6th advanced W.S-8 Newton's I st & 2nd law (1)

Task-1

(1)

$m = 2\,kg$; $u = 0$; $t = 4\,sec$; $a = 1.5\,m/s^2$.

The velocity of the body after '4' sec

$v = u + at$

$\Rightarrow v = 0 + (1.5) \times 4$

$\Rightarrow v = 6\,m/s$

$\therefore$ Gain in momentum $dp = m(v-u)$

$= 2(6-0)$

$= 12\,kgm/s$

(2)

$m = 0.4\,kg$; $u = 0$; $t = 10\,sec.$ $S = 100m$;

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

$\Rightarrow 100 = 0 \times 20 + \frac{1}{2} \times a \times (20)^2$

$\Rightarrow 100 = \frac{1}{2} \times a \times 400 \Rightarrow a = \frac{1}{2} = 0.5\,m/s^2$

Force $F = m \times a = 0.4 \times \frac{1}{2} = 0.2\,N$

(4)

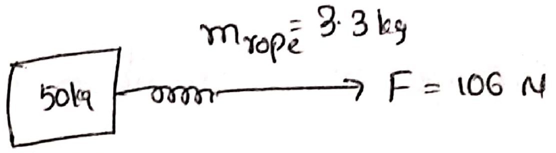
$m = 50kg$; $L_{rope} = 6m$; $F = 106N$.

linear density $\lambda = \frac{m}{l} = 0.55 \; kg/m$.

mass of 6m rope = $m_{rope} = 0.55 \times L$

$= 0.55 \times 6$

$= 3.3 \; kg$.



⇒ Acceleration of system $a = \frac{F}{m + m_{rope}}$

$\Rightarrow a = \frac{106}{50 + 3.3} = \frac{106}{53.3}$

Force acting on 50 kg = $m \times a$

$= 50 \times \frac{106}{53.3}$ kg N

$\simeq 100$ N.

(5)

$M_{bullet} = 4 \times 10^{-2}$ kg ; $u_{bullet} = 20 m/s$; $V_{bullet} = 0$

$t = 5 \times 10^{-2}$ sec.

From $v = u + at$

$\Rightarrow 0 = 20 + a \times 5 \times 10^{-2} \Rightarrow a = -\frac{20}{5 \times 10^{-2}}$

∴ Resistance offered by the sand bag = $M_{bullet} \, a$

$= 4 \times 10^{-2} \times \left(\frac{-20}{5 \times 10^{-2}} \right)$

$= -16$ N.

'-ve' sign shows the force is Resistive.

(6)

$F = 100N$; $m = 2kg$; $t = 10 sec$; $u = 0$

Acceleration $a = \frac{F}{m} = \frac{100}{2} = 50\ m/s^2$

Velocity after '10' sec

$v = u + at$

$\Rightarrow v = 0 + 50 \times 10 = 500\ m/s.$

$\therefore$ change in momentum $dp = m(v-u)$

$= 2(500-0)$

$= 2 \times 500 = 1000 Ns$

(7)

$m_1 = 3\ kg \rightarrow a_1 = 0.5\ m/s^2.$

$m_2 = 1.5\ kg \rightarrow a_2 = ?$

Here given on both bodies same force is acting $\therefore$ when $F = constant$

$m \propto \frac{1}{a}$

$\Rightarrow \frac{a_2}{a_1} = \frac{m_1}{m_2} \Rightarrow a_2 = a_1 \times \frac{m_1}{m_2}$

$\Rightarrow a_2 = 0.5 \times \frac{3}{1.5} = 1\ m/s^2$

(8)

$m_1 = 2\ kg \rightarrow a_1 = 1\ m/s^2$

$m_2 = 2+2 = 4\ kg \rightarrow a_2 = ?$. Here given Force is same in both cases then From $F = ma$

$\Rightarrow m_1 a_1 = m_2 a_2$

$\Rightarrow 2 \times 1 = 4 \times a_2$

$\Rightarrow 4a_2 = 2$

$\Rightarrow a_2 = \frac{2}{4} = 0.5\ m/s^2$

(9)

$m = 2\ kg$; $t = 2\ sec$; increase in speed $du = 3\ m/s$.

