WS-7 Integrated 9th class ①

Task

①

$d = 0.8\ kg/cc$ $\quad V = 2\ m/s$

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

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

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

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

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

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

$\Rightarrow 1.6\ J/cc$

②

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

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

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

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

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

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

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

K_3, K_1, K_2. [Descending order]

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③

work done = change in k.E

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

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

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

$S_1 \propto \frac{v^2}{F}$: $S_2 \propto \frac{(2v)^2}{\frac{F}{2}}$

$\Rightarrow S_2 \propto 4 \frac{V^2}{\frac{F}{2}} \Rightarrow S_2 \propto 8 \frac{V^2}{F}$

$S_3 \propto \frac{[\frac{V}{2}]^2}{2F} \Rightarrow S_3 \propto \frac{V^2}{4 \times 2F} \Rightarrow S_3 \propto \frac{V^2}{8F}$

Ascending order $\rightarrow S_3, S_1, S_2$.

④

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

$v' = 2v$

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

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

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

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

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

100% increased

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(5)

$m_1 = 2\,gm$; $m_2 = 8\,gm$

Given $k.E_1 = k.E_2$.

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

$\Rightarrow 2m\,k.E = p^2$

$\Rightarrow p^2 \propto m$

$\Rightarrow \left[\frac{P_1}{P_2}\right]^2 = \frac{m_1}{m_2}$

$\Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} =$

$\Rightarrow \frac{P_1}{P_2} = \sqrt{\frac{2}{8}} = \frac{1}{2}.$

(6)

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

$a = 2\,m/s^2$

$t = 2\,sec.$

From $v = u + at$

$v = 0 + 2 \times 2 = 4\,m/s$

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

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

$= 16 - 0$

$= 16J.$

(7)

$m = 0.5\,kg$; $u = 2\,m/s$

$v = 0$; $s = 2m$

we know According to

W-E theorem

$W = \Delta k.E$

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

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

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

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

Force is resistive force

(8)

$m_1 = 3\,kg$; $m_2 = 2\,kg$

$k.E_{Initial} = 600\,J.$

According to Law of conservation of Linear momentum

$m_1 v_1 = m_2 v_2$

$\Rightarrow 3v_1 = -2v_2$

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

We know $k.E \propto mv^2$

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

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

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8^{th} continuation

$$k.E_2 = \frac{3}{2} k.E_1$$

Given Total $k.E = 600\,J$

$$\Rightarrow k.E_1 + k.E_2 = 600J$$

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

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

$$\Rightarrow k.E_1 = 2 \times \frac{\overset{12}{\cancel{600}}}{\cancel{5}} = 2 \times 120 = 240J$$

⑨

$m = 200\ gm$ $\quad l = 1\,m,\ \theta = 60^\circ$

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

As the pendulum passing through mean position

$$k.E = \frac{1}{2} m v^2 \qquad v = \sqrt{2gl(1-\cos\theta)}$$

$$\Rightarrow k.E = \frac{1}{\cancel{2}} \times \cancel{2} \times 10^{-1} \times (\sqrt{2gl(1-\cos\theta)}\,)^{\cancel{2}}$$

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

$$= 10^{-1} \times 19.6 \times (1-\tfrac{1}{2}] = 19.6 \times 10^{-1} \times \frac{1}{2} = 0.98J$$

$$\simeq 1J$$

⑩

$m_{Bullet} = m\ ;\ u_{Bullet} = u$

According to law of conservation of linear momentum

$$P_{gun} = -P_{Bullet}$$

$$\Rightarrow M_g V_g = -m_{Bullet}\, u_{Bullet}$$

$$\Rightarrow M\, V_g = -mu$$

$$\Rightarrow V_g = -\frac{m}{M} u.$$

$$\frac{k.E_{Bullet}}{k.E_{gun}} = \frac{\frac{1}{2} m_B u_B^2}{\frac{1}{2} M_g V_g^2} = \frac{m\,u^2}{M(\frac{m}{M} u)^2}$$

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

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L Task

Jee main level

(1)

Given $m = 40\ kg$

$F_1 = 4N$; $F_2 = 3N$; $\theta = 90°$

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

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

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

$\therefore$ Acceleration of the body $a = \frac{F}{m} = \cancel{\frac{40}{5}} = \cancel{8\ m/s^2}\ \frac{5}{10} = \frac{1}{2}$

After $t = 10$ sec velocity $v = u + at$

$\Rightarrow v = 0 + \cancel{8} \times \cancel{10}^{5} / \cancel{2} = \cancel{80\ m/s}\ 5\ m/s$

$\therefore$ ~~$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times 40^{20} \times (80)^2$~~

~~$= 20 \times 6400 = 128000$~~

$=$ ~~128~~ kJ.

