**Review notes for Exam 1 (Math Review)**  
This is a list of concepts that will be tested, not a list of potential exam problems.

1) Vectors  
   a. A vector contains a magnitude and direction. The magnitude contains one piece of information, while the direction contains two. These three independent pieces of information can also be expressed as vector components. Be able to interconvert between the magnitude-direction representation and the component representation.
   b. Understand what unit vectors are and how to use them. Be able to interconvert between spherical-coordinate angles and direction cosines.
   c. Be able to add and subtract vectors, as well as multiplying them together via scalar (dot) and vector (cross) products.
   d. Be able to project a vector onto another direction, which is to determine the vector component along that direction.

2) Calculus  
   a. Calculus is the art of cutting things up into tiny pieces called differentials. Adding up differentials is called “integration”. Taking ratios of differentials is called differentiation.
   b. Common integrals and derivatives that should be memorized include those of the polynomial, exponential, natural log, sin and cos functions.
   c. Be familiar with cylindrical and spherical coordinates.
   d. Know how to calculate lengths, areas, and volumes of interesting shapes  
      i. Length of a straight line.
      ii. Length of an arc  
      iii. Circumference of a circle  
      iv. Area of a square  
      v. Area of a circle  
      vi. Volume of a cylinder (cylindrical coordinates)  
      vii. Volume of a cone  
      viii. Area of a cone (tricky slope)  
      ix. Area of a sphere (spherical coordinates)  
      x. Volume of a sphere (using full 3D integral or 1D and 2D subsets)
   e. Be familiar with a variety of different ways to cut these shapes up into differentials. Be able to write down expressions for these differentials.
   f. Understand why one choice of differential is sometimes more convenient or correct than another. For example, when integrating densities, one must choose a differential that has constant density across it’s length, area, or volume.
   g. Know the traditional density symbols for length ($\lambda$), area ($\sigma$) and volume ($\rho$).
   h. Relate $dQ$ to $dx$, $dA$, and $dV$ via respective densities $\lambda$, $\sigma$, $\rho$.
   i. Given an expression for the charge or mass density of an object as a function of convenient spatial coordinates, integrate the density to determine its total charge or mass.