**ANSWERS TO EVEN PROBLEMS**

P8.2 (a) $1.11 \times 10^8$ J  (b) 0.2

P8.4 (a) $v_b = 5.94 \text{ m/s}$; $v_c = 7.67 \text{ m/s}$  (b) 147 J

P8.6 (a) see the solution  (b) 60.0°

P8.8 (a) $\sqrt{\frac{2(m_1-m_2)gh}{m_1+m_2}}$  (b) $\frac{2m_1h}{m_1+m_2}$

P8.10 (a) 18.5 km, 51.0 km  (b) 10.0 MJ

P8.12 $\left(\frac{8gh}{15}\right)^{1/2}$

P8.14 (a) 0.791 m/s  (b) 0.531 m/s

P8.16 (i) (a), (b), (c), (f)  (ii) (g), (i), (j)  (iii) (d)  (iv) (e) cannot be true because the friction force is proportional to $\mu_k$ and not $\mu_k^2$. And (k) cannot be true because the presence of friction will reduce the speed compared to the $\mu_k = 0$ case.  (v) Expression (h) is correct if the spring force is strong enough to produce motion against static friction and if the spring energy is large enough to make the block slide the full distance $d$.  (vi) The expression gives an imaginary answer because the spring does not contain enough energy in this case to make the block slide the full distance $d$.

P8.18 (a) $U_f = 22.0 \text{ J}$; $E = 40.0 \text{ J}$  (b) Yes. The total mechanical energy changes.

P8.20 26.5 m/s

P8.22 (a) 24.5 m/s  (b) Yes; his landing speed is too high to be safe.  (c) 206 m  (d) Not realistic. Air drag depends strongly on speed.

P8.24 (a) $r = 1.5 \text{ mm}$ and 3.2 mm, stable; 2.3 mm unstable; $r \rightarrow \infty$ neutral  (b) $-5.6 \leq E < 1 \text{ J}$
(c) $0.6 \text{ mm} \leq r \leq 3.6 \text{ mm}$  (d) 2.6 J  (e) 1.5 mm  (f) 4 J

P8.26 168 J

P8.28 8.01 W

P8.30 (a) 1.24 kW  (b) 20.9%

P8.32 (a) 5.91 kW  (b) 11.1 kW

P8.34 194 m

P8.36 No. (a) 582  (b) $90.5 \text{ W} = 0.121 \text{ hp}$
P8.38  (a) yes       (b) 2.49 m/s      (c) No, but mechanical energy is conserved for the 3.50-kg block in its projectile motion with the Earth.   (d) 5.45 m/s     (e) no     (f) 18.6 N to the left     (h) A little push is required. The speeds are still accurate.  

P8.40  (a) $x = 0.403$ m or $-0.357$ m     (b) From a perch at a height of 2.80 m above the top of a pile of mattresses, a 46.0-kg child jumps straight upward at 2.40 m/s. The mattresses behave as a linear spring with force constant 19.4 kN/m. Find the maximum amount by which the mattresses are compressed when the child lands on them. Physical meaning of the answer: The positive value of $x$ represents the maximum spring compression. The negative value represents the extension of the equivalent spring if the child sticks to the top of the mattress pile as the child rebounds upward without friction.  

P8.42  (a) 5.60 J       (b) 0.152      (c) 2.28 rev  

P8.44  See the solution. Our model predicts the same proportionalities as the empirical equation, and gives $D = 1$ for the drag coefficient. Air actually slips around the moving object, instead of accumulating in front of it. For this reason, the drag coefficient is not necessarily unity. It is typically less than one for a streamlined object and can be greater than one if the airflow around the object is complicated.  

P8.46  (a) $(627 \text{ N}) y$     (b) $U_s = 0$ for $y > 39.2$ m and $U_s = \frac{1}{2}(81 \text{ N/m})(39.2 \text{ m} - y)^2$ for $y \leq 39.2$ m     (c) $U_g + U_s = (627 \text{ N}) y$, for $y > 39.2$ m and $U_g + U_s = (40.5 \text{ N/m}) y^2 - (2 \text{ 550 N}) y + 62 \text{ 200 J}$ for $y \leq 39.2$ m     (d) see the solution     (e) 10.0 m     (f) yes: stable equilibrium at 31.5 m     (g) 24.1 m/s  

P8.48  (a) see the solution     (b) For a block of weight $w$ pushed over a rough horizontal surface at constant velocity, $b = \mu_c$. For a load pulled vertically upward at constant velocity, $b = 1$.  

P8.50  (a) 0.588 J       (b) 0.588 J      (c) 2.42 m/s      (d) $U_c = 0.392 \text{ J}$, $K_c = 0.196 \text{ J}$  

P8.52  $48.2^\circ$  

P8.54  (a) 0.378 m     (b) 2.30 m/s     (c) 1.08 m  

P8.56  (a) see the solution      (b) 7.42 m/s  

P8.58  (a) 6.15 m/s     (b) 9.87 m/s  

P8.60  (a) $H = 1.6 \text{ m}(1 + 8.64 \text{ N}^2/F^2)^{-1}$     (b) 0.166 m     (c) 1.47 m     (d) $H \rightarrow 0$ proportionally to $F^2$     (e) $H$ approaches 1.60 m     (f) $H_{eq} = 0.8 \text{ m}[1 - (F^2/8.64 \text{ N}^2 + 1)^{1/2}]$     (g) 0.574 m     (h) 0.800 m  

P8.62  see the solution  

P8.64  (a) 2.5 $R$     (b) see the solution  

P8.66  (a) see the solution      (b) 0.342