Lakhmir Singh Solutions Class 9 Physics Chapter 4 Work And Energy

Question 1:

How much work is done when a body of mass *m* is raised to a height *h* above the ground?

ANSWER:

We can calculate the work done against gravity in moving a body of mass (*m*) by a height (*h*) as, Work done in lifting a body = (Weight of body) (Vertical distance)
So, $W = (m)\ (g)\ (h)$

Question 2:

State the SI unit of work.

ANSWER:

Joule is the SI unit of work. It is denoted by 'J.

Question 3:

Is work a scalar or a vector quantity?

ANSWER:

Work is a scalar quantity as it has only magnitude.

Question 4:

Define 1 joule of work.

ANSWER:

Joule is the SI unit of work. Work done is said to be of 1 Joule when a force of 1 Newton moves a body by 1 m along the direction of the force applied.

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Question 5:

What is the condition for a force to do work on a body?

ANSWER:

The necessary condition for force to do work is that the applied force should produce motion in the body in any direction except the direction perpendicular to the force applied.

Question 6:

Is energy a vector quantity?

ANSWER:

No, energy is a scalar quantity as it has only magnitude.

Question 7:

What are the units of (a) work, and (b) energy?

ANSWER:

The units of work and energy are the same.
(a) Work - Joule (J)
(b) Energy - Joule (J)

Question 8:

What is the work done against gravity when a body is moved horizontally along a frictionless surface?

ANSWER:

When a body is moved horizontally along a frictionless surface, the work done against gravity is zero because the direction of motion of the body is perpendicular to the direction of the gravitational force.

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Question 9:

By how much will the kinetic energy of a body increase if its speed is doubled?

ANSWER:

Kinetic energy of a body is directly proportional to the square of velocity. So, the kinetic energy will become four times the initial value when velocity is doubled.

Question 10:

Write an expression for the kinetic energy of a body of mass *m* moving with a velocity *v*.

ANSWER:

The expression for kinetic energy is as follows:
$K.E=12mv2$K.E=12mv2
Where,
(*K.E*) - Kinetic Energy
(*m*) - Mass
(*v*) - Velocity

Question 11:

If the speed of a body is halved, what will be the change in its kinetic energy?

ANSWER:

Kinetic energy of a body is directly proportional to the square of velocity. So, the kinetic energy will become (14)14 the initial kinetic energy when velocity is halved.

Question 12:

On what factors does the kinetic energy of a body depend?

ANSWER:

The kinetic energy of a moving body depends upon two factors. It is directly proportional to the following:

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(i) The mass of the moving body
(ii) The square of the velocity of the moving body

Question 13:

Which would have a greater effect on the kinetic energy of an object : doubling the mass or doubling the velocity?

ANSWER:

Kinetic energy of a body is directly proportional to the mass and square of velocity of the moving body. So, doubling the velocity will have a greater effect on the kinetic energy of a body.

Question 14:

How fast should a man of 50 kg run so that his kinetic energy be 625 J?

ANSWER:

We have to find the speed of the running man. We have,
Mass of the man (*m*) = 50 kg
Kinetic energy of the man (*K.E*) = 325 J
So, we use the expression of kinetic energy to find the unknown quantity as,
$K.E=12mv2$K.E=12mv2
Where,
KE - Kinetic Energy
m - Mass
v - Speed
So,
$v=2(K.E)(m)−−−−−√Therefore,v=2(625)50−−−−−√m/s =25−−√m/s =5 m/sv=2(K.E)(m)$The refore,v=2(625)50m/s =25m/s =5 m/s
So, the man should be running with a speed of 5 m/s.

Question 15:

State whether the following objects possess kinetic energy, potential energy, or both :

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(a) A man climbing a hill
(b) A flying aeroplane
(c) A bird running on the ground
(d) A ceiling fan in the off position
(e) A stretched spring lying on the ground.

ANSWER:

(a) A man climbing up a hill has both kinetic energy as well as potential energy.
(b) A flying aeroplane has both kinetic energy as well as potential energy.
(c) A bird running on the ground possesses only kinetic energy.
(d) When switched off, a ceiling fan possesses only potential energy.
(e) A stretched spring lying on the ground possesses potential energy.

Question 16:

Two bodies A and B of equal masses are kept at heights of *h* and 2*h* respectively. What will be the ratio of their potential energies?

ANSWER:

Potential energy of a body is directly proportional to the height of the object.
Hence, Potential energy of APotential energy of B=12Potential energy of APotential energy of B=12
Ratio of A and B = 1:2

Question 17:

What is the kinetic energy of a body of mass 1 kg moving with a speed of 2 m/s?

ANSWER:

We have to find the kinetic energy of the moving body. We have,
Mass of the body (*m*) = 1 kg
Speed of the moving body (*v*) = 2 m/s
So,
K.E=12mv2K.E=12mv2
Where,
K.E - Kinetic Energy
m - Mass
v - Speed
Therefore,

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$K.E = \frac{1}{2}(1)(2)^2$ J $= 2$ J$K.E = \frac{1}{2}(1)(2)^2$ J $= 2$ J
So, the kinetic energy of the moving object is 2 J.

Question 18:

Is potential energy a vector or a scalar quantity?

ANSWER:

Potential energy is a scalar quantity as it has only magnitude.

Question 19:

A load of 100 kg is pulled up by 5 m. Calculate the work done. (g = 9.8 m/s^2)

ANSWER:

Mass of the body (m) = 100 kg
Height by which the body is lifted (h) = 5 m
Work done in lifting a body = (Weight of body) (Vertical distance)
So, $W = (m)\,(g)\,(h)$
Therefore,
$(\mathrm{W}) = (100)(9.8)(5)$ J $= 4900$ J$(\mathrm{W}) = (100)(9.8)(5)$ J $= 4900$ J
So, the work done is 4900 J.

Question 20:

State whether the following statement is true or false :
The potential energy of a body of mass 1 kg kept at a height of 1 m is 1 J.

ANSWER:

The given statement is **false**.
We know, PE = mgh
So, for h = 1 m, m = 1 kg and g = 9.8 m/s^2 the PE is = (1)(9.8)(1) = 9.8 J

Question 21:

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What happens to the potential energy of a body when its height is doubled?

ANSWER:

Potential energy of a body is directly proportional to the height of the body. So, if the height of the object is doubled, then the potential energy also gets doubled.

Question 22:

What kind of energy is possessed by the following?

(a) A stone kept on roof-top
(b) A running car
(c) Water stored in the reservoir of a dam
(d) A compressed spring
(e) A stretched rubber band

ANSWER:

(a) A stone kept on a roof possesses gravitational potential energy because of its height from the ground.
(b) A running car possesses kinetic energy due to its speed.
(c) Water stored in the reservoir of a dam possesses gravitational potential energy.
(d) A compressed spring possesses elastic potential energy.
(e) A stretched rubber band possesses elastic potential energy.

Question 23:

Fill in the following blanks with suitable words :
(a) Work is measured as a product of _____ and _____.
(b) The work done on a body moving in a circular path is _____.
(c) 1 joule is the work done when a force of 1 _____ moves an object through a distance of one _____ in the direction of _____.
(d) The ability of a body to do work is called _____. The ability of a body to do work because of its motion is called _____.
(e) The sum of the potential and kinetic energies of a body is called _____ energy.

ANSWER:

(a) Work is measured as a product of force and distance.
(b) The work done on a body moving in a circular path is zero.

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(c) 1 joule is the work done when a force of 1 Newton moves an object through a distance of one meter in the direction of force.
(d) The ability of a body to do work is called energy. The ability of a body to do work because of its motion is called kinetic energy.
(e) The sum of the potential and kinetic energies of a body is called mechanical energy.

Question 24:

What are the quantities on which the amount of work done depends? How are they related to work?

ANSWER:

The work done by a force on a body depends on two factors:
(i) Magnitude of force applied
(ii) Displacement in the direction of force applied
The relation between work (W), force (F) and displacement (S) is given by following equation:
$W = F.S. \cos \theta$
Where,
(W) - Work done
(F) - Force
(S) - Displacement
(θ) - Angle between the force applied and displacement of the body.

Question 25:

Is it possible that a force is acting on a body but still the work done is zero? Explain giving one example.

ANSWER:

Yes, it is possible that a force is acting on a body but the work done is still zero. Following are the cases:
1. The displacement is zero.
2. The force and displacement are perpendicular to each other.
We know,
$W = (F) (S) \cos \theta$
Where,
(W) - Work done

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(F) - Force
(S) - Displacement
(θ) - Angle between force and displacement
From the equation itself, when the displacement is zero the work done is zero.
Example: No work is done when one pushes a wall that remains static even after pushing very hard.
When the force is perpendicular to the direction of motion, , and hence the work done is also zero.
Example - Work done by the force of gravity on a horizontally moving body is zero, because the force of gravity is perpendicular to the horizontal.

Question 26:

A boy throws a rubber ball vertically upwards. What type of work, positive or negative, is done :

(a) by the force applied by the boy?
(b) by the gravitational force of earth?

ANSWER:

A boy throws a rubber ball vertically upwards. Work done by the two forces:
(a) Work done by the force applied by the boy is positive because the displacement of the ball is in the direction of force applied.
(b) Work done by the gravitational force is negative because the displacement of the ball is opposite to the direction of gravitational force.

