9th foundation

WS-7- Energy

(1)

Given $m = 1\,kg$; Energy = 980 J

$K.E' = \frac{1}{2}\ K.E$

loss of K.E is converted into P.E

$\therefore\ mgh = \frac{1}{2}\ K.E$

$\Rightarrow 1 \times 9.8 \times h = \frac{1}{\cancel{2}} \times \cancel{980}^{490}$

$\Rightarrow h = \frac{490}{9.8} = \frac{4900}{98} = 50\,m$ –c

(2)

Given $\frac{m_1}{m_2} = \frac{3}{1}$; $\frac{k_1}{k_2} = \frac{1}{3}$.

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

$\Rightarrow \frac{k_1}{k_2} = \frac{m_1}{m_2}\left[\frac{v_1}{v_2}\right]^2$

$\Rightarrow \frac{1}{3} = \frac{3}{1}\left[\frac{v_1}{v_2}\right]^2$

$\Rightarrow \left[\frac{1}{3}\right]^2 = \left[\frac{v_1}{v_2}\right]^2 \Rightarrow \frac{v_1}{v_2} = \frac{1}{3}$

(3)

Given $K.E = 3.5 \times 10^{-17}\,J$; $m_\alpha = 6.65 \times 10^{-27}\,kg$.

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

$\Rightarrow 3.5 \times 10^{-17} = \frac{1}{2} \times 6.65 \times 10^{-27} \times v^2$

$\Rightarrow \frac{7 \times 10^{10}}{6.65} = v^2 \Rightarrow v^2 = 1.053 \times 10^{10}$

$\Rightarrow v = 1.026 \times 10^5\,m/s$ → B

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(4)

speed $v = 4$ m/s. we know density of water $= 10^3$ kg/m^3

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

$$= \frac{1}{2} d \times vol \times v^2$$

$$\Rightarrow \frac{K.E}{vol} = \frac{1}{2} \times 10^3 \times 4^2$$

$$= \frac{1}{2} \times \overset{8}{\cancel{16}} \times 10^3$$

$$= 8000 \text{ J/m}^3 \rightarrow C$$

(5)

$K.E = \cancel{K}$. let mass of the body $m' = \frac{1}{4} m$

velocity $v' = 2v$.

$\therefore$ New kinetic energy $K.E' = \frac{1}{2} m' v'^2$

$$\Rightarrow K.E' = \frac{1}{2} \left(\frac{1}{4} m\right)((2v))^2$$

$$= \frac{1}{\cancel{8}_{2}} m \times 4 v^2$$

$$= \frac{1}{2} m v^2 = K \rightarrow D$$

(6)

Given $m = 2$ kg. $v = 2$ m/s

kinetic energy of the body $= \frac{1}{2} m v^2$

$$= \frac{1}{\cancel{2}} (\cancel{2})(2)^2$$

$$= 4 J \rightarrow B$$

(7)

Given $m = 3\,kg$; $h = 3m$.

$P.E = mgh = 3 \times 10 \times 3 = 90J.$

(8)

let $h_1 = 4m$; $h_2 = 16m$.

we know $P.E = mgh$

$\Rightarrow \frac{P.E_1}{P.E_2} = \frac{h_1}{h_2} = \frac{4}{16} = \frac{1}{4} \rightarrow D$

(9)

Given potential energy $P.E = 50J$.

mass $m = 5kg$

$\therefore P.E = mgh$

$\Rightarrow 50 = 5 \times 10 \times h$

$\Rightarrow h = \frac{50}{50} = 1m \rightarrow D.$

(10)

Given potential energy $P.E = 100J$

height $h = 10m.$

$\therefore P.E = mgh$

$\Rightarrow 100 = m \times 10 \times 10$

$\Rightarrow m = \underline{1}\,kg \rightarrow A$

Advanced

(4) , (5)

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

when p = momentum is constant

$K.E \propto \frac{1}{m}$

∴ lighter is a body ~~havie~~ heavier is K.E .

