

WS-7 Integrated 9th class ①
Task

①

$$d = 0.8 \text{ kg/cc}$$

$$= 0.8 \times 10^6 \text{ kg/m}^3$$

$$v = 2 \text{ m/s}$$

we know $K.E = \frac{1}{2} m v^2$

$$\Rightarrow K.E = \frac{1}{2} \times d \times \text{vol} \times v^2$$

$$\Rightarrow \frac{K.E}{\text{vol}} = \frac{1}{2} \times d \times v^2$$

$$= \frac{1}{2} \times 0.8 \times 10^6 \times (2)^2$$

$$\Rightarrow 1.6 \times 10^6 \text{ J/m}^3$$

$$\Rightarrow \underline{1.6 \text{ J/cc}}$$

②

we know

$$K.E = \frac{1}{2} m v^2$$

$$= \frac{1}{2} \times \text{density} \times \text{volume} \times v^2$$

$$= \frac{1}{2} \times d \times \frac{4\pi}{3} r^3 \times v^2$$

$$\therefore K.E \propto d r^3 v^2$$

$$K_1 \propto d r^3 v^2$$

$$K_2 \propto d \left(\frac{r}{2}\right)^3 \left(\frac{v}{2}\right)^2 \Rightarrow K_2 \propto d \frac{r^3}{8} \frac{v^2}{4} \Rightarrow K_2 \propto \frac{d r^3 v^2}{32}$$

$$K_3 \propto \frac{d}{2} (2r)^3 (v)^2 \Rightarrow K_3 \propto \frac{d}{2} \times 8 r^3 \times v^2 \Rightarrow K_3 \propto 4 d r^3 v^2$$

K_3, K_1, K_2 . [descending order]

(2)

(3)

work done = change in k.E

$$\Rightarrow F \cdot s = \frac{1}{2} m (v^2 - u^2) \quad [v=0 \text{ because the body is coming to rest}]$$

$$\Rightarrow F \cdot s = -\frac{1}{2} m u^2$$

$$\Rightarrow s = -\frac{1}{2} m \frac{u^2}{F} \Rightarrow s \propto \frac{u^2}{F}$$

$$s_1 \propto \frac{u^2}{F} ; \quad s_2 \propto \frac{(2u)^2}{\frac{F}{2}}$$

$$\Rightarrow s_2 \propto 4 \frac{u^2}{\frac{F}{2}} \Rightarrow s_2 \propto 8 \frac{u^2}{F}$$

$$s_3 \propto \frac{\left(\frac{u}{2}\right)^2}{2F} \Rightarrow s_3 \propto \frac{u^2}{4 \times 2F} \Rightarrow s_3 \propto \frac{u^2}{8F}$$

Ascending order $\rightarrow s_3, s_1, s_2$.

(4)

$$m' = \frac{1}{8} m$$

$$v' = 2v$$

$$k.E = \frac{1}{2} m v^2$$

$$k.E' = \frac{1}{2} m' v'^2$$

$$\Rightarrow \frac{k.E}{k.E'} = \frac{\frac{1}{2} m v^2}{\frac{1}{2} m' v'^2} = \frac{m v^2}{m' v'^2} = \frac{m v^2}{\frac{m}{8} \times (2v)^2}$$

$$\Rightarrow \frac{k.E}{k.E'} = \frac{m v^2}{\frac{4}{8} \times m v^2} = \frac{8}{4} = \frac{2}{1}$$

$$\Rightarrow k.E' = \frac{1}{2} k.E \times 100 = 200\% \quad k.E = [100+100]\% k.E$$

100% increased

(5)

$$m_1 = 2 \text{ gm} ; m_2 = 8 \text{ gm}$$

$$\text{Given } k \cdot E_1 = k \cdot E_2$$

$$\text{we know that } k \cdot E = \frac{p^2}{2m}$$

$$\Rightarrow 2m \cdot k \cdot E = p^2$$

$$\Rightarrow p^2 \propto m$$

$$\Rightarrow \left(\frac{p_1}{p_2} \right)^2 = \frac{m_1}{m_2}$$

$$\Rightarrow \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$$

$$\Rightarrow \frac{p_1}{p_2} = \sqrt{\frac{2}{8}} = \frac{1}{2}$$

(6)

$$m = 2 \text{ kg} ; u = 0$$

$$a = 2 \text{ m/s}^2$$

$$t = 2 \text{ sec.}$$

$$\text{From } v = u + at$$

$$v = 0 + 2 \times 2 = 4 \text{ m/s}$$

$$\text{Gain in } k \cdot E = \frac{1}{2} m (v^2 - u^2)$$

$$= \frac{1}{2} \times 2 (4^2 - 0^2)$$

$$= 16 - 0$$

$$= 16 \text{ J}$$

(7)