Question 27:

Write the formula for work done on a body when the body moves at an angle to the direction of force. Give the meaning of each symbol used.

ANSWER:

When the body travels at an angle to the direction of force applied, then the work done will be equal to the product of the displacement and the component of force in the direction of displacement.

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So, work done is given by the following formula:
$W = (F)\ (S) \cos \theta$
Where,
(W) - Work done
(F) - Force
(S) - Displacement
(θ) - Angle between force and displacement

Question 28:

How does the kinetic energy of a moving body depend on its (i) speed, and (ii) mass?

ANSWER:

The kinetic energy of a moving body depends on two factors because:
(i) Kinetic energy of a moving body is directly proportional to the square of the speed of the moving body.
(ii) Kinetic energy of a moving body is directly proportional to the mass of the moving body.

Question 29:

Give one example each in which a force does (a) positive work (b) negative work, and (c) zero work.

ANSWER:

The examples of positive, negative and zero work are as follows:
(a) Positive work - When we kick a football, it moves in the direction of the force applied and hence, the work done in this case is positive.
(b) Negative work - Work done by the frictional force on a rolling football to decrease its motion is an example of negative work, as the direction of frictional force (acting on the ball) is opposite to the direction of the football's motion
(c) Zero work - Work done by the earth on a satellite moving around the earth is zero as the direction of the motion of the satellite is always perpendicular to the direction of the gravitational force.

Question 30:

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A ball of mass 200 g falls from a height of 5 metres. What is its kinetic energy when it just reaches the ground? (g = 9.8 m/s^2)

ANSWER:

Mass of the ball, (m) = 0.2 kg
Height from which the ball is dropped, (h) = 5 m
Initial velocity of the ball, (u) = 0 m/s
Acceleration due to gravity, (g) = 9.8 m/s^2
Let the final velocity of the ball when it just reaches the ground be (v)
We will use the third equation of motion to find the velocity of the ball when it just reaches the ground,
$v^2 = u^2 + 2as$
So,
$v^2 = 0 + 2(9.8)(5)$
$\Rightarrow v^2 = 98$
Now we can find the kinetic energy as,
$K.E = \frac{1}{2}mv^2$K.E=12mv2
Therefore,
$K.E = (1/2)(0.2)(98)$
$\Rightarrow K.E = 9.8$ J
So, the kinetic energy of the moving object is 9.8 J.

Question 31:

Find the momentum of a body of mass 100 g having a kinetic energy of 20 J.

ANSWER:

We have,
Kinetic energy of the moving body, ($K.E$) = 20 J
Mass of the moving body, (m) = 0.1 kg
We have a relation between momentum and kinetic energy
as, $P = \sqrt{2(K.E)\ (m)}$P=2(K.E) (m)−−−−−−−−−−√
So,
$(P) = \sqrt{2(20)\ (0.1)}$(P)=2(20) (0.1)−−−−−−−−−√ $= 2$ kg.m/s $= 2$ kg.m/s
So, the momentum of the moving body is 2 kg.m/s.

Question 32:

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Two objects having equal masses are moving with uniform velocities of 2 m/s and 6 m/s respectively. Calculate the ratio of their kinetic energies.

ANSWER:

Let the masses of the two bodies be (m_1) = m kg and (m_2) = m kg.
Velocity of the first body, (v_1) = 2 m/s
Velocity of the first body, (v_2) = 6 m/s
The required ratio is-
$=(\text{kinetic energy})_1(\text{Kinetic energy})_2=12(m1)\ (v1)212(m2)(v2)2$=(kinetic energy)1(Kinetic energy)2=12(m1) (v1)212(m2)(v2)2
So, put the values to get the ratio,
$=(2)2(6)2=19$=(2)2(6)2=19

The ratio of the kinetic energies is, K.E of body 1 : K.E of body 2 = 1 : 9

Question 33:

A body of 2 kg falls from rest. What will be its kinetic energy during the fall at the end of 2 s? (Assume g = 10 m/s^2)

ANSWER:

Mass of the body, (m) = 2 kg
Initial velocity of the ball, (u) = 0 m/s
Time, (t) = 2s
Acceleration due to gravity, (g) = 10 m/s^2
Let the final velocity of the ball after 2 s be (v)
We know $v = u + at$
So, v = 0 + 10 (2) = 20 m/s
Now we can find the kinetic energy as:
Therefore,
$K.E=12(2)(20)2$ J =400 JK.E=12(2)(20)2 J =400 J
So, the kinetic energy of the moving object is 400 J.

Question 34:

On a level road, a scooterist applies brakes to slow down from a speed of 10 m/s to 5 m/s. If the mass of the scooterist and the scooter be 150 kg, calculate the work done by the brakes. (Neglect air resistance and friction)

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ANSWER:

Mass of the scooterist and the scooter, (m) = 150 kg
Initial velocity, (v_1) = 10 m/s
Final velocity, (v_2) = 5 m/s
So, initial kinetic energy can be calculated as,
$K.E=12mv2K.E=12mv2$
Therefore,
$(K.E)1=12(150)(10)2 J = 7500 J(K.E)1=12(150)(10)2 J = 7500 J$
Similarly, final kinetic energy,
$(K.E)2=12(150)(5)2 J = 1875 J(K.E)2=12(150)(5)2 J = 1875 J$
So, Work done by the brakes = Change in kinetic energy
Therefore, work done by the brakes,
Work done by the brakes = $(K.E)_2 – (K.E)_1$
= (1875 – 7500) J, $=−5625 J=-5625 J$
Negative sign shows that the force applied by brakes is opposite to the direction of motion of the body.

Question 35:

A man drops a 10 kg rock from the top of a 5 m ladder. What is its speed just before it hits the ground? What is its kinetic energy when it reaches the ground? (g = 10 m/s^2)

ANSWER:

Mass of the body dropped, (m) = 10 kg
Height from which the body is dropped, (h) = 5 m
Initial velocity of the ball, (u) = 0 m/s
Acceleration due to gravity, (g) = 10 m/s^2
Let the final velocity of the ball when it just reaches the ground be (v)
We will use the third equation of motion to find the velocity of the body when it just reaches the ground,
$v^2 = u^2 + 2as$
So,
$v=0+2(10)(5) m/s−−−−−−−−−−−−−−√ =10 m/sv=0+2(10)(5) m/s =10 m/s$
Now, we can find the kinetic energy as,
$K.E=12mv2K.E=12mv2$
Therefore,
$K.E=12(10)(10)2 J =500 JK.E=12(10)(10)2 J =500 J$
So, the kinetic energy of the moving object is 500 J.

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Question 36:

Calculate the work done by the brakes of a car of mass 1000 kg when its speed is reduced from 20 m/s to 10 m/s?

ANSWER:

Mass of the car, (m) = 1000 kg
Initial velocity, (v_1) = 20 m/s
Final velocity, (v_2) = 10 m/s
So, initial kinetic energy can be calculated as,
$K.E=12mv2K.E=12mv2$
Therefore,
$(K.E)1=12(1000)(20)2$ J $=200000$ J$(K.E)1=12(1000)(20)2$ J $=200000$ J
Similarly, final kinetic energy,
$(K.E)2=12(1000)(10)2$ J $=50000$ J$(K.E)2=12(1000)(10)2$ J $=50000$ J
So,
Work done by the brakes = Change in kinetic energy
Therefore work done by the brakes,
Work done by the brakes
$= (K.E)_2 – (K.E)_1$
= (50000 – 200000) J
= –150000 J
$=−150$ KJ=-150 KJ
Negative sign shows the force applied by brakes is opposite to the direction of motion of the body.

Question 37:

A body of mass 100 kg is lifted up by 10 m. Find :
(i) the amount of work done
(ii) potential energy of the body at that height (value of g = 10 m/s^2)

ANSWER:

(i) Mass of the body, (m) = 100 kg
Height above the ground, (h) = 10 m
Acceleration due to gravity, (g) = 10 m/s^2
We can calculate the work done against gravity as,
Work done in lifting a body = (Weight of body) × (Vertical distance)

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So, $W = (m) \times (g) \times (h)$
So work done,
$W = (100) \times (10) \times (10)$ J
$= 10$ KJ= 10 KJ
(ii) Potential energy of a body kept at the same height is equal to the amount of work done against gravity in moving the body to that position. Therefore, the potential energy of the body at that height is 10 KJ 10 KJ .

Question 38:

A boy weighing 50 kg climbs up a vertical height of 100 m. Calculate the amount of work done by him. How much potential energy does he gain? (g = 9.8 m/s^2)

ANSWER:

(i) Mass of the boy, (m) = 50 kg
Height above the ground, (h) = 100
Acceleration due to gravity, (g) = 9.8 m/s^2
We can calculate the work done against gravity as,
Work done in lifting a body = (Weight of body) × (Vertical distance)
So, $W = m \times g \times h$
So work done,
$W = 50 \times 9.8 \times 100$ J
$= 49$ KJ49 KJ
Now, potential energy of a body kept at the same height is equal to the amount of work done against gravity in moving the body to that position. Therefore, the potential energy of the boy at that height is 49 KJ49 KJ

Question 39:

When is the work done by a force on a body : (a) positive, (b) negative, and (c) zero?

