Physics 10154 - Exam #3D

Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. <u>Clearly indicate your answer with a circle or box</u> and remember to include correct <u>units</u> and <u>significant figures</u>.

1. (30 pts) Two pucks have a 1-dimensional, elastic collision on a frictionless, horizontal surface. Puck A has half the mass of puck B and is initially moving along the x-axis with a velocity of 7.44 m/s, and puck B is initially at rest.

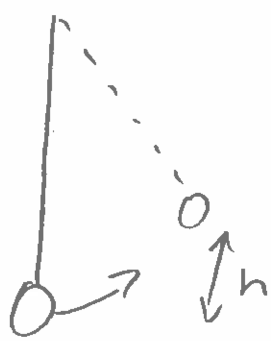
a) After the collision, what is the magnitude and direction of the velocity of each puck?
b) Puck B is a pendulum bob attached to a vertical string of length 2.1 meters. After the collision, what is the maximum angle the string makes with the vertical?

a) $$V_{1f} = \frac{m_1 - m_2}{m_1 + m_2} V_{1i} + 0 = \frac{m - 2m}{m + 2m}(7.44) = \boxed{-2.48 \text{ m/s}}$$

$$V_{2f} = \frac{2m_1}{m_1 + m_2} V_{1i} + 0 = \frac{2m}{m + 2m}(7.44) = \boxed{4.96 \text{ m/s}}$$

use V_{2f} as V_0

b)



$$\Sigma W_F = -mgh = 0 - \tfrac{1}{2} m v_0^2$$

$$h = \frac{v_0^2}{2g} = 1.255 m$$

$$h = l(1 - \cos\theta)$$

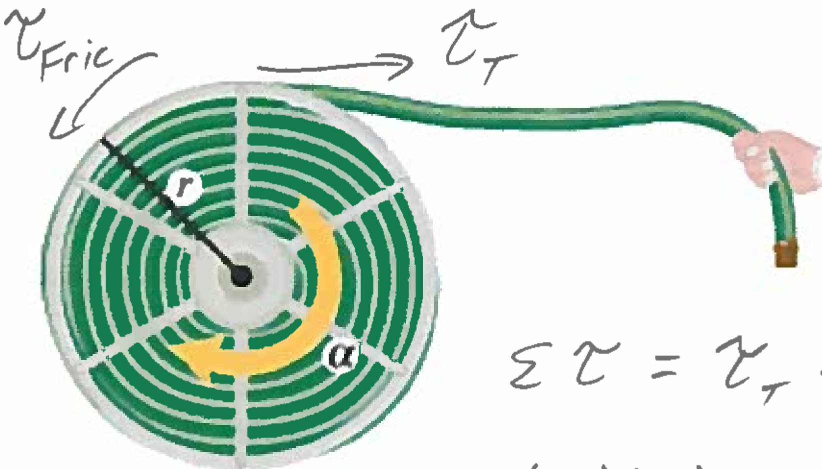
$$1.255 = 2.1(1 - \cos\theta)$$

$$0.5977 = 1 - \cos\theta$$

$$\cos\theta = 0.4023$$

$$\boxed{\theta = 66.3^\circ}$$

2. (35 pts) A 16.0-m length of hose is wound around a reel, initially at rest. The moment of inertia is 0.880 kg-m² and the radius of the reel is 18.0 cm (both assumed to be constant for this problem). When turning, friction exerts a torque of magnitude 3.85 N-m on the reel. A hose is pulled tangent to the reel with a constant tension of 26.0 N. How many seconds does it take to completely unwind the hose? Neglect the mass of the hose and assume the hose unwinds without slipping.



$$\Sigma \tau = \tau_T + \tau_{Fric} = I\alpha$$

$$-(.18)(26)\sin 90 + 3.85 = .880\alpha$$

$$-0.83 = .880\alpha$$

$$\alpha = -0.943 \text{ rad/s}^2$$

$$\omega_0 = 0$$

$$\Delta\theta = \frac{\Delta s}{r} = \frac{16.0\text{m}}{.18} = -88.9 \text{ rad (clockwise)}$$

$$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$-88.9 = \frac{1}{2}(-.943)t^2$$

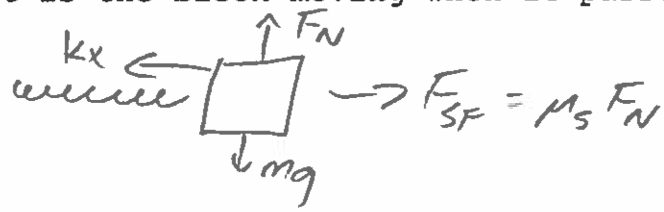
$$t^2 = 188.5 \Rightarrow \boxed{t = 13.7 \text{ s}}$$

3. (35 pts) A 3.50-kg mass is attached to one end of a horizontal spring (k = 1240 N/m) while the other end of the spring is fixed in place.

a) If the coefficient of static friction between the block and surface is 0.550, what is the maximum length to which the spring can be compressed for which the mass will not move in response to the spring force?

b) Suppose the spring is compressed a distance 25.0% larger than your answer to (a) and released. If the coefficient of kinetic friction between the block and surface is 0.115, how fast is the block moving when it passes through equilibrium?

a)



$$\Sigma F_x : +\mu_s F_N - k_s x = 0$$

$$\mu_s mg - k_s x = 0 \quad \Rightarrow x = \frac{\mu_s mg}{k_s}$$

$$= \boxed{1.52 \text{ cm}}$$

b) $x = (1.25)(1.52) = 1.90 \text{ cm}$

$$\Sigma W_F = W_{spr} + W_{KF} = \Delta K$$

$$\tfrac{1}{2}kx^2 + |F_{KF}||\Delta s| \cos\theta = \tfrac{1}{2}mv^2 - 0$$

$$\tfrac{1}{2}kx^2 + \mu_k F_N \Delta s(-1) = \tfrac{1}{2}mv^2$$

$$\tfrac{1}{2}kx^2 - \mu_k mg \Delta s = \tfrac{1}{2}mv^2$$

$$.224 - .075 = \tfrac{1}{2}(3.50)v^2$$

$$0.149 = 1.75v^2$$

$$\boxed{v = 0.292 \text{ m/s}}$$