

ws-8 → power
Thank.

①

Given mass $m = 10^3 \text{ kg}$; No. of floors = 6.

height of each floor = 3.5 m. : time to cross each floor = 6 sec.

Total height to which lift was lifting load = $6 \times 3.5 = 21 \text{ m}$.

$$P = \frac{W}{t} = \frac{mgh}{t} = \frac{10^3 \times 10 \times 21}{6} = 3.5 \times 10^3$$

If we take $g = 9.8 \text{ m/s}^2$ we get $P = 3.43 \times 10^3 \text{ W}$
→ A

②

Given force = 40 N.

distance travelled $S = 30 \text{ m}$; time = 1 min = 60 sec.

$$\text{Power} = \frac{W}{t} = \frac{F \cdot S}{t} = \frac{40 \times 30}{60} = \frac{40}{2} = 20 \text{ W.}$$

→ C

③

Given Speed $u = 20 \text{ m/s}$. Resistance = 600 N.

$$\text{Power} = F \cdot v = 600 \times 20 = 12000 \text{ W} = 12 \text{ kW}$$

→ C

④

Given mass $m = 300 \text{ kg}$; time $t = 10 \text{ s}$; $h = 100 \text{ m}$

$$\text{Power} = \frac{mgh}{t} = \frac{300 \times 9.8 \times 100}{10} = 98 \times 10^3 = 9800 \text{ W}$$

→ A

5

Given speed $v = 30 \text{ m/s}$

Resistance = 300 N

$$\text{Power} = F v = 300 \times 300 = 90000 \text{ W} \\ = 90 \text{ kW} \rightarrow B$$

6

Given mass $m = 300 \text{ kg}$; time = 60 sec

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

$$\text{work done } W = m g (h + d) = 300 \times 9.8 (20 + 20)$$

$$= 300 \times 9.8 \times 40$$

$$\text{Power} = \frac{W}{t} = \frac{300 \times 9.8 \times 40 \times 2}{60} = 19.6 \times 100$$

$$= 1.96 \times 10^3 \text{ W} = 1.96 \text{ kW} \rightarrow C$$

7

Given mass $m = 200 \text{ kg}$; height $h = 200 \text{ m}$

$t = 10 \text{ s}$

$$\text{Power} = \frac{W}{t} = \frac{m g h}{t} = \frac{200 \times 200 \times 10}{10}$$

$$= 4 \times 10^3 \text{ W} = 40 \text{ kW} \rightarrow A$$

8

depth = 20 m

$$V_d = 2238 \text{ lit} = 2238 \times 10^{-3} \text{ m}^3$$

height = 10 m

$$\therefore \text{Power} = 1 \text{ Hp} = 748 \text{ W}$$

$$\left[m = d V \right. \\ \left. = 2238 \times 10^{-3} \times 10^3 \right]$$

$$P = \frac{W}{t} = \frac{m g (d + h)}{t}$$

$$\therefore 748 = \frac{2238 \times 10 \times (20 + 10)}{t} \Rightarrow t = \frac{2238 \times 10 \times 30}{748} = 15 \text{ min} \\ = 897 \text{ sec}$$

9

Given $m = 2.05 \times 10^6 \text{ kg}$; speed = $u = 5 \text{ m/s}$
 $v = 25 \text{ m/s}$
 time = $5 \text{ min} = 5 \times 60 \text{ sec}$

$$\text{Power} = \frac{W}{t} = \frac{\text{change in k.E}}{\text{time}}$$

$$= \frac{\frac{1}{2} m (v^2 - u^2)}{t} = \frac{\frac{1}{2} \times 2.05 \times 10^6 (25^2 - 5^2)}{5 \times 60}$$

$$= \frac{2.05 \times 10^6 \times 30 \times 20}{10 \times 60} = 2.05 \times 10^6 = 2.05 \text{ MW}$$

10

Given $m = 2 \text{ kg}$ starts from rest i.e. $u = 0$

$v = 20 \text{ m/s}$ $t = 4 \text{ s}$ From $v = u + at$

$$\text{Power} = \frac{W}{t} = \frac{\text{change in k.E}}{\text{time}}$$

$$\Rightarrow 20 = 0 + 4a$$

$$\Rightarrow a = 5 \text{ m/s}^2$$

$$= \frac{\frac{1}{2} m (v^2 - u^2)}{t} = \frac{\frac{1}{2} \times 2 (20^2 - 0^2)}{4}$$

$$= \frac{100}{2}$$

At the end of 2 sec

$$v = u + at = 0 + 2 \times 5 = 10 \text{ m/s}$$

$$\therefore W = \frac{\frac{1}{2} \times 2 (10^2 - 0^2)}{2} = \frac{100}{2} = 50 \text{ W}$$

Advanced

①

A body can have energy without having momentum if it possess P.E but if body possess momentum then it must possess K.E. momentum and energy have different dimension.
A body cannot have energy without having momentum but it can have momentum without having energy.

(d)

Due to law of conservation of linear momentum both gun and bullet have same momentum but in opposite directions.

