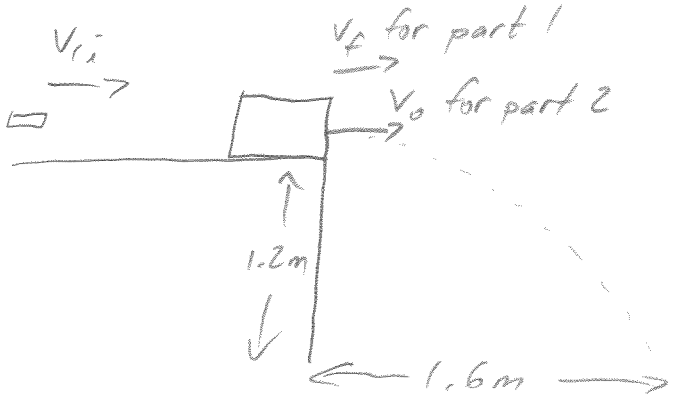
Physics 10154 - Exam #3a

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. (35 pts) A 8.0 gram bullet with an unknown speed is fired horizontally into a 220 gram block initially at rest on the edge of a 1.2 meter high table. After the collision, the bullet is embedded in the block, and the combined mass flies horizontally off the table, eventually landing 1.6 meters horizontally away from the base of the table. What was the initial speed of the bullet?



Collision

$m_1 V_{1i} + m_2 V_{2i} = (m_1 + m_2) V_f$

$.008 V_{1i} = (1.228) V_f$

Projectile Motion

$\Delta y = 1.2$

$V_{0y} = 0$

$V_y = ?$

$a_y = 9.8$

$t = ?$

$\Delta y = V_{0y} t + \frac{1}{2} a_y t^2$

$1.2 = 0 + 4.9 t^2$

$t = \sqrt{1.2/4.9} = 0.495\ s$

$\Delta x = V_{0x} t + \frac{1}{2} a_x t^2$

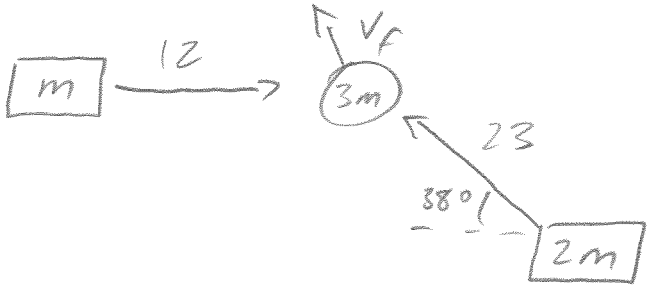
$1.6 = V_{0x} (.495)$

$V_{0x} = 3.23\ m/s$

$= V_0$

$V_{1i} = \frac{0.228 (3.23)}{0.008} = 92\ m/s$

2. (30 pts) Car 1 moves East with a speed of 12 meters/sec. Car 2 is twice as massive as car 1, and it moves 38° North of West at a speed of 23 meters/sec. If the two cars stick together after their collision, what is the magnitude and direction of the final velocity of the combined wreck?



$$x: \; m_1 v_{1i,x} + m_2 v_{2i,x} = (m_1 + m_2) v_{f,x}$$

$$m(12) + 2m(-18.12) = (3m) v_{f,x}$$

$$-24.2m = 3m\, v_{f,x}$$

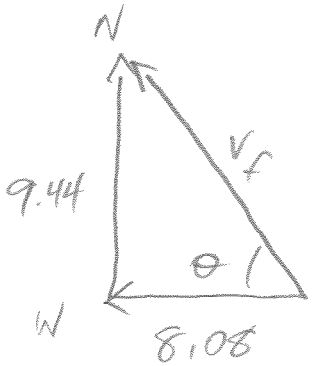
$$v_{f,x} = -8.08 \text{ m/s}$$

$$y: \; m_1 v_{1i,y} + m_2 v_{2i,y} = (m_1 + m_2) v_{f,y}$$

$$m(0) + 2m(14.16) = (3m) v_{f,y}$$

$$28.32m = 3m\, v_{f,y}$$

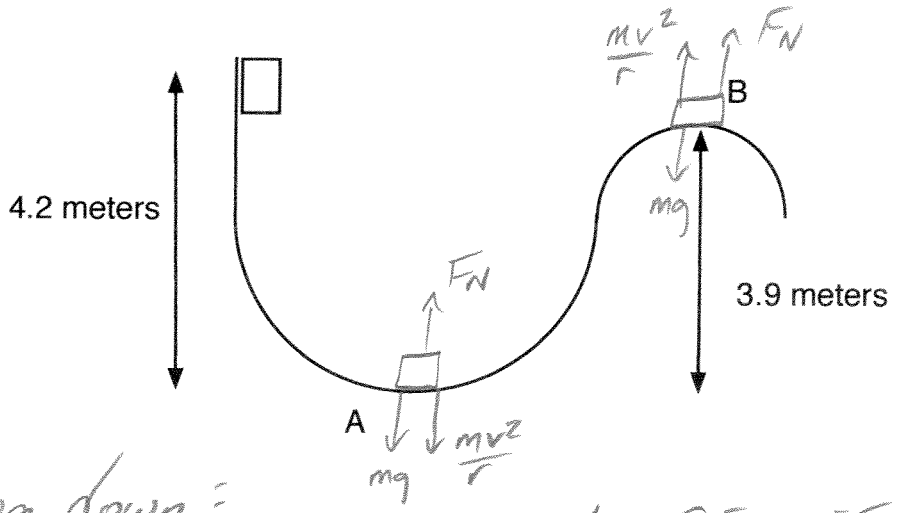
$$v_{f,y} = 9.44 \text{ m/s}$$



$$v_f = \sqrt{(8.08)^2 + (9.44)^2} = \boxed{12 \text{ m/s}}$$

$$\theta = \tan^{-1}\left(\frac{9.44}{8.08}\right) = \boxed{49° \text{ N of W}}$$

3. (35 pts) A 2.0 kg block slides along a frictionless track as shown below, starting from rest. When the block is sliding through point A, at the bottom of the bigger curve,, the radius of curvature of the track is 2.6 meters. When the block is sliding through point B, at the top of the smaller curve, the radius of curvature of the track is 1.3 meters. Find the normal force acting on the block at point A and point B.



Sliding down:

$W_{grav} = \Delta K$

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

$v = \sqrt{2g(4.2)} = 9.07\ m/s$

At A: $\Sigma F_{rad} = F_N + \frac{mv^2}{r} + mg = 0$

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

$= 19.6 + 63.2$

$= \boxed{83\ N}$

At B: $W_{grav} = \Delta K$

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

$v = \sqrt{2(g)(0.3)} = 2.42\ m/s$

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

$F_N = mg - \frac{mv^2}{r}$

$= 19.6 - 9.01$

$= 10.6\ N$ or $\boxed{11\ N}$