University of Alabama
Department of Physics and Astronomy

PH 126 LeClair Fall 2011

Problem Set 1

Instructions:

1. Answer all questions below. All questions have equal weight. Show your work for full credit.
2. All problems are due Friday 26 August 2011 by 11:59pm.
3. You may collaborate, but everyone must turn in their own work.

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

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

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

2. Find the angle between the *body* diagonals of a cube. Use one of the vector products.

3. If $\vec{\mathbf{a}}=\hat{\mathbf{x}}-\hat{\mathbf{y}}+\hat{\mathbf{z}}$, $\vec{\mathbf{b}}=2\hat{\mathbf{x}}-\hat{\mathbf{y}}$, and $\vec{\mathbf{c}}=3\hat{\mathbf{x}}+5\hat{\mathbf{y}}-7\hat{\mathbf{z}}$, verify the identity

$$\vec{\mathbf{a}} \times \left(\vec{\mathbf{b}} \times \vec{\mathbf{c}}\right) = (\vec{\mathbf{a}} \cdot \vec{\mathbf{c}})\,\vec{\mathbf{b}} - \left(\vec{\mathbf{a}} \cdot \vec{\mathbf{b}}\right)\vec{\mathbf{c}}$$

4. At each corner of a square is a particle with charge $\mathtt{q}$. Fixed at the center of the square is a point charge with opposite sign, of magnitude $\mathtt{Q}$. What value must $\mathtt{Q}$ have to make the total force on each of the four particles zero? With $\mathtt{Q}$ set at that value, the system, in the absence of other forces, is in equilibrium. Do you think the equilibrium is stable?