Class Notes	
Class : IX	**Topics:(**NCERT Exemplar / Chapter Force and Laws of Motion**)**
Subject: Physics	

OPJS/Class IX/Physics/NCERT Exemplar Chapter Force and Laws of Motion 'II'

Question 1.
Which of the following statement is not correct for an object moving along a straight path in an accelerated motion?
(a) Its speed keeps changing.
(b) Its velocity always changes.
(c) It always goes away from the earth.
(d) A force is always acting on it.
Solution:
(c) An object moving along a straight path in an accelerated motion does not always go away from the earth.

Question 2.
According to the third law of motion, action and reaction
(a) always act on the same body
(b) always act on different bodies in opposite directions
(c) have same magnitude and directions
(d) act on either body at normal to each other.
Solution:
(b) According to the third law of motion, action and reaction always act on different bodies in opposite directions.

Question 3.
A goalkeeper in a game of football pulls his hands backwards after holding the ball shot at the goal. This enables the goal keeper to
(a) exert larger force on the ball
(b) reduce the force exerted by the ball on hands
(c) increase the rate of change of momentum
(d) decrease the rate of change of momentum.
Solution:
(b, d): A goalkeeper in a game of football pulls his hands backwards after holding the ball shot at the goal. This enables the goalkeeper to decrease the rate of change of momentum and hence reduce the force exerted by the ball on hands.

Question 4.
The inertia of an object tends to cause the object
(a) to increase its speed
(b) to decrease its speed
(c) to resist any change in its state of motion
(d) to decelerate due to friction.
Solution:
(c) The inertia of an object tends to cause the object to resist any change in its state of motion.

Question 5.
A passenger in a moving train tosses a coin which falls behind him. it means that motion of the train is

(a) accelerated
(b) uniform
(c) retarded
(d) along circular tracks.
Solution:
(a) As the coin tossed falls behind the passenger, so it means that motion of the train is accelerated.

Question 6.
An object of mass 2 kg is sliding with a constant velocity of 4 m s'1 on a frictionless horizontal table. The force required to keep the object moving with the same velocity is
(a) 32N
(b) 0N
(c) 2N
(d) 8N
Solution:
(b) According to Newton's first law of motion, an object continues to be in a state of rest or of uniform motion unless acted upon by an unbalanced force. So, there is no requirement of applying force on the object to keep it moving with constant velocity.

Question 7.
Rocket works on the principle of conservation of
(a) mass
(b) energy
(c) momentum
(d) velocity.
Solution:
(c) Rocket works on the principle of conservation of momentum.

Question 8.
A water tanker filled up to – of its height is moving with a uniform speed. On sudden application of the brake, the water in the tank would
(a) move backward
(b) move forward
(c) be unaffected
(d) rise upwards.
Solution:
(b) Due to inertia of motion, the water in the tank would move forward on sudden application of the brake.

Question 9.
There are three solids made up of aluminium, steel and wood, of the same shape and same volume. Which of them would have highest inertia?
Solution:
As the mass is a measure of inertia, the solid of same shape and size having more mass than other solids will have highest inertia. Out of aluminium, steel and wood, density of steel is maximum and hence the mass, therefore, solid made up of steel would have highest inertia.

Question 10.
Two balls of the same size but of different materials, rubber and iron are kept on the smooth floor of a moving train. The brakes are applied suddenly to stop the train. Will the balls start rolling? If so, in which direction? Will they move with the same speed? Give reasons for your answer.

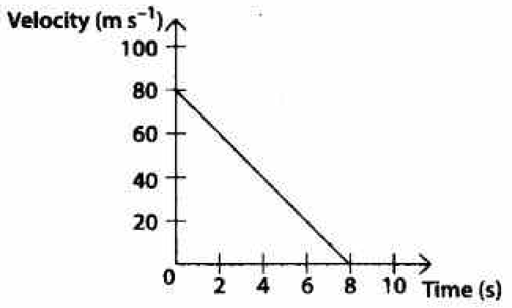
Solution:
Yes, the balls will start rolling in the direction in which the train was moving. This is because, after applying the brakes, train comes to rest but the balls continue to move due to inertia. Since the masses of the balls are different and hence the inertial forces, the balls will move with different speeds. Iron ball being heavier than the rubber ball will move with lower speed.

