Question 1. A dog weighing 25 kg, while chasing a cat, jumps over a fence of height 1.6 m. What is the potential energy of dog at the top of fence ?
(Take gravity due to earth 'g'=10 m s^{-2})

(a) 160 Joules
(b) 320 Joules
(c) 380 Joules
(d) 480 Joules

Answer. (c) 380 Joules

Question 2. In winters, rubbing of hands together for some time, causes a sensation of warmth mainly because of

(a) heat caused by the force of friction
(b) heat caused by the momentum
(c) heat caused by the motion
(d) heat flows from the blood to skin

Answer. (a) heat caused by the force of friction

Question 3. A soldier makes a swing jump between two points, by holding one end of a rope, other end of which is tied to some higher point. Work done by rope in jumping of soldier from one point to another is an example of :

(a) Negative work
(b) Positive work
(c) Zero work done
(d) None of the above

Answer. (c) Zero work done

Question 4. Which of the following does not have unit as Joule?

(a) Work done
(b) Kinetic energy
(c) Potential energy
(d) Force

Answer. (d) Force

Question 5 . The commercial unit of energy consumption in households, industries and commercial establishments is

(a) Joule

(b) Watt
(c) kW
(d) KW h (kilowatt hour)

Answer. (d) KW h (kilowatt hour)

Question 6. A runner, while moving, is facing a wind from the opposite direction. The work done by the wind on runner will be

(a) Zero
(b) negative
(c) Positive
(d) infinity

Answer. (b) negative

Question 7. The value of 1 Kilo Watt Hour is

(a) $1.8 \times 10^5 J$
(b) $3.6 \times 10^6 J$
(c) $5.4 \times 10^8 J$
(d) $7.2 \times 10^{10} J$

Answer. (b) $3.6 \times 10^6 J$

Question 8. An external force is being applied on an object at some angle and it causes the object either to be pulled or pushed on a rough surface. Which of the following holds true ?

(a) It is easier to push the object
(b) It is easier to pull the object
(c) It requires same efforts to push or pull the object
(d) None of the above

Answer. (b) Pulling is easier

Question 9. A car with mass 'M' is moving on horizontal road with velocity 'v'. Driver applies accelerator and increases it speed 3 times to '3v'. The final K.E. acquired by the car will be :

(a) $1.5\ Mv^2$
(b) $2.5\ Mv^2$
(c) $3.5\ Mv^2$
(d) $4.5\ Mv^2$

Answer. (d) $4.5\ Mv^2$
Question 10. As per the statement given in Q.9 above, What change it will take place for

the potential energy of the car

(a) It will remain the same
(b) It will increase
(c) It will decrease
(d) It will becomes 3 times the Intial P.E.

Answer. (a) It will remain the same

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Question 11. As per the statement of Q.9, the amount of addition work done by the car, after applying the accelerator, is

(a) 1.5 Mv^2
(b) 2.5 Mv^2
(c) 3.5 Mv^2
(d) 4 Mv^2

Answer. (d) 4 Mv^2

Question 12. In first case, a force of 5 N is applied on a object for 6 minutes and displaces it by 10 meters. In second case, A force of 10 N is applied on the same object for 3 minutes and displaces it by 5 meters. In which case there is more work done?

(a) First case
(b) Second case
(c) In both cases, work done is same
(d) In both cases, work done is zero

Answer. (c) In both cases, work done is same

Question 13. A cyclist is moving at a speed of 5 m/s on leveled road. While going down the slop, his speed increases to 7 m/s. Here the nature of work done by gravitational force in increasing the speed of cyclist is an example of ?

(a) positive work done
(b) negative work done
(c) Infinite work done
(d) Zero work done

Answer. (a) positive work done

Question 14. The person will have maximum Potential Energy, when ?

(a) he is sleeping on the ground
(b) he is sitting on the ground
(c) he is sleeping on the bed
(d) he is standing on the roof

Answer. (d) standing on the roof

Question 15. When we stretch a rubber band, the Elastic Potential Energy of rubber band

(a) remains unchanged
(b) becomes zero
(c) increases
(d) decreases

Answer. (c) increases

Question 16. Expression for Power of an object is equal to:

(a) Power = Work done X Time
(b) Power = Time/ Work done
(c) Power = Work done/Time
(d) Power = Force X Displacement

Answer. (c) Power = Work done/Time

Question 17. When a body falls freely towards the earth then the total energy

(a) remains constant
(b) increases
(c) decreases
(d) first increases and then decreases

Answer. (a) remains constant

Question 18. In hydro electricity generation, water stored in a dam possesses:

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

Answer. (d) potential energy

Question 19. When a body slides down on an inclined surface, which holds true ?

(a) It has no energy

(b) It has potential energy only
(c) It has kinetic energy only
(d) It has both kinetic and potential energy

Answer. (d) It has both kinetic and potential energy

Question 20. According to the law of conservation of energy, which of the statements given below is correct ?

(a) Energy can not be transformed from one form to another
(b) It can be created or destroyed.
(c) The total energy before and after the transformation always remains constant.
(d) The total energy before and after the transformation is always different.

Answer. (c) The total energy before and after the transformation always remains constant.

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Question 21. An object is displaced by 10 meters in the direction of applied force. If the applied force is 75 N, What is the work done by the force?

(a) 0.75 Joule
(b) 7.5 Joule
(c) 75 joule
(d) 750 joule

Answer. (d) 750 joule

Question 22. An object is subjected to free fall from height 'h' to ground. At mid point of its fall i.e. at 1/2 of height H, it will acquire?

(a) more kinetic and less potential energy
(b) less kinetic and more potential energy
(c) same kinetic and potential energy
(d) only potential energy

Answer. (c) same kinetic and potential energy

Question 23. An object is thrown vertically upward and it reaches to a maximum height 'h' from the ground. During its flight, on reaching 3/4 of height H, it will acquire?

(a) less potential and high kinetic energy
(b) more potential and less kinetic energy
(c) same potential and kinetic energy
(d) only kinetic energy

Answer. more potential and less kinetic energy

Question 24. In a construction site, a crane lifts 1000 kg of concrete mix to roof top at a height of 20 meters in 50 seconds. If the value of gravity 'g' due to earth is 10 m s^{-2}, the power of elevator will be..

(a) 2 KW
(b) 3 KW
(c) 4 KW
(d) 5 KW

Answer. (c) 4 KW

Question 25. A body is moving with velocity 4 m/s , possesses 56 Joules of Kinetic Energy. The momentum of body will be equal to

(a) 7 $kgms^{-1}$
(b) 14 $kgms^{-1}$
(c) 21 $kgms^{-1}$
(d) 28 $kgms^{-1}$

Answer. (d) 28 $kgms^{-1}$

Question 26. Which of the following is correct?

(a) A fruit hanging from the tree possesses gravitational potential energy
(b) A running player acquires Kinetic Energy
(c) A piston with compressed air contains potential energy
(d) All of the above

Answer. (d) All of the above

Question 27. A vector quantity has both magnitude as well as direction, where as a scalar quantity has only magnitude and no direction. which of the given below is a scalar quantity?

(a) Velocity
(b) Force
(c) Work done
(d) Momentum

Answer. (c) Work done

Question 28. In Force vs Displacement graph, What does the area under the curve represents :

(a) Velocity
(b) Acceleration

(c) Force
(d) Work done

Answer. d) Work done

Question 29. For an object of mass 'm', falling freely from height 'h', under acceleration due to gravity 'g', If v is the velocity of the object at a given instant, then during the course of its fall, for all points, which of the expression given below is correct ?

(a) $mgh > 1/2\ mv^2$
(b) $mgh < 1/2\ mv^2$
(c) $mgh = 1/2\ mv^2$
(d) $mgh + 1/2\ mv^2 = Constant$

Answer. (d) $mgh + 1/2\ mv^2 = Constant$

Question 30. According to the law of conservation of energy,

(a) Energy can only be transformed from one form to another
(b) It can neither be created nor destroyed
(c) The total energy before and after the transformation always remains constant
(d) All of the above

Answer. (d) All of the above

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Question 31. According to standard definition of Work done, when the force 'F' acts on the object and object is displaced through a distance 's' in the direction of the force, then work done by a force is equal to

(a) W = F/s
(b) W = s/F
(c) W = F × s
(d) W = Zero

Answer. (c) W = F × s

Question 32. 1 J is the amount of work done on an object when a force of 1 N displaces it along its line of action by :

(a) 1 cm .
(b) 1 m
(c) 100 m
(d) 1 km

Answer. (b) 1 m

Question 33. A joule (J) is used as a unit of measurement for :

(a) Kinetic Energy
(b) Potential Energy
(c) Work done
(d) All of the above

Answer. (d) All of the above

Question 34. Power of an agent is

(a) the rate of generation of energy .
(b) the rate of transfer of energy
(c) the rate of consumption of energy
(d) the rate of work done
(e) All of the above

Answer. (e) All of the above

Question 35. Newton meter per second or 1 joule/second or 1 watt is unit of

(a) Force
(b) Work
(c) Power
(d) Energy

Answer. (c) Power

Question 36. When a spring is compressed or stretched beyond its natural position by applying some force, work is done on it. Its elastic potential energy

(a) increases
(b) Decreases
(c) Disappears
(d) Does not change

Answer. (b) Increases

Question 37. As a person climbs up from ground floor of the building to higher floor, The potential energy of person on the higher floor, relative to the ground floor, can be expressed as

(a) the work done in lifting his weight from ground floor to higher floor.
(b) the product of his weight and the distance between the ground and higher floor.
(c) the energy the person because of his position above the ground floor.

(d) Any one of the above

Answer. (d) Any one of the above

Question 38. A car which is 8 times heavier than a motorcycle is moving at a speed which is just 1/2 the speed of motorcycle. . The amount of work done required to stop the car as compare to that of motorcycle, will be ?

(a) The same amount
(b) Twice as much.
(c) Three times as much
(d) Four times as much.

Answer. (b) Twice as much.

Question 39. Our planet Earth receives or transfers most of its energy in the form of :

(a) Radiant energy.
(b) Geo-thermal energy
(c) Chemical energy
(d) Wind energy

Answer. (a) radiant energy.

