Chapter 7

2. With speed v = 11200 m/s, we find

$$K = \frac{1}{2}mv^2 = \frac{1}{2}(2.9\times10^5 \text{ kg})\ (11200 \text{ m/s})^2 = 1.8\times10^{13} \text{ J.}$$

5. We denote the mass of the father as m and his initial speed v_i. The initial kinetic energy of the father is

$$K_i = \frac{1}{2}K_{\text{son}}$$

and his final kinetic energy (when his speed is $v_f = v_i + 1.0$ m/s) is $K_f = K_{\text{son}}$. We use these relations along with Eq. 7-1 in our solution.

(a) We see from the above that $K_i = \frac{1}{2}K_f$, which (with SI units understood) leads to

$$\frac{1}{2}mv_i^2 = \frac{1}{2}\left[\frac{1}{2}m\ \left(v_i + 1.0 \text{ m/s}\right)^2\right].$$

The mass cancels and we find a second-degree equation for v_i : $\frac{1}{2}v_i^2 - v_i - \frac{1}{2} = 0.$ The positive root (from the quadratic formula) yields v_i = 2.4 m/s.

(b) From the first relation above $\left(K_i = \frac{1}{2}K_{\text{son}}\right)$, we have

$$\frac{1}{2}mv_i^2 = \frac{1}{2}\left(\frac{1}{2}\ (m/2)\ v_{\text{son}}^2\right)$$

and (after canceling m and one factor of 1/2) are led to $v_{\text{son}} = 2v_i = 4.8\ \text{m/s}.$

8. Using Eq. 7-8 (and Eq. 3-23), we find the work done by the water on the ice block:

$$W = \vec{F}\cdot\vec{d} = \left[(210 \text{ N})\,\hat{\text{i}} - (150 \text{ N})\,\hat{\text{j}}\right]\cdot\left[(15 \text{ m})\,\hat{\text{i}} - (12 \text{ m})\hat{\text{j}}\right] = (210 \text{ N})(15 \text{ m}) + (-150 \text{ N})(-12 \text{ m})$$
$$= 5.0\times10^3 \text{ J.}$$

19. Equation 7-15 applies, but the wording of the problem suggests that it is only necessary to examine the contribution from the rope (which would be the "W_a" term in Eq. 7-15):

$$W_a = -(50\text{ N})(0.50\text{ m}) = -25\text{ J}$$

(the minus sign arises from the fact that the pull from the rope is anti-parallel to the direction of motion of the block). Thus, the kinetic energy would have been 25 J greater if the rope had not been attached (given the same displacement).

55. **THINK** A horse is doing work to pull a cart at a constant speed. We'd like to know the work done during a time interval and the corresponding average power.

EXPRESS The horse pulls with a force $\vec{F}$. As the cart moves through a displacement $\vec{d}$, the work done by $\vec{F}$ is $W = \vec{F}\cdot\vec{d} = Fd\cos\phi,$ where ϕ is the angle between $\vec{F}$ and $\vec{d}$.

ANALYZE (a) In 10 min the cart moves a distance

$$d = v\Delta t = \left(6.0\ \frac{\text{mi}}{\text{h}}\right)\left(\frac{5280\text{ ft/mi}}{60\text{ min/h}}\right)(10\text{ min}) = 5280\text{ ft}$$

so that Eq. 7-7 yields

$$W = Fd\cos\phi = (40\text{ lb})(5280\text{ ft})\cos 30° = 1.8\times10^5\ \text{ft}\cdot\text{lb}.$$

(b) The average power is given by Eq. 7-42. With $\Delta t = 10\ \text{min} = 600\,\text{s}$, we obtain

$$P_{\text{avg}} = \frac{W}{\Delta t} = \frac{1.8\times10^5\ \text{ft}\cdot\text{lb}}{600\text{ s}} = 305\text{ ft}\cdot\text{lb/s},$$

which (using the conversion factor $1\,\text{hp} = 550\,\text{ft}\cdot\text{lb/s}$ found on the inside back cover) converts to $P_{\text{avg}} = 0.55$ hp.

LEARN The average power can also be calculate by using Eq. 7-48: $P_{\text{avg}} = Fv\cos\phi$. Converting the speed to $v = (6.0\text{ mi/h})\left(\frac{5280\text{ ft/mi}}{3600\text{ s/h}}\right) = 8.8\,\text{ft/s}$, we get

$$P_{\text{avg}} = Fv\cos\phi = (40\text{ lb})(8.8\text{ ft/s})\cos30° = 305\text{ ft}\cdot\text{lb} = 0.55\text{ hp}$$

which agrees with that found in (b).

66. After converting the speed: $v = 120\,\text{km/h} = 33.33\,\text{m/s}$, we find

$$K = \frac{1}{2}mv^2 = \frac{1}{2}\left(1200\,\text{kg}\right)\left(33.33\,\text{m/s}\right)^2 = 6.67\times 10^5\ \text{J}.$$

$$v_f = \sqrt{v_i^2 + \frac{2W}{m}} = \sqrt{(4.00\ \text{m/s})^2 + \frac{2(28\ \text{J})}{2.00\ \text{kg}}} = 6.63\,\text{m/s}\ .$$