Question 11.
Two identical bullets are fired one by a light rifle and another by a heavy rifle with the same force. Which rifle will hurt the shoulder more and why?
Solution:
According to conservation of momentum, momentum of each identical bullet fired is equal to the momentum of light rifle as well as momentum of heavy rifle but in opposite direction. So, the light rifle will recoil faster and hence it will hurt the shoulder more.

Question 12.
A horse continues to apply a force in order to move a cart with a constant speed. Explain why?
Solution:
A horse continues to apply a force so that frictional force between the cart and the ground is overcome and the cart could move with a constant speed.

Question 13.
Suppose a ball of mass m is thrown vertically upward with an initial speed u, its speed decreases continuously till it becomes zero. Thereafter, the ball begins to fall downward and attains the speed u again before striking the ground. It implies that the magnitude of initial and final momentums of the ball are same. Yet, it is not an example of conservation of momentum. Explain why?
Solution:
Law of conservation of momentum is applicable to isolated systems, i.e., systems in which no external force is applied. In the mentioned case, change in velocity is taking place due to gravitational pull of earth only, thus, it is not an example of conservation of momentum.

Question 14.
Velocity versus time graph of a ball of mass 50 g rolling on a concrete floor is shown in Fig. Calculate the acceleration and frictional force of the floor on the ball



Solution:

From the given velocity – time graph, acceleration of the ball,

$$a = \frac{\text{Change in velocity}}{\text{Change in time}} = \frac{0-80}{8-0}\ \text{m s}^{-2}$$

$= -10\ \text{m s}^{-2}$

Frictional force of the floor on the ball $= ma$

$= (0.05 \times 10)\ \text{N}\ (\because m = 50g = 0.05\ \text{kg})$

$= 0.5\ \text{N}$

Question 15.
A truck of mass M is moved under a force F. If the truck is then loaded with an object equal to the mass of the truck and the driving force is halved, then how does the acceleration change?
Solution:

Initially, acceleration of the truck

$$= \frac{\text{Driving force}}{\text{Mass}} = \frac{F}{M}$$

Finally, acceleration of the truck

$$= \frac{F/2}{2M} = \frac{1}{4} \cdot \frac{F}{M}$$

$\therefore$ The acceleration of the truck becomes

$\frac{1}{4}^{th}$ of its initial value.

Question 16.
Two friends on roller-skates are standing 5 m apart facing each other. One of them throws a ball of 2 kg towards the other, who catches it, how will this activity affect the position of the two? Explain your answer.
Solution:
Initially, the momentum of both of them is zero. The one who throws the ball will move backward to conserve the momentum imparted on ball. Now, the other one who catches it will also move backward as he will experience a net force after catching the ball. Hence, separation between them will increase.

Question 17.
Water sprinkler used for grass lawns begins to rotate as soon as the water is supplied. Explain the principle on which it works.
Solution:
The rotation of water sprinklers used for grass lawns can be explained on the basis of Newton's third law of motion. As soon as the water comes out of sprinkler, it exerts an equal and opposite force on the sprinkler and it starts rotating.

Long Answer Type Questions

Question 18.
Using second law of motion, derive the relation between force and acceleration. A bullet of 10 g strikes a sand-bag at a speed of 103 m s'1 and gets embedded after travelling 5 cm. Calculate
(i) the resistive force exerted by the sand on the bullet
(ii) the time taken by the bullet to come to rest.
Solution:

