Chapter - 8
Motion

Multiple Choice Questions

1. A particle is moving in a circular path of radius r. The displacement after half a circle would be:
(a) Zero
(b) π r
(c) 2 r
(d) 2π r

Soln:

Answer is (c) 2 r

Explanation:

After half revolution

Distance travelled = $\frac{1}{2}$X circumference= πr
Path length

Displacement = Final position- Initial Position

It comes out to be the diameter of the circle = 2R.

2. A body is thrown vertically upward with velocity u, the greatest height h to which it will rise is,
(a) u/g
(b) $u^2/2g$
(c) u^2/g
(d) u/2g

Soln:

Answer is (b) $u^2/2g$

Explanation:
$V^2= u^2+2$ as
here v = 0
a = -g
s = H

$0 = u^2 -2gH$

$H = u^2/2g$

3. The numerical ratio of displacement to distance for a moving object is
(a) always less than 1
(b) always equal to 1
(c) always more than 1
(d) equal or less than 1

Soln:

Answer is (d) equal or less than 1

Explanation:

Shortest distance between initial and end point is called displacement. Distance is the total path length.

Displacement is vector and it may be positive or negative whereas Distance is scalar and it can never be negative.

Distance can be equal or greater than displacement which means ratio of displacement to distance is always equal to or less than 1.

4. If the displacement of an object is proportional to square of time, then the object moves with
(a) uniform velocity
(b) uniform acceleration
(c) increasing acceleration
(d) decreasing acceleration

Soln:
Answer is (b) uniform acceleration

Explanation:
Velocity is measured in distance /second and acceleration is measured in Distance/ second^2. Hence Uniform acceleration is the right answer.

5. From the given v – t graph (Fig. 8.1), it can be inferred that the object is
(a) in uniform motion
(b) at rest
(c) in non-uniform motion
(d) moving with uniform acceleration

Soln:

Answer is (a) in uniform motion

Explanation:

From the above given graph it is clear that velocity of the object remain constant throughout hence the object is in uniform motion.

6. Suppose a boy is enjoying a ride on a merry-go-round which is moving with a constant speed of 10 m s–1. It implies that the boy is
(a) at rest
(b) moving with no acceleration
(c) in accelerated motion
(d) moving with uniform velocity

Soln:

Answer is (c) in accelerated motion

Explanation:

Boy is moving in a circular motion and circular motion is an accelerated motion hence C) is right answer.

7. Area under a v – t graph represents a physical quantity which has the unit
(a) m^2
(b) m
(c) m^3
(d) m s^{-1}

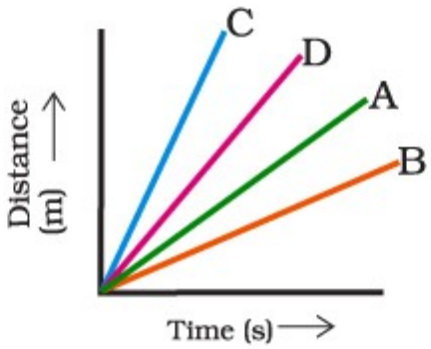
Soln:

Answer is (b) m

Explanation:

Area given in the graph represents Displacement and its unit is meter. Hence the answer is (b) m

8. Four cars A, B, C and D are moving on a levelled road. Their distance versus time graphs are shown in Fig. 8.2. Choose the correct statement
(a) Car A is faster than car D.
(b) Car B is the slowest.
(c) Car D is faster than car C.
(d) Car C is the slowest.



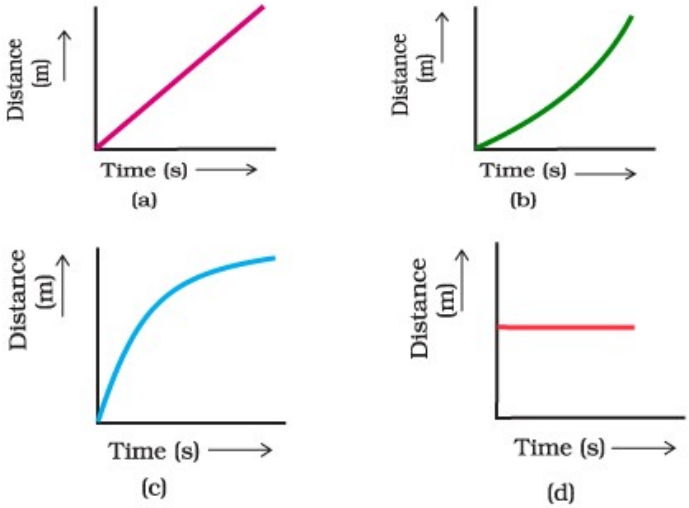
Soln:

Answer is (b) Car B is the slowest.

