Very Short Answer Type Questions

[1 Mark]

Q. 1. List two conditions which need to be satisfied for the work to be done on an object.

Ans. $W = Fs$

Work is done when

(a) a force acts on an object

(b) object is displaced.

Q. 2. Explain the following terms with one example each:

(a) Positive work (b) Zero work

Ans. (a) When force acts in the direction of motion of body work done is positive. When a lawn roller is pulled forward, work done is positive.

(b) When force is perpendicular to the direction of motion, work done is zero. A porter carrying load does no work.

Q. 3. From where do we get energy for the life processes?

Ans. The energy required for the various life processes comes from the food that we eat.

Q. 4. A girl is running along a circular path with a uniform speed. How much work is done by the girl?

Ans. Zero.

Q. 5. Moment of force and work done by a force have the same units. Then, what is the difference between them?

Ans. Moment of a force produces rotatory motion in a body whereas when a force does work on a body it produces translatory motion in it.

Q.6. A coolie is walking on a railway platform with a load of 27 kg on his head. What is the amount of work done by him?

Ans. Work done by the coolie is zero, as $W = Fs \cos 90^0 = 0$.

Q. 7. What is the amount of work done by a man in pressing a rigid wall with a force of 400 N?

Ans. Zero because there is no displacement.

Q. 8. Which law was verified experimentally by James Prescott Joule?

Ans. Law of conservation of energy.

Q. 9. State the law of conservation of energy.

Ans. The law of conservation of energy states that energy can neither be created nor destroyed, it can only be transformed from one form to another.

Q. 10. Name the two common forms of mechanical energy.

Ans. Kinetic energy and potential energy.

Q. 11. By what factor does the kinetic energy of a body increase when its speed is doubled?

Ans. By a factor of 4 (**KE** $\propto v^2$).

Q. 12. What is negative work.

Ans. Work done against friction is a negative work.

Q. 13. Out of a light and a heavy body having equal kinetic energy, which one will is move fast?

Ans. The lighter body because $v = \sqrt{\frac{2KE}{m}}$.

Q. 14. What type of energy is stored in the spring of a watch?

Ans. Elastic potential energy.

Q. 15. When an arrow is shot from its bow, it has kinetic energy. From where does it get this kinetic energy?

Ans. A stretched bow possesses potential energy on account of a change in its shape. When the arrow is released, the potential energy of the bow gets converted into the kinetic energy of the arrow.

Q. 16. Can kinetic energy of a body be negative?

Ans. No, because both m and v^2 are always positive.

Q. 17. An electric cell converts which form of energy into which other form?

Ans. Chemical energy gets converted into electrical energy.

Q. 18. Which instrument transforms electrical energy into mechanical energy?

Ans. Electric motor.

Q. 19. When an electric bulb is switched on, what energy transformation takes place?

Ans. Electric energy changes into light energy and heat energy.

Q. 20. What kind of energy transformation takes place at thermal power station?

Ans. Heat energy is converted into electrical energy.

Q. 21. A car is accelerated on a levelled road and attains a velocity four times its initial velocity. In this process, how does the potential energy of the car change?

Ans. Potential energy (= *mgh*) does not change as it does not depend on velocity.

Q. 22. What is the angle between the force and displacement in the case of negative work?

Ans. 180^0.

Q. 23. A student picks up four books from the floor, walks across the room through some distance with the books at the same height and then keeps these books at the new place. In which of these sequence of actions work is said to be performed?

Ans. When the student is picking up books from the floor in the beginning.

Short Answer Type Questions – I

[2 marks]

Q. 1. Give two examples from everyday life where work is done.

Ans. (i) We apply a force to lift a book at a height and the book rises.

(ii) When a bullock pulls a cart, it moves as work is done by the bullock on the cart.

Q. 2. On what factors the work done on a body depends?

Ans. The work done on a body depends upon two factors:

(i) Magnitude of the force (F), and

(ii) The displacement through which the body moves (*s*).

