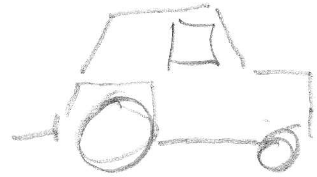
1.



$F = 7.50 \times 10^3\ N$

$\Delta s = 3.20\ km = 3200\ m$

$P = 25\ kW = 25{,}000\ W$

$P = \frac{W}{\Delta t}$ $\Delta t = \frac{W}{P} = \frac{F \cdot \Delta s}{P} = \frac{(7.50 \times 10^3 N)(3200 m)}{25{,}000 W}$

$\Delta t = 960\ s$

Units: $\frac{N \cdot m}{W} = \frac{J}{J/s} = s$

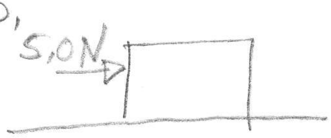
2.

$\Delta t = 2.5\ min = 150\ s$

The elevator would require greater power, but the same amount of energy.

Greater power probably means a bigger motor with more heat loss ⇒ greater expense.
Landlord should have said would need greater power.

3.



Constant velocity ⇒ $\Sigma F = 0$

$m = 6\ kg$
$V = 2.5\ m/s$, $\Delta t = 25\ s$

a) $W = F \cdot \Delta s$ $\Delta s = V\Delta t = (2.5\ m/s)(25\ s) = 62.5\ m$

$W = (5.0\ N)(62.5\ m)$

$W = 312.5\ J$

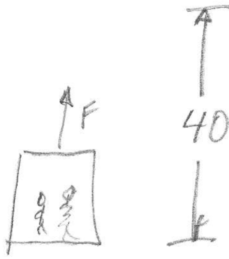
b) $P = \frac{W}{\Delta t} = \frac{312.5\ J}{25\ s} =$

$P = 12.5\ W$

3 (cont'd)

c) $F_f = 5.0\,N$ magnitude. Constant velocity $\Sigma F = 0$.

4.



$m = 1300\,kg$ $\Delta t = 75\,s$

$g = 9.8\,m/s^2$ $\Delta s = 40\,m$

$$F = F_g = mg$$

$$W = F \cdot \Delta s = mg \cdot \Delta s = (1300kg)(9.8m/s^2)(40m)$$

$$W = 509{,}600\,J$$

Units $(kg\,m/s^2)(m) = N \cdot m = J$

Power $P = \frac{W}{\Delta t} = \frac{509{,}600\,J}{75s}$

$$P = 6795\,W$$

Units $\frac{J}{s} = W$

5.

$m = 3(80kg) = 240kg$

$\Delta s = 300m$

$\Delta t = 30s$

The horizontal motion does not figure into the work, because it is perpendicular to the force lifting. The work in the horizontal motion comes from the friction.

a)

$W = F \cdot \Delta s = mg \cdot \Delta s$

$= (240kg)(9.8m/s^2)(300m)$

$W = 705{,}600\,J$

$\boxed{P = 23{,}520W}$

$P = \frac{W}{\Delta t} = \frac{705{,}600J}{30s} = 23{,}520\,W$

p. 338

5. (cont'd)

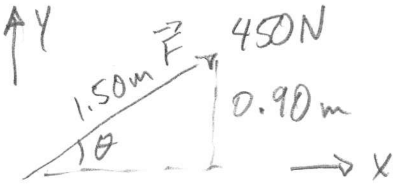
b) An increase of 25% of power P is calculated

$$P_{tot} = P + 25\% P$$
$$= P + 0.25 P$$
$$P_{tot} = (1.25) P$$

$$P_{tot} = 1.25 P = (1.25)(23,520 W)$$

$$\boxed{P_{tot} = 29,400 W}$$

6.



$$\sin\theta = \frac{h}{l} \qquad \theta = \sin^{-1}\left(\frac{h}{l}\right)$$

$F = 60 N$

$\Delta s = 400 m$

$$\theta = \sin^{-1}\left(\frac{0.90 m}{1.50 m}\right) = 36.87°$$

The component of the force in the direction of the motion, F_x, is

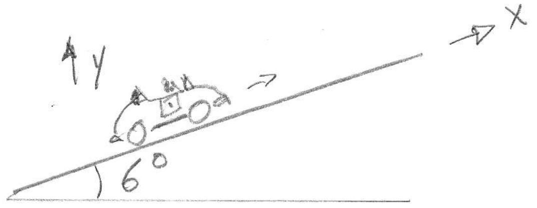
$$F_x = F\cos\theta = (60N)\cos 36.87°$$

$$F_x = 48 N$$

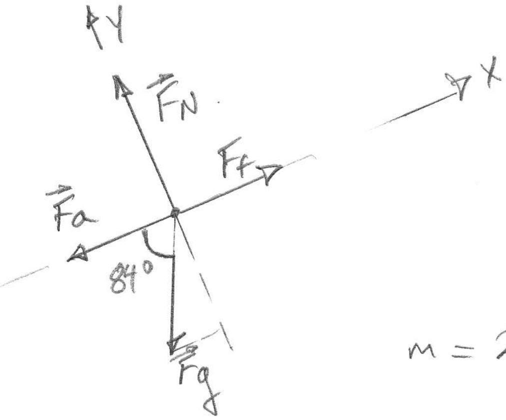
$$W = \vec{F} \cdot \Delta\vec{s} = F_x \cdot \Delta s = (48 N)(400 m)$$

$$\boxed{W = 19200 J}$$

7.



a)



m = 2000kg

$$V = \left(90\frac{km}{h}\right)\left(\frac{1000m}{1km}\right)\left(\frac{1h}{3600s}\right)$$

$$V = 25\,m/s$$

F_N - Normal force

F_a - Air resistance force = 450N

F_g - Gravitational force = mg

F_f - Friction that prevents the tires from slipping. It is this force that pushes the car forward.

b) The force exerted by the engine makes the tires turn. What we mean here is F_f.

Constant velocity means the net force = 0.

$$\Sigma F_x = F_f - F_a - F_g \cos 84° = 0$$

$$F_f = F_a + mg \cos 84°$$

$$F_f = 450N + (2000kg)(9.8m/s^2)\cos 84°$$

$$\boxed{F_f = 2499\ N}$$

It is really the static friction force of the tires on the road that move the car forward. The forces & torques in the engine & power train cause the tires to rotate. The friction prevents the rotation & pushes car forward.

Dr. Bob

7. (cont'd)

c) $W = ?$ $\Delta t = 5\,min = 5\,min\left(\frac{60s}{1\,min}\right)$

$\Delta t = 300s$

$\Delta x = v \cdot \Delta t = (25\,m/s)(300\,s)$

$\Delta s = \Delta x = 7500\,m$

$W = F \cdot \Delta s = (2499\,N)(7500\,m)$

$W = 18,742,500\,J$

d)

$P = \frac{W}{\Delta t} = \frac{18,742,500\,J}{300\,s}$ $W = \frac{J}{s}$

$\boxed{P = 62,475\,W}$

1 horsepower = 1 hp = 545.7 W

$P = 62,475\,W\left(\frac{1\,hp}{545.7\,W}\right)$

$P = 114.5\,hp$ Makes sense