

$$2 \times 6 + 4 \times 2 = 2v_1 + 4 \times 4$$

$$\Rightarrow 12 + 8 = 2v_1 + 16 \Rightarrow 2v_1 = 4 \Rightarrow v_1 = 2 \text{ m/s}$$

①

$$m_b = 150 \text{ gm}$$

$$= 150 \times 10^{-3} \text{ kg} ; u = 20 \text{ m/s} ; b = 0.04 \text{ m} ; e = 4 \times 10^{-2}$$

$$\text{From Newton's 2nd law } F = m \frac{du}{dt} = 150 \times 10^{-3} \times \frac{20}{4 \times 10^{-2}}$$

$$F = -75 \text{ N}$$

$$\text{From } F = ma \Rightarrow a = \frac{F}{m} = \frac{-75}{150 \times 10^{-3}} = -500 \text{ m/s}^2$$

$$\text{From } v^2 - u^2 = 2as$$

$$\Rightarrow 0 - (20)^2 = -2(500)s$$

$$\Rightarrow -400 = -1000 s$$

$$\Rightarrow s = \frac{400}{1000} = 0.4 \text{ m}$$

⑦

$$m_{\text{bullet}} = 50 \text{ gm} = 50 \times 10^{-3} \text{ kg}$$

$$u_{\text{bullet}} = 1000 \text{ m/s}$$

$$F = 180 \text{ N}$$

$$= 20.52 \times 10^{-2}$$

$$= 0.8 \text{ m}$$

(2)

$$m = 0.05 \text{ kg} = 5 \times 10^{-2} \text{ kg}$$

$$u = 4 \text{ m/s} \quad v = -u = -4 \text{ m/s} \quad \Delta t = 0.01 \text{ s} = 10^{-2} \text{ s}$$

$$\therefore \text{ we know } F = \frac{dp}{dt} = m \frac{dv}{dt}$$

$$F = 5 \times 10^{-2} \left[\frac{v - u}{\Delta t} \right]$$

$$= 5 \times 10^{-2} \times \left[\frac{-4 - 4}{10^{-2}} \right]$$

$$= 5 \times (-8) = -40 \text{ N}$$

Force is opposing force.



Ask Copilot



2 of 129



$$m_A = 6 \text{ kg} : u_A = 2 \text{ m/s}$$

$$m_B = 4 \text{ kg} : u_B = -1.5 \text{ m/s}$$

After collision two bodies struck with

∴ they move with same velocity after collision

$$v_A = v_B = v_{\text{com}}$$

According to law of conservation of linear momentum

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

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

$$\Rightarrow 12 - 6 = 10 v_{\text{com}} \Rightarrow 10 v_{\text{com}} = 6$$

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

(4)

$$m_1 = 6 \text{ kg} : u_2 = 0$$

After collision $v_2 = \frac{1}{3} u_1 = v$, $m_2 = ?$

According to law of conservation of linear momentum

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

$$\Rightarrow 6 \times u_1 + m_2 (0) = 6 \left(\frac{1}{3} u_1 \right) + m_2 \left(\frac{1}{3} u_1 \right)$$

$$\Rightarrow 6 u_1 = 2 u_1 + \frac{m_2}{3} u_1$$

$$\Rightarrow 6 = 2 + \frac{m_2}{3} \Rightarrow \frac{m_2}{3} = 6 - 2 \Rightarrow \frac{m_2}{3} = 4 \Rightarrow m_2 = 12 \text{ kg}$$

(5)

mass of shot $m_1 = m$, let its velocity be $u_1 = 140 \text{ m/s}$

mass of block $m_2 = M = 13m$; $u_2 = 0$

After firing both shot and block travel with some velocity

According to law of conservation of linear momentum

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

$$\Rightarrow m \times 140 + m_2(0) = m v_{cm} + 13m v_{cm}$$

$$\Rightarrow m \times 140 = 14m v_{cm}$$

$$\Rightarrow v_{cm} = 10 \text{ m/s}$$

⑥

$m_1 = 2 \text{ kg}$; $u_1 = 6 \text{ m/s}$; $m_2 = 4 \text{ kg}$; $u_2 = 2 \text{ m/s}$

$u_2 = 4 \text{ m/s}$

According to law of conservation of linear momentum

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

$$\Rightarrow 2 \times 6 + 4 \times 2 = 2 v_1 + 4 \times 4$$

$$\Rightarrow 12 + 8 = 2 v_1 + 16 \Rightarrow 2 v_1 = 4 \Rightarrow v_1 = 2 \text{ m/s}$$