Rate of change of momentum

$$= \frac{\text{Change in momentum}}{\text{Time taken}} = \frac{m(v-u)}{t} \quad ...(i)$$

using $v = u + at$

$$\therefore \; a = \frac{v-u}{t} \quad ...(ii)$$

From (i) and (ii), we get

Rate of change of momentum = ma

According to Newton's second law of motion

Force $\propto$ rate of change of momentum

$F \propto m \times a$

Then $F = K\,ma$; K is a constant

$\therefore \; F = ma$

Here, mass of bullet, $m = 10$ g $= 0.01$ kg

Initial speed, $u = 10^3$ m s^{-1}

Final speed, $v = 0$

Distance travelled, $s = 5$ cm $= 0.05$ m

(i) Using $v^2 - u^2 = 2as$, we get

$0 - (10^3)^2 = 2 \times a \times 0.05 = 0.1a$

$$\text{or } a = \frac{-10^6}{0.1} = -10^7 \text{ m s}^{-2}$$

Therefore, the resistive force exerted by the sand on the bullet = – (force exerted by bullet on sand)

$= -ma = -0.01 \times (-10^7)$ N $= +10^5$ N

(ii) Time taken by the bullet to come to rest,

$$t = \frac{v-u}{a} = \frac{0-10^3}{-10^7} \text{ s} = 10^{-4} \text{ s}$$

Question 19.
Derive the unit of force using the second law of motion. A force of 5 N produces an acceleration of 8 m s^{-2} on a mass m and an acceleration of 24 m s-2 on a mass m2. What acceleration would the same force provide if both the masses are tied together?
Solution:

Using the relationship, $F = ma$
If m is measured in kg and a is measured in m s^{-1}
Then the unit of force is kg m s^{-2}
1 kg m s^{-2} = 1 N

$F = 5$ N, $a_1 = 8$ m s^{-2}, $a_2 = 24$ m s^{-2}

$$\therefore m_1 = \frac{F}{a_1} = \frac{5}{8}\text{ kg} \text{ and } m_2 = \frac{F}{a_2} = \frac{5}{24}\text{ kg}$$

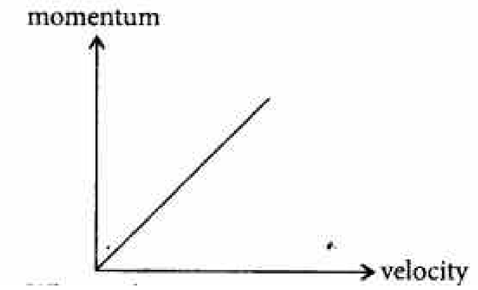
Now, total mass when both the masses are tied together,

$$m = m_1 + m_2 = \left(\frac{5}{8} + \frac{5}{24}\right)\text{kg}$$

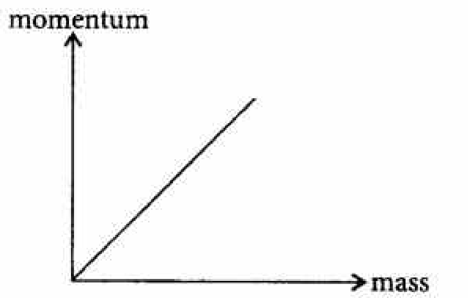
$$= \left(\frac{15+5}{24}\right)\text{kg} = \frac{20}{24}\text{ kg} = \frac{5}{6}\text{ kg}$$

$$\therefore \text{Acceleration, } a = \frac{F}{m} = \frac{5}{5/6} = 6\text{ m}s^{-2}$$

Question 20.
What is momentum? Write its SI unit. Interpret force in terms of momentum. Represent the following graphically.
(a) Momentum versus velocity when mass is fixed.
(b) Momentum versus mass when velocity is constant.
Solution:
Momentum is a property of a moving body by the virtue of both its mass and velocity. It is equal to the product of mass and velocity. p = m × v
Its SI unit is kg ms^{-1}
As momentum = mass x velocity
(a) When mass is fixed,
momentum α velocity



(b) When velocity is constant, momentum ∝ mass



Class Notes	
Class : IX	**Topics:(**NCERT Exemplar / Chapter Gravitation**)**
Subject: Physics	

OPJS/Class IX/Physics/NCERT Exemplar Chapter Gravitation 'III'

Question 1.
Two objects of different masses falling freely near the surface of moon would
(a) have same velocities at any instant
(b) have different accelerations
(c) experience forces of same magnitude
(d) undergo a change in their inertia
Solution:
(a) For the two /objects, of different masses falling freely near the surface of moon,
u = 0 and a = g_M
v = u + at =$g_M t$
At any instant of time, both will have same velocity.

