Physics 321, Autumn Quarter 2015
Electrodynamics: Homework Assignment 2

Turn in all problems and clearly note all constants and assumptions you use. (1-point penalty each otherwise)

Due 9:30 am Thursday October 15

1. Suppose you're interested in the question of the relative strengths of gravitational and electrostatic forces. You calculate the gravitational force on a proton at the surface of the Sun. How many electrons placed at the center of the Sun yield the same electrostatic force on the proton?

2. Suppose you yank an electron from the surface of the initially-neutral Sun and send it off to infinity. What's the total (gravitational plus electrostatic) escape kinetic energy for this process? Hint: extracting the electron yields a charge imbalance. Ignore binding energies.

3. Recall the Cavendish spheres from the first lecture. In the late 1800's Cavendish took two initially-neutral, isolated, concentric conducting spherical shells. He then connected the two by a thin conducting wire and charged the system. He then removed the wire, grounded the outer shell, and tested the inner shell for charge. From these studies, he concluded that an electrostatic inverse-force law of the form $\frac{1}{r^{2+\varepsilon}}$ had $|\varepsilon| < 10^{-3}$.

a. Suppose $\varepsilon = 0$. How much charge remains on the inner shell?
b. Why did Cavendish ground the outer shell? Hint: The only instrument at his disposal was a two-leaf electrometer.
c. Challenge problem. Suppose the inner sphere is the size of a baseball, the outer the size of a basketball, and the system was charged to 10,000 volts. Estimate the residual charge on the inner

sphere assuming the extreme allowed value $\varepsilon = 10^{-3}$. Hint: How much excess charge is needed to satisfy Gauss's Law?

4. Consider a spherical surface of radius *a* and a point charge *q* located outside the shell a distance *r* from the center of the surface. What's the average potential over the surface? Hint: you might ponder the related problem of a uniform charge Q on the shell and the resulting potential at the point outside the shell.

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