NYU Physics 2 — Problem Set 2

Due by Friday 2002 February 8 at 1pm at Irene Port's office in Meyer 424.

Problem 1

A dipole of dipole moment $\vec{p}$ and moment of inertia I lies in a uniform electric field $\vec{E}$. It is at equilibrium when $\vec{p}$ is parallel to $\vec{E}$. If the dipole is displaced (ie, tilted) by a small angle θ away from equilibrium and released, what will be the period of its simple harmonic oscillation?

Problem 2

Imagine a rod with length πR and uniformly distributed charge Q bent into a semi-circle of radius R. What is the direction and magnitude of the electric field $\vec{E}$ at the center of the semi-circle?

Problem 3

A very long (ie, infinite) cylinder of radius a is filled with a constant positive charge density ρ (charge per unit volume). Concentric with this cylinder is a thin (ie, zero thickness) outer uniformly negatively charged cylindrical shell of radius b, with equal and opposite total charge to that contained in the inner cylinder. There are no other charges. Use Gauss's law to determine the magnitude E of the electric field at any perpendicular distance r from the center of the cylinders. Write explicit expressions for E in the three regions $r < a$, $a < r < b$ and $r > b$. Make a plot of $E(r)$, noting the quantitative values of E at $r = 0$, $r = a$, $r = b$, and $r = \infty$. Are there any discontinuities in E? If so, where? What is the surface charge density σ (charge per unit area) on the outer cylindrical shell?