, h = 0.2 m

Question 6:

A boy weighing 25 kgf climbs up from the first floor at height 3 m above the ground to the third floor at height 9m above the ground. What will be the increase in his gravitational potential energy? (Take g = 10 N kg^{-1})

Solution 6:

Force of gravity on boy = mg = 25 × 10 = 250N

Increase in gravitational potential energy = Mg (h_2-h_1)

= 250 × (9−3)

=250 × 6 = 1500 J

Question 7:

A vessel containing 50 kg of water is placed at a height 15 m above the ground. Assuming the gravitational potential energy at ground to be zero, what will be the gravitational potential energy of water in the vessel? ($g = 10\ m\ s^{-2}$)

Solution 7:

Mass of water, m = 50kg

Height, h = 15m

Gravitational potential energy = mgh

$= 50 \times 10 \times 15$

= 7500 J

Question 8:

A man of mass 50 kg climbs up a ladder of height 10 m. Calculate: (i) the work done by the man, (ii) the increase in his potential energy. ($g = 9.8\ m\ s^{-2}$)

Solution 8:

Mass of man = 50kg

Height of ladder, $h_2 = 10m$

(i) Work done by man = mgh_2

$= 50 \times 9.8 \times 10 = 4900J$

(ii) increase in his potential energy:

Height, $h_2 = 10m$

Reference point is ground, $h_1 = 0m$

Gravitational potential energy = Mg (h_2-h_1)

$= 50 \times 9.8 \times (10-0)$

$= 50 \times 9.8 \times 10 = 4900J$

Question 9:

A block A, whose weight is 200 N, is pulled up a slope of length 5 m by means of a constant force F (= 150 N) as illustrated in Fig 2.13

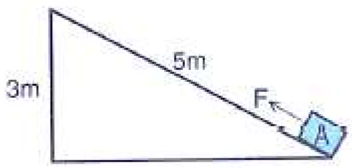


Fig. 2.13

(a) what is the work done by the force F in moving the block A, 5 m along the slope?
(b) By how much has the potential energy of the block A increased?
(c) Account for the difference in work done by the force and the increase in potential energy of the block.

Solution 9:

F = 150N

(a) Work done by the force in moving the block 5m along the slope = Force x displacement in the direction of force = 150 × 5 =750 J
(b) The potential energy gained by the block
U = mgh where h = 3m
= 200 × 3 = 600 J
(c) The difference i.e., 150 J energy is used in doing work against friction between the block and the slope, which will appear as heat energy.

Question 10:

Find the kinetic energy of a body of mass 1 kg moving with a uniform velocity of 10 m s^{-1}.

Solution 10:

Mass, m = 1kg
Velocity, v = 10m/s

Kinetic energy $= \frac{1}{2} \times mass \times (velocity)^2$

$= \frac{1}{2} \times 1 \times (10)^2 = \frac{1}{2} \times 1 \times 100$

= 50J

Question 11:

If the speed of a car is halved, how does its kinetic energy change?

Solution 11:

If the speed is halved (keeping the mass same), the kinetic energy decreases, it becomes one-fourth (since kinetic energy is proportional to the square of velocity).

Question 12:
Two bodies of equal masses are moving with uniform velocities v and 2v. Find the ratio of their kinetic energies.

Solution 12:
Given, velocity of first body $v_1 = v$
And velocity of second body, $v_2 = 2v$
Since masses are same, kinetic energy is directly proportional to the square of the velocity ($K\alpha v^2$)
Hence, ratio of their kinetic energies is:

$$\frac{k_1}{k_2} = \frac{v_1^2}{v_2^2} = \frac{v^2}{(2v)^2} = \frac{v^2}{4v^2} = \frac{1}{4} = 1:4$$

Question 13:
A car is running at a speed of 15 km h^{-1} while another similar car is moving at a speed of 30 km h^{-1}. Find the ration of their kinetic energies.