Question 40. Two objects A and B are moving with same momentum. Mass of object 'B' is greater then mass of object 'A'. Which of the two object will have higher kinetic energy?

(a) Object A
(b) Object B
(c) Both the objects will have same Kinetic Energy
(d) Object with greater mass will have higher kinetic energy

Answer. (a) Object A

VERY SHORT ANSWER TYPE

Question 1.
Define the following terms.
(a) Work was done
(b) Energy
(c) Mechanical energy
(d) Kinetic energy
(e) Potential energy
(f) Power
(g) Commercial unit of energy.
Answer:
(a) Work done: Work done by a force acting on an object is equal to the magnitude of the force multiplied by the distance moved in the direction of the force.
(b) Energy: Energy of a body is defined as the capacity or ability of the body to do work.
(c) Mechanical energy: Mechanical energy includes kinetic energy and potential energy.
(d) Kinetic energy: The energy possessed by a body by virtue of its motion.
(e) Potential energy: The energy possessed by a body due to its position or configuration.
(f) Power: Power is defined as the rate of doing work or the rate of transfer of energy.
(g) Commercial unit of energy: The energy used in households, industries, and commercial establishment are usually expressed in kilowatt-hour.
1 kWh 1 unit = 3.6×10^6J

Question 2.
Write down the type of energy stored in
(a) spring of a watch
(b) flowing water
(c) rolling stone
(d) raised hammer
(e) running athlete
Answer:
(a) potential energy
(b) kinetic energy
(c) kinetic energy
(d) potential energy
(e) kinetic energy.

Question 3.
What will be the kinetic energy of a body when its mass is made four-time and the velocity is doubled?
Answer:
Initial kinetic energy,

$E_{Ki}=\frac{1}{2}mv^2$
Final kinetic energy,
$E_{Kf}=\frac{1}{2}(4m)\times(2v)^2$
= 16 x $\frac{1}{2}mu^2$
$E_{Kf}=16E_{Ki}$
Question 4.
If we lift a body of 7 kg vertically upwards to a height of 10 m, calculate the work done in lifting the body.
Answer:
Given, m = 7 kg
s = 10m
Workdone, W = F x s
E = mg x s
W = 7 x 10 x 10 J
w = 7000 J

Question 5.
State the transformation of energy that takes place when

- Green plants prepare their food.
- Head of a nail hammered hard and it becomes hot.

Answer:

- Solar energy of sun into chemical energy.
- The kinetic energy of the hammer into heat energy.

Question 6.
How much work is done by a man who tries to push the wall of a house but fails to do so?
Answer:
W = Fs = 0
As there is no displacement.

Question 7.
Establish a relationship between SI unit and commercial unit of energy.
Answer:
SI unit of energy is joule and the commercial unit of energy is the joule.
1kWh = 1000 W x 3600 s = 3.6 x 10^6J

Question 8.
Write down the energy transformation taking place
(a) In electric bulb
(b) In torch

(c) In the thermal power station
(d) In solar cell
(e) Electric heater
Answer:
(a) Electricity into light energy
(b) The chemical energy of the cell into light and heat energy
(c) The chemical energy of fuel into electricity
(d) Solar energy into electricity
(e) Electricity into heat energy.

Question 9.
A body of mass m is moving in a circular path of radius r. How much work is done on the body?
Answer:
Zero. This is because the centripetal force acting on the body is perpendicular to the displacement of the body.

Question 10.
A horse of mass 200 kg and a dog of mass 20 kg are running at the same speed. Which of the two possesses more kinetic energy? How?
Answer:
The kinetic energy of the horse is more as kinetic energy is directly proportional to mass.

Question 11.
What is the condition for work done to be positive?
Answer:
For positive work, the angle between force and displacement should be acute.

Question 12.
Write down the relation between kinetic energy and momentum of a body.
Answer:
$E_K = p^2 2m$
E_k = kinetic energy of a body
p = momentum of the body
m = mass of the body.
Question 13.
A cyclist comes to a skidding stop at 50 m. During this process, the force on the cycle due to the road is 1000 N and is directed opposite to the motion. How much work does the road do on the cycle?
Answer:
Given,
Displacement, s = 50 m
Force, F = – 1000 N
Workdone, W = F x s

W = -1000 x 50J
W = 50000J

Question 14.
A boy pushes a book by applying a force of 40 N. Find the work done by this force as the book is displaced through 25 cm along the path.
Answer:
Given, Force (F) = 40 N
Displacement (s) = 25 cm = x 10^{-2} m
Workdone, W = F x s
= 40 x 25 x 10^{-2}
= 10J
∴ W = 10J

SHORT ANSWER TYPE 1

Question 1.
State law of conservation of energy and law of conservation of mechanical energy.
Answer:
Law of conservation of energy: Energy can neither be created nor be destroyed, it can only be transformed from one form to another.
Conservation of mechanical energy: If there is no energy, then the mechanical energy of a system is always constant.

Question 2.
Define (a) 1 joule (b) 1 watt.
Answer:
(a) 1 joule is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.
(b) 1 watt is the power of an agent, which does work at the rate of 1 joule per second.

Question 3.
Write down SI unit of the following quantities.
(a) work
(b) kinetic energy
(c) potential energy
(d) power
Answer:
(a) joule (J)
(b) joule (J)
(c) joule (J)
(d) watt (W).

Question 4.
What is the sequence of energy change that takes place in the production of electricity from adam?
Answer:
The potential energy of stored water is converted into the rotational kinetic energy of turbine blades. The rotational kinetic energy of turbine blades is finally converted into electric energy by the generator.

Question 5.
A light and a heavy object have the same momentum. Find out the ratio of their kinetic energies. Which one has larger kinetic energy?
Answer:
The relation between kinetic energy and momentum
Given,

$$E_K = \frac{p^2}{2m}$$

Given, $p_1 = p_2$

Take $m_1 > m_2$,

$$E_{K_1} = \frac{P_1^2}{2m_1}$$

and $$\boxed{E_{K_2} = \frac{p_2^2}{2m_2}}$$

$$\therefore \quad \frac{E_{K_1}}{E_{K_2}} = \frac{m_2}{m_1}$$

$E_{K_2} > E_{K_1}$ as $m_1 > m_2$

Question 6.
Why a man does not do work when he moves on a level road while carrying a box on his head?
Answer:
When a man carries a load on his head, the angle between displacement (s) and force (F) is 900. Therefore work done is zero.

Question 7.
If an electric iron of 1200 W is used for 30 minutes every day, find electric energy consumed in the month of April.
Answer:
Given,
Power, P = 1200 W
time, t = 30 minutes

Power, p = $\frac{W}{t} = \frac{E}{t}$
E = P x t
Energy consumed, E = 1200 x 30 x 60
= 2.16 x 10^6J = 2.16MJ
Question 8.
What is work done by a force of gravity in the following cases?
(a) Satellite moving around the Earth in a circular orbit of radius 35000 km.
(b) A stone of mass 250 g is thrown up through a height of 2.5 m.
Answer:
(a) Zero
(b) Given,
mass (m) = 250 g = 0.25 kg
height (h) = 2.5 m
Workdone, W = Fs = mgh
= 0.25 x 10 x 2.5
= 6.25 J
W = 625 J

Question 9.
A car and a truck have kinetic energies of 8 x 10 J and 9 x 10 J respectively. If they are brought to a halt at the same distance, find the ratio of the force applied to both the vehicles.
Answer:
Given,
Kinetic energy of car, $\frac{1}{2}$ = 8 x 10 J
Kinetic energy of truck, $\frac{1}{2}$ = 9 x 10 J
W = Fs
Work done,

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$Fs = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$Fs = 0 - \frac{1}{2}mu^2$$

$$Fs = 0 - k$$

$$-k = Fs$$

For car, $-k_c = F_c s$

For train, $-k_t = F_t s$

$\therefore$ $\boxed{\frac{k_c}{k_t} = \frac{F_c}{F_t} = \frac{8}{9}}$

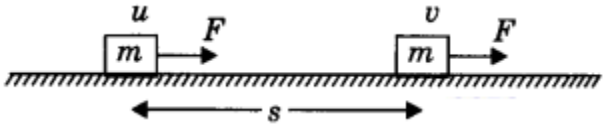
Question 10.
A bus of mass 10,000 kg is moving with a velocity 90 km/h. Calculate the work done to stop this bus.
Answer:
Given,
mass of object, m = 1000 kg
Initial velocity of object, u = 90 km/h

$= {}^{5}\cancel{90} \times \frac{5}{\cancel{18}}$ m/s

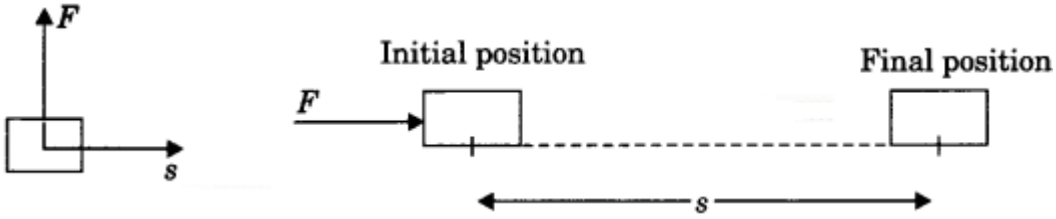
= 25 m/s
Work done = 12 mu^2 – 12 mu^2 = 0 – 12 x 10000 x $(25)^2$ = 312.5 x 10^4 J

Work, Power And Energy Class 9 Extra Questions Short Answer Type 2

Question 1.
The velocity of a body moving in a straight line is increased by applying constant force F, for some distance in the direction of motion. Prove that the increase ¡n the kinetic energy of the body is equal to the work done by the force on the body.
Answer:
Let us consider an object lying on a frictionless surface having mass 'm'.

