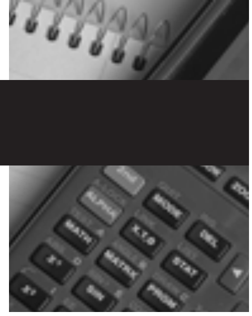

Work and Energy

Additional Practice A

Givens	Solutions
1. $W = 1.15 \times 10^3$ J $m = 60.0$ kg $g = 9.81$ m/s^2 $\theta = 0°$	$W = Fd(\cos\theta) = mgd(\cos\theta)$ $d = \frac{W}{mg(\cos\theta)} = \frac{1.15 \times 10^5 \text{ J}}{(60.0 \text{ kg})(9.81 \text{ m/s}^2)(\cos 0°)}$ $d = \boxed{195 \text{ m}}$
2. $m = 1.45 \times 10^6$ kg $g = 9.81$ m/s^2 $\theta = 0°$ $W = 1.00 \times 10^2$ MJ $F = (2.00 \times 10^{-2})\ mg$	$W = Fd(\cos\theta)$ $d = \frac{W}{F(\cos\theta)} = \frac{1.00 \times 10^8 \text{ J}}{(2.00 \times 10^{-2})(1.45 \times 10^6 \text{ kg})(9.81 \text{ m/s}^2)(\cos 0.00°)}$ $d = \boxed{352 \text{ m}}$
3. $m = 1.7$ g $W = 0.15$ J $a_{net} = 1.2$ m/s^2 $\theta = 0°$ $g = 9.81$ m/s^2	$F_{net} = ma_{net} = F - mg$ $F = ma_{net} + mg$ $W = Fd(\cos\theta) = m(a_{net} + g)d(\cos\theta)$ $d = \frac{W}{m(a_{net} + g)(\cos\theta)} = \frac{0.15 \text{ J}}{(1.7 \times 10^{-3} \text{ kg})(1.2 \text{ m/s}^2 + 9.81 \text{ m/s}^2)(\cos 0°)}$ $d = \frac{0.15 \text{ J}}{(1.7 \times 10^{-3} \text{ kg})(11.0 \text{ m/s}^2)}$ $d = \boxed{8.0 \text{ m}}$
4. $m = 5.40 \times 10^2$ kg $W = 5.30 \times 10^4$ J $g = 9.81$ m/s^2 $\theta = 30.0°$ $\theta' = 0°$	$W = Fd(\cos\theta') = Fd$ $F = mg(\sin\theta)$ $W = mg(\sin\theta)d$ $d = \frac{W}{mg(\sin\theta)} = \frac{5.30 \times 10^4 \text{ J}}{(5.40 \times 10^2 \text{ kg})(9.81 \text{ m/s}^3)(\sin 30.0°)}$ $d = \boxed{20.0 \text{ m}}$

