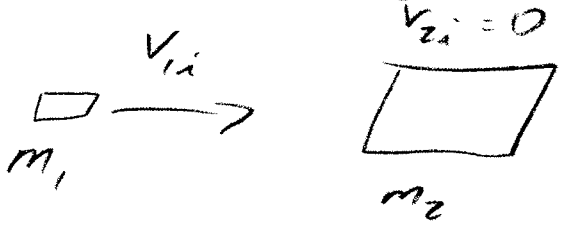
Physics 10154 - Exam #2b

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. (40 pts) A 12 gram bullet is fired horizontally into a 250 gram stationary wooden block. The bullet embeds itself into the block after the collision. After the collision, the bullet/block combination slides 2.5 meters across a rough surface (coefficient of kinetic friction is 0.350).

What is the initial velocity of the bullet prior to the collision?

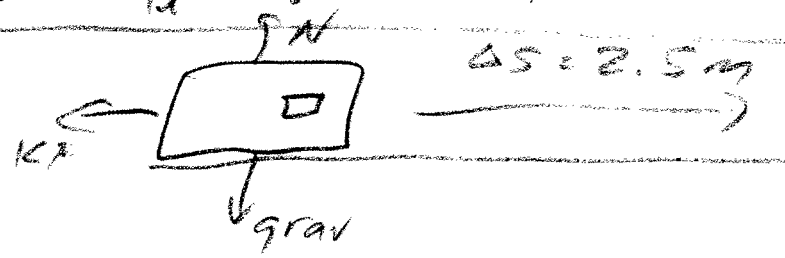
Collision



$$m_1 V_{1i} + m_2(0) = (m_1 + m_2) V_f$$

$$.012\, V_{1i} = .262\, V_f$$

Friction



$$\Sigma W_F = W_N + W_{grav} + W_{KF} = \tfrac{1}{2} m v^2 - \tfrac{1}{2} m v_0^2$$

$$0 + 0 - \mu_K m g \Delta s = 0 - \tfrac{1}{2} m v_0^2$$

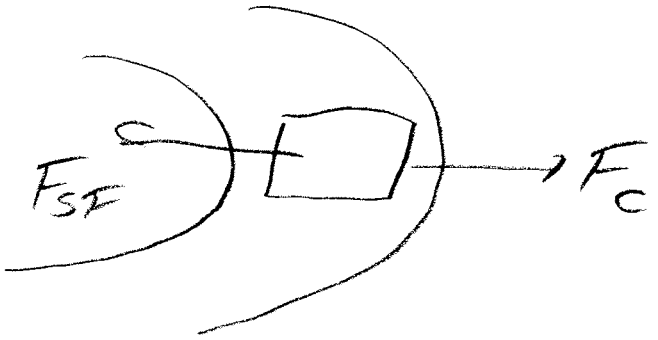
$$(.350)(.262)(9.8)(2.5) = \tfrac{1}{2}(.262)\, v_0^2$$

$$v_0^2 = 17.15 \qquad v_0 = 4.14\ m/s$$

↳ V_f for part 1

$$V_{1i} = \frac{.262}{.012}(4.14) = \boxed{90\ m/s}$$

2. (30 pts) If the coefficient of static friction ~~between~~ a car's tires and the pavement is 0.85, find the maximum speed that a car can go around a flat circular curve of radius ~~65~~ meters without slipping. Answer in miles/hour.



threshold language

$$\Sigma F_{rad} = F_C - F_{SF,MAX} = 0$$

F_N

$$\frac{mv^2}{r} = \mu_s m g$$

$$v^2 = \mu_s g r$$

$$v^2 = (.85)(9.8)(65) = 541$$

$$v = 23.3 \text{ m/s}$$

$$= \boxed{52 \text{ mi/hr}}$$

3. (30 pts) If a rocket is launched directly upwards from the North Pole with an initial velocity of 11,000 miles/hour, to what maximum altitude above Earth's surface does it rise? <u>You may not assume acceleration is constant in this problem</u>.

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

$$-\Delta U_{grav} = \Delta K$$

$$-(U_f - U_i) = K_f - K_i$$

$$U_i - U_f = K_f - K_i$$

$$U_i = -\frac{GMm}{R_E} = \frac{(6.676\times10^{-11})(5.98\times10^{24})m}{6.38\times10^6}$$

$$= (6.26\times10^7)m$$

$$U_f = -\frac{GMm}{r_f} = \frac{3.99\times10^{14}m}{r_f}$$

$$K_f = 0$$

$$K_i = \frac{1}{2}mv^2 = \frac{1}{2}(m)(4916)^2 = (1.21\times10^7)m$$

$$6.26\times10^7 m + \frac{3.99\times10^{14} m}{r_f} = 0 + 1.21\times10^7 m$$

$$5.05\times10^7 = \frac{3.99\times10^{14}}{r_f}$$

$$r_f = 7.90\times10^6 \qquad h = r - R_E$$

$$= 7.90\times10^6 - 6.38\times10^6 = \boxed{1.5\times10^6 m}$$

- 94c - 1.