Solution 13:
Given, velocity of first car, $v_1 = 15$ km/h
And velocity of second car, $v_2 = 30$ km/h
Since masses are same, kinetic energy is directly proportional to the square of the velocity ($K\alpha v^2$)
Hence, ratio of their kinetic energies is:

$$\frac{k_1}{k_2} = \frac{v_1^2}{v_2^2} = \frac{15^2}{(30)^2} = \frac{15\times15}{30\times30} = \frac{1}{4} = 1:4$$

Question 14:
A bullet of mass 0.5 kg slows down from a speed of 5 m s^{-1} to that of 3 m s^{-1}. Calculate the change in kinetic energy of the ball.

Solution 14:
Mass of ball = 0.5kg
Initial velocity = 5m/s
Initial kinetic energy $= \frac{1}{2} \times mass \times (velocity)^2$
$= \frac{1}{2} \times 0.5 \times (5)^2$
$= \frac{1}{2} \times 0.5 \times 25 = 6.25$J
Final velocity of the ball = 3m/s
Final kinetic energy of the ball $= \frac{1}{2} \times mass \times (velocity)^2$

$= \frac{1}{2} \times 0.5 \times (3)^2$

$= \frac{1}{2} \times 0.5 \times 9 = 2.25J$

Change in the kinetic energy of the ball = 2.25 J − 6.25J = − 4J

There is a decrease in the kinetic energy of the ball

Question 15:

A cannon ball of mass 500 g is fired with a speed of 15 m s^{-1}. Find: (i) its kinetic energy and (ii) its momentum.

Solution 15:

Mass of canon ball = 500g = 0.5 kg

Speed, v = 15m/s

(a) Kinetic energy of ball = $\frac{1}{2} \times mass \times (velocity)^2$

$= \frac{1}{2} \times 0.5 \times (15)^2$

$= \frac{1}{2} \times 0.5 \times 225 = 56.25J$

(b) Momentum of the ball = mass × velocity

= 0.5 × 15 = 7.5 kgm/s

Question 16:

A bullet of mass 50 g is moving with a velocity of 500 m s^{-1}. It penetrated 10 cm into a still target and comes to rest. Calculate: (a) the kinetic energy possessed by the bullet, (b) the average retarding force offered by the target.

Solution 16:

Mass of bullet = 50g = 0.05kg

Velocity = 500m/s

Distance penetrated by the bullet = 10cm = 0.1m

(a) Kinetic energy of the bullet = $\frac{1}{2} \times mass \times (velocity)^2$

$= \frac{1}{2} \times 0.05 \times (500)^2$

$= \frac{1}{2} \times 0.05 \times 500 \times 500 = 6250\ J$

(b) Work done by the bullet against the material of the target= resistive force x distance

6250 = resistive force × 0.1m

Resistive force = 62500 N

Question 17:
A body of mass 10 kg is moving with a velocity 20 m s^{-1}. If the mass of the body is doubled and its velocity is halved, find the ratio of the initial kinetic energy to the final kinetic energy.

Solution 17:
Let initial Mass, m_1= 10kg and velocity, v_1 = 20 m/s
Final mass, $m_2 = 2 \times 10 = 20$ kg and velocity, $v_2 = 20/2 = 10$m/s
Initial kinetic energy, $K_1 = \frac{1}{2} \times mass \times (velocity)^2$
$= \frac{1}{2} \times 10 \times (20)^2$
$= \frac{1}{2} \times 10 \times 20 \times 20$
= 2000 J
Final kinetic energy, $K_2 = \frac{1}{2} \times mass \times (velocity)^2$
$= \frac{1}{2} \times 20 \times (10)^2$
$= \frac{1}{2} \times 20 \times 10 \times 10$
= 1000J

$$\frac{K_1}{K_2} = \frac{2000}{1000} = \frac{2}{1} = 2:1$$

Question 18:
A truck weighing 1000 kgf changes its speed from 36 km h^{-1} to 72 km h^{-1} in 2minutes. Calculate: (i) the work done by the engine and (ii) its power/ (g = 10 m s^{-2})

Solution 18:
U = 36 km/h = $\frac{36 \times 1000\text{m}}{3600\text{s}} = 10\text{m/s}$
and v = 72km/h = $\frac{72 \times 1000\text{m}}{3600\text{s}} = 20\text{m/s}$
mass of the truck = 1000 kg
(i) w = $\frac{1}{2} \times 1000 \times (20^2 - 10^2)$
W = 500 × (400 – 100)
W = 500 × 300 = 150000J
W = 1.5×10^5J
(iii)Power = $\frac{\text{work done}}{\text{time taken}} = \frac{1.5 \times 10^5\text{J}}{120\text{s}} = 1.25 \times 10^3$ w

Question 19:

A body of mass 60 kg has the momentum 3000 kg m s^{-1}. Calculate: (i) the kinetic energy and (ii) the speed of the body.

