9th integrated ①

WS-6

Thask.

①

No. of steps = 40 : width $w = 35$ cm

$m = 20$ kg. height $h = 25$ cm

Total height he ascends = $n \times h = 40 \times 25$

$= 1000$ cm $= 10$m

∴ work done = $mgh = 20 \times 10 \times 10$

$= 2 \times 10^3 J$

②

$M_{Rain} = \frac{1}{10}$ gm $= 10^{-4}$ kg : $h = 100$m.

$g = 9.8\ m/s^2$

work done by gravity = mgh

$= 10^{-4} \times 9.8 \times 100$

$= 0.098 J$

③

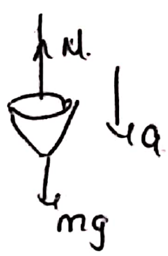
$a = \frac{g}{4}$; displacement = d.

work done = $F \times S \times \cos\theta$ [$\theta = 0°$ F & S are in same direction]

$= m(a-g) \times d \times \cos 0$

$= m(\frac{g}{4} - g) d \times 1$

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



(4)

$u = 0$; $F = 2N$: $m = 5\ kg$

$t = 10 sec$

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

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

$\Rightarrow S = 0 \times 10 + \frac{1}{2} \times \frac{2}{5} \times (10)^2$

$= \frac{1}{5} \times 100 = 20m$

work done $= F \times S = 2 \times 20 = 40J$

(5)

$\frac{m_1}{m_2} = \frac{1}{2}$: $\frac{S_1}{S_2} = \frac{2}{1}$: $\frac{F_1}{F_2} = \frac{1}{2}$ $\frac{\theta_1}{\theta_2} = \frac{30^\circ}{60^\circ}$

work done $= F\, S \cos\theta$

$\Rightarrow \omega \propto F\, S \cos\theta$

$\Rightarrow \frac{\omega_1}{\omega_1} = \frac{F_1}{F_2} \frac{S_1}{S_2} \frac{\cos\theta_1}{\cos\theta_2}$

$= \frac{1}{\cancel{2}} \times \frac{\cancel{2}}{1} \frac{\cos 30}{\cos 60^\circ}$

$= \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \frac{\sqrt{3}}{1}$

(6)

length of hanging part $= \frac{1}{5} L$. $= [\frac{1}{nth} L$ ie $n = 5]$

If $\frac{1}{n}$th Part of chain is hanging from the edge of a table work done to bring hanging part $= \frac{mgL}{2n^2}$

$\omega = \frac{mg L}{2(5)^2} = \frac{mgL}{2 \times 25} = \frac{mgL}{50}$

(7)

$m = 10\,kg$

From $x = 0 \rightarrow 8\,cm$

displacemen $= 8\,cm = 8\times10^{-2}\,m$.

work done $= F \times$ displacement

$\Rightarrow m\,a \times s$

$= m \times$ Area of given graph

$= 10 \times [8\times10^{-2} \times 20\times10^{-2}]$

$\Rightarrow 16\times10^{-2}\,J$

(8)

length of hanging Part $= \frac{1}{3^{rd}} L$ $[n = 3]$

If $\frac{1}{n^{th}}$ Part of chain is hanging from edge of a table, then the work done to Pull hanging Part

$$W = \frac{mgL}{2n^2} = \frac{mgL}{2\times3^2}$$

$$W = \frac{mgL}{2\times9} = \frac{mgL}{18}.$$

(9)

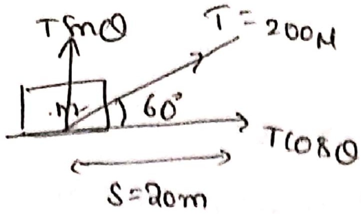
$m = 70\,kg$: $n = 36$; $h = 20\,cm = 20\times10^{-2}\,m$

work done $= nmgh$ $\Rightarrow 36 \times \cancel{70} \times \cancel{20} \times 10^{-2} \times 9.8$

$\Rightarrow 36\times14\times9.8$.

$= 4939\,J$

(10)



T sin θ & displacement are perpendicular to each other

∴ work done by T sin θ component is zero.

∴ work done by T cos θ = $T\cos\theta \times S$

$= 200 \times \cos 60 \times 20$

$= 200 \times \frac{1}{2} \times 20$ 10

$= 2000\ J$

(11)

(a)

frictional force always acts in a direction opposite to the motion of a body (displacement)

i.e. $\theta = 180^\circ \Rightarrow \cos 180^\circ = -1$

$W = f_r\, S \cos\theta = -ve$.

