WS-13 Momentum

6th foundation + Thrash

(i)

①

Given $m = 1200\,kg$; velocity $u = 30\,m/s$

$\therefore$ momentum $p = m \times velocity$

$\Rightarrow p = 1200 \times 30 = 36\,000\,kg\,m/s \rightarrow D$

②

Given masses $m_1 = 5\,kg$; $m_2 = 25\,kg$.

when p = momentum is constant

$m \propto \frac{1}{v}$ $[p = mv]$

$\Rightarrow \frac{v_1}{v_2} = \frac{m_2}{m_1}$

$\Rightarrow \frac{v_1}{v_2} = \frac{25}{5} = \frac{5}{1} \rightarrow B$

(3)

let m_1 = mass of 1st bicycle = 10 kg

$u_1 = 5$ m/s

m_2 = mass of 2nd bicycle = 15 kg.

$u_2 = 3$ m/s.

The momentum after collision = momentum before collision

$= m_1 u_1 + m_2 u_2$

$= 10 \times 5 + 15 \times 3$

$= 50 + 45$

$= 95$ kg m/s → A

(4)

Given momentum $p = 18$ Ns

velocity $v = 3$ m/s

mass $m = \frac{p}{v} = \frac{18}{3} = 6$ kg → D

(5)

Given $m_{ball} = 0.4$ kg ; $v_{ball} = 12$ m/s

Momentum = $p = m_{ball} v_{ball}$

$= 0.4 \times 12$

$= 4.8$ kg m/s → B

(6)

Given $m = 8$ kg ; momentum $p = 24$ Ns

We know momentum $p = mv$

$\Rightarrow 24 = 8 \times v$

$\Rightarrow v = \frac{24}{8} = 3$ m/s

(7)

Given $m = 3\,kg$. Velocity $= 3i + 4j$ m/s.

momentum of the body $p = m\,v$

$= 3[3\hat{i} + 4\hat{j}]$

$|\vec{P}| = 3\sqrt{3^2 + 4^2} = 3\sqrt{9+16} = 3\times\sqrt{25} = 15\,N s$

$\rightarrow p$

(8)

Given

mass $m = 250\,gm = 250\times10^{-3}\,kg$.

initial speed $u = 2\,m/s$.

Rebouncing speed $v = -2\,m/s$

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

$= 250\times10^{-3}(-2-2)$

$= 250\times10^{-3}\times(-4)$

$= 1\,kg\,m/s$

Advanced

(1)

we know momentum $p = m\,v$.

For p = same $m \propto \frac{1}{v}$

so large mass, small velocity (or) small mass, large velocity results same momentum.

(2)

we know momentum p = mass x velocity

so both mass & velocity affects momentum.

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(3)

we know momentum = mass × velocity.

when velocity is same

momentum ∝ 1/velocity 1/mass

Since mass of truck is more than bicycle

so momentum of bicycle is more than truck

A is false R is true → D.

(4)

we know momentum = mass × velocity.

∴ if velocity = 0 ie) the body is at rest

∴ it's momentum is zero. → A

(6), (7), (8)

Given $m_1 = 5\,kg$; $m_2 = 4\,kg$

$u_1 = 5\,m/s$; $u_2 = 8\,m/s$ [Before collision]

$v_1 = 5\,m/s$; $v_2 = 3\,m/s$ [After collision]

Momentum before collision $= m_1 u_1 + m_2 u_2$

$\Rightarrow 5 \times 5 + 8 \times 4 \Rightarrow 25 + 32 = 57$

momentum of 5kg body after collision $P_1 = m_1 v_1 = 5 \times 5$

$= 25\,m/s$

Total momentum after collision

$P = m_1 v_1 + m_2 v_2$

$= 5 \times 5 + 4 \times 3 = 25 + 12 = 37$ Ns

Advanced Task

(9)

Given $m_{car} = 1200$ kg ; $V_{car} = 25$ m/s.

∴ momentum of car $= m_{car} V_{car}$

$= 1200 \times 25$

$= 30000$ kg m/s

(10)

Given momentum $= 5$ kg m/s.

velocity $= 10$ m/s.

We know mass $= \frac{P}{V} = \frac{5}{10} = 0.5$ kg

L Task

CUQ's

(1)

According to Newton's IInd law

$F = \frac{dP}{dt}$

$\Rightarrow dP = F \times dt$

∴ Area under F-t gives change in momentum.

(2)

In case of vertically Projected body the velocity of the body decreases gradually while it is moving up and zero at maximum height. This is due to the body moves against gravity.