⑦

$$m_1 = 150 \text{ g}$$

Task

⑦

Given Retarding force $F = -150 \text{ N}$

Mass $m = 50 \text{ kg}$

Initial speed $u = 30 \text{ m/s}$; Final speed $v = 0$

From $F = ma$

$$\Rightarrow -150 = 50 \times a \quad \Rightarrow a = \frac{-150}{50} = -3 \text{ m/s}^2$$

From

$$v = u + at$$

$$\Rightarrow 0 = 30 + (-3)t$$

$$\Rightarrow -30 = -3t \Rightarrow t = 10 \text{ s.}$$

⑧

According to law of conservation of linear momentum

8

According to law of conservation of linear momentum

momentum of 3rd piece is in a direction opposite to the resultant momentum of 2 pieces.

let original mass = M ; speed $u=0$

$$m_1 = \frac{2M}{3} : m_2 = \frac{M}{3} : m_3 = \frac{M}{3}$$

Acc to LCLM

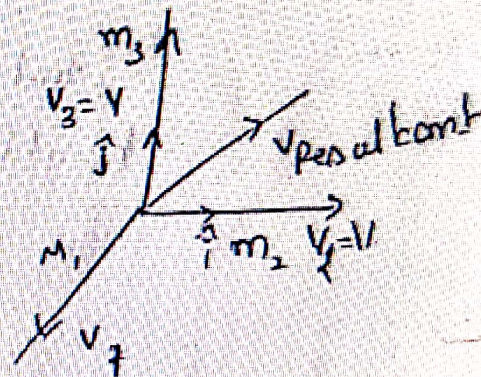
$$Mu = m_1 v_1 + m_2 v_2 + m_3 v_3$$

$$\Rightarrow 0 = \frac{2M}{3} v_1 + \frac{M}{3} v_2 + \frac{M}{3} v_3$$

$$\Rightarrow \frac{2M v_1}{3} = - \left[\frac{M}{3} v_2 + \frac{M}{3} v_3 \right]$$

$$\Rightarrow \frac{2M}{3} v_1 = - \frac{M}{3} (v_2 + v_3)$$

$$\Rightarrow 2v_1 = -v \sqrt{1^2 + 1^2}$$



$$\Rightarrow 2v_1 = -v\sqrt{2}$$

$$\Rightarrow v_1 = -v \frac{\sqrt{2}}{2}$$

$$\Rightarrow v_1 = -\frac{v}{\sqrt{2}}$$

(9)

No. of bullets per sec $\frac{N}{t} = 40$

$$m_{\text{bullet}} = 35 \times 10^{-3} \text{ kg}$$

$$u_{\text{bullet}} = 400 \text{ m/s}$$

$$M_{\text{Rifle}} = 20 \text{ kg}$$

According to Law of conservation of linear momentum

$$u_{\text{recoil}} = - \frac{m_{\text{bullet}} u_{\text{bullet}} \times N}{M_{\text{Rifle}}}$$

$$= - \frac{35 \times 10^{-3} \times 400 \times 40}{20}$$

$$= - 35 \times 800 \times 10^{-3}$$

$$= - 28000 \times 10^{-3} = - 28 \text{ m/s}$$

$$\text{Force acting on rifle} = m \frac{du}{dt}$$

For 'N' bullets

$$F = N m \frac{du}{dt}$$

$$= 4 \times 35 \times 10^{-3} \times 400$$

$$F = - 56 \text{ N}$$

(10)

10

Given

$$m_{\text{bullet}} = 10 \text{ gm} = 10 \times 10^{-3} \text{ kg} = 10^{-2} \text{ kg}$$

$$\text{initial velocity } u = 1000 \text{ m/s}; \text{ final velocity } v = 500 \text{ m/s}$$

$$\text{height of rifle } h = 50 \text{ m}$$

$$\text{work done against air resistance } W = mgh + \frac{1}{2}m(u^2 - v^2)$$

$$W = 10^{-2} \times 10 \times 50 + \frac{1}{2} \times 10^{-2} (1000^2 - 500^2)$$