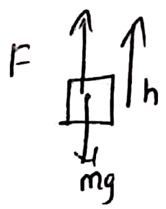
(b)

For vertically projected body displacement of the body and force due to gravity are opposite. here also $\theta = 180^\circ$

(12)

(a)

work done by applied force $= F S$



$F = -F_g = -mg$ [For every action an equal and opposite reaction]

$S = h$

$W = mgh$ [F & S are in same direction $\theta = 0^\circ$]

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Continuation

(b)

work done by gravity $= -mgh$

[G.F and displacement are in opposite direction]

(c)

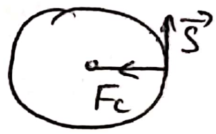
$$\omega_{Total} = \omega_{applied} + \omega_{gravity}$$
$$= mgh + (-mgh)$$
$$= mgh - mgh = 0$$

(13)

(a)

Work done by centripetal force $= 0$ because centripetal force and displacement are almost Perpendicular

$\theta = 90^\circ$



$\cos 90^\circ = 0$ $\Rightarrow \omega = F_c \, s \cos\theta$

$= F_c \, s \cos 90 = 0$

(b)

Here also Tension in the string of Pendulum and displacement of Pendulum are perpendicular. $[\theta = 90^\circ]$

(c)

The weight of Person + load [Gravitational force] and displacement of him are Perpendicular $[\theta = 90^\circ]$

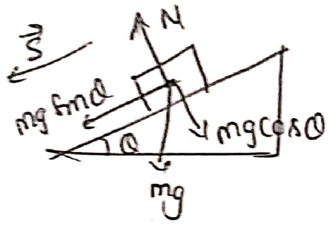
(14)

(a) Since frictional force always opposes motion of a body [displacement] i.e. $\theta = 180°$

$\therefore$

$$W_{friction} = \text{friction} \times \text{displacement} \cos\theta$$
$$= f s \cos 180°$$
$$= -fs.$$

(c)



work done $= F_g \, s \cos\theta$

$= mg\sin\theta \; s \cos 0°$

$= (mg\sin\theta)\, s$

Here $mg\sin\theta$ & $\vec{s}$ are in same direction so $\theta = 0°$

$mg\cos\theta \perp^{er} \vec{s}$ so $\theta = 90°$

$W = F_g \, s \cos\theta$

$= (mg\cos\theta)\, s \cos 90°$

$= 0$

(16)

A:- Because for one round displacement is zero

R:- Even the body is rotating centripetal force is acting

(17)

A:- If a man pushes wall due to reaction from ~~a~~ wall, the man moves back so the angle between displacement of man and force applied by man are opposite $[\theta = 180°]$

$W = FS\cos 180° = -FS = -ve.$

(18)

We know $W = FS\cos\theta$

$W \propto \cos\theta$

(a) $\theta = 0^\circ$ $W \propto \cos 0$ $\Rightarrow W \propto 1$ +ve

(b) $\theta = 180^\circ$ $W \propto \cos 180^\circ \Rightarrow W \propto -1(-ve)$

(c) $\theta = 90^\circ$ $W \propto \cos 90^\circ \Rightarrow W = 0$.

(d) other than $\theta = 0^\circ$ $W \propto \cos\theta$ finite work

(19)

$m = 300$ kg.

$u = 0$; $v = 90$ kmph $= \cancel{90}^{5} \times \frac{5}{\cancel{18}} = 25$ m/s

$t = 5$ sec

$S = 1.5$ km $= 15 \times 10^2$ m

From $v = u + at$

$\Rightarrow 25 = 0 + a \times 5 \Rightarrow \cancel{5}a = \cancel{25}^{5} \Rightarrow a = 5\ m/s^2$

Force $F = ma = 300 \times 5 = 1500$ N

work done $= F \cdot S \Rightarrow 1500 \times 15 \times 10^2$

$\Rightarrow 225 \times 10^4$ J

L Task

Jee mains level

① $s = 5m$, $F = 50N$

work don = $F \times S = 50 \times 5 = 250\ J$

② $S = 30m$; $F = 3N$

work done = $F \times S = 3 \times 30 = 90\ J$

③ Since the man is waiting by holding a box.

