Physics 271, Fall 2017
Homework 1
Due date: Monday Sept. 11, 2017

Reading: Chapter 1, Kleppner and Kolenkow

1. Vector warm up:
   (a) Given two vectors in cartesian coordinates, \( \vec{A} = (2, -3, 7) \) and \( \vec{B} = (5, 1, 2) \), find:
      i. \( \vec{A} + \vec{B} \)
      ii. \( \vec{A} - \vec{B} \)
      iii. \( \vec{A} \cdot \vec{B} \)
      iv. \( \vec{A} \times \vec{B} \)
   (b) Find the angles \( (\theta_A, \theta_B, \theta_{AXB}) \) that \( \vec{A} \), \( \vec{B} \), and \( \vec{A} \times \vec{B} \) make with the vertical (z axis).

2. Rotation:
   Two Cartesian systems of reference \( S \) and \( S' \) have the same origin and vertical axis \( (z = z') \), but the \( S' \) system is rotated about the \( z \) axis counterclockwise with respect to the \( S \) system. Let \( \theta \) be the angle formed by the \( x' \) axis with the \( x \) axis.
   Show that the components \( (x, y) \) in terms of \( (x', y') \) can be written as:
   \[
   y = x' \sin \theta + y' \cos \theta \quad \text{and} \quad x = x' \cos \theta - y' \sin \theta.
   \]

3. Kinematics-One Dimension Warm Up:
   A bus leaves a stop at College Ave and accelerates at a constant rate for 5 seconds. During this time the bus traveled 25 meters. Then the bus traveled at a constant speed for 15 seconds. Then the driver noticed a red light 18 meters ahead and slams on the brakes. Assume the bus decelerates at a constant rate and comes to a stop some time later just at the light.
   a) What was the initial acceleration of the bus?
   b) What was the velocity of the bus after 5 seconds?
c) What was the braking acceleration of the bus? Is it positive or negative?

d) How long did the bus brake?

e) What was the distance from the bus stop to the light?

f) Make a graph of the acceleration vs. time for the entire trip.

g) Make a graph of the velocity vs. time for the entire trip.

h) Make a graph of the position vs. time for the entire trip.

4. **Kinematics (K&K 1.12)**

The acceleration of gravity can be measured by projecting a body upward and measuring the time that it takes to pass two given points in both directions.

Show that if the time the body takes to pass a horizontal line $A$ in both directions is $T_A$, and the time to go by a second line $B$ is $T_B$, then, assuming that the acceleration is constant, its magnitude is

\[
g = \frac{8h}{T_A^2 - T_B^2}
\]