Physics 10154 - Summer 2013 - Exam #3A

Instructions: Be sure to SHOW ALL WORK and clearly indicate your answers. I will not give full credit if I cannot logically follow how you got your answer, even if the answer is correct. Partial credit will be given provided you are solving parts of the problem correctly. Clearly indicate your final answer, including correct units and significant figures.

1. (40 pts) Object #1 (with mass m) is attached to a 1.2 meter long rope and held at rest as a pendulum 23° from the vertical position. The object is released. At the bottom of its motion, the object has an elastic collision with object #2 (with mass 2m), initially at rest. The 2nd object then slides across a rough surface (coefficient of kinetic friction 0.31) until coming to rest. How far does the 2nd object slide?

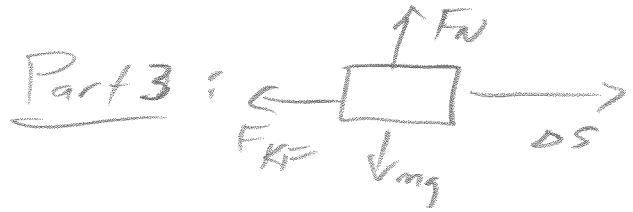
Part 1 $mgh = \frac{1}{2}mv^2$ $\quad h = \ell - \ell\cos\theta$

$v = \sqrt{2gh}$ $\quad = 1.2(1-\cos 23°)$

$= 1.37\ m/s$ $\quad = 0.0954\ m$

Part 2: $v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} = \frac{2m}{3m}(1.37) = \underline{0.911\ m/s}$

Part 3:

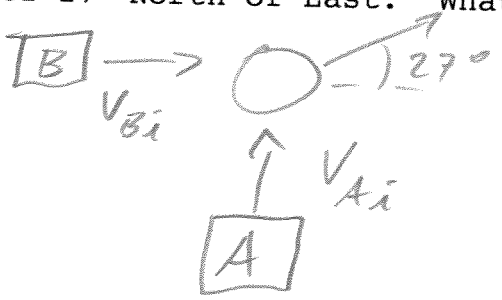


$\Sigma W_F = W_{KF} = 0 - \frac{1}{2}mv_0^2$

$-\mu_K m g \Delta s = -\frac{1}{2}mv_0^2$

$\Delta s = \frac{v_0^2}{2\mu_K g} = 0.14\ m$

2. (30 pts) Car A (mass 2200 kg) is moving North with a speed of 37 miles/hour. Car B (mass 2900 kg) is moving East with an unknown speed. The two cars collide and stick together. The combined wreck moves away from the point of impact at an angle of 27° North of East. What was car B's initial speed?



$$m_A v_{Ai,x} + m_B v_{Bi,x} = (m_A + m_B) v_{f,x}$$

$$0 + 2900\, v_{Bi} = 5100\, v_f \cos 27°$$

$$m_A v_{Ai,y} + m_B v_{Bi,y} = (m_A + m_B) v_{f,y}$$

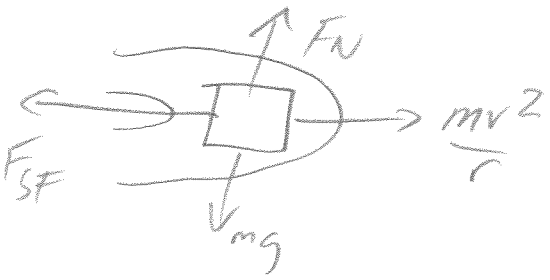
$$(2200)(37) + 0 = 5100\, v_f \sin 27°$$

$$v_f = 35.2 \text{ m/s}$$

$$v_{Bi} = \frac{5100 v_f \cos 27°}{2900} = 55 \text{ mi/hr}$$

or 25 m/s

3. (30 pts) A small mass is on the edge of a turntable of radius 85 cm. The turntable starts to accelerate with an angular acceleration of 0.11 rad/sec^2. If the coefficient of static friction between the mass and the turntable is 0.66, how many revolutions does the turntable make before the mass begins to slide radially off the edge?



$F_N = mg \quad F_{SF} = \mu_s F_N = \mu_s mg$

threshold = "begins to slide"

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

$$\frac{v^2}{r} = \mu_s g$$

$$v = \sqrt{\mu_s g r} = 2.34 \text{ m/s}$$

$$\omega = \frac{v}{r} = 2.76 \text{ rad/s}$$

$\Delta\theta = ?$
$\omega_0 = 0$
$\omega = 2.76$
$\alpha = 0.11$
$t = ?$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$(2.76)^2 = 0 + 2(.11)\Delta\theta$$

$$\Delta\theta = 34.6 \text{ rad}$$

$= 5.5$ rev