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3rd HOMEWORK

Due March 17, 2008

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1. Consider a sphere that has a total charg Q. Assume that the charge is uniformly distributed over its volume.

   (a) Calculate the electric field generated by the sphere at each point of space (both inside and outside the sphere)

   (b) Calculate the energy stored in the electric field.

   (c) Calculate the self energy of the sphere by calculating the work that must be done to create the sphere by bringing infinitesmally thin shells from infinity. Is the result that you obtain the same as the result of the previous part?

   (d) Suppose that this sphere is the electron. What should be the radius of the electron such that the total energy stored in the electric field is equal to the rest mass energy given by $E_{restmass} = m_e c^2$?

2. According to the alpha-particle model of the nucleus, some nuclei consist of a regular geometric arrangement of alpha particle. For instance, the nucleus of ^{12}C consistes of three alpha particles arranged on an equilateral triangle. Assuming that the distance between pair of alpha particles is 3.0×10^{-15} m, what is the electric energy (in eV) of this arrangement of alpha particles? Treat the alpha particles as pointlike.

3. Tho thin rods of length ℓ carry equal charges Q uniformly distributed over their lengths. This rods are aligned, and their nearests ends are separated by a distance x. Calculate the mutual electric potential energy. Ignore the self energy of each rod.

4. A spherical shell of inner radius a and outer radius b carries a charge Q uniformly distributed over its volume. What is the electric energy of this charge distribution?

5. Your head is approximately a conducting sphere of radius 10 cm. What is the capacitance of your head? What will be the charge on your head if, by means of an electrostatic machine, you raise you head (and your body) to a potential of $100,000$ V?

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6. A parallel plate capacitor of plate area A and spacing d is filled with two parallel slabs of dielectric of equal thickness with dielectric constants κ_1 and κ_2, respectively. What is the capacitance?

7. A parallel plate capacitor of plate area A and separation d contains a slab of dielectric of thickness $d/2$ and dielectric constant κ. The potential difference between the plates is ΔV.

   (a) In terms of the given quantities, find the electric field in the empty region of space between the plates.

   (b) Find the electric field inside the dielectric.

   (c) Find the density of bound charge on the surface of the dielectric.