II

Givens	Solutions
5. $d = 5.45$ m $W = 4.60 \times 10^4$ J $\theta = 0°$	$F_{net} = F_{lift} - F_g = 0$ $F = F_{lift} = F_g$ $W = Fd(\cos\theta) = F_g d(\cos\theta)$ $F_g = \frac{W}{d(\cos\theta)} = \frac{4.60 \times 10^4 \text{ J}}{(5.45 \text{ m})(\cos 0°)} = \boxed{8.44 \times 10^3 \text{ N}}$
6. $d = 52.0$ m $m = 40.0$ kg $W = 2.04 \times 10^4$ J $\theta = 0°$	$F = \frac{W}{d(\cos\theta)} = \frac{2.04 \times 10^4 \text{ J}}{(52.0 \text{ m})(\cos 0°)} = \boxed{392 \text{ N}}$
7. $d = 646$ m $W = 2.15 \times 10^5$ J $\theta = 0°$	$F = \frac{W}{d(\cos\theta)} = \frac{2.15 \times 10^5 \text{ J}}{(646 \text{ m})(\cos 0°)} = \boxed{333 \text{ N}}$
8. $m = 1.02 \times 10^3$ kg $d = 18.0$ m angle of incline = $\theta = 10.0°$ $\theta' = 0°$ $g = 9.81 \text{ m/s}^2$ $\mu_k = 0.13$	$F_{net} = F_g - F_k = mg(\sin\theta) - \mu_k mg(\cos\theta)$ $W_{net} = F_{net}d(\cos\theta') = mgd(\cos\theta')[(\sin\theta) - \mu_k(\cos\theta)]$ $W_{net} = (1.02 \times 10^3 \text{ kg})(9.81 \text{ m/s}^2)(18.0 \text{ m})(\cos 0°)[(\sin 10.0°) - (0.13)(\cos 10.0°)]$ $W_{net} = (1.02 \times 10^3 \text{ kg})(9.81 \text{ m/s}^2)(18.0 \text{ m})(0.174 - 0.128)$ $W_{net} = (1.02 \times 10^3 \text{ kg})(9.81 \text{ m/s}^2)(18.0 \text{ m})(0.046)$ $W_{net} = \boxed{8.3 \times 10^3 \text{ J}}$
9. $d = 881.0$ m $F_{applied} = 40.00$ N $\theta = 45.00°$ $F_k = 28.00$ N $\theta' = 0°$	$W_{net} = F_{net}d(\cos\theta')$ $F_{net} = F_{applied}(\cos\theta) - F_k$ $W_{net} = [F_{applied}(\cos\theta) - F_k]d(\cos\theta')$ $W_{net} = [40.00 \text{ N}(\cos 45.00°) - 28.00° \text{ N}](881.0 \text{ m})(\cos\theta)$ $W_{net} = (28.28 \text{ N} - 28.00 \text{ N})(881.0 \text{ m}) = (0.28 \text{ N})(881.0 \text{ m})$ $W_{net} = \boxed{246.7 \text{ J}}$
10. $m = 9.7 \times 10^3$ kg $\theta = 45°$ $F = F_1 = F_2 = 1.2 \times 10^3$ N $d = 12$ m	$W_{net} = F_{net}d(\cos\theta) = (F_1 + F_2)d(\cos\theta) = 2Fd(\cos\theta)$ $W_{net} = (2)(1.2 \times 10^3 \text{ N})(12 \text{ m})(\cos 45°) = \boxed{2.0 \times 10^4 \text{ J}}$
11. $m = 1.24 \times 10^3$ kg $\mathbf{F_1} = 8.00 \times 10^3$ N east $\mathbf{F_2} = 5.00 \times 10^3$ N 30.0° south of east $\mathbf{d} = 20.0$ m south	Only $\mathbf{F_2}$ contributes to the work done in moving the flag south. $\theta = 90.0° - 30.0° = 60.0°$ $W_{net} = F_{net}d(\cos\theta) = F_2 d(\cos\theta) = (5.00 \times 10^3 \text{ N})(20.0 \text{ m})(\cos 60.0°)$ $W_{net} = \boxed{5.00 \times 10^4 \text{ J}}$

