

Prelim: Electromagnetism
Fall 2014

Saturday September 13th 2014
Choose 2 out of the 3 problems.

Problem 1: (20 points)

An infinite conducting plane is featureless except for a small hemispherical bulge of radius a . A charge q is placed above the bulge at a distance p from the plane (or $p - a$ from the top of the bulge). The plane (and bulge) are held at a potential $V = 0$.

- First consider just the hemispherical bulge. What is the magnitude and location of an image charge that would make $V = 0$ on the bulge (or a sphere of the same radius)?
- Now introduce two more image charges that will cancel out the potential due to the original charge and the image charge from (a) to make the potential $V = 0$ on the plane. Show that the potential on the bulge is still zero.
- What is the magnitude and sign of the force on the original charge?

Problem 2: (20 points)

- The intensity of dipole radiation is given by $J = \alpha d^2 p / dt^2$ where α is a constant and p is the time dependent dipole moment. Find the intensity of radiation of a particle of mass m and charge e moving in a circular orbit of radius a under Coulomb forces. Express the answer in terms of the particle's energy.
- In contrast, consider a flywheel of radius R with a charge q spread uniformly on its rim, rotating at a constant angular velocity ω . What is the intensity of radiation?

Problem 3: (20 points)

A plane monochromatic wave of light (wavelength λ) is normally incident on a perfectly reflecting mirror. A glass photographic plate is placed so that it forms a small angle α with respect to the plane of the mirror. The photographic emulsion is almost transparent and light passes through, reflects off the mirror and interferes with the incoming light at the plate giving rise to a series of alternating dark and bright bands when the plate is developed. Assume the light is polarized perpendicular to the plane of incidence.

- What is the spacing of the bands and their location measured from the mirror-plate junction?
- If the light is now incident at 45° what happens to the band spacing?