Q. 3. What is energy? What is unit of energy?

Ans. The capacity of a body to do work is called energy possessed by the body. Itis a scalar quantity and is measured in joule (J).

Generally, for practical purposes, a bigger unit called kilojoule (kJ) is used (1 kJ = 1000 J).

Q. 4. Give any two uses of kinetic energy.

Ans. (i) The kinetic energy of air is used to run windmills.

(ii) The kinetic energy of the running water is used to generate electricity.

Q. 5. Give one example each of potential energy (i) due to position (ii) due to shape.

Ans. (i) Potential energy due to position: Water stored in dam has potential energy.

(ii) Potential energy due to shape: In a toy car, the wound spring possesses potential energy, and as the spring is released, its potential energy changes into kinetic energy due to which the car moves.

Q. 6. (a) What kind of energy transformation takes place when a body is dropped from a certain height?

Ans. When a body falls, its potential energy gradually gets converted into kinetic energy. On reaching the ground, the whole of the potential energy of the body gets converted into kinetic energy.

(b) What is the commercial unit of energy?

Ans. The commercial unit of energy is kilowatt hour [kWh].

1 kWh is the energy used in one hour at the rate of 1000 Js^{-1}.

Q. 7. What is the relationship between the commercial unit and SI unit of energy?

Ans. We know that,

1kWh = 1kW x 1 h

= 1000 W x 3600 s
= 1000 Js^{-1} x 3600 s
= 3600000 J
∴ 1kWh = 3.6 x 10^6J

Q. 8. Calculate the work done against the gravity.

Ans. Suppose a body of mass *m* is lifted vertically upwards through a distance *h*. In this case, the force required to lift the body will be equal to weight of the body, *mg* (where m is mass and g is acceleration due to gravity), Now,

Work done in lifting a body = Weight of body x Vertical distance

W = *mg* × h

= *mgh*

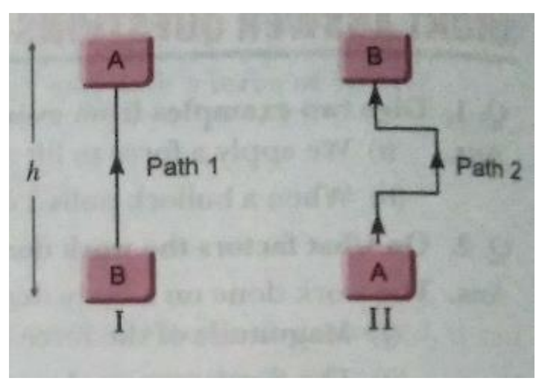
Where W = Work done, and h = Height through which the body is lifted.

Q. 9. What is power? How do you differentiate kilowatt from kilowatt hour?

Ans. Power is the rate of doing work. Kilowatt is the unit of power and kilowatt hour is the unit of energy.

Q. 10. Observe the diagrams I and II carefully. An object of mass *m* is lifted from A to B to height *h* along path 1 and path 2. What would be the work done on the object in both the cases? Give reasons for your answer.

Ans. Work done in diagram I = *mgh*. Work done in diagram II = *mgh*. Work done by gravity depends on the differences in vertical heights of the initial and final positions of the object and not on the path along which the object is moved.



Short Answer Type Questions – II

[3 marks]

Q. 1. Give three examples when the object is not displaced in spite of a force acting on it.

Ans. Three examples when force being supplied and still there is no displacement are:

(i) A man pushing a stationary truck.
(ii) A man pushing a rigid wall.
(iii) A boy carrying a basket on his head and standing still. Here, force of gravity acts on the basket, but there is no displacement.

Q. 2. What types of energy transformation takes place in the following:

(i) Electric heater **(ii) Solar battery**
(iii) Dynamo **(iv) Steam engine and**
(v) Hydroelectric power station?

Ans. (i) Electric heater: Electric energy into heat energy.

(ii) Solar battery: Solar energy into electric energy.