Question 2.
The value of acceleration due to gravity
(a) is same on equator and pole?
(b) is least on poles
(c) is least on equator
(d) increases from pole to equator
Solution:
(c) Acceleration due to gravity, $g=GM/R^2$
As the radius of the earth is smaller at the poles as compared to the equator, the value of g is greater at the poles and is least on equator.

Question 3.
The gravitational force between two objects is F. If masses of both objects are halved without changing distance between them, then the
gravitational force would become
(a) F/4
(b) F/2
(c) F
(d) 2 F
Solution:
(a): Let the masses of two objects be ml
and m2 placed at d distance apart.
So, $F=Gm_1m_2 / d^2$
When the masses of two objects are halved,
$F'=G\frac{m_1}{2}\cdot\frac{m_2}{2} / d^2=Gm_1m_2 / 4d^2=F/4$

Question 4.
A boy is whirling a stone tied with a string in a horizontal circular path. If the string breaks, the stone
(a) will continue to move in the circular path
(b) will move along a straight line towards the centre of the circular path
(c) will move along a straight line tangential to the circular path
(d) will move along a straight line perpendicular to the circular path away from the boy
Solution:

(c) If the string breaks, the force that was causing it to move along a circular path, i.e., centripetal force is no longer there, so the stone will move along a straight line tangential to the circular path.

Question 5
In the relation $F=GMm/d^2$, the quantity G
(a) depends on the value of g at the place of observation
(b) is used only when the earth is one of the two masses
(c) is greatest at the surface of the earth
(d) is universal constant of nature
Solution:
(d) In the relation $F=G\frac{Mm}{d^2}$,the quantity G is universal constant of nature.

Question 6.
Law of gravitation gives the gravitational force between
(a) the earth and a point mass only
(b) the earth and sun only
(c) any two bodies having some mass
(d) two charged bodies only
Solution:
(c) Law of gravitation gives the gravitational force between any two bodies having some mass as it is a universal law.

Question 7.
The value of quantity G in the law of gravitation
(a) depends on mass of earth only
(b) depends on radius of earth only
(c) depends on both mass and radius of earth
(d) is independent of mass and radius of the earth
Solution:
(d) The value of quantity G in the law of gravitation is independent of mass and radius of the earth.

Question 8.
Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be
(a) 1/4 times
(b) 4 times
(c) 1/2 times
(d) unchanged
Solution:
So, the gravitational force between the two particles will become 4 times.

Question 9.
The atmosphere is held to the earth by
(a) gravity
(b) wind
(c) clouds
(d) earth's magnetic field
Solution:
(a) The atmosphere is held to the earth by gravity.

Question 10.
The force of attraction between two unit point masses separated by a unit distance is called

(a) gravitational potential
(b) acceleration due to gravity
(c) gravitational field
(d) universal gravitational constant
Solution:
(d) $F=G\frac{m_1m_2}{d^2}$
F = G, i.e., the force of attraction between two unit point masses separated by a unit distance is universal gravitational constant.

Question 11.
The weight of an object at the centre of the earth of radius R is
(a) zero
(b) infinite
(c) R times the weight at the surface of the earth
(d) 1/R2 times the weight at surface of the earth
Solution: (a): Acceleration due to gravity (g) is zero at the centre of earth. Therefore the weight of an object at the centre of earth = mg = m x 0 = 0.

Question 12.
An apple falls from a tree because of gravitational attraction between the earth and apple. If F, is the magnitude of force exerted by the earth on the apple and F2 is the magnitude of force exerted by apple on earth, then
(a) F_1 is very much greater than F_2
(b)F_2 is very much greater than F_1
(c)F_1 is only a little greater than F_2
(d)F_1 and F_2 are equal
Solution:
(d) F_1 and F_2 are equal as Newton's law of gravitation obeys the Newton's third law of motion, i.e., if an object exerts a force on another object, then the second object exerts an equal and opposite force on the first object.