Solution 19:

Mass of body = 60kg

Momentum, p = 3000kgm/s

(i) Kinetic energy = $\frac{p^2}{2m}$

$= \frac{(3000)^2}{2 \times 60} = \frac{3000 \times 3000}{120} = 75000\text{J}$

$= 7.5 \times 10^4$ J

(ii) Momentum = mass × velocity

3000 = 60 × velocity

Velocity = 50m/s

Question 20:

How much work is needed to be done on a ball of mass 50 g to give it s momentum of 500 g cm s^{-1}?

Solution 20:

Momentum , p = 500 gcm/s = 0.005 kgm/s

Mass of ball = 50 g = 0.05kg

(a) Kinetic energy of the ball = $\frac{p^2}{2m}$

$= \frac{p^2}{2m} = \frac{(0.005)^2}{2 \times 0.05} = 2.5 \times 10^{-4}$ J

Question 21:

How much energy is gained by a box of mass 20 kg when a man

(a) carrying the box waits for 5 minutes for a bus?

(b) runs carrying the box with a speed of 3 m s^{-1} to catch the bus?

(c) Raises the box by 0.5 m in order to place it inside the bus? (g = 10 m s^{-2})

Solution 21:

Mass of box = 20 kg

(a) Zero work is done as there is no displacement of the man.

(b) Work done, Kinetic energy of man

$= \frac{1}{2} \times \text{mass} \times (\text{velocity})^2$

$= \frac{1}{2} \times 20 \times (3)^2$

$= \frac{1}{2} \times 20 \times 9 = 90$ J

(c) Work done in raising the box, Potential energy = mgh

U = 20 × 10 × 0.5 = 100 J

Question 22:

A spring is kept compressed by a small trolley of mass 0.5 kg lying on a smooth horizontal surface as shown in the adjacent fig. 2.14 when the trolley is released, it is found to move at a speed v = 2 m s^{-1}. What potential energy did the spring possess when compressed?

Fig. 2.14

Solution 22:

Mass of trolley = 0.5 kg

Velocity = 2 m/s

When the compressed spring is released, its potential energy is converted into kinetic energy completely.

Potential energy of compressed spring = kinetic energy of moving trolley

Kinetic energy of trolley = $\frac{1}{2} \times$ mass × $(\text{velocity})^2$

$= \frac{1}{2} \times 0.5 \times (2)^2$

$= \frac{1}{2} \times 0.5 \times 2 \times 2 = 1\text{J}$

Hence, potential energy of compressed spring = 1.0J

EXERCISE - 2(C)

Question 1:

State two characteristic which a source of energy must have.

Solution 1:

Two characteristics which a source of energy must have are as listed below:

i. It should provide an adequate amount of useful energy at a steady rate over a longer period of time.
ii. It should be safe and convenient to use and economical.

Question 2:
Name the two groups in which various sources of energy are classified. State on what basis are they classified.
Solution 2:
Sources of energy are classified as shown below:

1. Renewable or non-conventional sources
2. Non-renewable or conventional sources

The above classification is done on the basis of availability of the energy sources.

Question 3:
What is meant by the renewable and non-renewable sources of energy? Distinguish between them giving two examples of weach.
Solution 3:

Renewable sources	Non-renewable sources
1. These are the sources from which energy can be obtained continuously over a very long period of time.	1. These are the sources from which energy cannot be continuously obtained over a very long period of time.
2. They are the non-conventional sources.	2. They are the conventional sources.
3. These resources can be regenerated.	3. These resources cannot be regenerated.
4. These are the natural sources which will not get exhausted.	4. These are the natural sources which would soon deplete.
5. Examples: solar energy, wind energy ,nuclear energy etc.	5. Examples: coal, petroleum and natural gas.

