WS-16 - Power 9th foundation + Thank ①

①

Given power $= 2\,kw$; $t = 1\,min = 60\,sec$

$h = 10m$.

we know that $P = \frac{W}{t}$

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

$\Rightarrow 2\times10^{3} = \frac{m\times10\times10}{60}$

$\Rightarrow m = 2\times10^{2}\times6 = 1200\,kg \rightarrow D$

②

Given $W = mg = 750N$: $h = 15m$: $t = 5\,sec$.

workdone by the machine $= mgh$

$= 750\times15$

$\Rightarrow 11250$

$= 11.250\,kJ$

③

Given weight $= Mg = 750N$; $h = 15m$; $t = 5\,sec$

Power $= \frac{W}{t} = \frac{Mgh}{t} = \frac{750\times\cancel{15}^{3}}{\cancel{5}} = 2250 = 2.25\,kw$

④

Given $m = 100\,kg$, $h = 3m$; $t = 10\,sec$

Power $= \frac{W}{t} = \frac{mgh}{t} = \frac{100\times\cancel{10}\times3}{\cancel{10}} = 300\,W$

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(17)

If $p' = \frac{150}{100} p = [p + \frac{50}{100} p]$

$= \frac{3}{4} p$

$K.E = \frac{p^2}{2m}$ $\Rightarrow \frac{K.E'}{K.E} = \left[\frac{p'}{p}\right]^2$

$\Rightarrow \frac{K.E'}{K.E} = \left[\frac{3p}{4p}\right]^2 = \frac{9}{16}$

$K.E' = \frac{9}{16} \times 100\, K.E = 225\% = [100+125]\%\ K.E$

Increases by 125%

(18)

Given $m = 40$ kg ; $u = 8$ m/s , $v = 9$ m/s

work done = change in K.E

$= \frac{1}{2} m (v^2 - u^2)$

$= \frac{1}{2} \times 40 [9^2 - 8^2]$

$= 20 \times 17 \times 1 = 340\,J$

(19)

Given $p' = 2p$ where $p \rightarrow$ original momentum

we know $K.E = \frac{p^2}{2m}$ $\Rightarrow \frac{K.E'}{K.E} = \left[\frac{2p}{p}\right]^2 = 4$

$\Rightarrow K.E \propto p^2$ $\Rightarrow K.E' = 4\, K.E$

$\Rightarrow \frac{K.E'}{K.E} = \left[\frac{p'}{p}\right]^2$

Kinetic Energy is increased by 4 times

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(7)

Given Force $F = \frac{k}{v} \Rightarrow k = Fv$

Since work done $= F \cdot S$

we know displacement = velocity × time

$= vt$

$\therefore$ $w = Fvt$

$w = kt \rightarrow c$

(8)

Given

$m_b = 0.5\ kg$: $v_{man} = 1\ m/s$

$u_{ball} = 25\ m/s.$ $h = 0.5$

we know Power $= \frac{dw}{dt}$

According W-E theorem $W = \Delta K.E$

$\cancel{W_{Mz}} + W_{man} + W_g = \Delta K.E$

$\Rightarrow W_{man} - mgH = \frac{1}{2}mv^2 - \frac{1}{2}mu_{man}^2$

$\Rightarrow W_{man} - 0.5 \times 10 \times 0.5 = \frac{1}{2}m(v^2 - u_m^2)$

$\Rightarrow W_{man} - 2.5 = \frac{1}{2} \times \frac{1}{2}(25^2 - 1^2]$

$\Rightarrow W_{man} - \frac{10}{4} = \frac{1}{4} \times 624$

$\Rightarrow W_{man} = \frac{634}{4}$

Power $= \frac{W_{man}}{t} = \frac{634}{4 \times 5} = \frac{634}{20} = \frac{63.4}{2} = 31.7W$

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(5)

