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Class - IX

Sec - D

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Force and laws of motion

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Exercise

9. A truck starts from rest and rolls down a hill with a constant acceleration. It travels a distance of 400 m in 20s. Find its acceleration. Find the force acting on it if its mass is 7 tonner.
(Hint: 1 tonne = 1000kg)

ans- $u = 0$ m/sec
$s = 400$ m
$t = 20$ sec

$m = 7$ tonner
$= 7 \times 1000$ kg $= 7000$ kg

$$s = ut + \frac{1}{2}at^2$$
$$400 = (0 \times 20) + \frac{1}{2}a(20)^2$$
$$\Rightarrow a = \frac{400 \times 2}{(20)^2}$$
$$\Rightarrow a = 2 \text{ m/s}^2$$

Force $\Rightarrow F = ma$
$= 7000 \times 2 = 14000$ N

6. A stone of 1kg is thrown with a velocity of 20 ms^{-1} across the frozen surface of a lake and comes to rest after travelling a distance of 50m. What is the force of friction between the stone and the ice?

ans- $m = 1$kg
$u = 20$ m/sec
$s = 50$m
$v = 0$

$v^2 - u^2 = 2as$
$(0)^2 - (20)^2 = 2a(50)$
$\therefore -400 = 100a$
$\therefore a = \frac{-400}{100} = -4 \text{ m/s}^2$

Force of Friction, $F = m \times a$
$= 1\text{kg} \times -4 \text{ m/s}^2 = -4$N

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7. A 8000 kg engine pulls a train of 5 wagons each of 2000 kg along a horizontal track. If the engine exerts a force of 40000 N and the track offers a friction force of 5000 N, then calculate:
(a) the net accelerating force and
(b) the acceleration of the train.

ans- (a) The net accelerating force
= Force exerted by the engine - friction force
= 40000 N - 5000 N = 35000 N

(b) The acceleration of the train (a) = ?
F = 35000 N
Mass of 5 Wagons pulled by engine = 5 x 2000
= 10000 kg

$F = ma \Rightarrow 35000 = 10000 \times a$
$\Rightarrow a = \frac{35000}{10000} = 3.5 \text{ m/s}^2$

8. An automobile vehicle has a mass of 1500 kg. What must be the force between the vehicle and road if the vehicle is to be ~~engine exerts a force of~~ stopped with a negative acceleration of 1.7 m s^{-2}?

ans- Mass = 1500 kg
$a = -1.7 \text{ m/s}^2$
F = ?

$F = m \times a$
$= 1500 \times (-1.7) = -2550 \text{ N}$
The Force between the vehicle and road is -2550 N.

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12. According to the Third law of motion when we push on an object, the object pushes back on us with an equal and opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opposite and equal forces cancel each other. Comment on this logic and explain why the truck does not move.

ans- The mass of truck is too large and hence its inertia is too high. The small force exerted on the truck can't move it and the truck remains at rest. For the truck to attain motion, an external ~~force~~ large amount of unbalanced force need to be exerted on it.

13. A hockey ball of mass 200g travelling at $10ms^{-1}$ is struck by a hockey stick so as to return it along its original path with a velocity at $5ms^{-1}$. Calculate the magnitude of change of momentum occured in the motion of the hockey ball by the force applied by the hockey stick.

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ans: Mass of ball (m) = 200 g = 0.2 kg
Initial speed of ball (u) = 10 m/s
Final speed of ball (v) = -5 m/s
Initial momentum of the ball = mu
= 0.2 kg x 10 m/s = 2 kg m/s
Final momentum of the ball = mv
= 0.2 kg x (-5 m/s) = -1 kg m/s
Hence, ~~change in momentum = Different in~~
Change in momentum = Different in the momentum
= 2 - (-1) = 2 + 1 = 3 kg m/s

14. A bullet of mass 10 g travelling horizontally with a ~~rest~~ velocity of 150 $m\,s^{-1}$ strikes a stationary wooden block and comes to rest in 0.03 s. Calculate the distance of penetration of the bullet into the block. ~~Also calculate the distance of penetration of the bullet into the block.~~ Also calculate the magnitude of the force exerted by the wooden block on the bullet.

ans: $m = 10\,g = \frac{10}{1000} = 0.01\,kg$

$u = 150$ m/s	$0 = 150 + a\,(0.03)$
$v = 0$ m/s	$a = \frac{-150}{0.03} = -5000\ m/s^2$
$t = 0.03$ s	$s = ?$
$v = u + at$	$F = ?$

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

$\therefore (0)^2 - (150)^2 = 2 \times 5000 \times s$

$\therefore 2 \times 5000 \times s = (0)^2 - (150)^2$

$\Rightarrow s = \frac{150 \times 150}{2 \times 5000}$

$\Rightarrow s = \frac{22500}{10000}$

$\Rightarrow s = 2.25\ m$

$\therefore$ The penetration distance of the bullet in the wooden block = 2.25m

Magnitude of Force (F) = $Ma = \frac{10}{1000} \times 5000$

$\Rightarrow F = 50\ N$

15. An object of mass 1 kg travelling in a straight line with a velocity of $10 ms^{-1}$ collides with, and sticks to, a stationary wooden block of mass 5 kg. Then they both move off together in the same straight line. Calculate the total momentum just before the impact and just after the impact. Also, calculate the velocity of the combined object.

ans: $m_1 = 1\ kg$

$v_1 = 10\ m/s$

Mass of wooden block = 5kg

$m_2 = 5kg + 1kg$ (Combined object) = 6 kg

Velocity of combined object = $v_2 = ?$

P_1 and $P_2 = ?$

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Momentum before impact (P) = $m_1 v_1$

$= 1 \times 10 = 10$ kg m/s

∴ Momentum before impact =

Momentum after impact

$\Rightarrow m_1 v_1 = m_2 v_2$

10 kg m/s $= 6 v_2$

$\therefore \frac{10}{6} = v_2$ $\therefore v_2 = 1.67$ m/s