$\therefore$ From Newton's II^{nd} law $F = \frac{dp}{dt}$

$$\Rightarrow F = m\frac{dv}{dt} \Rightarrow 2 \times \frac{3}{2} = 3N$$

(10)

$F = 15N$. $m = 20\ kg$; $t = 8\ sec$; $u = 0$

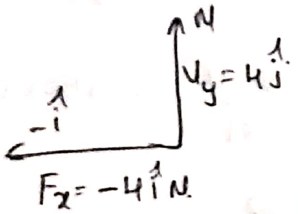
From $F = ma$

$$\Rightarrow a = \frac{F}{m} = \frac{15}{20} = \frac{3}{4}\ m/s^2$$

From $v = u + at$

$$\Rightarrow v = 0 + \frac{3}{4} \times 8 = 0 + 3 \times 2 = 6\ m/s$$

(3)



$m = 2\ kg$ From $F = ma$

$$\Rightarrow a = \frac{F}{m} = \frac{-4\hat{i}}{2}$$

$$a = -2\hat{i}\ m/s^2$$

After 2 sec.

Displacement of the body $s = ut + \frac{1}{2}at^2$

$$\Rightarrow \vec{S} = 4\hat{j} \times 2 + \frac{1}{2}(-2\hat{i})(2)^2$$

$$\vec{S} = 8\hat{j} - 4\hat{i}$$

magnitude of $\vec{S} = \sqrt{(8)^2 + (-4)^2} = \sqrt{64 + 16} = \sqrt{80}$

$$= 8.94m$$

(15)

when cloth is Pulled from table, the cloth comes in state of motion but dishes remain stationary due to inertia.

(18)

$m = 10\ kg$; $u = 0$; $F = 20N$; $v = 30\ m/s$.

Here initial momentum $P_I = mu = 10 \times 0 = 0$

Final momentum $P_F = mv = 10 \times 30 = 300\ kg\,m/s$

Acceleration of the body $a = \frac{F}{m} = \frac{20}{10} = 2\ m/s^2$

(19)

$m = 150\ gm = 150 \times 10^{-3}\ kg$; $u = 20\ m/s$; $v = -12\ m/s$

contact time $dt = \frac{1}{25}$ sec.

From Newton's II^{nd} law the force acting $= \frac{dP}{dt}$

$F = m\frac{[v-u]}{dt} = 150 \times 10^{-3}\frac{[-12-20]}{\frac{1}{25}}$

$= -15 \times 10^{-2} \times 32 \times 25 = 12000 \times 10^{-2} = 120N$

(20)

$a_1 = 16\ m/s^2$; $m_1 = 0.5\ kg$; $m_2 = ?$ $a_2 = 4\ m/s^2$

same force is acting $m_2 = \frac{a_1}{a_2} \times m_1 = \frac{16}{4} \times 0.5 = 2\ kg$.

If two masses are tied then $m' = m_1 + m_2 = 0.5 + 2 = 2.5\ kg$

Here same force is acting so $m_1 a_1 = m' a'$

$\Rightarrow 0.5 \times 16 = 2.5\, a' \Rightarrow a' = \frac{8}{2.5} = 3.2\ m/s^2$

L Task
CUQ's

(9)

$m = 1\,kg$; weight $= mg = 1 \times 9.8 = 9.8\,N$

(12)

$F = 1$ dyne ; $m = 1\,gm$

$a = \frac{F}{m} = \frac{1}{1} = 1\ cm/s^2$

Jee mains level

(1)

Force $F = 15\,N$; $m = 15\,kg$; $t = 8$ sec

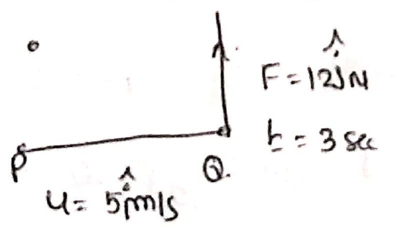
From Newton's IInd law $F = ma \Rightarrow a = \frac{F}{m} = 1\,m/s^2$

velocity after 8 sec $V = u + at$

$V = 0 + 1 \times 8 \Rightarrow 8\,m/s$

(2)

$m = 3\,kg$: $u = 5\,m/s$



From $F = ma$

$\Rightarrow a = \frac{F}{m} = \frac{12\hat{j}}{3}$

$\Rightarrow a = 4\hat{j}\,m/s^2$

From $v = u + at$ at the end of '3' sec

$\Rightarrow$ Velocity $V = 5\hat{i} + 4 \times 3\hat{j} = 5\hat{i} + 12\hat{j}$

$|\vec{V}| = \sqrt{5^2 + 12^2} = 13\,m/s$

(3)

If we want to move the body with uniform speed

V = constant ∴ Acceleration = 0

∴ $F = m(a) = m(0) = 0$

No force is required.