If a liquid of density ρ is flowing through a pipe of section A at speed v, the mass coming out per second is

$$\frac{dm}{dt} = \rho A v$$

In order to get 'n' times of water in the same time, we get

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

Here pipe and liquid are same $A' = A$; $\rho' = \rho$

$$\therefore v' = nv$$

$$\therefore \frac{F'}{F} = \frac{v'\left(\frac{dm}{dt}\right)'}{v\left(\frac{dm}{dt}\right)}$$ [From Newton's IInd law $F = \frac{dp}{dt} = v\frac{dm}{dt}$]

$$\Rightarrow \frac{F'}{F} = \frac{n\cancel{v}\, n\cancel{\frac{dm}{dt}}}{\cancel{v}\frac{dm}{dt}} = n^2 \Rightarrow F' = n^2 F$$

We know Power $P = Fv$

New power $P' = F'v' \Rightarrow P' = n^2 F\, nv = n^3 Fv$

$$P' = n^3 P$$

Given $P' \propto n^k P$ $\therefore k = 3 \rightarrow A$

(6)

Given $P = 3t^2$

$$\Rightarrow \frac{dw}{dt} = 3t^2$$

$$\Rightarrow w = \int 3t^2 dt$$

We know According to W-E theorem

$$W = \Delta K.E$$

$$\Rightarrow \Delta K.E = \int_2^4 3t^2 dt$$

$$= 3\left[\frac{t^3}{3}\right]_2^4 \quad \left[\int x^n dx = \frac{x^{n+1}}{n+1}\right]$$

$$= [4^3 - 2^3]$$

$$= 56\ J \rightarrow C.$$

= 21.7 kw

(9)

Given velocity = 100 kmph = $100 \times \frac{5}{18}$ m/s

F = 3920 N.

Power wasted = 20%

So 80% of power used

$\therefore$ 80% P = F V

$\Rightarrow \frac{80}{100} P = 3920 \times 100 \times \frac{5}{18}$

$\Rightarrow P = 3920 \times 100 \times \frac{5}{18} \times \frac{100}{80}$

$= 13.16 \times 10^4$ w in Hp

$P = \frac{13.16 \times 10^4}{748} = 182.5$ hp

(10)

Given

Volume $V = 30\ m^3$; time = 15 min = 15 × 60

Given

$h = 40m$; $\eta = 30\%$; $\rho_{water} = 10^3$ kg/l

$m_{water} = \rho V = 10^3 \times 30 = 30 \times 10^3$ kg.

work done $w = mgh = 30 \times 10^3 \times 9.8 \times 40 = 11760$ kJ

$P_{out} = mgh \times t = 11760 \times 10^3 \times 15 \times 60 = 13.066$ kw

$$\eta = \frac{P_{out}}{P_{in}} \Rightarrow \frac{30}{100} = \frac{13.066}{P_{in}}$$

$P_{in} = 43.6$ kw → A

(14), (15), (16)

Given Power = 2 H.P = 2×748 w

$$\eta = 75\% = \frac{75}{100} = \frac{3}{4}$$

$$\frac{P_{out}}{P_{in}} = \frac{3}{4} \Rightarrow P_{out} = \frac{3}{4} P_{in} = \frac{3}{4} \times 2 \times \overset{374}{\cancel{748}}$$

$\Rightarrow P_{out} = 1122$ w.

If the 2nd machine is connected, output of Ist machine will act as input for 2nd machine.

and given input for 2nd machine also 2 H.P = 2×748

so it's efficiency $\eta = \frac{P_{out}}{P_{in}} \times 100 = \frac{1122}{2 \times 748} \times 100$

$\eta = 75\%$

∴ Over all efficiency = 75%

(16) Given $\eta = 50\%$

$$\frac{P_{out}}{P_{in}} = \frac{50}{100} \Rightarrow P_{out} = \frac{1}{2} P_{in} = \frac{1}{2} \times 2\ H.P = 1\ H.P$$

→ A

LTask

Jee Main level

(4)

(1) Given volume $= 60\ lit = 60 \times 10^{-3}\ m^3$

$h = 20m$; $t = 5\ sec$

$M_{water} = d \times vol = 10^3 \times 60 \times 10^{-3} = 60\ kg$

$Power = \frac{w}{t} = \frac{Mgh}{t} = \frac{60 \times 10 \times \cancel{20}\,4}{\cancel{5}} = 2400W \rightarrow B$

