Physics 272. Midterm I

Please write your name at the top of the page There are 4 problems. Each is assigned 25 points. Show your work.

Problem 1: 25 points

Three point charges are placed on the x-axis. $q_1 = -6.0\mu$C is at $x = -3.0$ m, $q_2 = 4.0\mu$C is at the origin and $q_3 = -6.0\mu$C is at $x = 3.0$ m.
(Useful constant: $k = 8.99 \times 10^9$ N/m^2C^2)

(a) Find the **magnitude** of the *force* on q_1.

(b) What is the **magnitude** of the *electric field* at the position of q_1. ?

(c) What is the direction of the *electric field* at the position of q_1. ?

Problem 2: 25 points

An infinitely long cylinder of radius R carries a uniform *volume* charge density $\rho(r) = \rho_0$.

(a) Find the *magnitude of the electric field* inside the cylinder as a function of radius. (draw a diagram which shows the Gaussian surface used.)

(b) Find the *magnitude of the electric field* outside the cylinder as a function of radius.

(c) What is the **direction** of the electric field ? (show it on your diagram)

Problem 3: 25 points

Two concentric spherical shell conductors carry equal and opposite charges. The inner shell has radius a and charge q; the outer shell has radius b and charge $-q$.

(a) Draw a sketch of this configuration.

(b) Find the *potential difference* between the two shells (i.e. $V_a - V_b$). (your answer should be given in terms of a, b and q.)

(c) Find the *capacitance* of this arrangement. (your answer should be given in terms of a, b and q.)

Problem 4: 25 points

(a) Half the charge is removed from a capacitor without changing the capacitance. What fraction of its stored energy is removed along with the charge ?

(b) Two charged metal spheres are connected by a conducting wire and sphere A is larger than sphere B, is the magnitude of the electric potential of sphere A *(larger, smaller, or the same)* as that of sphere B ? Explain.

(c) Two metal balls have charge $+q$ and $-q$. How will the *force* on them change if the balls are placed in water, the distance between them being unchanged ?

(d) Three charges $+q$, $+Q$, $-q$ are placed at the corners of an equilateral triangle as shown. What is the *direction of the net force* on charge $+q$?

(e) A dielectric with dielectric constant $\kappa = 3.0$ is inserted between the plates of a parallel plate capacitor, by what factor does the *potential difference* and *capacitance* change ?