Class IX : WORK, ENERGY AND POWER PYQs

1-MARK QUESTIONS

Question.1 Does work done depend upon the velocity of the body. [SAII-2014]
Answer. No.

Question.2 State the law of conservation of energy. [SAII-2014]
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 ? [SAII-2014]
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. [SAII-2010]
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. [SAII-2011]
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'. [SAll-2012]
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 ?

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Answer. Yes.

Question.18 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

Question19 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.20 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.21 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.22 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.23 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.24 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.25 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.26 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.27 Define energy.
Answer.
Energy is the ability of a body to do work. It is also defined as the capacity to do work.

Question.28 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.29 What is the SI unit of energy?
Answer. The SI unit of energy is joule.

Question.30 Does a body at rest possess any kinetic energy ?
Answer. No.

Question.31 What will happen to the kinetic energy of a body if its mass is doubled ?
Answer. Its kinetic energy will be doubled.

Question.32 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.33 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.34 Can a body possess energy even if it is not in motion ?
Answer. Yes, it can possess potential energy.

Question.35 Define potential energy.
Answer. It is defined as the energy possessed by a body by virtue of its position or change in shape.

Question.36 Name the energy possessed by a stretched rubber band lying on the table.
Answer. Potential energy.

Question.37 Give the SI unit of potential energy.
Answer. The SI unit of potential energy is.joule.

Question.38 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.39 Can energy be destroyed? Can energy be created ?
Answer. No,

Question.40 A cell converts one form of energy into another. Name the two forms.
Answer.
It converts chemical energy into electrical energy.

Question.41 Name one unit of power bigger than watt.
Answer. A unit bigger than watt is kilowatt.

Question.42 When an arrow is shot from its bow, it has kinetic energy. From where does it get the kinetic energy ? [SAll-2010]
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.43 Name at least three commonly used units of energy.
Answer. (i) Joule (ii) Erg (iii) Kilowatt hour.

Question.44 Name the practical unit of power in engineering.
Answer. Horsepower.

Question.45 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.46 How many watt are there in 1 horse – power ?
Answer. 746 watt.

Question.47 What is horsepower ?
Answer. It is a unit of power.

Question.48 A light and a heavy body have equal kinetic energy. Which one is moving fast ? [SAII-2011]
Answer. The lighter body is moving fast.

2 MARKS QUESTIONS

Question.1 State the relation between kW h and joule. Define 1 watt. [SAII-2014]
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. [SAII-2012]
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? [SAII-2013]
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. [SAII-2013]
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? [SAII-2010]
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 ? [SAll-2011]
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? Think;
discuss this question with your friends and teacher. [SAII-2012]
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 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.15 A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy ? [SAI1-2011]
Answer. The KE on reaching the ground changes into heat energy, sound energy etc. and, therefore, gets dissipated in air.

Question.16 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.17 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.18 What are the factors on which the work done depends ? [SAII-2010]
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.19 How are kinetic energy and momentum related ?
Answer. Kinetic energy and momentum of a body can be related as follows:
We know that formula of Kinetic energy, $K.E=1/2mv^2$
Now, multiply and divide R.H.S. by m.
$K.E=(1/2mv^2)\times m/m$
$K.E=m^2 v^2 / 2m$
We know that, $p=mv$
$\therefore K.E= m^2 v^2 / 2m = p^2 /2m$
The above equation gives the relation between Kinetic energy and the momentum of the object under motion.

Question.20 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.21 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.22 What is the amount of work done by a force when a body moves in a circular path ? [SAll-2012]
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 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.

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. [SAll-2014]
Answer. The energy consumed by the bulbs,
As we know enegry=power×time
3 bulbs × 30 watts × 5 hours × 31 days = 13950 Wh
The energy consumed by the tubes,
4 tubes × 50 watts × 8 hours × 31 days = 49600 Wh
The energy consumed by the fridge,
1 fridge × 300 watts × 24 hours × 31 days = 223200 Wh
Therefore, the total energy consumption is given by,
13950+49600+223200 = 286750 Wh = 286.75 KWh
We need to convert it into units, where 1 unit = 1 kWh
So, electricity bill = 286.75 units × 2 rs = Rs. 573.5

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. [SAII-2013]
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) 2×10^5 J

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 ? [SAII-2013]

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 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.6 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? [SAII-2010]
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. [SAll-2013]
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 ? [SAII-2012]
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? [SAII-2013]
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.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.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. [SA II – 2011]
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. [SA II – 2011]
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. [SA II – 2012]
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.