Short Answer Type Questions

Question 13.
What is the source of centripetal force that a planet requires to revolve around the sun? On i what factors does that force depend?
Solution:
A planet requires centripetal force to revolve around the sun which is provided by the gravitational force of sun on the planet.
As $F=G\frac{M_sM_p}{r^2}$ the force depends on the mass of sun (M_s), mass of planet (M_P) and the distance between the two (r).

Question 14.
On the earth, a stone is thrown from a height in a direction parallel to the earth's surface while another stone is simultaneously dropped from the same height. Which stone would reach the ground first and why?
Solution:
A stone is thrown from a height in a direction parallel to earth's surface, i.e., the stone is given initial velocity in the horizontal direction.
For vertical motion of the stone, u = 0, a = g and s = h
Using $s=ut+\frac{1}{2}at^2$,
we get, $t = \sqrt{(2h/g)}$

Similarly, for the second stone, vertical motion is same as that of first. So, both the stones would reach the ground simultaneously.

Question 15.
Suppose gravity of earth suddenly becomes zero, then in which direction will the moon begin to move if no other celestial body affects it?
Solution:
The circular motion of the moon around earth is due to the centripetal force provided by gravitational force of earth. Therefore,
when gravity of earth suddenly becomes zero, the moon will begin to move in a straight line in the direction in which it was moving at that instant. That is the moon will move along the tangent to the circular orbit at that instant.

Question 16.
Identical packets are dropped from two aeroplanes, one above the equator and the other above the north pole, both at height h.
Assuming all conditions are identical, will those packets take same time to reach the surface of earth. Justify your answer.
Solution:
The value of acceleration due to gravity is greater at the poles than at the equator. So, the packet dropped at North Pole from a height h, will accelerate more than the packet dropped at equator from the same height and hence will reach the surface of earth earlier.

Question 17.
The weight of any person on the moon is about 1 /6 times that on the earth. He can lift a mass of 15 kg on the earth. What will be the maximum mass, which can be lifted by the same force applied by the person on the moon?
Solution:
Since weight of a person on the moon is $\frac{1}{6}$ times that on earth,

i.e., $W_M = \frac{1}{6} W_E$

$\therefore\ g_M = \frac{1}{6} g_E$ ... (i)

Force applied by the person to lift a mass of 15 kg on earth is $F = mg_E = 15g_E$ N

So, maximum mass which can be lifted by the same force applied by the person on the moon is

$$m' = \frac{F}{g_M} = \frac{15g_E}{g_M} = \frac{15g_E}{g_E/6} \quad \text{(Using (i))}$$

$$= 15 \times 6 = 90 \text{ kg.}$$

Question 18.
The earth is acted upon by gravitation of sun, even though it does not fall into the sun. Why?
Solution:
if The gravitational force of sun on earth is utilised in providing it centripetal force which is required for revolution around the sun. Hence, the earth does not fall in to the sun.

Long Answer Type Questions

Question 19.
How does the weight of an object vary with respect to mass and radius of the earth. In a hypothetical case, if the diameter of the earth becomes half of its present value and its mass becomes four times of its present value, then how would the weight of any object on the surface of the earth be affected?
Solution:
Weight of an object of mass m,

$$W = mg = G\frac{Mm}{R^2}$$

Weight varies directly with respect to mass of earth, W∝ M and inversely with respect to radius of earth, $W \propto \frac{1}{R^2}$.

When diameter of the earth becomes half, radius of earth also becomes half and mass becomes 4 times of its initial value, then

$$W' = G\frac{4Mm}{(R/2)^2} = 16\frac{GMm}{R^2} = 16W$$

i.e., weight will become 16 times its initial value.

