Physics 10154 - Exam #3b

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

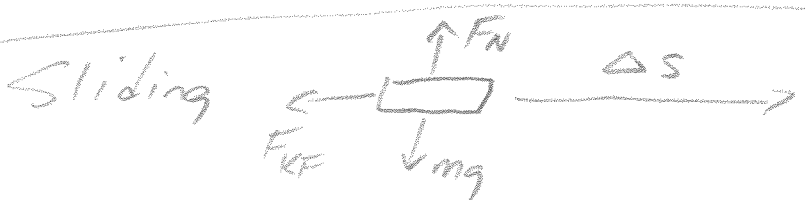
1. (30 pts) A small puck slides across and has a speed of 12 m/s just as it strikes a larger puck, initially at rest, with twice the mass of the small puck. The collision is elastic. After the collision, the larger puck slides 8.2 meters before coming to rest. What is the coefficient of kinetic friction between the larger puck and the table?

$m_1 = m \qquad v_{1i} = 12$

$m_2 = 2m \qquad v_{2i} = 0$

$$v_{2f} = \frac{2m}{3m}(12) + 0 = 8 \text{ m/s}$$

Sliding

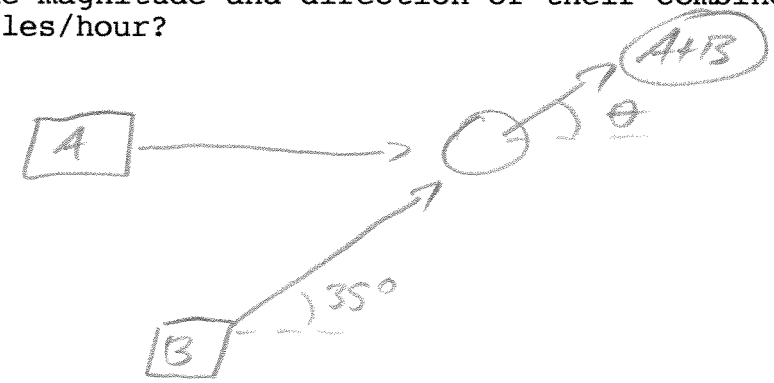


$$\Sigma W_F = W_{Fric} = 0 - \frac{1}{2}mv_0^2$$

$$-\mu_k mg\Delta s = -\frac{1}{2}mv_0^2$$

$$\mu_k = \frac{v_0^2}{2g\Delta s} = \frac{8^2}{2(9.8)(8.2)} = \boxed{0.40}$$

2. (30 pts) A 2500 kg car (call it car A) is initially moving East with a speed of 33 miles/hour. It collides with 3500 kg car B moving initially at 65 miles/hour in a direction 35° North of East. If the two cars move together after the collision, what is the magnitude and direction of their combined final velocity, in miles/hour?



$33 \frac{mi}{hr} = 14.75$

$5 \frac{mi}{hr} = 29.05$

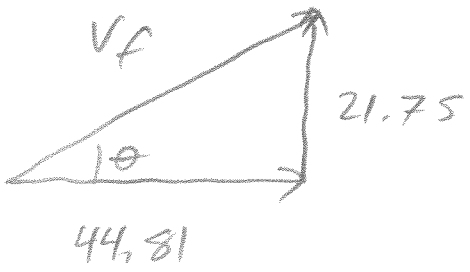
$x: \; m_A v_{A_i,x} + m_B v_{B_i,x} = (m_A + m_B) v_{f,x}$

$(2500)(33) + (3500)(65 \cos 35°) = (6000) v_{f,x}$

$v_{f,x} = 44.81 \; mi/hr \quad (20.03 \; m/s)$

$y: \; (2500)(0) + (3500)(65 \sin 35°) = (6000) v_{f,y}$

$v_{f,y} = 21.75 \; mi/hr \quad (9.72 \; m/s)$



$v_f = \sqrt{(44.81)^2 + (21.75)^2}$

$= 49.81 \quad (22 \; m/s)$

$\theta = \tan^{-1}\left(\frac{21.75}{44.81}\right)$

$= 25.89°$

$v_f = 50 \; mi/hr, \; 26° \; N \; of \; E$

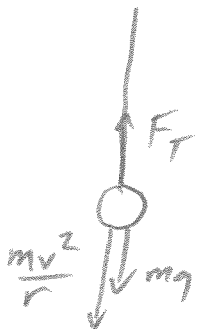
3. (40 pts) A 240 gram object is tied to a 1.2 meter long string and is moving with a speed of 2.5 m/s as it passes through the lowest point in its pendulum motion.

a) What is the tension in the string at this lowest point?

b) When the pendulum swings up to its maximum height, what angle does the string make with the vertical?

c) At maximum height, what is the tension in the string?

a)



$$\Sigma F_{rad} = -F_T + mg + \frac{mv^2}{r} = 0$$

$$F_T = mg + \frac{mv^2}{r}$$

$$= (.240)(9.8) + (.240)\frac{(2.5)^2}{1.2}$$

$$= 2.352 + 1.25$$

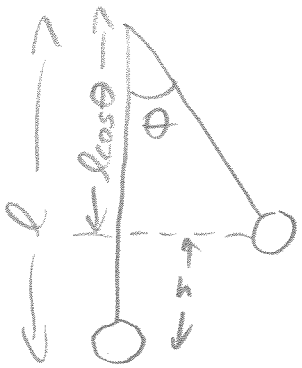
$$= \boxed{3.6\ N}$$

b) $\Sigma W_F = \Delta K$

$W_{grav} = \Delta K$ $\quad W_{cent} = 0,\ W_T = 0$

$-mgh = 0 - \frac{1}{2}mv_0^2$

$$h = \frac{v_0^2}{2g} = \frac{(2.5)^2}{2(9.8)} = 0.319\ m$$



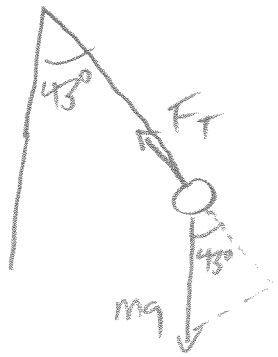
$h = \ell - \ell\cos\theta$

$0.319 = 1.2 - 1.2\cos\theta$

$-0.881 = -1.2\cos\theta$

$0.734 = \cos\theta$

$\boxed{\theta = 43^\circ}$



$\Sigma F_{rad} = -F_T + mg\cos 43^\circ = 0$

$F = (.240)(9.8)\cos 43^\circ$

$= \boxed{1.7\ N}$