MIDTERM 1

Physics 9C-03 **NAME:**

Feb. 4, 1999 **Social Sec. #:**

General Instructions: This examination is closed book. Only a calculator is allowed. Please show all your work and box your answers. Credit will only be given for *complete* solutions. Answers must have correct units. There are six problems on four pages. Note that not all the problems are worth the same number of points. The constant $k = 9\text{x}10^9 Nm^2/C^2$. The kinetic energy of a point particle is $\frac{1}{2}mv^2$.

[20 points] 1. Consider two infinitely long, concentric cylindrical shells. The inner shell has radius R_1 and carries a uniform surface charge density σ_1 and the outer shell has radius R_2 and carries a uniform surface charge density σ_2.

a. Use Gauss' law to find the electric field in the regions $r < R_1, R_1 < r < R_2$, and $R_2 < r$. Do not just state the answer, but show how it follows from Gauss' law.

b. What should the ratio σ_2/σ_1 be in order to make $E = 0$ for $r > R_2$? What would E be for $R_1 < r < R_2$ in this case?

[20 points] 2. Two positive point charges $+Q$ are on the x axis at $x = +a$ and $x = -a$.

a. Find the potential at any point on the y axis.

b. Use your result from (a) to find the electric field at any point on the y axis.

[20 points] 3. Two particles of charge $Q = 5\,C$ are placed on the x–axis at $x = +4$ meters and $x = -4$ meters. These particles are fixed in position. A third particle of charge $q = 0.2\,C$ and mass $m = 8$ kg is then placed on the y–axis at $y = +3$ meters, and released from rest. Find the velocity of the third particle after a long time has passed.

[20 points] 4. A square conducting slab with 5 meter sides and thickness 0.01 meters carries a net charge of 80 μC.

a. Find the charge density on each face of the slab, and the electric field just outside one face of the slab.

b. The slab is placed to the right of an infinite charged nonconducting plane with charge density 2 $\mu C/m^2$ so that the faces of the slab are parallel to the plane. Find the electric field on each side of the slab far from its edges, and the charge density on each face.

[10 points] 5. Draw reasonable positions for the locations of charges which would give rise to the electric field lines shown below. In each case, indicate if the charges are positive or negative.

[10 points] 6. The figure below shows the potential $V(x)$ due to some point charges located on the x axis.

a. Draw the likely location of the charges, and indicate their signs.

b. Indicate the position where a third charge would be in equilibrium.

c. If the third charge is positive, and is placed at the position marked 'P', in what direction will it move?