PHYS 4392
Fall 2014
TE Coan
Due: 19 Sep '14 6:00 pm

Homework 3

1. Show that the electric potential V of two infinitely long parallel lines of charge of opposite polarity is

$$V(r_-, r_+) = (\frac{\lambda}{2\pi\epsilon_0}) \ln (r_-/r_+),$$

where λ is the magnitude of the linear charge density, r_- is the perpendicular distance from the point considered to the line of negative charge and r_+ is the corresponding distance to the line of positive charge. If you get an answer that is infinite or of the form $0/0$, try another method.

2. Find the potential $V(z)$ a perpendicular distance z above the center of a uniformly charged circular ring of radius R. Let the linear charge density of the ring be λ.

3. Consider two identical very large area parallel plates initially separated by a distance d small compared to their width or length. The plates are oppositely charged, each with a uniform charge density of magnitude σ. Suppose further that each plate has a uniform mass per unit area of η. After being charged, the plates are released. How long T does it take for the plates to strike one another? As always, box your answer.

4. For real parallel plate capacitors that have plates of finite area, the electric field between the two plates at the plate edges **cannot** be as shown in the figure. (The field must extend out beyond the edges.) The electric field at the edges has a different shape from the field at points far from the edges. You are told this in introductory physics when we say "consider the electric field between the plates and ignore edge effects." Succinctly explain why the electric field at the *edges* of the plates cannot be as shown in the figure. No essays or novels are desired nor needed, just crisp succinct prose with correct grammar and maybe an equation or two.

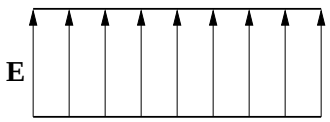

Figure 1: The electric field at the plate *edges* cannot be as shown. Why?

5. A cup in the form of an upright hollow hemisphere of radius R carries a uniform surface charge density σ. See the figure. Let A be the point in the center of the circle formed by the top rim of the cup and let B be the very bottom of the cup. Find the potential difference $V_B - V_A$ between points B and A.

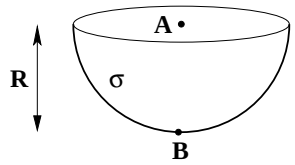

Figure 2: Hemispherical cup with uniform surface charge density σ.

6. Consider two electrons a distance 1 meter apart. Calculate the ratio F_E/F_G of the magnitude of the gravitational force to the coulombic force between them. Evidently, gravity is a very weak force compared to the electric force. Think about why it is then that we don't seem to directly experience electric forces between electric charges. On a daily basis we just seem to be aware of gravity. (No need to write anything, just think about this last question.)