(iii) Dynamo: Mechanical energy into electric energy.

(iv) Steam engine: Heat energy to mechanical energy.

(v) Hydroelectric power station: Mechanical energy into electric energy.

Q. 3. (a) Derive an expression for kinetic energy of an object.

(b) If the velocity of an object is doubled. What will be change in its kinetic energy?

Ans. Suppose a body of mass m is moving with velocity v. It is brought to rest by applying a retarding force F. Suppose it traverses a distance s before coming to rest.
Kinetic energy of body, KE = Work done by retarding force to stop it.

i.e., Kinetic energy = F. s … (i)

But Retarding force, $F = ma$ … (ii)

Initial velocity = v, final velocity = From the equation, $v^2 = u^2 + 2as$, we have
$0 = v^2 - 2as$ (because here a is retardation)

$\Longrightarrow$ Distance, $s = \frac{v^2}{2a}$ … (iii)

Substituting values of F and s from (ii) and (iii) in (i), we get

Kinetic energy, KE = $ma \times \frac{v^2}{2a} = \frac{1}{2} mv^2$

Q. 4. A rocket is moving up with a velocity *v*. If the velocity of this rocket is suddenly tripled, what will be the ratio of two kinetic energies?

Ans. Initial velocity = v, then final velocity, $v' = 3v$

Initial kinetic energy = $\frac{1}{2} mv^2$

Final kinetic energy (KE) = $\frac{1}{2} mv'^2 = \frac{1}{2} m(3v)^2 = 9 \left(\frac{1}{2}mv^2\right)$

$(KE)_{initial} : (KE)_{final} = 1 : 9$.

Q. 5. Avinash can run at a speed of 8 ms^{-1} against the frictional force of 10 N, and Kapil can move at a speed of 3 ms^{-1} against the frictional force of 25 N. Who is more powerful and why?

Ans. Power of Avinash $P_A = F_A . v_A = 10 \times 8 = 80$ W

Power of Kapil $P_K . F_K . v_K = 25 \times 3 = 75$ W

So, Avinash is more powerful than Kapil.

Q. 6. The velocity of a body moving in a straight line is increased by applying a constant force F, for some distance in the direction of the motion. Prove that the increase in the kinetic energy of the body is equal to the work done by the force on the body.

Ans. $v^2 - u^2 = 2as$

This gives $s = \frac{v^2-u^2}{2a}$

$F = ma$

We can write work done (W) by this force F

$W = Fs$

$W = ma\left(\frac{v^2-u^2}{2a}\right)$

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

= Final KE - Initial KE.

Q. 7. (a) Give one example of each of the following:

(i) Small mass but high kinetic energy
(ii) Large mass but low kinetic energy

(b) Prove mathematically that the total mechanical energy of a freely falling body in air is conserved.

Ans. (a) (i) A cricket/hockey ball which has been hit hard and is travelling fast.

(ii) A shot put thrown by an athlete

(b) Let the body of mass m at height h above the ground starting from rest, be falling freely. Total energy of the body at height h

