WS-14 - Power 9th advanced

Think

(1)

No. of bullets fired per min $= \frac{360}{60} = 6$

$v = 600\ m/s$

$P = 5.4\ kW = 5.4 \times 10^3 = 54 \times 10^2\ W$

From def of Power $= \frac{W}{t} = \frac{n \frac{1}{2} mv^2}{t}$

$\cancel{54}^{9} \times 10^2 = \cancel{6} \times \frac{1}{2} \times m \times (600)^2$

$\Rightarrow 9 \times 10^{\cancel{2}} = \frac{m}{2} \times \cancel{36}^{18} \times 10^{\cancel{4}}$

$\Rightarrow m = \frac{9}{18 \times 10^2} = 5\ gm$

(2)

Power $= 1\ H.P = 748\ W$; depth $= 20m$

volume $= 2238\ lit = 2238 \times 10^{-3}\ m^3$; height from ground $= 10m$

mass = density × volume

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

$\Rightarrow 748 = \frac{10^3 \times 2238 \times 10 \times 30 \times 10^{-3}}{t}$

$\Rightarrow t = \frac{2238 \times 300}{748} =$

$= 3 \times 300$

$= 3 \times 5\ min$

$= 15\ min$

(3)

$m = 2.05\times10^{6}\,kg$; $u = 5\,m/s$ $v = 25\,m/s$; $t = 5\,min$

$$\text{Power} = \frac{W}{t} = \frac{\frac{1}{2}m(v^2-u^2)}{t}$$

$$= \frac{\frac{1}{2}\times 2.05\times10^{6}\,(25^2-5^2)}{5\times60}$$

$$= \frac{2.05\times10^{6}}{\cancel{2}}\times\frac{\cancel{30}\times\cancel{20}\ 10\ \cancel{2}}{\cancel{5}\times\cancel{60}\ 2} = 2.05\times10^{6} = 2.05\,MW$$

(4)

$m = 60\,kg$; $m_{lifting} = 15\,kg$; $h = 10\,m$; $t = 5\,min$

$$\text{Efficiency } \eta = \frac{P_{out}}{P_{in}}\times100 = \frac{m_{liftn}\,gh}{m_{Total}\,gh}\times100$$

$$= \frac{\cancel{15}}{\cancel{75}\ 5}\times\cancel{100}^{\,20} = 20\%$$

(6)

$d = 10\,m$; $Vol = 30\,m^3$; $t = 10\,min = 600\,sec.$

The tank is at a height of 20 m, $\eta = 20\%$ wasted

So Remaining 80% efficiency is used to lift water from depth 10 m

$$\eta = \frac{P_{out}}{P_{in}} \Rightarrow 80\% = \frac{\frac{mgh}{t}}{P_m}$$

$$\Rightarrow \frac{80}{100} = \frac{mgh}{t\times P_m} \Rightarrow \frac{4}{5}P_m = \frac{mgh}{t} = \frac{dVgh}{t}$$

$$\Rightarrow \frac{4}{5}P_m = \frac{10\times\cancel{30}\times\cancel{10}\times\cancel{30}\ 15}{\cancel{600}\ \cancel{20}\ 2}$$

$$\Rightarrow P_m = 15\times\frac{5}{4} = 18.75\,W$$

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(7)

Given $V = 2\hat{i} - \hat{j} + 4\hat{k}$ m/s ; $F = \hat{i} - 3\hat{j} + 2\hat{k}$ N

Power $= P = F \cdot V$

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

$= 1 \cdot 2 + (-3)(-1) + 2(4)$

$= 2 + 3 + 8 = 13$ W

(8)

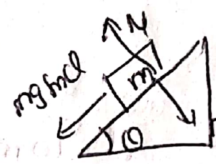
Given $\frac{m}{t} = 5$ kg/s ; $v = 6$ m/s

Power $= \frac{W}{t} = \frac{\frac{1}{2}mv^2}{t} \Rightarrow \frac{1}{2} \times 5 \times 6^2 = 90$ W