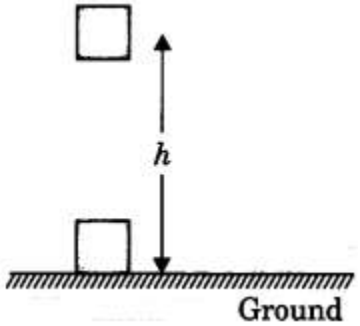


$$P = \frac{\text{Work}}{\text{Time}} = \frac{W}{t}$$



A force of constant magnitude 'F' is acting on the body. Here initial velocity of the body is u and the final velocity is u. As there is no dissipative forces, work on the body will be stored in the form of a change in kinetic energy. It can be proved as
W = Fs ……(1)
and hence from the equation of motion
u^2 – u^2 = 2as
s = $v^2-u^2 2a$ ……(2)
As we know that F = ma
Using (1), (2) and (3),
W = ma x $v^2-u^2 2a$
= 12 m (u^2 – u^2)
= 12mu^2 – 12mu^2
= change in kinetic energy
Question 2.
Derive an expression for potential energy. Write Its SI unit.
Answer:
When work is done on the body, the work is stored in the form of energy. Consider an

object of mass, m. Let it be raised through a height, h from the ground. A force is required to do this. The minimum force required to raise the object is equal to the weight of the object, mg. The object gains energy equal to the work done on it. Let the work done on the object against gravity h be W.
i.e., W = force x displacement = mgh



Since work done on the object is equal to mgh, an energy equal to mgh units is gained by the object. This is the potential energy (E_p) of the object.
∴ E_p = mgh
SI unit of potential energy is the joule (J).

Question 3.
A girl having a mass of 35 kg sits on a trolley of mass 5 kg. The trolley is given an initial velocity of 4 ms1 by applying a force. The trolley comes to rest after traversing a distance of 16 m.
(a) How much work is done on the trolley?
(b) How much work is done by the girl?
Answer:
Given, mass of girl, m = 35 kg
mass of trolley, m = 5 kg.
initial velocity of trolley, u = 4 m/s

(a) using work done = change in kinetic energy
W = $E_{Kf} - E_{Ki}$
= o – 12 x 40 x $(4)^2$ = – 320
∴ W = 320 J_J
(b) Work done by the girl = 0.
Question 4.
Express kilowatt in terms of joule per second. A 150 kg car engine develops 500 W for each kg. What forces does it exert in moving the car at a speed of 20 ms^{-1}?
Answer:
1 kW = iooo w = 10^3 J/S
Given, mass (m) = 150 kg
power (P) = 500 W
velocity (u) = 20 m/s
Using P = Fu
or, 500 = F x 20

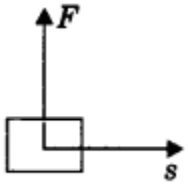
= F =$\frac{500}{20}$ = 25
F= 25 N
Question 5.
How is the power related to the speed at which a body can be lifted? How many kilograms will a man working at the power of 100 W, be able to lift at constant speed of 1 mr1 vertically? (g = 10 ms^{-2})
Answer:
We know that,

$$P = \frac{\text{Work}}{\text{Time}} = \frac{W}{t}$$

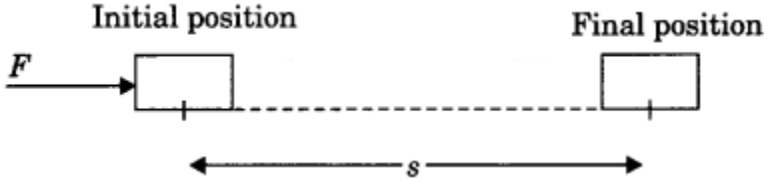
or, p = $\frac{F.s}{t}$ P = Fυ = mg.υ [F = mg]
where, F = force
s = displacement
υ = velocity
t = time
Given,
power (P) = 100 W
velocity (υ) = 1 m/s
g = 10 m/s^2
or, 100 = m x 10 x 1
∴ m = 10 kg
Question 6.
A car of mass 2000 kg is lifted up a distance of 30 m by a crane in 1 minute. A second crane does the same job in 2 minutes. What is the power applied by each crane?
Answer:
Given, mass of the car to be lifted, m = 2000 kg
height through which the car is to be lifted, h = 30 m
Time taken by first crane, t_1 = 1 minute = 60 s
time taken by second crane, t_1 = 2 minutes = 120 s
Amount of work done by each crane,
W = mgh = 2000 x 10 x 30 J
W= 6 x 10^6 J
Power of first crane, ‘
$P_1 = \frac{W_1}{t_1} = \frac{6 \times 10^5 J}{60 s}$ = 10kW
Power of second crane
$P_2 = \frac{W_2}{t_2} = \frac{6 \times 10^5 J}{120 s}$ = 10kW
Question 7.
Calculate the electricity bill amount for a month of June, if 6 bulbs of 100 W for5 hours, 4 tube lights of 60 W for 5 hours, a TV of 50 W for 6 hours are used per day. The cost per unit is ₹ 5.
Answer:
Total energy used in a day = (6 x 100 x 5 + 4 x 60 x 5 + 1 x 50 x 6) Wh
= (3000+ 1200 +300)Wh = 4500 Wh
Total energy = 4.5 kWh = 4.5 unit
Total energy used in 30 days = 4.5 x 30 = 135 units
Bill amount = 135 units x ₹ 5 unit = ₹ 675.

LONG ANSWER TYPE

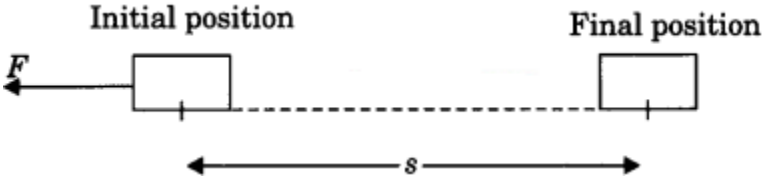
Question 1.
State the conditions for positive, negative, and zero work. Give at least one example of each.
Answer:
1. Zero work: If the angle between force and displacement is 90°, then work done is said to be zero work.
Example: When a man carries a load on his head and moves on a level road. Work done by the man on the load is zero.



2. Positive work: Work done is said to be positive if the force applied on an object and displacement are in the same direction.
W = Fs



Example: Work done by the force of gravity on a falling body is positive.
3. Negative work: Work done is said to be negative if the applied force on an object and displacement is in opposite direction.
W = -Fs
Her displacement is taken to be negative (- s).

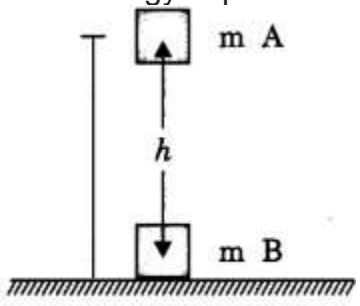


Example: Work done by friction force applied is negative on a moving body.

Question 2.
Give a reason for the following:
(a) A bullet is released on firing the pistol.
(b) An arrow moves forward when released from the stretched bow.
(c) Winding the spring of a toy car makes it to run on the ground.
(d) Falling water from a dam generates electricity.
(e) Winding the spring of our watch, the hands of the watch movement.

Answer:
(a) The chemical energy of gun powder is converted into kinetic energy of the bullet.
(b) The elastic potential energy in a stretched bow is converted into kinetic energy of the arrow.
(c) The potential energy of a spring is converted into kinetic energy of the toy.
(d) The kinetic energy of water is converted into electric energy.
(e) The potential energy of spring due to its windings is converted into mechanical energy of the watch.

Question 3.
State the law of conservation of energy. Show that the energy of a freely falling body is conserved.
Answer:
Energy can neither be created nor be destroyed, it can only be transformed ‘ m A from one form to another. The total energy before and after the transformation always remains constant.
Let us consider an object of mass ‘m’ dropped from a height h.
Total energy at point A



$E_{TA}=E_K+E_P$
or, $E_{TA}=0+mgh$
$\therefore E_{TA}=mgh$
Total energy at point B,
$E_{TB}=E_T+E_p$
For finding out velocity at point B
apply $u^2 - u^2 = 2as$
$v_{2B}=2gh = 2gh$
Hence, $E_{TB}=12mV_{2B}+mg$
$E_{TB}=12m(2gh)=mgh$
Here, $E_{TA}=E_{TB}$
Hence if there is no energy loss, total energy is conserved.

HOTS

Question 1.
A running man has half the kinetic energy that a body of half of his mass has. The man speeds up by 1 m/s and then has the same kinetic energy as the boy. What are the original speeds of the man and the boy?
Answer:
Let us take
mass of boy = m
mass of man = M
velocity of boy = u
velocity of man = υ
Here, m = $M2$
Initially
$E_K$of man = 12 E_K of boy
12 Mu^2 = 12 mu^2 x 12
and 12 Mu^2 = 12 $12(M2)u2×12$
∴ $υ^2$ = $u24$ ……(1)
Finally
E_K of man = E_K of boy
$12M(υ+1)^2$ = 12 mu^2
$12M(υ+1)^2$ = $12(M2)u2$
$(υ+1)^2$ = $u22$
∴ $υ+1$ = $u2\sqrt{}$ ……(2)
$υ = 2-\sqrt{} + 1 = 2.41$ m/s
and u = 4.82 m/s
Question 2.
Avinash can run with a speed of 8 m/s against the frictional force of 10 N, and Kapil can move with a speed of 3 m/s against the frictional force of 25 N. Who is more powerful and why?
Answer:
Power can be expressed as, P = Fu
Power of Avinash, P = Fu = 10 x 8 = 80 W
Power of Kapil, P = Fu = 25 x 3 = 75 W
Avinash is more powerful than Kapil.