Explanation:

Graph shows that Car B covers less distance in a given time than A, C and D cars hence it is the the slowest.

9. Which of the following figures (Fig. 8.3) represents uniform motion of a moving object correctly?



Soln:

Answer is (a)

Explanation:

Distance in graph a) is uniformly increasing with time hence it represents uniform motion.

10. Slope of a velocity – time graph gives
(a) the distance
(b) the displacement
(c) the acceleration
(d) the speed

Soln:

Answer is (c) the acceleration

11. In which of the following cases of motions, the distance moved and the magnitude of displacement are equal?
(a) If the car is moving on straight road
(b) If the car is moving in circular path
(c) The pendulum is moving to and fro
(d) The earth is revolving around the Sun

Soln:

Answer is (a) If the car is moving on straight road

Explanation:

In other cases given here displace can be less than distance hence option (a) If the car is moving on straight road is the right answer.

Short Answer Questions

12. The displacement of a moving object in a given interval of time is zero. Would the distance travelled by the object also be zero? Justify you answer.

Soln:

Displace zero does not mean zero distance. Distance can be zero when moving object back to the place it started. Displacement is either equal or less than distance but distance is always greater than one and it cannot be a negative value.

13. How will the equations of motion for an object moving with a uniform velocity change?

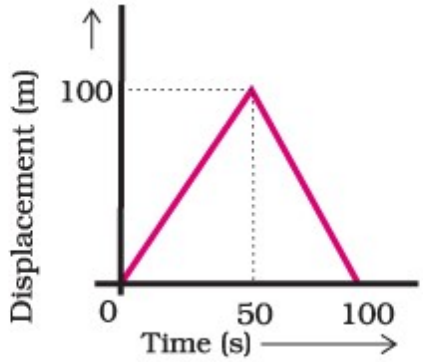
Soln:

If object moving in a uniform velocity then $v=\mu$ and $a=0$. In this scenario equation for distance is given below.

$S= ut$ and $V^2- \mu^2=0$

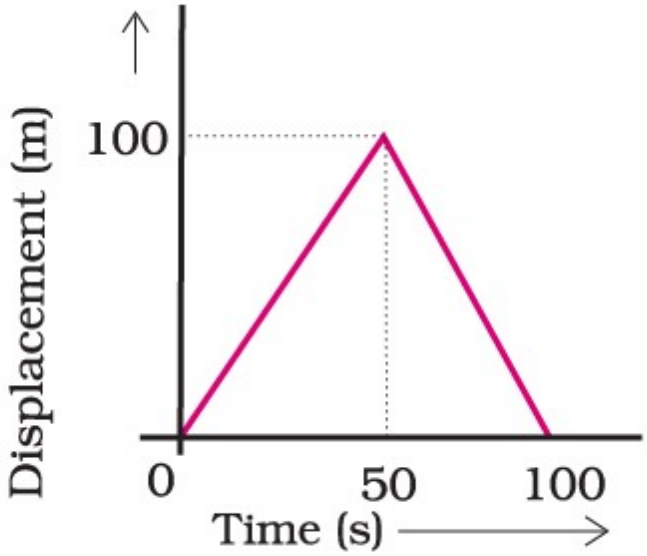
14. A girl walks along a straight path to drop a letter in the letterbox and comes back to her initial position. Her displacement–time graph is shown in Fig.8.4. Plot a velocity–time graph for the same.

Soln:



15. A car starts from rest and moves along the x-axis with constant acceleration 5 m s–2 for 8 seconds. If it then continues with constant velocity, what distance will the car cover in 12 seconds since it started from the rest?