②

① Given $m = 100 \text{ kg}$; $t = 10 \text{ sec}$; $h = 100 \text{ m}$.

$$P = \frac{mgh}{t} = \frac{100 \times 10 \times 100}{10} = 10000 \text{ W} = 10 \text{ kW}$$

③

Given

speed $u = 20 \text{ m/s}$; Power = 3 kW .

$$\text{From } P = F \cdot u$$

$$3 \times 10^3 = F \times 20$$

$$F = \frac{3000}{20} = 150 \text{ N}$$

(9)

(7)

Number of bullets per min: $\frac{N}{t} = \frac{300}{60} = 5/\text{sec}$

velocity $v = 100 \text{ m/s}$

Power = 250 W

$$\therefore P = \frac{N \cdot \frac{1}{2} m v^2}{t}$$

$$\Rightarrow \frac{250}{250} = \frac{5 \times \frac{1}{2} \times m \times (100)^2}{t}$$

$$\Rightarrow 100 = m \times (100)^2$$

$$\therefore m = \frac{1}{100} \text{ kg} = 10^{-3} \text{ kg}$$

L Task

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(8)

Given Power = 0.392 W : $h = 10 \text{ m}$
 $= 392 \times 10^{-3} \text{ W}$ $t = 60 \text{ sec}$

$$P = \frac{mgh}{t}$$

$$\Rightarrow 392 \times 10^{-3} = \frac{m \times 9.8 \times 10}{60}$$

$$\Rightarrow m = \frac{392 \times 10^{-3} \times 60}{9.8} = 240 \times 10^{-3} \times 10^3$$

$$= 240 \text{ kg} \quad \left[\text{Power } 392 \times 10^{-2} \text{ kW} \right. \\ \left. = 392 \text{ W} \right]$$

(10)

The rate of the water flowing through pipe is $\frac{dm}{dt} = A v \rho$

where $A \rightarrow$ Area of cross section

$v \rightarrow$ velocity of water

$\rho \rightarrow$ density of water.

$$\begin{aligned} \text{Power} &= F v \\ &= \frac{dm}{dt} v \\ &= v^2 \frac{dm}{dt} \end{aligned}$$

To get 'n' times of water from same pipe

$$\text{Rate of flow of water } \frac{dm'}{dt} = n \frac{dm}{dt}$$

$$\Rightarrow A v' \rho = n A v \rho$$

velocity of water becomes $v' = n v$

$$\text{so Power } P' = F v' = \left[v' \frac{dm'}{dt} \right] v'$$

[From newton's II law]

$$P' = \frac{dm'}{dt} v'^2 = n \frac{dm}{dt} (n v)^2$$

$$P' = n^3 \frac{dm}{dt} v^2$$

$$P' = n^3 P$$

Tee main's level

①

$$\text{Given } T = 4500 \text{ N} : v = 2 \text{ m/s}$$

$$\begin{aligned} \text{Power} &= T \times v = 4500 \times 2 = 9000 \text{ W} \\ &= 9 \text{ kW} \end{aligned}$$

②

Given $V = 20 \text{ m/s}$: Power = 7500 W.

From $P = \text{Force} \times \text{velocity}$

$$\Rightarrow 7500 = F \times 20$$

$$F = 375 \text{ N.}$$

③

Given $\frac{dm}{dt} = 100 \text{ kg/s}$: $h = 100 \text{ m.}$

Power delivered to turbine - $\omega = \frac{mgh}{t}$

$$\omega = 100 \times 10 \times 100$$

$$\Rightarrow 100 \text{ kW}$$

④

Given Power = 10 kW = 10^4 W : $m = 200 \text{ kg}$; $h = 40 \text{ m}$

we know Power = $\frac{mgh}{t}$

$$\Rightarrow t = \frac{mgh}{P} = \frac{200 \times 10 \times 40}{10^4}$$

$$\Rightarrow t = 2 \times 4 = 8 \text{ sec}$$

⑤

velocity = 7.2 kmph = $7.2 \times \frac{5}{18} = 2 \text{ m/s}$

slope = $\sin \theta = \frac{1}{20}$: $m = 100 \text{ kg}$

$$\text{power} = mg \sin \theta v = 100 \times 9.8 \times \frac{1}{20} \times v$$

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

$$= 98 \text{ W}$$



⑥

$$\text{volume} = 4000 \times 10^{-6} \text{ m}^3$$

$$\text{time} = 1 \text{ min} = 60 \text{ sec.}; \quad \text{Pressure} = 130 \text{ mm of Hg}$$