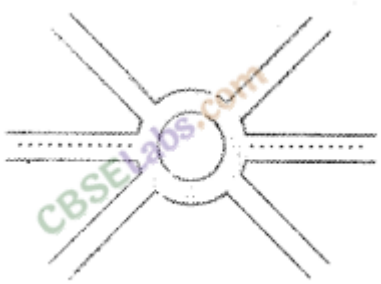
Question.5
(a) Is it possible that a body be in accelerated motion under the action of a force, yet no work is being done by the force? Explain with an example.
(b) Two bodies of masses m, and m2 have equal kinetic energies. What is the ratio of their
linear momenta? [SA II – 2012]
Answer.
(a) Yes, it 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.

EXEMPLAR QUESTIONS

Question 10.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?
Solution:
Let the mass of the rocket be m.
Kinetic energy of rocket when it moves with velocity v,
$K_1=1/2mv^2$
Kinetic energy of rocket when it moves with velocity 3v,
Undefined control sequence \therefore

Question 11. Avinash can run with a speed of 8 m s^{-1} against the frictional force of 10 N, and Kapil can move with a speed of 3 ms^{-1} against the frictional force of 25 N. Who is more powerful and why?
Solution:
Since, Power = Force x Velocity
∴Power of Avinash, PA = 10 N x 8 m s^{-1}= 80 W
Power of Kapil, P_K= 25 N x 3 m s^{-1}= 75 W
As $P_A > P_K$/ so, Avinash is more powerful than Kapil.

Question 12. A boy is moving on a straight road against a frictional force of 5 N. After travelling a distance of 1.5 km he forgot the correct path at a round about as shown in figure of radius 100 m. However, he moves on the circular path for one and half cycle and then he moves forward upto 2.0 km. Calculate the work done by him.



Solution:
Frictional force, F = 5 N As frictional force was always there in the motion of boy,
∴ Work done by boy = Force * Total distance covered
=5 N × [1.5 km+32× 2× π × 0.1 km +2 km]
=5 N × 4.442 km
=5 N × 4442m=22210J

Question 13. Can any object have mechanical energy even if its momentum is zero? Explain.
Solution:
Yes, if momentum of an object is zero, i.e.; p = mv =0
which gives v = 0 as m ≠ 0
Kinetic energy of the object =12mv²= 0
Now, Mechanical energy = potential energy + kinetic energy (= 0) – potential energy (∴ K. E = 0)
So any object can have mechanical energy even if its momentum is zero.

Question 14. Can any object have momentum even if its mechanical energy is zero? Explain.
Solution:
No, if mechanical energy = kinetic energy + potential energy = 0,
So, potential energy = kinetic energy = 0
or 12mv2= 0 or v = 0
So, momentum, p = mv = 0
Any object can not have momentum even if
its mechanical energy is zero.

Question 15. The power of a motor pump is 2 kW. How much water per. minute the pump can raise to a height of 10 m? (Given g = 10m s^{-2})
Solution:
Here, power of motor pump, P = 2 kW
= 2000 W
Height to which water is raised, h = 10 m
As mght or ptgh
∴ Water raised per minute (= 60 s)
2000×6010×10=200

Question 16. The weight of a person on a planet A is about half that on the earth. He can jump upto 0.4 m height on the surface of the earth. How high he can jump on the planet A?
Solution:
Weight of a person on a planet is half that on the earth,
$W_A=12W_E$
or $mg_A = 12\ mg_E$
or $g_A = 12g_E$
Now, as the person jumps, gain in potential energy remains same.
So, $mg_Ah_A= mg_Eh_E$

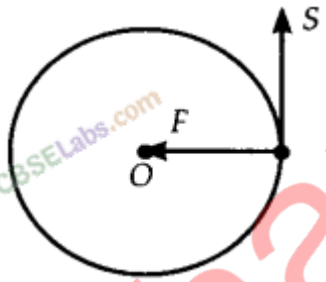
$$\therefore \quad h_A = \frac{g_E h_E}{g_A}$$

$$= \frac{g_E \times 0.4\ \text{m}}{g_E/2} \qquad \text{(Using (i) and } h_E = 0.4\ \text{m)}$$

