PHYS 206: Exam 3 – Spring 2019

Short Problems:

A) a) Yes, since the spring force is all internal to the system. Hence, net external force in the horizontal direction is zero. [LO 48.1]
b) Yes, spring force is a conservative force. In this process, the potential energy stored in the spring is converted to the kinetic energies of the two blocks. [LO50.1]
c) $K_A = 3K_B$ [LO 48.2, 34.1, 3.1]

B) a) $(1/12)M(a^2 + b^2) + (1/4)Ma^2$ [LO 51.1,52.1]
b) $(1/12)M(a^2 + b^2) + (1/4)Mb^2$ [LO 51.2,52.2]
c) $(1/3)M(a^2 + b^2)$ [LO 51.3,52.3]

C) a) $\omega = L/I = \tau t/I = F_{tan}Rt/I$ [LO 54.1,55.1,3.2,14.1]
b) $\theta = ½ \alpha t^2 = F_{tan}Rt^2/2I$ [LO 14.2]
c) $W = \tau\Delta\theta = (F_{tan}Rt)^2/2I$ [LO 56.1]

D) Coordinate system drawn [LO 9.1]
Free body diagram [LO 23.1, 26.1]
$\tan(\theta) = a/b$ [LO 45.1, 3.3]

Long Problems:

Problem 1

a) Inelastic, since they stick to each other [LO 50.2]

b) P_{car} = 30,000 kg*m/s in the x-direction [LO 46.1,10.1]

P_{truck} = 40,000 kg*m/s in the y-direction [LO 46.2,10.2]

c) $\mathbf{P}_f$ = 50,000 kg*m/s at angle 51.3 degrees counterclockwise from +x [LO 46.3,48.3,3.4, 2.1]

d) Impulse = 50,000 kg*m/s. It is an inelastic collision [LO 49.1, 50.3]

e) Magnitude of average force = 500,000 N [LO 49.2]

Problem 2

a) $M_Agh + 0 + 0 = M_Bgh + (1/2)[M_Av^2 + M_Bv^2 + (mR^2/2)\omega^2]$ [LO 38.1,34.2,35.1,51.4,16.1]

$= M_Bgh + (1/2)[M_Av^2 + M_Bv^2 + (mR^2/2)(v/R)^2] = M_Bgh + (1/2)[M_Av^2 + M_Bv^2 + m/2]v^2$
$v = 1$ m/s [LO3.5]
b) $a = 1$ m/s^2, $\alpha = 5$ rad/s^2 [LO 14.3,16.2]
c) $\Delta\theta = 2.5$ rad [LO 16.3]
d) $\tau_A = 9.0$ Nm clockwise, $W_A = + 22.5$ Nm [LO 21.1,24.1,54.2,56.2]

Problem 3

a) The forces at the hinge don't produce any net torque, neither does the gravitation force at the center of gravity. Net external torque is zero, hence angular momentum is conserved. [LO 59.1]

b) Before $L_i = mv_0(1.00 - 0.50) = 1\ \text{kgm}^2/\text{s}$ [LO 57.1]

After $L_f = I\omega = (ML^2/3)\omega = (0.5\ \text{kgm}^2)\ \omega$ [LO 57.2,51.5]

c) $L_i = L_f$; $\omega = (1\ \text{kgm}^2/\text{s})/(0.50\ \text{kgm}^2) = 2\ \text{rad/s}$ [LO 59.2,3.6]

d) $Mg(l/2) + (1/2)I\omega^2 = (1/2)I\omega_f^2$ [LO 38.2,45.2,35.2,35.3]

$(I = Ml^2/3 = 0.5\ \text{kgm}^2)$ [LO 51.6]

$\omega_f^2 = [Mgl + I\omega^2]/I$; $\omega_f = \sqrt{34}$ rad/s [LO 3.7]