Bilkent University - Physics Department
Phys-112 Electricity & Magnetism

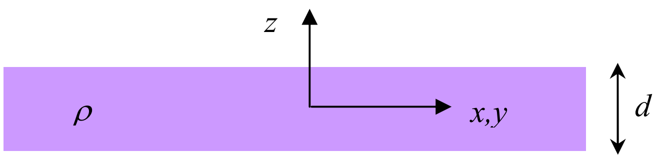
MIDTERM-I

Duration: 90 minutes 8 March 2007

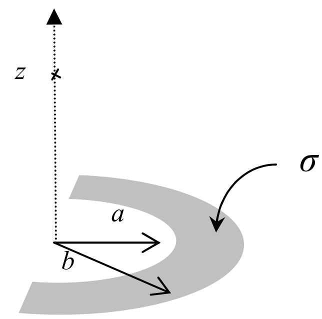
1] (25 pts)
The Earth has a net charge and it can be considered as a spherical conductor. The resulting electric field near the surface is measured to have an average value about 150 V/m, directed towards the center of the Earth. **a)** What is the corresponding surface charge density? **b)** To how many electrons does the total surface charge correspond to? **c)** Outside the atmosphere, there is no electrostatic field. How can you explain this fact? ε_0=8.85·10^{-12} F/m, R_{Earth}=6.4·10^{6} m, e=-1.6· 10^{-19} C.

2] (25 pts)
Three charges each of $+q$ with an equilateral triangular arrangement with sides L are placed concentric with a spherical conducting shell of inner radius a, outer radius b. **a)** Sketch the electric field lines everywhere, **b)** Determine $V(a)$ and $V(b)$ with the potential reference chosen at infinity.

3] (25 pts)
Determine the electric field vector everywhere for a uniformly charged slab of volume charge density ρ which is infinite along the x-y plane and has a thickness d along the z-axis.



4] (25 pts)
A half annular region between $b>r>a$ contains a uniform charge distribution of surface charge density σ.
Determine,
a) the electric potential along the z-axis (see figure), choosing the reference potential at infinity,
b) from the electric potential obtain the z-component of the electric field vector along the z-axis.



Information:

$$\vec{E}(x,y,z) = -\hat{i}\frac{\partial V(x,y,z)}{\partial x} - \hat{j}\frac{\partial V(x,y,z)}{\partial y} - \hat{k}\frac{\partial V(x,y,z)}{\partial z},$$

At a conductor-vacuum interface: $E_n = \frac{\sigma}{\varepsilon_0}$.