Faculty of sciences and technology (University of Khenchela)
Physics 2 (Electricity)

1 ST
2024/2025

Final Exam (1h, 30')

Exercise N° 01: (6pts)

Three identical point charges: $q_A = q_B = q_C = +4\mu C$, are placed respectively on three points on *(Oxy)* plan; *A(-2,0); B(0,-1)* and *C (3,0)*, with length unit is the centimeter.

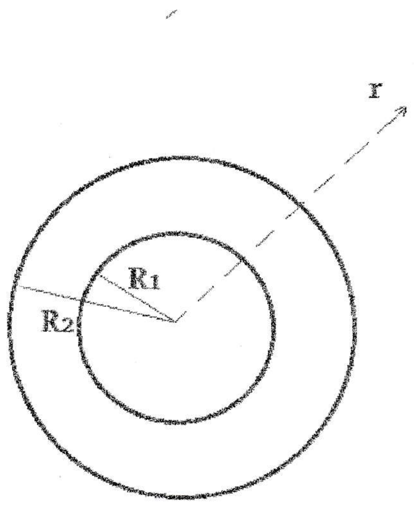
1- Calculate and represent the electric field vector at the origin O.

2- Calculate the electric potential in the origin.

We give: $K = \frac{1}{4\pi\varepsilon_0} = 9.10^9 Nm^2/C^2$

Exercise N° 02: (6pts)

Consider two charges $Q_1 = -Q$ and $Q_2 = 3Q$ $(Q > 0)$ distributed uniformly on surface of two concentric spheres with radius are $R_1 = R$ and $R_2 = 2R$.



1- Give the relationships between the charge densities (σ_1, σ_2) and Q and R.

2- Using Gauss's law; calculate the electric field as a function of (r, Q, and ε_0) at a distance "r" from the center of the spheres.

3- Knowing that $V(R_1) = -V_0$ and $V(R_2) = V_0$, calculate the electric potential at the distance "r".

Exercise N° 03: (3pts)

Consider a parallel plate capacitor formed by two conductor plates of area $A = 2cm$ separated by a dielectric of permittivity $\varepsilon = 5.10^{-9}$ F/cm and thickness of 20 µm.

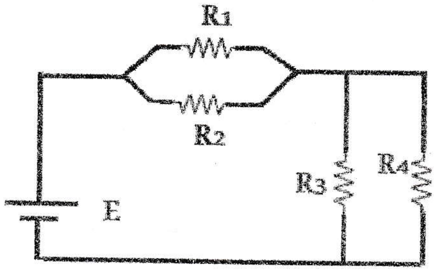
1- Calculate its capacitance.

2- If we make this capacitor into a cylindrical shape of radius $R_1 = 3,18$ *mm* and $R_2 = 3,20$ *mm* and height $h = 1cm$, what will its capacitance?

3- Compare the two values.

Exercise N° 04: (5pts)

Consider the opposite circuit.



1- Calculate the equivalent resistance.

2- Using current divisor; calculate and represent the currents flowing through each branch.

Numerical application: $E = 10V$, $R_1 = 10\Omega$, $R_2 = 15\Omega$, $R_3 = 15\Omega$, $R_4 = 30\Omega$.

Good luck

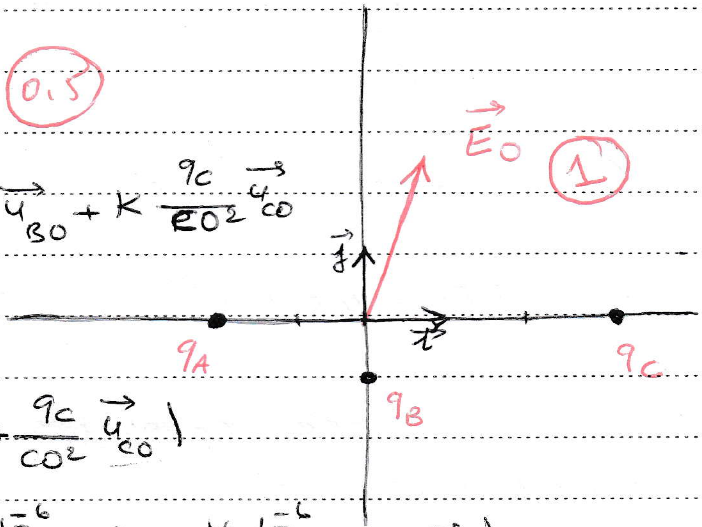
Correction of the F.E

1ST — Physics 2 (2025) — Final Exam

Exercise N° 01 (06 pts)

$$\boxed{\vec{E}_0 = \vec{E}_{AO} + \vec{E}_{BO} + \vec{E}_{CO}}$$ 0.5

$$\vec{E}_0 = \underbrace{K\frac{q_A}{AO^2}\vec{u}_{AO}}_{1} + K\frac{q_B}{BO^2}\vec{u}_{BO} + K\frac{q_C}{CO^2}\vec{u}_{CO}$$



$$\vec{E}_0 = K\left(\frac{q_A}{AO^2}\vec{u}_{AO} + \frac{q_B}{BO^2}\vec{u}_{BO} + \frac{q_C}{CO^2}\vec{u}_{CO}\right)$$

$$\vec{E}_0 = 9.10^9\left(\frac{4\times10^{-6}}{(2.10^{-2})^2}\vec{i} + \frac{4.10^{-6}}{(1.10^{-2})^2}\vec{j} + \frac{4.10^{-6}}{(3.10^{-2})^2}(-\vec{i})\right)$$

$$\vec{E}_0 = 9.10^9.4.10^{-6}.10^4\left(\frac{1}{4}\vec{i} - \frac{1}{9}\vec{i} + \vec{j}\right)$$

