Foundation +

WS-10 9th class

Thank

(1)

(1)

$m_{bullet} = 40\ gm = 40\times10^{-3}\ kg$: $M_{Riffle} = 16\ kg$

$V_{bullet} = 200\ m/s$ $V_{recoil} = ?$

According to law of conservation of linear momentum

$$V_{recoil} = -\frac{m_b u_b}{M_R}$$ -ve sign shows gun give kick in backward direction

$$\Rightarrow V_{recoil} = +\frac{40\times10^{-3}\times200}{16}$$

$$= \frac{8}{16} = 0.5\ m/s$$

(2)

$m_{bullet} = 100\ gm = 10^{-1}\ kg$: $u_{bullet} = 60\ m/s$.

$V_{recoil} = -2\ m/s$ $M_{gun} = ?$

According to law of conservation of linear momentum

$$V_{recoil} = -\frac{m_{bullet}\ u_{bullet}}{M_{gun}}$$

$$\Rightarrow +2 = +\frac{10^{-1}\times60}{M_{gun}} \Rightarrow M_{gun} = 30\times10^{-1} = 3\ kg$$

(3)

$m_A = 6\ kg$: $m_B = 4\ kg$

$u_A = 2\ m/s$ $u_B = -1.5\ m/s$ After collision the two bodies get struck and move with same velocity

$$V_A = V_B = V_{com}$$

According to LCLM $m_A u_A + m_B u_B = m_A V_A + m_B V_B$

3rd continuation

$\Rightarrow 6\times 2 + 4(-1.5) = 6V_{com} + 4V_{com}$

$\Rightarrow 12 - 6 = 10V_{com} \Rightarrow 10V_{com} = 6$

$\Rightarrow V_{com} = \frac{6}{10} = 0.6 m/s$

(4)

$m_1 = 6$ kg $\quad m_2 = ?$

u_1 = initial velocity $\quad u_2 = 0$

velocities of two bodies after collision $V_1 = V_2 = \frac{u_1}{3}$

∴ Acc to law of conservation of linear momentum

$m_1u_1 + m_2u_2 = m_1V_1 + m_2V_2$

$\Rightarrow 6\times u_1 + m_2\times 0 = 6\frac{u_1}{3} + m_2\frac{u_1}{3}$

$\Rightarrow 6u_1 = \frac{u_1}{3}(6+m_2) \Rightarrow 6 = \frac{1}{3}(6+m_2)$

$\Rightarrow 6+m_2 = 18$

$\Rightarrow m_2 = 12$ kg.

(5)

$u_{shot} = 140$ m/s $\quad m_{Block} = 13 m_{shot}$

$u_{Block} = 0.$

After striking both shot and block move with same velocity $V_{shot} = V_{Block} = V.$

Acc to law of conservation of linear momentum

$\Rightarrow m_s u_s + m_B u_B = m_s V_s + m_B V_B$

$\Rightarrow m_s\times 140 + m_B\times 0 = m_s V + 13 m_s V$

$\Rightarrow \frac{140}{10} m/s = 14 m/s\ V$

$\Rightarrow V = 10$ m/s

(6)

$m_1 = 2\ kg$; $m_2 = 4\ kg$

$u_1 = 6\ m/s$ $u_2 = 2\ m/s$

$v_1 = ?$ $v_2 = 4\ m/s$

According to Law of conservation of linear momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\Rightarrow 2\times6 + 4\times2 = 2v_1 + 2\times4$$

$$\Rightarrow 12 + 8 = 2v_1 + 16 \Rightarrow 2v_1 = 20 - 16$$

$$\Rightarrow 2v_1 = 4$$

$$\Rightarrow v_1 = 2\ m/s$$

(7)

$m_1 = 2\ kg$ $t = 2\ sec$ increase in speed $= 3$

$dv = 3\ m/s$

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

$$\Rightarrow F = 2\times\frac{3}{1} = 3\ N$$

(8)

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

From $F = ma$

$$\Rightarrow a = \frac{F}{m} = \frac{15}{20} = \frac{3}{4}$$

From $v = u + at \Rightarrow v = 0 + \frac{3}{4}\times8^2$

$$\Rightarrow v = 3\times2 = 6\ m/s$$

(9)

$m_b = 10\ gm = 10^{-2}\ kg$; $u_b = 300\ m/s$

$M_{gun} = 6\ kg$ $\quad v_{recoil} = ?$

According to law of conservation of linear momentum

$$v_{recoil} = -\frac{m_b u_b}{M_{gun}}$$

$$v_{recoil} = -\frac{10^{-2} \times 300}{6} = -0.5\ m/s$$

(10)

$m_b = 10\ gm = 10^{-2}\ kg$ $\quad u_b = 400\ m/s$

$m_{block} = 900\ gm$ After collision both bullet and block move with same velocity

$u_{block} = 0$

$v_{bullet} = v_{block} = v_{com}$.