(5) Given $m = 5\ kg$; $h = 10m$; $t = 10 sec$

$Power = \frac{w}{t} = \frac{Mgh}{t} = \frac{5 \times 10 \times 10}{10} = 50w \rightarrow A$

(3) Given $m = 20kg$; $h = 5m$; $t = 2\ sec.$

$power = \frac{w}{t} = \frac{Mgh}{t} = \frac{20 \times 10 \times 5}{2} = 500w \rightarrow C$

(4) Given No. of stairs $= 25$; $m = 60\ kg$; $t = 3\ sec$

height of each stair $= 20\ cm = 20 \times 10^{-2} m$

Total height $= nh = 25 \times 20 \times 10^{-2} = 5m$

$Power = \frac{w}{t} = \frac{Mgh}{t} = \frac{\overset{20}{\cancel{60}} \times \cancel{10}8 \times 5}{\cancel{3}} = 980W$

(5) Given $m = \frac{10}{7}\ kg$: initial velocity $u = 1\ m/s$.

We know $P = \frac{w}{t}$ From graph $P = 0.2x + 2$.

$\Rightarrow FV = 0.2x + 2$

$\Rightarrow maV = 0.2x + 2$

$\Rightarrow m\frac{dv}{dt} V = 0.2x + 2$

$m/h = 15$

3 ks/h

$$\Rightarrow m v \frac{dv}{dx}\frac{dx}{dt} = 0.2x + 2$$

$$\Rightarrow m v \frac{dv}{dx}(v) = 0.2x + 2$$

$$\Rightarrow m v^2 \, dv = (0.2x+2)\,dx$$

$$\int_1^v m v^2 \, dv = \int_1^{10} (0.2x+2)\,dx$$

$$\Rightarrow m\left[\frac{v^3}{3}\right]_1^v = \frac{0.1}{\cancel{0.2}}\left[\frac{x^2}{\cancel{2}}\right]_0^{10} + 2\left[x\right]_0^{10}$$

$$= \frac{10}{7}\left[\frac{v^3-1}{3}\right] = 0.1\left[10^2-0\right] + 2\left[10-0\right]$$

$$\Rightarrow \frac{10}{7}\left[\frac{v^3-1}{3}\right] = 10+20$$

$$\Rightarrow v^3 - 1 = 3 \times 3 \times 7$$

$$v^3 = 64 \Rightarrow v = 4 \text{ m/s} \rightarrow A$$

(6)

Given

$m = 1000 \text{ kg}$, $h = 100 \text{ m}$, $t = 0.5 \text{ s}$

$$\text{Actual power} = \frac{mgh}{t} = \frac{100 \times 10 \times 100}{0.5} = 2 \times 10^5 \, W$$

$$\text{Power required} = \frac{\text{Actual power}}{\eta} = \frac{2 \times 10^5}{\frac{25}{100}}$$

$$\Rightarrow \frac{200 \times 10^5}{25} = 800 \text{ kW} \Rightarrow B$$

(7)

let

mass of each coach $m_c = m$

mass of Engine $m_e = 2m$

$\therefore$ Total weight $F = 4m_c + m_e = 4m + 2m = 6m$

Power $P = FV = 6mgV \rightarrow (1)$

For 12 coaches $F = 12m + 2m = 14m$

$\therefore$ Power $P' = F V_1 = 14mg V_1 \rightarrow (2)$

$P = P'$

$\Rightarrow 6mgv = 14 mg v'$

$\Rightarrow v' = \frac{6}{14} v$ Given $v = 20$ m/s

$\Rightarrow v' = \frac{6}{14} \times 20 = 8.5$ m/s

For 6 coaches

Force $= 6m_c + m_e = 6m + 2m = 8m$

Power $= F V_2 \Rightarrow 8mg V_2 \rightarrow (3)$

$\therefore$ (1) and (3)

$6mgv = 8mg V_2$

$\Rightarrow V_2 = \frac{6}{8} \times 20 = 15$ m/s $\rightarrow$ A

(8)

Mass of coal $= 20$ ton $= 20 \times 10^3$ kg.

time $= 2$ sec $\quad s = 10$m

Power $= \frac{W}{t} = \frac{F \cdot S}{t} = \frac{20 \times 10^3 \times 100}{2} = 1000$ kW