$$= 5 + \frac{1}{2} \times 10^{-2} \times (1500)(500)$$

$$= 5 + \frac{7500}{2} = 5 + 3750 = 3755 \text{ J}$$

7th foundation
Advanced

7th Foundation + 68-11

Advanced

②

①

Given

$$m_{\text{bullet}} = 50 \text{ gm} = 50 \times 10^{-3} \text{ kg}$$

$$u_{\text{bullet}} = 30 \text{ m/s}$$

$$v_{\text{gun}} = 1 \text{ m/s} : M_{\text{gun}} = ?$$

According to law of conservation of linear momentum

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

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

$$\therefore M_{\text{gun}} = 0.15 \text{ kg}$$

⑩

Given

$$m_{\text{gun}} = 10 \text{ kg}$$

$$m_{\text{bullet}} = 10 \text{ gm} = 10 \times 10^{-3} \text{ kg} \\ = 10^{-2} \text{ kg}$$

(10)

Given $m_{\text{gun}} = 10 \text{ kg}$: $m_{\text{bullet}} = 10 \text{ gm} = 10 \times 10^{-3} \text{ kg}$
 $= 10^{-2} \text{ kg}$

$$v_{\text{bullet}} = 400 \text{ m/s}$$

No. of bullets fired $N = 4$

According to law of conservation of linear momentum



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

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

$$= -1.6 \text{ m/s}$$

'-ve' sign shows gun given kick in backward direction after firing.

Task

Ice man's level

①

$$M = 300 \text{ kg} \quad u = 0$$

$$m_1 = 200 \text{ kg} \quad u_1 = 12 \text{ m/s } (-\hat{i}) \quad [-\hat{i} \text{ is a vector towards west}]$$

$$m_2 = 100 \text{ kg} \quad v_2 = ?$$

According to law of conservation of linear momentum

$$Mu = m_1 u_1 + m_2 v_2$$

$$\Rightarrow M(0) = 200(-12\hat{i}) + 100 v_2$$

$$\Rightarrow 200 \times 12 \hat{i} = 100 v_2$$

$$v_2 = 24 \hat{i} \rightarrow \text{towards East}$$

$$= 24 \text{ m/s}$$

②

$$M_{\text{shot}} = 2 \text{ kg} \quad \therefore M_{\text{cannon}} = 198 \text{ kg} \quad \therefore u_{\text{shot}} = 50 \text{ m/s}$$

According to law of conservation of linear momentum

$$v_{\text{recoil}} = - \frac{M_{\text{shot}} u_{\text{shot}}}{M_{\text{can}}}$$

$$= - \frac{2 \times 50}{198} = - \frac{100}{198} \approx -0.5 \text{ m/s}$$

③

$$M_{\text{shell}} = M \quad u = v$$

$$V_{\text{recoil}} = - \frac{M_{\text{shot}} U_{\text{shot}}}{M_{\text{can}}}$$

$$V_{\text{recoil}} = - \frac{2 \times 50}{100} = - \frac{100}{100} = -0.5 \text{ m/s}$$

③

$$M_{\text{shell}} = M \therefore U = V$$

$$m_1 \text{ is at rest } u=0 \quad m_2 = (M-m) \therefore V_2$$

According to law of conservation of linear momentum

$$M V = m_1 u_1 + m_2 u_2$$

$$\therefore M U = m(0) + (M-m) V_2$$

$$\therefore V_2 = \frac{M U}{M-m}$$

④

$$m_b = 40 \text{ m} = 40 \times 10^{-3} \text{ kg} \quad ; \quad u_b = 100 \text{ m/s}$$

$$m_p = 16 \text{ kg}$$

$$V_p = ?$$

According to law of conservation of linear momentum

$$V_{\text{recoil}} = - \frac{m_b u_b}{m_p}$$

$$= - \frac{40 \times 10^{-3} \times 100}{16}$$

$$= - \frac{1}{4} = -0.25 \text{ m/s}$$

⑤

$$m_1 = 6 \text{ kg} \quad m_2 = 8 \text{ kg} \quad u_1 = 4 \text{ m/s} \quad u_2 = 2 \text{ m/s}$$



$$= -\frac{1}{4} = -0.25 \text{ m/s}$$

5

$$m_1 = 6 \text{ kg} ; m_2 = 8 \text{ kg} ; u_1 = 4 \text{ m/s} ; u_2 = 2 \text{ m/s}$$

$$v_1 = ? ; v_2 = 8 \text{ m/s}$$

According to law of conservation of linear momentum

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

$$\Rightarrow 6 \times 4 + 8 \times 2 = 6 v_1 + 8 \times 8$$

$$\Rightarrow 24 + 16 = 6 v_1 + 64$$

$$\Rightarrow 6 v_1 = 40 - 64 \Rightarrow 6 v_1 = -24 \Rightarrow v_1 = -4 \text{ m/s}$$