Question 20.
How does the force of attraction between the two bodies depend upon their masses and distance between them? A student thought that two bricks tied together would fall faster than a single one under the action of gravity. Do you agree with his hypothesis or not? Comment.
Solution:
Student's hypothesis is wrong. As acceleration due to gravity is independent of the mass of the falling body, therefore, the two bricks tied together, falls with same speed as the single one to reach the ground at the same time under the action of gravity.

Question 21.
Two objects of masses m_1, and m_2 having the same size are dropped simultaneously from heights h, and h2 respectively. Find out the ratio of time they would take in reaching the ground. Will this ratio remain the same if (i) one of the objects is hollow and the other one is solid and (ii) both of them are hollow, size remaining the same in each case? Give reason.
Solution:

Yes, the ratio remains the same in both the cases as this ratio is independent of mass and size of the objects.

For the object of mass m_1 dropped from height h_1, $u = 0$, $a = g$, $s = h_1$.

Using $s = ut + \frac{1}{2}at^2$, we get $h_1 = 0 + \frac{1}{2}gt_1^2$

or $t_1 = \sqrt{\frac{2h_1}{g}}$

Similarly, for the object of mass m_2 dropped from height h_2,

$$t_2 = \sqrt{\frac{2h_2}{g}}$$

$$\therefore \quad \frac{t_1}{t_2} = \sqrt{\frac{2h_1}{g}} \times \sqrt{\frac{g}{2h_2}} = \sqrt{\frac{h_1}{h_2}}.$$

Class Notes	
Class : IX	**Topics: (**NCERT Exemplar / Chapter: Work and Energy**)**
Subject: Physics	

OPJS/Class IX/Physics/NCERT Exemplar Chapter Work and Energy 'IV'

Question 1.
When a body falls freely towards the earth, then its total energy
(a) increases
(b) decreases
(c) remains constant
(d) first increases and then decreases
Solution:
(c) When a body falls freely towards the earth, its potential energy decreases which intum increases the kinetic energy. Therefore, its total energy remains constant.

Question 2.
A car is accelerated on a levelled road and attains a velocity 4 times of its initial velocity. In this process the potential energy of the car
(a) does not change
(b) becomes twice to that of initial
(c) becomes 4 times that of initial
(d) becomes 16 times that of initial
Solution:
(a) In the given process, the potential energy of the car does not change as it does not depend on velocity.

Question 3.
In case of negative work the angle between the force and displacement is
(a) 0°
(b) 45°
(c) 90°
(d) 180°
Solution:
(d) Work done is negative when force acts opposite to the direction of displacement, i.e. the angle between the two directions is 180°.

Question 4.
An iron sphere of mass 10 kg has the same diameter as an aluminium sphere of mass is 3.5 kg. Both spheres are dropped simultaneously from a tower. When they are 10 m above the ground, they have the same
(a) acceleration
(b) momenta
(c) potential energy
(d) kinetic energy
Solution:
(a) Both spheres have the same acceleration that is acceleration due to gravity g. Momenta, potential energy and kinetic energy depend on mass which is different for the two spheres and hence the quantities will differ for the two spheres.

Question 5.
A girl is carrying a school bag of 3 kg mass on her back and moves 200 m on a levelled road. The

work done against the gravitational force will be (g =10 m s’2)
(a) 6×10^3 J
(b) 6 J
(c) 0.6 J
(d) zero
Solution:
(d) The gravitational force on the bag, i.e. the weight of bag is in vertically downward direction whereas the distance moved by her is in horizontal direction. It means that the force and displacement are perpendicular to each other, therefore no work is done.

Question 6.
Which one of the following is not the unit of energy?
(a) Joule
(b) Newton metre
(c) kilowatt
(d) kilowatt hour
Solution:
(c) Kilowatt is the unit of power, not of energy.

Question 7.
The work done on an object does not depend upon the
(a) displacement
(b) force applied
(c) angle between force and displacement
(d) initial velocity of the object
Solution:
(d) The work done on an object does not depend upon the initial velocity of the object.

Question 8.
Water stored in a dam possesses
(a) no energy
(b) electrical energy
(c) kinetic energy
(d) potential energy
Solution:
(d) Water stored in a dam possesses potential energy as it is stored at a certain height from the ground level.