Additional Practice B

Givens	*Solutions*
1. $\Delta x = 1.00 \times 10^2$ m $\Delta t = 9.85$ s $KE = 3.40 \times 10^3$ J	$v = \frac{\Delta x}{\Delta t}$ $KE = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{\Delta x}{\Delta t}\right)^2$ $m = \frac{2KE\Delta t^2}{\Delta x^2} = \frac{(2)(3.40 \times 10^3 \text{ J})(9.85 \text{ s})^2}{(1.00 \times 10^2 \text{ m})^2} = \boxed{66.0 \text{ kg}}$
2. $v = 4.00 \times 10^2$ km/h $KE = 2.10 \times 10^7$ J	$m = \frac{2KE}{v^2} = \frac{(2)(2.10 \times 10^7 \text{ J})}{(4.00 \times 10^2 \text{ km/h})^2 \, (10^3 \text{ m km})^2 \, (1 \text{ h}/3600 \text{ s})^2} = \boxed{3.40 \times 10^3 \text{ kg}}$
3. $v = 50.3$ km/h $KE = 6.54 \times 10^3$ J	$m = \frac{2KE}{v^2} = \frac{(2)(6.54 \times 10^3 \text{ J})}{(50.3 \text{ km/h})^2 (10^3 \text{ m/km})^2 \, (1 \text{ h}/3600 \text{ s})} = \boxed{67.0 \text{ kg}}$
4. $v = 318$ km/h $KE = 3.80$ MJ	$m = \frac{2KE}{v^2} = \frac{(2)(3.80 \times 10^6 \text{ J})}{(318 \text{ km/h})^2 \, (10^3 \text{ m/km})^2 \, (1 \text{ h}/3600 \text{ s})} = \boxed{974 \text{ kg}}$
5. $m = 51.0$ kg $KE = 9.96 \times 10^4$ J	$v = \sqrt{\frac{2\,KE}{m}} = \sqrt{\frac{(2)(9.96 \times 10^4 \text{ J})}{51.0 \text{ kg}}} = \boxed{62.5 \text{ m/s} = 225 \text{ km/h}}$
6. $\Delta x = 93.625$ km $\Delta t = 24.00$ h $m = 55$ kg	**a.** $v_{avg} = \frac{\Delta x}{\Delta t} = \frac{9.3625 \times 10^4 \text{ m}}{(24.00 \text{ h})(3600 \text{ s/h})} = \boxed{1.084 \text{ m/s}}$ **b.** $KE = \frac{1}{2}mv^2 = \frac{1}{2}(55 \text{ kg})(1.084 \text{ m/s})^2 = \boxed{32 \text{ J}}$
7. $m = 3.38 \times 10^{31}$ kg $KE = 1.10 \times 10^{42}$ J	$v = \sqrt{\frac{2\,KE}{m}} = \sqrt{\frac{(2)(1.10 \times 10^{42} \text{ J})}{3.38 \times 10^{31} \text{ kg}}} = 2.55 \times 10^5 \text{ m/s} = \boxed{255 \text{ km/s}}$
8. $m = 680$ kg $v = 56.0$ km/h $KE_{LB} = 3.40 \times 10^3$ J	**a.** $KE = \frac{1}{2}mv^2 = \frac{1}{2}(680 \text{ kg})[(56.0 \text{ km/h})(10^3 \text{ m/km})(1 \text{ h}/3600 \text{ s})]^2 = \boxed{8.23 \times 10^4 \text{ J}}$ **b.** $\frac{KE_{Pb}}{KE_{LB}} = \frac{8.2 \times 10^4 \text{ J}}{3.40 \times 10^3 \text{ J}} = \boxed{\frac{24}{1}}$
9. $v = 11.2$ km/s $m = 2.3 \times 10^5$ kg	$KE = \frac{1}{2}mv^2 = \frac{1}{2}(2.3 \times 10^5 \text{ kg})(11.2 \times 10^3 \text{ m/s})^2 = \boxed{1.4 \times 10^{13} \text{ J}}$

Additional Practice C

Givens	Solutions
1. $d = 227$ m	$W_{net} = \Delta KE = KE_f - KE_i = KE_f$
$m = 655$ g	$W_{net} = F_{net}d(\cos\theta)$
$g = 9.81$ m/s^2	$F_{net} = F_g - F_{resistance} = mg - (0.0220)mg = mg(1 - 0.0220)$
$F_{resistance} = (0.0220)mg$	$KE_f = mg(1 - 0.0220)d(\cos\theta) = (655 \times 10^{-3}\text{ kg})(9.81\text{ m/s}^2)(1 - 0.0220)(227\text{ m})(\cos 0°)$
$\theta = 0°$	$KE_f = (0.655\text{ kg})(9.81\text{ m/s}^2)(0.9780)(227\text{ m})$
$KE_i = 0$ J	$KE_f = \boxed{1.43 \times 10^3\text{ J}}$

Givens	Solutions
2. $v_i = 12.92$ m/s	W_{net} is the work done by friction.
$W_{net} = -2830$ J	$W_{net} = \Delta KE = KE_f - KE_i = KE_f - \frac{1}{2}mv_i^2$
$m = 55.0$ kg	$KE_f = W_{net} + \frac{1}{2}mv_i^2 = -2830\text{ J} + \frac{1}{2}(55.0\text{ kg})(12.92\text{ m/s})^2 = -2830\text{ J} + 4590\text{ J}$
	$KE_f = \boxed{1.76 \times 10^3\text{ J}}$

Givens	Solutions
3. $m = 25.0$ g	$W_{net} = \Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$h_i = 553$ m	$W_{net} = F_{net}d(\cos\theta)$
$h_f = 353$ m	$F_{net} = F_g - F_r = mg - F_r$
$v_i = 0$ m/s	$d = h_i - h_f$
$v_f = 30.0$ m/s	$W_{net} = (mg - F_r)(h_i - h_f)(\cos\theta)$
$g = 9.81$ m/s^2	$mg - F_r = \dfrac{\frac{1}{2}m(v_f^2 - v_i^2)}{(h_i - h_f)(\cos\theta)}$
$\theta = 0°$	$F_r = m\left[g - \dfrac{(v_f^2 - v_i^2)}{2(h_i - h_f)(\cos\theta)}\right] = (25.0 \times 10^{-3}\text{ kg})\left[9.81\text{ m/s}^2 - \dfrac{(30.0\text{ m/s})^2 - (0\text{ m/s})^2}{(2)(553\text{ m} - 353\text{ m})(\cos 0°)}\right]$
	$F_r = (25.0 \times 10^{-3}\text{ kg})\left[9.81\text{ m/s}^2 - \dfrac{9.00 \times 10^2\text{ m}^2/\text{s}^2}{(2)(2.00 \times 10^2\text{ m})}\right]$
	$F_r = (25.0 \times 10^{-3}\text{ kg})(9.81\text{ m/s}^2 - 2.25\text{ m/s}^2) = (25.0 \times 10^{-3}\text{ kg})(7.56\text{ m/s}^2)$
	$F_r = \boxed{0.189\text{ N}}$