$$m = 0.5 \text{ kg} ; u = 2 \text{ m/s}$$

$$v = 0 ; s = 2 \text{ m}$$

we know According to

W-E Theorem

$$W = \Delta k \cdot E$$

$$W = \frac{1}{2} m (v^2 - u^2)$$

$$= \frac{1}{2} \times 0.5 \times (0^2 - 2^2)$$

$$= \frac{1}{2} \times \frac{1}{2} \times (0 - 4)$$

$$= -\frac{4}{4} = -1 \text{ J}$$

Force is resistive force

(8)

$$m_1 = 3 \text{ kg} ; m_2 = 2 \text{ kg}$$

$$k \cdot E_{\text{Initial}} = 600 \text{ J}$$

According to Law of conserve
of linear momentum

$$m_1 u_1 = m_2 v_2$$

$$\Rightarrow 3u_1 = -2v_2$$

$$\Rightarrow v_2 = -\frac{3}{2} u_1$$

we know $k \cdot E \propto m v^2$

$$\Rightarrow \frac{k \cdot E_1}{k \cdot E_2} = \frac{m_1 v_1^2}{m_2 v_2^2} = \frac{3}{2} \frac{v_1^2}{(-\frac{3}{2} v_1)^2}$$

$$\frac{k \cdot E_1}{k \cdot E_2} = \frac{3}{2} \times \frac{4}{9} \times \frac{v_1^2}{v_1^2} = \frac{2}{3}$$



$$\underline{k \cdot E_2} = \frac{3}{2} k \cdot E_1$$

Given total $k \cdot E = 600 \text{ J}$

$$\Rightarrow k \cdot E_1 + k \cdot E_2 = 600 \text{ J}$$

$$\Rightarrow k \cdot E_1 + \frac{3}{2} k \cdot E_1 = 600$$

$$\Rightarrow \frac{5}{2} k \cdot E_1 = 600$$

$$\Rightarrow k \cdot E_1 = 2 \times \frac{600}{5} = 2 \times 120 = 240 \text{ J}$$

(9)

$$m = 200 \text{ gm}$$

$$l = 1 \text{ m}, \theta = 60^\circ$$

$$= 200 \times 10^{-3} \text{ kg}$$

As the pendulum passing through mean position

$$k \cdot E = \frac{1}{2} m v^2$$

$$v = \sqrt{2gl(1 - \cos\theta)}$$

$$\Rightarrow k \cdot E = \frac{1}{2} \times 2 \times 10^{-1} \times (\sqrt{2 \times 9.8 \times 1 (1 - \cos 60)})^2$$

$$= 10^{-1} \times [2 \times 9.8 \times 1 (1 - \cos 60)]$$

$$= 10^{-1} \times 19.6 \times (1 - \frac{1}{2}) = 19.6 \times 10^{-1} \times \frac{1}{2} = 0.98 \text{ J} \approx 1 \text{ J}$$

(10)

$$m_{\text{Bullet}} = m : u_{\text{bullet}} = u$$

According to law of conservation of linear momentum

$$P_{\text{gun}} = -P_{\text{bullet}}$$

$$\Rightarrow M_g v_g = -m_{\text{bullet}} u_{\text{bullet}}$$

$$\Rightarrow M v_g = -m u$$

$$\Rightarrow v_g = -\frac{m}{M} u$$

$$\frac{k \cdot E_{\text{bullet}}}{k \cdot E_{\text{gun}}} = \frac{\frac{1}{2} m u^2}{\frac{1}{2} M v_g^2} = \frac{m u^2}{M (\frac{m}{M} u)^2}$$

$$= \frac{m}{M} \frac{M^2}{m^2} \frac{u^2}{u^2} = \frac{M}{m}$$

L TaskJee main level

(1)

Given $m = 40 \text{ kg}$

$$F_1 = 4 \text{ N}; \quad F_2 = 3 \text{ N}; \quad \theta = 90^\circ$$

$$\text{Resultant force } F = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos \theta}$$

$$\Rightarrow F = \sqrt{4^2 + 3^2 + 2 \times 4 \times 3 \times \cos 90^\circ}$$

$$= \sqrt{16 + 9} = \sqrt{25} = 5 \text{ N}$$

$$\therefore \text{Acceleration of the body } a = \frac{F}{m} = \frac{5}{40} = \frac{1}{8} \text{ m/s}^2$$

$$\text{After } t = 10 \text{ sec velocity } v = u + at$$

$$\Rightarrow v = 0 + \frac{1}{8} \times 10 = \frac{10}{8} = 1.25 \text{ m/s}$$

$$\therefore \text{K.E.} = \frac{1}{2} m v^2 = \frac{1}{2} \times 40 \times \left(\frac{10}{8}\right)^2$$

$$= 20 \times 6.25 = 125 \text{ J}$$

$$\text{K.E.} = \frac{1}{2} m v^2 = \frac{1}{2} \times 40 \times (1.25)^2 = 125 \text{ J}$$