= mgh (**PE**) + 0 (**KE**) = mgh

After the body has fallen freely through a distance x (say),

KE = mgh, PE = $mg(h - x)$

Total energy = KE + PE

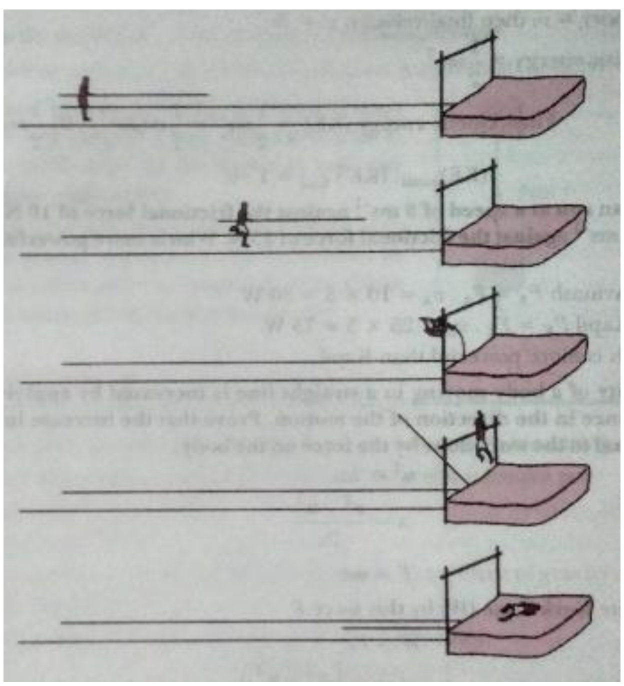
= $mgh + mg(h - x) = mgh$

When it reaches the ground KE = $\frac{1}{2} m.2gh$ = mgh

PE = 0, Total Energy = KE + PE = mgh

Thus, the total mechanical energy, which is the sum of KE and PE is always equal to mgh.

Q. 8. Figure shows, in order, five stages of an athlete successfully performing a pole-vault.



Describe the energy changes which take place during the performance of the pole-vault, from the original stationary position of the pole-vaulter before the run-up, to the final stationary position after the vault.

Ans. Standing : Chemical energy

Run-up : Kinetic energy

Pole bent : Elastic energy

Rise : Potential energy gained

Fall : Kinetic energy gained

On mat : Heat or sound energy

Q. 9. Two workmen are employed on a building project, as shown in figure.

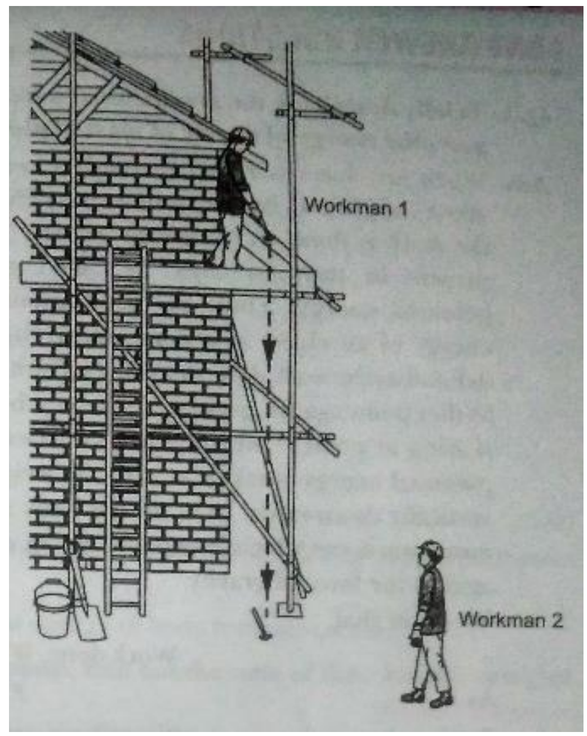
(i) Workman 1 drops a hammer, which falls to the ground. The hammer has a mass of 2.0 kg, and is dropped from a height of 4.8 m above the ground.

(a) Calculate the change in gravitational potential energy of the hammer when it is dropped.

(b) Describe the energy changes from the time the hammer leaves the hand of workman 1 until it is at rest on the ground.

(ii) Workman 2 picks up the hammer and takes it back, up the ladder to workman 1. He climbs the first 3.0 m in 5.0 s. His total weight, including the hammer, is 520 N.

Calculate the useful power which his legs are producing.



Ans. (i) (a) Mass, m = 2.0 kg, height, h = 4.8 m
Change in gravitational potential energy
= *mgh*
=2 × 10 × 4.8 = 96 J

(b) Potential energy ⟶ Kinetic energy ⟶ Heat and/or sound energy

(ii) Weight, mg = 520 N, height, h = 3.0 m, Time, t = 5.0 s

useful power = $\frac{\text{Work done}}{\text{Time taken}}$

= $\frac{(mg)h}{t} = \frac{520 \times 3}{5}$

= 312 W

Q. 10. (a) A body thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and 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?

