Mohamed Boudiaf University of Msila.
Faculty of sciences
Field : Sciences of matter (SM)
1st year LMD Semester 02.

جامعـة محمد بوضياف -المسيلـة
كليـة العلـوم
ميدان : علوم المادة
السنة الأولى ل م د - السداسي 02

Physics 02: Electricity and magnetism

University Year 2023-2024

Evaluation exam of physics 02

First Name	Last Name	Gr		Note

Exercise 1

Tick (✓) the correct answer (3 pts)

1- Like charges:

a- repel. ☐ ✓

b- attract each other. ☐

2- Outer electrons in conductors are:

a- weakly bound to the nuclei. ☐ ✓

b- tightly bound to the nuclei. ☐

3- Electric force is:

a- $F = k\frac{|q_1.q_2|}{r}$ ☐

b- $F = k\frac{|q_1.q_2|}{r^2}$ ☐ ✓

c- $F = k\frac{|q_1.q_2|}{\sqrt{r}}$ ☐

4-Gauss's theorem is :

a- $\emptyset = \oint_S \vec{E}.d\vec{S} = \frac{q_{enclosed}}{\varepsilon_0}$ ☐ ✓

b- $\emptyset = \oint_L \vec{E}.d\vec{L} = \frac{q_{enclosed}}{\varepsilon_0}$ ☐

c- $\emptyset = \oint_S \vec{E}.d\vec{S} = \frac{q_{Outer}}{\varepsilon_0}$ ☐

5- The electric field is zero:

a - inside the conductor. ☐ ✓

b- outside a charged conductor. ☐

c- just outside a charged conductor. ☐

6- Any net charge on an isolated conductor reside:

a- on its surface. ☐ ✓

b- inside the conductor (volume distribution). ☐

c- on its center. ☐

7- Charge *Q* on the capacitor depends:

a- on the applied difference of potential *V*. ☐

b- on geometry and size of capacitor. ☐

c- material between plates. ☐

d- all these factors. ☐ ✓

8- **When *n* capacitors are associated in series, the equivalent capacitance is:**

a- lower than the capacitance of each one of the associated capacitors. ☐ ✓

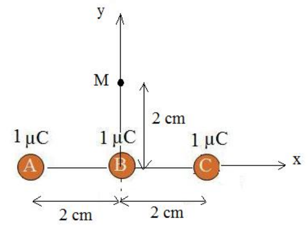
b- greater than the capacitance of each one of the associated capacitors. ☐

EXERCISE 02

A(-a,0), B(0,0)

C(a,0), M(0,a)

a= 2 cm



1- The electric field at the point M.

$$\vec{E}(M) = \vec{E_A}(M) + \vec{E_B}(M) + \vec{E_C}(M)$$

$$\vec{E_A}(M) = k\frac{q}{AM^3}\vec{AM}$$

$$\vec{E_B}(D) = k\frac{q}{BM^3}\vec{BM}$$

$$\vec{E_C}(D) = k\frac{q}{CM^3}\vec{CM}$$

$$\vec{AM} = a\,\vec{i} + a\vec{j},\quad \vec{BM} = a\,\vec{j}\quad,\vec{CM} = -a\vec{i} + a\vec{j}$$

$$AM = CM = a\sqrt{2},\qquad BM = a$$

$$\vec{E_A}(M) = k\frac{q}{(a\sqrt{2})^3}(a\,\vec{i} + a\vec{j}) = k\frac{q}{(2\sqrt{2})a^2}(\vec{i} + \vec{j})$$

$$\vec{E_B}(M) = k\frac{q}{a^3}(a\,\vec{j}) = k\frac{q}{a^2}(\vec{j})$$

$$\vec{E_C}(M) = k\frac{q}{(a\sqrt{2})^3}(-a\,\vec{i} + a\vec{j})$$

$$= k\frac{q}{(2\sqrt{2})a^2}(-\vec{i} + \vec{j})$$

$$\vec{E}(M) = \vec{E_A}(M) + \vec{E_B}(M) + \vec{E_C}(M)$$

$$\vec{E}(M) = k\frac{q}{a^2}\left[\frac{1}{2\sqrt{2}}(\vec{i} + \vec{j} - \vec{i} + \vec{j}) + (\vec{j})\right]$$

