Show and explain all of your work! Correct answers for which we cannot follow your work are worth no credit.

1. (0 points) Please install Mathematica 8.0 on your computer, or find a computer that you can regularly use that has it installed already (like the ones in the computer room). As a registered CU student, you can obtain a (free!) student license from `http://oit.colorado.edu/software-hardware/site-licenses/mathematica`, but it can take a day or so to get the activation key. Future problem sets will require some Mathematica use. If you have never used Mathematica before, you might want to watch the first 2 or 3 parts to the "Hands-on Start" Tutorial videos, at `http://www.wolfram.com/broadcast/screencasts/handsonstart/`, which will take less than 25 minutes.

2. (0.5 point) Show that $\frac{1}{2}\sin(\frac{\pi}{2}+\alpha) + \frac{1}{2}\sin(\frac{\pi}{2}-\alpha) = \cos(\alpha)$.

3. (0.5 point) Given the two vectors $\vec{B} = \{2,2,1\}$ and $\vec{C} = \{1,2,-6\}$, what is $\vec{B} \times \vec{C}$?

4. (0.5 point) Are $\vec{B}$ and $\vec{C}$ in the previous problem orthogonal to each other? How can you tell?

5. (1 point) Given the function $f(x,y) = xy + z$, what is the gradient of f, $\boldsymbol{\nabla}f$? Is it a vector or scalar?

6. (1 points) Given the function $\vec{F} = x\hat{i} + xy\hat{j} + \hat{k}$, what is the curl of $\vec{F}$, $\boldsymbol{\nabla} \times \vec{F}$? Is it a vector or scalar?

7. (1 point) Given the function $\vec{F} = x\hat{i} + xy\hat{j} + \hat{k}$, what is the divergence of $\vec{F}$, $\boldsymbol{\nabla} \cdot \vec{F}$? Is it a vector or scalar?

8. (2.5 points) Use an appropriate volume integral to find an expression for the volume enclosed between a sphere of radius 1 centered on the origin and a circular cone of half-angle β with its vertex at the origin. (This intersection is sort of shaped like an ice cream cone.) Show that in the limits where $\beta = 0$ and $\beta = \pi$ that your expression gives the expected values.

9. (3 points) A 3-kg block is moved up a 37° incline (relative to horizontal) under the action of a constant *horizontal* force of 40 N. The coefficient of kinetic friction is 0.1 and the block is displaced 2 m along the incline.

   a) Calculate the work done by the 40 N force.

   b) Calculate the work done by friction.

   c) If the block is initially at rest, how long does it take the block to travel 2 m along the incline?