ANSWER:

(a) Positive work – Work done is positive when the force aplied and the displacement caused are in same direction.
Example: When we kick a football, it moves in the direction of the force applied and hence, the work done in this case is positive.

(b) Negative work – Work done is negative when the force applied and the displacement

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caused are in opposite direction.
Example: Work done by the frictional force on a rolling football to decrease its motion is an example of negative work, as the direction of frictional force (acting on the ball) is opposite to the direction of the football's motion

(c) Zero work – Work done can be zero for the following two reasons:
1. The displacement is zero.
2. The force and displacement are perpendicular to each other.
Work done by the earth on a satellite moving around the earth is zero as the direction of the motion of the satellite is always perpendicular to the direction of the gravitational force.

Question 40:

To what height should a box of mass 150 kg be lifted, so that its potential energy may become 7350 joules? (g = 9.8 m/s^2)

ANSWER:

Mass of the box, (*m*) = 150 kg
Acceleration due to gravity, (*g*) = 9.8 m/s^2
Potential energy, (*P.E*) = 7352 J
Let the height above the ground be (*h*)
We can calculate potential energy as,
(*P.E*) = (*m*)(*g*)(*h*)
So, height can be calculated as,
$h=\text{P.E(m)(g)So,h=7350(150)(9.8)m}\ =73501470\ =5\ \text{mh=P.E(m)(g)So,h=7350(150)(9.8)m}\ =7350$ 1470 =5 m

Question 41:

A body of mass 2 kg is thrown vertically upwards with an initial velocity of 20 m/s. What will be its potential energy at the end of 2 s? (Assume g = 10 m/s^2).

ANSWER:

Mass of the body, (*m*) = 2 kg
Initial velocity of the body, (*u*) = 20 m/s
Time, (*t*) = 2s
Acceleration due to gravity, (*g*) = 10 m/s^2
Let the height attained at the end of 2 s be (*s*)

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We will use the second equation of motion to find the height of the body,
$s=ut+\frac{1}{2}at^2$So, $s=20(2)+\frac{1}{2}(-10)(2)^2 =(40-20)\ m = 20\ m$s=ut+12at2So, s=20(2)+12(-10)(2)2 =(40 –20) m = 20 m
(We have taken a negative because it is opposite in direction to the initial velocity)
We can calculate potential energy as,
P.E = (*m*) (*g*) (*h*)
So,
P.E = 2 × 10 × 20 J
$=400\ J$=400 J

Question 42:

How much work is done when a force of 1 N moves a body through a distance of 1 m in its own direction?

ANSWER:

When a force of 1 Newton moves a body by a distance of 1 m in its own direction, then the work done is said to be of 1 Joule. It is the standard definition of 1 Joule work done.

Question 43:

A car is being driven by a force of 2.5×10^{10} N. Travelling at a constant speed of 5 m/s, it takes 2 minutes to reach a certain place. Calculate the work done.

ANSWER:

Force applied by the car, (F) = 2.5×10^{10} N
Speed of the car, (*v*) = 5 m/s
Time taken, (*t*) = 120 s
So distance travelled,
Distance = Speed × Time
= 5 × 120 m
= 600 m
So, Work done = (Force) × (Distance)
$=2.5\times10^{10}\times600\ J=1.5\times10^{13}$ J=2.5×1010×600 J=1.5×1013 J

Question 44:

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Explain by an example that a body may possess energy even when it is not in motion.

ANSWER:

A body can have energy even if it is not in motion. The statement can be justified by: Water stored in the reservoir at the roof of a building possesses gravitational potential energy due to its position above the ground.

Question 45:

(a) On what factors does the gravitational potential energy of a body depend?
(b) Give one example each of a body possessing : (i) kinetic energy, and (ii) potential energy.

ANSWER:

(a) Gravitational potential energy of a body depends on its position above the ground.
Example - A book kept on a table possesses gravitational potential energy because of its position above the ground.

(b) (i) Kinetic energy - A car moving with some speed on a road possesses kinetic energy.
(ii) Potential energy- A stretched rubber band possesses potential energy due to the change in its configuration.

Question 46:

Give two examples where a body possesses both, kinetic energy as well as potential energy.

ANSWER:

Two examples in which the body possesses kinetic energy as well as potential energy are-
(i) A man climbing a hill
(ii) A bird flying in the sky
In both of the above examples, we can observe that the body has speed and its position is above the ground. Therefore, these bodies have kinetic and potential energy.

Question 47:

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How much is the mass of a man if he has to do 2500 joules of work in climbing a tree 5 m tall? (g = 10 m s^{-2})

ANSWER:

Work done in climbing or potential energy, (*P.E*) = 2500 J
Acceleration due to gravity, (*g*) = 10 m/s^2
Height above the ground be, (*h*) = 5 m
Let the mass of the man be (*m*)
We have a relation as,
P.E = $m \times g \times h$
So, mass can be calculated as,
$m = \frac{P.E}{h \times g}$m=P.Eh×gm=P.Eh×g
So, mass of the man,
$m = \frac{25005}{\times 10}\text{kg} \quad = 2505\text{kg} \quad = 50\ \text{kg}$m=25005×10kg =2505kg =50 kg

Question 48:

If the work done by a force in moving an object through a distance of 20 cm is 24.2 J, what is the magnitude of the force?

ANSWER:

Work done in moving the body, (*W*) = 24.2 J
Distance travelled by the body, (*S*) = 0.2 m
We have a relation as,
$F = \frac{W}{S}$F=WSF=WS
Therefore,
$F = \frac{24.2}{0.2}\text{N} \quad = 121\ \text{N}$F=24.20.2N =121 N

Question 49:

A boy weighing 40 kg makes a high jump of 1.5 m.
(i) What is his kinetic energy at the highest point?
(ii) What is his potential energy at the highest point? (g = 10 m/s^2)

ANSWER:

(i) The kinetic energy at the highest point is zero because at the highest point, velocity of the high jumper becomes zero.

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(ii) Mass of the boy, (m) = 40 kg
Acceleration due to gravity, (g) = 10 m/s^2
Height above the ground, (h) = 1.5 m
We can calculate potential energy as,
$P.E$ = (m) (g) (h)
So,
$P.E = (40)(10)(1.5)\ J = 600\ J$ $P.E = (40)(10)(1.5)\ J = 600\ J$

Question 50:

What type of energy is possessed :
(a) by the stretched rubber strings of a catapult?
(b) by the piece of stone which is thrown away on releasing the stretched rubber strings of catapult?

Figure

ANSWER:

(a) The stretched rubber string of a catapult possesses potential energy, as the work done to change the shape of the rubber string is stored in it.

(b) The stone possesses kinetic energy because on releasing the rubber string of the catapult, potential energy of the rubber string is transformed into the kinetic energy of the stone thrown.

Question 51:

A weightlifter is lifting weights of mass 200 kg up to a height of 2 metres. If g = 9.8 $m\ s^{-2}$, calculate :
(a) potential energy acquired by the weights.
(b) work done by the weightlifter

Figure

ANSWER:

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(a) Mass of the weights, (m) = 200 kg
Acceleration due to gravity, (g) = 9.8 m/s^2
Height above the ground, (h) = 2 m
We can calculate potential energy as,
$F.E = m \times g \times h$
So,
$\mathrm{P.E} = 200 \times 9.8 \times 2\ \mathrm{J} \quad = 3920\ \mathrm{J}$P.E = 200 × 9.8 × 2 J =3920 J

(b) Potential energy of a body kept at some height is equal to the amount of work done against gravity in moving the body to that position. Therefore, work done by the weight lifter is $3920\ \mathrm{J}$3920 J.

Question 52:

(a) Define the term 'work'. Write the formula for the work done on a body when a force acts on the body in the direction of its displacement. Give the meaning of each symbol which occurs in the formula.
(b) A person of mass 50 kg climbs a tower of height 72 metres. Calculate the work done. (g = 9.8 m s^{-2})

ANSWER:

(a) Work is said to be done when a force causes a displacement. It is a scalar quantity that is mathematically given by the scalar product of the applied force and displacement caused. Joule is the SI unit of work. It is denoted by 'J'.
We have a relation as,
W = FS cos θ
Where,
(F) - Force
(W) - Work
(S) - Displacement
θ - Angle between F and S
When F and S are parallel, θ = 0.
Then, work done is, W = FS

(b) Mass of the body, (m) = 50 kg
Height above the ground, (h) = 72 m
Acceleration due to gravity, (g) = 9.8 m/s^2
We can calculate the work done against gravity as,
Work done in lifting a body = Weight of body × Vertical distance
So,

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$W = m \times g \times h$
So work done,
W = 50 × 9.8 × 72 J
$=35280$ J=35280 J
So, the work done by the man is 35280 J.

Question 53:

(a) When do we say that work is done? Write the formula for the work done by a body in moving up against gravity. Give the meaning of each symbol which occurs in it.

(b) How much work is done when a force of 2 N moves a body through a distance of 10 cm in the direction of force?