According to law of conservation of linear momentum

$$m_{bullet} u_{bullet} + M_{block} u_{block} = M_{bullet} v_{bullet} + M_{block} v_{block}$$

$$\Rightarrow 10^{-2} \times 400 + 900 \times 0 = 10 v_{com} + 900 v_{com}$$

$$\rightarrow 4000 = 910\ v_{com}$$

$$\rightarrow v_{com} = \frac{4000}{910} = 4.4\ m/s$$

(16), (17)

$m_1 = 1$ kg ; $m_2 = 3$ kg

$u_1 = 9$ m/s ; $u_2 = 3$ m/s

$v_1 = 2$ m/s

Before collision $P = m_1 u_1 + m_2 u_2$

$= 1 \times 9 + 3 \times 3$

$= 9 + 9 = 18$ kg m/s

According to law of conservation of linear momentum

$P_{Before} = m_1 v_1 + m_2 v_2$

$\Rightarrow 18 = 1 \times v_1 + 3 \times 2$

$\Rightarrow 18 = v_1 + 6 \Rightarrow v_1 = 18 - 6 = 12$ m/s

(18), (19)

$m_1 = 4$ kg ; $m_2 = 8$ kg ; $u_1 = 4$ m/s ; $u_2 = 2$ m/s

$v_2 = 8$ m/s $v_1 = ?$

According to LCLM

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

$\Rightarrow 4 \times 4 + 8 \times 2 = 4 \times v_1 + 8 \times 8$

$\Rightarrow 16 + 16 = 4 v_1 + 64$

$\Rightarrow 32 = 4 v_1 + 64$

$\Rightarrow 4 v_1 = 32 - 64$

$\Rightarrow 4 v_1 = -32$

$\Rightarrow v_1 = -8$ m/s

If $v_1 = v_2 = v_{com}$

$$P_{Before} = P_{After}$$

$$\Rightarrow m_1 u_1 + m_2 u_2 = m_1 v_{com} + m_2 v_{com}$$

$$\Rightarrow 32 = 4 v_{com} + 8 v_{com}$$

$$\Rightarrow 32 = 12 v_{com}$$

$$v_{com} = \frac{32}{12} = \frac{8}{3} = 2.66 \text{ m/s}$$

LTask

SAQ's

(1)

$M = 300$ gm, $u = 0$

$m_1 = 200$ gm, $v_1 = 12(-\hat{i})$ m/s

$m_2 = 100$ gm, $v_2 = ?$

According to law of conservation of linear momentum

$$Mu = m_1 v_1 + m_2 v_2$$

$$\Rightarrow 300 \times 0 = 200[12(-\hat{i})] + 100 v_2$$

$$\Rightarrow 0 = 2400(-\hat{i}) + 100 v_2$$

$$\Rightarrow 100 v_2 = +2400\hat{i} \Rightarrow v_2 = 24\hat{i}$$ towards North

(2)

$m_s = 2$ kg, $M_c = 198$ kg, $u_s = 50$ m/s

According to LCLM

$$v_{recoil} = -\frac{m_s u_s}{M_c}$$

$$= -\frac{2 \times 50}{198}$$

$$= -\frac{100}{198} \simeq -0.5 \text{ m/s}$$

(3)

M, V.

$m_1 = m$ $\quad u_1 = 0$ $\quad m_2 = M - m$ $\quad v_2 = ?$

Acc to LCLM

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$\Rightarrow MV = m \times 0 + (M-m) v_2$$

$$\Rightarrow MV = (M-m) v_2$$

$$\Rightarrow v_2 = \frac{MV}{M-m}$$

(4)

$M_{t_1} = 1200$ kg $\quad u_1 = 7$ m/s ; $M_{t_2} = 1600$ kg $\quad u_2 = 0$

After collision both are moving with same velocity

$$v_1 = v_2 = v_{com}.$$

Acc to law of conservation of linear momentum

$$m_{t_1} u_1 + m_{t_2} u_2 = M_{t_1} v_1 + m_{t_2} v_2$$

$$\Rightarrow 1200 \times 7 + 1600 \times 0 = 1200 v_{com} + 1600 v_{com}$$

$$\Rightarrow \overset{3}{\cancel{1200}} \times 7 = \overset{4}{\cancel{2800}} v_{com} \Rightarrow v_{com} = 3 \text{ m/s}$$

(9)

$a = 1 \text{ m/s}^2$; $m = 500 \text{ gm} = 5 \times 10^{-1}$ kg.

