

9th advanced
ws-q-work

①

Task

①

$$\vec{r}_1 = 3\hat{i} + 2\hat{j} - 5\hat{k} \quad \vec{F} = 2\hat{i} - \hat{j} - \hat{k}$$

$$\therefore W = \vec{F} \cdot \vec{r} \Rightarrow (2\hat{i} - \hat{j} - \hat{k}) \cdot (3\hat{i} + 2\hat{j} - 5\hat{k})$$

$$W = (2 \cdot 3) + (-1 \cdot 2) + (-1) \cdot (-5)$$

$$= 6 - 2 + 5 = 9 \text{ J}$$

②

$$r = 7 \text{ m} \quad \text{depth } h = 20 \text{ m} \quad d_w = 10 \text{ m}$$

$$m = d \cdot V = 10^3 \times \pi r^2 h = 10^3 \times \frac{22}{7} \times 7^2 \times 10 = 154 \times 10^4 \text{ kg}$$

$$W \cdot D = \frac{1}{2} M g \left[h + \frac{d_w}{2} \right]$$

$$= 154 \times 10^4 \times 10 [20 + 5]$$

$$= 385 \times 10^6 \text{ J} = 385 \text{ MJ}$$

③

$$n = 20$$

$$m = 100 \text{ gm} = \frac{1}{10} \text{ kg}$$

$$U_p = m g \frac{h}{2}$$

$$h = 10 \text{ cm} = 10^{-2} \text{ m}$$

$$= \frac{1}{10} \times 10 \times \frac{10 \times 10^{-2}}{2} = 1 \text{ J}$$

$$\text{After falling } U_f = -m g h \text{ from } g \text{ side}$$

$$= -20 \times \frac{1}{10} \times 10 \times 5 \times 20 \times \frac{1}{100}$$

$$= -20 \text{ J}$$

$$W = -U_f + U_p = -20 + 1 = 19 \text{ J}$$

(4)

$$F = \hat{i} + 2\hat{j} + 3\hat{k}$$

$$S = 4\hat{k}$$

$$W = F \cdot S = (\hat{i} + 2\hat{j} + 3\hat{k}) \cdot 4\hat{k}$$

$$\Rightarrow 3 \times 4 = 12J$$

(5)

$$v = kx \Rightarrow \frac{dv}{dx} = k$$

$$\text{acceleration } a = v \frac{dv}{dx}$$

$$\Rightarrow a = v \times k = (kx)k$$

$$\Rightarrow a = k^2 x$$

$$F = ma = mk^2 x$$

$$\text{work} = \int_{x_1}^{x_2} F dx = \int_0^d mk^2 x dx$$

$$= mk^2 \left[\frac{x^2}{2} \right]_0^d = \frac{mk^2 d^2}{2}$$

(6)

$$l = 5m; \theta = 30^\circ$$

$$m = 10 \text{ kg}$$

$$W = mgl \sin \theta$$

$$= 10 \times 9.8 \times 5 \times \sin 30^\circ$$

$$= 98 \times \frac{1}{2} \times 5$$

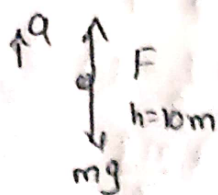
$$= 49 \times 5$$

$$= 245J$$

②

$$m = 10 \text{ kg} ; v = 2 \text{ m/s}$$

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



$$\text{Net force} = F - mg$$

$$\Rightarrow ma = F - mg$$

$$F = ma + mg$$

$$F = m(g + a) \Rightarrow$$

$$F = 10(9.8 + 0.2) = 100 \text{ N}$$

$$W = F \times h = 100 \times 10 = 1000 \text{ J}$$

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

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

$$\Rightarrow a = 0.2 \text{ m/s}^2$$

③

$$W_{\text{bucket}} + \text{Rope} = 20 + 0.2x$$

work done in raising the rope

+ bucket by depth $dx = dW$

$$\Rightarrow dW = mg dx$$

Integrating on both sides.