ANSWER:

(a) The necessary condition for a force to do work is: the applied force must cause a displacement along the direction of the force.
Work done can be negative, positive or zero depending upon the direction of motion and force applied.
We can calculate the work done against gravity in moving a body of mass (m) by a height (h) as, Work done in lifting a body = (Weight of body) × (Vertical distance)
So, $W = m \times g \times h$
Where,
(W) - Work done
(m) - Mass of body
(g) - Acceleration due to gravity
(h) - Height through which the body is lifted

(b) Force, (F) = 2N
Distance travelled by the body, (S) = 0.1 m
We have a relation as, $W = FS$
So,
W = 2 × 0.1
$=0.2$J=0.2J
Therefore, the work done is 0.2 J.

Question 54:

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(a) What happens to the work done when the dispacement of body is at right angles to the direction of force acting on it? Explain your answer.
(b) A force of 50 N acts on a body and moves it a distance of 4 m on horizontal surface. Calculate the work done if the direction of force is at an angle of 60° to the horizontal surface.

ANSWER:

(a) When the force is perpendicular to the direction of motion, the work done in such cases is zero. We have a relation as,
$W = FS \cos \theta$

Where,
(W) - Work done
(F) - Force
(S) - Displacement
(θ) - Angle between force and distance
When the force is perpendicular to the direction of motion, cos 90° = 0, and hence the work done is also zero.
Example - The work done by the earth on a satellite moving in a circular orbit around it is zero because gravitational force of attraction and displacement of sattelite at any instant are perpendicular to each other.

(b) We have a situation in which, work is done by force acting obliquely.
Force, (F) = 50 N
Distance travelled by the body, (S) = 4 m
Angle between force and direction of distance, (θ) = 60°
We have a relation as,
$W = (F)(S) \cos \theta$
So,
$W=(50)\ (4)\ \cos 60° \quad =200(12)J \quad =100\ JW=(50)\ (4)\ \cos 60° \quad =20012J \quad =100\ J$
So, the work done is 100 J.

Question 55:

(a) Define the term 'energy' of a body. What is the SI unit of energy.
(b) What are the various forms of energy?
(c) Two bodies having equal masses are moving with uniform speeds of v and 2v respectively. Find the ratio of their kinetic energies.

ANSWER:

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(a) Energy is the ability to do work. The amount of energy possessed by a body is equal to the amount of work it can do when its energy is released. It is a scalar quantity as it has only magnitude.
The SI unit of energy is Joule (J).

(b) Energy exists in various forms in our universe. Some of the major forms of energy are:
(i) Kinetic energy
(ii) Potential energy
(iii) Chemical energy
(iv) Heat energy
(v) Light energy
(vi) Sound energy
(vii) Electrical energy
(viii) Nuclear energy

(c) Let the masses of the two bodies be (m_1) = m kg and (m_2) = m kg .
Velocity of the first body, (v_1) = v m/s
Velocity of the first body, (v_2) = $2v$ m/s
The required ratio is-
$=(\text{Kinetic energy})_1(\text{Kinetic energy})_2=12(m1)(v1)2\ 12(m2)(v2)2$ =(Kinetic energy)1(Kinetic energy)2=12m1v1 2 12m2v22
So put the values to get,
$=(1)2(2)2=14$=(1)2(2)2=14
The ratio of K.E is, K.E of body 1 : K.E of body 2 = 1 : 4.

Question 56:

(a) What do you understand by the kinetic energy of a body?
(b) A body is thrown vertically upwards. Its velocity goes on decreasing. What happens to its kinetic energy as its velocity becomes zero?
(c) A horse and a dog are running with the same speed. If the weight of the horse is ten times that of the dog, What is the ration of their kinetic energies?

ANSWER:

(a) The energy possessed by a body by virtue of its motion is known as kinetic energy. It is directly proportional to the mass and square of the velocity of the moving body.

(b) When a body is thrown vertically upwards against the force of gravity, its kinetic energy keeps on decreasing as its velocity decreases. At the maximum height, kinetic energy becomes zero, as the velocity of the body becomes zero at this moment. The kinetic energy

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of the body is completely transformed in to potential energy at the maximum height.

(c) Kinetic energy of a moving body is directly proportional to its mass. Hence, if the mass of the horse is 10 times the mass of the dog, then,
$(\text{Kinetic energy})_{\text{Horse}}(\text{Kinetic energy})_{\text{Dog}}=101$Kinetic energyHorse(Kinetic energy)Dog=101

Question 57:

(a) Explain by an example what is meant by potential energy. Write down the expression for gravitational potential energy of a body of mass *m* placed at a height *h* above the surface of the earth.
(b) What is the difference between potential energy and kinetic energy?
(c) A ball of mass 0.5 kg slows down from a speed of 5 m/s so that of 3 m/s. Calculate the change in kinetic energy of the ball. State your answer giving proper units.

ANSWER:

(a) An example to explain the fundamental meaning of potential energy is as follows:
A brick lying on the ground has no energy, so it cannot do any work. If we lift the brick to the roof of a house, the work done in lifting the brick against gravity gets stored in it in the form of potential energy. Thus, the energy in the brick is due to its higher position with respect to the ground, which is known as potential energy.

We can calculate the potential energy of a body of mass (*m*) lifted by a height (*h*) as,
Potential energy = (Weight of body) × (Vertical distance)
So,
$P.E = m \times g \times h$
Where,
(*P.E*) - Potential energy
(*m*) - Mass of body
(*g*) - Acceleration due to gravity
(*h*) - Height by which the body is lifted

(b) The difference between potential and kinetic energy are:

Potential Energy	Kinetic Energy
It is the energy of a body by virtue of its change in shape, size or configuration.	It is the energy of a body by virtue of its motion.
It is independent on the speed of the body.	It is directly proportional to the square of the speed of the moving body.

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(c) Mass of the ball, (m) = 0.5 kg
Initial velocity, (v_1) = 5 m/s
Final velocity, (v_2) = 3 m/s
So, initial kinetic energy can be calculated as,
$K.E = \frac{1}{2}mv^2$
Therefore, initial kinetic energy,
$(K.E)_1 = \frac{1}{2} \times 0.5 \times 5^2$ J $= 6.25$ J
Similarly, final kinetic energy,
$(K.E)_2 = \frac{1}{2} \times 0.5 \times 3^2$ J $= 2.25$ J
So, Work done = Change in kinetic energy
Therefore work done,
Work done = $(KE)_2 - (KE)_1$
= (2.25 – 6.25) J
= – 4 J
A negative sign shows that the force applied is opposite to the direction of motion of the body.

Question 58:

(a) What is the difference between gravitational potential energy and elastic potential energy? Give one example of a body having gravitational potential energy and another having elastic potential energy.
(b) If 784 J of work was done in lifting a 20 kg mass, calculate the height through which it was lifted. (g = 9.8 m/s^2)

ANSWER:

(a) We can differentiate between gravitational and elastic potential energy as -

Gravitational potential energy	Elastic potential energy
A body possesses gravitational potential energy if it is placed any height above the ground. (ground is considered as the refence level)	A body possesses elastic potential energy if its shape is changed by squeezing, pushing or pulling.
Gravitational force is responsible for this energy.	Elastic property of the body is responsible for this energy.

Example:
(i) Gravitational potential energy - A book kept on a table possesses gravitational potential energy because of its position above the ground.

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(ii) Elastic potential energy - The stretched rubber string of a catapult possesses elastic potential energy because of the change in shape of the string.

(b) Mass of the box (m) = 20 kg
Acceleration due to gravity (g) = 9.8 m/s^2
Work done against gravity (W) = 784 J
Let the height above the ground be (h)
So, $W = m \times g \times h$
So, height can be calculated as,
$h = \frac{W}{m \times g}$So,h=78420×9.8m =784196m =4 mh = Wm×gSo,h=78420×9.8m =784196m = 4 m
So the body is lifted to a height of 4 m.

Question 59:

A car is accelerated on a levelled road and acquires a velocity 4 times of its initial velocity. During this process, the potential energy of the car :

(a) does not change
(b) becomes twice that of initial potential energy
(c) becomes 4 times that of initial potential energy
(d) becomes 16 times that of initial potential energy

ANSWER:

Potential energy of an object depends only on its position above the ground and mass.. So, the potential energy of a car traveling on a levelled road does not change.
Therefore, the answer is,
(a) does not change

Question 60:

A car is accelerated on a levelled road and attains a speed of 4 times its initial speed. In this process, the kinetic energy of the car :

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(a) does not change
(b) becomes 4 times that of initial kinetic energy
(c) becomes 8 times that of initial kinetic energy
(d) becomes 16 times that of initial kinetic energy

ANSWER:

Kinetic energy of a body is directly proportional to the square of the velocity. So, the kinetic energy will become 16 times its initial value if the velocity is increased 4 times.
Therefore, the answer is,
(d) becomes 16 times that of initial kinetic energy.