Question 4:
Select the renewable and non-renewable sources of energy from the following:
(a) Coal
(b) Wood
(c) Water
(d) Diesel
(e) Wind
(f) Oil

Solution 4:

Renewable sources	Non-renewable sources
Wood	Coal
Water	Diesel
Wind	Oil

Question 5:
Why is the use of wood as a fuel not advisable although wood is a renewable source of energy?
Solution 5:
A tree usually takes more than 15 years to grow fully; therefore renewal of wood as energy source takes a long time. Further, the cutting of trees on a large scale causes depletion of forests which results in environmental imbalance. Hence use of wood as a fuel must be avoided.

Question 6:
Name five renewable and three non-renewable sources of energy.
Solution 6:
Five renewable sources of energy:
1. Sun
2. Wind
3. Flowing water
4. Bio-mass
5. Tides

Three non-renewable sources of energy:
1. Coal
2. Petroleum
3. Natural gas
4.

Question 7:
What is (i) tidal, (ii) ocean and (iii) geo thermal energy? Explain in brief.
Solution 7:
(i) **Tidal energy:** The energy possessed by rising and falling water in tides is known as tidal energy.

Dams are constructed across a narrow opening to the sea to harness tidal energy and produce electricity. However, it is not a major source of energy as the rise and fall of seawater during tides is not enough to generate electricity on a large scale.

(ii) **Ocean energy:** Water in the oceans possesses energy in two forms:

(a) Ocean thermal energy- The energy available due to the difference in temperature of water at the surface and at deeper levels of ocean is called the ocean thermal energy. This energy is harnessed for producing electricity by a device called ocean thermal energy conversion power plant (OCTEC power plant).

(b) Oceanic waves energy- The kinetic energy possessed by fast moving oceanic (or sea) waves is called oceanic waves energy. Though models have been made to generate electricity from oceanic waves, but so far it has not been put to practical use.

(iii) **Geo thermal energy:** The heat energy possessed by the rocks inside the Earth is called geothermal energy.

The hot rocks present at the hot spots deep inside the Earth, heat the underground water and turn it into steam. This steam is compressed at high pressure between the rocks. Holes are drilled deep into the Earth up to the hot spots to extract the steam through pipes, which is utilized to rotate the turbines connected to the armature of an electric generator to produce electricity.

Question 8:

What is the main source of energy for earth?

Solution 8:

Sun is the main source of energy on earth.

Question 9:

What is solar energy? How is the solar energy used to generate electricity in a solar power plant?

Solution 9:

The energy obtained from sun is called the solar energy. A solar power plant is a device in which heat energy of sun is used to generate electricity. It consists of a large number of concave reflectors, at the focus of which there are black painted water pipes. The reflectors concentrate the heat energy of the sun rays on the pipes due to which water inside the pipes starts boiling and produces steam. The steam thus produced is used to rotate a steam turbine which drives a generator producing electricity.

Question 10:
What is a solar cell? State two uses of solar cells. State whether a solar cell produces a.c. or d.c. Give one disadvantage of using a solar cell.

Solution 10:
A solar cell is an electrical device that converts light energy directly into electricity with the help of photovoltaic effect. Solar cells are usually made from semiconductors like silicon and gallium with some impurity added to it. When sunlight is made incident on a solar cell, a potential difference is produced between its surface, due to which a current flows in the circuit connected between the opposite faces of the semiconductor.

Two uses of solar cells are as listed below:

i. They do not require maintenance and last over a long period of time at zero running cost.
ii. They are very useful for remote, inaccessible and isolated places where electric power lines cannot be laid.

Solar cell produces d.c. (direct current).

One disadvantage of solar cell is listed below:

i. The initial cost of a solar panel is sufficiently high.

Question 11:
State two advantages and two disadvantages of producing electricity from solar energy.

Solution 11:
Advantages of using solar panels:

1. They do not cause any pollution in the environment.
2. Running cost of solar panel is almost zero.
3. They last over a long period of time.
4. They do not require any maintenance.
5. They are suitable for remote and inaccessible places where electricity power lines cannot be laid.