Soln:



Car Starts from rest hence Initial velocity u=o acceleration a=5 ms^2 and time t=8s
v=u+at
v=0+5x8
v= 40ms^{-1}

From second equation

s= ut+$\frac{1}{2}at^2$

s= 0x8 +$\frac{1}{2}$x5x$(8)^2$

s=+$\frac{1}{2}$x5x$(8)^2$

s=$\frac{1}{2}$x5x64

s=5x32=160

16. A motorcyclist drives from A to B with a uniform speed of 30 km h–1 and returns back with a speed of 20 km h^{-1}. Find its average speed.

Soln:

Let the distance from A to B is D kms.
Distance for the entire journey is 2D kms.
Time taken to go from A to B is D/30 hr and that of B to A is D/20 hr. So, total time taken T
T = (D/30) + (D/20). By solving, we will get,
T = D/12 hrs.
Average speed = Total distance/Total time.
Av.speed = 2D ÷ D/12
=> 2D x 12/D = 24 km/h.
Hence Average speed of the motocycle is 24 km/h.

17. The velocity-time graph (Fig. 8.5) shows the motion of a cyclist. Find (i) its acceleration (ii) its velocity and (iii) the distance covered by the cyclist in 15 seconds

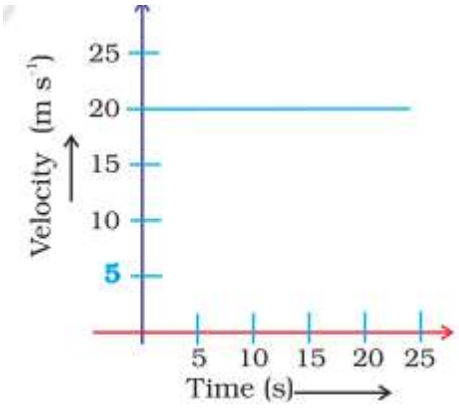


Fig. 8.5

Soln:

Here Velocity is constant hence v=20ms-1

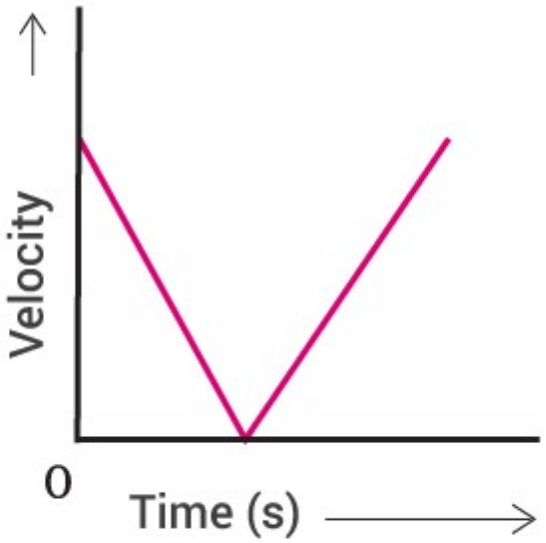
(iii) s = v x t

= 20 x 15

= 300 m

18. Draw a velocity versus time graph of a stone thrown vertically upwards and then coming downwards after attaining the maximum height.

Soln:



19. An object is dropped from rest at a height of 150 m and simultaneously another object is dropped from rest at a height 100 m. What is the difference in their heights after 2 s if both the objects drop with same accelerations? How does the difference in heights vary with time?

Soln:

When two objects fall with same acceleration simultaneously. after 2 seconds the difference in their heights will not change and it remain 50 m.

$d_1 = h_1 - s_1$

$d_1 = 150 - \frac{1}{2}at^2 = 150 - \left(\frac{1}{2} \times 10 \times 4\right)$

$d_1 = 150 - 20 = 130$ m

Therefore the height of first object after 2 seconds is 130 m.

In the same way the height of second object is

$$d_2 = h_2 - s_2$$
$$d_2 = 100 - \frac{1}{2}at^2 = 100 - \left(\frac{1}{2} \times 10 \times 4\right)$$
$$d_1 = 100 - 20 = 80 \text{ m}$$

Therefore, the height of second object after 2 seconds is 80 m.

So, the difference is same, i.e. 50 m.

This concludes that the difference in height of the two objects does not depend on time and will always be same.

20. An object starting from rest travels 20 m in first 2 s and 160 m in next 4 s. What will be the velocity after 7 s from the start.