from $0 \rightarrow 20 \text{ m}$

$$\Rightarrow W = \int_0^{20} (20 + 0.2x) g dx$$

$$= \int_0^{20} 20g dx + 0.2 \int_0^{20} xg dx$$

$$= 20 \times 10 [x]_0^{20} + 0.2 \times 10 \left[\frac{x^2}{2} \right]_0^{20}$$

$$= 200[20 - 0] + 2 \left(\frac{4000 - 0}{2} \right) = 4000 + 400$$

$$= 4400 \text{ J}$$

$$m_b = 20$$

$$h = 20 \text{ m}$$

$$\lambda = \frac{m}{l} = 0.2$$

For x meter

$$m_{\text{Rope}} = 0.2x$$

(9)

$$\text{mass of block} = m$$

$$h = d; \quad a = \frac{g}{3}$$

$$F = m(g - a)$$

$$= m\left(\frac{g}{3} - g\right)$$

$$W = F \times d$$

$$= -\frac{2mg}{3}$$

$$= -\frac{2}{3}mgd$$

(10)

$$\vec{F} = 5\hat{i} - 3\hat{j} + 2\hat{k} \text{ N}$$

$$\vec{r}_1 = 2\hat{i} + 7\hat{j} + 4\hat{k} \text{ m}$$

$$\vec{r}_2 = 5\hat{i} + 2\hat{j} + 8\hat{k} \text{ m}$$

$$\vec{S} = \vec{r}_2 - \vec{r}_1 = 5\hat{i} + 2\hat{j} + 8\hat{k} - 2\hat{i} - 7\hat{j} - 4\hat{k}$$

$$\vec{S} = 3\hat{i} - 5\hat{j} + 4\hat{k}$$

$$W = \vec{F} \cdot \vec{S} = (5\hat{i} - 3\hat{j} + 2\hat{k}) \cdot (3\hat{i} - 5\hat{j} + 4\hat{k})$$

$$= 5 \cdot 3 + (-3)(-5) + 2 \cdot 4$$

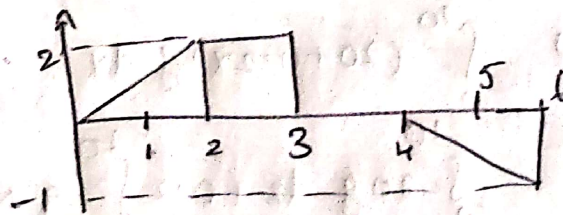
$$= 15 + 15 + 8 = 38 \text{ J}$$

(14)

(15)

(16)

From



(14)

From fig $x = 0 \rightarrow 3 \text{ m}$ $W = F \times d = \text{Area of graph}$

$$= \frac{1}{2} \times b \times h_1 + b \times h_2$$

$$= \frac{1}{2} \times 2 \times 2 + 1 \times 2 = 2 + 2 = 4 \text{ J}$$

(16)

From $x = 3 \rightarrow 4 \text{ m}$ $\Rightarrow \text{displacement} = 0$

$$W = F \times d = F \times 0 = 0 \text{ J}$$

(15) continuation

(3)

From $x = 4\text{ m}$ to 6 m .

$$W = \text{Area of graph} = \frac{1}{2} \times b \times h$$
$$= \frac{1}{2} \times 2 \times (-1)$$
$$= -1\text{ J}$$

(17)

$$F = 2\hat{i} + 3\hat{j} \text{ N.} \rightarrow (1)$$

Given $3y + 10x = 5$

$$\Rightarrow y = -\frac{10}{3}x + \frac{5}{3}$$

comparing with $y = mx + c$

$$\text{so } m_1 = -\frac{10}{3}$$

From (1) $\tan\theta = \text{slope } m_2 = \frac{3}{2}$

$\therefore F \perp$ to displacement $\therefore$ work done is zero.

(2) $m_1 m_2 = -1 \Rightarrow \frac{3}{2} \times (-\frac{10}{3}) = -1$

$$\Rightarrow 10 = 2$$

(18)

$$m_{\text{cycle}} = 1\text{ kg}$$

$$\text{length} = 1.6\text{ m}$$

$$g = 10\text{ m/s}^2$$

$$\text{work done} = \frac{mgh}{2}$$

$$W = \frac{1 \times 10 \times 1.6}{2}$$

$$W = 8\text{ J}$$

whenever the object like (ladder, stick, chain etc) are in contact with some other object or walls at the end points, its mass is divided into 2 equal parts

(19)

$$v = 3t$$

$$\Rightarrow \frac{dx}{dt} = 3t$$

$$\Rightarrow dx = 3t dt$$

$$\therefore x = \int 3t dt$$

$$x = 3 \frac{t^2}{2}$$

acceleration $a = \frac{dv}{dt} = \frac{d}{dt}(3t)$

$$a = 3 \frac{dt}{dt} = 3 \text{ m/s}^2$$

Given $m = 5 \text{ kg}$

$$W = F s$$

$$= ma s$$

$$\Rightarrow W = 5 \times 3 \times \frac{3t^2}{2}$$

At $t = 2 \text{ sec}$

$$\Rightarrow W = 15 \times 3 \times \frac{2^2}{2} = 15 \times 3 \times 2 = 90 \text{ J}$$