Question 61:

In case of negative work, the angle between the force and displacement is :

(a) 0°
(b) 45°
(c) 90°
(d) 180°

ANSWER:

Work done is negative when the direction of force is opposite to the direction of motion. So, the angle between force and displacement in the case of negative work is .
Therefore, the answer is, (d) 180°

Question 62:

An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass 3.5 kg. Both the spheres are dropped simultaneously from a tower. When they are 10 m above the ground, they have the same :

(a) acceleration
(b) momentum
(c) potential energy
(d) kinetic energy

ANSWER:

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Momentum, potential energy and kinetic energy depend on the mass of the body. So, the answer is acceleration as it is independent of mass.
Therefore, the answer is,
(a) Acceleration

Question 63:

A girl is carrying a school bag of 3 kg mass on her back and moves 200 m on a levelled road. If the value of g be 10 m/s^2, the work done by the girl against the gravitational force will be :

(a) 6000 J
(b) 0.6 J
(c) 0 J
(d) 6 J

ANSWER:

The girl is moving with the bag on a levelled road. Her direction of motion is perpendicular to the direction of gravitational force. So, work done by the girl against gravity is zero.
Therefore, the answer is 0 J
(c) 0 J

Question 64:

The work done on an object does not depend on the :

(a) displacement
(b) angle between force and displacement
(c) force applied
(d) initial velocity of the object

ANSWER:

The work done on an object does not depend upon the initial velocity of the moving object.
Therefore, the answer is,
(d) Initial velocity of the object.

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Question 65:

Water stored in a dam possesses :

(a) no energy
(b) electrical energy
(c) kinetic energy
(d) potential energy

ANSWER:

Water stored in a tank possesses gravitational potential energy because of its position above the ground.
Therefore, the answer is,
(d) Potential energy.

Question 66:

The momentum of a bullet of mass 20 g fired from a gun is 10 kg.m/s. The kinetic energy of this bullet in kJ will be :

(a) 5
(b) 1.5
(c) 2.5
(d) 25

ANSWER:

Mass of the bullet, (m), = 0.02 gm
Momentum of the bullet, (P) = 10 kg.m/s
The relation between momentum, mass and kinetic energy is as follows -
$K.E=12(P2m)So,K.E=12((10)20.02)J \quad =1000.04J \quad =2500\ J \quad =2.5\ KJK.E=12P2mSo,K.E=12(10)20.02J \quad =1000.04J \quad =2500\ J \quad =2.5\ KJ$
Therefore, the answer is -
(c) 2.5.

Question 67:

Each of the following statement describes a force acting. Which force is causing work to be done?

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(a) the weight of a book at rest on a table
(b) the pull of a moving railway engine on its coaches
(b) the tension in an elastic band wrapped around a parcel
(d) the push of a person's feet when standing on the floor

ANSWER:

We will justify all statements one by one as:
(a) The weight of a book at rest on a table cannot do any work as the book is at rest. So, the work done by this force is zero.
(b) The pulling force applied by the railway engine on its coaches is doing work, as the force applied by the engine results in the motion of the coaches.
(c) The tension force in an elastic band wrapped around a parcel cannot do any work, as there is no motion of the parcel because of the tension force of the rubber band.
(d) The push of a person’s feet on a floor when he is standing cannot do any work because there is no motion involved due to the applied force.

Therefore, the answer is -
(b) The pull of a moving railway engine on its coaches.

Question 68:

A girl weighing 400 N climbs a vertical ladder. If the value of g be 10 m s^{-2}, the work by her after climbing 2 m will be :

(a) 200 J
(b) 800 J
(c) 8000 J
(d) 2000 J

ANSWER:

Weight of the girl (W) = 400 N
Vertical height (h) = 2 m
Acceleration due to gravity (g) = 10 m/s^2
We can calculate the work done against gravity in moving a body of mass (m) by a height (h) as,
Work done in lifting a body = (Weight of body) (Vertical distance)
So,
$W = (m)(g)(h)$
So,

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Work done in lifting a body
= (400)(2) J
$=800$ J=800 J
Therefore, the answer is:
(b) 800 J.

Question 69:

Which of the following does not posses the ability to do work not because of motion?

(a) a sparrow flying in the sky
(b) a sparrow moving slowly on the ground
(c) a sparrow in the nest on a tree
(d) a squirrel going up a tree

ANSWER:

We will justify all statements one by one as,
(a) A sparrow flying in the sky possesses kinetic energy, which can be transformed into work.
(b) A sparrow moving slowly on the ground possesses kinetic energy, which can be transformed into work.
(c) A sparrow in the nest does not possess any kinetic energy as it is at rest. It does not possess the ability to do work in terms of motion of the body.
(d) A squirrel going up a tree possesses kinetic energy, which can be transformed into work.

Therefore, the answer is:
(c) A sparrow in the nest of a tree.

Question 70:

A stone is thrown upwards as shown in the diagram. When it reaches P, which of the following has the greatest value of the stone?

Figure

(a) its acceleration
(b) its kinetic energy
(c) its potential energy
(d) its weight

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ANSWER:

When a stone is thrown vertically upwards, the following conclusions can be done for point P,
(a) The acceleration for the entire journey of the stone is constant, as acceleration due to gravity near the surface of the earth is constant.
(b) The velocity of the stone at P will be the least. Hence, kinetic energy at this point will be the least.
(c) The stone is at a maximum height at point P. Hence, the potential energy is the maximum at P.
(d) Weight of the stone will remain nearly constant, as acceleration due to gravity near the surface of the earth is constant.

Therefore, the answer is:
(c) Its potential energy.

Question 71:

A boy tries to push a truck parked on the roadside. The truck does not move at all. Another boy pushes a bicycle. The bicycle moves through a certain distance. In which case was the work done more : on the trick or on the bicycle? Give a reason to support your answer.

ANSWER:

Work done is more when the boy pushes a bicycle because the force applied by him on the bicycle results in the motion of the bicycle. On the other hand, the boy trying to push a heavy truck parked on the roadside results in zero work, as there is no motion in the truck.

Question 72:

The work done by a force acting obliquely is given by the formula : $W = F \cos \theta \times s$. What will happen to the work done if angle θ between the direction of force and motion of the body is increased gradually? Will it increase, decrease or remain constant.

ANSWER:

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The relation between work, force, distance and angle between the two is:
W = (F) (S) cos θ
Where,
(W) - Work done
(F) - Force
(S) - Displacement
(θ) - Angle between force and displacement
Let us see the graph of to understand the dependence of work on the angle between force and distance



From the graph, we can observe that on increasing the value of angle between force and distance, value of cos θ continuously decreases and becomes negative after $\pi 2 \pi 2$.
Hence, if we increase the angle between force and distance gradually, the value of work done will continuously decrease.

Question 73:

What should be the angle between the direction of force and the direction of motion of a body so that the work done is zero?

ANSWER:

The relation between work, force, distance and angle between the two is:
W = (F) (S) cos θ
Where,
(W) - Work done
(F) - Force
(S) - Displacement
(θ) - Angle between force and displacement
When the force is perpendicular to the direction of motion, and hence, the work done is also zero.
Example - The work done by the earth on a satellite moving in a circular orbit around it is zero.

Question 74:

In which of the following case the work done by a force will be maximum : when the angle between the direction of force and direction of motion is 0° or 90°?

ANSWER:

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The relation between work, force, distance and angle between the two is:
W = (F) (S) cos θ
Where,
(W) - Work done
(F) - Force
(S)- Displacement
(θ)- Angle between force and displacement
When the force is perpendicular to the direction of motion, and hence, the work done is also zero.
When the direction of force is similar the direction of motion, and hence, the work done is maximum.

Question 75:

How much work is done by the gravitational force of earth acting on a satellite moving around it in a circular path? Give reason for your answer.

ANSWER:

The relation between work, force, distance and angle between the two is:
$W = (F) (S) \cos \theta$
Where,
(W) - Work done
(F)- Force
(S)- Displacement
(θ) - Angle between force and displacement
The work done by the earth on a satellite moving in a circular orbit around it is zero, as gravitational force is perpendicular to the direction of motion at every instant, and hence, the work done is zero.

Question 76:

A man is instructed to carry a package from the base camp at B to summit A of a hill at a height of 1200 metres. The man weighs 800 N and the package weighs 200 N. If g = 10 m/s^2,
(i) how much work does man do against gravity?
(ii) what is the potential energy of the package at A if its is assumed to be zero at B?

ANSWER:

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(i) Weight of the man (W_1) = 800 N
Weight of the package (W_2) = 200 N
Height of hill (h) = 1200 m
Acceleration due to gravity (g) = 10 m/s^2
So total weight,
$W = W_1 + W_2$
= (800 + 200) N
= 1000 N
We can calculate the work done against gravity as
Work done in lifting a body = Weight of body × Vertical distance
= 1000 × 1200 J
$=1200\ \text{KJ}=1200$ KJ

(ii) Weight of the package, (mg) = 200 N
Acceleration due to gravity, (g) = 10 m/s^2
Height above the ground, (h) = 1200 m
We can calculate potential energy as
$P.E = m \times g \times h$
So,
$\text{P.E}=(200)(1200)\ \text{J} \quad =240000\ \text{J} \quad =240\ \text{KJ}$P.E=(200)(1200) J =240000 J =240 KJ

Question 77:

When a ball is thrown vertically upwards, its velocity goes on decreasing. What happens to its potential energy as its velocity becomes zero?

ANSWER:

When a ball is thrown vertically upwards, its velocity goes on decreasing and hence, its kinetic energy also keeps on decreasing. As the ball is thrown vertically upwards, its height continuously increases to a certain point and hence, its potential energy increases continuously and reaches its maximum value when the ball reaches the maximum height.

Question 78:

A max X goes to the top of a building by a vertical spiral staircase. Another man Y of the same mass goes to the top of the same building by a slanting ladder. Which of the two does more work against gravity and why?

