(1)

Given $m = 1\,kg$; $u_1 = 25\,m/s$

Rebouncing speed $v = -10\,m/s$.

Impulse = change in momentum $= m(v-u)$

$= 1[-10-25]$

$\Rightarrow -35\,kg\,m/s$.

or $-35\,Ns$

'-ve' sign shows direction of impulse ↑.

(2)

Given $m = 2.5\,kg$: initial speed $u = 1\,m/s$; $v = 0$

distance moved by the nail $= 10\,cm = 10 \times 10^{-2}\,m = 10^{-1}\,m$

Impulse = change in momentum.

$= m(v-u)$ or $F \cdot dt$.

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

$\Rightarrow 0^2 - 1^2 = 2a(10^{-1})$

$\Rightarrow -1 = 2 \times 10^{-1} a$

$\Rightarrow a = -\frac{1}{2 \times 10^{-1}} = -5\,m/s^2$

From $v = u + at$

$\Rightarrow 0 = u + at$

$\Rightarrow t = -\frac{u}{a} = \frac{-1}{-5}$

$\Rightarrow t = \frac{1}{5}\,sec$

∴ Impulse $= F \times dt$

$= ma \times dt$

$\Rightarrow 2.5 \times 5 \times \frac{1}{5}$

$= 2.5\,kg\,m/s$

Here Nail is in retardation so we get -ve sign for acceleration

Given $m = 0.04$ kg $= 4\times10^{-2}$ kg   initial velocity $u = 20$ m/s   Final velocity $V = 0$

$dt = 0.25$ sec.

initial momentum $p = mu$

$= 4\times10^{-2}\times20$

$= 80\times10^{-2}$

$\Rightarrow 0.8$ NS $\rightarrow$ C

(4)

Given $m = 4$ kg   let initial speed $= u$.

In a time $t = 3$ sec   Increase in speed $du = 3$ m/s.

$F = m\times a$

$= m\times\frac{dv}{t} = 4\times\frac{3}{3} = 4$ N $\rightarrow$ C

(5)

Given $F = 1$ N. ; $m = 10$ kg. ; $u = ?$

In $t = 4$ sec ; distance $s = 100$ cm (or) 1m. ;

From Newton's second law $F = ma$

$\Rightarrow a = \frac{F}{m} = \frac{1}{10}$ m/s^2

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

$\Rightarrow 1 = 4u + \frac{1}{2}\times\frac{1}{10}\times4^2$

$\Rightarrow 1 = 4u + \frac{16}{20}$

$\Rightarrow 1 = 4u + 0.8$

$\Rightarrow 4u = 1 - 0.8$ $\Rightarrow 4u = 0.2$ $\Rightarrow u = \frac{0.2}{4}$ m/s

$\Rightarrow u = \frac{20}{4}$ cm/s $= 5$ cm/s $\rightarrow$ D

(6)

Given $F = 15N$; $m = 20\,kg$; $t = 8\,sec$ $v = ?$ $u = 0$

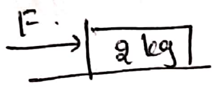
From $F = ma \Rightarrow a = \frac{F}{m} = \frac{15}{20} = \frac{3}{4}\,m/s^2$

From $v = u + at$

$\Rightarrow v = 0 + \frac{3}{4} \times 8^2 \Rightarrow 0 + 3 \times 2$

$\Rightarrow v = 0 + 6 = 6\,m/s. \rightarrow D$

(7)



$u = 0$, $m = 2\,kg$

speed of the block becomes $v = 3\,m/s$

distance traveled $s = 1m$.

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

$\Rightarrow 3^2 - 0^2 = 2(a)(1) \Rightarrow 2a = 9 \Rightarrow a = \frac{9}{2}\,m/s^2$

From $F = ma = 2 \times \frac{9}{2} = 9N \rightarrow C$

(8)

Given $m = 160\,gm = 160 \times 10^{-3}\,kg$ → initial velocity $u = 25\,m/s$

Final velocity $V = -30\,m/s$

Impulse = change in momentum = $m(v-u)$

$= 160 \times 10^{-3}(-30 - 25)$

$\Rightarrow$ ~~160×10^{-3}~~ $(-55) \times 160 \times 10^{-3}$

$\Rightarrow$ ~~980~~ $\times 10^{-3}$

$\Rightarrow 8800 \times 10^{-3}$

$\Rightarrow 8.8\,NS \rightarrow D$

(9)

Given $m = 0.03 kg$ $\frac{n}{t} = 200$; velocity $u = 30 m/s$

Average force acting $F = \frac{dp}{dt}$ $[P = n mu]$

$F = \frac{n m du}{dt} \Rightarrow 200 \times 0.03 \times 30$

$= 180 N \rightarrow B$

(10)

Given mass $m = 8 kg$; initial velocity $u = 36$ kmph $= 36 \times \frac{5}{18} = 10 m/s$

Final velocity $= 18$ kmph ; $dt = 0.5$ sec

$= 18 \times \frac{5}{18}$

$= 5 m/s$

$\therefore$ Force $= m\frac{du}{dt} = \frac{m[V-u]}{t}$

$\Rightarrow \frac{8 \times [5-10]}{0.5} = 16 \times (-5) = -80 N \rightarrow B$

'-ve' sign shows force is a retarding force.

