your name(s)_____

Physics 321 Quiz #3 - Friday, Jan. 25

Work in groups of 3, open notes/book/internet/mouth

1. (10 pts) Two cannonballs are fired with the same muzzle velocity and initial angle (45 degrees). They feel a drag force of magnitude

$$|\boldsymbol{F_d}| = \kappa \rho_{m,\mathrm{atm}} A v^2,$$

where $\boldsymbol{A}$ is the cross-sectional area of the cannonball, $\rho_{m,\mathrm{atm}}$ is the mass density of air, $\boldsymbol{v}$ is the speed of the cannonball, and the drag coefficient κ is the same form both balls. Both balls are made of solid iron.

The first ball, $\boldsymbol{a}$, has a radius $\boldsymbol{R_a}$, and the second is larger with a radius $\boldsymbol{R_b = 2R_a}$.

Which ball flies further?

$\vec{a} = -\vec{g} - \hat{v}$ (something) $\frac{A}{m}$ smaller for B

$A \sim r^2$

$M \sim r^3$

B

2. Machine gun Tammy has two ice boats which glide on a frictionless lake. The mass of each boat is $\boldsymbol{M_B = 50}$ kg, and Tammy has a mass of 100 kg (including her maching gun). Each boat carries an additional mass of bullets, of 100 kg. The machine gun has a muzzle velocity of 1000 m/s.

   (a) (10 pts) How fast can Tammy go, starting from rest, by firing the machine gun in one direction? Allow her to disconnect the boats at any time.

$$v = v_{bullet} \cdot \ln \frac{M_{BOAT} + M_{TAMMY} + M_{BULLETS}}{M_{BOAT} + M_{TAMMY}}$$

$$+ v_{bullet} \cdot \ln \frac{2M_{BOAT} + 2M_{BULLETS} + M_{TAMMY}}{2M_{BOAT} + M_{BULLETS} + M_{TAMMY}}$$

   (b) (10 pts) How fast can Tammy go if she had 100 boats? You can write answer as a sum.

$$v = \sum_{n=1}^{100} v_{BULLET} \ln \left[\frac{M_{TAMMY} + n(m_{BULLETS} + m_{BOAT})}{M_{TAMMY} + n M_{BOAT} + (n-1) m_{BULLET}} \right]$$

$$= \sum_{n=1}^{100} v_{BULLET} \ln \frac{3n+2}{3n} = v_{BULLET} \ln \frac{1}{2} \frac{(3n+2)!!!}{3n!!!}$$