Ch-2 FORCE AND LAWS OF MOTION.

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NCERT

(Q/A)

5) A truck starts from rest & rolls down a hill with a const. accl^n. It travels a distance of 400 m in 20s. Find its accl^n. Find the force acting on it, if its mass is 7 tonnes. (1 tonne = 1000 kg)

Ans) Initial velocity, $u = 0$ {truck at rest}.
Distance travelled, $s = 400$ m
Time = 20 s
$a = ?$

A/ 2nd eq^n

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

$$a = \frac{2s}{t^2} = \frac{2 \times 400}{20^2} = 2 \text{ m/s}^2.$$

$m = 7 \text{ tonnes} = 7000 \text{ kg}$

$F = ma$

$= 7000 \times 2$

$= 14000 \text{ N (or)}$

$= 14 \text{ KN}$

6) A stone of 1kg is thrown with a velocity of 20 m/s across the frozen surface of a lake & comes to rest after travelling a distance of 50 m. What is the force of friction b/w the stone & the ice?

Ans) Given:

$m = 1 \text{ kg}$

$u = 20 \text{ m/s}$

$v = 0 \text{ m/s}$

$s = 50 \text{ m}$

A/3rd eqn of motion

$\Rightarrow v^2 = u^2 = 2as$

$\Rightarrow a = \dfrac{0 - u^2}{2as}$

$\Rightarrow a = \dfrac{-400}{2 \times 50}$

$\Rightarrow a = -4 \text{ m/s}^2$

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$f = ma$

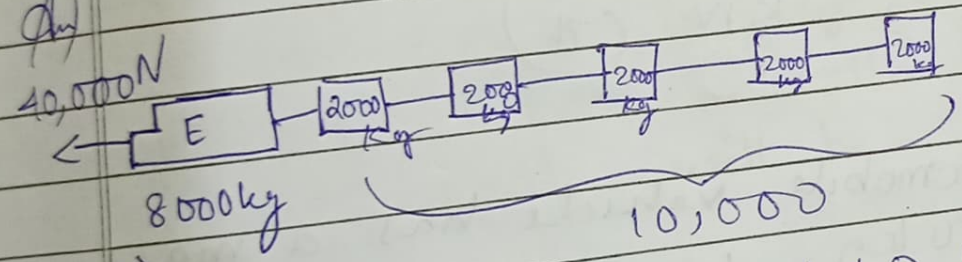
$f = 1 \times -4$

$f = -4N$ (Ans).

7) A 8000kg engine pulls a train of 5 wagons, each of 2000kg, along a horizontal track. If the engine exerts a force of 40,000N & the track offers a friction force of 5000N then calculate:-

a) the net accelerating force.

(Ans)



$T_m = 8,000 + 10,000$

$= 18000$ kg.

Net force $= 40,000 - 5000$

$= 35000$ N

b) The accln of the train:-

(Ans) Net accln $= \frac{f_{Net}}{m}$

$$a = \frac{35000}{18000} = +1.94\ m/s^2$$

c) the force of wagon 1 on wagon 2.

Ans) $F = ma$

$$a_w = \frac{35000}{5 \times 2000} = \frac{35}{10} = 3.5\ m/s^2$$

$$F = 8000 \times 3.5$$
$$= 28000\ N \text{ (or)}$$
$$= 28\ KN \text{ (Ans)}$$

8) An automobile vehicle has a mass of 1500 kg. What must be the force b/w the vehicle & road if the vehicle is to be stopped with a negative accl^n of $1.7\ m/s^2$?

Ans) Given,

$m = 1500\ kg$

$a = -1.7\ m/s^2$

$$F = ma = 1500 \times \frac{-1.7}{10} = -2550\ N.$$

9) What is the momentum of an object of mass m, moving with a velocity v?

a) $(mv)^2$

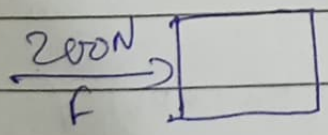
b) ~~$(mv)^3$~~ mv^2

c) $\frac{1}{2}mv^2$

d) mv

10) Using a horizontal force of 200 N, we intend to move a ~~wo~~ wooden cabinet across a floor at a constant velocity. What is ~~the force~~ friction force that will be exerted on the cabinet?

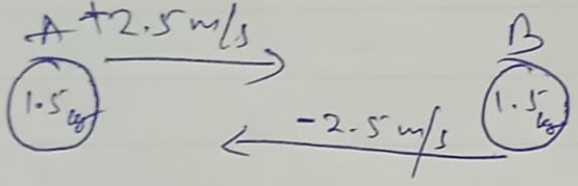
Ans) $v = \text{const} = N_F = 0$



$\leftarrow$ 200 N (Friction force) [in opp dir^n]

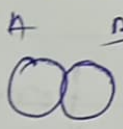
11) Two objects, each of mass 1.5 kg, are moving in the same straight line but in opp. dirns. The velocity of each object is 2.5 m/s before the collision during which they stick together. What will be the velocity of the combined object after collision?

Ans)

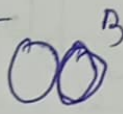


$m_a = 1.5$ kg
$m_b = 1.5$ kg
$u_a = 2.5$ m/s
$u_b = -2.5$ m/s

During collision.