Task CUA

(6)

$$W = F s \cos \theta$$

if $\theta \rightarrow 90^\circ \rightarrow 180^\circ$

$$\cos \theta = -ve.$$

$$\therefore W = -ve$$

(8)

$$W = F s \cos \theta$$

if $\theta \Rightarrow 0^\circ \rightarrow 90^\circ$

$$\cos \theta = +ve.$$

$$W = +ve.$$

(9)

$$W = F s \cos \theta$$

when $\theta = 0^\circ$

$$\cos \theta = 1 \rightarrow \text{maximum value of } \cos \theta.$$

$$\therefore W = \text{maximum} = F s$$

(10)

When body moves in circular path centripetal force and displacement are perpendicular $\theta = 90^\circ$

$$W = F s \cos 90^\circ = 0.$$



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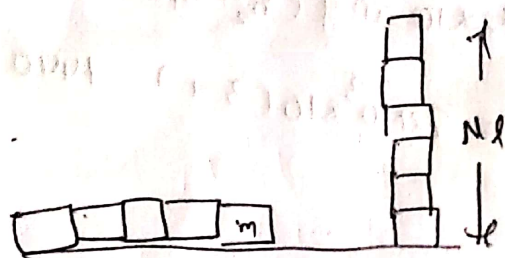
$M = 4 \text{ kg}$; $L = 2 \text{ m}$ length of hanging part = 0.6 m

mass of hanging part $m = \frac{M}{L} \times l = \frac{4}{2} \times 0.6$

$$m = 1.2 \text{ kg.}$$

$$\begin{aligned} \text{work done to pull hanging part } W &= mg \frac{h}{2} \\ &= 1.2 \times 10 \times \frac{0.6}{2} \\ &= 3.6 \text{ J} \end{aligned}$$

②



P.E of each block = $mg \frac{l}{2}$

For n blocks.

$$P.E_1 = n mg \frac{l}{2}$$

Total length of arrangement = $\frac{n l}{2}$

The final P.E of the system $P.E_2 = nmg (\frac{n l}{2})$

$$\begin{aligned} \text{work done} &= P.E_2 - P.E_1 \\ &= n mg \frac{n l}{2} - n mg \frac{l}{2} \\ &= mg \frac{l}{2} n(n-1) \end{aligned}$$

③

total mass = $m = 50 + 20 = 70$

height $h = 20 \times 0.2 = 4 \text{ m}$

$$\begin{aligned} \text{work done} &= mgh = 70 \times 10 \times 4 \\ &= 2800 \text{ J} \end{aligned}$$

(4)

$$\text{mass} = \text{density} \times \text{vol}$$

$$= 10^3 \times 6 \times 4 \times 2 = 72 \times 10^3 \text{ kg}$$

when face with large area is in contact with the ground its height is 2m

centre of mass is at a height of 1m = h_1

when face with small area is in contact with the ground its height is 6m. • centre of mass height $h_2 = 3\text{m}$

$$W = 72 \times 10^3 \text{ m g } (h_2 - h_1)$$

$$= 72 \times 10^3 \times 10 (3 - 1) = 1440 \text{ kJ}$$

(5)

Given $m = 5 \text{ kg}$; $u = 4 \text{ m/s}$; $v = 8 \text{ m/s}$. $F = 10 \text{ N}$

$$F = 10 \text{ N}$$

$$a = \frac{F}{m} = \frac{10}{5} = 2 \text{ m/s}^2$$

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

$$\Rightarrow 64 - 16 = 2 \times 2 \times s$$

$$\Rightarrow 48 = 4s$$

$$\Rightarrow s = 12 \text{ m}$$

$$W = F \cdot s$$

$$= 10 \times 12$$

$$= 120 \text{ J}$$

(6)

$m = 5 \text{ kg}$; $\theta = 30^\circ$ $L = 2 \text{ m}$

$$\text{Work done} = mg \frac{L}{2} \sin \theta$$

$$= 5 \times 10 \times \frac{2}{2} \times \sin 30 = 50 \times \frac{1}{2} = 25 \text{ J}$$

