

Electrodynamics I: Assignment 2

Due no later than October 19 at 4:00 pm
Pacific time.

On-line submission procedure:

1. Scan your solutions as a single PDF file
2. Name your file **HW2-*lastname*.pdf**
3. Attach your file to an email...
4. ... with subject line **HW2-*lastname* ...**
5. ... and send the email to
ljrosenberg@phys.washington.edu

1. (Green's reciprocity theorem for discrete charges) Consider a set of point charges $\{q_i\}$ with potentials at the positions of those charges $\{\Phi_i\}$ (where a potential Φ_i at the position of charge q_i doesn't include the potential due to charge q_i). If you replace these charges with a different set of charges $\{q'_i\}$ at the same positions, giving rise to new potentials $\{\Phi'_i\}$ at the same positions, show that $\sum_i \Phi_i q'_i = \sum_i \Phi'_i q_i$.

2. (Classic but contrived problem.) Consider a plane geometry.

- a. What's the Dirichlet 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 with its unit charge, what's the corresponding induced charge on the plane?
- c. Suppose as a boundary value problem the plane has potential

$$\Phi_s = \frac{Q_0}{2\pi\epsilon_0} \frac{(\rho^2 + z_0^2)^{3/2}}{z_0^3} \frac{1}{\rho} e^{-\rho/z_0},$$
 where Q_0 and z_0 are constants. Using the Green's Function from (a), find the potential at position ($\rho=0$, $z=z_0$).

3. (Image charge 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's the approximate sphere radius that just cancels the Coulomb force between the two charges?

4. (Image charge 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?