Question 3.
The weight of a person on a planet A is about half that on the earth. He can jump up to 0.4 m height on the surface of the earth. How high can he can jump on planet A?
Answer:
For the case, of jump, the energy imparted by the person is converted into potential energy,

Hence,
$(m_A g_A)h_A = (m_e g_e)h_e$ ……(1)
Given, $m_A g_A = m_e g_e 2$ ……(2)
Using (1) and (2),
$h_A 2 = h_e$
∴ $h_A = 2h_e = 2 \times 0.4 = 0.8m$
Question 4.
A ball is dropped from a height of 10 m. If the energy of the bal] is reduced by 40% after striking the ground, how much high can the ball bounce back? (g 10 m/s^2)
Answer:
Given,
height, h = 10
If the energy of the ball is reduced by 40%, the remaining energy of the ball is 60% of initial.
Hence ball will rebound to 60% of the initial height
h = 60100 x 10 m
∴ h = 6m
Question 5.
Four men lift a 250 kg box to a height of 1 m and hold it. Without raising or lowering it
(a) How much work is done by men in lifting the box?
(b) How much work they do in just holding it?
Answer:
Given, mass of block, m = 250 kg
height, h = 1 m
(a) work done in lifting,
W = Fs = mgh = 250 x 10 x 1
W = 2500 J
(b) work done in holding, W = 0

Question 6.
What is power? How do you differentiate kilowatt from kilowatt-hour? The Jog falls in Karnataka state are nearly 20 m high. 2000 tonnes of water falls from it in a minute. Calculate the equivalent power if all this energy can be utilized. (g = 10 ms^{-2})
Answer:
1. Power is rate of doing work.
2. Kilowatt is the unit of power and kilowatt-hour is unit of energy.
3. Given, height, h = 20 m
Mass per unit time,
m/t = 2000 tonnes per minutes = $2000 \times 10^3 60$ kg/s
Power P = $Wt = mght = 2000 \times 10^3 60$ = 10 x 20
∴ P = 6.67 x 10^6 W = 6.67 MW
Question 7.
What happens to the kinetic energy when:
1. the mass of the body is doubled at constant velocity?
2. the velocity of the body is doubled at constant mass?
3. the mass of the body is doubled but velocity is reduced to one fourth?

Answer:
1. The kinetic energy of body is given by,
$E_k = 12\ mu^6$, $E_k \propto m$. If the mass of the body is doubled its kinetic energy is also doubled.
2. Kinetic energy, $E_k \propto u^2$
If velocity of the body is doubled, its kinetic energy becomes four times.

3. Initial kinetic energy,
$E_{Ki} = 12\ mu^2$
Final kinetic energy,
$E_{Kf} = 12(2m)\ (v4)2 = mv216$
Kinetic Energy becomes one eighth.
Question 8.
Why is the water at the bottom of a waterfall warmer than the water on the top?
Answer:
When waterfalls, its potential energy is converted into kinetic energy of molecules, and the kinetic energy of molecules is converted into heat energy.

VALUE BASED (VBQS)

Question 1.
Aman is a student of class IX. He saw an old man trying to keep his box on the roof of a bus but was unable to do so. Aman picked up his box and placed the box on the roof of the bus.
The old man thanked Aman.
Answer the following questions based on the given paragraph:

- Is the work done by Aman while placing the box on the roof of the bus positive or negative?
- Is the work done by gravity on the box positive or negative?
- What values are shown by Aman?

Answer:

- Positive
- Negative
- Aman is a kind and helpful person.

Question 2.
In the winter season, John gifted an electric heater to his grandfather. The electric heater uses electricity to increase room temperature.
Answer the following questions based on the above paragraph:

- Write down the energy transformation in the electric heater.
- What values are shown by John?

Answer:

- Electric heater converts electricity into heat energy.
- John is an intelligent and caring person.

Question 3.
The government of a state decided to construct dams on the river for power generation. Nowadays the demand of electricity is continuously increasing and therefore more generation is required.
Answer the following questions based on the above paragraph:
(a) Write down the type of energy conversion is taking place in dams.
(b) Write down the values shown by the state government.
Answer:
(a) The potential energy of stored water is converted into electricity.
(b) The state government is working efficiently and showing good governance.

EXTRAAAAAA WORK AND ENERGY

1-MARK QUESTIONS

Question.1 Does work done depend upon the velocity of the body.
Answer. No.

Question.2 State the law of conservation of energy.
Answer. It states that energy can neither be created nor destroyed. It can only change its form.

Question.3 In a tug-of-war one team gives way to the other. What work is being done and by whom ?
Answer.
The winning team does work. The work is equal to the product of the resultant force and the displacement undergone by the losing team.

Question.4 What will cause greater change in kinetic energy of a body? Changing its mass or changing its velocity ?
Answer. Changing its velocity.

Question.5 List two essential conditions for work to be done.
Answer. (i) A force must act and (ii) There should be displacement in the body.

Question.6 When is 1 joule of work said to be done ?
Answer. When a force of 1 newton acting on a body displaces it in its own direction.

Question.7 What is the SI unit of work done and power ?
Answer. Joule and Watt.

Question.8 What is power? What is its SI unit ?
Answer. It is defined as the rate of doing work. Its unit is watt.

Question.9 Find the energy in kWh consumed in 10 hours by a machine of power 500 W.
Answer. W = P x t = 500 x 10 = 5000 Wh – 5 kWh.

Question.10. When is work said to be done against the force of gravity ?
Answer. When a body lifted the work is done against the force of gravity.

Question.11 Write an expression for the work done in lifting a body of mass 'm' through a vertical height 'h'.
Answer. Work done W = mgh, where g is acceleration due to gravity.

Question.12 When a book is lifted from a table, against which force work is done ?
Answer. Work is done against the force of gravity.

Question.13 Will work be done by a man who pushes a wall ?
Answer. No.

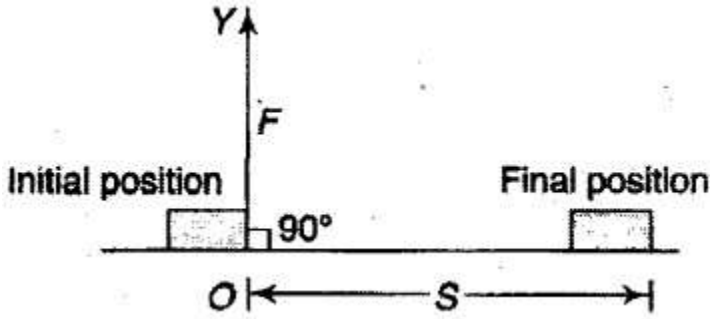
Question.14 What is the work done when the force acting on the body and the displacement produced in the body are at right angles to each other ?
Answer. Zero.

Question.15 Is it possible that some force is acting on a body but still the work done is zero ?
Answer. Yes, when force acts at an angle of 90° with the displacement.

Question.16 What is the work done on a body moving in a circular path ?
Answer. Zero, because force and displacement are perpendicular to each other.

Question.17 Does every change in energy of the body involve work ?
Answer. Yes.

Question.18 What is the work done in the situation shown below ?



Answer. Zero.

Question.19 A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force. Let us take it that the force acts on the object through the displacement. What is the work done in this case ?
Answer.
Given, displacement = 8 m,
Force = 7N
Now, Work done = Force x Displacement
= 7 x 8 = 56 J

Question.20 When do we say that work is done ? ~
Answer.
Work is said to be done when a force causes displacement of an object in the direction of applied force.

Question.21 Write an expression for the work done when a force is acting on an object in the direction of its displacement.
Answer.
Work done = Force x Displacement

Question.22 A pair of bullocks exert a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field ?
Answer.
Work done = Force x Displacement = 140 x 15 = 2100 J

Question.23 What is the kinetic energy of an object?
Answer.
The energy possessed by a body by virtue of its motion is called kinetic energy.

Question.24 Write an expression for the kinetic energy of an object.
Answer.
The expression is KE = 1/2 mv^2, where 'm' is the mass and V is the velocity of the body.

Question.25 Define 1 watt of power.
Answer.
When a work of 1 joule is done in 1s, the power is said to be one watt.

Question.26 A lamp consumes 1000 J of electrical energy in 10 s. What is its power ?
Answer.
Given, W = 1000 J, t = 10 s, R = ?
Using p = W/t = 1000/10 = 100 W

Question.27 Define average power.
Answer.
When a machine or person does different amounts of work or uses energy in different intervals of time, the ratio between the total work or energy consumed to the total time is average power.

Question.28 Define energy.
Answer.
Energy is the ability of a body to do work. It is also defined as the capacity to do work.

Question.29 A body performs no work. Does it imply that the body possesses no energy ?
Answer.
When a body does not perform any work, it never implies that the body has no energy. The body may have energy but still does not perform any work, e.g., a book placed on a table has potential energy but is not performing any work.

Question.30 What is the SI unit of energy?
Answer. The SI unit of energy is joule.

Question.31 Does a body at rest possess any kinetic energy ?
Answer. No.

Question.32 What will happen to the kinetic energy of a body if its mass is doubled ?
Answer. Its kinetic energy will be doubled.

Question.33 What will happen to the kinetic energy of a body if its velocity is halved ?
Answer. The kinetic energy of the body will become one-fourth.

Question.34 By how much will the speed of a body, of fixed mass, increase if its kinetic energy becomes four times its initial kinetic energy ?
Answer. The speed is doubled.

Question.35 Can a body possess energy even if it is not in motion ?
Answer. Yes, it can possess potential energy.

Question.36 Define potential energy.
Answer. It is defined as the energy possessed by a body by virtue of its position or change in shape.

Question.37 Name the energy possessed by a stretched rubber band lying on the table.
Answer. Potential energy.

Question.38 Give the SI unit of potential energy.
Answer. The SI unit of potential energy is.joule.

Question.39 What do you mean by trans- formation of energy ?
Answer. It is the change of energy from one form of energy into another form of energy.

Question.40 Can energy be destroyed? Can energy be created ?
Answer. No,

Question.41 A cell converts one form of energy into another. Name the two forms.
Answer.
It converts chemical energy into electrical energy.

Question.42 Name one unit of power bigger than watt.
Answer. A unit bigger than watt is kilowatt.

Question.43 When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy ?
Answer.

A stretched bow possesses potential energy on account of a change in its shape. To shoot an arrow; the bow is released. The potential energy of the bow is converted into the kinetic energy of the arrow.

Question.44 Name at least three commonly used units of energy.
Answer. (i) Joule (ii) Erg (iii) Kilowatt hour.

Question.45 Name the practical unit of power in engineering.
Answer. Horsepower.

Question.46 Name at least six forms of energy.
Answer.
(i) Chemical energy
(ii) Heat energy
(iii) Light energy
(iv) Electrical energy
(v) Sound energy
(vi)Solar energy

Question.47 How many watt are there in 1 horse – power ?
Answer. 746 watt.