∴ displacement $= 0$

$\omega = F S \cos\theta = F(0)\cos\theta = 0$

④ $m = 50\ kg$; $h = 20\ m$; $n = 4$ bags

∴ work done in lifting the bags $= n \times mgh$

$= 4 \times 50 \times 9.8 \times 20$

$\Rightarrow 4000 \times 9.8$

$\Rightarrow 39.2\ kJ$

⑤ $m = 60\ kg$; $\vec{S} = 30m$;

$\vec{F} = 3N$ $\theta = 60°$

work done by the applied force $w = F S \cos\theta$

$= 3 \times 30 \times \cos 60$

$\Rightarrow 3 \times 30 \times \frac{1}{2} = 45J$

⑥

⑤

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

$r_1 = 2\hat{i} + 7\hat{j} + 4\hat{k}$; $r_2 = 5\hat{i} + 2\hat{j} + 8\hat{k}$

displacement $\vec{s} = \vec{r_2} - \vec{r_1} = 5\hat{i} + 2\hat{j} + 8\hat{k} - 2\hat{i} - 7\hat{j} - 4\hat{k}$

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

$\therefore$ work done $= \vec{F} \cdot \vec{s}$

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

$\Rightarrow (5)(3) + (-3)(-5) + (2)(4)$

$\Rightarrow 15 + 15 + 8 = 38$ J

⑦

$F = 2\hat{i} + 4\hat{j} + 3\hat{k}$ N. displacement $= 6$m along z-axis

$= 6\hat{k}$.

$\therefore$ work done $= \vec{F} \cdot \vec{s}$

$= (2\hat{i} + 4\hat{j} + 3\hat{k}) \cdot 6\hat{k}$

$\Rightarrow 3 \times 6 = 18$ J.

⑧

$m = 20$ kg : $u = 0$: $F = 5$N : $t = 1$ sec.

$a = \frac{F}{m} = \frac{\cancel{20}5}{\cancel{20}} = \frac{1}{4}$ m/s^2

$S = u \times t + \frac{1}{2}at^2 \Rightarrow 0 \times 1 + \frac{1}{2} \times \frac{1}{4} \times 1^2 = \frac{1}{8}$ m

$\therefore$ $W = F \cdot S = ma\,s$

$= \cancel{20}^{5} \times \frac{1}{\cancel{4}} \times \frac{1}{8}$

$= \cancel{160}$ J $\quad 5 \times \frac{1}{8}$

$= \frac{5}{8}$ J

(9)

displacement $S = 10m$; $F = 5N$

work done = 25 J

we know that $W = FS\cos\theta$

$$\Rightarrow \cancel{25}^{5} = \cancel{5}\times 10\cos\theta$$

$$\Rightarrow 5 = 10\cos\theta$$

$$\Rightarrow \cos\theta = \frac{5}{10} = \frac{1}{2}$$

$$\Rightarrow \theta = 60^\circ$$

(10).

$\vec{F} = 6\hat{i} - 8\hat{j}$ N

Along x-axis $\vec{S}_x = 4\hat{i}$

along y-axis $\vec{S}_y = 6\hat{j}$.

$\therefore \vec{S} = S_x + S_y$

$\vec{S} = 4\hat{i} + 6\hat{j}$

work done $= (6\hat{i} - 8\hat{j})\cdot(4\hat{i} + 6\hat{j})$

$$\Rightarrow (6\cdot4) + (-8)\cdot6.$$

$$\Rightarrow 24 - 48 = -24J$$

Advanced

(1)

work done by the man on suitcase depends on weight of the suit case because work done by conservative force does not rely upon the path taken.

Also while lifting only conservative forces comes into play. so it depends on the initial and final position and the force required that in turn will be equal to weight of suit case.

(2)

(6)

a, d are correct

As the gravitational force acts downward and the displacement of the bucket is upward, force acts opposite to the displacement of the body, the work done being a dot product of force and displacement vectors becomes negative as cosine $\cos 180^\circ = -1$

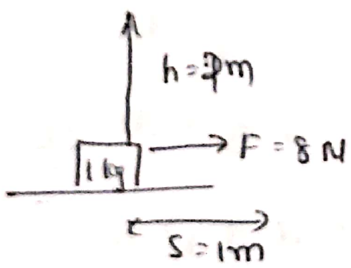
$$W = F S \cos\theta = F S \cos 180^\circ = -FS$$

(6)

Here both x and y are identical and are raised through same height

$W = mgh$ $\therefore$ W is same for x & y

(8)(9)(10)



work done = $F S \cos\theta \Rightarrow 8 \times 1 \times \cos 0 = 8J$ {horizontal}

work done = $F S \cos\theta = mgh = 1 \times 2 \times 10 = 20J$ (Vertical)

Total work done = $W_{Horizontally} + W_{vertical}$

$= 8J + 20J$

$= 28J$