40. The average power received by the collector is $(1\ \text{kW/m}^2)(15\ \text{m}^2) = 15\ \text{kW}$, so it would take $\Delta t = \Delta W/\bar{P} = 40\ \text{kWh}/15\ \text{kW} = 2.67\ \text{h}$ to collect the required energy. (The average intensity of sunlight is discussed in more detail in Chapter 29.)

62. Appendix C lists the energy content of oil as 39 kWh/gal. Therefore, the import rate is $(800\ \text{GW})(1\ \text{gal}/39\ \text{kWh})\times(24\ \text{h/d})$, or roughly 490 million gallons per day.

64. **INTERPRET** We have the mass and power of a car, and need to find the highest rate at which it can climb a given slope. We use work and energy techniques.

DEVELOP The car's power is 35 kW. The mass is 1750 kg. The slope is 4.5°. We can use the relationship between power, force, and velocity, $P = \vec{F}\cdot\vec{v}$, where the force is due to gravity, $\vec{F} = -m\vec{g}$. The angle between the force of gravity and the velocity is 94.5°, so the angle θ between the force provided by the *car* and the velocity is 85.5°.

EVALUATE $P = \vec{F}\cdot\vec{v} = (mg)(v)\cos\theta \rightarrow v = \frac{P}{mg\cos\theta} = 26\ \text{m/s}.$

ASSESS This speed (58 mph) seems reasonable for the grade involved. The actual maximum speed will be lower due to air resistance, which is not negligible at this speed.

68. **(a)** Provided the stirring force is applied always parallel to the velocity of the spoon, $P_{\text{app}} = F_{\text{app}}v = (45\ \text{N})(0.29\ \text{m/s}) = 13.1\ \text{W}$. **(b)** $W_{\text{app}} = P_{\text{app}}t = (13.1\ \text{W})(60\ \text{s}) = 783\ \text{J}$.

70. If the price differential is equal to the difference in the cost of energy over a period of time t, then $\$(1150-850) = (P_{\text{std}}\times 20\%t - P_{\text{eff}}\times 11\%t)(\$0.095/\text{kWh})$.

Solving for t, we find

$$t = (300)[(0.425\times 0.2 - 0.225\times 0.11)(0.095)]^{-1}\ \text{h} = 5.24\times 10^4\ \text{h} = 2.18\times 10^3\ \text{d} \simeq 6.0\,\text{y}.$$

72. Since we assume that the constant power supplied by the locomotive, starting from rest, provides the net work done on the train, $W_{\text{net}} = \int P\,dt = Pt = \Delta K = \frac{1}{2}Mv^2$. (This would be the case, for example, if no work were done by gravity or friction.) Then the speed of the train is $v = \sqrt{2Pt/M}$. The distance the train moves along the track can be found by integrating $v = dx/dt$. Thus $x - x_0 = \sqrt{2Pt/M}\,dt = \frac{2}{3}\sqrt{2P/M}\,t^{3/2}$.

80. **INTERPRET** We need to convert barbell lifts to calories to find out how many lifts we should do in order to burn off the energy provided by a chocolate bar. We use $W = Fs$.

DEVELOP We consider only the lifting portion of the exercise, and find work done in Joules. We also convert the energy in the bar to kcal, and divide the energy of the bar by the work per lift to find the number of lifts we need to do. $s = 2.5$ m, $m = 45$ kg, and the energy of the chocolate bar is $E = 230$ kcal.

EVALUATE The work done in one lift is $W_1 = Fs = mgs = (45\ \text{kg})\times(9.8\ \text{m/s}^2)\times(2.5\ \text{m}) = 1100\ \text{J} = 1.1\ \text{kJ}$. The energy of the chocolate bar is $E = (230\ \text{kcal})\times\frac{4.186\ \text{kJ}}{1\ \text{kcal}} = 963\ \text{kJ}$. The number of lifts required is $N = \frac{963\ \text{kJ}}{1.1\ \text{kJ/lift}} = 873$ lifts.

ASSESS It is important to remember that the food Calorie (with a capital "C") is a thousand times bigger than the physics calorie.