Question.48 What is horsepower ?
Answer. It is a unit of power.

Question.49 A light and a heavy body have equal kinetic energy. Which one is moving fast ?
Answer. The lighter body is moving fast.

2 MARKS QUESTIONS

Question.1 State the relation between kW h and joule. Define 1 watt.
Answer.
1 kW h – 1000 W h = 1000 Js^{-1} x 60 x 60 s = 3.6 x 10^6 J
1 watt is the power of an agent which can do one joule of work in one second.

Question.2 Is it possible that a body be in accelerated motion under a force acting on the body, yet no work is being done by the force? Explain your answer giving a suitable example.
Answer. Yes, it is possible, when the force is perpendicular to the direction of motion. The moon revolving round the earth under the centripetal force of attraction of the earth but earth does not do any work on the motion of The moon.

Question.3 Define work. How is work measured ? When is work done by a force negative?
Answer. Work is said to be done if force acting on an object displaces it through a certain distance.
It is measured as the product of force and displacement.
Work done is negative if force and displacement are in the opposite direction.

Question.4 What is the work done by the force of gravity in the following cases ?
(a) Satellite moving around the earth in a circular orbit of radius 35000 km.
(b) A stone of mass 250 g is thrown up through a height of 2.5 m.
Answer.
(a) Zero, as the displacement in one complete revolution is zero.
(b) Given m = 250 g = 0.25 kg, h = 2.5 m, g = 10 ms^{-2}, W = ?
Now, W = FS = mg x h = 0.25 x 10 x 2.5 = 6.25 J

Question.5 A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer.
Answer. The work done is zero. This is because the gravitational force and displacement are perpendicular to each other.

Question.6 The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?
Answer. It does not violate the law of conservation of energy. Whatever, is the decrease in PE due to loss of height, same is the increase in the KE due to increase in velocity of the body.

Question.7 What are the various energy transformations that occur when you are riding a bicycle?
Answer. The chemical energy of the food changes into heat and then to muscular energy. On paddling, the muscular energy changes into mechanical energy.

Question.8 Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going?
Answer. Energy transfer does not take place as no displacement takes place in the direction of applied force; the energy spent is used to overcome inertia of rest of the rock.

Question.9 An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object ?
Answer. Since the body returns to a point which is on the same horizontal line through

the point of projection, no displacement has taken place against the force of gravity; therefore, no work is done by the force due to gravity.

Question.10 A battery lights a bulb. Describe the energy changes involved in the process.
Answer. Within the electric cell of the battery the chemical energy changes into electrical energy. The electric energy on flowing through the filament of the bulb, first changes into heat energy and then into the light energy.

Question.11 What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.
Answer. The work done by the force of gravity on the satellite is zero because the force of gravity acts at right angles to the direction of motion of the satellite. Therefore, no displacement is caused in the direction of applied force. The force of gravity only changes the direction of motion of the i satellite.

Question.12 Can there be displacement of an object in the absence of any force acting on it?
Answer. The answer is. both Yes and No. Yes, because when an object moves in deep space from one
point to another point in a straight line, the displacement takes place, without the application of
force. No, because force cannot be zero for displacement on the surface of earth. Some force is i essential.

Question.13 A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not ? justify your answer.
Answer. The person does not do work because no displacement takes place in the direction of applied force as the force acts in the vertically upward direction.

Question.14 An object of mass, m is moving with a constant velocity, v. How much work should be done on the object in order to bring the object to rest ?
Answer. Work done to bring the object to rest is equal change in kinetic energy of the object.
Here, $u_i = v$ and $v_f = 0$

Using $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mu_i^2$, we have

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

Question.15 Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her ? Why ?

Answer. Yes, we do agree when the number of forces act on a body, such that they constitute balanced forces, then net force acting on the body is zero. In such a situation no acceleration acts on the object.

Question.16 A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy ?
Answer. The KE on reaching the ground changes into heat energy, sound energy etc. and, therefore, gets dissipated in air.

Question.17 What kinds of energy transformations take place at a thermal power station ?
Answer. At a thermal power station, the chemical energy of coal is changed into heat energy which is further changed into electrical energy with the help of an electric generator.

Question.18 Name the transformation of energy involved in the following cases :
(a) When a body is thrown upwards.
(b) When a body falls from the top of a hill.
(c) When coal burns.
(d) When a gas bums.
(e) When water falls from a height.
Answer.
(a) Kinetic energy into potential energy.
(fa) Potential energy into kinetic energy.
(c) Chemical energy into heat energy.
(cf) Chemical energy into heat energy.
(e) Potential energy into kinetic energy.

Question.19 What are the factors on which the work done depends ?
Answer. The work done by a force depends upon:
(i) The magnitude of the force.
(ii) The magnitude of the displacement and
(iii) The angle between force and displacement.

Question.20 How are kinetic energy and momentum related ?
Answer.

Kinetic energy is given by the relation $K = \frac{1}{2}mv^2$. Multiplying and dividing the right hand side of the equation by m, we have $K = \frac{1}{2}\frac{(mv)^2}{m}$, but $mv = p$ is momentum of a body, therefore, $p = \sqrt{2mK}$.

Question.21 What is the work done by a coolie walking on a horizontal platform with a load on his head ?
Answer. In order to balance the load on his head, the coolie applies a force on it in the upward direction, equal to its weight. His displacement is along the horizontal direction. Thus, the angle between force F and displacement is 90°. Therefore, work done W = FS cos θ = FS cos 90° =0.

Question.22 We wind our watch once a day, what happens to the energy ?
Answer. When we wind our watch, we wind the spring inside the watch. As a result, energy is stored in the spring in the form of elastic potential energy. This elastic potential energy is used to make the watch work the whole day. .

Question.23 What is the amount of work done by a force when a body moves in a circular path ?
Answer. Work done is given by the expression W = FS cos θ. When a body moves in a circular path, then the displacement (S) is zero. Therefore, work done is W = F x 0 = 0.

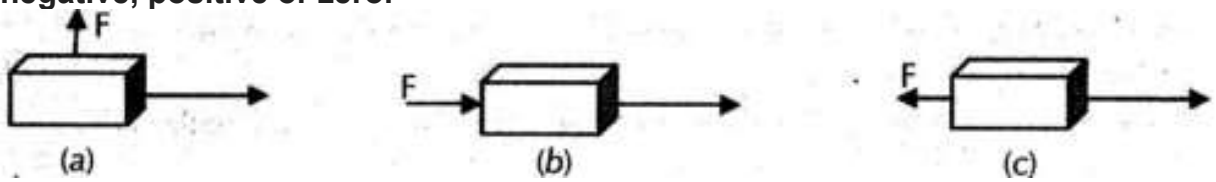
3 MARKS QUESTIONS

Question.1 Look at the activities listed below.
Reason out whether or not work is done in the light of your understanding of the term 'work'
(i) Suma is swimming in a pbnd.
(ii) A donkey is carrying a load on its back.
(iii) A wind-mill is filling water from a well.
(iv) A green plant is carrying out photosynthesis.
(v) An engine is pulling a train.
(vi)Food grains are getting dried in the sun.
(vii) A sailboat is moving due to wind energy.
Answer.
(i) Work is done because the displacement of swimmer takes place in the direction of applied force.
(ii) If the donkey is not moving, no work is done as the displacement of load does not take place in the direction of applied force.
(iii) Work is done, as the displacement takes place in the direction of force.
(iv) No work is done, because no displacement takes place.
(v) Work is done, because displacement takes place in the direction of applied force.
(vi)No work is done, because displacement does not take place.
(vii)Work is done because displacement takes place in the direction of the force.

Question.2 Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest ? What happens to its energy eventually ? Is it a violation of the law of conservation of energy ?

Answer. When the pendulum bob is pulled (say towards left), the energy supplied is stored in it is the form of PE on account of its higher position. When the pendulum is released so that it stars moving towards right, then its PE changes into KE, such that in mean position, it has maximum KE, and zero PE. As the pendulum moves towards extreme right, its -KE changes into PE such that at the extreme position, of has maximum PE and zero KE. When it moves from this extreme position to mean position, its PE again changes to KE. This illustrates the law of conservation of energy.
Eventually, the bob comes to rest, because during each oscillation a part of the energy possessed by it transferred to air and- m overcoming friction at the point of suspension. Thus, the energy of the pendulum is dissipated in air.
The law of conservation of energy is not violated because the energy merely changes its form and is not destroyed.

Question.3 In each of the following a force, F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe the diagrams carefully and state whether the work done by the force is negative, positive or zero.



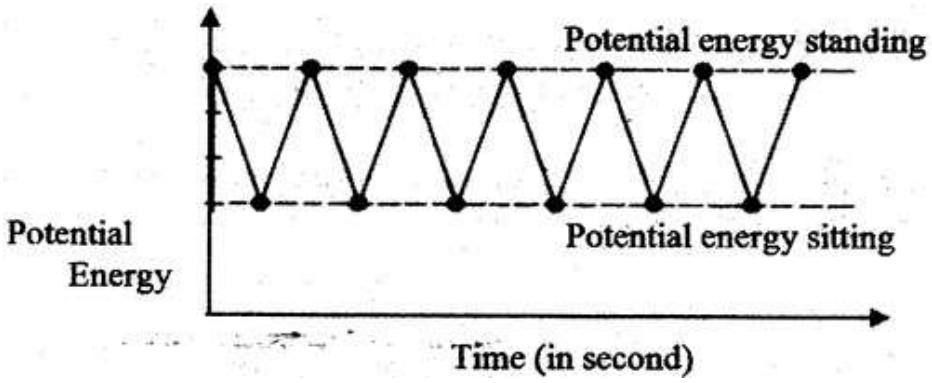
Answer.

In case of fig. (a), W = 0, because the force acts perpendicular to the direction of displacement.
In case of fig. (*b*), W = positive, because the force acts in the direction of displacement.
In case of fig. (c), W = negative, because the force acts in the direction opposite to the displacement.