(11)

From Newton's II law $F = ma$

when $m =$ constant $F \propto a$.

when $F =$ constant $m \propto \frac{1}{a}$.

(16)

Given $m = 10\,kg$; Initial velocity $u = 0$

$F_{applied} = 20\,N$ < velocity > = 30 m/s

$V = 30\,m/s$

Final momentum $P_{Final} = m\,V$

$= 10 \times 30$

$= 300\,kg\,m/s$

Initial momentum $P_{Initial} = m\,u$

$= 10 \times 0 = 0$

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

(18)

Given mass $= 100\,kg$; Initial velocity $u = 36\,kmph$

$u = \frac{36 \times 5}{18} = 2 \times 5 = 10\,m/s$

Final velocity $V = 108\,kmph$

$= 108 \times \frac{5}{18} = 6 \times 5 = 30\,m/s$.

change in momentum $= m(V-u) = 100\,(30-10)$

$= 2000\,NS$

(19)

Given $m = 0.3\,kg$; $F = kx$. $k = 15\,N/m$.

$x = 20\,cm = 20 \times 10^{-2}\,m$.

From $F = ma$ & $F = kx$

$\Rightarrow ma = kx$

$\Rightarrow 0.3 \times a = 15 \times 20 \times 10^{-2}$

$\Rightarrow a = \frac{300 \times 10^{-2}}{0.3} = \frac{30}{3} = 10\,m/s^2$

L Task

(5) To overcome inertia of rest.

An athlete runs before jumping to gain momentum because it helps in jumping higher and longer because of the inertia of motion gained due to motion. when the athletes jump, they already have a forward motion that would be greater than that of a jump made from standing in one spot. while running, the athlete cannot gain energy or apply larger force because initially, he would be rest and while running, he will lose energy.

(3)

Due to direction, passengers are thrown outwards because of inertia of direction. If suddenly the breaks are applied passengers will be thrown forward, and if suddenly the bus is accelered the passengers will be thrown backward.

(5)

The mass of stone is greater than mass of rubber ball.
Since mass is measure of inertia.
∴ stone is more inertia than rubber.

(6)

As the horse goes forward, the force pulls the cart. so, the movement of horse is due to the force exerted by the ground. This force is known as friction force

(7)

Because for every action there is an equal and opposite reaction takes place. So when we jump forward out of a boat standing in water, it moves backwards.

(8)

Because chinaware and glass are delicate substances and will break if it falls. The straw covers the substance and absorbs shocks and any sudden force will not cause the breakage of the glass or chinaware.

(9)

Given $m = 1kg$ weight $= mg \Rightarrow 1 \times 9.8$

$\Rightarrow 9.8 N.$

(ii)

$F = 1$ dyne ; $m = 1gm$; $a = ?$

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

Jee mains level

(1)

Given $F = 200N$; initial velocity $u = 0$; $dt = 0.25$ sec

initial momentum $P = m \times u$ (or) $F \cdot dt$

$P = 200 \times 0.25 = 200 \times \frac{1}{4} =$

$P = 50$ Ns

(2)

Given $m = 100\ gm = 100 \times 10^{-3}\ kg = 10^{-1}\ kg$.

Initial velocity $u = 12\ m/s$

Final velocity $v = 20\ m/s$.

$dt = 0.01\ sec = 10^{-2}\ sec$.