From $F = ma = 5 \times 10^{-1} \times 1$

$= 0.5 N$

(5)

$m_1 = 10000\,kg$; $u_1 = 1\,m/s$

$m_2 = 2m_1$ $\quad u_2 = -0.2\,m/s$ After collision the two trucks are coupled so their velocity after collision is same

$$v_1 = v_2 = v$$

Acc to law of conservation of linear momentum

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$\Rightarrow m_1 \times 1 + 2m_1 \times (-0.2) = m_1v + 2m_1v$$

$$\Rightarrow m_1 - 0.4m_1 = 3m_1v$$

$$\Rightarrow 0.6m_1 = 3m_1v \Rightarrow v = \frac{0.6}{3} = 0.2\,m/s$$

(6)

$M = 238$ $\quad u = 0$

After α-particle [$_2He^4$] was emitted

mass of remaining nucleus $m_1 = 234$; $m_2 = m_\alpha = 4$

$$v_\alpha = v.$$

According to law of conservation of linear momentum

$$Mu = m_1v_1 + m_2v_2$$

$$\Rightarrow 238 \times 0 = 234v_1 + 4v$$

$$\Rightarrow 234v_1 = -4v$$

$$\Rightarrow v_1 = -\frac{4v}{234}$$

(7)

$M_{man} = 50\ kg$ $\quad m_{stone} = 0.1\ kg$

$V_{man} = ?$ $\quad V_{stone} = 10\ m/s$

According to law of conservation of linear momentum

$$V_{man} = - \frac{m_{stone} \times V_{stone}}{M_{man}}$$

$$\Rightarrow V_{man} = - \frac{0.1 \times 10}{50} = -\frac{1}{50} = -0.02\ m/s$$

'-ve' sign shows both stone and man moves back in opposite direction to motion of stone

(8)

$M = 40\ kg$; $u = 80\ m/s$

$m_1 = 32\ kg$; $m_2 = 8\ kg$

$V_1 = ?$ $\quad V_2 = 0$

Acc to LCLM $\quad Mu = m_1V_1 + m_2V_2$

$$\Rightarrow 40 \times 80 = 32 \times V_1 + 8 \times 0$$

$$\Rightarrow 3200 = 32 V_1$$

$$\Rightarrow V_1 = 100\ m/s$$

(10)

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

$F = ma = 20 \times 5 = 100$ dynes

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

$= 10^{-3}\ N$

(12)

Given $\frac{m_1}{m_2} = \frac{2}{3}$

when shell is exploded into 2 pieces. Acc to law of conservation of linear momentum the two pieces have equal and opposite momenta's.

$P_1 = -P_2$

$\Rightarrow m_1 v_1 = -m_2 v_2$

$\Rightarrow \frac{v_1}{v_2} = -\frac{m_2}{m_1} = \frac{3}{2}$

$\frac{P_1}{P_2} = \frac{1}{1}$ ∴ lighter body have greater velocity

because mass $\propto \frac{1}{\text{velocity}}$ [P = constant]

(18)

$m_{bullet} = 50\ gm = 50 \times 10^{-3}\ kg$ $\quad u_{bullet} = 30\ m/s$

$M_{gun} = ?$ $\quad v_{recoil} = -1\ m/s$

According to law of conservation of linear momentum

$$v_{recoil} = -\frac{m_{bullet} \times v_{bullet}}{M_{gun}}$$

$$\Rightarrow +1 = +\frac{50 \times 10^{-3} \times 30}{M_{gun}}$$

$$\Rightarrow M_{gun} = 1500 \times 10^{-3}$$

$$= 1.5\ kg$$

(19)

$M_G = 10\ kg$ $\quad m_b = 10\ gm = 10^{-2}\ kg$

$U_{recoil} = ?$ $\quad u_b = 400\ m/s$ $\quad n = 4$

According to LCLM $\quad U_{recoil} = -n\frac{m_b u_b}{M_G}$

$\Rightarrow U_{recoil} = -4\times\frac{10^{-2}\times 400}{10}$

$= -0.4\ m/s \times 4$

$= -1.6\ m/s.$

(20) (21)

$m_1 = 6\ kg$, $m_2 = 8\ kg$ $\quad u_2 = 8\ m/s$

$u_1 = 4\ m/s$; $u_2 = 2\ m/s$ $\quad V_1 = ?$

According to law of conservation of linear momentum

$m_1 u_1 + m_2 u_2 = m_1 V_1 + m_2 V_2$

$\Rightarrow 6\times 4 + 8\times 2 = 6\times V_1 + 8\times 8$

$\Rightarrow 24 + 16 = 6V_1 + 64$

$\Rightarrow 40 = 6V_1 + 64 \Rightarrow 6V_1 = -24 \Rightarrow V_1 = -4\ m/s$

momentum After collision $= m_1 V_1 + m_2 V_2$

$= 6\times(-4) + 8\times 8$

$= -24 + 64$

$= 40\ Ns$