Tutorial 2

Chater 2: Electric Force and Electric Field

Exercice 1:

You have been given an infinitely long uniformly charged thick pipe. The pipe is a non-conductor. That is, the charge does not move. The inner radius of the pipe is a, and the outer radius is 2a. The amount of charge per length of the pipe is λ. Find the electric field vector for locations inside, within, and outside the uniformly charged pipe. i.e. find E for

1. $r \geq 2a$
2. $a \leq r \leq 2a$
3. $r \leq a$

where r is the radial distance from the axis.

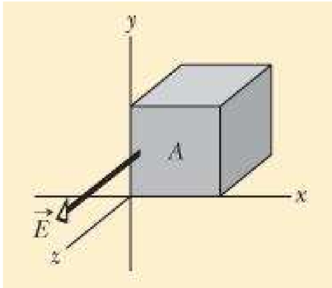
Exercice 2:

Consider two infinite planes of charge. Each of the planes are infinitely thin and are parallel to each other. The planes are separated by a distance a as shown in the figure. The plane on the left has a surface charge density of $+\sigma_0$. The plane on the right has a surface charge density of $-2\sigma_0$. Find an expression for the electric field in all regions of space.

Exercice 3:

The figure here shows a Gaussian cube of face area A immersed in a uniform electric field that points in the +z direction. In terms of E and A, what is the flux through

1. the front face (which is in the xy plane),
2. the rear face,



3. the top face, and
4. the whole cube?

Exercice 4:

Consider a Gaussian cylinder of radius R. The electric field $\vec{E}$ is uniform and in the direction of the cylinder axis. We will find the net flux Φ through the cylinder.

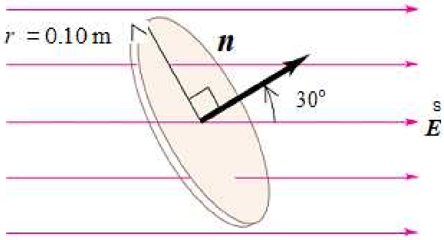
1. Is the cylinder a physical object or is it imaginary?
2. Find the flux through the left end. **Hints:** What is $\vec{E} \cdot d\vec{A}$ on this end? Can E come out of the integral $\int \vec{E} \cdot d\vec{A}$
3. Find the ?ux through the right end.

Exercice 5:

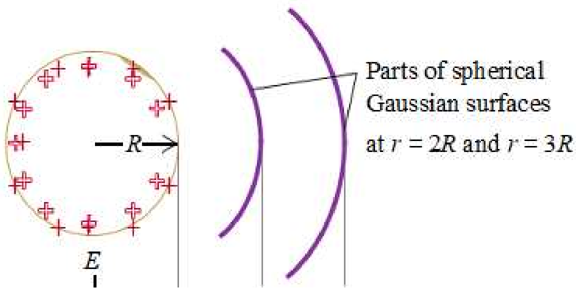
A disk of radius 0.10 m is oriented with its normal unit vector $\hat{n}$ n at 30ř to a uniform electric field $\vec{E}$ of magnitude 2.0×10^3 N/C (see figure). Since this isn't a closed surface, it has no "inside" or "outside".

Note: *That's why we have to specify the direction of $\hat{n}$ n in the figure.*

1. What is the electric flux through the disk?
2. What is the flux through the disk if it is turned so that $\hat{n}$ is perpendicular to $\vec{E}$?
3. What is the flux through the disk if $\hat{n}$ is parallel to $\vec{E}$?



Exercice 6:



We place a total positive charge q on a solid conducting sphere with radius R (see figure). Find $\vec{E}$ at any point inside or outside the sphere.

Note: *Outside the sphere, the field is the same as if all of the charge were concentrated at the center of the sphere.*

Exercice 7:

Positive electric charge Q is distributed uniformly throughout the volume of an insulating sphere with radius R. Find the magnitude of the electric field at a point P a distance r from the center of the sphere and plot the graph of E versus r.