⑦

$$F = mg = 300 \text{ N} \quad ; \quad l = 5 \text{ m} \quad , \quad C.O.M = 2 \text{ m from A.}$$

$$W = F_1 d_1 + F_2 d_2$$

$$F_2 = 80 \text{ N}$$

$$d_1 = 2 \text{ m}$$

$$= 300 \times 2 + 80 \times 5$$

$$= 1000 \text{ J}$$

⑧

$$F = 4\hat{i} + 6\hat{j} \text{ N}$$

$$\text{slope of force } m_1 = \tan \theta = \frac{6}{4} = \frac{3}{2}$$

$$\text{Given line } 3y + kx = 5 \Rightarrow y = \frac{5 - kx}{3} = \frac{5}{3} - \frac{k}{3}x$$

$$\text{compare with } y = mx + c$$

$$\therefore \text{slope } m = m_2 = -\frac{k}{3}$$

Here F & displacement are Perpendicular to each other

$$\therefore m_1 m_2 = -1$$

$$\Rightarrow \frac{3}{2} \left(-\frac{k}{3}\right) = -1 \Rightarrow k = 2$$

⑨

For motion of the particle from $(0,0)$ to $(a,0)$

$$\vec{F} = -k(0\hat{i} + a\hat{j}) = -ka\hat{j}$$

$$\text{Displacement } \vec{r} = (a\hat{i} + 0\hat{j}) = a\hat{i}$$

$$W = \vec{F} \cdot \vec{r} = -ka\hat{j} \cdot a\hat{i} = 0$$

For motion from $(a,0)$ to (a,a)

$$\vec{F} = -k(a\hat{i} + a\hat{j})$$

9th continuation

Displacement

$$\vec{r} = (a\hat{i} + a\hat{j}) - (a\hat{i} + 0\hat{j}) \\ = a\hat{j}$$

$\therefore$ work done $W = \vec{F} \cdot \vec{r}$

$$= -k(a\hat{i} + a\hat{j}) \cdot a\hat{j} \\ = -ka^2$$

(10)

Total weight = 20 kg

A bucket is leaking for every meter 0.5 kg mass reduced

$$\therefore F = (20 - 0.5x)g$$

For displacement dx

$$W = \int_0^{20} F dx = \int_0^{20} (20 - 0.5x)g dx$$

$$= \left[20x - 0.5 \frac{x^2}{2} \right]_0^{20} g$$

$$= \left(20(20 - 0) - \frac{0.5}{2} (20^2 - 0) \right) \times 10$$

$$= (400 - \frac{0.5}{2} \times 400) \times 10$$

$$= (400 - 100) \times 10 = 3000 \text{ kJ}$$

$$= 3 \text{ kJ}$$

14, 15, 16

6

$$m = 2.5 \text{ kg} \quad s = 2.2 \text{ m}$$

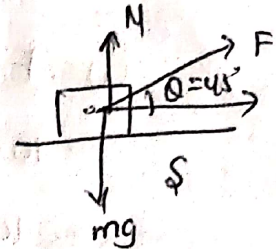
$$F = 16 \text{ N}$$

$$(14) \quad W = FS \cos \theta$$

$$= mg FS \cos 45$$

$$= 16 \times 2.2 \times \frac{1}{\sqrt{2}}$$

$$= 24.9 \text{ J}$$



$$(15) \quad W_g = mg \cos \theta + s \quad \theta = 90^\circ$$

$$= 2.5 \times 10 \times \cos 90 + 2.2$$

$$= 0$$

$$(16) \quad W_N = NS \cos \theta$$

$$N \perp S \quad \theta = 90^\circ$$

$$= NS \cos 90$$

$$= 0$$

17

$$s = t^2 + 2t; m = 2$$

$$v = \frac{ds}{dt} = \frac{d}{dt} (t^2 + 2t)$$

$$= 2t + 2$$

$$v_1 = 2(2) + 2 \rightarrow t_1 = 2 \text{ sec}$$

$$= 6 \text{ m/s}$$

$$\text{For } t = 4 \text{ sec}$$

$$v_2 = 2(4) + 2$$

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

W-E Theorem

$$W = \frac{1}{2} m (v_2^2 - v_1^2)$$

From 2 → 4 sec

$$W = \frac{1}{2} m (v_2^2 - v_1^2)$$

$$W = \frac{1}{2} \times 2 [10^2 - 6^2]$$

$$= [16] \times 4$$

$$= 64 \text{ J}$$

(18)

$$F = 10 \text{ N}$$

$$S = 10 \text{ m}$$

$$W = F S \cos \theta$$

$$= 10 \times 10 \times \cos 120^\circ$$

$$= 100 \times \left(-\frac{1}{2}\right)$$

$$= -50 \text{ J}$$

(19)

$$F = 100 \text{ N}; m = 10 \text{ kg}; S = 5 \text{ m}$$

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

$$\text{weight} = mg = 10 \times 10 = 100 \text{ N}$$

$$\text{velocity} = \frac{S}{t} = \frac{5}{2} = 2.5 \text{ m/s}$$

$$W = F S \cos \theta \quad (\theta = 0)$$

$$= 100 \times 5 \times \cos 0$$

$$= 500 \text{ J +ve.}$$