Question.4 Distinguish between work, energy and power. State the SI units for each of these quantities.
Answer.
Work: It is defined as the product of force applied and the distance moved by the body on the application of the force. In SI it is measured in joule.
Energy : It is defined as the capacity of a body to do work. In SI it is measured in joule.
Power: It is defined as the rate of doing work. It measures how fast or slow the work is done. In SI it is measured in watt.

Question.5 A girl sits and stands repeatedly for 5 minutes. Draw a graph to show variation of potential energy with time.

Answer.



5 MARKS QUESTIONS

Question.1 Calculate the electricity bill amount for a month of 31 days, if the following devices are used as specified :
(a) 3 bulbs of 40 W for 6 hours.
(b) 4 tubelights of 50 W for 8 hours,
(c) A TV of 120 W fro 6 hours.
Give the rate of electricity is Rs 2.50 per unit. [SAII-2014]
Answer.

(a) $E_1 = P \times t = 0.04 \times 6 \times 3 = 0.72$ kWh

(b) $E_2 = P \times t = 0.05 \times 8 \times 4 = 1.60$ kWh

(c) $E_3 = 0.12 \times 6 = 0.72$ kWh

Total E = 0.72 + 1.6 + 0.72 = 3.04 kWh.

Cost 31 days = Rate × E

= 3.04 × 2.50 × 31 = ₹ 235.60

Question.2
(a) What is meant by mechanical energy ? State its two forms. State the law of conservation of energy. Give an example in which we observe a continuous change of one form of energy into another and vice-versa.
(b) Calculate the amount of work required to stop a car of 1000 kg moving with a speed of 72 km h"1.
Answer.
(a) It is the sum of KE and PE of an object. It states that energy can neither be created nor be destroyed. We observe a continuous change in energy in a simple pendulum and its : explanation. At the mean position, the energy is wholly kinetic while at the extreme position it is wholly potential. As the pendulum oscillates its energy continuously

changes between kinetic and potential.

(*b*) Given $m = 1000$ kg, $u = 72$ km $h^{-1} = 20$ m s^{-1}, $v = 0$

Work done = Change in kinetic energy

$= \frac{1}{2} m (v^2 - u^2) = \frac{1}{2} \times 1000 \times (0^2 - 20^2)$

$= -200000$ J $= -2 \times 10^5$ J

Question.3 State the law of conservation of energy? Show that when a body falls from a certain height the total mechanical energy remains conserved.

Answer.

According to this principle, the total mechanical energy (kinetic energy and potential energy) remains constant under the action of conservative forces.

Mathematically, if E represents the total energy, T the kinetic energy and U the potential energy, then, we have

$$E = T + U$$

Suppose a ball of mass m falls under the effect of gravity as shown in figure. Let us find the kinetic and the potential energy of the ball at various points of its free fall. Let the ball fall from point A at a height *h* above the surface of the earth.

AT POINT A:

At point A, the ball is stationary, therefore, its velocity is zero. Therefore,

Kinetic energy, $T = 0$

And potential energy, $U = mgh$

Hence, total mechanical energy at point A is

$E = T + U = 0 + mgh = mgh$ ... (1)

AT POINT B :

Suppose the ball covers a distance x when it moves from A to B. Let v be the velocity of the ball at point B. Then by the equation of motion

$v^2 - u^2 = 2aS$, we have

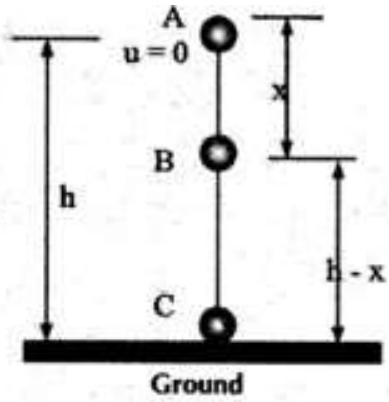
$v^2 - 0 = 2gx$ or $v^2 = 2gx$. Therefore,

Kinetic energy, $T = \frac{1}{2}mv^2 = \frac{1}{2}m(2gx) = mgx$ and

Potential energy, $U = mg(h - x)$

Hence, total energy at point B is

$E = T + U = mgx + gx(h - x) = mgh$ ... (2)



AT POINT C :

Suppose the ball covers a distance h when it moves from A to C. Let V be the velocity of the ball at point C just before it touches the ground. Then by the equation of motion $v^2 - u^2 = 2aS$, we have $V^2 - 0 = 2gh$ or $V^2 = 2gh$. Therefore,

Kinetic energy, $T = \frac{1}{2}mV^2 = \frac{1}{2}m\,(2gh) = mgh$ and potential energy, $U = 0$

Hence, total energy at point B is

$E = T + U = mgx + 0 = mgh$ ... (3)

Thus, it is clear from equations 1, 2 and 3, that the total mechanical energy of a freely falling ball remains constant. There is, simply, a transformation of mechanical energy.

Question.4

(a)Derive an expression for kinetic energy of a body having mass m and moving with a velocity v.

(b)When velocity of a body is increased 5 times, what is the change in its kinetic energy ?

(c)Two masses m and 2m are dropped from heights h and 2h. On reaching the ground, which will have greater kinetic energy and why ?

Answer.

(a)For derivation see above questions.

(b)Kinetic energy is given by the expression

KE = 1/2 mv^2, therefore, if velocity is made 5 times KE will increase by 25 times.

(c)More the potential energy more will be the kinetic energy of the body when it falls. Hence, the body with mass 2m will have greater kinetic energy as it has more potential energy.

Question.5

(a)State the law of conservation of energy.

(b)What is the work done to increase the velocity of a car from 36 km h-1 to 72 km h~1 if the mass of the car is 1500 kg ? Does the work done by the force have a negative or a positive magnitude ?

(c)Where does an oscillating pendulum have maximum PE and KE ?
Answer.

(a) It states that energy can neither be created nor be destroyed.

(b) Given $m = 1500$ kg, $u = 36$ km h^{-1} $= 10$ m s^{-1}, $v = 72$ km h^{-1} $= 20$ m s^{-1}, W = ?
Work done = Change in kinetic energy $= \frac{1}{2} m (v^2 - u^2) = \frac{1}{2} \times 1500 \times (20^2 - 10^2) = 225000$ J
The work done is positive.

(c) It has maximum potential energy at its extreme position and maximum kinetic energy at the mean position.

APPLICATION BASED QUESTIONS

Question.1 A light body and a heavy body have the same kinetic energy. Which one will have the greater momentum ?
Answer.

As $p = \sqrt{2mK}$. Since K is the same for both the bodies, $p \propto \sqrt{m}$ *i.e.*, the heavier body has more momentum than the lighter body.

Question.2 A light and a heavy body have the same momentum. Which one will have greater kinetic energy ?
Answer.

As $K = \frac{p^2}{2m}$ and p is same for both. Hence, $K \propto \frac{1}{m}$. Thus, the lighter body has more kinetic energy than the heavier body.

Question.3
(a) Can a body have energy without having momentum ? Explain.
(b) Can a body have momentum without having energy ? Explain.

Answer.

(a) Yes. A body at rest has no momentum *i.e.*, $p = 0$ and as such its kinetic energy $(= p^2/2m) = 0$. But it can have potential energy (U) by virtue of its position or configuration. Thus, its total energy, $E = K + U = U$ and in not zero. *e.g.*, a stone lying on a roof or a wound up spring of a clock.

(b) Yes. If $E = 0$, $K + U = 0$ *i.e.*, either $K = U = 0$ or $K = -U$. Thus, when $E = 0$, the body can possess KE and on account of that possess momentum. An electron in an atom has momentum even when its total energy is negative. But note that a body, which has momentum, must be in motion and consequently possess kinetic energy.

Question.4 When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy ?

Answer. A stretched bow possesses potential energy on account of a change in its shape. To shoot an arrow; the bow is released. The potential energy of the bow is converted into the kinetic energy of the arrow.

Question.5 A spring which has been kept compressed by tying its ends together is allowed to be dissolved in an acid. What happens to the potential energy of the spring ?

Answer. The PE of the spring gets converted into KE of acid molecules whose temperature rises.

HIGHER ORDER THINKING SKILLS (HOTS) QUESTIONS

Question.1 justify giving proper reasoning whether the work done in the following cases is positive or negative :

(a) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket.

(b) Work done by gravitational force in the above case.

(c) Work done by friction on a body sliding down an inclined plane.

(d) Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity.

(e) Work done by resistive force of air on a vibrating pendulum in bringing it to rest.

Answer.

(a) Work done is positive as the bucket moves in the direction of force applied by the man.

(b) Work done by the gravitational force is negative, as the bucket moves upwards i.e., opposite to the gravitational force.

(c) Work done is negative, as frictional force acts opposite to the direction of motion of the body.
(d) Work done is positive because applied force acts along the same direction as the direction of motion of the body.
(e) Work done is negative because the resistive force of air always acts opposite of the direction of motion of the vibrating*pendulum.

Question.2 What is the work done by a coolie walking on a horizontal platform with a load on his head?
Answer. In order to balance the load on his head, the coolie applies a force on it in the upward direction, equal to its weight. His displacement is along the horizontal direction. Thus, the angle between force F and displacement is 90°. Therefore, work done W = FS cos θ = FS cos 90° = 0.

Question.3 The work done in lifting a box on to a platform does not depend upon how fast it is lifted up.
Explain your answer giving proper reasoning.
Answer. The work done (W) in lifting a box through a distance (S) against the gravitational force (F) is given by W = FS. Hence, it is obvious that it is independent of the rate at which the box is lifted.

Question.4 Is it possible that a body be in accelerated motion under a force acting on the body, yet no work is being done by the force ? Explain your answer giving a suitable example.
Answer. Yes, it is possible, when the force is perpendicular to the direction of motion. The moon revolving round the earth under the centripetal force of attraction of the earth, but earth does no work on the motion.

Question.5 A body moves along a circular path. How much work is done in doing so? Explain.
Answer. In case of a body moving along a circular path, the force (centripetal) is always along the radius while displacement is tangential. Hence, work done W = FS cos 90° = 0 as angle between F and S is 90°.