$$\rho_{\text{Hg}} = 13.6 \times 10^3 \text{ kg/m}^3$$

$$\text{Power} = \rho g \times V \times t$$

$$= 13.6 \times 10^3 \times 10 \times 4000 \times 10^{-6} \times 60$$

$$= 136 \times 60 \text{ J}$$

$$= \frac{8.160}{748} = 1.1 \text{ HP} \rightarrow \text{C.}$$

⑦

$$\text{Tension} = 4500 \text{ N}; \quad v = 22 \text{ m/s}$$

$$\text{Power} = T v$$

$$= 4500 \times 22$$

$$= 99 \text{ kW} \rightarrow \text{B}$$

⑧

$$\text{Power} = 100 \text{ Hp}; \quad \text{speed} = 72 \text{ kmph.}$$

$$= 100 \times 748 \text{ W}$$

$$= 72 \times \frac{5}{18} = 20 \text{ m/s}$$

$$\text{Power} = \text{Force} \times \text{thrust}$$

$$= 748 \times 100 = F \times 20$$

$$\Rightarrow F = 3740 \text{ N} \rightarrow \text{D}$$

9

$$v = 9 \text{ kmph} = 9 \times \frac{5}{18} = \frac{5}{2} \text{ m/s}$$

$$m = 100 \text{ kg} ; \theta = 30^\circ$$

$$P_{\text{ower}} = mg \sin \theta \cdot v$$

$$= 100 \times 10 \times \sin 30^\circ \times \frac{5}{2}$$

$$= 100 \times 10 \times \frac{1}{2} \times \frac{5}{2}$$

$$= 1250 \text{ W}$$

10

$$m = 7200 \text{ kg} ; t = 1 \text{ hr} = 3600 \text{ sec} ; \text{depth} = 100 \text{ m}$$

$$\eta = 50\% = \frac{50}{100} = \frac{1}{2}$$

$$\Rightarrow \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{1}{2} \Rightarrow P_{\text{out}} = \frac{P_{\text{in}}}{2}$$

$$\Rightarrow P_{\text{out}} = \frac{mgh}{2t} = \frac{7200 \times 10 \times 100}{3600 \times 2} = 1000 \text{ W}$$

10

$$\text{Given } m = 7200 \text{ kg} ; t = 1 \text{ hr} = 3600 \text{ sec} ; \text{depth} = 100 \text{ m}$$

$$\eta = 50\% \Rightarrow \frac{P_o}{P_{in}} = 0.5$$

$$\Rightarrow P_o = 0.5 P_{in}$$

$$\Rightarrow \frac{mgh}{t} = 0.5 P_{in}$$

$$\Rightarrow \frac{7200 \times 10 \times 100}{3600} = 0.5 P_{in}$$

$$P_{in} = \frac{2 \times 10^3}{0.5}$$

$$= 4 \times 10^3$$

$$= 4 \text{ kW}$$



Advanced level

②

$$m_1 = 50 \text{ kg}; m_2 = 30 \text{ kg}; h = 20 \text{ m}; t = 40 \text{ sec.}$$

$$\text{work done in lifting} = (m_1 + m_2) g h$$

$$= (50 + 30) \times 10 \times 20$$

$$= 80 \times 10 \times 20$$

$$= 16000 \text{ J}$$

$$\text{Power} = \frac{W}{t} = \frac{16000}{40} = 400 \text{ W}$$

③

At maximum height total K.E is converted into P.E, because Energy is conserved.

(u)

$$\text{Given } F = i + j + k \text{ N}; \vec{v} = i - j + k \text{ m/s}$$

$$\text{Power} = F \cdot v = (i + j + k) \cdot (i - j + k)$$

$$= 1 \times 1 + 1 \times (-1) + 1 \times 1$$

$$= 1 - 1 + 1 = 1 \text{ W}$$

⑥, ⑦, ⑧ ⑧

when body reaches maximum height

$$T \cdot E = mgh$$

$$\Rightarrow K \cdot E + P \cdot E = mgh$$

At a height $\frac{3h}{4}$: $P \cdot E = mg(\frac{3h}{4}) = \frac{3}{4} mgh \rightarrow A$

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

$$\Rightarrow K \cdot E = mgh - P \cdot E = mgh - \frac{3}{4} mgh = \frac{1}{4} mgh \rightarrow B$$

$$\therefore \frac{K \cdot E}{P \cdot E} = \frac{\frac{1}{4} mgh}{\frac{3}{4} mgh} = \frac{1}{3}$$

⑨ ⑩

Rate of amount of water flowing per sec = $\frac{dm}{dt} = A v \rho$

where $A \rightarrow$ Area, $v \rightarrow$ velocity, $\rho \rightarrow$ density of water

$$\text{Force} = \frac{dp}{dt} = \frac{d}{dt}(mv) = v \frac{dm}{dt}$$

$$\text{Power } P = F \times v = v \frac{dm}{dt} v = v^2 \frac{dm}{dt}$$

To obtain n times of water from same pipe

$$\left(\frac{dm}{dt}\right)' = n \frac{dm}{dt} = A v' \rho$$

$$\therefore A v' \rho = n A v \rho \Rightarrow \boxed{v' = n v}$$

$$\text{force } F' = v' \left(\frac{dm}{dt}\right)' = (nv) (n \frac{dm}{dt}) = n^2 v \frac{dm}{dt}$$

$$\boxed{F' = n^2 F}$$

$$\text{Power } P' = F' v' = (n^2 F)(nv) = n^3 F v = \underline{n^3 P}$$