Problem Set 4

Issued: Thu, Feb 24
Due: Fri, Mar 4 4PM <- note Date + Time!

Reading suggestions (from Young & Freedman)

Fri, 2/25: Electric Potential, Capacitance: 23-4, 24-1
Mon, 2/28: Energy Storage in Capacitors, Dielectrics: 24-3, 24-4
Wed, 3/2: Capacitors in Circuits: 24-2
Fri, 3/4: Conductors and Insulators, EF Experiment 25-1

Homework Problems (30 points total)

Problem 1 (8 points) Two point-like charges $Q_1 = 1\, \text{C}$ and $Q_2 = -1\, \text{C}$ are separated by a distance of 1m. Suppose in an x-y coordinate system $Q_1$ sits at (-0.5m, 0) and $Q_2$ sits at (+0.5m, 0).
(a) What is the force on charge $Q_1$ due to $Q_2$?
(b) Find the minimum of the x-component of the field between $-0.5 \, \text{m} < x < 0.5 \, \text{m}$.
What is the magnitude of the field in units of [V/m]?
(c) Draw graphs of the x-component and y-component of the total electric field $E_x(x,y)$ and $E_y(x,y)$ vs x between $-0.5 \, \text{m} < x < 0.5 \, \text{m}$ for y=0, y=-10cm, y=+10cm (the three curves for each component can be combined into one graph, if properly labeled).
(d) Sketch the electric field of this charge configuration using fieldlines. Does this sketch correspond to the graphs from (c)?

Problem 2 (8 points) Two point-like charges $Q_1 = 1\, \text{C}$ and $Q_2 = -2\, \text{C}$ sit at $x_1 = -0.5\, \text{m}$ and $x_2 = +0.5\, \text{m}$ along the x-axis of some coordinate system.
a. Draw a graph the electric potential due to $Q_1$, $Q_2$ separately and the total electric potential from $x = -2\, \text{m}$ to $x = +2\, \text{m}$.
b. How could one approximate the total potential of $Q_1 + Q_2$ for distances $x >> 1\, \text{m}$?
c. Draw a graph of the potential energy for a charge $Q_3$ of $-0.1\, \text{C}$ in the potential created by $Q_1$ and $Q_2$ between $-2\, \text{m} < x < 2\, \text{m}$

Problem 3 (6 points) Young & Freedman, Problem 24-60
Problem 4 (8 points) Young & Freedman, Problem 24-71

Note that check-off and experiment write-up (FROM BOTH PARTNERS) for experiment ‘HVPS’ are due on Fri, 3/4. HVPS questions have been provided in a separate document. There will be 2 bonus points for HVPS on 2/28 and 1 bonus point on 3/1.