(b) You lift a heavily packed carton of mass m in vertically upward direction through a height *h*. What is the work done (i) by you on the carton, (ii) by force of gravity on the carton?

(c) Anil is doing work at a rapid rate but works for only one hour. Ashok does work at a somewhat slower rate but continues to work for six hours. Who has greater power? Who has more energy?

Ans. (a) Work done is zero. This is because equal and opposite work is done in the two paths.

(b) (i) Work done by me is positive and having a value = *mgh*. This is because I am applying force in vertically upward direction on the carton to hold it and displacement is also in the same direction.

(ii) Work done by the force of gravity on the carton = - *mgh*. This in because force is vertically downward but motion is vertically upward.

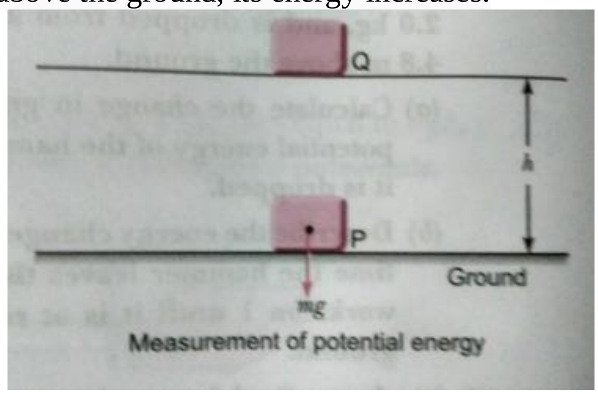
(b) Anil has greater power because his rate of doing work is more. Ashok has more energy as he worked for a longer time and the total work done by him in definitely more.

Long Answer Type Questions

[5 marks]

Q. 1. Briefly describing the gravitational potential energy, deduce an expression for the gravitational potential energy of a body of mass m placed at a height *h*, above the ground.

Ans. When an object is raised through a certain height above the ground, its energy increases. This is because the work is done on it, against gravity. The energy present in such an object is called gravitational potential energy. Thus, the gravitational potential energy of an object at a point above the ground is defined as the work done in raising it from the ground to that point against gravity. Consider a body of mass m lying at point P on the Earth's surface, where its potential energy is taken as zero. As weight, *mg* acts vertically downwards, so to lift the body to another position Q at a height *h*, we have to apply a minimum force which is equal to *mg* in the upward direction. Thus, work is done on the body against the force of gravity.



We know that,

Work done, $W = Fs$ … (*i*)

As $F = mg$ and $s = h$

Putting these values in equation (i), we get

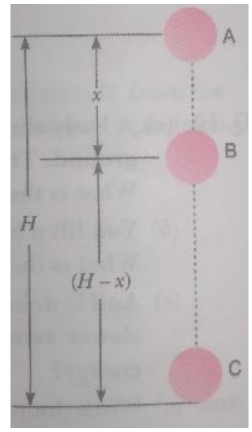
$W = mg \times h = mgh$

This work done on the body is equal to the gain in energy of the body. This is the potential energy of the body.

∴ Potential energy PE $= mgh$

Q. 2. Show that when a body is dropped from a certain height, the sum of its kinetic energy at any instant during its fall is constant.

Ans. The mechanical energy (kinetic energy + potential energy) of a freely falling object remains constant. It may be shown by calculation as follows:



suppose a body of mass m falls from point A, which is at height 'H' from the surface of earth. Initially at point A, kinetic energy is zero and the body has only potential energy.

