Midterm 2 for Algebra-Based Physics-1: Mechanics (PHYS135A-01)

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1 Vectors and Newton's Laws

1. Let $\vec{F}_1 = \frac{3}{4}\hat{i} + 1\hat{j}$ N, and $\vec{F}_2 = -1\hat{i} + \frac{3}{4}\hat{j}$ N. a) Give the magnitude of each force. b) What is the net force? c) What is the angle between these two forces?

2. Imagine you are sitting in an airplane that has just lifted off with an acceleration vector 20 degrees with respect to horizontal. Draw a free-body diagram corresponding to you, showing all forces acting on you.

3. Imagine you are riding a skateboard down a hill (no friction), and the incline angle is 30 degrees. Draw a free-body diagram corresponding to you, showing all forces acting on you.

2 Young's Modulus

1. Someone in the laboratory hands us a piece of metal, and needs to know what kind of metal it is. We decide to measure the Young's modulus, Y. The piece of metal is a cylinder with cross-sectional area $A = 4\pi \times 10^{-4}$ m^2, and length $L = 0.1$ m. We apply a force $F = 10^4$ N to squeeze the piece of metal, and the length changes by $x = 10^{-5}$ m. Young's modulus Y is defined so that:

$$\frac{x}{L} = \frac{p}{Y} = \frac{F/A}{Y} \tag{1}$$

   What is Y, for this material? How does this value compare to aluminum or iron?

   - 8×10^8 Pa
   - 80×10^9 N
   - 80×10^9 Pa
   - 8×10^9 Pa

3 Frictional Forces

1. There is a spill of a mystery toxic liquid on a shop floor, and no one wants to touch it. Someone gets the bright idea that they can identify it by the coefficient of kinetic friction and a steel plate. Draw a free body diagram corresponding to a steel plate sliding along the liquid/floor, with friction decelerating it.

2. What is the coefficient of kinetic friction, μ_{k}, if a steel plate with an initial speed of 2 m/s comes to a stop after 1.0 seconds, assuming $g = 10$ m/s^2? (Use the definition of acceleration $\Delta v/\Delta t = a$).

   - 0.1
   - 0.2
   - 0.5
   - 1.2

3. Suppose they get a sample of the mystery liquid in a vile. They assume the drag force is given by Stoke's Law, $F_{\mathrm{D}} = 6\pi r\eta v$, where v is the velocity of a particle moving through they fluid, r is the radius of the particle, and η is the *viscosity*. They drop a bead with $r = 1$ mm and a mass of 2 grams into the fluid, and observe the bead sink with a constant (terminal) velocity of 1 m/s. What is the viscosity of the fluid? Units: kg/(m s).

   - $10/(3\pi)$ kg/(m s)
   - $1/(3\pi)$ kg/(m s)
   - 20 kg/(m s)
   - 10 kg/(m s)