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ANSWER:

'X' and 'Y' are two persons doing the same amount of work against gravity in climbing to the top of the building. Work done against gravity depends on the vertical distance through which the body is lifted and is independent of the path travelled to achieve that height. Both men travel the same distance vertically, so the work done by them against gravity is equal.

Question 79:

When a ball is thrown inside a moving bus, does its kinetic energy depend on the speed of the bus? Explain.

ANSWER:

The kinetic energy of a ball thrown inside a moving bus depends on the speed of the bus because the kinetic energy is directly proportional to the square of the speed of the moving ball. The speed of the bus adds up to the speed with which the ball is thrown inside the bus. Hence, more the speed of bus, higher will be the ball's kinetic energy.

Question 80:

A bullet of mass 15 g has a speed of 400 m/s. What is its kinetic energy? If the bullet strikes a thick target and is brought to rest in 2 cm, calculate the average net force acting on the bullet. What happens to the kinetic energy originally in the bullet?

ANSWER:

Mass of bullet, (m) = 0.015 kg
Initial velocity of bullet, (v_1) = 400 m/s
Distance, (S) = 0.02 m
So, initial kinetic energy of bullet,
$K.E=12mvK.E=12mv^2$
Therefore, initial kinetic energy,
$(K.E)1=12(0.015)(400)2$ J $=1200$ JK.E1=12(0.015)(400)2 J =1200 J

Similarly, final kinetic energy as the final velocity is zero,
$(K.E)_2 = 0$
So,
Work done = Change in kinetic energy
Therefore work done,

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Work done = $(K.E)_2 - (K.E)_1$
(Force) (Distance) = (0 –1200) J
So,
Force $= -12000.02 = -60000 = -(6)(10)4$ JForce =-12000.02 =-60000 =-(6)(10)4 J

Negative sign shows that the force applied is opposite to the direction of motion of the bullet.

Page No 162:

Question 1:

Name the commercial unit of measurement of energy.

ANSWER:

Kilowatt- hour (kWh) is the commercial unit of measurement of energy.

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Question 2:

Define kilowatt-hour.

ANSWER:

One-kilowatt hour can be defined as the amount of electrical energy consumed when an electrical appliance of power rating 1 kilowatt is used for 1 hour.

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Question 3:

Name two units of power bigger than watt.

ANSWER:

Two units of power bigger than watt are,
(a) Megawatt (1 MW = 10^6 W)
(b) Kilowatt (1 kW = 10^3 W)

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Question 4:

Define the term 'watt'.

ANSWER:

Watt is the SI unit of power. One watt is the power of an appliance which works at the rate of 1 Joule per second.

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Question 5:

How many watts equal one horse power?

ANSWER:

The relation between two units of power is as follows -
1 hours power = 746 W
1 h.p. = 746 W

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Question 6:

Name the physical quantity whose unit is watt.

ANSWER:

Power is the physical quantity whose SI unit is watt. Power is defined as rate of doing work.

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Question 7:

What is the power of a body which is doing work at the rate of one joule per second?

ANSWER:

1 watt is the power of a body working at the rate of 1 Joule per second.

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Question 8:

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A body does 1200 joules of work in 2 minutes. Calculate its power.

ANSWER:

Work done (*W*) = 1200 J
Time taken (*t*) = 120 s
We can calculate the power of the body as,
$\text{Power} = \frac{\text{Work done}}{\text{Time}}$ So, $\text{Power} = \frac{1200}{120}\text{W} = 10\text{ W}$ Power=Work doneTimeSo,Power= 1200120W =10 W
So, the power of this appliance is 10 W.

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Question 9:

How many joules are there in one kilowatt-hour?

ANSWER:

There are 3.6×10^6 J in one kilowatt-hour.

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Question 10:

Name the quantity whose unit is :

(a) kilowatt
(b) kilowatt-hour

ANSWER:

(a) Power is the quantity whose unit is kilowatt (kW).
(b) Energy is the quantity whose unit is kilowatt- hour (kWh).

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Question 11:

What is the common name of '1 kWh' of electrical energy?

ANSWER:

1 kilowatt of electrical energy is commonly known as ‘1 unit’ of electricity.

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Question 12:

A cell converts one form of energy into another form. Name the two forms.

ANSWER:

A cell converts chemical energy (one form of energy) into electrical energy (another form).

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Question 13:

Name the device which converts electrical energy into mechanical energy.

ANSWER:

An electric motor is a device that converts electrical energy into mechanical energy.

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Question 14:

Name the devices or machines which convert :

(a) Mechanical energy into electrical energy.
(b) Chemical energy into electrical energy.
(c) Electrical energy into heat energy.
(d) Light energy into electrical energy.
(e) Electrical energy into light energy.

ANSWER:

(a) An electric generator converts mechanical energy into electrical energy.
(b) A cell, or battery, converts chemical energy into electrical energy.
(c) An electric iron converts electrical energy into heat energy.
(d) A solar cell converts light energy into electrical energy.
(e) An electric bulb converts electrical energy into light energy.

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Question 15:

Name the devices or machines which convert :

(i) Electrical energy into sound energy.

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(ii) Heat energy into kinetic energy (or mechanical energy).
(iii) Chemical energy into kinetic energy (or mechanical energy).
(iv) Chemical energy into heat energy.
(v) light energy into heat energy.

ANSWER:

(i) A speaker in radio and television converts electrical energy into sound energy.
(ii) A steam engine converts heat energy into mechanical energy.
(iii) A car engine converts chemical energy into mechanical energy.
(iv) A gas stove converts chemical energy into heat energy.
(v) A solar water heater converts light energy into heat energy.

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Question 16:

Fill in the following blanks with suitable words :
(a) Power is the rate of doing _____.
(b) One watt is a rate of working of one _____ per _____.
(c) The electricity meter installed in our homes measure electrical energy in the units of_____.
(d) The principle of _____ of energy says energy can be transformed from one form to another, but it cannot be _____ or _____.
(e) When a ball is thrown upwards, _____ energy is transformed into _____ energy.

ANSWER:

(a) Power is the rate of doing work.
(b) One watt is a rate of working of one joule per second.
(c) The electricity meter installed in our homes measure electrical energy in the units of kilowatt- hour.
(d) The principle of conservation of energy says energy can be transformed from one form to another, but it cannot be created or destroyed.
(e) When a ball is thrown upwards, kinetic energy is transformed into potential energy.

Question 17:

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A trolley is pushed along a road with a force of 400 N through a distance of 60 m in 1 minute. Calculate the power developed.

ANSWER:

Force applied, (F) = 400 N
Distance travelled, (S) = 60 m
Time, (t) = 60 s
So,
Work done = Force × Distance
= (400) (60) J
= 24000 J
Now, we can calculate the power of the body as,
$\text{Power} = \frac{\text{Work done}}{\text{Time}}$ So, $\text{Power} = \frac{24000}{60}\text{W} = 400\ \text{W}$Power=Work doneTimeSo, Power=2400060W =400 W
So, the power of this appliance is 400 W.

Question 18:

What kind of energy transformation take place at a hydroelectric power station?

ANSWER:

At a hydroelectric power station, a dam is built on a river. The water collected in a reservoir has lots of gravitational potential energy. The kinetic energy of the falling water is used to drive huge turbines, which are connected to the electric generator. This energy transformation can be shown as,
Gravitational potential energy > Kinetic energy > Electrical energy

Question 19:

What kind of energy transformations take place at a coal-based thermal power station?

ANSWER:

At a thermal power station, the chemical energy of coal is converted into heat energy, which is further converted into kinetic energy of fast moving steam which drives huge turbines. The turbines connected to the electric generator generates electrical energy. The energy transformation can be shown as,
Chemical energy > Heat energy > Kinetic energy > Electrical energy

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Question 20:

A man weighing 500 N carried a load of 100 N up a flight of stairs 4 m high in 5 seconds. What is the power?

ANSWER:

Weight of the man, (W_1) = 500 N
Weight of the load, (W_2) = 100 N
Height, (h) = 4 m
Time taken, (t) = 5s
So total weight,
$W = W_1 + W_2$
= (500 + 100) N
= 600 N
We can calculate the work done against gravity as,Work done by the man is = (total weight)(vertical distance)
= (600)(4)
= 2400 J
Now, we can calculate the power of the man as,
$\text{Power}=\text{Work done}\text{Time}\text{So,Power}=24005\text{W} \quad =480\ \text{W}$Power=Work doneTimeSo,Power=24005W =480 W
So, the power of man is 480 W.

Question 21:

The power output of an engine is 3kW. How much work does the engine do in 20 s?

ANSWER:

Power output of the engine is,
= 3 kW
= 3000 W
Time, (t) = 20 s
Now, we can calculate the work done by the engine as:
Work done = (Power) (time)
So,
Work done = (3000) (20)
$=60\ \text{kJ}=60\ \text{kJ}$
So, work done by the engine is 60 kJ.

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Question 22:

An electric heater uses 600 kJ of electrical energy in 5 minutes. Calculate its power rating.

ANSWER:

Electrical energy used:
(E) = 600 kJ
= 600000 J
Time taken:
(t) = 5(60) s
= 300 s
Now, we can calculate the power of the body as:
$\text{Power}=\frac{600000}{300}\text{W} \quad =2000\ \text{W}$Power=600000300W =2000 W
So, the power of electric heater is 2000 W.