Disadvantages of using solar panels:

1. The initial cost of a solar panel is sufficiently high.
2. The efficiency of conversion of solar energy to electricity is low.
3. A solar panel produces d.c. electricity which cannot be directly used for many household purposes.

Question 12:
What is wind energy? How is wind energy used to produce electricity? How much electric power is generated in India using the wing energy?

Solution 12:

The kinetic energy of the moving large masses of air is called the wind energy. Wind energy is used in a wind generator to produce electricity by making use of wind mill to drive a wind generator.

At present in India, more than 1025MW electric power is generated using the wind energy.

Question 13:

State two advantages and two disadvantages of using wind energy for generating electricity.

Solution 13:

Advantages of using the wind energy:

1. It does not cause any kind of pollution.
2. It is an everlasting source.

Disadvantages of using wind energy:

1. The establishment of a wind farm is expensive.

A large area of land is needed for the establishment of a wind farm.

Question 14:

What is hydro energy? Explain the principle of generating electricity from hydro energy. How much hydroelectric power is generated in India?

Solution 14:

The kinetic energy possessed by the flowing water is called the water or hydro energy. Principle of a hydroelectric power plant is that the water flowing in high altitude rivers is collected in a high dam (or reservoir). The water from dam is then allowed to fall on a water turbine which is located near the bottom of the dam. The shaft of the turbine is connected to the armature of an electric generator or dynamo.

At present only 23% of the total electricity is generated by the hydro energy.

Question 15:

State two advantage and two disadvantages of producing hydroelectricity.

Solution 15:

Advantages of producing the hydroelectricity:

1. It does not produce any environmental pollution.
2. It is a renewable source of energy.

Disadvantages of producing hydroelectricity:

1. Due to the construction of dams over the rivers, plants and animals of that place get destroyed or killed.
2. The ecological balance in the downstream areas of rivers gets disturbed.

Question 16:
What is nuclear energy? Explain the principle of producing electricity using the nuclear energy.
Solution 16:
When a heavy nucleus is bombarded with slow neutrons, it splits into two nearly equal light nuclei with a release of tremendous amount of energy. In this process of nuclear fission, the total sum of masses of products is less than the total sum of masses of reactants. This lost mass gets converted into energy. The energy so released is called nuclear energy.
Principle: The heat energy released due to the controlled chain reaction of nuclear fission of uranium-235 in a nuclear reactor is absorbed by the coolant which then passes through the coils of a heat exchanger containing water. The water in heat exchanger gets heated and converts into steam. The steam is used to rotate the turbine which in turn rotates the armature of a generator in a magnetic field and thus produces electricity.

Question 17:
What percentage of total electrical power generated in india is obtained from nuclear power plant? Name two places in india where electricity is generated from nuclear power plants.
Solution 17:
At present only about 3% of the total electrical power generated in India is obtained from the nuclear power plants.
Tarapur in Maharashtra and Narora in Uttar Pradesh are the places where electricity is produced by use of nuclear energy

Question 18:
State two advantages and two disadvantages of using nuclear energy for producing electricity.
Solution 18:
Advantages of using nuclear energy:
1. A very small amount of nuclear fuel can produce a tremendous amount of energy.
2. Once the nuclear fuel is loaded into nuclear power plant, it continues to release energy for several years.

Disadvantages of using nuclear energy:
1. It is not a clean source of energy because very harmful nuclear radiations are produced in the process.
2. The waste causes environmental pollution.

Question 19:
State the energy transformation on the following:
(i) Electricity is obtained from solar energy.
(ii) electricity is obtained from wind energy
(iii) Electricity is obtained from hydro energy.
(iv) Electricity is obtained from nuclear energy.
Solution 19:
(a)Light energy into electrical energy
(b)Mechanical energy into electrical energy.
(c)Mechanical energy into electrical energy.
(d)Nuclear energy(or heat energy) into electrical energy.

Question 20:
State four ways for the judicious use of energy.
Solution 20:
Four ways for the judicious use of energy:
(a) The fossil fuels such as coal, petroleum, natural gas should be used only for the limited purposes when there is no other alternative source of energy available.
(b) The wastage of energy should be avoided.
(c) Efforts must be made to make use of energy for community or group purposes.
(d) The cutting of trees must be banned and more and more new trees must be roped to grow.

