Home Assignment 4

Electrostatic Potential

Due on Crowdmark as per Syllabus' schedule. Total points: **100**. Total points: **100**.

HA submission instructions:

- Please, submit the answer to each question starting on a separate page.
- Write as clearly and legibly as you can.
- Use a black pen to ensure good contrast.
- Avoid using a flash when taking a picture, which should be taken in good light.
- Use only one side of the paper, to ensure there is no bleeding through from the other side.
- The solutions can be handwritten or typeset.

HA 4.1 The electrostatic potential V of a hollow sphere with finite thickness. [40 points]

Consider a hollow sphere with inner radius R_1 and outer radius R_2. In the region between R_1 and R_2 consider a charge distribution with volume density $\rho = \rho_0 R_2/r$ (cf. Fig. HA4.1).

1) Calculate $\vec{E}$ by means of Gauss' theorem at any point in space (no need to show any symmetry argument). [10 points]

2) Calculate V at any point in space from $\vec{E}$ found in 1). Hint: Start from outside the sphere and use regular condition at infinity for V. [30 points]

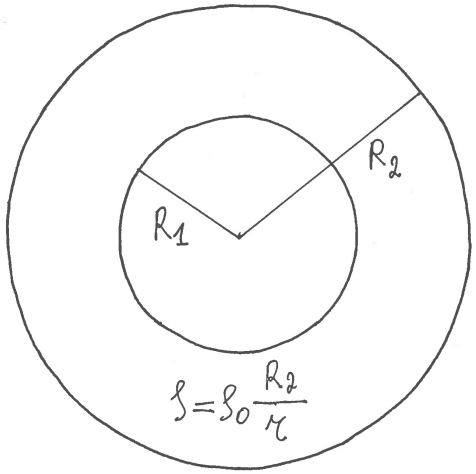

Figure HA4.1

HA 4.2 Work of a continuous charge distribution. [20 points]

Consider an infinite plane uniformly charged with constant surface density σ and a finite line of length L uniformly charged with charge q. The line is parallel to the plane at a distance d from it (cf. Fig. HA4.2).

The line is then rotated by an angle $\pi/2$ counter-clockwise, as indicated in the figure. Calculate the work of the field forces to move the line.

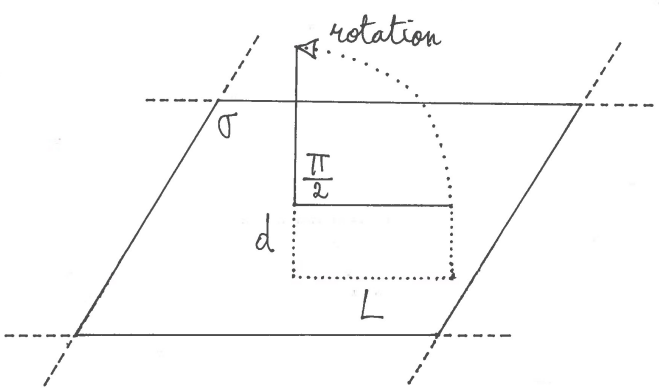

Figure HA4.2

HA 4.3 Potential difference for charged coaxial cylinders. [40 points]

Consider two infinite concentric hollow cylinders. The internal cylinder has radius R_1 and the external R_2. Assume the internal cylinder is uniformly charged with negative surface density (constant) $-\sigma$ and the external with $+\tilde{\sigma}$ (cf. Fig. HA4.3). Assume the overall structure to be neutral.

1) Calculate the field $\vec{E}$ at any point in space by means of Gauss' theorem (the symmetry arguments are the same as for an infinite straight line; show them). [5 points]

2) Calculate the potential difference between the outer and inner cylinder. [35 points]

Show all calculations.

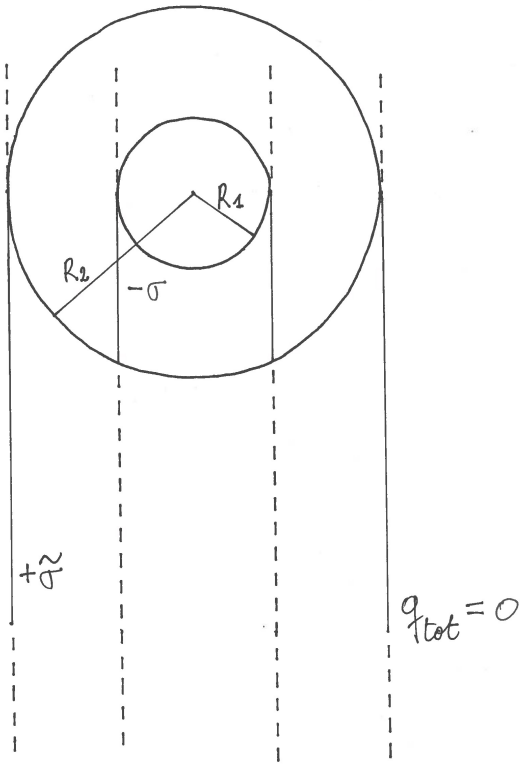

Figure HA4.3