S11 PHY114 Problem Set 3

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1. The electric flux through the surface of a box whose sides are $8.1 \times 11.5 \times 12.2$ cm is $2000 N m^2 C^{-1}$. (a) What is the total electric charge inside the box? (b) Now imagine a sphere of radius 1.3 m that surrounds the box. What is the flux through through this sphere?

2. A long thin wire, hundreds of meters long, carries a uniformly distributed charge of $-8\mu C$ per meter of its length. What is the magnitude and direction of the electric field at a distance of 10.3 m from axis of the wire?

3. A non-conducting sphere of radius R carries a total positive charge q which is distributed uniformly throught its volume. What is the electric field at a distance r from the center when (a) $r < R$ and (b) $r > R$? Plot the magnitude of the electric field as a function of distance when $q = 2\mu C$ and $R = 3m$.

4. A pair of parallel plates carry equal and opposite charge densities and are at a distance d apart. Assume that the charge is distributed uniformly; i.e., the surface charge densities are constant. A particle of mass m and positive charge q is released from rest at the surface of the positively charged plate and strikes the surface of the opposite plate in a time interval t. What is its acceleration? What is the electric field between the plates? What is the magnitude of the electric charge per unit area on the plates? Express your answers in terms of q, m, d, t and constants of nature.

5. Notice the similarity between Coulomb's law and Newton's law of gravitation.(a) State an important difference between the two. (b) What is the analogue of electric field? Find a version of Gauss' Law that applies to gravity. (c) Use it to show that the gravitational field outside a spherical star is the same as if all its mass were concentrated at its center. (d) Would this statement still be true if the star is not spherical?