Question.6 A man rowing a boat upstream is at rest with respect to the shore. Is he doing work ?
Answer. The man is doing work relative to the stream because he is applying force to produce relative motion between the boat and the stream. But he does zero work relative to the shore as the displacement relative to the shore is zero.

Question.7 What type of energy is stored in the spring of a watch?
Answer. When we wind a watch, the configuration of its spring is changed. The energy stored in the spring is obviously potential in nature (elastic potential energy to be more accurate).

Question.8 What happens to the kinetic energy when :
(i) the mass of the body is doubled at constant velocity?
(ii)the velocity of the body is doubled at constant mass?
(iii)the mass of thesbody is doubled but the velocity is reduced to half?
Answer.

The kinetic energy of a body of mass m and moving with velocity v is given by the expression

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

Here, $m = 2m$ and $v = v$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}2mv^2 = 2K$ *i.e.*, the kinetic energy gets doubled.

Here, $m = m$ and $v = 2v$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}m(2v)^2 = 4K$ *i.e.*, the kinetic energy becomes four times the original.

Here, $m = 2m$ and $v = v/2$, therefore, final kinetic energy of the body will be $K_F = \frac{1}{2}2m(v/2)^2 = K/2$ *i.e.*, the kinetic energy becomes half.

Question.9 When a constant force is applied to a body moving with constant acceleration, is the power of the force constant ? If not, how would force have to vary with speed for the power to be constant ?
Answer.

We know that power (P) = force (F) × velocity (V). Since the body is moving with acceleration, V changes and as a result of that P also changes, F being constant. For P to be constant, FV = constant or $F \propto 1/V$.

Thus, as V increases, F should decrease to keep P constant.

Question.10 A spring which is kept compressed by tying its ends together is allowed to be dissolved in an acid. What happens to the potential energy of the spring ?
Answer. The potential energy of the spring gets converted into heat energy (kinetic energy of acid molecules). Due to this heat, the temperature of the acid rises.

Reasoning Questions
Question.1
(a) Define power. Give its SI unit.
(b) Taking the example of a simple pendulum, explain the variations in the forms of energy and the; inter-conversions involved.
Answer.
(a) Power is defined as the rate of doing work. Its SI unit is watt.
(b) For a simple pendulum, the inter-conversion of energy is as shown in the table

below :

Poisition	PE	KE
Extreme 1	max	zero
Between extreme 1 and mean	decreasing	increasing
Mean	zero	max
Between mean and extreme 2 increasing		decreasing
Extreme 2	max	zero

Question.2
(a) How much work is done when a force of 1 N moves a body through a distance of 1 m in its direction?
(b) Is it possible that a force is acting on a body but still the work done is zero? Explain
giving one example.
Answer.
(a) 1 J of work is done.
(b) Yes, it is possible when force acts at right angles to the direction of motion of the body. Example Gravitational force of earth acts on a satellite at right angles to its direction of motion.

Question.3
(a) What is meant by potential energy? Is potential energy vector or scalar quantity?
(b) Give one example of a body having potential energy.
Answer.
(a) The energy possessed by a body by virtue of its position or configuration. It is a scalar
quantity.
(b) Stretched string of a bow.

Question.4 When is the work done by a force said to be negative? Give one situation in which one of the forces acting on the object is doing positive work and the other is doing negative work.
Answer. We know that work done W = FS cos 0, where 0 is the angle between F and S. Clearly, W will be -ve, if 0 is between 90° and 180° because then cos 0 will be -ve. Consider the case of a body falling under gravity. The body experiences an upward frictional force and downward force due to gravity. Since the body is moving downwards, the work done by force to gravity will be +ve but that is against the upward thrust will be -ve.

Question.5
(a) Is it possible that a body be in accelerated motion under the action of a force, yet no work is being done by the force? Explain with an example.
(b) Two bodies of masses m, and m2 have equal kinetic energies. What is the ratio of their linear momenta?
Answer.
(a) Yes, it is possible in the case of a body moving in a circular path with a speed v. The body has a centripetal acceleration directed along the radius of the circular path. The displacement is, however, tangential to the radius i.e., 0 = 90°. Thus, work done, W = FS cos 90° = 0.
(*b*) We know that the relation between kinetic energy K and momentum *p* as

$$p = \sqrt{2mK}$$

$$\therefore \quad p_1 = \sqrt{2m_1K}$$

$$p_2 = \sqrt{2m_2K}$$

$$\therefore \quad \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$$

IMPORTANT TOPICS/AREAS/QUESTIONS WHICH ARE FREQUENTLY ASKED IN THE EXAMINATION

Question.1 An object of mass mwhen raised To height h possess a potential energy of 1200 J. Find the new potential energy :
(a) if the same object is raised to height h/4.
(b) if the same object is raised to height 4h. [SAII-2014]
Answer.
PE = 1200 Joules
(a) New PE = 1/4 Old PE = 1/4 × 1200 = 300 Joules
(*b*) New PE = 4 × Old PE = 4 × 1200 = 4800 Joules

Question.2 Define 1 watt of power. A lamp consumes 1000] of electrical energy in 10 s. Calculate its power.
Answer.
The power of an agent is said to be one watt if it does one joule of work in one second.
Given $W = 1000$ J, $t = 10$ s, $P = ?$
Using the expression, $P = W/t$, we have $P = 1000/10 = 100$ W

Question.3 Explain that the flying bird has; potential and kinetic energy and give their expressions.
Answer.
The potential energy of the bird while flying in sky is with respect to the earth. The KE is due to its velocity with which it is flying.
$PE = mgh$ and $KE = \frac{1}{2} mv^2$

Question.4
(a)An arrow moves forward when released from a stretched bow. Explain the transformation of energy in the process.
(b)A boy of mass 50 kg climbs up a vertical height of 100 m. Calculate the amount of potential energy he gains.
Answer.
(a) When the bow is stretched it stores potential energy. When the arrow is released, the potential energy stored in the bow gets transformed into the kinetic energy of the arrow.
(b) Given $m = 50$ kg, $h = 100$ m, $g = 10\ ms^{-2}$, $PE = ?$
$PE = mgh = 50 \times 10 \times 100 = 5000$ J

Question.5
(a)What is the commercial unit of energy ? Give its relationship with SI unit of energy.
(b)An electric bulb of 60 W is lighted for 10 hours everyday. How many units of electrical energy is consumed by this bulb in one day ?
Answer.
(a) The commercial unit of energy is kilowatt hour (kW h). 1 kWh $= 3.6 \times 10^6$ J
(b) Given $P = 60$ W, $t = 10$ h, $W = ?$
$W = P \times t = 60 \times 10 = 600$ W h $= 0.6$ kW h.

Question.6 Define : (a) power (b) work done (c) kinetic energy. Give SI unit of each.
Answer.
(a) The rate of doing work is called power. Its SI unit is watt.
(b) Work is the product of force and displacement. Its SI unit is joule.
(c) It is the energy possessed by a body by virtue of its motion. Its SI unit is joule.

Question.7 Define power. Write commercial unit and SI unit of electrical energy. An electrical geyser of 1.5 kW works for 2 hours. Find the electrical energy units consumed in a day.

Answer.

Power is defined as the rate of doing work. The commercial unit of electrical energy is kW h and the SI unit is joule.

Given $P = 1.5$ kW, $t = 2$ hours,

$E = P \times t = ?$

$E = 1.5 \times 2 = 3$ kW h

Question.8 The masses of scooter and bike are in the ratio of 2 : 3 but moving with same speed of 108 km h~1. Compute the ratio of their kinetic energy.

Answer.

(*a*) The energy possessed by a body by virtue of its motion.

(*b*) Given $\frac{m_1}{m_2} = \frac{2}{3}$, the ratio of KE is equal to the ratio of their masses if they have the same velocity, therefore, ratio of their KE is also 2 : 3.

NUMERICAL PROBLEMS

Question.1 The kinetic energy of an object of mass 'm' moving with a velocity of 5 ms-1 is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times?

Solution.

Given, $v = 5\ ms^{-1}$, $m = ?$, $KE = 25$ J

Using the expression $KE = \frac{1}{2}mv^2$, we have

$$m = \frac{2 \times KE}{v^2} = \frac{2 \times 25}{(5)^2} = 2\ kg$$

(*i*) When velocity is doubled *i.e.*, $v = 10\ ms^{-1}$, then, we have

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

(*ii*) When velocity is tripled *i.e.*, $v = 15\ ms^{-1}$, then, we have

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times (15)^2 = 225\ J$$

Question.2 Certain force acting on a 20 kg mass changes its velocity from 5 ms^{-1} to 2 ms^{-1}. Calculate the work done by the force.

Solution.

Work done by the force is equal to the change in kinetic energy produced in the body.

Now, $m = 20$ kg, $u = 5$ ms^{-1}, $v = 2$ ms^{-1}, $W = ?$

Using the expression $W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$, we have

$$W = \frac{1}{2}m\left(v^2 - u^2\right) = \frac{1}{2} \times 20\left((2)^2 - (5)^2\right)$$

or $W = -210$ J

The negative sign indicates that work has been done in slowing the body.

Question.3. A certain household has consumed 250 units of energy during a month. How much energy is this in joule?

Solution.

Energy consumed in a month = 250 units

= 250 kWh = 250 kW × 1 h

= 250 × 1000 W × 3600 s

= 90,00,00,000 = 9×10^8 J

Question.4 An electric heater is rated 1500 W. How much energy does it use in 10 hours?

Solution.

Energy used by heater = Power × Time = 1500 W × 10 h

$$= \frac{1500 \times 10}{1000} = 15 \text{ kWh}$$

Question.5 Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 kmh-1?

Solution.

Given, mass of car = 1500 kg, u = 60 kmh^{-1} = $60\times\frac{5}{18}=16.67\,\text{ms}^{-1}$, v = 0

Using the expression

$W=\frac{1}{2}mv^2-\frac{1}{2}mu^2$, we have

$W=\frac{1}{2}m\left(v^2-u^2\right)=\frac{1}{2}\times1500\left((0)^2-(16.67)^2\right)$ or W = – 208416.68 J

Question.6 Find the energy in kWh consumed in 10 hours by four devices of power 500 W each.

Solution.

