DPP – 07

Power

SOLUTION

1. Net force on lift, $F_{net} = mg + f$

mg will be downward and f also will be downward.

$F_{net} = (2000 \times 10 + 4000) = 24000$ N

Power $= F_{net} \times$ speed

$$\text{Speed} = \frac{\text{Power}}{F_{net}} = \frac{60 \times 746}{24000}$$

Speed $= 1.865 \text{ m s}^{-1} \approx 1.9 \text{ m s}^{-1}$

2. Power = Force × velocity $= (ma)(v) = (ma)(at) = ma^2t$

or Power $= m\left(\frac{v}{T}\right)^2 (t) = \frac{mv^2}{T^2}t$

3. Here, $P = 1$ J/s, $m = 2$ kg

$Pt = W = \Delta K$ or $Pt = \frac{1}{2}mv^2$

or $t = v^2 \Rightarrow v = \sqrt{t} \Rightarrow \frac{ds}{dt} = \sqrt{t}$ or $\int_0^s ds = \int_0^9 \sqrt{t}dt$

or $s = \frac{2}{3}\left[(t)^{3/2}\right]_0^9$ or $s = \frac{2}{3} \times 27 = 18$ m

4. We assuming that climber has no significant speed.

Then $K_f = K_i$, and the work done by the muscles is

$W_{nc} = 0 + (U_f - U_i) = mg(y_f - y_i)$

$= (90.0\text{Kg})(10.0 \text{ m/s}^2)(600 \text{ m})$

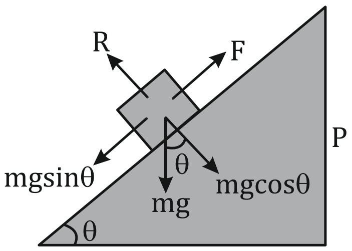
$= 5.40 \times 10^5$ J

The average power delivered is

$$P = \frac{W_{nc}}{\Delta t} = \frac{5.40 \times 10^5 \text{ J}}{(90 \text{ min})(60 \text{ s/1 min})} = 100 \text{ W}$$

5. $v = 7.2\frac{km}{h} = 7.2 \times \frac{5}{18} = 2\ m/s$

Slope is given 1 in 20



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

When man and cycle move up then component of weight opposes it motion i.e.,

$F = mg\sin\theta$

So power of the man $P = F \times v = mg\ \sin\theta \times v$

$= 100 \times 9.8 \times \left(\frac{1}{20}\right) \times 2 = 98\ W$

6. $P = \frac{mgh}{t} \Rightarrow m = \frac{p\times t}{gh} = \frac{2\times10^3\times60}{10\times10} = 1200\ kg$

As volume $= \frac{mass}{density} \Rightarrow v = \frac{1200\ kg}{10^3\ kg/m^3} = 1.2\ m^2$

Volume $= 1.2\ m^2 = 1.2 \times 10^3$ litre $= 1200$ litre

7. $P = \frac{mgh}{t} = 10 \times 10^3 \Rightarrow t = \frac{200\times40\times10}{10\times10^3} = 8sec$

8. Force required to move with constant velocity
$\therefore$ Power $= FV$
Force is required to oppose the resistive force R and also to accelerate the body of mass with acceleration a.
$\therefore$ Power $= (R + ma)V$

9. Work output of engine $= mgh = 100 \times 10 \times 10 = 10^4$ J

Efficiency $(\eta) = \frac{output}{input}$

$\therefore$ Input energy $= \frac{output}{\eta}$

$$= \frac{10^4}{60} \times 100 = \frac{10^5}{6}\ \text{J}$$

$$\therefore\ \text{Power} = \frac{\text{input energy}}{\text{time}} = \frac{10^5/6}{5} = \frac{10^5}{30} = 3.3\ \text{kW}$$

10. The useful output energy is

$$120\text{Wh}(1-0.60) = \text{mg}\,(y_f - y_i) = (\text{mg})\Delta y$$

$$\Delta y = \frac{120\text{W}(3600\text{s}) \times 0.40}{900\text{N}}\left(\frac{\text{J}}{\text{W.s}}\right)\left(\frac{\text{N.m}}{\text{J}}\right) = 192\ \text{m}$$

11. The marine must exert an 800-N upward force, opposite the gravitational force, to lift his body at constant speed.

$$\text{Power} = \frac{W}{t}$$

$$P = \frac{mgh}{t} = \frac{(800\text{N})(12.0\text{m})}{8.00\ \text{s}} = 1200\ \text{W} = 1.2\ \text{kW}$$