Instructions: You have a total of 50 minutes to complete this test. Answer each question completely. In order to obtain full credit for the problems, **you must** supply sketches, words, and details (including all assumptions) showing clearly how you obtained your answer. Correct SI units must be provided for numerical answers where required.

Time Start_____ Time finish _____pledged _____

Constants: $k=8.987x10^{9}\frac{Nm^2}{C^2}:\epsilon_0=8.854x10^{-12}\frac{C^2}{Nm^2}$

[1] An infinitely long wire along the z-axis has a uniform linear charge density per unit length given by λ .

(a) Find the **vector electric field** , $\vec{E}$ at a distance s from the wire. You should use for the cylindrical coordinate unit vector the symbol $\hat{s}$. Be sure to include pictures, assumptions, and other details here.

(b) Suppose that $\lambda=10\frac{\mu C}{m}$. What is the **vector electric field** at a distance of 10 m from the wire with correct SI units?

(c) If a charge $q_p=-5\mu C$ is placed 10 m from the wire, what is the **vector electric force** on the charge with correct SI units?

[2] Two charges have the following coordinates: #1: +q(+a,0) and #2: -q(-a,0).

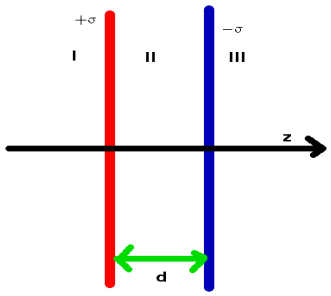
(a) Find the **vector electric field** , $\vec{E}$ at the origin which has coordinates (0,0) in terms of k,q, and a. Note that a is assumed to be positive here.

(b) If a charge q_p is placed at the origin, what is the **vector electric force** on this charge in terms of k,q,q_p, and a?

(c) Provide a numerical result for the **vector electric force** with correct SI units on this charge for the case a=10m, and with both q_p and q given by 1 μC.

(d) Calculate the vector dipole moment of the distribution for the values given in (c).

[3] An ideal parallel plate capacitor is in the x-y plane a shown. The capacitor is charged with a surface charge density +σ on the plate located at z=0 and -σ on the plate located at z=d.



(a) Make a sketch of the electric field, including electric field directions on the diagram below. You will need to use several lines here to correctly show this. In each of the 3 regions, **use a double line arrow to represent fields from +σ** and **use a single line arrow to represent the field from -σ**.

(b) Find the **vector electric field** , $\vec{E}$ between the plates of the capacitor (in region 2). You must show details and assumptions here (and a sketch).

(c) If $\sigma = 1 \times 10^{-10} \frac{C}{m^2}$. Find a numerical result for the **vector electric field** in region 2 with correct SI units.

(d) Find the capacitance when $\sigma = 1 \times 10^{-10} \frac{C}{m^2}$, d=0.1 m and A=1 m^2.

(e) Find the energy stored in the capacitor when $\sigma = 1 \times 10^{-10} \frac{C}{m^2}$, d=0.1 m and A=1 m^2.

[4] In order to obtain full credit for this problem, **you must** supply sketches, words, and details (including all assumptions) showing clearly how you obtained your answer.

A sphere of radius a has a volume charge density per unit volume given by $\rho(r)=\rho_0\left(\frac{r}{a}\right)^3$ and the total charge on the sphere is Q.

(a) Find the value of ρ_0.

(b) Find the **vector electric field** , $\vec{E}$ **outside** the sphere of charge.

(c) Find the potential at the surface of the sphere.

(d) Find the capacitance of the sphere.

(e) If two 10μf capacitors are connected in series, find the equivalent capacitance.

(f) If two 10Ω resistors are connected in series, find the equivalent resistance.