Worksheet 11, Spring 2008

Due Friday 4th April at 6pm

This worksheet requires the use of Mathematica to solve and display solutions to some problems from electricty and magnetism. For plotting electric field vectors, look up VectorFieldPlots.

PROBLEM 1.

Write down the expression for the electrostatic potential of a dipole where the positive charge q is located at position $(0, 0, 1)m$ and the negative charge $(-q)$ is at $(0, 0, -1)$, with $q = 1\mu C$. Make a 3-D plot of the potential in the x-z plane. Find the electric field of the dipole using $\vec{E} = -\vec{\nabla}V$.

PROBLEM 2.

Four point charges are placed at the corners of a square, with $q_1 = 10^{-6}C$ at (0,1), $q_2 = -2 \times 10^{-6}C$ at (1,1), $q_3 = -3 \times 10^{-6}C$ at (0,0) and $q_4 = 2 \times 10^{-6}C$ at (1,0), with the distances measured in centimeters.

a) Find an expression for the electrostatic potential, V, at position (x,y).

b) The electric field is related to the electrostatic potential by $\vec{E} = -\vec{\nabla}V$. Use the Mathematica function VectorFieldPlot to display the electric field in the x-y plane.

c) Find the vector force on a charge $q_0 = 1 \times 10^{-6}C$ placed at position (2,1). Note that the force is related to the electric field via $\vec{F} = q\vec{E}$.

PROBLEM 3.

A uniformly charged rod of length 2 meters, and with charge per unit length $\lambda = 1\mu C/m$, is located on the z-axis and is centered at the origin. The electrostatic potential due to this charge distribution has cylindrical symmetry, with the z-axis the symmetry axis. By making a table and using NIntegrate, find and plot the electrostatic potential in the $x - z$ plane (use ListPlot 3D).

PROBLEM 4.

An electron moving in the x-direction with velocity $300m/s$ enters a region of space in which there is an electric field $E = .01V/m$ in the y-direction, and there is also a magnetic field $B = 0.1T$ in the y-direction. Find the motion of the electron and make a 3-D parametric plot of its trajectory.