$$\vec{E}(M) = k\frac{q}{a^2}\left[\frac{1}{\sqrt{2}} + 1\right]\vec{j}$$

$$\vec{E}(M) = 9\times10^9\frac{10^{-6}}{(2\times10^{-2})^2}\left[\frac{1}{\sqrt{2}} + 1\right]\vec{j}$$

$$\vec{E}(D) = 3.84\times10^7\,\vec{j}$$

$$E(M) = 3.84\times10^7 N/C$$

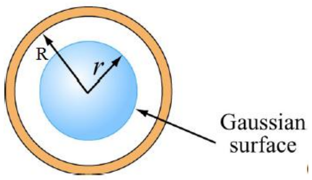
EXERCISE 03

1- Determination of the electric field

From Gauss's law:

$$\emptyset = \oiint \vec{E}.d\vec{S} = \frac{Q_{enclosed}}{\varepsilon_0}$$

$$E \times S_G = \frac{Q_{enclosed}}{\varepsilon_0}$$



$S_G = 4\pi r^2$

$$\Rightarrow \boldsymbol{E \times 4\pi r^2 = \frac{Q_{enclosed}}{\varepsilon_0}}$$

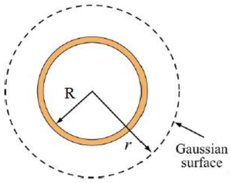
Case 1: r < R

$$\emptyset = \oiint \vec{E}.d\vec{S} = \frac{Q_{enclosed}}{\varepsilon_0} = 0$$

$$\Rightarrow E \times 4\pi r^2 = \frac{q}{\varepsilon_0} = 0 \Rightarrow \boldsymbol{E_1 = 0}$$

Case 2: r> R

$$\emptyset = \oiint \vec{E}.d\vec{S} = \frac{Q_{enclosed}}{\varepsilon_0}$$

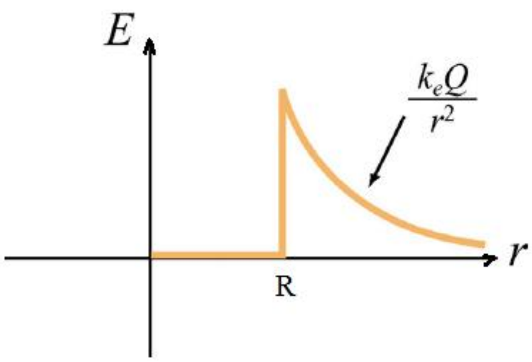


$$\Rightarrow E_2 \times S_G = \frac{Q_{enclosed}}{\varepsilon_0} \Rightarrow E_2 \times 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$\Rightarrow \boldsymbol{E_2 = \frac{Q}{4\pi\varepsilon_0}\frac{1}{r^2} = kQ\frac{1}{r^2}}$$

$$\boldsymbol{Q = \sigma 4\pi R^2 \Rightarrow E_2 = \frac{\sigma 4\pi R^2}{4\pi\varepsilon_0}\frac{1}{r^2}}$$

$$\Rightarrow \boldsymbol{E_2 = \frac{\sigma R^2}{\varepsilon_0}\frac{1}{r^2}}$$



2- Determination of the potential

$$\vec{E} = -\overrightarrow{\text{grad}}\, V$$

Case 2: r > R

$$E_2 = \frac{\sigma R^2}{\varepsilon_0}\frac{1}{r^2} \Rightarrow E_2 = -\frac{\partial V_2}{\partial r} \Rightarrow dV_2 = -E_2 dr \Rightarrow dV_2 = -\frac{\sigma R^2}{\varepsilon_0}\frac{1}{r^2}\, dr$$

$$\Rightarrow V_2 = \frac{\sigma R^2}{\varepsilon_0}\frac{1}{r} + C_2$$

$$V_2(\infty) = 0 \Rightarrow C_2 = 0 \ \Rightarrow V_2 = \frac{\sigma R^2}{\varepsilon_0}\frac{1}{r}$$

Case 1: r < R

$$dV_1 = -E_1 dr \Rightarrow dV_1 = -0\, dr = 0$$

$$\Rightarrow V_1 = C_1$$

we have: $V_2(R) = V_1(R)$

$$\Rightarrow V_2 = \frac{\sigma R^2}{\varepsilon_0}\frac{1}{R} = C_1$$

$$\Rightarrow C_1 = \frac{\sigma R}{\varepsilon_0} \Rightarrow V_1 = \frac{\sigma R}{\varepsilon_0}$$