Question 23:

How much electrical energy in joules does a 100 watt lamp consume :
(a) in 1 second?
(b) in 1 minute?

ANSWER:

Power of the lamp, (P) = 100 W
(a) Time, (t) = 1 s
Now, we can calculate the electrical energy consumed as:
Energy consumed = Power × Time
So,
Energy consumed = 100 × 1 J
$=100\ \text{J}=100\ \text{J}$
So, the energy consumed is 100 J.

(b) Time (t) = 60 s
Now, we can calculate the electrical energy consumed as,
Energy consumed = Power × Time
So,
Energy consumed = 100 × 60 J
$=6000\ \text{J}=6000\ \text{J}$
So, the energy consumed is 6000 J.

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Question 24:

Five electric fans of 120 watts each are used for 4 hours. Calculate the electrical energy consumed in kilowatt-hours.

ANSWER:

Power of each fan,
(P) = 120 W
= 0.12 kW
Time duration, (t) = 4 hr
Now, we can calculate the electrical energy consumed as,
Energy consumed = Power × Time
So,
Energy consumed by 1 fan
= 0.12 × 4 kWh
= 0.48 kWh
So, the energy consumed by 5 fans is,
Energy consumed by 5 fan
= (0.48) (5) kWh
$=2.4\ \mathrm{kWh}$=2.4 kWh

Question 25:

Describe the energy changes which take place in a radio.

ANSWER:

A radio converts electrical energy into sound energy. In a radio set, electrical energy causes the speaker's diaphragm to vibrate and produce sound. So, the radio converts electrical energy into kinetic energy and finally into sound energy. This energy transformation can be written as,
Electrical energy → Kinetic energy → Sound energy

Question 26:

Write the energy transformations which take place in an electric bulb (or electric lamp).

ANSWER:

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An electric bulb converts electrical energy into light energy. Electrical energy causes the filament in the bulb to become white-hot and give out light. So, in an electric bulb, the electrical energy is first converted into heat energy and then to light energy. This energy transformation can be written as,
Electrical energy → Heat energy → Light

Question 27:

Name five appliances or machines which use an electric motor.

ANSWER:

Five appliances that use electric motor are:
(i) Electric fans
(ii) Washing machines
(iii) Refrigerators
(iv) Mixer and grinder
(v) Hair dryer

Question 28:

A bulb lights up when connected to a battery. State the energy change which takes place :

ANSWER:

When a bulb is connected to a battery, it lights up because of the following energy transformations:
(a) In the battery, chemical energy is transformed into electrical energy.
(b) In the bulb, electrical energy is converted into heat energy and then to light energy.

Question 29:

The hanging bob of a simple pendulum is displaced to one extreme position B and then released. It swings towards centre position A and then to the other extreme position C. In which position does the bob have :

(i) maximum potential energy?
(ii) maximum kinetic energy?

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ANSWER:

The extreme positions of the given pendulum are B and C. The centre position is A.
(a) Maximum potential energy is at B and C because at these two positions, the bob is at maximum height from ground. Kinetic energy at these points is zero.
(b) Maximum kinetic energy is at A because at this position, the bob has maximum velocity. Potential energy at this point is zero.

Question 30:

A car of weight 20000 N climbs up a hill at a steady speed of 8 m/s, gaining a height of 120 m is 100 s. Calculate :
(a) work done by the car.
(b) power of engine of car.

ANSWER:

(a) Weight of the car, (*W*) = 20000 N
Height, (*h*) = 120 m
Time taken, (*t*) = 100 s
We can calculate the work done against gravity as,
Work done by the car = Weight of body × Vertical distance
= 20000 × 120 J
= 2400000
$=2.4\times10_6$ J=2.4×106 J
(b) Now, we can calculate the power of the body as,
$\text{Power} = \text{Work done}_{\text{Time}}\text{So, Power} = \frac{2400000}{100}\text{W} \quad =24\ \text{kW}$Power = Work doneTimeSo , Power = 2400000100W =24 kW
So, the power of car is 24 kW.

Question 31:

(a) What do you understand by the term 'transformation of energy"? Explain with an example.
(b) Explain the transformation of energy in the following cases :
(i) A ball thrown upwards.
(ii) A stone dropped from the roof of a building.

ANSWER:

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(a) The change of one form of energy into another form is known as transformation of energy. This process helps us to convert one form of energy into a more desirable form of energy.
Example - Energy transformation at a hydroelectric power plant
At a hydroelectric power station, a dam is built on a river. Water collected in the reservoir has lots of potential energy. The potential energy of the water gets converted into kinetic energy as it begins to fall down. The kinetic energy of falling water is used to drive huge turbines, which are connected to the electric generator.

(b)
(i) When a ball is thrown upwards, its kinetic energy at the thrower's hand is transformed into potential energy at the maximum height. As the stone continues to move upwards, its potential energy gradually increases, but its kinetic energy decreases as velocity of the stone decreases.

(ii) When a stone is dropped from a height its potential energy at the height is transformed into kinetic energy on reaching the ground. As the stone descends, its potential energy gradually decreases and its kinetic energy increases.

Question 32:

(a) State and explain the law of conservation of energy with an example.
(b) Explain how, the total energy a swinging pendulum at any instant of time remains conserved. Illustrate your answer with the help of a labelled diagram.

ANSWER:

(a) Law of conservation of energy: Total energy of this universe is conserved (is constant). Energy cannot be created nor be destroyed. But can be transformed from one form to another.
Example - In an electric bulb, when the electrical energy is converted into light energy, some energy is wasted in the form of heat. Although some energy is wasted in the form of heat but the total energy of the system remains same.

(b) A swinging simple pendulum is a simple illustration of conservation of energy. It shows the transformation of potential energy into kinetic energy, and of kinetic energy back into potential energy.

Initially, the bob of a simple pendulum is at mean position B. When the bob is pulled to one side at A, and then released, the bob starts swinging. At the extreme positions A and C, all the energy is in the form of potential energy, and at the mean position B, all the energy is

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kinetic energy. At all other intermediate position, energy of the pendulum is partly potential and partly kinetic. But total energy of the simple pendulum remains conserved.

Question 33:

(a) What is the meaning of the symbol kWh? What quantity does it represent?
(b) How much electric energy in kWh is consumed by an electrical appliance of 1000 watts when it is switched on for 60 minutes?

ANSWER:

(a) Kilowatt- hour (kWh) is the commercial unit of measurement of electrical energy. One-kilowatt hour can be defined as the amount of electrical energy consumed when an electrical appliance of power rating 1 kilowatt is used for 1 hour.

(b) Power,
(P) = 1000 W
= 1 kW
Time duration,
(t) = 1 hr
Now, we can calculate the electrical energy consumed as,
Energy consumed = (Power) (Time)
So,
Energy consumed
= (1)(1) kWh
$=1\ \mathrm{kWh}$=1 kWh
So, energy consumed is 1kWh.

Question 34:

(a) Derive the relation between commercial unit of energy (kWh) and SI unit of energy (joule).
(b) A certain household consumes 650 units of electricity in a month. How much is this electricity in joules?

ANSWER:

(a) We can establish a relation between kilowatt-hour (kWh) and Joule (J) as –
1 kilowatt-hour = 1 kilowatt for 1 hour
= 1000 watt for 1 hour

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But,
$1 \text{ watt} = \frac{1 \text{ Joule}}{1 \text{ s}}$ 1 watt=1 Joule1 s
So,
$1 \text{ kilowatt-hour} = 1000 \frac{\text{Joule}}{\text{second}}$ for 1 hour $= 1000 \frac{\text{Joules}}{\text{seconds}} 60 \times 60$ seconds $= 3.6 \times 10^6$ J 1 kilowatt-hour = 1000Joulessecond for 1 hour =1000Joulesseconds60×60 seconds =3.6×106 J

(b) Kilowatt- hour (kWh) is the commercial unit of measurement of energy. It is also known as unit.
So, total units consumed are 650.
We can establish a relation between kilowatt-hour (kWh) and Joule (J) as –
1 kilowatt-hour = 3.6×10^6 J
So,
650 kilowatt-hour
$= 650 \times 3.6 \times 10^6$ J
$= 2.34 \times 10^9$ J=2.34×109 J

Question 35:

(a) Define power. Give the SI unit of power.
(b) A boy weighing 40 kg carries a box weighing 20 kg to the top of a building 15 m high in 25 seconds. Calculate the power. (g = 10 m/s^2)

ANSWER:

(a) Power is defined as rate of doing work. It is also defined as rate at which energy is consumed. SI unit of power is watt.

(b) Mass of the boy, (m_1) = 40 kg
Mass of the box, (m_2) = 20 kg
Height, (h) = 15 m
Acceleration due to gravity, (g) = 10 m/s^2
Time taken, (t) = 25 s
Total mass of the system,
$M = m_1 + m_2$
=> $M = 40 + 20 = 60$ kg
So, work done by the boy is,
$W = mgh$
=> $W = (60)(10)(15)$
=> $W = 9000$ J

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Now, we can calculate the power of the boy as,
$\text{Power} = \frac{\text{Work done}}{\text{Time}}$ So, $\text{Power} = \frac{900025}{}\text{W} = 360\ \text{W}$ Power=Work doneTimeSo,Power=900025W =360 W
So, the power is 360 W.

