# Physics 511: Electrodynamics

Spring 2018

Midterm Exam #1

March 5, 2018

Instructions:

- Do any 1 of the first 2 problems and the remaining problem. All problems carry equal weight.

- This is a closed-book closed-note exam.

- You may use personal notes that fit on a doubles-sided $A4$ paper.

1- A pair of equal point charges q are located symmetrically with respect to the center of a spherical cavity of radius a at a distance a from each other. The cavity is inside a spherical conductor of radius b that is placed in free space. Find the electric potential in all regions.
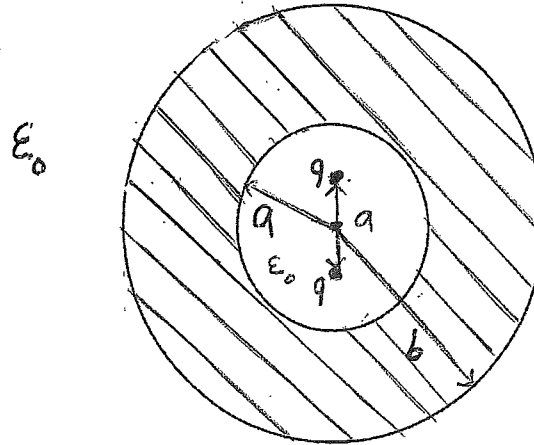
2- A conducting spherical shell of inner and outer radii a and b is placed in a uniform external electric field $\vec{E}_0$. The space at $r < a$ is filled with dielectric material of permittivity ϵ, and a point charge q is located at its center.

(a) Determine the electric potential in all regions.

(b) Find the surface density of free and bound charges on the interfaces at at $r = a$ and $r = b$.
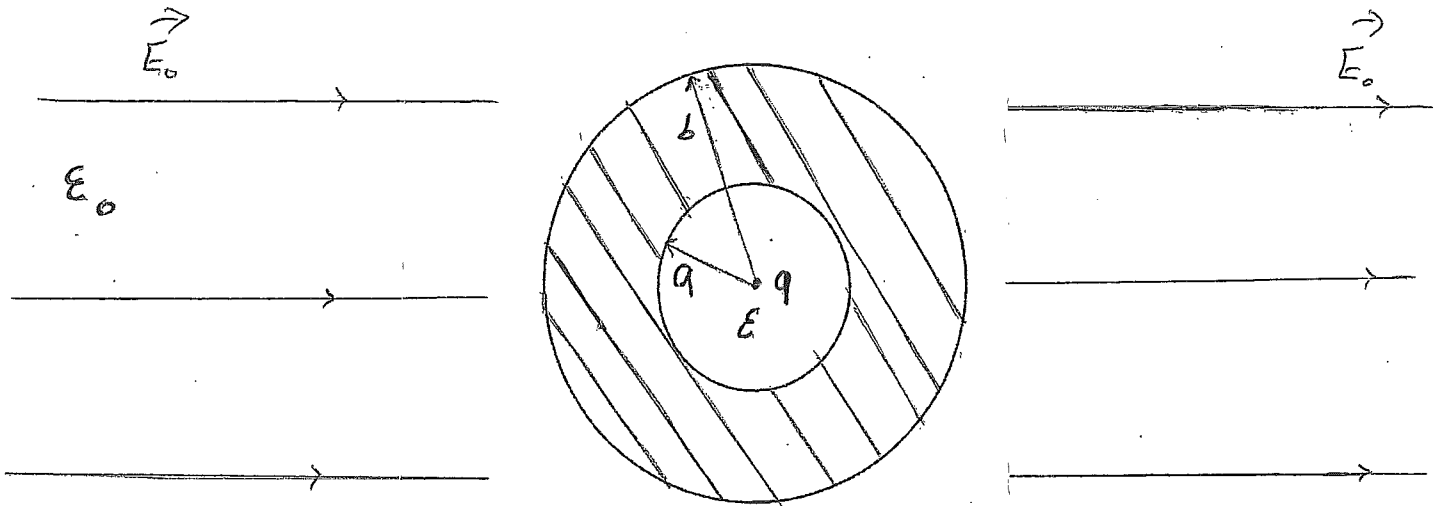
3- A circular loop of radius a carrying a current I_a is placed parallel to another loop of radius b carrying a current I_b. The loops are co-axial but the smaller loop is centerd at a height h below the larger one. The currents flow in the same direction in both loops. Conswider the limiting case when $a \ll b, \ h$.

(a) What is the force expeienced by the smaller loop?

(b) How does the force change when the direction of the current in (1) one of the loops is reversed; (ii) both loops is reversed?

(Hint: In the limit $a \ll b, \ h$ the smaller loop may be considered as a magnetic dipole.)