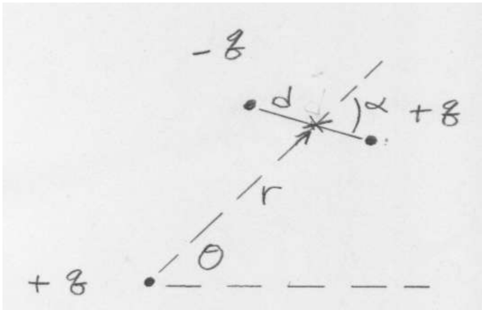
Physics 513, Autumn Quarter 2017 Electrodynamics: Homework Assignment 2 Due October 12 either 11:00am in class or 10:45am in the instructor's mailbox.

1. (Classic problem.) Consider a plane geometry. (NB., the Green's Functions for non-planar geometries are discussed in Jackson chapter 3.)
a. What is the Green's Function for this geometry? Use cylindrical coordinates with the plane containing the origin, *z* the distance above the plane, and ρ the cylindrical radial coordinate.
b. With this Green's Function, what's the corresponding induced charge on the plane?
c. Suppose the plane has potential $\Phi_S = \frac{Q_0}{2\pi\epsilon_0} \frac{\left(\rho^2+z_0^2\right)^{3/2}}{z_0^3} \frac{1}{\rho} e^{-\rho/z_0}$,
where q_0 and z_0 are constants. Using the Green's Function from (a), find the potential at position (ρ=0, $z=z_0$).

2. (Classic problem.) Two equal charges *q* are separated by a distance *d*. A grounded conducting sphere of radius *R* (with $R \ll d$) is located at the center of this system on the axis between the two charges. What is the sphere radius that just cancels the Coulomb force between the two charges?

3. (Classic problem. Jackson problem and elsewhere, but try to do it first without looking at the solution.) Two equal and opposite charges +*q* and -*q* are separated by a fixed distance *d*. In addition, each charge is accompanied by a mass *m*. The center-of-mass of this system orbits under the influence of electrostatic forces around another fixed charge +*q*, and the two orbiting charges always move in the orbit plane. The distance between the two orbiting charges *d* is much smaller than the orbit distance. This is not a radiation problem. You should use coordinates (r, θ, α) shown:



a. What is the equation of motion of this system? (This can be derived with Lagrangian methods, where the potential energy is electrostatic and the kinetic energy is mechanical; the solution found on the web directly integrating Coulomb's Law looks wrong to me.)

b. Suppose the charge-pair executes a circular orbit around the fixed charge. What's the small-amplitude oscillation frequency of the two co-orbiting charges about each other?

4. (Classic problem.) A conducting hemisphere of radius R is placed, flat side down, on an infinite conducting plane. A point charge q is located above the hemisphere a distance z_0 above the plane. What is the force on the charge?

5. In class we talked about the conventions underlying the common form of Maxwell's Equations. Suppose there were magnetic charge with a magnetic Coulomb's Law $\nabla \cdot B = \mu_0 \rho_m$ with ρ_m the magnetic charge density.
a. What is the magnetic field produced by a magnetic charge q_m?
b. With the magnetic charge fixed in place, what is the equation of motion for an electric charge q_e in the vicinity of q_m?
c. Is the kinetic energy of the electric-charged particle conserved?
d. Subtle point: An combined electric field and magnetic field carry intrinsic angular momentum density (see Jackson 6.159). What, therefore, is another conserved quantity in this motion?

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