$\langle$Power$\rangle = \frac{1}{2} \langle P_{instantaneous} \rangle = \frac{1000}{2} = 500$ kW $\rightarrow$ A

(9)

Given $F = 4\hat{i} - 3\hat{j} + 2\hat{k}$ N

Displacement $\vec{s} = (-3+2)\hat{i} + (-1+2)\hat{j} + (4+1)\hat{k}$

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

Power work $= \vec{F} \cdot \vec{s} = [4\hat{i} - 3\hat{j} + 2\hat{k}] \cdot [\hat{i} - 3\hat{j} + 5\hat{k}]$

$= -4 \times 1 + (-3)(-3) + 2(5)$

$= -4 + 9 + 10 = 15$ J $\rightarrow$ B

Given $M_{water} = 2000\ kg.$

height of dam = 550 m

height of Power house = 50m

$$Power = \frac{W}{t} = \frac{mg\,\Delta h}{t} = \frac{2000 \times 10 \times (550-50)}{1}$$

$$= 10 MW$$

Efficiency = 80%

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$$P_{out} = \eta \times P_{in} = \frac{80}{100} \times 10\ MW = 8MW \rightarrow B$$

Given $F = 150N$, $S = 20m$; $t = 2 sec$

15

$$Power = \frac{W}{t} = \frac{F \cdot S}{t} = \frac{150 \times 20}{2} = 1500W \rightarrow C$$

Given

$W = 2500 J$; $t = 5$ sec.

16

$$Power = \frac{W}{t} = \frac{2500}{5} = 500W \rightarrow A$$

we know

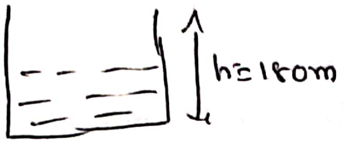
$$P = \frac{W}{t} = \frac{\Delta K.E}{t.}$$

$$P = \frac{\frac{1}{2} m v^2}{\frac{S}{V}} \Rightarrow P = \frac{1}{2} \frac{m}{S} v^3$$

$P \propto v^3$

Given $P_1 = P$; $P_2 = 2P$

$$\therefore \frac{P_2}{P_1} = \left(\frac{V_2}{V_1}\right)^3 \Rightarrow \frac{2P}{P} = \left(\frac{V_2}{V}\right)^3 \Rightarrow V_2 = (2)^{1/3} V \rightarrow A.$$



$m = 10{,}000\ kg$; $t = 1\ hr$

$= 10 \times 10^3\ kg$; $= 3600\ sec$

$P = \frac{W}{t} = \frac{mgh}{t} = \frac{10 \times 10^3 \times 10 \times 180}{3600}$

$= 5 \times 10^3\ W$

$P_{in} = \frac{P}{\eta} = \frac{5 \times 10^3}{80\%} = \frac{5}{\frac{80}{100}} \times 10^3 = \frac{50}{8} \times 10^3 \Rightarrow 6.25\ kW$

18

Given

$F = 4000\ N.$; $v = 3\ m/s$

$P = Fv = 4000 \times 3 = 12000\ W.$

$1\ kWh = 3.6 \times 10^5\ J$ $= 12 \times 10^3\ W$

$= 12\ kW$

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$P_{in} = k.$; P_{out}

1. $\eta = \frac{P_{out}}{P_{in}} \Rightarrow P_{in} = \frac{P_{out}}{k} = \frac{100}{\frac{50}{100}} = \frac{1000}{5} \Rightarrow 200W \rightarrow C$

2. $P_{in} = 60W$; $\eta = 20\% = \frac{1}{5} \Rightarrow P_{out} = \eta \times P_{in} = \frac{1}{5} \times 60 = 12W \rightarrow D$

3. $P_{in} = P_{out} \Rightarrow \eta = \frac{P_{out}}{P_{in}} = 1 = 100\% \rightarrow A$

4. $\eta = 20\% = \frac{1}{5} \Rightarrow P_{in} = \frac{P_{out}}{\eta} = \frac{450}{\frac{1}{5}} = 2250W \rightarrow B$

$P_{out} = 450$