Physics 10154 - Exam #3c

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.

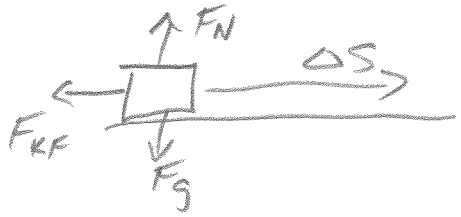
1. (30 pts) A 13 gram bullet collides with a 940 gram mass on a rough surface. After the impact, the bullet deflects backwards with a speed of 34 m/s, and the block slides 75 cm before coming to a stop. The coefficient of kinetic friction between the block and the surface is 0.28. What is the initial speed of the bullet?

Collision

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

$$(.013)\, v_{1i} + 0 = (.013)(-34) + (.940)\, v_{2f}$$

Sliding



$$\Sigma W_F = W_{kf} = \Delta K$$

$$-\mu_k F_N \Delta s = 0 - \tfrac{1}{2} m v_0^2$$

$$-\mu_k m g \Delta s = -\tfrac{1}{2} m v_0^2$$

$$v_0^2 = 2 \mu_k g \Delta s =$$

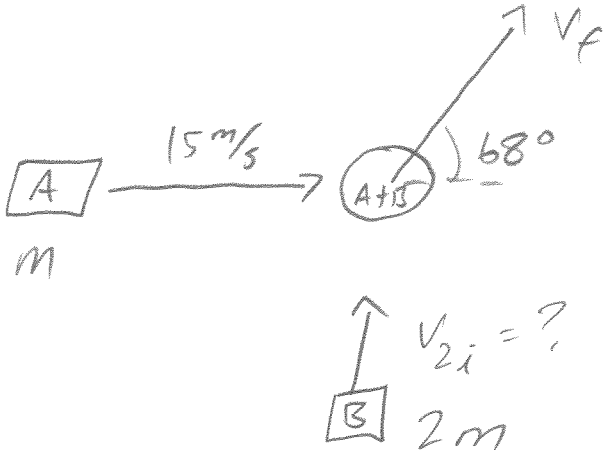
$$= 2(.28)(9.8)(.75) = 4.116$$

$$v_0 = 2.03$$

$$.013\, v_{1i} = (.013)(-34) + (.940)(2.03)$$

$$v_{1i} = \frac{-.442 + 1.908}{.013} = 110 \text{ m/s}$$

2. (35 pts) Two cars collide and move together after the collision. Car A is initially East with a speed of 15 m/s, car B is initially traveling North at an unknown speed. The combined masses of the wrecked cars move off at an angle of 68° North of East after the collision. What was the initial speed of car B? The mass of car B is twice that of car A.



$$x: m(15) + 2m(0) = 3m v_f \cos 68°$$

$$15 = 3 v_f \cos 68°$$

$$v_f = \frac{15}{3\cos 68°} = 13.35 \text{ m/s}$$

$$y: m(0) + 2m(v_{2i}) = 3m v_f \sin 68°$$

$$2 v_{2i} = 3 v_f \sin 68°$$

$$v_{2i} = \frac{3(13.35)\sin 68°}{2} = 18.56 \text{ m/s}$$

$$\approx 19 \text{ m/s}$$

3. (35 pts) A projectile is launched vertically from Earth's surface and given some initial velocity. After launch, the only force acting on the projectile is gravity. The projectile reaches a maximum altitude of 1500 miles above Earth's surface. What was the initial launch velocity?

$1500 \text{ miles} = 2.41 \times 10^6 \text{ m}$

$r_f = R_E + h = 6.38 \times 10^6 + 2.41 \times 10^6$

$= 8.79 \times 10^6$

Only gravity does work, so energy conserved

$U_i + K_i = U_f + K_f$

$U_i = -\frac{GM_E m}{R_E} = -(6.25 \times 10^7)m$

on surface of Earth

$K_i = \frac{1}{2} m v_0^2$

$U_f = -\frac{GM_E m}{r_f} = -(4.54 \times 10^7)m$

$K_f = 0$ (at max height)

$-(6.25 \times 10^7)m + \frac{1}{2} m v_0^2 = -(4.54 \times 10^7)m$

$\frac{1}{2} v_0^2 = 1.71 \times 10^7$

$\Rightarrow v_0 = 5850 \text{ m/s}$