Givens	Solutions
4. $v_i = 404$ km/h	$W_{net} = \Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$W_{net} = -3.00$ MJ	$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_i^2 + W_{net}$
$m = 1.00 \times 10^3$ kg	$v_f = \sqrt{v_i^2 + \dfrac{2W_{net}}{m}} = \sqrt{[(404\text{ km/h})(10^3\text{ m/km})(1\text{ h}/3600\text{ s})]^2 + \dfrac{(2)(-3.00 \times 10^6\text{ J})}{1.00 \times 10^3\text{ kg}}}$
	$v_f = \sqrt{1.26 \times 10^4\text{ m}^2/\text{s}^2 - 6.00 \times 10^3\text{ m}^2/\text{s}^2} = \sqrt{6.6 \times 10^3\text{ m}^2/\text{s}^2}$
	$v_f = \boxed{81\text{ m/s} = 290\text{ km/h}}$

Givens	Solutions
5. $m = 45.0$ g	$W_{net} = \Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$h_i = 8848.0$ m	$W_{net} = F_{net}d(\cos\theta)$
$h_f = 8806.0$ m	$F_{net} = F_g - F_r = mg - F_r$
$v_i = 0$ m/s	$d = h_i - h_f$
$v_f = 27.0$ m/s	$W_{net} = mg(h_i - h_f)(\cos\theta) - F_r(h_i - h_f)(\cos\theta)$
$g = 9.81$ m/s^2	$-F_r(h_i - h_f)(\cos\theta) = F_r(h_i - h_f)(\cos 180° + \theta) = W_r$
$\theta = 0°$	$\frac{1}{2}m(v_f^2 - v_i^2) = mg(h_i - h_f)(\cos\theta) + W_r$

II

Givens	Solutions
	$W_r = m[\frac{1}{2}(v_f^2 - v_i^2) - g(h_i - h_f)(\cos\theta)] = (45.0 \times 10^{-3}\text{ kg})\Big[\frac{1}{2}(27.0\text{ m/s})^2 - \frac{1}{2}(0\text{ m/s})^2 - (9.81\text{ m/s}^2)(8848.0\text{ m} - 8806.0\text{ m})(\cos 0°)\Big]$
	$W_r = (45.0 \times 10^{-3}\text{ kg})[364\text{ m}^2/\text{s}^2 - (9.81\text{ m/s}^2)(42.0\text{ m})]$
	$W_r = (45.0 \times 10^{-3}\text{ kg})(364\text{ m}^2/\text{s}^2 - 412\text{ m}^2/\text{s}^2)$
	$W_r = (45.0 \times 10^{-3}\text{ kg})(-48\text{ m}^2/\text{s}^2) = \boxed{-2.16\text{ J}}$

6. $v_f = 35.0$ m/s

$v_i = 25.0$ m/s

$W_{net} = 21$ kJ

$$W_{net} = \Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$m = \frac{2W_{net}}{v_f^2 - v_i^2} = \frac{(2)(21 \times 10^3\text{ J})}{(35.0\text{ m/s})^2 - (25.0\text{ m/s})^2} = \frac{42 \times 10^3\text{ J}}{1220\text{ m}^2/\text{s}^2 - 625\text{ m}^2/\text{s}^2}$$

$$m = \frac{42 \times 10^3\text{ J}}{6.0 \times 10^2\text{ m}^2/\text{s}^2} = \boxed{7.0 \times 10^1\text{ kg}}$$