From Newton's 2nd law $F = \frac{dp}{dt}$ $[p = mv]$

$\Rightarrow F = m \frac{dv}{dt}$

$= 10^{-1} \times \frac{(20+12)}{10^{-2}} \Rightarrow 32 \times 10^{2} \times 10^{-1}$

$\Rightarrow$ ~~80~~ $320\ N$

(3)

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

Initial velocity $u = 1000\ m/s$.

time = 1 min = 60 sec

$= \frac{1}{60}$ min

Force = 180 N. ; $\frac{n}{t} = ?$

From Newton's 2nd law $F = \frac{dp}{dt}$ [where $p = nmu$]

$\Rightarrow F = n \times m \frac{dv}{dt}$

$\Rightarrow 180 = \frac{n}{dt} \times 3 \times 10^{-3} \times 1000$

$\Rightarrow 180 = 3 \times \frac{n}{t} \times 60$

$\Rightarrow \frac{n}{t} = 1$

(4)

Given acceleration $a = 5\ cm/s^2$; $m = 20\ gm$

Force $= ma = 20 \times a = 20 \times 5$

$= 100\ gm\ cm/s^2 \Rightarrow 100 \times 10^{-5} = 10^{-3}\ N$

(5)

Given $m = 10$ kg/s $u = 10$ m/s ; $v = 0$.

$dt = 1$ sec.

From IInd law $F = \frac{dp}{dt}$ [where $p = mu$]

$\Rightarrow F = m\frac{du}{dt} = 10 \times \frac{10}{1} = 100$ N.

(6)

For same force

From $F = ma$ $m_1 = 2$ kg

$\Rightarrow m \propto \frac{1}{a}$ $m_2 = 3$ kg

$\therefore \frac{a_1}{a_2} = \frac{m_2}{m_1} = \frac{3}{2}$.

(7)

Given $m = 200$ gm $= 200 \times 10^{-3}$ kg. Initial velocity $u = 15$ m/s

Final velocity $v = 25$ m/s ; $t = 2.5$ sec.

$\therefore$ Force $= \frac{dp}{dt} = m\frac{du}{dt} = 200 \times 10^{-3}\left[\frac{25-15}{2.5}\right]$

$= \frac{0.2 \times 10 \times 10^2}{25} = 4 \times 0.2 = 0.8$ N.

(8)

Given $m = 200$ gm $= 200 \times 10^{-3}$ kg ; $S = 400$ cm $= 4$ m

$u = 0$ $t = 2$ sec.

From $S = ut + \frac{1}{2}at^2 \Rightarrow 0 \times 2 + \frac{1}{2}a(2)^2$

$\Rightarrow 4 = 2a \Rightarrow a = 2$ m/s^2

The magnitude of force $F = ma = 200 \times 10^{-3} \times 2$

$= 0.4$ N.

(9)

$m = 2\,kg$ $\quad \left(\frac{dm}{dt}\right) = 1\,kg/sec.$ $\quad ; V_w = 5\,m/s$

From $F = \frac{dp}{dt}$ [Here $p = mv$]

$\Rightarrow ma = V_w \times \frac{dm}{dt}$

$\Rightarrow 2a = 5 \times 1$ $\Rightarrow a = \frac{5}{2} = 2.5\,m/s^2$

(10)

$V_{train} = 10\,m/s$; $\frac{dm}{dt} = 5\,kg/s$

From $F = \frac{dp}{dt} = V_{train} \times \frac{dm}{dt}$

$= 10 \times 5$

$= 50\,N.$

(13), (14), (15), (16)

Given $m = 2\,kg$; initial velocity $u = 5\,m/s$

Final velocity $v = 6\,m/s$

time $= 0.1\,sec$

initial momentum $p = mu = 2 \times 5 = 10\,kg\,m/s$

Final momentum $P_F = mv = 2 \times 6 = 12\,kg\,m/s$

change in momentum of ball $= P_F - P_I$

$= 12 - 10 = 2\,kg\,m/s$

From $F = \frac{dp}{dt}$

$\Rightarrow ma = \frac{P_F - P_I}{dt}$

$\Rightarrow 2a = \frac{2}{0.1} \Rightarrow 20$; $F = 2 \times 10$

$= 20\,N.$

$\Rightarrow a = \frac{20}{2} = 10\,m/s^2$

(17)

Given $\frac{dm}{dt} = 0.5$ kg/sec ; $v = 2$ m/sec.

From Newton's 2nd law $F = \frac{dp}{dt}$

$\Rightarrow F = v\frac{dm}{dt}$ $[P = mv]$

$\Rightarrow F = 2 \times 0.5 = 1$ N.

(18)

Given

mass = 5 kg ; Initial velocity $\vec{u} = 30\hat{i} - 40\hat{j}$ m/s
(u_x, u_y)

$F = -\hat{i} - 5\hat{j}$ N/s
(F_x, F_y)

when we consider y-component of velocity ie $u_y = 40$ m/s

The force also y-component $F_y = -5$ N.

From $F = ma$

$\Rightarrow F_y = m a_y$

$\Rightarrow F_y = m \frac{u_y}{t}$

$\Rightarrow \cancel{+}5 = \cancel{5} \times \frac{40}{t}$

$\Rightarrow t = 40$ sec.