(9)

Given $m = 6 \times 10^3$ kg; $v = 18$ kmph $= \cancel{18} \times \frac{5}{\cancel{18}} = 5$ m/s

$\sin\theta = \frac{1}{20}$



Power $= mg\sin\theta\, v$ [f v]

$= \cancel{6}^{3} \times 10^3 \times 10 \times \frac{1}{\cancel{20}_{2}} \times 5$

$= 15 \times 10^3 = 15$ kW

$N = mg\cos\theta$

Resultant force $f = mg\sin\theta$

(10)

Power $= 200$ W ; $\frac{m}{t} = 2$ kg/s ; $d = 10$ m

$P = \frac{W}{t} = \frac{\frac{1}{2}mv^2 + mgh}{t}$

$\Rightarrow 200 = \frac{1}{2} \times 2 \times v^2 + 2 \times 9.8 \times 10$

$\Rightarrow 200 = v^2 + 196 \Rightarrow v^2 = 200 - 196$

$\Rightarrow v^2 = 4$

$\Rightarrow v = 2$ m/s

16

Given $P_{in} = 2\ H.P = 2 \times 748\ W$; $\eta = 75\%$

$$\eta = \frac{P_{out}}{P_{in}} \Rightarrow P_{out} = \eta\ P_{in}$$

$$= \frac{75}{60} \times 2 \times 748$$

$$= 1122 \simeq 1119\ W.$$

17

No change in efficiency

18

We know $P_{in} = 2\ H.P$

If $P_{out} = 1\ H.P$ then $\eta = \frac{P_{out}}{P_{in}} \times 100$

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

19

Given $\frac{dm}{dt} = 5\ kg/s$; velocity of belt $= 2\ m/s$

Force required to keep the ball moving

$$F = V\frac{dm}{dt} = 2 \times 5 = 10\ N$$

Power delivered $= F \times V = 10 \times 2 = 20\ W$

20

$m = 200\ kg$; $t = 5\ min$; $d = 120\ m$

$$\text{Power} = \frac{W}{t} = \frac{mgh}{t} = \frac{200 \times 10 \times 120}{5 \times 60} = 800\ \text{watt}$$

LTask SAQ

(1)

Given $P = 3t^2 - 2t + 1$

$$\Delta K.E = \int P\,dt = \int_2^4 (3t^2 - 2t + 1)\,dt$$

$$= 3\int_2^4 t^2\,dt - 2\int_2^4 t\,dt + \int_2^4 dt$$

$$\Rightarrow 3\left[\frac{t^3}{3}\right]_2^4 - 2\left[\frac{t^2}{2}\right]_2^4 + [t]_2^4$$

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

$$= 64 - 8 - (16 - 4) + 2$$

$$= 46\,J$$

(2)

$m_w = 2000\,kg$, $h = 240\,m$, $t = 1\,sec$

$P_{out} = 3.6\,MW = 3.6 \times 10^6\,W = 36 \times 10^5\,W$

$$P_{in} = \frac{mgh}{t} = \frac{2000 \times 10 \times 240}{1} = 48 \times 10^5\,W$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{36 \times 10^5}{48 \times 10^5} = \frac{3}{4} \times \cancel{100}^{25} = 75\%$$

(3)

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

We know that $P = FV$

$\Rightarrow P = ma\,v$

$= m\frac{dv}{dt}\,v$

$\Rightarrow P.dt = m\,v\,dv$

on integrating both sides

$\Rightarrow \int P.dt = \int m\,v\,dv$

$\Rightarrow Pt = m\left[\frac{v^2}{2}\right]$

$\Rightarrow v^2 = \left[\frac{2Pt}{m}\right] \Rightarrow v = \left[\frac{2Pt}{m}\right]^{1/2}$