(4)

$u = 0$.

$m_{truck} = 5$ tonnes $= 5 \times 10^3$ kg

$F = 400$ N.

Resistance per tonne = 60N

∴ Resistance for 5 tonnes $= 60 \times 5$

$= 300$ N.

∴ Net force acting on truck

$F_{net} = [F_{app} - \text{Resistance}]$

$= 400 - 300 = 100$ N.

∴ acceleration of truck $= \frac{F_{net}}{m} = \frac{100}{5 \times 10^3}$

$= \frac{1}{50}$ m/s^2

velocity at the end of 30 sec is determined

by using $v = u + at$

$\Rightarrow v = 0 + [\frac{1}{50}] \times 30 = \frac{3}{5} = 0.6$ m/s

⑤

$F = 100N$; $m = 20kg$; $u = 0$

From $F = ma \Rightarrow a = \frac{F}{m} = \frac{100}{20} = 5 m/s^2$

⑥

$m = 2kg$: $V = 4 m/s$

Given velocity is constant

$\therefore$ Acceleration $= 0$

$\therefore$ $F = ma = 2(0) = 0$

$\therefore$ No force is required

⑦

$a = 2 m/s^2$: $m_1 = 1.5$ kg

From $F = ma = 1.5 \times 2$

$= 3 N.$

⑧

Given $m = 20$ gm $= 20 \times 10^{-3}$ kg

$a = 5 cm/s^2 = 5$

$\therefore$ From $F = ma = 20 \times 5 = 100$ gm cm/s^2

$= 100 \times 10^{-5}$ N

$= 1 \times 10^{-3}$ N.

(9)

$a = 3\ cm/s^2$; $m = 250\ gm.$

From Newton's IInd law $F = ma$

$\Rightarrow F = 250 \times 3 = 750\ gm\ cm/s^2$

$= 750 \times 10^{-5}\ N$

$= 75 \times 10^{-4}\ N.$

(10)

$m = 2\ kg.$

$\left[\frac{dm}{dt}\right]_{water} = 1\ kg/sec$

$V_{water} = 5\ m/s$

From Newton's IInd law $F = \frac{dp}{dt}$

$\therefore M_{block} \times a_{block} = V_{water}\left[\frac{dm}{dt}\right]_{water}$

$\Rightarrow 2 \times a_{block} = 5 \times 2$

$\Rightarrow a_{block} = 5\ m/s^2.$

(11)

$V_{train} = 10\ m/s$

$\left[\frac{dm}{dt}\right]_{rain} = 5\ kg/sec.$

Force required to maintain the velocity

$F = \frac{dp}{dt} = V_{train}\left[\frac{dm}{dt}\right]$

$= 10 \times 5$

$= 50\ N.$

(18)

$m = 2\ kg$; $u = 5\ m/s$; $t = 0.1\ sec$; $V = 6\ m/s$

Initial momentum of the ball $= m \times u$

$= 2 \times 5$

$= 10\ kg\,m/s$

Final momentum of the ball $= m\,V$

$= 2 \times 6 = 12\ kg\,m/s$.

(19)

$F = 100$ dynes ; $m = 5\ gms$; $t = 10\ sec$; $u = 0$

From $F = m\,a$

$a = \frac{F}{m} = \frac{100}{5} = {}^{\cdot}20\ cm/s^2$

velocity after 10 sec is $V = u + at$

$\Rightarrow V = 0 + (20) \times 10 = 200\ cm/sec$

(20)

$\left(\frac{dm}{dt}\right)_{gravel} = 0.5\ kg/sec.$; $V_{belt} = 2\ m/s$

Force required $F = \frac{dp}{dt} = V\left[\frac{dm}{dt}\right]$

$F = 2 \times 0.5$

$= 1N.$