Total energy of body at point A

= Kinetic energy + Potential energy

= $0 + mgH = mgH$ … (i)

Suppose during fall, the body is at position B. The body has fallen at a distance x from its initial position. If velocity of body at B is v, then from formula $v^2 = u^2 + 2as$, we have

$v^2 = 0 + 2gx = 2gx$

∴ Kinetic energy of body at point B = $\frac{1}{2}mv^2$

= $\frac{1}{2}m \times 2gx = mgx$

Potential energy of body at point B = $mg\ (H\text{-}x)$

∴ Total energy of body at point B = Kinetic energy + Potential energy

= $mgx + mg\ (H - x) = mgH$ … (ii)

Now suppose the body is at point C, just above the surface of earth ($i.e.$, just about to strike the earth). Its potential energy is zero.

The height by which the body falls = H

If v is velocity of body at C, then from formula

$v^2 = u^2 + 2as$

We have $u = 0$, $a = g, s = H$

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

∴ Kinetic energy of body at position C = $\frac{1}{2}mv^2$

= $\frac{1}{2}m \times 2gH = mgH$

∴ Total energy of body at C

= Kinetic energy + Potential energy

= $mgH + 0 = mgH$ … (iii)

Thus, we see that the sum of kinetic energy and potential energy of freely falling body at each point remains constant.

Thus, under force of gravity, the total mechanical energy of body remains constant.

Q. 3. A light and a heavy object have the same momentum, find out the ratio of their kinetic energies. Which one has a larger kinetic energy?

Ans. Linear momentum of first object, $p_1 = m_1v_1$ and of second object, $p_2 = m_2v_2$
But, $p_1 = p_2$
or, $m_1v_1 = m_2v_2$
If $m_1 < m_2$ then $v_1 > v_2$
$(K.E.)_1 = \frac{1}{2}(m_1v_1)v_1 = \frac{1}{2}p_1v_1$

and $(K.E.)_2 = \frac{1}{2}(m_2v_2)v_2 = \frac{1}{2}p_2v_2$

So, $\frac{(K.E.)_1}{(K.E.)_2} = \frac{\frac{1}{2}p_1v_1}{\frac{1}{2}p_2v_2} = \frac{v_1}{v_2}$

But, $v_1 > v_2$
Therefore, $(K.E.)_1 > (K.E.)_2$

Q. 4. 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 the men in lifting the box? (b) How much work do they do in just holding it? (c) Why do they get tired while holding it? (g = 10 ms^{-2})

Ans. (a) F = 250 kg × 10 ms^{-2} (g = 10 ms^{-2})

= 2500 N

s = 1 m

W = F. s

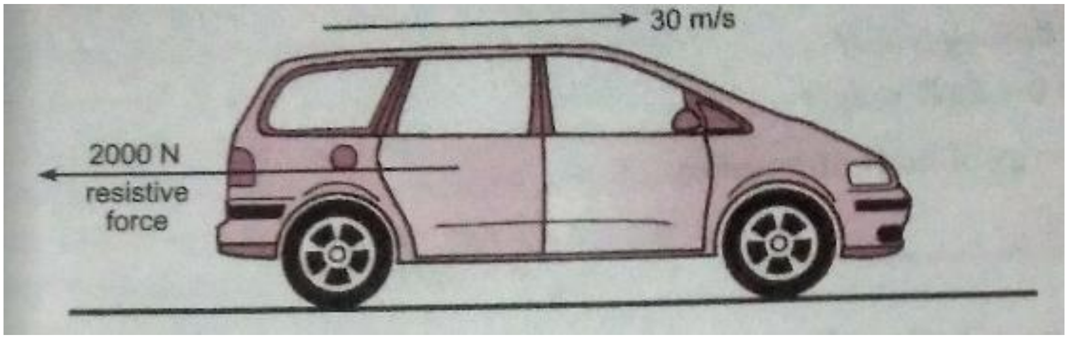
= 2500 N x 1 m

= 2500 Nm = 2500 J

(b) Zero, as the box does not move at all while holding it.

(c) In order to hold the box, men are applying a force which is opposite and equal to the gravitational force acting on the box. While applying the force, muscular effort is involved. So, they feel tired.

