Physics 201, Fall 2007 Josh Erlich
Problem Set 1
Due Wednesday, September 12.

General Problem Set Instructions: You may work together, but you must write up your solutions independently (*i.e.* don't copy anyone else's solutions). You *must* show all of your work. No credit will be given for the final answer unless it is derived or explained, nor will credit be given for solutions to the wrong problems. Problem sets will also be available at the course website, http://physics.wm.edu/~erlich/201F07/ and will be due in class one week after they are handed out.

Problems from Taylor, Zafiratos and Dubson:

1.4, 1.6, 1.7, 1.11, 1.21, 1.23, 1.25

Additional Problems:

1. *Angle addition formulae*

This problem is meant to familiarize you with the rotation transformation of vectors. A two-dimensional vector $\mathbf{v} = (v_x, v_y)$ rotated in the counter-clockwise direction by an angle θ has components,

$$\mathbf{v}' = (v_x \cos\theta - v_y \sin\theta,\ v_y \cos\theta + v_x \sin\theta).$$

Rotation by an angle θ_1, followed by a rotation by an angle θ_2, is equivalent to a rotation by an angle $(\theta_1 + \theta_2)$. Use this fact and the rotation transformation of the vector $\mathbf{v}$ to prove the angle addition formulae:

$$\begin{aligned} \cos(\theta_1 + \theta_2) &= \cos\theta_1 \cos\theta_2 - \sin\theta_1 \sin\theta_2 \\ \sin(\theta_1 + \theta_2) &= \sin\theta_1 \cos\theta_2 + \cos\theta_1 \sin\theta_2. \end{aligned}$$

2. *Rotation Invariance of Newton's Second Law*

It is an experimental fact that forces transform as vectors under rotations: If $\mathbf{F} = (F_x, F_y)$ then $\mathbf{F}'$, which is obtained by rotating $\mathbf{F}$ counter-clockwise by angle θ, has components,

$$\mathbf{F}' = (F_x \cos\theta - F_y \sin\theta,\ F_y \cos\theta + F_x \sin\theta).$$

Use this to prove that Newton's second law, $\mathbf{F} = m\mathbf{a}$, is invariant under rotations.