Instructions: You have a total of 50 minutes to complete this test.
Answer each of the following questions completely.

Time Start_____ Time finish_____ Pledged_____

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

Do not discuss any aspect of this test with anyone until I return the test.

(1)A sphere of charge of radius a has a total charge Q and a uniform volume charge distribution $\rho_{0.}$

(a) Find the value of $\rho_{0.}$

(b) Find the **vector** electric field outside the sphere.

(c) Find the **vector** electric field inside the sphere.

(d) Find the electric potential at at the surface of the sphere.

(e) Find the capacitance of the sphere.

(f) If Q = 1 μC and a=1 m, provide numerical answers for d and e with correct SI units.

(2) Two charges are located at (1:-q; a,0) and (2:+q;-a,0) respectively.

(a) Find the vector electric field at the coordinates (0,b).

(b) What is the dipole moment of the distribution?

(c) If a charge q is placed at (3:+q;0,b), find the electric force on charge 3.

(d) Provide a numerical answer with correct SI units to (a) (b) and (c) above for the special case of a=1m, b=1m and q=1 μC.

(3) A material with a dielectric constant 10 is inserted and completely fills a capacitor with a geometrical capacitance of 1 μf.

(a) What is the capacitance with the material inserted?

(b) Two capacitors with the material inserted as in a are connected in series. What is the equivalent capacitance?

(c) Two capacitors with the material inserted as in a are connected in parallel. What is the equivalent capacitance?

A material has a resistivity of 10 Ωm. It is formed into the shape of a cyliner of cross section 0.1 m^2 area and length 2 m.

(d) What is the resistance of this resistor?

(e) Two such resistors described in (d) are placed in series. What is the equivalent resistance?

(f) Two such resistors described in (d) are placed in parallel. What is the equivalent resistance?

(4) An infinite plane is located in the x-y plane at z=0 and has a uniform surface charge density +σ. A second plane is located (parallel to the first) at z=+d and has a surface charge density -σ.

(4:a) Showing complete details, find the **vector** electric field at z<0 and z>d.

(4:b) Find the **vector** electric field in the region z>0 and z<d.

(4:c) Find the magnitude of the potential difference between the plates.

(4:d) If the plates have an area A and the separation between the plates is d, Find the capacitance.

(4:e) If the plates have an area A and the separation between the plates is d, Find the energy stored in the capacitor.