=0.8m
(Using (i) and hE = 0.4 m)

Question 17. 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.
Solution:
Let the body covers a distance s when a constant force F is applied in the direction of motion.
Work done by this force, W=F . s
Let the velocity of object of mass m change
from u to v with acceleration a on application
of constant force F, then F = ma
From equation of motion, v2-u2 = 2as, we get
$s=v^2-u^2 2a$
$\therefore W=Fs=ma(v^2-u^2 2a)$
$=12mv^2-12mu^2$
= final kinetic energy – initial kinetic energy
= change in kinetic energy

Question 18. 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 it with an example.
Solution:
Yes, it is 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.



For example, an object moving in a circular path due to centripetal force acting on it.
At any instant of time, a constant acceleration due to the centripetal force act on the object along the radius towards the centre while the direction of displacement is tangential to the circle. That is, force and displacement are perpendicular to each other and hence no work is being done.

Question 19. A ball is dropped from a height of 10 m. If the energy of the ball reduces by 40% after striking the ground, how much high can the ball bounce back? (g = 10 m s^{-2})
Solution:
Let the mass of the ball be m, then, initial potential energy of the ball
= mgh = 10 x 10 x m
=100 m J
Since the energy of the ball reduces by 40% after striking the ground, energy left with the ball = 60% of P.E.

=60100 x 100 m = 60 m J
Let the ball bounce back to height W due to this remaining energy,
∴ mgh = 60 m
h=160mmg=6m

Question 20. If an electric iron of 1200 W is used for 30 minutes everyday, find electric energy consumed in the month of April.
Solution:
Power of electric iron, P = 1200 W Time for which it is used in one day, t = 30 min
= 30 x 60 s = 1800 s
Energy consumed in one day = P x t
= 1200 W x 1800 s
= 2.16 x 10^6 J
As there are 30 days in April, so energy consumed in the month of April = 2.16 x 10^6 x 30 J
= 6.48 x 10^7 J

Long Answer Type Questions

Question 21. 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?
Solution:
Let m and M be the masses of a light and a heavy object moving with velocities v and V respectively.
As both have the same momentum,
∴ mv = MV
or MV …(i)
Kinetic energy of light object,
$K_m=\frac{1}{2}mv^2$
Kinetic energy of heavy object,
$K_m=\frac{1}{2}mV^2$
Kinetic energy of heavy object,

$$K_M = \frac{1}{2}MV^2$$

$$\therefore \quad \frac{K_m}{K_M} = \frac{\frac{1}{2}mv^2}{\frac{1}{2}MV^2} = \frac{m}{M}\cdot\frac{v^2}{V^2}$$

$$= \frac{m}{M}\times\left(\frac{M}{m}\right)^2 = \frac{M}{m} \qquad \text{(Using (i))}$$

As M>m;
$K_m > K_M$, i.e. light object has larger kinetic energy.

Question 22. An automobile engine propels a 1000 kg car (A) along a levelled road at a speed of 36 km h '. Find the power if the opposing frictional force is 100 N. Now, suppose after travelling a distance of 200 m, this car collides with another stationary car (8) of same mass and comes to rest. Let its engine also stop at the same time. Now car (B) starts moving on the same level road without getting its engine started. Find the speed of the car (6) just after the collision.
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?
Solution:
Here, mass of the car A, mA = 1000 kg
Initial speed of the car A, uA = 36 km h_1
= 36 x 518= 10m s^{-1}
Opposing frictional force, F = 100 N
∴ Power of the engine of car A
= F μ_A = (100 N) x (10 m s^{-1}) = 1000 W
When car A collides with car B of mass 1000 kg,
Final speed of car A, vA = 0
Initial speed of car B, uB = 0
Applying conservation of momentum, P, = P,
$m_A v_A + m_B u_B = m_A v_A + m_B v_B$
1000 x 10 + 1000 x 0 = 1000 x o + 1000 x v_B
∴v_B = 10m s^{-1}
So, the speed of the car B just after collision is 10m s^{-1}