$V = \frac{dx}{dt} \Rightarrow \frac{dx}{dt} = \left[\frac{2Pt}{m}\right]^{1/2}$

$\Rightarrow dx = \left[\frac{2P}{m}\right]^{1/2} t^{1/2}\,dt$

$\Rightarrow \int dx = \left[\frac{2P}{m}\right]^{1/2} \int t^{1/2}\,dt$

$\Rightarrow x = \left[\frac{2P}{m}\right]^{1/2} \left[\frac{t^{\frac{1}{2}+1}}{\frac{1}{2}+1}\right]$

$\Rightarrow x = \left[\frac{2P}{m}\right]^{1/2} \frac{t^{3/2}}{\frac{2}{3}} \Rightarrow x \propto t^{3/2}$

4

$\sin\theta = \frac{1}{50}$; $v = 15$ kmph $= 15 \times \frac{5}{18}$

Given $F_R = \frac{1}{25}$ [weight of car]

$= \frac{1}{25} mg$

Power when car is moving up $P = [mg\sin\theta + F_R]\,v$

$= \left[\frac{mg}{50} + \frac{mg}{25}\right] = \frac{3mg\,v}{50}$

Power when car is moving down $P' = [mg\sin\theta \sim F_R]\,v'$

$= \left[\frac{mg}{50} \sim \frac{mg}{25}\right] v'$

$= \frac{mg}{50} v'$

Given $P = P'$

$\Rightarrow 3\frac{\cancel{mg}}{\cancel{50}} \times v = \frac{\cancel{mg}}{\cancel{50}} v'$

$\Rightarrow v' = 3v = 3 \times 15 = 45$ kmph

5

vol $= 70$ cc $= 70 \times 10^{-6}\,m^3$; $P = 125$ mm of Hg

$\frac{n}{t}$ - freequency $= 72$ per min ; work $= P\,dV$

$P = \frac{W}{t} = n\frac{P\,dV}{dt}$; $P = h\rho g = 125 \times 10^{-3} \times 13.6 \times 10^{3} \times 9.8$

$= 125 \times 9.8$

$= \frac{72}{60} \times 125 \times 9.8 \times 70 \times 10^{-6}$

$= \underline{1.4\ W}$

(6)

Pressure $= 1\ atm = 10^5\ N/m^2$

Vol $= 10^3 cc = 10^{-3}\ m^3$

$\frac{n}{t} = \frac{30}{60} = \frac{1}{2}$ sec

Power $= \frac{n}{t}\ P\,dv$

$= \frac{1}{2} \times 10^5 \times 10^{-3}$

$= 50\ W$

(7)

$P = 150W$; $m = 10\ kg$

$v = 10\ m/s$; $u = 4\ m/s$; $t = 4s$

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

$= \frac{\frac{1}{2} \times 10 \times (10^2 - 4^2)}{4}$

$= 105\ W$

$\eta = \frac{P_{out}}{P_{in}} \times 100 = \frac{\cancel{105}^{35}}{\cancel{150}_{5}} \times \cancel{100}^{2}$

$= 70\%$

(8)

mass of train $m = 400 \times 10^3\ kg$

$\sin\theta = \frac{1}{98}$; $v = 10\ m/s$

Resistance per ton $= 10N$

For 400 metric tone

$= 4000N$.

Power $= (mg\sin\theta + F_R)\,v$

$= (\cancel{400000 \times 9.8 \times \frac{1}{98} + 40000) \times v}$

$= \cancel{(40 + 40000) \times 10}$

$= (400 \times 10^3 \times \cancel{9.8}^{0.1} \times \frac{1}{\cancel{98}} + 40000) \times 10$

$= (40000 + 4000)10$

$= 44000 \times 10$

$= 440 \times 10^3\ W$

$= 440\ kW$

(9)

Angular velocity

$\omega = 200\ rad/s$

$r = 8\ cm = 8 \times 10^{-2}\ m$

$T_1 = 135N$; $T_2 = 45N$

$\tau = T_1R - T_2R$

$= R(T_1 - T_2)$

$= 8 \times 10^{-2}(135 - 45)$

$\tau = 90 \times 8 \times 10^{-2}$

Power $= \tau\omega$

$= 90 \times 8 \times 10^{-2} \times 200$

$= 1440\ W$

$= 1.44\ kW$

(10)

let the constant resistive force acting on the car be R.