(7) , (8)

Given $m = 12\,kg$; height $h_a = 0.30\,m$.

Maximum height $h = 1.05\,m$

∴ Potential Energy $= mg\,(h_a - h_a)$

$= 12 \times 10\,[1.05 - 0.3]$

$= 120\,[1.2]$

$\simeq 150\,J$.

At maximum height speed $v = 0$

L Task [CUQ's]

(2)

when body is travelled from rest [u=0

$S = \frac{1}{2} a t^2$ $\quad V = u + at = V = at$

$K.E = \frac{1}{2} m v^2$ $\quad v^2 - u^2 = 2as$

$= \frac{1}{2} m (2as)$ $\quad \Rightarrow v^2 = 2as$

$= \frac{1}{2} m \left(\frac{F}{m}\right) s$ $\quad \Rightarrow v^2 \propto s$

$K.E = FS$ → independent of m

(3), (8)

According to law of conservation of linear momentum

momentum of bullet = - momentum of rifle.

$$\Rightarrow \quad m_b u_b = - M_R V_R.$$

$$\Rightarrow \quad V_R = - \frac{m_b u_b}{M_R}.$$

$\therefore \quad K.E = \frac{p^2}{2m}$ under constant momentum

$K.E \propto \frac{1}{m} \Rightarrow M_{Rifle} > M_{bullet}$

$$\therefore \quad K.E_{bullet} > K.E_{Rifle}.$$

(4)

we know that Total Mechemical Energy $E = K + U$

P.E in Gravitational field $U = -\frac{GMm}{r}$.

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

For a body to bound to Earth $K.E < P.E$

$\therefore$ Total Energy $E < 0$

(5)

According to work energy theorem the work done by all forces is equal to the change in K.E

$$W_{Pseudo} + W_c + W_{nc} + W_{other} = \Delta K.$$

$$work = \vec{F} \cdot \vec{S}.$$

$\therefore$ Potential energy can only be changed by conservative forces.

(10) We know Total energy $E = K.E + P.E$

$\Rightarrow 0 = K.E - mgh$

$\Rightarrow K.E = mgh$

$\boxed{K.E \propto h}$

For a freely falling body $u=0$: $s=h$; $a=g$

From $s = ut + \frac{1}{2}at^2$

$\Rightarrow h = 0 \times t + \frac{1}{2} g t^2$

$\Rightarrow h = \frac{1}{2} g t^2$

$\therefore K.E = mg\left[\frac{1}{2} g t^2\right] = \frac{mg^2 t^2}{2}$

$\therefore \boxed{K.E \propto t^2}$

Jee main's level

(11)

Given mass $m = 4\,kg$ Energy $= 980\,J$

$\therefore$ Given $P.E = \frac{1}{2} K.E$

$\Rightarrow mgh = \frac{1}{2} \times 980$

$\Rightarrow 4 \times 1\cancel{0} \times h = 49\cancel{0}$

$\Rightarrow h = \frac{49}{4} = 12.25\,m$

(2)

Given $\frac{m_1}{m_2} = \frac{3}{1}$: $\frac{k_1}{k_2} = \frac{1}{3}$.

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

$$\Rightarrow \frac{k_1}{k_2} = \frac{m_1}{m_2} \left(\frac{v_1}{v_2}\right)^2$$

$$\Rightarrow \frac{1}{3} = \frac{3}{1} \left(\frac{v_1}{v_2}\right)^2$$

$$\Rightarrow \left(\frac{1}{3}\right)^2 = \left(\frac{v_1}{v_2}\right)^2 \Rightarrow \frac{v_1}{v_3} = \frac{1}{3}$$

(3)

Given $k.E = 25\,J$; mass $= 0.5\,kg$

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

$$\Rightarrow 25 = \frac{1}{2} \times (0.5) v^2$$

$$\Rightarrow 25 = \frac{1}{2} \times \frac{1}{2} \times v^2$$

$$\Rightarrow v^2 = 100 \Rightarrow v = \sqrt{100} = 10\,m/s$$

(4)

Given $v = 2\,m/s$: density of water $= 10^3\,kg/m^3$.

