Physics 20 - Lesson 26
Work, Energy, Power

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1) /4

a) work = area of a force-distance graph

$W = 3.5N \cdot 16.0m$

$\boxed{W = 56J}$

b)

$W = \frac{1}{2}ab + lw$

$W = \frac{1}{2}(-4.0N)(3.0m) + (-4.0N)(5.0m)$

$\boxed{W = -26J}$

2) /4

$W = F\Delta d$

$W = 2.2\times10^{4}N(7.6m)$

$\boxed{W = +1.7\times10^{5}J}$

Work is <u>positive</u> since the object is being <u>raised</u> (i.e. the potential energy increases)

3) /6

a) up

$F = 685N + 915N = 1600N$

$W = F\Delta d$

$W = 1600N(15.2m)$

$\boxed{W = +2.43\times10^{4}N\cdot m}$

b) down

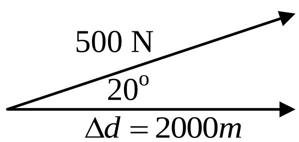
$F = 685N$

$W = F\Delta d$

$W = 685N(-15.2m)$

$\boxed{W = -1.04\times10^{4}N\cdot m}$

4) /4

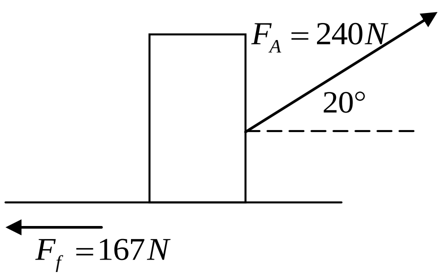


$W = F\Delta d\cos\theta\times2 \leftarrow$ two locomotives

$W = 5000N(2000m)\cos20\times2$

$\boxed{W = 1.88\times10^{7}J}$

5) /6



$W_A = F_A\Delta d\cos\theta$

$W_A = 240N(8.00m)\cos20°$

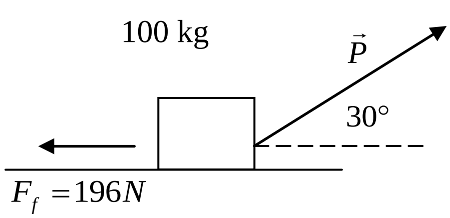
$\boxed{W_A = 1.80\times10^{3}N\cdot m}$

$W_f = F_f\Delta d$

$W_f = -167N\cdot8.00m$

$\boxed{W_f = -1.34\times10^{3}N\cdot m}$

6) /5



If $W_{net} = 0 \rightarrow F_{net} = 0$

$\vec{F}_{net} = \vec{P}\cos30° + \vec{F}_f$

$0 = P\cos30° - F_f$

$P = \frac{F_f}{\cos30°}$

$P = \frac{196N}{\cos30°}$

$\boxed{P = 226N}$

7) a)

$W = F\Delta d$

$W = F_g \Delta d$

$W = 155kg(9.81\,m/s^2)\cdot 120m$

$\boxed{W = 1.82\times 10^5 J}$

/8

b) From the diagram we see that the weight is distributed between the three ropes

$3T = weight$

$3T = F_g$

$T = \frac{F_g}{3}$

$T = \frac{mg}{3}$

$T = \frac{155kg(9.81)}{3}$

$T = \boxed{507N}$

c) Work on scaffold = work done by window washer

$W = F\Delta d$

$\Delta d = \frac{W}{F}$

$\Delta d = \frac{1.82\times 10^5 J}{570N}$

$\Delta d = \boxed{360m}$

or 3 ropes $\times$ 120m = $\boxed{360m}$

Kinetic / Potential Problems

1) /3

$$E_k = \frac{1}{2}mv^2$$

$$E_k = \frac{1}{2}(65.0kg)(5.70m/s)^2$$

$$\boxed{E_k = 913J}$$

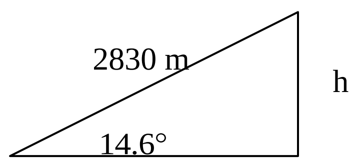
2) /3

$$E_p = mgh$$

$$E_p = 55.0kg(9.81 \tfrac{m}{s^2})(443m)$$

$$\boxed{E_p = 239kJ}$$

3) /4



$$h = 2830(\sin 14.6°)$$

$$h = 713.4m$$

$$E_p = mgh$$

$$E_p = 75.0kg(9.81 \tfrac{m}{s^2})(713.4m)$$

$$\boxed{E_p = 525kJ}$$

4) /6

$$k = \frac{F}{x}$$

$$k = \frac{120N}{0.045m}$$

$$k = 2.7 \times 10^3\, N/m$$

$$E_p = \tfrac{1}{2}kx^2$$

$$E_p = \tfrac{1}{2}(2.67 \times 10^3\, \tfrac{N}{m})(0.045m)^2$$

$$\boxed{E_p = 2.7J}$$

5) /3

$$E_p = \tfrac{1}{2}kx^2$$

$$E_p = \tfrac{1}{2}(25N/m)(0.096m)^2$$

$$\boxed{E_p = 0.12J}$$

Power

1) $\text{Standard unit} = \text{Watt}$

$kWh = kW \times h \rightarrow$ unit of energy

/3 $P \times t = E$

2) $P = \frac{W}{t}$

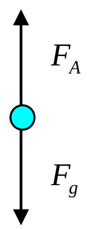
/3 $P = \frac{F\Delta d}{t}$

$P = \frac{(2.5\times10^4 N)(60.0m)}{12.0s}$

$\boxed{P = 125kW}$

3)

/4



$F_A = F_g$

$F_A = mg$

$F_A = 5000kg(9.81 \,^{m}/_{s^2})$

$F_A = 49050N$

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

$t = \frac{F\Delta d}{P}$

$t = \frac{49050N(2.5m)}{10000W}$

$\boxed{t = 12.3s}$

4)

/4

$mass\,rate = 1.2 \text{ x } 10^6 \text{ kg/s}$

$\frac{m}{t} = \frac{1.2 \text{ x } 10^6 \text{ kg}}{1\text{s}}$

$h = 50m$

$P = ?$

$P = \frac{\Delta E}{t}$

$P = \frac{\Delta E_p}{t}$

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

$P = \frac{(1.2 \times 10^6 \text{ kg})}{1s}(9.81 \,^{m}/_{s^2})(50.0m)$

$\boxed{P = 5.9 \times 10^8 \ W}$

5)

$W_{net} = E_{Total} - E_{heat}$

/3 $W_{net} = P \cdot t - E_{heat}$

$W_{net} = 3.5\times10^3 W(10\,\text{min})(60\frac{s}{\text{min}}) - (500\times10^3 J)$

$\boxed{W_{net} = 1.6MJ}$