Soln:

Here Object starts from rest hence initial velocity u=0 t =2s and s=20 m

According to Second equation of motion $s= ut+\frac{1}{2}at^2$

$S=0+\frac{1}{2}a\ x2^2$

$20=2+\frac{1}{2}a\ x2^2= 2a$

=20/2
a=10m/s

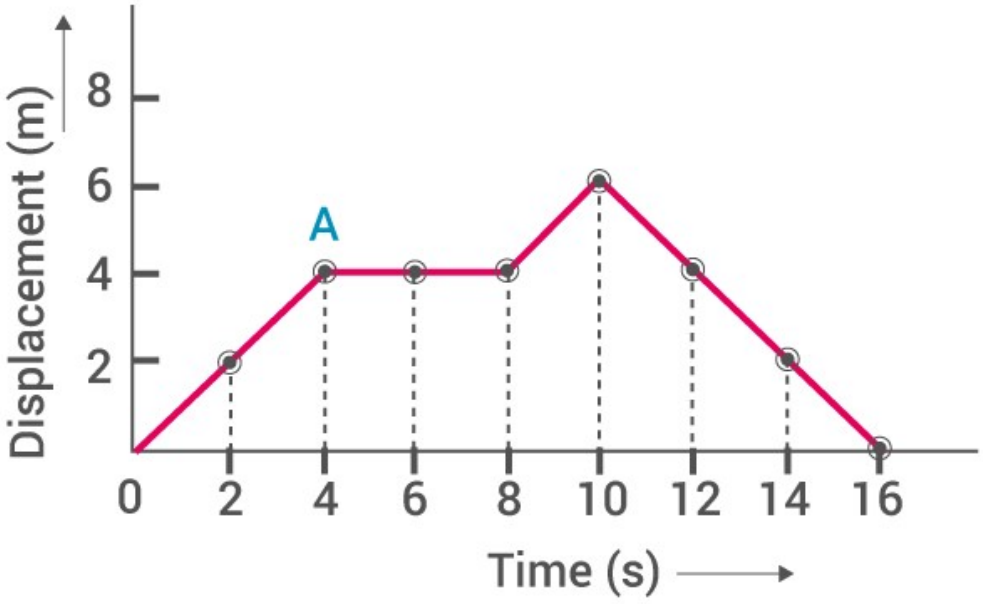
According to first equation of motion velocity after 7 s from the start
V=u+at
V=0+10x7
V=70m/s

21. Using following data, draw time - displacement graph for a moving object:

Time(s)	**0**	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**16**
Displacement(m)	**0**	**2**	**4**	**4**	**4**	**6**	**4**	**2**	**0**

Use this graph to find average velocity for first 4 s, for next 4 s and for last 6 s.

Soln



Average velocity for the first 4s=$\frac{Chang\ \ in\ displacement}{Total\ time\ taken}$

Average velocity of next 4 s=V= $\frac{4-4}{8-4}=\frac{0}{4}$

Average velocity for last 6 s=$\frac{(0-6)m}{(16-10)s}=\frac{(-6)}{6}$= 1 ms^{-1}

22. An electron moving with a velocity of 5 × 104 m s-1 enters into a uniform electric field and acquires a uniform acceleration of 104 m s–2 in the direction of its initial motion.
(i) Calculate the time in which the electron would acquire a velocity double of its initial velocity.
(ii) How much distance the electron would cover in this time?

Soln:

Given initial velocity, u = 5 × 104 m s-1 and acceleration, a = 104 m s–2

(i) final velocity = v = 2 u = 2 × 5 ×104 m s–1 =10 × 104 m s–1

To find t, use v = at or t = u - u / a

(ii)

Using s = ut + $\frac{1}{2}$at 2 = (5 ×10^4) × 5 + 1/ 2 (10) × (5) 2

= $\frac{25 \times 10^4 + 25}{2 \times 10^4}$

= 37.5×10^4 m

23. Obtain a relation for the distance travelled by an object moving with a uniform acceleration in the interval between 4th and 5th seconds.

Soln:

a = dv/dt

Assume that air resistanceis nil.