Q. 5. A car of mass 900 kg is travelling at a steady speed of 30 m/s against a resistive force of 2000 N, as illustrated in figure.



(i) Calculate the kinetic energy of the car.

(ii) Calculate the energy used in 1.0 s against the resistive force.

(iii) What is the minimum power that the car engine has to deliver to the wheels?

(iv) What form of energy is in the fuel, used by the engine to drive the car?

Ans. (i) Kinetic energy $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 900 \times (30)^2 = \frac{1}{2} \times 900 \times 900$

= 4,05,000 J

(ii) Energy used = Work done against resistive force

= Force × Distance

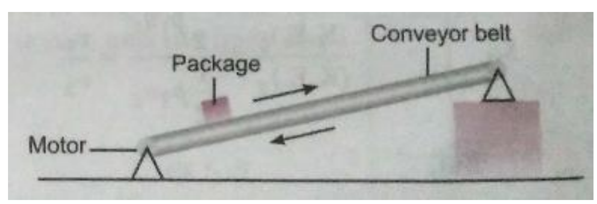
= 2,000 × 30 = 60,000 J = 60 kJ

(iii) Minimum power $= \frac{\text{Energy used}}{\text{Time taken}}$

$= \frac{60{,}000 \text{ J}}{\text{Is}}$ = 60,000 W = 60 kW

(iv) Chemical energy.

Q. 6. Figure shows a conveyor belt transporting a package to a raised platform. The belt is driven by a motor.



(i) State three types of energy, other than gravitational potential energy, into which the electrical energy supplied to the motor is converted.

(ii) The mass of the package is 36 kg. Calculate the increase in the gravitational potential energy (P.E.) of the package when it is raised through a vertical height of 2.4 m.

(iii) The package is raised through the vertical height of 2.4 m in 4.4 s. Calculate the power needed to raise the package.

(iv) Assume that the power available to raise package is constant. A package of mass greater than 36 kg is raised through the same height. Suggest and explain the effect of this increase in mass on the operation of the belt.

Ans. (i) (a) Kinetic energy of belt or the package

(b) Heat energy

(c) Sound energy

(ii) m = 36 kg, h = 2.4 m, g = 10 m/s^2

Gravitational potential energy = mgh

= 36 x 10 x 2.4 = 864 J

(iii) Power = $\frac{\text{Work done}}{\text{Time taken}} = \frac{36\times10\times2.4}{4.4} = \frac{864}{4.4} = \frac{2160}{11}$ = 196.36 W

(iv) Mass is increased and power is constant, so increase in potential energy of mass is greater. Also, as mass is increased, speed is reduced and hence time taken is longer.

HOTS (Higher Order Thinking Skills)

Q. 1. Can any object have mechanical energy even if its momentum is zero? Explain.

Ans. Yes, mechanical energy comprises of both potential energy and kinetic energy. Zero momentum means that velocity is zero. Hence, there is no kinetic energy but the object may possess potential energy.

Q. 2. Can any object have momentum even if its mechanical energy is zero? Explain

Ans. No. Zero mechanical energy means that there is no potential energy and no kinetic energy. Therefore, if kinetic energy is zero, becomes zero and hence, there will be no momentum.

Mathematically,

Mechanical energy = 0

⇒ PE = 0, KE = 0
⇒ $V = 0$
⇒ mv = p = 0

Q. 3. Is it possible that an object is in the state of accelerated motion due to external force acting on it, but no work is being done by the force? Explain with example.

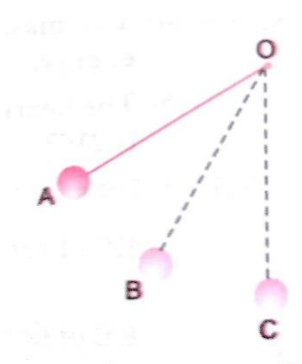
Ans. Yes, it is possible, if an object is moving in a circular path because force is always acting perpendicular to the direction of displacement.