Since $P \propto V$, momentum (P) also decreases

(3)

A shell at rest explodes, the two pieces flies in opposite direction with same momentum, due to law of conservation of linear momentum.

let 'M' be mass of shell, and is at rest initially

So $u=0$

$\therefore P_{shell} = Mu = 0$

After Explosion m_1, m_2 and v_1, v_2 are masses and velocities of two pieces.

$$\therefore P_{shell} = P_{pieces}$$

$$\Rightarrow 0 = m_1 v_1 + m_2 v_2$$

$$\Rightarrow m_1 v_1 = -m_2 v_2$$

$$\Rightarrow P_{1\,piece} = -P_{2\,piece}.$$

(4)

when No force is acting ; $P = \text{constant}$

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

when $P = \text{constant}$; $F = 0$

(5)

In case of freely falling body, velocity of the body increases gradually because the body moves in the direction of gravity

Since momentum = mass x velocity

As velocity increases, momentum also increases

(9)

when body is at rest velocity = 0

we know that momentum = mass × velocity

∴ momentum = 0

(10)

we know that

momentum (p) = m × velocity

when p = constant ⇒ $m \propto \frac{1}{velocity}$

∴ lighter body will have more velocity.

Jee main level

(1)

Given mass m = 6 kg ; velocity v = 2 m/s

∴ momentum (p) = m × v = 6 × 2 = 12 kg m/s → D

(2)

initial velocity (u) = $-2\hat{i} - \hat{j}$ m/s

Final velocity v = $4\hat{i} + 7\hat{j}$ m/s

mass m = 2 kg

∴ change in momentum = m (v − u)

$\Rightarrow 2 (4\hat{i} + 7\hat{j} - (-2\hat{i} - \hat{j}))$

$= 2 [4\hat{i} + 7\hat{j} + 2\hat{i} + \hat{j}]$

$d\vec{p} = 2 [6\hat{i} + 8\hat{j}]$

∴ magnitude of change in momentum $|d\vec{p}| = 2\sqrt{6^2 + 8^2}$

$= 2\sqrt{36+64}$

$= 2 \times 10 = 20$ kg m/s

(3)

Given mass $m = 3M$

Initial velocity $u = 1.5V$; Final velocity $V = -1.5V$

∴ change in momentum $dp = m(V-u)$

$\Rightarrow 3M(-1.5V - 1.5V)$

$\Rightarrow 3M(-3V)$

$\Rightarrow -9MV \rightarrow B$

'-ve' sign shows dp is away from wall.

(4)

Given mass $m = 0.2$ kg ; velocity $= 15$ m/s

∴ momentum of the ball $= m \times V$

$= 0.2 \times 15$

$\Rightarrow 3$ kg m/s $\rightarrow B$

(5)

Given mass $m = 11$ kg ; momentum $= 44$ Ns

we know momentum $(p) = m \times V$

$\Rightarrow 44 = 11V$

$\Rightarrow V = 4$ m/s $\rightarrow A$

(6)

Given $m = 5000$ kg ; velocity $V = 20$ m/s

∴ momentum $(p) = m \times V$

$= 5000 \times 20$

$\Rightarrow 1,00,000$ kg m/s $\rightarrow D$

(7)

Given $m = 500\ gm = 500 \times 10^{-3}\ kg = 0.5$

Initial speed $(u) = 4 m/s$

Final speed $v = -4\ m/s$

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

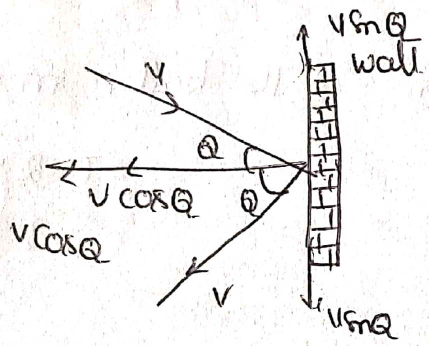
$\Rightarrow 0.5[-4-4)$

$\Rightarrow 0.5[-8]$

$\Rightarrow 4\ kg m/s$

Advanced

(1)



Here v sinQ are equal and opposite so they cancel with each other.

Initial velocity $= u\cos Q$

Final velocity $= v \cos Q$

$\therefore$ change in momentum $= m[v\cos Q + v\cos Q]$

$= 2mu\cos Q$

wall is at rest before and after collision so ~~it~~ does ~~not~~ its momentum is zero and does not change.

(2)

we know momentum = mass × velocity

As velocity doubled $v' = 2v$

$P \propto v \Rightarrow \frac{p'}{p} = \frac{v'}{v} \Rightarrow \frac{p'}{p} = \frac{2v}{v}$

$\Rightarrow p' = 2p$ → momentum doubled

8. (7), (8), (9)

Given mass $m = 4 kg$; initial velocity $u = 0$

Final velocity $v = 6 m/s$

∴ initial momentum P_I = m × initial velocity

= 4 × 0

= 0

Final momentum P_F = m × Final velocity

= 4 × 6

= 24 kgm/s.

change in momentum = $P_F - P_I$

= 24 − 0

= 24 kgm/s