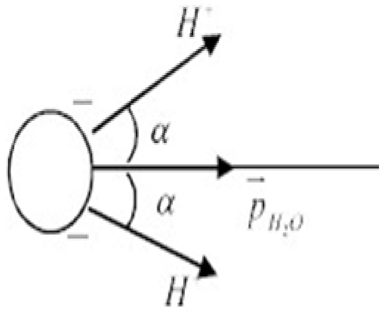
Physics 2

Tutorial N°3

Exercise 1 : Electric dipôle

The water molecule is made up of two H^+ ions and one O^{-2} ion, arranged so that the angle formed between the two OH bonds is equal to 104°



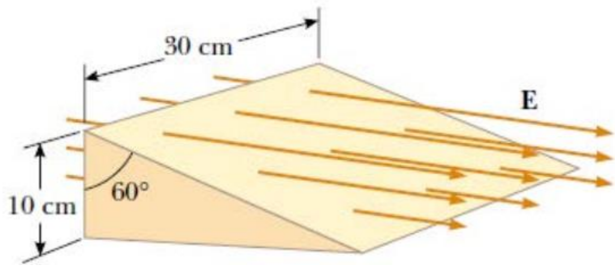
1. calculate the value of the dipole moment $\vec{P}$, knowing that the distance between O^{-2} and the two H^+ ions are both equal to d=1A°
2. Place $\vec{P}$ at point O parallel to axis OX. Determine the direction and nature of the force exerted by $\vec{P}$ on a charge q placed in M at a distance r from point O on axis OX
3. In place of the charge q, we place another dipole of moment $\vec{p}_0$ oriented along $\overrightarrow{OM}$ .What is the potential energy of $\vec{p}_0$ in the field $\vec{E}$(M) created in M by the molecule?

Exercise 2: Electric Flux

Consider a closed triangular box resting within a horizontal electric field of magnitude E=7.80x10^4 (N/C) as shown in.

Calculate the electric flux through

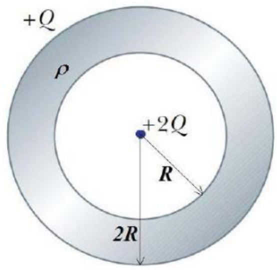
a) The vertical rectangular surface,
b) The slanted surface
c) The entire surface of the box.



Exercise3:

There is a +2Q point charge at the centre of an empty insulating sphere which carriers +Q total charge and has charge density ρ
Find the electric fields in terms of k, Q, r, and R for

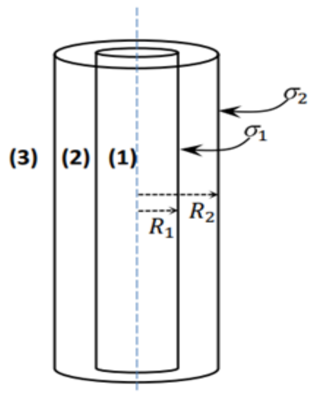
1. r<2R region
2. R<r<2R region
3. r>2R region



Exercise4:

Let two coaxial conducting cylinders 1 and 2, of radius R_1 and R_2 and length L , loaded with surface densities σ_1 and σ_2, respectively .

1. Using Gauss's theorem, find the expression of electrostatic field, away from the two extremes of the cylinders and in each of the regions (1), (2) and (3), knowing that σ_1 et σ_2 are two positive constants
2. Give the expression of the electrostatic potential in zone (3).



Exercise 5:

A solid, non-conducting sphere of radius a has a charge of +2Q distributed uniformly throughout its volume. A conducting shell with an inner radius of b and an outer radius of c is located concentrically around the solid sphere, and has a net charge of –Q. Express all answers in terms of the given values and fundamental constants.

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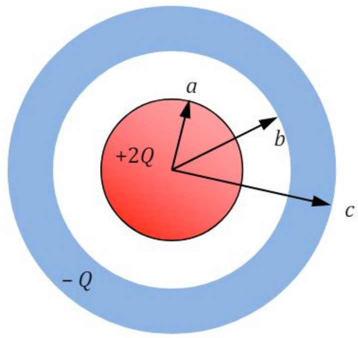
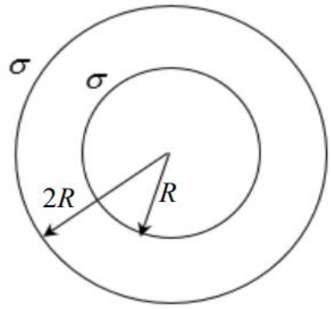
1. Use Gauss's Law to determine the magnitude and direction of the electric field E at a point located r away from the center of the spheres, where:
   a. r > c
   b. b > r >a.
2. Identify the total amount of charge induced on the inner surface of the conducting shell, at radius b.
3. Identify the total amount of charge induced on the outer surface of the conducting shell, at radius c.
4. Use Gauss's Law to determine the magnitude and direction of the electric field E as a function of r, where r < a
5. Sketch a graph of electric field E as a function of radius r, from r = 0 to 2c, with radius a, b, and c clearly identified



Exercise6:

Consider a sphere of radius R, center O, containing a surface distribution of charges whose
density σ is constant. This sphere is surrounded by other sphere of radius $2R$, with the same center as the first one and also carrying the same distribution (σ) as the first.
The position of a point M in space is identified by its distance r from the center O of the sphere.

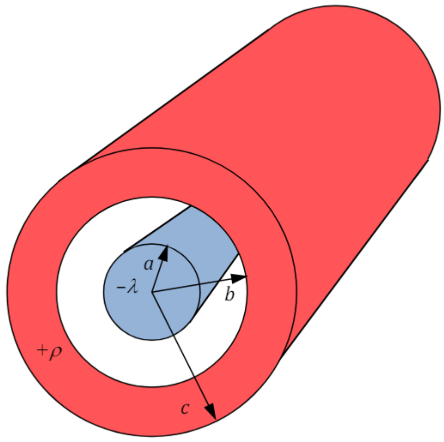
1. Determine the induced charge on each of the two spheres.
2. Using Gauss's theorem, determine the electric field at any point M in space.



Exercise7:

An infinitely long cylindrical conductor has a radius a and a linear charge density of $-\lambda$ as shown above. The conductor is surrounded by a cylindrical shell made of a nonconducting material of inner radius b, outer radius c, and with a constant volume charge density of $\rho>0$. The conductor and nonconductor are located concentrically about a common axis.

1. Determine the net electric flux per unit length passing through a cylindrically symmetric Gaussian surface located just outside the surface of the conductor.
2. Use Gauss's Law to determine the magnitude of the electric field E as a function of radius r, where:
   i. r < a
   ii. a < r < b
   iii. r > c



Exercise 8:

Consider two concentric spheres with the same center O and respective radii R_1 and $R_2 = \sqrt{2.5}\, R_1$, carrying charges such that :- The inner sphere (O, R_1) carries a volume charge density $\rho = 15/4R_1\ C/m^3$.- The outer sphere (O, R_2) carries a surface charge density σ = - 0.5 C/m^2.

1- Determine the total charges carried by each sphere.

2- Using Gauss's theorem, find the electric field at any point in space point in space ($0 < r < \infty$). Destinguish the regions:($0 < r \le R_1$), ($R_1 < r \le R_2$), ($r \ge R_2$).