Q. 4. The diagram below shows a pendulum which was released from position A.

(**a) What form(s) of energy did the pendulum have at**

(i) A? (ii) B? (iii) C?

(b) Eventually the pendulum would stop moving. Explain what has happened to the initial energy of the pendulum.



Ans. (a) (i) Potential energy

(ii) Potential energy + Kinetic energy

(iii) Kinetic energy

(b) The initial energy is transformed into heat energy when the pendulum bob strikes the air molecules. Thus, the amplitude of pendulum decreases and finally it stops.

Value Based Questions

1. On a railway station, a passenger hires a coolie to pick his luggage and carry it to the train. When the coolie finished his work, he asked for the money. But the passenger refused to pay him saying that he has done no work.

Answer the following questions based on the above information:

(i) Was the passenger right in saying so?
(ii) What values are not promoted by the passenger?
(iii) Give a situation seen in everyday life when no work is said to be done by you even though you get tired.

Ans. **(i)** The passenger was right in saying so according to the laws of physics. Since the direction of force is vertically up and displacement horizontal, no work is said to be done.

(ii) Sympathy and value for other's work.

(iii) When you push a heavy boulder but are unable to displace it.

2. Ram's family was worried about heavy electricity bills to be paid. Their neighbour Mohan suggested some easy and effective steps to reduce the same. Next month's bill came as a relief to Ram, as the consumption of electricity had reduced by 50 units and so had the bill.

(i) In what other aspects of life can this situation help?
(ii) What is the unit of energy?
(iii) Write any three steps that you think Mohan might have suggested to Ram.

Ans. **(i)** Promotes saving habits and judicial uses of resources.

(ii) Joule.

(iii) -Switch off the power where it is not need.

-Use of CFL light.

-To check the proper wiring as to avoid leakage of power.

3. Prachi and Kanchi were observing a building having two different staircase. One slanting and other vertically spiral. Prachi was of the opinion that a person using slanting staircase will be doing more work against gravity but Kanchi thought otherwise. They started arguing. Sanchi, their friend, explained and gave entirely different view and pacified them.

(i) What according to you was the explanation given by Sanchi?
(ii) What appreciable values do you see in Sanchi?

Ans. **(i)** Sanchi explained that the energy required in both the cases is equal because whenever the work is done against gravity, the amount of work is equal to the product of weight of the body and the vertical distance through which the body is lifted.

(Work done in lifting a body = Weight of body x Vertical height).

(ii) Sanchi has problem solving values and conceptual value.

4. Shyam and his friends were playing with a catapult (gulel) in his garden. Several mangoes were dislodged and fell with the help of catapult. One of his friend was aiming the catapult on a bird. Shyam prevented him from doing so.

(i) Name the energy possessed by the stretched string of the catapult.
(ii) What will happen if the stone is thrown without stretching the string of a catapult?
(iii) Why did Shyam prevent his friend from aiming at the bird? Which quality is highlighted in Shyam's behavior?

Ans. (i) Elastic potential energy.

(ii) If the stone is thrown without stretching the string of catapult the stone will fall down. As the stretched catapult posses potential energy due to a change in their shape it throws the stone with the high speed.

(iii) Shyam prevents his friend form aiming at the bird because he does not want to harm or kill the bird, this shows his care and love for the animals.

5. Anil lives in a village and his school is 8 km away from his home. His father suggests buying a motor cycle to go to school. Anil opposes the idea and opts for a bicycle instead.

(i) Write the energy transformation taking place while Anil rides his bicycle.
(ii) Justify the stand taken by Anil in your own words.
(iii) How can he convince his friends to do the same?

Ans. (i) Muscular (chemical) energy converts into mechanical energy.

(ii) Anil wisely opt for the bicycle as he was concerned towards environment, to avoid noise and air pollution.

(iii) By informing them about the harms of pollution, by putting forward the advantages of cycle.