WS-1 - Power 9th advanced

Tbank

(1)

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

$v = 600$ m/s

$P = 504$ kw $= 5.4 \times 10^3 = 54 \times 10^2$ W

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

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

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

$\Rightarrow m = \frac{9}{18 \times 10^2} = \cancel{0}.5$ gm

(2)

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

volume = 2238 lit = 2238×10^{-3} m3 ; 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

$m = 2.05 \times 10^6\ kg$; $u_1 = 5\ m/s$ $v = 25\ m/s$; $t = 5\ min$

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

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

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

(4)

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

$$Efficiency\ \eta = \frac{P_{out}}{P_{in}} \times 100 = \frac{m_{liftn}\, gh}{m_{Total}\, gh} \times 100$$

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

(6)

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

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

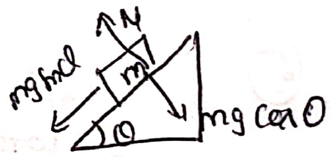
Given $\frac{m}{t} = 5$ kg/s ; $V = 6$ m/s

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

(9)

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

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



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

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

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

$N = mg\cos\theta$

Resultant force $f = mg\sin\theta$

(10)

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

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

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

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

$\Rightarrow V^2 = 4$

$\Rightarrow V = 2$ m/s

(16)

Given

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

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

$= \frac{75}{100} \times 2 \times 748$

$= 1122 \simeq 1119\ W.$

(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)

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

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

LTask SAQ

(1)

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

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

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

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

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

$$= 104 - 8 - (16 - 4) + 2$$

$$= 46\,J$$

(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 $P = FV$

$\Rightarrow P = maV$

$= m\frac{dv}{dt} V$

$\Rightarrow P.dt = mv\,dv$

on integrating both sides

$\Rightarrow \int P.dt = \int mv\,dv$

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

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

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

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

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

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

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

(4)

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

Given

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

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

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

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

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 $P = P'$

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

$\Rightarrow V' = 3V = 3 \times 15 = 45\text{ kmph}$

(5)

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

$\frac{n}{t}$ = frequency $= 72$ per min ; work $= P dV$

$P = \frac{W}{t} = n\frac{P dV}{dt}$; $P = h\rho g = 125 \times 10^{-3} \times 13.6 \times 10^{3} \times 9$

$= 125 \times 9.8$

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

$= \underline{1.04\text{ W}}$

(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)

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

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

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

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

$= 105\,W$

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

$= 70\%$

(8)

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

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

Resistance per ton $= 10\,N$

For 400 metric tone

$= 4000\,N.$

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

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

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

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

$= (40000 + 4000)\,10$

$= 44000 \times 10$

$= 440 \times 10^3\,W$

$= 440\,kW$

(9)

Angular velocity

$\omega = 200\,rad/s$

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

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

$\tau = T_1 R - T_2 R$

$= R(T_1 - T_2)$

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

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

Power $= \tau\,\omega$

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

$= 1440\,W$

$= 1.44\,kW$

16

$m = 10$; $u = 4$; $\frac{\frac{1}{2}mv^2}{t}$; $\frac{10 \times 1}{4}$; $= \omega$; $10 = !$; $0.$

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

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

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

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

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

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

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

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

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

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

(15)

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

(16)

$dP = \frac{w}{t} = FV$

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

From $\Rightarrow d \times A \times \frac{l}{dt} V \times dv$

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

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

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

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

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

$= \frac{5}{4} \times 10^4 \times \frac{\cancel{10} \times \cancel{180}}{\cancel{3600}_{20}}$

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

(18)

Tension $T = 4000\,N$

$v = 3\,m/s$

Power $= TV$

$= 4000 \times 3$

$= 12000\,W$

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

$= 12\,kW$