We can directly contain it by using Newton's equations of motion or from the below mentioned method:

Thus area under the v-t curve and the x-axis where the slope of the curve is the instantaneous acceleration.

In this case acceleration g is constant and due to free fall condition, initial velocity is zero.Therefore the v-t curve is a straight line with a slope equal to g equal to 9.81 m/s passing through origin.

On dividing the total area under the curve into interval of unit seconds, then we initially obtain a triangle followed by trapeziums of increasing height.

The ratio of area of first triangle to second triangle to third triangle is equal to the ratio of displacement in first, second and third second. We get ratio equal to 1:3:5:7:9... and so on.

For 4th & 5th second it is 7:9.

24. Two stones are thrown vertically upwards simultaneously with their initial velocities u1 and u2 respectively. Prove that the heights reached by them would be in the ratio of u 2 2 1 2 :u (Assume upward acceleration is –g and downward acceleration to be +g).

Soln:

We know for upward motion, $v^2 = u^2 - 2gh$ or $h = \frac{u^2 - v^2}{2g}$

But at highest point $v = 0$

Therefore, $h = u^2/2g$

For first ball, $h_1 = u_1^2/2g$

and for second ball, $h_2 = u_2^2/2g$

Thus $\frac{h_1}{h_2} = \frac{u_1^2/2g}{u_2^2/2g} = \frac{u_1^2}{u_2^2}$ or $h_1 : h_2 = u_1^2 : u_2^2$

Chapter - 9
Force and Laws of Motion

Multiple Choice Questions

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

Soln:

Answer is (c) It always goes away from the earth

Explanation:

To move away from earth Object's acceleration should be more than the acceleration due to gravity. To escape from gravity only moving along a straight path is not enough hence option © is a wrong statement.

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.

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

Soln:

Answer is (b) always act on different bodies in opposite directions

Explanation:

Newton's third law states that "For every action there is equal and opposite reaction". Hence answer is b)

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

Soln:

Answer is (b) reduce the force exerted by the ball on hands

Explanation:

Pulling hands backwards will help goalkeeper to reduce the momentum of the ball which inturn reduces the force of the ball exerted on goalkeeper's hands.

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

Soln:

Answer is (c) to resist any change in its state of motion

Explanation:

Inertia is the property which resists the state of motion of an object. Object remains in its existing state of rest or uniform motion in a straight line, unless that state is changed by an external force.

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

Soln:

Answer is (a) accelerated

Explanation:

If the motion of train is uniform the coin would have fallen in his hand. If the motion is retarded coin would have fallen ahead of him. Since the coin falls behind the person motion of the train is accelerated.

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) 32 N
(b) 0 N
(c) 2 N
(d) 8 N

Soln:

Answer is (b) 0 N

Explanation:

Here the friction is opposing the force hence no force is required to keep the object in uniform motion. Hence the answer is 0 N.

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

Soln:
Answer is (c) momentum

Explanation:

Velocity of hot gases coming out of rocket provided large momentum in opposite direction which makes the rocket move upwards. Here the conservation of momentum takes place.

8. A water tanker filled up to 2/3 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

Soln:

Answer is (b) move forward

Explanation:

On applying brakes water tanker comes to rest but water will be in motion this makes the water to come forward.

Short Answer Questions

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?

Soln:

Inertia depends on the mass of the object. For the solids with same size and volume inertia is determined by its mass. Hence steel will have highest inertia.

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.

Soln:

Yes the balls start rolling in the direction of train was moving.. When brakes are applied, train will come to rest and balls try to attain rest because of inertia balls remain in motion and they began to roll. Since the mass between two balls are not same inertia of iron ball is greater than the inertia of rubber ball. Hence rubber ball rolls faster than iron ball.

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?

Soln:

The momentum of the bullet depends on the backward momentum of the rifle. Since momentum of lighter rifle is more than the heavier rifle, bullet fired from lighter rifle hurts the shoulder more.

12. A horse continues to apply a force in order to move a cart with a constant speed. Explain why?

Soln:

When cart moves on the road it has to encounter the friction. In order to keep the cart moving horse should overcome the friction. Hence it continues to apply the force.

13. Suppose a ball of mass m is thrown vertically upward with an initial speed v, its speed decreases continuously till it becomes zero. Thereafter, the ball begins to fall downward and attains the speed v 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?

