UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 125 / LeClair Spring 2009

Problem Set 1: Math and units refresher

Instructions:

1. Answer all questions below. Follow the problem-solving template provided.
2. Some problems have different due dates!
3. You may collaborate, but everyone must turn in their own work

The following two problems are due 13 January 2009 at the beginning of class.

1. Water is poured into a container that has a leak. The mass m of the water is as a function of time t is

$$m = 5.00t^{0.8} - 3.00t + 20.00$$

with $t \geq 0$, m in grams, and t in seconds. At what time is the water mass greatest?

2. Antarctica is roughly semicircular, with a radius of 2000 km. The average thickness of its ice cover is 3000 m. How many cubic centimeters of ice does Antarctica contain? (Ignore the curvature of the earth.)

The following three problems are due 15 January 2009 at the beginning of class.

3. A person walks in the following pattern: 3.1 km north, then 2.4 km west, and finally 5.2 km south. How far, and in what direction would a bird fly in a straight line from the same starting point to the same final point?

4. Here are two vectors:

$$\vec{\mathbf{a}} = 4.0\,\hat{\boldsymbol{\imath}} + 3.0\,\hat{\boldsymbol{\jmath}} \qquad \vec{\mathbf{b}} = 6.0\,\hat{\boldsymbol{\imath}} + 8.0\,\hat{\boldsymbol{\jmath}}$$

Find the following quantities:

- the magnitude of $\vec{\mathbf{a}}$
- the angle of $\vec{\mathbf{a}}$ relative to $\vec{\mathbf{b}}$
- the magnitude and angle of $\vec{\mathbf{a}} + \vec{\mathbf{b}}$
- the magnitude and angle of $\vec{\mathbf{a}} - \vec{\mathbf{b}}$

5. Here are three vectors:

$$\vec{\mathbf{d}}_1 = -3.0\,\hat{\boldsymbol{\imath}} + 3.0\,\hat{\boldsymbol{\jmath}} + 2.0\,\hat{\mathbf{k}}$$
$$\vec{\mathbf{d}}_2 = -2.0\,\hat{\boldsymbol{\imath}} - 4.0\,\hat{\boldsymbol{\jmath}} + 2.0\,\hat{\mathbf{k}}$$
$$\vec{\mathbf{d}}_3 = 2.0\,\hat{\boldsymbol{\imath}} + 3.0\,\hat{\boldsymbol{\jmath}} + 1.0\,\hat{\mathbf{k}}$$

What results from:

- $\vec{\mathbf{d}}_1 \cdot \left(\vec{\mathbf{d}}_2 + \vec{\mathbf{d}}_3\right)$
- $\vec{\mathbf{d}}_1 \cdot \left(\vec{\mathbf{d}}_2 \times \vec{\mathbf{d}}_3\right)$
- $\vec{\mathbf{d}}_1 \times \left(\vec{\mathbf{d}}_2 + \vec{\mathbf{d}}_3\right)$

The following three problems are due 16 January 2009 by the end of the day.

6. A hoodlum throws a stone vertically downward with an initial speed of $12.0\,\mathrm{m/s}$ from the roof of a building $30.0\,\mathrm{m}$ above the ground. How long does it take the stone to reach the ground, and what is its speed on impact?

7. The position of a particle moving along the x axis is given in centimeters by

$$x = 9.75 + 1.50t^3$$

where t is in seconds. Calculate the instantaneous velocity and acceleration at $t = 2.50\,\mathrm{s}$.

8. Two trains are $100\,\mathrm{km}$ apart on the same track, headed on a collision course towards each other. Both are traveling $50\,\mathrm{km}$ per hour. A very speedy bird takes off from the first train and flies at $75\,\mathrm{km}$ per hour toward the second train. The bird then immediately turns around and flies back to the first train. Then he flies back to the second train, and repeats the process over and over as the distance between the trains diminishes. How far will he have flown before the trains collide?

1.

Find / Given:	**Sketch:**

Relevant equations:	**Symbolic solution:**

Numeric solution:	**Double Check**	
	Dimensions	Order-of-magnitude