Total power of 4 devices = 4 × 500 = 2000 W = 2 kW

Time = 10 h

Therefore, Energy consumed = Power × Time = 2 kW × 10 h = 20 kWh

Question.7 Two bodies of equal masses move with the uniform velocities v and 3v respectively. Find the , ratio of their kinetic energies.

Solution.

Let the mass of each body be m. Then, KE of the first body, $K_1=\frac{1}{2}mv^2$ ...(1)

KE of the second body $K_2=\frac{1}{2}mv_2^2=\frac{1}{2}m\,(3v)^2=\frac{9}{2}mv^2$ ...(2)

Dividing (2) by (1), we have $\frac{K_2}{K_1}=\frac{\frac{9}{2}mv^2}{\frac{1}{2}mv^2}=\frac{9}{1}$

Thus, the kinetic energy of the second body is nine times the kinetic energy of the first body.

Question.8 A man of mass 60 kg runs up a flight of 30 steps in 40 seconds. If each step is 20 cm high, calculate the power of the man.

Solution.

Given, m = 60 kg, t = 40 s, h = 30 × 20 = 600 cm = 6 m, g = 9.8 ms^{-2}

Now, $P=\frac{W}{t}=\frac{mgh}{t}=\frac{60\times10\times6}{40}=90\,\text{W}$

Question.9 Calculate the amount of work done in moving a 50 kg block through a distance of 10 m by applying a force of 100 N.

Solution.
Work done in moving a body through a certain distance is given by the expression, $W = FS\cos\theta = FS$, here m = 50 kg, S = 10 m. Therefore,
W = FS = 100 × 50 = 5000 J.

Question.10 A block of mass 5 kg is lying bn a frictionless table. A force of 20 N is applied on it for 10 seconds. Calculate its kinetic energy.
Solution.
Given, F = 20 N, t = 10 s, m = 5 kg

The acceleration produced in the body is $a = \frac{F}{m} = \frac{20}{5} = 4 ms^{-2}$

The velocity gained by the body is $v = 0 + 4 \times 10 = 40\ ms^{-1}$ (Using $v = u + at$)
Therefore, kinetic energy of the body KE = ½ mv^2 = ½ × 5 × $(40)^2$ = 4000 J

Question.11 A girl of mass 40 kg climbs a rope 6 m long at constant speed in 15 seconds. What power she expands during the climb?
Solution.
P = W/t, here, W = mgh and t = 15 s
Therefore, power is given by

$$P = \frac{W}{t} = \frac{mgh}{t} = \frac{40 \times 9.8 \times 6}{15} = 156.8\ W$$

Question.12 A man weighing 70 kg carries a weight of 10 kg to the top 6f a tower 100 m high. Calculate the work done.
Solution. We know that work done is given by W = FS = mgh i.e., change in potential energy, therefore, we have W = mgh = (70 + 10) x 9.8 x100 = 78400 J

Question.13 Calculate the kinetic energy of a body of mass 2 kg moving with a velocity of 0.1 ms-1.
Solution.
Given, mass, m = 2 kg, velocity, v = 0.1 ms^{-1}

We know, kinetic energy of a body = $\frac{1}{2}mv^2$

$$KE = \frac{1}{2} \times (0.1)^2 = 0.01 J$$

Question.14 Find the velocity of a body of mass 100 g having a kinetic energy of 20 J.

Solution.

Given, mass of the body, $m = 100\ g = 0.1\ kg$, kinetic energy, $KE = 20\ J$, velocity, $v = ?$

Now, kinetic energy is given by $\frac{1}{2}mv^2$. Therefore,

$$v=\sqrt{\frac{2\times KE}{m}}=\sqrt{\frac{2\times 20}{0.1}}=20\ ms^{-1}$$

Question.15 A man drops a 10 kg rock from the top of a 5 m ladder. What is its kinetic energy when reaches the ground? What is its speed just before it hits the ground?

Solution.

Given, mass, $m = 10\ kg$, height, $h = 5\ m$, $g = 9.8\ ms^{-2}$

Therefore, potential energy (PE) at the top $= mgh = 10 \times 9.8 \times 5\ m = 490\ J$

On reaching the ground, the whole of the potential energy of the falling rock is converted into kinetic energy. Therefore,

Kinetic energy of the rock on reaching the ground = Potential energy of the rock at the top of the ladder.

Hence, KE of the rock on the ground = 490 J

Now, Initial velocity, $u = 0\ ms^{-1}$, final velocity, $v = ?$, displacement, $S = 5\ m$ and $g = 9.8\ ms^{-2}$

Using the relationship, $v^2 - u^2 = 2gS$, we have

$$v^2 - 0 = 2 \times 9.8 \times 5 = 98$$

Therefore, $v=\sqrt{98}=9.9\ ms^{-1}$

Question.16 Which would have greater effect on kinetic energy of an object – doubling the mass, or doubling the velocity?

Solution. We .know that KE∝ m, KE ∝ v2

Therefore, by doubling the mass, the kinetic energy doubles, while by doubling the velocity, the kinetic energy increases four times. Therefore, doubling the velocity will have a greater effect on the kinetic energy of an object.

Question.17 A body of mass 4 kg initially at rest is subjected to a force of I6 N. What is the kinetic energy acquired by the body at the end of 10 s?

Solution.

Given, $m = 4$ kg, F = 16 N, $u = 0$, time $t = 10$ s

Now, acceleration, $a = \frac{F}{m} = \frac{16}{4} = 4\ ms^{-2}$

Therefore, velocity v of the body after 10 s is given by

$$v = u + at = 0 + 4 \times 10 = 40\ ms^{-1}$$

Hence, KE of the body at the end of 10s

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 4 \times (40)^2 = 3200\,J$$

Question.18 A crane pulls up a car weighing 500 kg to a vertical height of 4 m. Calculate the work done by the crane.

Solution.

In order to lift the car, the crane has to do work against the force of gravity.
Therefore, the force required = Mg = 500 x 9.8 = 4900 N
Now, displacement undergone by the car, S = 4 m
Hence, work done = FS = 4900 x 4 = 19600 J

Question.19 A force of 10 N displaces a body by a distance of 2 m at an angle 60° to its own direction. Find the amount of work done.

Solution.

By definition, Work = Force x Displacement in the direction of force = FD cos θ
Given, F = 10 N;S = 2m;θ = 60°. Therefore,
W = 10 x 2 x cos 60° = 10 x 2 x 1/2 =10J

Question.20 A boy of mass 40 kg runs up flight of 50 steps each 10 cm high in 5 seconds. Find: (i) the work done by the boy. (ii) the power developed, (g = 9.8 ms^{-2})

Solution.

The boy has to overcome the force of gravity. Hence, force of gravity on the boy

$$F = mg = 40 \times 9.8 = 392\ N$$

Total distance covered, S = 50 × 10 = 500 cm = 5 m

(*i*) Work done by the boy in climbing = Force × Distance = W = 392 × 5 = 1960 J

(*ii*) Power developed = $\frac{W}{t} = \frac{1960}{5} = 392\ W$

Question.21 Calculate the power of an engine required to lift 10s kg of coal per hour from a mine 360 m deep, (Take g = 10ms^{-2}).

Solution.

The work needed in lifting a mass m to a height h against the gravitational force.

$W = mgh$

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

Given, $m = 10^5$ kg, $g = 10\ ms^{-2}$, $h = 360$ m, $t = 1$ h $= 60 \times 60$ s $= 3600$ s

$$P = \frac{10^5 \times 10 \times 360}{3600} = 10^5 \text{ W}$$

Question.22 A man whose mass is 50 kg climbs up 30 steps of a stair in 30 s. If each step is 20 cm high, calculate the power used in climbing the stairs. [Take g = 10 ms^{-2}]

Solution.

Given, vertical height climbed = Height of step × No. of steps = 20 cm × 30 cm
= 600 cm = 6 m

Acceleration due to gravity (g) = 10 ms^{-2}

Mass of the boy (m) = 50 kg

Since work done is equal to gain in potential energy, therefore, we have

$W = 50 \times 10 \times 6 = 3000$ J

Hence, power developed by the boy $P = \frac{W}{t} = \frac{3000}{30} = 100W$

Question.23 A mass of 10 kg is dropped from a height of 50 cm. Find its : (i) Kinetic energy (ii) Velocity just as it reaches the ground. Does the velocity depend upon the mass of the particle? Explain. [Take g = 10 ms^{-2}]

Solution.

(*i*) Given Initial velocity (u) = 0 , Final velocity (v) = ?

Distance (S) = 50 cm = 0.5 m, Acceleration (g) = 10 ms^{-2}

Using the equation of motion $v^2 - u^2 = 2gh \Rightarrow v^2 = u^2 + 2gh$, we have

$v^2 = 0 + 2 \times 10 \times 0.5 = 10$

$v^2 = \sqrt{10}$ 3.16 ms^{-1}

(*ii*) Kinetic energy of the body = $\frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 10 = 50$ J

(*iii*) Velocity of the body does not depend upon its mass, because the Earth attracts all bodies with same acceleration due to gravity.

Question.24 If you apply 1 J of energy to lift a book of 0.5 kg, how high will it rise? [Take g = 10 ms^{-2}]

Solution.
We know that PE = mgh
1 = 0.5 x 10 x h
Therefore, h = 0.2 m = 20 cm

Question.25 A woman pulls a bucket of water of total mass 5 kg from a well which is 10 m in 10 s. Calculate the power used by her. [Take g = 10 ms^{-2}]
Solution.
Given, mass of water (m) = 5 kg
Height through which water is raised (h) = 10 m
Acceleration due to gravity (g) = 10 ms^{-2}
∴ Work done by the woman = PE = mgh = 5 × 10 × 10 = 500 J

∴ Power used by the woman, $P = \frac{W}{t} = \frac{500}{10} = 50$ J

Question.26
(a) Define average power.
(b) A lamp consumes 1000 J of electrical energy in 10 s. What is its power?
(c) Give the commercial unit of energy in Joules.
Solution.
(a) Average power is defined as the ratio of total energy consumed to the total time taken.
(b) P = E/t = 1000 /10 = 100 W
(c) 1 kW h = 3.6 × 10^6 J