7. $v_i = 104.5$ km/h

$v_f = \frac{1}{2}v_i$

$\mu_k = 0.120$

$g = 9.81\text{ m/s}^2$

$\theta = 180°$

$$W_{net} = \Delta KE = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$W_{net} = W_k d(\cos\theta) = F_k d(\cos\theta) = \mu_k mgd(\cos\theta)$$

$$\frac{1}{2}m(v_f^2 - v_i^2) = \mu_k mgd(\cos\theta)$$

$$d = \frac{v_f^2 - v_i^2}{2\mu_k g(\cos\theta)} = \frac{[(104.5\text{ km/h})(10^3\text{ m/km})(1\text{ h}/3600\text{ s})]^2[(\frac{1}{2})^2 - (1)^2]}{(2)(0.120)(9.81\text{ m/s}^2)(\cos 180°)}$$

$$d = \frac{\left(\frac{104.5}{3.600}\text{ m/s}\right)^2\left(\frac{1}{4} - 1\right)}{-(2)(0.120)(9.81\text{ m/s}^2)} = \frac{-(3)\left(\frac{104.5}{3.600}\text{ m/s}\right)^2}{-(8)(0.120)(9.81\text{ m/s}^2)}$$

$$d = \boxed{268\text{ m}}$$

Additional Practice D

1. $h = 6.13/2\text{ m} = 3.07$ m

$PE_g = 4.80$ kJ

$g = 9.81\text{ m/s}^2$

$$m = \frac{PE_g}{gh} = \frac{4.80 \times 10^3\text{ J}}{(9.81\text{ m/s}^2)(3.07\text{ m})} = \boxed{1.59 \times 10^2\text{ kg}}$$

2. $h = 1.70$ m

$PE_g = 3.04 \times 10^3$ J

$g = 9.81\text{ m/s}^2$

$$m = \frac{PE_g}{gh} = \frac{3.04 \times 10^3\text{ J}}{(9.81\text{ m/s}^2)(1.70\text{ m})} = \boxed{182\text{ kg}}$$

3. $PE_g = 1.48 \times 10^7$ J

$h = (0.100)(180\text{ km})$

$g = 9.81\text{ m/s}^2$

$$m = \frac{PE_g}{gh} = \frac{1.48 \times 10^7\text{ J}}{(9.81\text{ m/s}^2)(0.100)(180 \times 10^3\text{ m})} = \boxed{83.8\text{ kg}}$$

4. $m = 3.6 \times 10^4$ kg

$PE_g = 8.88 \times 10^8$ J

$g = 9.81\text{ m/s}^2$

$$h = \frac{PE_g}{mg} = \frac{8.88 \times 10^8\text{ J}}{(3.6 \times 10^4\text{ kg})(9.81\text{ m/s}^2)} = \boxed{2.5 \times 10^3\text{ m} = 2.5\text{ km}}$$