$K.E = \frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times (5)^2 = 125 J$

(2)

Given Percentage increase in momentum

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

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

$= 2 \times 0.01$

$\Rightarrow 0.02\%$

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(3)

let p' be the New momentum of a body

then $p' = P_0 + \frac{100}{100} P_0 = \frac{200}{100} P_1' = 2P_0$

k.E be initial kinetic energy.

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

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

$\Rightarrow \frac{k.E}{k.E'} = \frac{1}{4} \Rightarrow k.E' = 4\,kE$

$= 400\%\ k.E$

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

$\therefore$ k.E increased by 300%

(4)

$m = 40\,kg$, $k.E = 21\,kJ$ $\quad \eta = 28\%$

$= 21\times10^3\,J$

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

$\Rightarrow \frac{28}{100} = \frac{mgh}{21\times10^3}$

$\Rightarrow mgh = 21\times10^{\cancel{3}}\times\frac{28}{\cancel{100}}$

$\Rightarrow 40\times1\cancel{0}\times h = 21\times\cancel{10}\times28$

$\Rightarrow h = \frac{21\times28}{40} = 14.7\,m$

$\simeq 15\,m$

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⑤

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

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

work done $= \vec{F} \cdot \vec{s} = (3\hat{i} + 4\hat{j}) \cdot (3\hat{i} + 4\hat{j})$

$= 3 \cdot 3 + 4 \cdot 4$

$= 9 + 16$

$= 25$ J

⑥

$h = 19.6$ m, $\quad v = ?$

here water falls like a freely falling body

$\therefore$ velocity with which water reaching ground

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6}$

$= \sqrt{19.6 \times 19.6}$

$v = 19.6$ m/s

⑦

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

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

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

k.E of the ball After impact $= 85\% \frac{1}{2} mv^2$ [it looses 15%]

$= \frac{85}{100} \times \frac{1}{2} \times m [u^2 + 234.04]$

let v_2 be the velocity just after collision with ground

so $\frac{1}{\cancel{2}} \cancel{m} v_2^2 = \frac{85}{100} \times \frac{1}{\cancel{2}} \cancel{m} (u^2 + 234.04]$

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7th — continuation

$$v_2^2 = \frac{85}{100}(u^2+234.04)$$

Now for upward motion $v=0$; $u=v_2$.

From $v^2-u^2=2as$ $(a=-g)$

$\Rightarrow 0^2-v_2^2=-2gh$

$\Rightarrow \cancel{-}v_2^2=\cancel{-}2gh$ $[h=12.4m]$

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

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

$\Rightarrow u^2+234.04 = 285.93$

$\Rightarrow u^2 = 285.93-234.04$

$\Rightarrow u^2 = 41.99 \Rightarrow u=\sqrt{41.99}\simeq 6.55 m/s$

8

Given $P.E = K.E$

or $K.E = P.E$

$\Rightarrow \frac{1}{2}\cancel{m}v^2=\cancel{m}gh$

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

$\Rightarrow v^2 = 200$

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

$\simeq 14.14$ m/s

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(9)

According to law of conservation of Energy

$\Rightarrow$ K.E + P.E = constant.

At maximum height Total Energy = P.E = mgh

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

$\therefore$ $K.E = T.E - P.E$

$= mgh - \frac{3}{4}mgh$

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

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

(10)

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

$\Rightarrow \frac{\cancel{m}gh}{\frac{1}{2}\cancel{m}v^2} = \frac{5}{2}$

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

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

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

$= \frac{4}{\cancel{8}} \times \overset{2}{\cancel{10}} \times 400$

$\Rightarrow v^2 = 3200 \Rightarrow v = 40\sqrt{2}$ m/s

$\simeq 56$ m/s

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Advanced

(8)

(d) $P.E + K.E$ = constant at any point.

(a) $P.E = K.E$

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

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

$\therefore$ At $\frac{h}{2}$ $\quad K.E = T.E - P.E$

$= mgh - mg\frac{h}{2}$

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

(c) $K.E = 2PE$

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

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

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

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

$\Rightarrow K.E = 2P.E \rightarrow$

(b) $PE = 2K.E$

at $\frac{2h}{3}$ $\quad P.E = mg(\frac{2h}{3}) = \frac{2}{3}mgh \rightarrow (1)$

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

$= \frac{1}{3}mgh \rightarrow (2)$

From (1) & (2) $\quad PE = 2K.E$

(9)

$m = 5$ kg : $P_I = 10$ kgm/s. $F = 0.2$ N

$mu = 10$

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

∴ acceleration $a = \frac{F}{m} = \frac{0.2}{5}$ m/s²

After '10' sec velocity $v = u + at$

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

$= 2 + 0.4 = 2.4$ m/s

∴ change in momentum $= m(v-u)$

$= 5[2.4 - 2]$

$= 5[0.4] = 2$ kgm/s

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

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

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

$= \frac{5}{\cancel{2}} \times 4.4 \times \cancel{0.4}^{0.2}$

$= 4.4$ J

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