Carleton University Physics Department
PHYS 3308 – Electromagnetism (Fall 2014)
Homework assignment #1

Handed out Thurs Sept 4; due Thurs Sept 11, 2014, at the start of class. H. Logan
Problems are worth 5 points each unless noted otherwise.

The purpose of this assignment is to review some physics and techniques involving Coulomb's law and continuous charge distributions that you learned in first-year physics. For full credit, draw a diagram whenever applicable, define all quantities you use, and briefly but clearly explain your reasoning. You are welcome to use an integral table (paper or electronic) to solve integrals.

1. Consider a line of charge with length L and total charge Q (uniformly distributed), centred at the origin and lying along the y axis. Find the electric field at a point on the x axis a distance x away from the centre of the line charge. *(Remember that the electric field is a vector: for a complete solution, you must account for all 3 components. Use symmetry arguments to simplify the problem as much as you can!)*

2. *(10 points)* Again consider a line of charge with length L and total charge Q (uniformly distributed). Now the line of charge is oriented along the positive y axis with one end at the origin.

   (a) Find the electric field at a point on the x axis a distance x away from the end of the line charge.

   (b) Show that when $x \gg L$, your answer in part (a) reduces to that for a point charge with total charge Q.

   (c) How would your answer to part (a) change if the charge Q were not uniformly distributed over the line charge? Define a linear charge density (a function of position along the line charge) and show how you would set up the integrals in part (a) using it.

3. *(10 points)* Consider a circular disk of radius R and total charge Q lying in the x-y plane with its centre at the origin.

   (a) If the charge on the disk is uniformly distributed, find the surface charge density σ.

   (b) Find the electric field at a point on the z axis a distance z from the centre of the disk. Check that your formula is also valid for negative values of z.

   (c) Show that when $z \gg R$, your answer in part (b) reduces to the electric field due to a point charge with total charge Q.

   (d) If you now hold σ constant and take $R \to \infty$, what does your formula from part (b) give for the electric field? (This is the electric field for a uniform infinite sheet of charge, which we will calculate again later using Gauss's Law.)