MULTIPLE CHOICE TYPE:

Question 1:
The ultimate source of energy is:
(a) wood
(b) wind
(c) water
(d) sun
Solution 1:
Sun

Question 2:
Renewable source of energy is:
(a) Coal
(b) fossil fuels
(c) natural gas
(d) sun
Solution 2:
Sun

EXCERCIE - 2(D)

Question 1:
State the law of conservation of energy.
Solution 1:
According to the law of conservation of energy, energy can neither be created nor can it be destroyed. It only changes from one form to another.

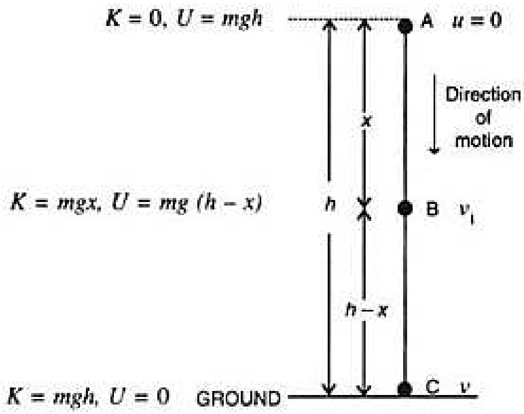
Question 2:
What do you understand by the conservation of mechanical energy? State the condition under which the mechanical energy is conserved.
Solution 2:
According to the law of conservation of mechanical energy, whenever there is an interchange between the potential energy and kinetic energy, the total mechanical energy (i.e., the sum of kinetic energy K and potential energy U) remains constant i.e., K + U = constant when there are no frictional forces.
Mechanical energy is conserved only when there are no frictional forces for a given system (i.e. between body and air). Thus, conservation of mechanical energy is strictly valid only in vacuum, where friction due to air is absent.

Question 3:
Name two examples in which the mechanical energy of a system remains constant.
Solution 3:
Motion of a simple pendulum and motion of a freely falling body.

Question 4:
A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero?
Solution 4:
Kinetic energy of the body changes to potential energy when it is thrown vertically upwards and its velocity becomes zero.

Question 5:
A body falls freely under gravity from rest. Name the kind of energy it will possess.
(a) at the point from where it falls.
(b) while falling.
(c) on reaching the ground.
Solution 5:
(a) Potential energy
(b) Potential energy and kinetic energy
(c) Kinetic energy

Question 6:
Show that the sum of kinetic energy and potential energy (i.e., total mechanical energy) is always conserves in the case of a freely falling body under gravity (with air resistance neglected) from a height h by finding it when (i) the body is at the top, (ii) the body has fallen a distance x, (iii) the body has reached the ground.
Solution 6:
Let a body of mass m be falling freely under gravity from a height h above the ground (i.e., from position A). Let us now calculate the sum of kinetic energy K and potential energy U at various positions, say at A (at height h above the ground), at B (when it has fallen through a distance x) and at C (on the ground).



(i) At the position A (at height h above the ground):

Initial velocity of body= 0 (since body is at rest at A)

Hence, kinetic energy K =0

Potential energy U = mgh

Hence total energy = K + U = 0 + mgh = mgh .. -----(i)

(ii) At the position B (when it has fallen a distance x):

Let v_1 be the velocity acquired by the body at B after falling through a distance x. Then u = 0, S = x, a = g

From equation $v^2 = u^2 + 2As$

$V_1^2 = 0 + 2gx = 2gx$

Hence, Kinetic energy K = $\frac{1}{2} mv_1^2$

Now at B, height of body above the ground = h – x

Hence, potential energy U = mg (h – x)

Hence total energy = K + U

= mgx + mg (h – x) = mgh ----------- (ii)

(iii) At the position C (on the ground):

Let the velocity acquired by the body on reaching the ground be v. Then u = 0, S = h, a = g

