Homework Solutions
9/21/2007

Problems

47. a.

$$PE_i + KE_i = PE_f + KE_f + W_{ar}$$

$$mgh_i + 0 = 0 + \frac{1}{2}mv^2 + F_{freefallair}d + F_{parachuteair}d$$

$$mgh_i - F_{freefallair}d - F_{parachuteair}d = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2\left(mgh_i - F_{freefallair}d - F_{parachuteair}d\right)}{m}}$$

$$v = \sqrt{\frac{2\left(784{,}000\,J - (50\,N)(800\,m) - (3600\,N)(200\,m)\right)}{70\,kg}}$$

$$v = 24.5\,\frac{m}{s}$$

b. Yes, that's pretty fast. The same as if you dropped from over 20m high!

c.

$$mgh_i + 0 = 0 + \frac{1}{2}mv^2 + F_{freefallair}d + F_{parachuteair}(1000m - d)$$

$$mgh_i - \frac{1}{2}mv^2 - F_{parachuteair}(1000m) = F_{freefallair}d - F_{parachuteair}d$$

$$d = \frac{mgh_i - \frac{1}{2}mv^2 - F_{parachuteair}(1000m)}{(F_{freefallair} - F_{parachuteair})}$$

$$d = \frac{784000J - 1000J - 3{,}600{,}000J}{(-3550N)}$$

$$d = 793m$$

$$h = 207m$$

d. It is not very reasonable to assume the retarding force of air resistance is constant because it depends on the speed of the diver.

54. a.

$$a = \frac{\Delta v}{t} = \frac{1.75\frac{m}{s} - 0\frac{m}{s}}{3.00s} = 0.583\frac{m}{s^2}$$

$$F_{motor} - mg = ma$$

$$F_{motor} - mg = ma$$

$$F_{motor} = ma + mg = m(a + g)$$

$$F_{motor} = (650kg)\left(9.80\frac{m}{s^2} + 0.583\frac{m}{s^2}\right) = 6750N$$

$$v_{avf} = \frac{v + v^0}{2} = \frac{1.75\frac{m}{s} + 0\frac{m}{s}}{2} = 0.875\frac{m}{s}$$

$$P = F \bullet v_{avg} = 6750N \bullet 0.875\frac{m}{s} = 5910W$$

b.

$$P = F \bullet v_{avg} = (mg) \bullet v = \left(650kg \bullet 9.80\frac{m}{s^2}\right) \bullet 1.75\frac{m}{s}$$

$$P = 11100W$$

73a. The potential energy of the wind is equal to the work it does.

$$PE_{wind} = W = F \bullet d$$

The distance, D in the figure, is equal to Lsinθ+LsinΦ (make traingles out of the two angles. The vertical distance dropped on the right equals L-Lcosθ, while the vertical height gained on the left from the bottom of the path equals L-LcosΦ. Assuming Jane just makes it to the other side, then the final kinetic energy is zero.

$$D = L\sin\theta + L\sin\phi$$

$$\sin\phi = \frac{D - L\sin\theta}{L}$$

$$\phi = \sin^{-1}\left(\frac{D - L\sin\theta}{L}\right) = 28.94°$$

$$TE_f = TE_i$$

$$(PE + KE +)_f = (PE + KE)_i - W_{wind}$$

$$mg(L - L\cos\phi) = mg(L - L\cos\theta) + \frac{1}{2}mv^2 - F[L\sin\theta + L\sin\phi]$$

$$\frac{1}{2}mv^2 = mg(L - L\cos\phi) - mg(L - L\cos\theta) + F[L\sin\theta + L\sin\phi]$$

$$v = \sqrt{\frac{2[mg(L - L\cos\phi) - mg(L - L\cos\theta) + F(L\sin\theta + L\sin\phi)]}{m}}$$

$$v = \sqrt{\frac{2[2447J - 7001J + 5499J]}{50kg}} = 6.15\frac{m}{s}$$

b.

$$(PE+KE)_f = (PE+KE)_i + W_{wind}$$

$$mg(L-L\cos\theta) = mg(L-L\cos\phi) + \frac{1}{2}mv^2 + F[L\sin\theta + L\sin\phi]$$

$$\frac{1}{2}mv^2 = mg(L-L\cos\theta) - mg(L-L\cos\phi) - F[L\sin\theta + L\sin\phi]$$

$$v = \sqrt{\frac{2[mg(L-L\cos\theta) - mg(L-L\cos\phi) - F[L\sin\theta + L\sin\phi]]}{m}}$$

$$v = \sqrt{\frac{2[18204J - 6363J - 5499J]}{130kg}} = 9.87\frac{m}{s}$$

87. a.

$$P = \frac{E}{t} = \frac{600kWh}{30.0d}\left(\frac{3.6 \bullet 10^6 J}{1kWh}\right)\left(\frac{1d}{3600s}\right) = 833W$$

$$\frac{P}{A} = \frac{833W}{(13.0m)(9.50m)} = 6.75\frac{W}{m^2}$$

b.

$$R_{fuel} = \frac{55.0\frac{mi}{h}}{25.0\frac{mi}{gal}} = 2.2\frac{gal}{h}\left(\frac{2.54kg}{1gal}\right) = 5.59\frac{kg}{h}$$

$$P = \left(5.59\frac{kg}{h}\right)\left(4.40 \bullet 10^7\frac{J}{kg}\right)\left(\frac{1h}{3600s}\right)$$

$$P = 6.83 \bullet 10^4 W = 68.3kW$$

$$\frac{P}{A} = \frac{68.3kW}{(2.10m)(4.90m)} = 6.64\frac{kW}{m^2}$$

c. In order to power a conventional automobile, the surface area of a solar panel would have to be much larger than the vehicle itself.