After collision



$T_{pi} = T_{pf}$

$m_a u_a + m_b u_b = m_a v_a + m_b v_b$

$\Rightarrow (1.5 \times 2.5) + (1.5 \times -2.5) = (m_a + m_b) v$

$\Rightarrow 0 = (1.5 + 1.5) v$

$\Rightarrow 0 = 3v$

$\Rightarrow v = 0$ m/s

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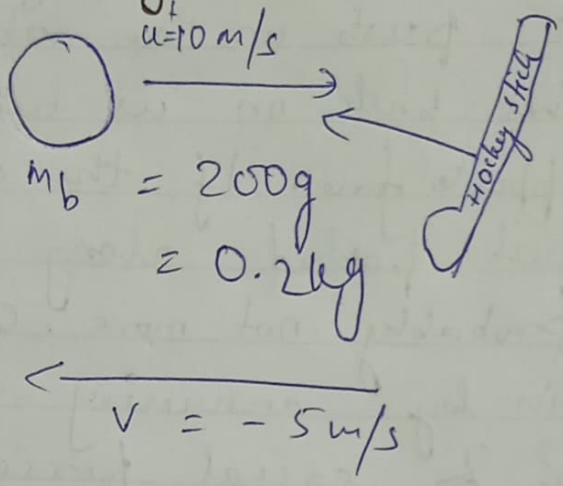
12) According to the third law of motion when we push on an object, the object pushes back on us with an equal & opposite force. If the object is a massive truck parked along the roadside, it will probably not move. A student justifies this by answering that the two opp. & equal forces cancel each other.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

Ans) The logic is that Action & Reaction always acts on diff. bodies, so they cannot cancel each other. When we push a massive truck, the force of friction between its tyres does not move. The force of friction cancels the force applied by a person's push. So, student's justification is correct.

13) A hockey ball of mass 200g travelling at 10m/s is struck by a hockey stick so as to return it along its original path with a velocity at 5 m/s. Calculate the change of momentum

occured in the motion of the hockey ball by the force applied by the hockey stick.

(Ans)



$$P_i = m \times u$$
$$= 0.2 \times 10$$
$$= 2 \text{ kg m/s}$$

$$P_f = m \times v$$
$$= 0.2 \times -5$$
$$= -1 \text{ kg m/s}$$

$$P_f - P_i = -1 - 2$$
$$= -3 \text{ kg m/s}$$

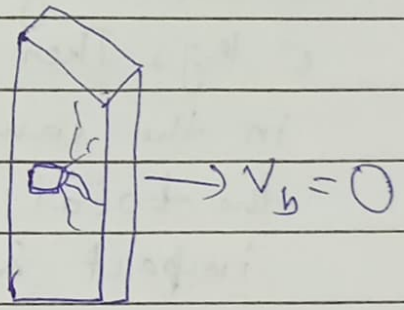
Magnitude = -3 kg m/s. {opp. dir^n}

14) A bullet of mass 10 g travelling horizontally with a velocity of 150 m/s strikes a stationary wooden block & comes to rest in 0.03 s. 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)

$m_b = 10g = 0.01$ kg

$\rightarrow u_b = 150$ m/s



$t = 0.03$ sec

$s = ?$

$F = ?$

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

$\Rightarrow s = \frac{v^2 - u^2}{2a}$

$\Rightarrow s = \frac{-u^2}{2a}$

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

$\Rightarrow s = \frac{9}{4} = 2.25$ m

$a =$ 1st eqn

$v = u + at$

$\Rightarrow a = \frac{v-u}{t}$

$= \frac{0-150}{0.03}$

$= \frac{-150}{0.03}$

$= -5000$ m/s^2

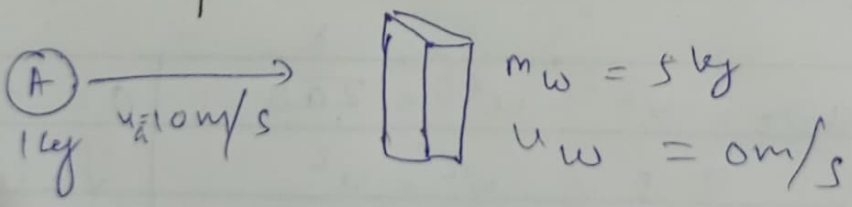
$$F = ma$$

$$= \frac{0.01}{100} \times -5000$$

$$= -50\ N \quad \{\text{in opp. dir}^n\}.$$

15) An object of mass 1kg travelling in a straight line with a velocity of 10m/s collides with, & sticks to, a stationary wooden ~~bla~~ block of mass 5 kg. Then they both move off together in the same straight line, Calculate the total momentum just before the impact & just after the impact. Also, calculate the velocity of the combined object.

Ans)



① $T_{pi} = m_a u_a + m_w u_w$

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

② $T_{pf} = m_a v_a + m_w v_w$

$= (m_a + m_w) v$

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$T_{pf} = 6\ V$

$T_{pi} = T_{pf}$

(3)

$\Rightarrow 10 = 6v$

$\Rightarrow v = \frac{6}{10}$ $1.67\ m/s$.