

9th foundation

WS-7-Energy

①

Given $m = 1 \text{ kg}$; Energy = 980 J

$$k \cdot E = \frac{1}{2} k \cdot E$$

loss of $k \cdot E$ is converted into $P \cdot E$

$$\therefore mgh = \frac{1}{2} k \cdot E$$

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

$$\Rightarrow h = \frac{490}{9.8} = \frac{4900}{98} = 50 \text{ m} - c$$

②

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

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

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

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

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

③

Given $k \cdot E = 3.5 \times 10^{-17} \text{ J}$; $m_e = 6.65 \times 10^{-27} \text{ kg}$.

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

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

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

$$\Rightarrow v = 1.026 \times 10^5 \text{ m/s} \rightarrow B$$

④

speed $u = 4 \text{ m/s}$. . . we know density of water $= 10^3 \text{ kg/m}^3$

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

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

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

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

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

⑤

$K.E = K$. let mass of the body $m' = \frac{1}{4} m$
velocity $u' = 2u$

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

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

$$= \frac{1}{8} m \times 4u^2$$

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

⑥

Given $m = 2 \text{ kg}$: $u = 2 \text{ m/s}$

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

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

$$= 4 \text{ J} \rightarrow B$$

7

Given $m = 3 \text{ kg}$; $h = 3 \text{ m}$.

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

8

let $h_1 = 4 \text{ m}$; $h_2 = 16 \text{ m}$.

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 $P.E = 50 \text{ J}$.

mass $m = 5 \text{ kg}$

$$\therefore P.E = mgh$$

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

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

10

Given potential energy $P.E = 100 \text{ J}$

height $h = 10 \text{ m}$.

$$P.E = mgh$$

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

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

Advanced

(4), (5)

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

when p = momentum is constant

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

$\therefore$ lighter is a body ~~more~~ heavier in $K.E$.

(7), (8)

Given $m = 12 \text{ kg}$; height $h_a = 0.30 \text{ m}$.

maximum height $h = 1.05 \text{ m}$

$\therefore$ Potential Energy = $mg(h_a - h_a)$

$$= 12 \times 10 (1.05 - 0.3)$$

$$= 120 [1.2]$$

$$\approx 150 \text{ J}$$

At maximum height speed $u = 0$

Task (CUGA)

(2)

when body is travelled from rest [$u = 0$]

$$s = \frac{1}{2} a t^2$$

$$v = u + at = v = at$$

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

$$v^2 - u^2 = 2as$$

$$= \frac{1}{2} m (2as)$$

$$\Rightarrow v^2 = 2as$$

$$= \frac{1}{2} m \left(\frac{E}{m} \right) s$$

$$\Rightarrow v^2 \propto s$$

$$K.E = FS \rightarrow \text{independent of } m$$



③, ⑧

According to law of conservation of linear momentum

momentum of bullet = - momentum of rifle.

$$\Rightarrow m_b u_b = - M_R v_R.$$

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

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

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

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

④

we know that Total mechanical energy $E = K + U$

$$P.E \text{ in gravitational field } U = - \frac{G M m}{r}.$$

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

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

$$\therefore \text{Total Energy } E < 0$$

⑤

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

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

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

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

6)

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 $u=0$; $s=h$; $a=g$

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

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

$$\Rightarrow h = \frac{1}{2}gt^2$$

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

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

See main's level

1)

Given mass $m = 4 \text{ kg}$ Energy = 980 J

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

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

$$\Rightarrow 4 \times 10 \times h = 490$$

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

(2)

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

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

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

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

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

(3)

Given $k \cdot E = 25 \text{ J}; \text{ mass} = 0.5 \text{ kg}$

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

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

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

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

(4)

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

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

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

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

$$= 2000 \text{ J/m}^3$$

5

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

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

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

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

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

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

6

Given mass $m = 4 \text{ kg}$; velocity $= 2 \text{ m/s}$

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

$$= 4 \times 2 = 8 \text{ J}$$

7

Given $m = 3 \text{ kg}$; $h = 4 \text{ m}$

$$p.E = mgh = 3 \times 10 \times 4 = 120 \text{ J}$$

8

we know that $p.E = mgh$

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

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

(5)

(9)

Given $m = 3 \text{ kg}$; $P.E = 150 \text{ J}$.

we know that $P.E = mgh$

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

$$\Rightarrow 150 = 30h$$

$$\Rightarrow h = 5 \text{ m}$$

(10)

$P.E = 200 \text{ J}$, $h = 20 \text{ m}$.

From $P.E = mgh$

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

$$\Rightarrow m = 1 \text{ kg}$$

Advanced

(9), (10)

Given $m = 5 \text{ kg}$; $u = 2 \text{ m/s}$.

$F = 0.2 \text{ N}$; $t = 10 \text{ s}$.

Initial kinetic energy $= \frac{1}{2} m u^2 = \frac{1}{2} \times 5 \times 2^2 = 10 \text{ J}$

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

From $v = u + at = 2 + (0.04) \times 10 = 2.4 \text{ m/s}$

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

increase in k.E $= \frac{5}{2} \times \frac{1}{2} m (v^2 - u^2) = \frac{5}{2} (2.4^2 - 2^2)$
 $= \frac{5}{2} \times (0.2) (4.4) = 4.4 \text{ J}$

(8)

we know

$$T.E = P.E + k.E = \text{constant} = mgh$$

(a)

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

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

$$\Rightarrow mgh = \frac{mgh}{2} + k.E = k.E = \frac{mgh}{2}$$

$$\therefore P.E = k.E$$

(b)

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

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

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

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

(c)

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

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

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

$$\Rightarrow P.E = 2 \left(\frac{1}{3} mgh \right)$$

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