Physics 10154 - Exam #3a

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.

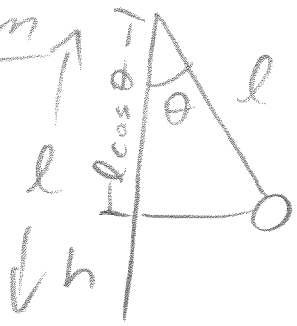
1. (30 pts) A 15 gram bullet collides with a 420 gram pendulum bob, initially at rest, hanging vertically from a 1.2 meter long thin string. After the impact, the bullet deflects backwards with a speed of 25 m/s, and the pendulum bob moves to a maximum angle of 32° from the vertical. What was the initial speed of the bullet?

Collision

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$0.015\, v_{1i} + 0 = -0.015(25) + 0.420 v_{2f}$$

Pendulum



$$h = l - l\cos\theta$$
$$= 1.2 - 1.2\cos 32^\circ$$
$$= 0.185$$

$$\Sigma W_F = \Delta K$$

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

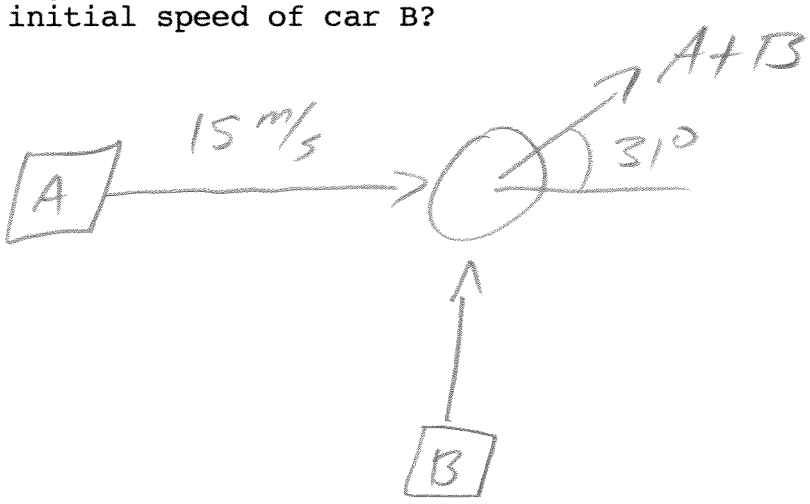
$$v_0 = \sqrt{2gh} = 1.89 \text{ m/s} \Rightarrow v_{2f}$$

$$0.015\, v_{1i} = -(.015)(25) + (.420)(1.89)$$

$$.015\, v_{1i} = 0.419$$

$$\boxed{v_{1i} = 28 \text{ m/s}}$$

2. (30 pts) Two cars of equal mass collide and move together after the collision. Car A is initially travelling East with a speed of 15 m/s, Car B is initially travelling North at an unknown speed. The combined masses of the wrecked cars moves off at an angle of 31° North of East after the collision. What was the initial speed of car B?



$$m_A v_{Ax} + m_B v_{Bx} = (m_A + m_B) v_{fx}$$

$$m \quad 0 \quad 2m$$

$$15 + 0 = 2 v_f \cos 31°$$

$$\Rightarrow v_f = \frac{15}{2\cos 31°} = 8.75$$

$$m_A v_{Ay} + m_B v_{By} = (m_A + m_B) v_{fy}$$

$$0 \quad m \quad 2m$$

$$0 + v_B = 2 v_f \sin 31°$$

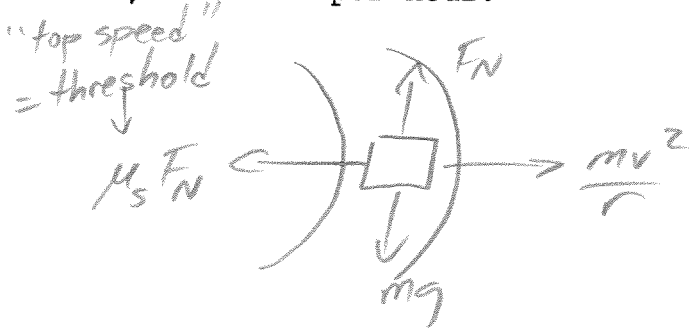
$$v_B = 2(8.75) \sin 31°$$

$$= \boxed{9.0 \text{ m/s}}$$

3. (40 pts) A car is moving at a constant speed around a curve in a flat road with radius of curvature 55 meters. The top speed that the car can go without slipping is 45 miles per hour.

a) What is the coefficient of static friction that prevents the car from slipping radially as it moves around the curve?

b) If the road is wet and the coefficient of static friction drops to 0.35, what will be the car's top speed around the same curve, in miles per hour?



$F_N = mg$

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

$V = 45 \frac{mi}{hr}$

$= 20.1 \, m/s$

$\frac{mv^2}{r} = \mu_s mg$

$\mu_s = \frac{v^2}{rg}$

$= \frac{(20.1)^2}{(55)(9.8)} = \boxed{0.75}$

b) Again, $\mu_s = \frac{v^2}{rg}$

$v = \sqrt{\mu_s rg}$

$= \sqrt{(.35)(55)(9.8)}$

$= 14 \, m/s = \boxed{31 \, mph}$