Instructions: You have a total of 55 minutes to complete this test. Answer each question completely.
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. Correct SI units must be provided for numerical answers where required.

Time Start_____ Time finish _____pledged _____

Constants: $k = 8.987 \times 10^{9} \frac{Nm^2}{C^2} : \varepsilon_0 = 8.854 \times 10^{-12} \frac{C^2}{Nm^2}$

1. 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 uniform charge distribution per unit volume given by $\rho = \rho_0$.

(a) Find the **vector electric field** $\vec{E}$ inside the sphere.

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

(c) Show that the two solutions are the same at the surface of the sphere.

2. An infinitely long wire has a linear charge distribution per unit length give by λ.

(a) Find the **vector electric field** $\vec{E}$ at a distance r from the wire. You should use for the cylindrical coordinate unit vector the symbol $\hat{s}$.

(b) Suppose that the charge distribution is given by: $\lambda = \frac{5\mu C}{m}$. What is the **vector electric field** at a distance of 10 m from the wire?

(c) If a charge $q_p = 7\mu C$ is placed 10 m from the wire, what is the **vector electric force** on the charge?

(3) An infinite plane with normal vectors along the +z and –z direction (i.e. the plane lies in the x-y plane) has a surface charge density given by σ.

(a) Find the **vector electric field** , $\vec{E}$ at a distance +z from the plane.

(b) If $\sigma = 5\frac{\mu C}{m^2}$, find the **vector electric force** on a charge $q = -3\mu C$ which is placed 10 m from the plane.

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

(a) Find the **vector electric field** , $\vec{E}$ at a point y_p along the positive y axis which has coordinates $(0,y_p,0)$.

(b) If a charge q_p is placed at y_p, what is the **vector electric force** on this charge?

(c) Provide a numerical for the electric force for the case a=0.1 m, y_p=1.0m, q_p and q=1μC.