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

$$= \frac{1}{2} d \times vol \times v^2$$

$$\Rightarrow \frac{k.E}{vol} = \frac{1}{\cancel{2}} \times 10^3 \times 2^{\cancel{2}} = 2 \times 10^3$$

$$= 2000\,J/m^3$$

(5)

let new mass $m' = \frac{3}{4} m$; $v' = 3v$.

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

New $K \cdot E = \frac{1}{2} m' v'^2$

$= \frac{1}{2} \left(\frac{3}{4} m\right)[3v]^2$

$\Rightarrow \frac{3}{8} m \times 9v^2 = \frac{27}{4} \times \frac{1}{2} m v^2$

$= \boxed{\frac{27}{4} k}$

(6)

Given mass $m = 4kg$; velocity $= 2 m/s$

$K \cdot E = \frac{1}{2} m v^2 = \frac{1}{\cancel{2}} \times 4 \times 2^{\cancel{2}}$

$= 4 \times 2 = 8 J$

(7)

Given $m = 3kg$; $h = 4m$

$P \cdot E = mgh = 3 \times 10 \times 4 = 120 J$

(8)

We know that $P \cdot E = mgh$

$\frac{P_1}{P_2} = \frac{h_1}{h_2} = \frac{5}{20}$

$\Rightarrow \frac{P_1}{P_2} = \frac{1}{4}$

9

Given $m = 3\,kg$; $P.E = 150J$.

we know that $P.E = mgh$

$\Rightarrow 150 = 3 \times 10 \times h$

$\Rightarrow \overset{5}{\cancel{150}} = \cancel{30}\,h$

$\Rightarrow h = 5m$

10

$P.E = 200J$, $h = 20m$.

From $P.E = mgh$

$\Rightarrow 200 = m \times 10 \times 20$

$\Rightarrow m = 1\,kg$

Advanced

9, 10

Given $m = 5\,kg$; $u = 2\,m/s$.

$F = 0.2\,N$; $t = 10\,sec$.

Initial kinetic Energy $= \frac{1}{2}mv^2 = \frac{1}{2} \times 5 \times 2^2 = 10J$

acceleration $a = \frac{F}{m} = \frac{0.2}{5} = 0.04\,m/s^2$

From $v' = u + at = 2 + (0.04) \times 10 = 2.4\,m/s$

Final kinetic Energy $= \frac{1}{2}m(v')^2 = \frac{1}{2} \times 5\,(2.4)^2$

increase in K.E $= \cancel{\frac{5}{2}} \times \frac{1}{2}m(v'^2 - v^2) = \frac{5}{2}(2.4^2 - 2^2)$

$= \frac{5}{\cancel{2}} \times (\overset{0.2}{\cancel{0.4}})(4.4) = 4.4J$

(8)

we know $T.E = P.E + K.E = \text{constant} = mgh.$

(a)

at a height $\frac{h}{2}$ $P.E = \frac{mgh}{2}$

$\therefore mgh = P.E + K.E$

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

$\therefore P.E = K.E$

(b)

at a height $\frac{h}{3}$ $P.E = \frac{mgh}{3}$

$\therefore mgh = \frac{mgh}{3} + K.E$

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

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

(c)

at a height $\frac{2h}{3}$ $\therefore P.E = \frac{2}{3} mgh$

$\therefore mgh = \frac{2mgh}{3} + K.E$

$\Rightarrow K.E = mgh - \frac{2mg}{3} = \frac{1}{3} mgh$

$\Rightarrow PE = 2\left(\frac{1}{3} mgh\right)$

$\Rightarrow PE = 2 K.E$