Givens	*Solutions*
5. $\frac{PE_g}{m} = 20.482\ \text{m}^2/\text{s}^2$ $g = 9.81\ \text{m/s}^2$	$\frac{PE_g}{m} = gh = 20.482\ \text{m}^2/\text{s}^2$ $h = \frac{20.482\ \text{m}^2/\text{s}^2}{g} = \frac{20.482\ \text{m}^2/\text{s}^2}{9.81\ \text{m/s}^2} = \boxed{2.09\ \text{m}}$
6. $k = 3.0 \times 10^4\ \text{N/m}$ $PE_{elastic} = 1.4 \times 10^2\ \text{J}$	$x = \pm\sqrt{\frac{2PE_{elastic}}{k}} = \pm\sqrt{\frac{(2)(1.4 \times 10^2\ \text{J})}{3.0 \times 10^4\ \text{N/m}}} = \boxed{+9.7 \times 10^{-2}\ \text{m} = 9.7\ \text{cm}}$
7. $m = 51\ \text{kg}$ $g = 9.81\ \text{m/s}^2$ $h = 321\ \text{m} - 179\ \text{m} = 142\ \text{m}$ $k = 32\ \text{N/m}$ $x = 179\ \text{m} - 104\ \text{m} = 75\ \text{m}$	$PE_{tot} = PE_g + PE_{elastic}$ Set $PE_g = 0$ J at the river level. $PE_g = mgh = (51\ \text{kg})(9.81\ \text{m/s}^2)(142\ \text{m}) = 7.1 \times 10^4\ \text{J}$ $PE_{elastic} = \frac{1}{2}kx^2 = \frac{1}{2}(32\ \text{N/m})(75\ \text{m})^2 = 9.0 \times 10^4\ \text{J}$ $PE_{tot} = (7.1 \times 10^4\ \text{J}) + (9.0 \times 10^4\ \text{J}) = \boxed{1.6 \times 10^5\ \text{J}}$
8. $h_2 = 4080\ \text{m}$ $h_1 = 1860\ \text{m}$ $m = 905\ \text{kg}$ $g = 9.81\ \text{m/s}^2$	$\Delta PE_g = PE_{g,2} - PE_{g,1} = mg(h_2 - h_1) = (905\ \text{kg})(9.81\ \text{m/s}^2)(4080\ \text{m} - 1860\ \text{m})$ $\Delta PE_g = (905\ \text{kg})(9.81\ \text{m/s}^2)(2220\ \text{m}) = \boxed{1.97 \times 10^7\ \text{J}}$
9. $m = 286\ \text{kg}$ $k = 9.50 \times 10^3\ \text{N/m}$ $g = 9.81\ \text{m/s}^2$ $x = 59.0\ \text{cm}$ $h_1 = 1.70\ \text{m}$ $h_2 = h_1 - x$	**a.** $PE_{elastic} = \frac{1}{2}kx^2 = \frac{1}{2}(9.50 \times 10^3\ \text{N/m})(0.590\ \text{m})^2 = \boxed{1.65 \times 10^3\ \text{J}}$ **b.** $PE_{g,1} = mgh_1 = (286\ \text{kg})(9.81\ \text{m/s}^2)(1.70\ \text{m}) = \boxed{4.77 \times 10^3\ \text{J}}$ **c.** $h_2 = 1.70\ \text{m} - 0.590\ \text{m} = 1.11\ \text{m}$ $PE_{g,2} = mgh_2 = (286\ \text{kg})(9.81\ \text{m/s}^2)(1.11\ \text{m}) = \boxed{3.11 \times 10^3\ \text{J}}$ **d.** $\Delta PE_g = PE_{g,2} - PE_{g,1} = (3.11 \times 10^3\ \text{J}) - (4.77 \times 10^3\ \text{J}) = \boxed{-1.66 \times 10^3\ \text{J}}$ The answer in part (d) is approximately equal in magnitude to that in (a); the slight difference arises from rounding. The increase in elastic potential energy corresponds to a decrease in gravitational potential energy; hence the difference in signs for the two answers.

II

Givens	*Solutions*

10. $\Delta x = 9.50 \times 10^2$ m

$\theta = 45.0°$

$m = 65.0$ g

$g = 9.81$ m/s^2

a. $v_x = v_i(\cos\theta) = \dfrac{\Delta x}{\Delta t}$

$$\Delta t = \frac{\Delta x}{v_i(\cos\theta)}$$

vertical speed of the arrow for the first half of the flight $= v_i(\sin\theta) = g\left(\dfrac{\Delta t}{2}\right)$

$$v_i(\sin\theta) = \frac{g\Delta x}{2v_i(\cos\theta)}$$

$$v_i = \sqrt{\frac{g\Delta x}{2(\sin\theta)(\cos\theta)}} = \sqrt{\frac{(9.81 \text{ m/s}^2)(9.50 \times 10^2 \text{ m})}{(2)(\sin 45.0°)(\cos 45.0°)}} = 96.5 \text{ m/s}$$

$$KE_i = \tfrac{1}{2}mv_i^2 = \tfrac{1}{2}(65.0 \times 10^{-3} \text{ kg})(96.5 \text{ m/s})^2 = \boxed{303 \text{ J}}$$

$x = 55.0$ cm

b. From the conservation of energy,

$$PE_{elastic} = KE_i$$

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

$$k = \frac{2KE_i}{x^2} = \frac{(2)(303 \text{ J})}{(55.0 \times 10^{-2} \text{ m})^2} = \boxed{2.00 \times 10^3 \text{ N/m}}$$

c. $KE_i = PE_{g,max} + KE_f$

$$KE_f = \tfrac{1}{2}mv_x^2 = \tfrac{1}{2}m[(v_i(\cos\theta)]^2 = \tfrac{1}{2}(65.0 \times 10^{-3} \text{ kg})(96.5 \text{ m/s})^2(\cos 45.0°)^2 = 151 \text{ J}$$

$$PE_{g,max} = KE_i - KE_f = 303 \text{ J} - 151 \text{ J} = 152 \text{ J}$$

$$h_{max} = \frac{PE_{g,max}}{mg} = \frac{152 \text{ J}}{(65.0 \times 10^{-3} \text{ kg})(9.81 \text{ m/s}^2)}$$