At maximum speed & velocity K.E of the car is not increasing further more. So the entire power delivered to the wheel is used up in doing work against resistive force $P = RV$

$R = \frac{P}{V}$ At time 't' let the displacement s

$\therefore$ Power = $\frac{\text{Resistive force} \times \text{displacement} + K.E}{t}$

$\Rightarrow P = \frac{R.s + \frac{1}{2}mv^2}{t} \Rightarrow Pt = R.s + \frac{1}{2}mu^2$

Differentiate on both sides w.r.t 't'

$\frac{d}{dt}(Pt) = \frac{d}{dt}(Rs + \frac{1}{2}mu^2)$

$\Rightarrow P\frac{dt}{dt} = R\frac{ds}{dt} + \frac{m}{2}\frac{d}{dt}(u^2)$ $\left[a = \frac{du}{dt}\right]$

$\Rightarrow P = Ru + \frac{m}{2}\,2u\frac{du}{dt} = RU + mau$

$\Rightarrow P = RU + F_{net}u \Rightarrow F_{net} = \left[\frac{P}{u} - R\right]$ $\left\{R = \frac{P}{v}\right\}$

where $u = \frac{V}{3}$ $\therefore F_{net} = \frac{P}{\frac{V}{3}} - \frac{P}{V} = \frac{3P}{V} - \frac{P}{V} = \frac{2P}{V}$

(14)

Force = 150 N ; $s = 20\,m$; $t = 2$ sec

$P = \frac{Fs}{t} = 150 \times \frac{20}{2} = 1500\,W$

(15)

$w = 2500\,J$; $t = 5$ sec $\Rightarrow$ Power $= \frac{w}{t} = \frac{2500}{5} = 500W$

(16)

$dP = \frac{w}{t} = F\,V$

$dp = maV = m\frac{dv}{dt}V \Rightarrow mV\frac{dv}{dt} = d \times vol \times V\frac{dv}{dt}$

From

$= d \times A \times \frac{l}{dt}\,V \times dV$

Here A = Area

d = density

V = velocity

$= d \times A\; V \times V \times dv$

$dp = dA\,V^2\,dv$

on integrating $\int dp = dA \int V^2 dV$

$\Rightarrow P = dA\left[\frac{V^{2+1}}{2+1}\right] \Rightarrow P = \frac{dA}{3}V^3$

$\therefore P \propto V^3$

$\Rightarrow \frac{P'}{P} = \left[\frac{V'}{V}\right]^3 \Rightarrow \frac{2P}{P} = \left[\frac{V'}{V}\right]^3 \Rightarrow 2 = \left[\frac{V'}{V}\right]^3$

$\Rightarrow \frac{V'}{V} = 2^{1/3} \Rightarrow V' = 2^{1/3}V$ (or) $(2V^3)^{1/3}$

(17)

$m = 10^4$ kg ; $t = 3600$ sec

$h = 180m$; $\eta = 80\% = \frac{4}{5}$

$\eta = \frac{P_{out}}{P_{in}}$

$\Rightarrow P_{in} = \frac{1}{\eta} \times P_{out}$

$\Rightarrow P_{in} = \frac{5}{4} \times \frac{mgh}{t}$

$= \frac{5}{4} \times \frac{10^4 \times 10 \times 180}{3600}$

$\Rightarrow \frac{5}{8} \times 10^4 = 6.25\,kW$

(18)

Tension $T = 4000\,N$

$V = 3\,m/s$

Power $= TV$

$= 4000 \times 3$

$= 12000\,W$

$= 12 \times 10^3\,W$

$= 12\,kW$