(2)

Given Percentage increase in momentum

$$\frac{\Delta p}{p} = 0.01\% \quad \because K.E. \propto p^2$$

$$\text{we know } \frac{\Delta K.E.}{K.E.} = 2 \frac{\Delta p}{p}$$

$$= 2 \times 0.01\%$$

$$\Rightarrow 0.02\%$$

(4)

(3)

let p' be the new momentum of a body

$$\text{then } p' = p_0 + \frac{100}{100} p_0 = \frac{200}{100} p_0 = 2p_0$$

$k \cdot E$ be initial kinetic energy.

$$k \cdot E \propto p^2 \Rightarrow \frac{k \cdot E}{k \cdot E'} = \left[\frac{p}{p'} \right]^2$$

$$\Rightarrow \frac{k \cdot E}{k \cdot E'} = \left[\frac{p}{2p} \right]^2 = \frac{1}{2^2}$$

$$\Rightarrow \frac{k \cdot E}{k \cdot E'} = \frac{1}{4} \Rightarrow k \cdot E' = 4 k \cdot E$$

$$= 400\% k \cdot E$$

$$= [100 + 300]\% k \cdot E$$

$\therefore k \cdot E$ increased by 300%

(4)

$$m = 40 \text{ kg}, \quad k \cdot E = 21 \text{ kJ}$$

$$= 21 \times 10^3 \text{ J} \quad \eta = 28\%$$

$$\text{we know efficiency } \eta = \frac{E_{\text{out}}}{E_{\text{in}}}$$

$$\Rightarrow \frac{28}{100} = \frac{mgh}{21 \times 10^3}$$

$$\Rightarrow mgh = 21 \times 10^3 \times \frac{28}{100}$$

$$\Rightarrow 40 \times 10 \times h = 21 \times 10^3 \times 28$$

$$\Rightarrow h = \frac{21 \times 28}{40} = 14.7 \text{ m}$$

$$\approx 15 \text{ m}$$



5

$$\vec{F} = 3\hat{i} + 4\hat{j} \text{ N.}$$

$$\vec{s} = 3\hat{i} + 4\hat{j} \text{ m}$$

$$\begin{aligned} \text{work done} &= \vec{F} \cdot \vec{s} = (3\hat{i} + 4\hat{j}) \cdot (3\hat{i} + 4\hat{j}) \\ &= 3 \cdot 3 + 4 \cdot 4 \\ &= 9 + 16 \\ &= 25 \text{ J} \end{aligned}$$

6

$$h = 19.6 \text{ m, } u = ?$$

here water falls like a freely falling body

$\therefore$ velocity with which water reaching ground

$$\begin{aligned} u &= \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6} \\ &= \sqrt{19.6 \times 19.6} \\ u &= 19.6 \text{ m/s} \end{aligned}$$

7

$$\text{Given } h = 12.4 \text{ m} : \text{ From } v^2 - u^2 = 2gh \Rightarrow v^2 = u^2 + 2gh$$

$$\Rightarrow v^2 = u^2 + 2 \times 9.8 \times 12.4 = u^2 + 243.04$$

$$\text{K.E of the ball when it just hits the wall} = \frac{1}{2}mv^2$$

$$\begin{aligned} \text{K.E of the ball After impact} &= 85\% \text{ of } \frac{1}{2}mv^2 \text{ [it loses 15\%]} \\ &= \frac{85}{100} \times \frac{1}{2} \times m [u^2 + 243.04] \end{aligned}$$

let v_2 be the velocity Just after collision with ground

$$\text{so } \frac{1}{2}mv_2^2 = \frac{85}{100} \times \frac{1}{2}m [u^2 + 243.04]$$

7th — continuation

⑤

$$V_2^2 = \frac{85}{100} (u^2 + 234.04)$$

Now for upward motion $V=0$; $u=V_2$.