$$h = \boxed{238 \text{ m}}$$

II

Additional Practice E

1. $m = 118$ kg

$h_i = 5.00$ m

$g = 9.81$ m/s^2

$v_i = 0$ m/s

$KE_f = 4.61$ kJ

$$PE_i + KE_i = PE_f + KE_f$$

$$mgh_i + \tfrac{1}{2}mv_i^2 = mgh_f + KE_f$$

$$mgh_f = mgh_i + \tfrac{1}{2}mv_i^2 - KE_f$$

$$h_f = h_i + \frac{v_i^2}{2g} - \frac{KE_f}{mg} = 5.00 \text{ m} + \frac{(0 \text{ m/s})^2}{(2)(9.81 \text{ m/s}^2)} - \frac{4.61 \times 10^3 \text{ J}}{(118 \text{ kg})(9.81 \text{ m/s}^2)}$$

$$h_f = 5.00 \text{ m} - 3.98 \text{ m} = \boxed{1.02 \text{ m above the ground}}$$

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2. $v_f = 42.7$ m/s

$h_f = 50.0$ m

$v_i = 0$ m

$g = 9.81$ m/s^2

$$PE_i + KE_i = PE_f + KE_f$$

$$mgh_i + \tfrac{1}{2}mv_i^2 = mgh_f + \tfrac{1}{2}mv_f^2$$

$$h_i = h_f + \frac{v_f^2 - v_i^2}{2g} = 50.0 \text{ m} + \frac{(42.7 \text{ m/s})^2 - (0 \text{ m/s})^2}{(2)(9.81 \text{ m/s}^2)} = 50.0 \text{ m} + 92.9 \text{ m}$$

$$h_i = \boxed{143 \text{ m}}$$

The mass of the nut is not needed for the calculation.

Givens / Solutions

3. $h_i = 3150$ m

$v_f = 60.0$ m/s

$KE_i = 0$ J

$g = 9.81$ m/s^2

$$PE_i + KE_i = PE_f + KE_f$$

$$mgh_i = mgh_f + \tfrac{1}{2}mv_f^2$$

$$h_f = h_i - \frac{v_f^2}{2g} = 3150 \text{ m} - \frac{(60.0 \text{ m/s})^2}{(2)(9.81 \text{ m/s}^2)} = 3150 \text{ m} - 183 \text{ m}$$

$$h_f = \boxed{2970 \text{ m}}$$

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4. $h_i = 1.20 \times 10^2$ m

$h_f = 30.0$ m

$m = 72.0$ kg

$g = 9.81$ m/s^2

$KE_i = 0$ J

$$PE_i + KE_i = PE_f + KE_f$$

$$PE_i - PE_f = KE_f$$

$$KE_f = \Delta PE = mg(h_i - h_f)$$

$$KE_f = (72.0 \text{ kg})(9.81 \text{ m/s}^2)(1.20 \times 10^2 \text{ m} - 30.0 \text{ m}) = (72.0 \text{ kg})(9.81 \text{ m/s}^2)(9.0 \times 10^1 \text{ m})$$

$$KE_f = \boxed{6.4 \times 10^4 \text{ J}}$$

$$v_f = \sqrt{\frac{2KE_f}{m}} = \sqrt{\frac{(2)(6.4 \times 10^4 \text{ J})}{72.0 \text{ kg}}}$$

$$v_f = \boxed{42 \text{ m/s}}$$

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5. $h_f = 250.0$ m

$\Delta ME = -2.55 \times 10^5$ J

$m = 250.0$ kg

$g = 9.81$ m/s^2

$$\Delta ME = PE_f - KE_i = mgh_f - \tfrac{1}{2}mv_i^2$$

$$v_i = \sqrt{2gh_f - \frac{2\Delta ME}{m}} = \sqrt{(2)(9.81 \text{ m/s}^2)(250.0 \text{ m}) - \frac{(2)(-2.55 \times 10^5 \text{ J})}{250.0 \text{ kg}}}$$

$$v_i = \sqrt{4.90 \times 10^3 \text{ m}^2/\text{s}^2 + 2.04 \times 10^3 \text{ m}^2/\text{s}^2} = \sqrt{6.94 \times 10^3 \text{ m}^2/\text{s}^2}$$

$$v_i = 83.3 \text{ m/s} = \boxed{3.00 \times 10^2 \text{ km/h}}$$

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6. $h_i = 12.3$ km

$m = 120.0$ g

$g = 9.81$ m/s^2

$KE_i = 0$ J

$\Delta h = h_i - h_f = 3.2$ km

$$PE_i + KE_i = PE_f + KE_f$$

$$PE_i - PE_f = KE_f$$

$$KE_f = PE_i - PE_f = mgh_i - mgh_f = mg\Delta h$$

$$KE_f = mg\Delta h = (0.1200 \text{ kg})(9.81 \text{ m/s}^2)(3.2 \times 10^3 \text{ m}) = \boxed{3.8 \times 10^3 \text{ J}}$$

