# 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. (35 pts) Mass A is attached to a string, making a 2.2 meter long pendulum, initially at rest at a height 0.65 meters above the lowest possible point in its swinging motion. Mass A is released, and at the bottom of its swing, it has an elastic collision with mass B, which is exactly three times as massive as mass A. To what maximum height does mass A rebound after the collision?

Downward swing: $W_{grav} = \Delta K$

$$mgh = \tfrac{1}{2}mv^2 - 0$$

$$v = \sqrt{2gh} = 3.57 \text{ m/s}$$

Collision: $V_{1f} = \dfrac{m_1 - m_2}{m_1 + m_2} V_{1i} + 0$

$$= \frac{m - 3m}{m + 3m}(3.57) = -\frac{2m}{4m}(3.57)$$

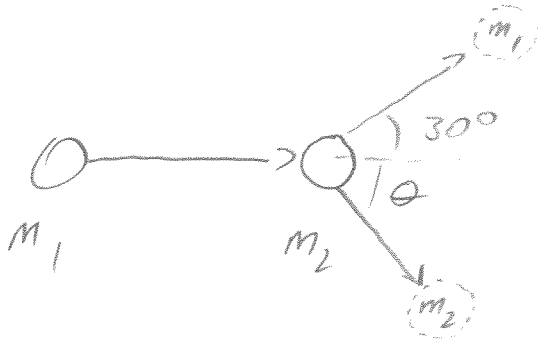
$$= -1.78 \text{ m/s}$$

Upward swing: $-mgh = 0 - \tfrac{1}{2}mv_0^2$

$$h = \frac{v_0^2}{2g} = \frac{(-1.78)^2}{2(9.8)} = \boxed{0.16 \text{ m}}$$

2. (30 pts) A 3.0 kg mass 1 slides across a frictionless surface in the +x direction with a speed of 5.0 meters/sec. It collides with a motionless identical mass 2. After the collision, mass 1 moves away with a speed of 4.33 meters/sec in a direction 30° above the +x direction.

a) What is the magnitude and direction of the speed of mass 2 after the collision?
b) Is the collision elastic? Justify your answer mathematically.




$x: (3)(5.0) + (3)(0) = (3)(4.33\cos 30°) + 3v_{2f,x}$

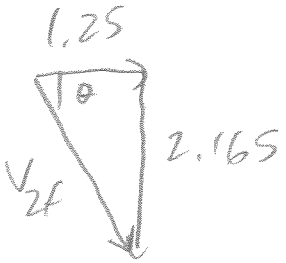
$15 = 11.25 + 3v_{2f,x}$

$3.75 = 3v_{2f,x}$ $\quad v_{2f,x} = 1.25\ m/s$

$y: (3)(0) + (3)(0) = 3(4.33\sin 30°) + 3v_{2f,y}$

$0 = 6.495 + 3v_{2f,y}$

$v_{2f,y} = -2.165\ m/s$




$v_{2f} = \sqrt{1.25^2 + 2.165^2} = 2.50\ m/s$

$\theta = \tan^{-1}\left(\frac{2.165}{1.25}\right) = 60°$ below +x

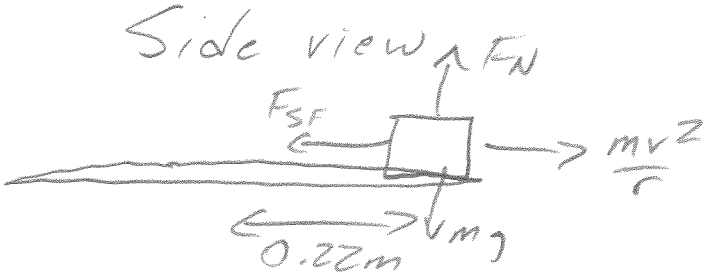
$K_i = \frac{1}{2}(3)(5)^2 + \frac{1}{2}(3)(0)^2 = 37.5\ J$

$K_f = \frac{1}{2}(3)(4.33)^2 + \frac{1}{2}(3)(2.5)^2 = 37.5\ J$

$\Delta K = 0$

elastic

3. (35 pts) A small block is placed on a turntable 22 cm away from the center of the turntable. Starting from rest, the turntable accelerates at a rate of 0.075 rad/sec$^2$. If the coefficient of static friction between the block and the turntable is 0.65, how many seconds elapse before the block begins to slide?




$\Sigma F_y : F_N - mg = 0$

$F_N = mg$

Block about to slide, so $F_{SF} = F_{SF,MAX} = \mu_s F_N$

or $\mu_s mg$

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

$$mr\omega^2 = \mu_s mg$$

$$\omega = \sqrt{\frac{\mu_s g}{r}} = 5.38 \text{ rad/s}$$

$\alpha = 0.075$

$\omega_0 = 0$

$$\omega = \omega_0 + \alpha t$$

$$5.38 = 0 + (.075)t$$

$$t = 72 \text{ s}$$