6

$$m_b = 100 \text{ gm} ; u_b = 60 \text{ m/s} ; v_{\text{recoil}} = 2 \text{ m/s} ; M_g = ?$$

According to law of conservation of linear momentum

$$M_g v_{\text{recoil}} = - m_b v_b$$

$$\Rightarrow M_g (2) = - (100) (60)$$

$$\Rightarrow M_g = 3000 \text{ gm} = 3 \text{ kg}$$

④

$$m_1 = 3 \text{ kg} ; m_2 = 6 \text{ kg} ; u_1 = 1 \text{ m/s} ; u_2 = 2 \text{ m/s}$$

$$u_2 = 6 \text{ m/s} ; v_1 = ?$$

According to law of conservation of linear momentum

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

$$\Rightarrow 3 \times 1 + 6 \times 2 = 3v_1 + 6 \times 6$$

$$\Rightarrow 3 + 12 = 3v_1 + 36$$

$$3v_1 = -21 \Rightarrow v_1 = -7 \text{ m/s}$$

⑧

$$M_{\text{man}} = 40 \text{ kg} ; u_{\text{m}} = 12 \text{ kmph}$$

$$m_{\text{can}} = 0.5 \text{ quintal} \\ = 50 \text{ kg}$$

After jumping into can

both man & can moving with same velocity

According to law of conservation of linear momentum

$$M_{\text{m}} u_{\text{m}} + 0 = M_{\text{m}} v_{\text{m}} + m_{\text{can}} v_{\text{can}}$$

$$\Rightarrow 40 \times 12 = 40 v_{\text{cm}} + 50 v_{\text{cm}}$$

$$\Rightarrow 40 \times 12 = 90 v_{\text{cm}}$$

$$\Rightarrow v_{\text{cm}} = \frac{480}{90} = 5.33 \text{ kmph}$$



19.

$$m_{\text{bullet}} = 50 \text{ gm} : u_b = 30 \text{ m/s}$$

$$m_{\text{gun}} = ?$$

$$v_{\text{recoil}} = -1 \text{ m/s}$$

According to law of conservation of momentum

$$v_{\text{recoil}} = - \frac{m_{\text{bullet}} u_b}{M_g}$$

$$\Rightarrow 1 = \frac{50 \times 30}{M_g}$$

$$\Rightarrow M_g = 1500 \text{ gm} = 1.5 \text{ kg}$$

20.

$$M_g = 10 \text{ kg} : m_{\text{bullet}} = 10 \text{ gm} = 10 \times 10^{-3} \text{ kg} = 10^{-2} \text{ kg}$$

$$u_{\text{bullet}} = 400 \text{ m/s}$$

For $n = 4$ per sec.

According to law of conservation of linear momentum

$$M_g v_g = \frac{n}{t} m_b u_b$$

$$\Rightarrow 10 v_g = 4 \times 10^{-2} \times 400$$

$$\Rightarrow v_g = \frac{4 \times 4}{10} = 1.6 \text{ m/s}$$



(9)

Given $M = 0.3$

(9)

Given

$$m_b = 50 \text{ gm} = 50 \times 10^{-3} \text{ kg}$$

$$v_b = 10^3 \text{ m/s} ; F_g = 180 \text{ N}$$

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

$$P = N m_b v_b$$

$$\Rightarrow F = N \frac{m_b v_b}{dt}$$

$$\Rightarrow 180 = \frac{N}{dt} \times 50 \times 10^{-3} \times 10^3$$

$$\Rightarrow \frac{N}{dt} = \frac{18}{5} = 3.6 \text{ in min} \\ = 3.6 \times 60 = 216.$$

(10)

$$M_{\text{air}} = 2 \text{ gm} = 2 \times 10^{-3}$$

$$v_{\text{air}} = 2 \text{ m/s} ; t = 5 \text{ sec}$$

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

$$\Rightarrow 2 \times 10^{-3} \times \frac{2}{5}$$

$$\Rightarrow 0.8 \times 10^{-3}$$

$$\Rightarrow 8 \times 10^{-4} \text{ N.}$$