Question 36:

When an object falls freely towards the earth, then its total energy :

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

ANSWER:

Total energy of a freely falling object remains conserved.
Therefore the answer is,
(c) Remains constant

Question 37:

Which one of the following is not the unit of energy?

(a) joule
(b) newton-metre
(c) kilowatt
(d) kilowatt-hour

ANSWER:

Kilowatt is the unit of power.
Therefore the answer is,
(c) Kilowatt

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Question 38:

Which of the following energy change involves frictional force?

(a) chemical energy to heat energy
(b) kinetic energy to heat energy
(c) potential energy to sound energy
(d) chemical energy to kinetic energy

ANSWER:

Frictional force is responsible for heating up of the tires of a moving vehicle. In such a situation, kinetic energy is converted into heat energy due to the frictional force.
Therefore the answer is,
(b) Kinetic energy to heat energy.

Question 39:

Which one of the following statements about power stations is not true?

(a) hydroelectric power stations use water to drive turbines
(b) in a power station, turbines drive generators
(c) electricity from thermal power stations differs from that produced in hydroelectric power stations
(d) in hydroelectric power stations and thermal power stations, alternators produce electricity

ANSWER:

Electricity produced in a hydroelectric power station is similar to electricity produced in thermal power plants.
Therefore, the answer is,
(c) The electricity from a thermal power station differs from that produced in a hydroelectric power station.

Question 40:

An electric motor raises a load of 0.2 kg, at a constant speed, through a vertical distance of 3.0 m in 2 s. If the acceleration of free fall is 10 m/s^2, the power in W developed by the motor in raising the load is :

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(a) 0.3
(b) 1.2
(c) 3.0
(d) 6.0

ANSWER:

Mass of the load (m_1) = 0.2 kg
Height (h) = 3 m
Acceleration due to gravity (g) =10 m/s^2
Time taken (t) = 2s
We can calculate the work done against gravity as,
Work done by the car = (Weight of body) (Vertical distance)
= (0.2)(10)(3) J
= 6 J
Now, we can calculate the power of the boy as,
Power=Work doneTimeSo,Power = 62W =3 WPower=Work doneTimeSo,Power = 62 W =3 W
So, the power is 3 W.
Therefore, the answer is,
(c) 3.0

Question 41:

An object is falling freely from a height x. After it has fallen a height x2x2, it will possess :

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

ANSWER:

During the free fall, potential energy is gradually converted into kinetic energy. At half of the maximum height, energy is equally distributed in the form of potential and kinetic energy.
Therefore, the answer is,
(c) Half potential and half kinetic.

Question 42:

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The commercial unit of energy is :

(a) watt
(b) watt-hour
(c) kilowatt-hour
(d) kilowatt

ANSWER:

Kilowatt-hour is the commercial unit of electricity.
Therefore, the answer is,
(c) Kilowatt-hour.

Question 43:

How much energy does a 100 W electric bulb transfer in 1 minute?

(a) 100 J
(b) 600 J
(c) 3600 J
(d) 6000 J

ANSWER:

Power, (P) = 100 W
Time duration, (t) = 60 s
Now, we can calculate the electrical energy consumed as,
Energy consumed = (Power) (Time)
So,
Energy consumed
= (100) (60) J
$=6000$ J=6000 J
So, the energy consumed is 6000 J.
Therefore, the answer is,
(d) 6000 J.

Question 44:

The device which converts mechanical energy into energy which runs our microwave oven is :

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(a) electric motor
(b) alternator
(c) turbine
(d) electric heater

ANSWER:

Alternator is the device that converts mechanical energy into energy, which runs in microwave oven.
Therefore the answer is,
(b) Alternator.

Question 45:

A microphone converts :

(a) electrical energy into sound energy in ordinary telephone
(b) microwave energy into sound energy in a mobile phone
(c) sound energy into mechanical energy is a stereo system
(d) sound energy into electrical energy in public address system

ANSWER:

A microphone converts sound energy into electrical energy in public address systems.
Therefore, the answer is,
(d) Sound energy into electrical energy in public address system.

Question 46:

The following data was obtained for a body of mass 1 kg dropped from a height of 5 metres :

Distance above ground	*Velocity*
5 m	0 m/s
3.2 m	6 m/s
0 m	10 m/s

Show by calculations that the above data verifies the law of conservation of energy (Neglect air resistance). ($g = 10\ m/s^2$).

ANSWER:

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Mass of the body, (m_1) = 1 kg
Acceleration due to gravity, (g) = 10 m/s^2
We can calculate the potential energy as,
Potential energy = (Weight of body) × (Vertical distance)
Now, we can find the kinetic energy as,
$K.E = \frac{1}{2}mv^2$
We have three cases:

Case – 1
Height (h) = 5 m
Velocity (v) = 0 m/s
So,
Potential energy = (Weight of body) × (Vertical distance)
1 × 10 × 5
= 50 J
And,
$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times (1) \times (0)$ J = 0 J
So total energy at this instant,
P.E + K.E
= (50 + 0) J
= 50 J

Case – 2
Height (h) = 3.2 m
Velocity (v) = 6 m/s
So,
Potential energy = (Weight of body) × (Vertical distance)
= (1) × (10) × (3.2) J
= 32 J
And,
$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times (1) \times (6)^2$ J = 18 J
So total energy at this instant,
P.E + K.E
= (32 + 18) J
= 50 J

Case – 3
Height (h) = 0 m
Velocity (v) = 10 m/s
So,
Potential energy = (Weight of body) × (Vertical distance)
= (1) × (10) × (0) J
= 0 J

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And,
$K.E = \frac{1}{2}mv^2 = \frac{1}{2}(1)(10)^2\ J = 50\ J$K.E=12mv2 =12(1)(10)2 J = 50 J
So total energy at this instant,
= *P.E* + *K.E*
= (0 + 50) J
= 50 J
We can observe that total energy in all the above cases is same, which satisfies the law of conservation of energy.

Question 47:

A ball falls to the ground as shown below :

Figure

(a) What is the kinetic energy of ball when it hits the ground?
(b) What is the potential energy of ball at B?
(c) Which law you have made use of in answering this question?

ANSWER:

(a) Total energy of a free falling object remains conserved.
So,
Kinetic energy at the ground = Potential energy at the top$= 80\ J$=80 J
(b) Total energy of a free falling object remains conserved.
So,
Total energy at A = Total energy at B
So,
$(K.E)_A + (P.E)_A = (K.E)_B + (P.E)_B$
Thus
Total energy at A = $(K.E)_B + (P.E)_B$
Therefore,
$(P.E)_B = (80 - 48)\ J = 32\ J$=32 J
(c) Law of conservation of energy is used in answering these questions.

Question 48:

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In an experiment to measure his power, a student records the time taken by him in running up a flight of steps on a staircase. Use the following data to calculate the power of the student :

Number of steps = 28
Height of each step = 20 cm
Time taken = 5.4 s
Mass of student = 55 kg
Acceleration = 9.8 m s^{-2}
due to gravity

ANSWER:

Mass of the student, (m_1) = 55 kg
Height of each step, (h) = 0.2 m
Number of steps, (n) = 28
So, total vertical height,
= (0.2) (28) m
= 5.6 m
Acceleration due to gravity, (g) = 9.8 m/s^2
Time taken (t) = 5.4 s
We can calculate the work done against gravity as,
Work done by the car = (Weight of body) × (Vertical distance)
= (55) × (9.8) × (5.6) J
= 3018.4 J
Now, we can calculate the power of the boy as,
Power=Work doneTimeSo, Power=3018.45.4W =558.96 W =559 WPower=Work doneTimeSo, Power=3018.45.4W =558.96 W =559 W
So, the power is 559 W.

Question 49:

In loading a truck, a man lifts boxes of 100 N each through a height of 1.5 m.
(a) How much work does he do in lifting one box?
(b) How much energy is transferred when one box is lifted?
(c) If the man lifts 4 boxes per minute, at what power is he working?
(g = 10 m s^{-2})

ANSWER:

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Weight of box, (W) = 100 N
Height, (h) = 1.5 m
Acceleration due to gravity, (g) = 10 m/s^2
(a) We can calculate the work done against gravity as,
Work done = (Weight of body) × (Vertical distance)
= (100) × (1.5) J
$=150$ J=150 J

(b) The work done against gravity is stored in the box in the form of potential energy. So, energy transferred when one box is lifted is 150 J150 J

(c) Work done in lifting 4 boxes,
Work done
= (150) × (4) J
$=600$ J=600 J
Time taken, (t) = 60 s
Now, we can calculate the power as,
$\text{Power}=\text{Work done}\text{Time}\text{So,Power}=60060\text{W}$ $=10$ WPower=Work doneTimeSo,Power=60060W =10 W
So, the power is 10 W.

Question 50:

Name the energy transfers which occur when :

Figure

(a) an electric ball rings
(b) someone speaks into a microphone
(c) there is a picture on a television screen
(d) a torch is on

ANSWER:

(a) An electric bell converts electrical energy to sound energy.
(b) A microphone converts sound energy to electrical energy.
(c) A television screen converts electrical energy into light energy and heat energy.
(d) A torch converts electrical energy of the battery into light and heat energy.

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