Question 9.
A body is falling from a height h. After it has fallen a height h2, it will possess
(a) only potential energy
(b) only kinetic energy
(c) half potential and half kinetic energy
(d) more kinetic and less potential energy
Solution:
(c) When a body falls from a height h2 its potential energy becomes half (as potential energy = mgh). The rest half of initial potential energy gets converted into kinetic energy.
Hence, the body will possess half potential energy and half kinetic energy.

Short Answer Type Questions

Question 10.
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 11.
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 =12mv^2= 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 12.
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 1/2mv2= 0 or v = 0
So, momentum, p = mv = 0
Any object cannot have momentum even if
its mechanical energy is zero.

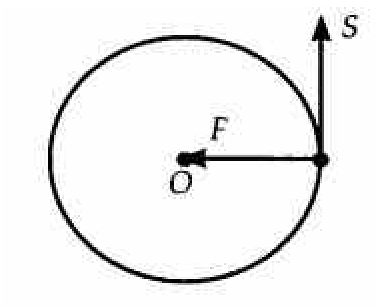
Question 13.
The power of a motor pump is 2 kW. How much water per. minute the pump can raise to a height of 10 m? (Given g = 10m s^{-2})
Solution:
Here, power of motor pump, P = 2 kW = 2000 W
Height to which water is raised, h = 10 m
Power P = W/t = mgh/t
Or, 2000 = (m X 10 X 10)/60
Or, m = 1200 kg

Question 14.
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 the earth W = mg
And on the planet W’ = mg’
Now, W’ = W/2
Or, mg’ = mg/2
Or, g’ = g/2
Gain in P.E. on jumping remains constant.
Therefore, mg’h’ = mgh
Or, g’h’ = gh
Or, gh’/2 = gh

Or, h’ = 2h = 2X0.4 = 0.8 m

Question 15.
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, $v^2-u^2 = 2as$, we get
$s = (v^2-u^2)/2a$
$\therefore W=Fs=ma\left((v^2-u^2)/2a\right)$
$=1/2mv^2-1/2mu^2$
= final kinetic energy – initial kinetic energy
= change in kinetic energy

Question 16.
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 17.
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 18.
If an electric iron of 1200 W is used for 30 minutes every day, 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
= 2.16×10^6 J
As there are 30 days in April, so energy consumed in the month of April = $2.16 \times 10^6 \times 30$ J
= 6.48×10^7 J

Long Answer Type Questions

Question 19.
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,
$K_m = 1/2 mv^2$
Kinetic energy of heavy object,
$K_m = 1/2 mV^2$
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 20.
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,
$m_A v_A + m_B u_B = m_A v_A + m_B v_B$

$1000 \times 10 + 1000 \times 0 = 1000 \times o + 1000 \times v_B$
$\therefore v_B = 10 m\ s^{-1}$
So, the speed of the car B just after collision is $10 m\ s^{-1}$

Question 21.
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 22.
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 up to 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 23.
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, E_f, = mgh
= 2000 x 10^3 x 10 x 20
= 4 x 10^8 J
Power generated if all this energy can be utilised

$$P = \frac{E_p}{t}$$
$$= \frac{4 \times 10^8 \text{ J}}{60 \text{ s}} \quad (\because\ t = 1 \text{ min} = 60 \text{ s})$$
$$= \frac{2}{3} \times 10^7 \text{ W}$$

Question 24.
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 ms^{-1} vertically?(g=10ms^{-2}),
Solution:
Power associated in lifting a body of mass m up to 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 25.
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 (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 26.
Compare the power at which each of the following is moving upwards against the force of gravity? (Given g =10m s^{-2}). A butterfly of mass 1.0 g that flies upward at a rate of 0.5 ms^{-1}. A 250 g squirrel climbing up on a tree at a rate of 0.5 ms^{-1}.

Mass of butterfly, m_b= 1 g = 10^{-3} kg Speed, v_b = 0.5 m s^{-1} Force of gravity on butterfly, F_h = 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	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.