Physics 380-001

Homework #1: Mathematical review

1. Strange Integrals (6 pts): Please do the following integrals:

$$\int_0^1 x^2\,\delta\left(x-\frac{1}{2}\right)dx$$

$$\int_0^1 x^2\,\delta\left(x+\frac{1}{2}\right)dx$$

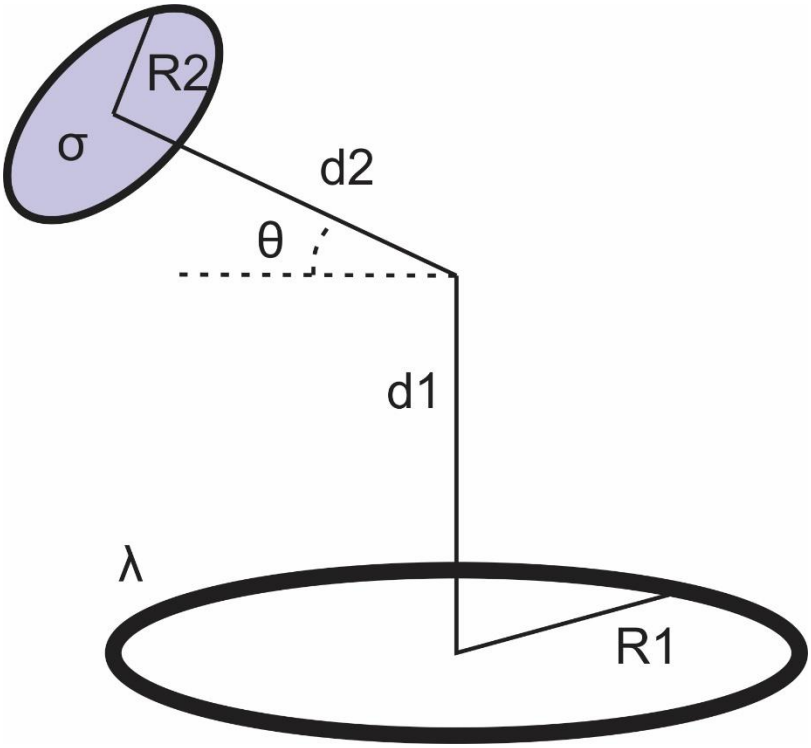
$$\int_{-1}^1 x^2\,\delta^3(r)d^3x$$

2. Many, Many Electrons (40 pts): Your experiment has detected 3708 electrons at various positions in a box. Please go to Moodle and download the X, Y, and Z positions of each electron contained in a file titled: "2013 - Phys380 - HW2 – RandomCharges.csv". (Don't get carried away with units too much, I'd like to know what the relative field is at various points.) Feel free to use any tool that you would like.

a. What is the electric field at (0,0,0)?
b. What is the electric field at (1,0,0)?
c. Can you make a plot of the field as you move in the x-direction at y=0 and z=0?

3. Spherical Shell (30 pts): Do problem 2.15 in textbook

Problem 4: Just Freakin Loopy [30 pts] Your team is building some unique piece of technology. Your team recognizes that a powerful electric field could be a problem at one location. Your boss remembers you have a physics degree (i.e., team physicist) and has asked you to find it. What is the electric field in the following location?



Both loops are in a plane (i.e, d2 and d1 form a plane that aligns to the paper.

R1 = 2d
R2 = d
d1 = 3d
d2 = 2d
$\lambda = \sigma d$
$\theta = 30°$

Problem 5: Helium Atom [40 pts]: You want to come up with a theory to understand helium better. In particular, you want to determine the potential of a Helium+ atom. The wave function of the bound electron is given by the following quantity:

$$\psi = A\exp(-r/a_0)$$

1. Normalize the wavefunction to find the value of A. (Hint the wavefunction is 3D)
2. Knowing that the charge distribution for the electron is given by:

$$\rho = -e\psi^*\psi$$

3. What would the charge density of the electron be?
4. What would be the charge density of the nucleus be?
5. What is the total charge density of the He^+ system?
6. Find an expression for $\vec{E}$ of r.

Problem 6: Straight line madness [20 pts] For this problem, a charge density λ is placed on 2 wires and are arranged as indicated below. The horizontal wire is has a length of L and the vertical wire has a length of L/2. If the place where the wires meet is the origin, find the electric field at point $(-L/2, L/2)$.