$$\boxed{\vec{E}_0 = 36.10^7(0{,}14\vec{i} + \vec{j})} \quad \text{or} \quad \boxed{\vec{E}_0 = 5.10^7\vec{i} + 36.10^7\vec{j}}$$ 1

$$\boxed{V_0 = V_{AO} + V_{BO} + V_{CO}}$$ 0.5

$$V_0 = \underbrace{K\frac{q_A}{AO}}_{1} + K\frac{q_B}{BO} + K\frac{q_C}{CO}$$

$$V_0 = 9.10^9\left(\frac{4.10^{-6}}{2.10^{-2}} + \frac{4.10^{-6}}{1.10^{-2}} + \frac{4.10^{-6}}{3.10^{-2}}\right)$$

$$\boxed{V_0 = 66.10^5\ V}$$ 1

Exercise N°02:

1) We have $\boxed{Q_1 = \sigma_1 . S_1} = \sigma_1 4\pi R_1^2$ 0,5

and $Q_2 = \sigma_2 . S_2 = \sigma_2 4\pi R_2^2$

$Q_1 = -Q = 4\pi R^2 \sigma_1 \Rightarrow \boxed{\sigma_1 = \frac{-Q}{4\pi R^2}}$ 0,5

$Q_2 = 3Q = 4\pi (2R)^2 \sigma_2 \Rightarrow \boxed{\sigma_2 = \frac{3Q}{16\pi R^2}}$ 0,5

2) We have Three cases for $\boxed{(r < R_1 ; R_1 < r < R_2 ; r > R_2)}$ 0,5

Gauss's law $\boxed{\oiint \vec{E} . \vec{ds} = \frac{\sum Q_{ins}}{\varepsilon_0}}$ 0,5

For $r < R_1$

$\oiint \vec{E} . \vec{ds} = E . S_G = E . \underline{(4\pi r^2)}$ 0,5

$Q_{ins} = 0 \Rightarrow \boxed{E = 0}$ 0,5

$V = -\int \vec{E} . \vec{dr} = C_1$ 0,5

$\boxed{V = \text{constant}}$

For $R_1 < r < R_2$

$Q_{ins} = Q_1 = -Q$

$E . 4\pi r^2 = \frac{-Q}{\varepsilon_0} \Rightarrow \boxed{E = \frac{-Q}{4\pi \varepsilon_0 r^2}}$ 0,5

$V = -\int \vec{E} . \vec{dr} = -\int \frac{-Q}{4\pi\varepsilon_0} \frac{1}{r^2} dr$

$\boxed{V = -\frac{Q}{4\pi\varepsilon_0} \frac{1}{r} + C_2}$ 0,5

For $r > 2R$

$$Q_{ins} = 3Q - Q = 2Q$$

$$E . 4\pi r^2 = \frac{2Q}{\varepsilon_0} \Rightarrow \boxed{E = \frac{2Q}{4\pi\varepsilon_0 r^2}}$$ 0,5

$$\boxed{V = \frac{2Q}{4\pi\varepsilon_0 r} + C_3}$$ 0,5

Exercise N°03

For a parallel plate capacitor we have

$$\boxed{C = \frac{\varepsilon S}{d} = \frac{\varepsilon A}{d}}$$ 0,5

$$\boxed{C = 5.10^{-9} \frac{2}{20.10^{-4}} = 0.5.10^{-5}\ F = 5.10^{-6}\ F}$$ 0,5

$$\boxed{C = 5\ \mu F}$$

For a cylindrical capacitor we have

$$\boxed{C = 2\pi\varepsilon \frac{h}{\ln\frac{R_2}{R_1}}}$$ 0,5

$$\boxed{C = 2.3,14.5.10^{-9} \frac{1}{\ln\frac{3,20}{3,18}} = 5,0082.10^{-6}\ F}$$ 0,5

$$\left.\begin{array}{l} C(\text{Plate}) \simeq C(\text{Cylinder}) \\ 02 \quad C(\text{Cylinder}) > C(\text{Plate}) \end{array}\right\} 1$$

Exercise N° 04

(1)

$$R_{eq} = (R_1 // R_2) + (R_3 // R_4)$$

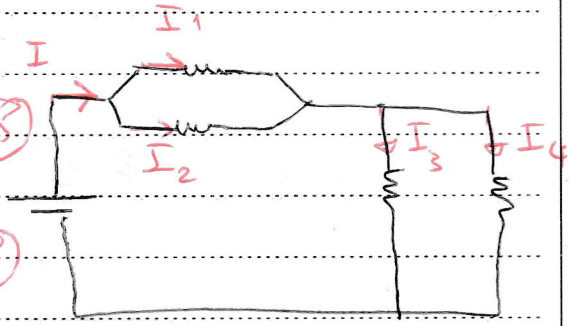
$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} + \frac{R_3 \cdot R_4}{R_3 + R_4}$$

$$\boxed{R_{eq} = 16\ \Omega}$$ 1

$$I_{tot} = \frac{E}{R_{eq}} = \frac{10}{16} = \boxed{0{,}625\ A}$$ 1

0,5

$$\boxed{I_1 = \frac{R_2}{R_1 + R_2} I} = \boxed{0{,}375\ A}$$ 0,5



0,5

$$I_2 = \frac{R_1}{R_1 + R_2} I = \boxed{0{,}250\ A}$$ 0,5

$$I_3 = \frac{R_4}{R_3 + R_4} I = \boxed{0{,}416\ A}$$ 0,5

$$I_4 = \frac{R_3}{R_3 + R_4} I = \boxed{0{,}208\ A}$$ 0,5