From equation: $v^2 = u^2 + 2aS$

$v^2 = 0^2 + 2gh$

$v^2 = 2gh$

Hence, kinetic energy K = $\frac{1}{2} mv^2$

= $\frac{1}{2} m$ (2gh) = mgh

And potentiall energy U = 0 (a the ground when h = 0)

Hence total energy = K+U = mgh + 0 = mgh ------ (iii)

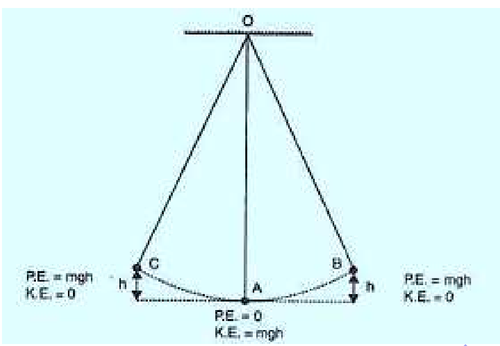
Thus from equation (i), (ii) and (iii), we note that the total mechanical energy i.e., the sum of kinetic energy and potential energy always remain constant at each point of motion and is equal to initial potential energy at height h.

Question 7:

A pendulum is oscillating on either side of its rest position. Explain the energy changes that takes place in the oscillating pendulum. How does the mechanical energy remains constant in it? Draw the necessary diagram.

Solution 7:

When the bob swings from A to B, the kinetic energy decreases and the potential energy becomes maximum at B where it is momentarily at rest.



From B to A, the potential energy again changes into the kinetic energy and the process gets repeated again and again.

Thus while swinging, the bob has only the potential energy at the extreme position B or C and only the kinetic energy at the resting position A. At an intermediate position (between A and B or between A and C), the bob has both the kinetic energy and potential energy, and the sum of both the energies (i.e., the total mechanical energy) remains constant throughout the swing.

Question 8:

A pendulum with bob of mass m is oscillating on either side from its resting position A between the extremes B and C at a vertical height h and A. what is the kinetic energy K and potential energy U when the pendulum is at position (i) A, (ii) B and (iii) C?

Solution 8:

(a) At position A, pendulum has maximum kinetic energy and its potential energy is zero at its resting position. Hence, K=mgh and U= 0.

(b) At B, kinetic energy decreases and potential energy increases. Hence, K= 0 and U=mgh
(c) At C also, kinetic energy K= 0 and potential energy U=mgh.

Question 9:
What do you mean by degradation of energy? Explain it by taking two examples of your daily life.
Solution 9:
The gradual decrease of useful energy due to friction etc. is called the degradation of energy.
Examples:
1. When we cook food over a fire, the major part of heat energy from the fuel is radiated out in the atmosphere. This radiated energy is of no use to us.
2. When electrical appliances are run by electricity, the major part of electrical energy is wasted in the form of heat energy.

MULTIPLE CHIOCE TYPE:

Question 1:
A ball of mass m is thrown vertically up with an initial velocity so as to reach a height h. The correct statement is:
(a) Potential energy of the ball at the ground in mgh.
(b) Kinetic energy imparted to the ball at the ground is zero.
(c) Kinetic energy of the ball at the highest point is mgh.
(d) potential energy of the ball at the highest point is mgh.
Solution 1:
Potential energy of the ball at the highest point is *mgh*.
Hint: At the highest point, the ball momentarily comes to rest and thus its kinetic energy becomes zero.

Question 2:
A pendulum is oscillating on either side of its rest position. The correct statement is:
(a) It has only the kinetic energy.
(b) it has the maximum kinetic energy at its extreme position.
(c) it has the maximum potential energy at its rest position.
(d) The sum of its kinetic and potential energies remains constant throughout the motion.

Solution 2:

The sum of its kinetic and potential energy remains constant throughout the motion.

Hint: In accordance with law of conservation of mechanical energy, whenever there is an interchange between the potential energy and kinetic energy, the total mechanical energy remains constant.

NUMERICALS:

Question 1:

A ball of mass 0.20 kg is thrown vertically upwards with an initial velocity of 20 m s^{-1}. Calculate the maximum potential energy it gains as it goes up.