Soln:

If external force did not act on the system momentum of that system remains constant. In the give case change in velocity is due to gravitation force of the earth.

14. Velocity versus time graph of a ball of mass 50 g rolling on a concrete floor is shown in Fig. 9.1. Calculate the acceleration and frictional force of the floor on the ball.

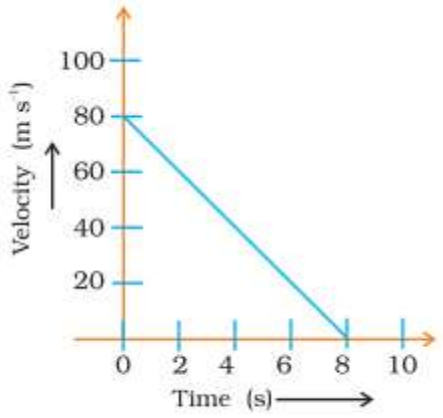


Fig. 9.1

Soln:
Given, m = 50g
F =?
Force = mass × acceleration
= $\frac{50}{1000}$ x10 = 0.5 N

velocity = 80ms^{-1}.

Velocity decelerates due to the friction of the floor with itself and comes to rest after 8 seconds.

a = $\frac{Change\ in\ velocity}{Time} = \frac{0-80}{8}$

= -10m/s^2

The negative sign indicates that the frictional force exerted opposes the motion of the ball. Now, using Newton's relation,

Force = mass× acceleration

= $\frac{50}{1000}$ × -10

= -0.5 N

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?

Soln:

Force = mass x acceleration

F=ma

a= f/m

When mass is doubles force is halved m becomes 2m and f becomes f/2

$a_2 = \frac{f}{4m}$ or $\frac{a2}{a1} = \frac{f}{4m} + \frac{f}{m} = \frac{1}{4}$

acceleration reduces to $\frac{1}{4}^{th}$

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.

Soln:

Distance between them will increase. Before throwing ball momentum of both of them will be zero. To conserve the momentum person who throws the ball moves backward. Person who catches the ball experiences a net force while catching the ball and he moves backwards.

17. Water sprinkler used for grass lawns begins to rotate as soon as the water is supplied. Explain the principle on which it works.

Soln:

Water sprinkler works on third law of motion. When water comes out of sprinkler an equal and opposite force is exerted. This will make the sprinkler rotate.

Long Answer Questions

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.

Soln:

(i) m =10 g

$= \frac{10}{1000}$kg u

=103 m/s

v = 0

$s=\frac{5}{100}$m

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

$0-(10^3)^2= 2a \frac{5}{100}$

$a=\frac{-1000x1000}{2.5}$x10

$=10^7 ms^{-2}$

F= ma

$=10^5$N

(ii) v=u+at

$0=10^3-10^7t$

$10^7 t = 10^3$

$t = 10^3/10^7$

$= 10^{-4}$s

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 m1 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?

Soln:

$F = m\,a = kg\ m\ s^{-2}$

This unit is also called newton. Its symbol is N.

$m1 = \frac{f}{a1} = \frac{5}{8}$kg

$m2 = \frac{F}{a2} = \frac{5}{24}$kg

$m = \frac{5}{8} + \frac{5}{24}$kg $= \frac{5}{6}$kg

Acceleration produced in M

$a = \frac{f}{m} = \frac{5}{5/6} = 6ms^{-2}$

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.

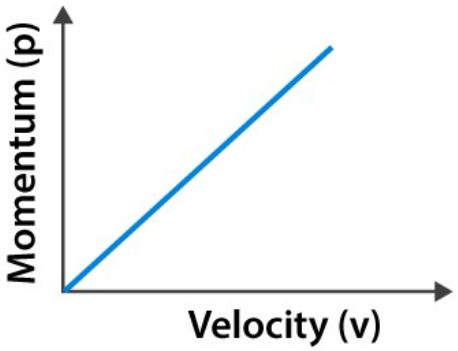
Soln:

The quantity of motion of a moving body is called momentum. It is measured as product of mass and velocity.

Momentum = mass × velocity
SI unit of momentum is kg m s^{-1}
Force = Rate of change in momentum

1)

P = xv



2)

P = mv