$$\text{From } V^2 - u^2 = 2as \quad (a=-g)$$

$$\Rightarrow 0^2 - V_2^2 = -2gh$$

$$\Rightarrow V_2^2 = 2gh \quad (h=12.4\text{ m})$$

$$\Rightarrow \frac{85}{100} (u^2 + 234.04) = 2 \times 9.8 \times 12.4$$

$$\Rightarrow u^2 + 234.04 = \frac{100}{85} \times 19.6 \times 12.4$$

$$\Rightarrow u^2 + 234.04 = 285.93$$

$$\Rightarrow u^2 = 285.93 - 234.04$$

$$\Rightarrow u^2 = 51.89 \Rightarrow u = \sqrt{51.89} \approx 7.2\text{ m/s}$$

⑧

Given $P.E = K.E$

$$\text{or } K.E = P.E$$

$$\Rightarrow \frac{1}{2}mv^2 = mgh$$

$$\Rightarrow \frac{v^2}{2} = 10 \times 10$$

$$\Rightarrow v^2 = 200$$

$$\Rightarrow v = \sqrt{200} = 10\sqrt{2} \text{ m/s}$$

$$\approx 14.14 \text{ m/s}$$

(9)

According to law of conservation of energy

$$\Rightarrow K.E + P.E = \text{constant}$$

At maximum height Total Energy = P.E = mgh

$$\text{At a height } \frac{3h}{4}, P.E = mg \left[\frac{3h}{4} \right] = \frac{3}{4} mgh$$

$$\begin{aligned} \therefore K.E &= T.E - P.E \\ &= mgh - \frac{3}{4} mgh \end{aligned}$$

$$K.E = \frac{1}{4} mgh$$

$$\therefore \text{At a height } \frac{3h}{4} \quad \frac{K.E}{P.E} = \frac{\frac{1}{4} mgh}{\frac{3}{4} mgh} = \frac{1}{3}$$

(10)

$$\text{Given at } h=400 \quad \frac{P.E}{K.E} = \frac{5}{2}$$

$$\Rightarrow \frac{mgh}{\frac{1}{2}mv^2} = \frac{5}{2}$$

$$\Rightarrow \frac{2gh}{v^2} = \frac{5}{2}$$

$$\Rightarrow v^2 = \frac{2}{5} \times 2gh$$

$$= \frac{4}{5} \times 9 \times 400$$

$$= \frac{4}{5} \times 10 \times 400$$

$$\Rightarrow v^2 = 3200 \quad \Rightarrow v = 40\sqrt{2} \text{ m/s} \\ \approx 56 \text{ m/s}$$



Advanced

⑧

(d)

$P.E + K.E = \text{constant at any point.}$

(a)

$$P.E = K.E$$

At a height $\frac{h}{2}$ $P.E = mg \frac{h}{2}$

we know $T.E = P.E = mgh$ at maximum height

$\therefore$

At $\frac{h}{2}$

$$K.E = T.E - P.E$$
$$= mgh - mg \frac{h}{2}$$

$$K.E = mg \frac{h}{2}$$

⑨

(c) $K.E = 2 P.E$

at $\frac{h}{3}$

$$P.E = mg \frac{h}{3}$$

$$K.E = T.E - P.E = mgh - mg \frac{h}{3}$$

$$= \frac{3mgh - mgh}{3}$$

$$= 2 \frac{mgh}{3}$$

$$\therefore K.E = 2 P.E \rightarrow \text{r}$$

(b)

$$P.E = 2 K.E$$

at $\frac{2h}{3}$

$$P.E = mg \left(\frac{2h}{3} \right) = \frac{2}{3} mgh \rightarrow \text{①}$$

$$K.E = T.E - P.E = mgh - \frac{2}{3} mgh$$

$$= \frac{1}{3} mgh \rightarrow \text{②}$$

From ① & ②

$$\underline{P.E = 2 K.E}$$



(9)

$$m = 5 \text{ kg}$$

$$p_i = 10 \text{ kg m/s}$$

$$F = 0.2 \text{ N}$$

$$mu = 10$$

$$u = \frac{10}{5} = 2 \text{ m/s}$$

$$\therefore \text{acceleration } a = \frac{F}{m} = \frac{0.2}{5} \text{ m/s}^2$$

$$\text{After '10' sec velocity } v = u + at$$

$$\Rightarrow v = 2 + \frac{0.2}{5} \times 10$$

$$= 2 + 0.4 = 2.4 \text{ m/s}$$

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

$$= 5(2.4 - 2)$$

$$= 5[0.4] = 2 \text{ kg m/s}$$

$$\text{Increase in K.E} = \frac{1}{2} m(v^2 - u^2)$$

$$= \frac{1}{2} \times 5 (2.4^2 - 2^2)$$

$$= \frac{5}{2} [2.4 + 2] [2.4 - 2]$$

$$= \frac{5}{2} \times 4.4 \times 0.4$$

$$= 4.4 \text{ J}$$