Problem 1. The Ballistic Pendulum:

(a) \( v = \sqrt{2gy} \)

(b) \( T = (m + M)g\left(1 + \frac{2y}{L}\right) \)

(c) \( v_0 = \frac{m + M}{m} \sqrt{2gy} \)

Problem 2. The center of mass:

(a) \( M = AL^2/2 \)

(b) \( x_{cm} = 2L/3 \)

Problem 3. Head-on elastic collision:

\( v_1 = v_{10} \left(\frac{m_1 - m_2}{m_1 + m_2}\right), \quad v_2 = v_{10} \left(\frac{2m_1}{m_1 + m_2}\right) \)

Problem 4. Lost wheel:

\( h = (1-1/3)10^2(1+0.8)/(2\times9.8) \) m = 6 m. For the solid disk: \( (1-1/3)10^2(1+0.5)/(2\times9.8) \) m = 5 m.

Problem 5. Neutron Star Glitches:

\( R_o - R = (1/2) (\Delta \omega/\omega_o) \) \( R_o = 10^{-6} \) \( R_o = 1 \) cm

Problem 6. Rolling downward an incline:

(a) \( v = \sqrt{\frac{2gh}{1+c}} \)

(b) \( a = g \sin\beta/(1+c) \)

(c) \( t = \sqrt{\frac{2h(1+c)/g}{1+c}} \sin\beta \)

Problem 7. Blocks descending over a massive pulley:

(a) \( v = \sqrt{\frac{2gd(m_2 - \mu_k m_1)}{m_1 + m_2 + I/R^2}} \)

(b) \( a = v^2/2d \)

(c) \( T_1 = m_1 (a + \mu_k g), \quad T_2 = m_2 (g - a); \quad T_2 > T_1 \)

Problem 8. Raising a crate:

\( F = M(g+a)R/r + Ia/(Rr) \)

Problem 9. Marbles in a container:

(a) \( F_A = F_C = mg/(2 \cos\theta), \quad F_B = 2mg, \quad \theta = 30^\circ \)

(b) \( n = mg/\sin(2\theta) \)

Problem 10. Bicycle wheel and a curb:

(a) \( F = mg(2Rh-h^2)^{1/2}/(R-h) \)

(b) \( F = mg(2Rh-h^2)^{1/2}/(2R-h) \)

(c) Less force is required when the force is applied at the top of the wheel.