$$PE_f = mgh_f = mg(h_i - \Delta h) = (0.1200 \text{ kg})(9.81 \text{ m/s}^2)(12.3 \times 10^3 \text{ m} - 3.2 \times 10^3 \text{ m})$$

$$PE_f = (0.1200 \text{ kg})(9.81 \text{ m/s}^2)(9.1 \times 10^3 \text{ m}) = \boxed{1.1 \times 10^4 \text{ J}}$$

Alternatively,

$$PE_f = PE_i - KE_f = mgh_i - KE_f$$

$$PE_f = (0.1200 \text{ kg})(9.81 \text{ m/s}^2)(12.3 \times 10^3 \text{ m}) - 3.8 \times 10^3 \text{ J} = 1.45 \times 10^4 \text{ J} - 3.8 \times 10^3 \text{ J}$$

$$PE_f = \boxed{1.07 \times 10^4 \text{ J}}$$

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7. $h = 68.6$ m

$v = 35.6$ m/s

$g = 9.81$ m/s^2

$PE_f = 0$ J

$KE_i = 0$ J

$$ME_i = PE_i = mgh$$

$$ME_f = KE_f = \tfrac{1}{2}mv^2$$

$$\text{percent of energy dissipated} = \frac{(ME_i - ME_f)(100)}{ME_i} = \left(\frac{mgh - \frac{1}{2}mv^2}{mgh}\right)(100)$$

$$\text{percent of energy dissipated} = \left(\frac{gh - \frac{1}{2}v^2}{gh}\right)(100)$$

$$\text{percent of energy dissipated} = \left(\frac{(9.81 \text{ m/s}^2)(68.6 \text{ m}) - \frac{1}{2}(35.6 \text{ m/s})^2}{(9.81 \text{ m/s}^2)(68.6 \text{ m})}\right)(100)$$

$$\text{percent of energy dissipated} = \frac{(673 \text{ J} - 634 \text{ J})(100)}{673 \text{ J}} = \frac{(39 \text{ J})\ (100)}{673 \text{ J}} = \boxed{5.8 \text{ percent}}$$

Additional Practice F

Givens	*Solutions*
1. $P = 56$ MW $\Delta t = 1.0$ h	$W = P\Delta t = (56 \times 10^6 \text{ W})(1.0 \text{ h})(3600 \text{ s/h}) = \boxed{2.0 \times 10^{11} \text{ J}}$
2. $\Delta t = 62.25$ min $P = 585.0$ W	$W = P\Delta t = (585.0 \text{ W})(62.25 \text{ min})(60 \text{ s/min}) = \boxed{2.185 \times 10^6 \text{ J}}$
3. $h = 106$ m $m = 14.0$ kg $g = 9.81 \text{ m/s}^2$ $P = 3.00 \times 10^2$ W $\theta = 0°$	$W = F_g d(\cos\theta) = F_g d = mgh$ $\Delta t = \frac{W}{P} = \frac{mgh}{P} = \frac{(14.0 \text{ kg})(9.81 \text{ m/s}^2)(106 \text{ m})}{3.00 \times 10^2 \text{ W}} = \boxed{48.5 \text{ s}}$
4. $P = 2984$ W $W = 3.60 \times 10^4$ J	$\Delta t = \frac{W}{P} = \frac{3.60 \times 10^4 \text{ J}}{2984 \text{ W}} = \boxed{12.1 \text{ s}}$
5. $\Delta t = 3.0$ min $W = 54$ kJ	$P = \frac{W}{\Delta t} = \frac{54 \times 10^3 \text{ J}}{(3.0 \text{ min})(60 \text{ s/min})} = \boxed{3.0 \times 10^2 \text{ W}}$
6. $\Delta t = 16.7$ s $h = 18.4$ m $m = 72.0$ kg $g = 9.81 \text{ m/s}^2$ $\theta = 0°$	$W = F_g d(\cos\theta) = mgh$ $P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t} = \frac{(72.0 \text{ kg})(9.81 \text{ m/s}^2)(18.4 \text{ m})}{16.7 \text{ s}}$ $P = \boxed{778 \text{ W}}$

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