

Spring 2013 Physics preliminary exam

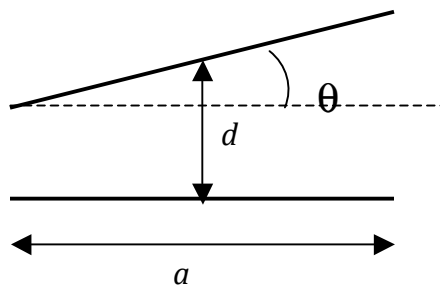
Feb 27th 2013

Attempt 2 questions out of 3

Question 1.

Calculate the capacitance of the following two devices:

- Two coaxial conducting thin cylindrical shells of radii a and b ($a < b$), have a length $L \gg a, b$. The region between the shells is filled with a dielectric material of dielectric constant κ . (10 pts)
- Two rectangular conducting strips of width a and length b are held as shown making a small angle θ with each other. The separation between the plates at the center is d . (10pts)



Question 2.

A point charge e is situated at a distance d away from the center of a conducting sphere of radius R ($>d$) that is grounded.

- a. Find the electric potential and electric field everywhere. (10pts)

- b. Determine the surface charge density that is induced on the sphere. (6pts)

- c. What is the total charge induced? (4pts)

Question 3.

A particle P of mass M and magnetic dipole moment m is placed on the axis of a circular current loop of radius a and current I (kept fixed) at a distance z_0 from the center of the loop. m is aligned in the direction of the loop field.

- (a) Find an expression for the force of attraction between the particle and the loop. (10pts)
- (b) What happens if the particle is placed at the center of the loop and displaced slightly out of the plane of the loop? Derive an equation governing the subsequent motion. (10pts)

