Part I - A

1. 11/13	2. –20 **k**	3. 4**F** / 3M	4. F/3	5. 13.5 N·s	6. 9000 N	7. 7ωML^2/24	8. 2g cosθ/(7L) or 20 cosθ/(7L)
9. BCDF	10. BD	11. v^{2}dm/dt	12. b/2	13. 2b	14. (2gH)$^{1/2}$ or (20H)$^{1/2}$	15. (4gH/3)$^{1/2}$ or (40H/3)$^{1/2}$	16. [0, 3R/(4+2π)]

Part I - B

1. –20 **k**	2. 11/13	3. 13.5 N·s	4. 9000 N	5. v^{2}dm/dt	6. BCDF	7. BD	8. b/2
9. 2b	10. 4**F**/3M	11. F/3	12. 7ωML^2/24	13. 2g cosθ/(7L) or 20 cosθ/(7L)	14. (2gH)$^{1/2}$ or (20H)$^{1/2}$	15. (4gH/3)$^{1/2}$ or (40H/3)$^{1/2}$	16. [0,3R/(4+2π)]

Part II

1. (a)

$$E_i = \frac{1}{2}kd^2 \textbf{ and } E_f = \frac{1}{2}mv^2 + |fd| = \frac{1}{2}mv^2 + \mu_k mgd$$

$$E_i = E_f \therefore K = \frac{1}{2}mv^2 = \frac{1}{2}kd^2 - \mu_k mgd, \therefore v = \sqrt{\frac{k}{m}d^2 - 2\mu_k gd}$$

(b) When $v = 0$ in (a), $\mu_k = kd / 2mg$.

(c)

$$E_f = \frac{mv^2(x)}{2} + \frac{kx^2}{2} + |f(d-x)| = \frac{mv^2(x)}{2} + \frac{kx^2}{2} + \frac{kd(d-x)}{2}$$

$$E_i = E_f \therefore K = \frac{mv^2(x)}{2} = \frac{k(xd - x^2)}{2}$$

$$\frac{dK}{dx} = 0 = \frac{k(d-2x)}{2} \Rightarrow x = \frac{d}{2}$$

2. (a)

$$U_i = mgl, K_i = 0; U_f = mg(l-x)(1-\cos\alpha), K_f = \frac{1}{2}mv^2; E_i = E_f$$

$$\therefore mgl = mg(l-x)(1-\cos\alpha) + \frac{1}{2}mv^2$$

$$\therefore K = \frac{1}{2}mv^2 = mgx + mg\cos\alpha(l-x) = mg(l\cos\alpha + x - x\cos\alpha).$$

(b) $$F_r = T - mg\cos\alpha = \frac{mv^2}{l-x}, \therefore T = mg\cos\alpha + \frac{mv^2}{l-x} = mg[\cos\alpha + \frac{2}{l-x}(l\cos\alpha + x - x\cos\alpha)].$$

$\alpha = \pi$, **at point A.** $\therefore T = \dfrac{5x - 3l}{l - x} mg$

(c) To complete a circle, the tension of rope at point A must be. $T \geq 0$ in (b).
Thus $x \geq 3l / 5$, the minimum of $x = 3l / 5$.

3. (See Example 9.8)

(a)

Momentum is conserved: $m_1v_1 + m_1m_2 = m_1v_{1f} + m_2v_{2f}$, so $v_{1f} + 2v_{2f} = 2$ ----- (1)

For elastic collision: $v_1 - v_2 = -(v_{1f} - v_{2f})$, $-v_{1f} + v_{2f} = 8$ ----- (2)

From (1) and (2), $v_{1f} = 10/3$ m/s, and $v_{2f} = -14/3$ m/s.

(b)

Use momentum conservation: $p_i = 2 = p_f = 3 + 2v_{2f}$, so $v_{2f} = -0.5$ m/s

(c)

E_{mech} is conserved. $K_i = K_f + U$

$K_i = 0.5\, m_1v_1^2 + 0.5\, m_2v_2^2 = 22$ (J), and $K_f = 0.5\, m_1v_{1f}^2 + 0.5\, m_2v_{2f}^2 = 4.75$ (J).

So $U = 17.25 = 0.5\, kd^2$, $d = 0.1$ m

(d)

The max U (occurs at max compression) of the spring would occur when the two blocks are moving with the same velocity v.

$p_i = (m_1 + m_2)v$, so $v = 2/3$. $U = K_i - K_f = 22 - 2/3 = 21.33$ (J)

4. (See Problem 11.35)

(a) $L_i = mvl$, $\Sigma\tau_{ext} = 0$, so $L_f = L_i = mvl$

(b) from (a), $L_f = (m + M)v_f\, l$, so $v_f = mv / (m + M)$

$K_i = mv^2/2$, $K_f = (m + M)\, v_f^2 / 2$

$v_f = mv / (m + M)$ = speed of the bullet and block

Fraction of K loss = $(K_i - K_f)/K_i = M/(m + M)$.