Question 23. A girl having mass of 35 kg sits on a trolley of mass 5 kg. The trolley is given an initial velocity of 4 10m s^{-1} 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?
Solution:
Effective mass of girl + trolley system = mass of girl + mass of trolley = 35 kg + 5 kg = 40 kg
Here, u = 4 10m s^{-1}, v – 0, s = 16 m
Using $v^2 – u^2 = 2as$, we get

$$a = \frac{v^2 - u^2}{2s} = \frac{0 - 4^2}{2 \times 16} = \frac{-1}{2} \text{ m s}^{-2}$$

$$\therefore \text{ Force, } F = ma = 40 \times \left(\frac{-1}{2}\right) \text{N} = -20 \text{ N}$$

(a) Work done on the trolley = – Work done by the trolley
= -Fs
= – (-20 N) x (16 m)
= 320 J
(b) As the girl keeps sitting on the trolley, there is no displacement in her position with respect to trolley, so no work is done by the girl.

Question 24. 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 m s^{-2})Solution:
Mass of the box, m = 250 kg
Height upto which it is raised, h = 1 m
(a) Work done by the men in lifting the box
= F.s = 250 x 10 x 1 J
(Here F = mg, s = h)
= 2500 J
(b) In just holding the box, there is no displacement, so no work is done.
(c) In order to hold the box at a certain height, men are applying a force which is equal and

opposite to the gravitational force acting on the box. While applying the force, muscular effort is involved.
So, men get tired while holding it.

Question 25. 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 p utilized? (g = 10 m s^{-2})
Solution:
Power is defined as the rate of doing work or the rate of transfer of energy, Kilowatt is the unit of power and kilowatt hour is the unit of energy or work as kilowatt hour = unit of power x unit of time.
Energy possessed by 2000 tonnes
(= 2000 x 10^3 kg) water at a height of 20 m, Ef, = mgh
= 2000 x 10^3 x 10 x 20
= 4 x 10^8 J
Power generated if all this energy can be
utilized,

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

$$= \frac{4 \times 10^8 \text{ J}}{60 \text{ s}} \quad (\because \quad t = 1 \text{ min} = 60 \text{ s})$$

$$= \frac{2}{3} \times 10^7 \text{ W}$$

Question 26. 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 m s'1 vertically? (g=10ms~2) ,
Solution:
Power associated in lifting a body of mass m upto a height h in time t is,
p=mght
Here, ht = speed = v
∴ P=mgv
Here P = 100W, v=1ms-1,10 ms-2
m=Pgv

$$\text{So, } m = \frac{100 \text{ W}}{10 \text{ m s}^{-2} \times 1 \text{ m s}^{-1}} = 10 \text{ kg}$$

Question 27. Define watt. Express kilowatt in terms of joule per second. A 150 kg car engine develops 500 W for each kg. What force does it exert in moving the car at a speed of 20 m s'1?
Solution:
One watt is the power of an agent which does work at the rate of one joule per second. 1 kilowatt = 1000 watt
= 1000 joule per second (v 1 W = 1 J s-1)
Mass of the car, m = 150 kg
Power developed by engine per kg = 500 W
Total power developed by engine,
P = 500 W x 150

= 75000 W
Speed of car, v = 20 m s_1 Power, P = Fv
=> Force exerted in moving the car, f = Pv
=75000W20ms–1
=3750 N

Question 28. Compare the power at which each of the following is moving upwards against the force of gravity? (given g =10m s^{-2})

1. a butterfly of mass 1.0 g that flies upward at a rate of 0.5 m s1.
2. a 250 g squirrel climbing up on a tree at a rate of 0.5 m s-1.

Solution:

1. Mass of butterfly, mb= 1 g = 10^{-3} kg
   Speed, vb = 0.5 m s^{-1}
   Force of gravity on butterfly, Fh = mbg
   = 10^{-3} x 10 = 10^{-2} N
   Power, $P_b = F_b.v_b$ = 10^{-2} N x 0.5 m s^{-1} = 0.005 W
2. Mass of squirrel, ms = 250 g = 0.25 kg
   Speed, vs = 0.5 m s^{-1}
   Force of gravity on squirrel,
   Fs = msg = 0.25 x 10 = 2.5 N
   Power, $P_s = F_s.v_s$= 2.5 N x 0.5 m s^{-1} = 1.25 W
   Hence, the squirrel exerts more power in climbing than a butterfly exerts in flying at the same rate.