Solution 1:

Potential energy at the maximum height= initial kinetic energy

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

$= \frac{1}{2} \times 0.20 \times 20 \times 20 = 40J$

Question 2:

A stone of mass 500g is thrown vertically upwards with a velocity of 15 m s^{-1}. Calculate: (a) the potential energy at the greatest height, (b) the kinetic energy on reaching the ground, (c) the total energy at its half-way point.

Solution 2:

(a) Potential energy at the greatest height = initial kinetic energy

or, mgh = $\frac{1}{2} mv^2$

$= \frac{1}{2} \times 0.500 \times 15 \times 15 = 56.25J$

(b) Kinetic energy on reaching the ground= potential energy at the greatest height = 56.25 J

(c) Total energy at its half-way point = $\frac{1}{2}$ (K + U) = 56.25J

Question 3:

A metal ball of mass 2 kg is allowed to fall freely from rest from a height of 5m above the ground.

(Take g = 10 m s^{-2})

(a) Calculate the potential energy possessed by the ball when initially at rest.
(b) what is the kinetic energy of the ball just before it hits the ground?
(c) what happens to the mechanical energy after the ball hits the ground and comes to rest?

Solution 3:

(a) Potential energy of the ball = mgh
= 2 x 10 x 5 =100J
(b) Kinetic energy of the ball just before hitting the ground = Initial potential energy= mgh = 2 x 10 x 5 =100J
(c) Mechanical energy converts into heat and sound energy.

Question 4:

The diagram given below shows a ski jump. A skier weighing 60 kgf stands at A at the top of ski jump. He moves from A to B and takes off for his jump at B.

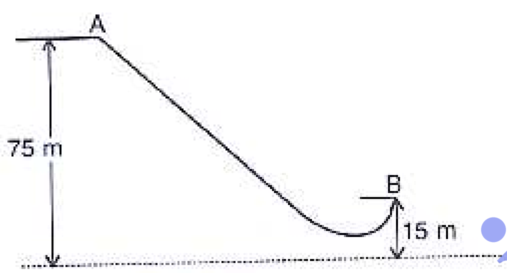


Fig. 2.22

(a) Calculate the change in the gravitational potential energy of the skier between A and B.
(b) If 75% of the energy in part (a) becomes kinetic energy at B. Calculate the speed at which the skier arrives at B.
(Take g=10 m s^{-2})

Solution 4:

(a) Mass of skier= 60kg
Loss in potential energy = $mg(h_1 - h_2)$
= 60 × 10 × (75 −15)
= 60 × 10 × 60 = 3.6×10^4J
(b) Kinetic energy at B = $\frac{75}{100} \times 3.6 \times 10^4 = 27000\,J$
= 2.7×10^4 J
Kinetic energy = $\frac{1}{2}mv^2$
$27000 = \frac{1}{2}mv^2$
$27000 = \frac{1}{2} \times 60 \times v^2$

$$v^2 = \frac{27000}{30} = 900$$

V = 30m / s

Question 5:

A hydroelectric power station takes its water from a lake whose water level if 50 m above the turbine. Assuming an overall efficiency of 40%, calculate the mass of water which must flow through the turbine each second to produce power output of 1 MV.

Solution 5:

Potential energy = mgh

Efficiency = 40%

Useful work done = 40% of potential energy

$= \frac{40}{100}$ (mgh) = 0.4 × (m×10×50)

= 200m

Power = work done pr second

1MW = 200 × mass of water flowing each second

1×10^6w = 200 × mass of water flowing each second

Mass of water flowing each second = $\frac{1 \times 10^6}{200} = 5000kg$

Question 6:

The bob of a simple pendulum is imparted a velocity 5 m s^{-1} when it is at its mean position. To what maximum vertical height will it rise on reaching to its extreme position if 60% of its energy is lost in overcome friction of air?

Solution 6:

Potential energy at the extreme position = 40% of kinetic energy at the resting position.

mgh = $\frac{40}{100} \times (\frac{1}{2} mv^2)$

$\frac{40}{100} \times (\frac{1}{2} mv^2)$ = mgh

0.4 × 0.5 × m × v^2 = mgh

0.2 × v^2 = 10×h

0.2 × 5 × 5 = 10h

H = $\frac{5}{10} = 0.5m$