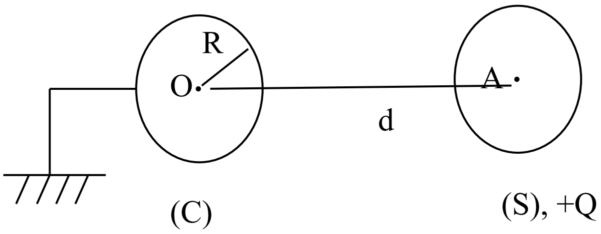
**University of Tlemcen**
**Faculty of Sciences**
**Department of Mathematics**

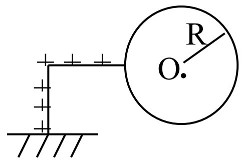
**A.Y: 2025/2026**
**1st year LMD-M and MI**

# Correction of SW N° 03
# Conductors and capacitors

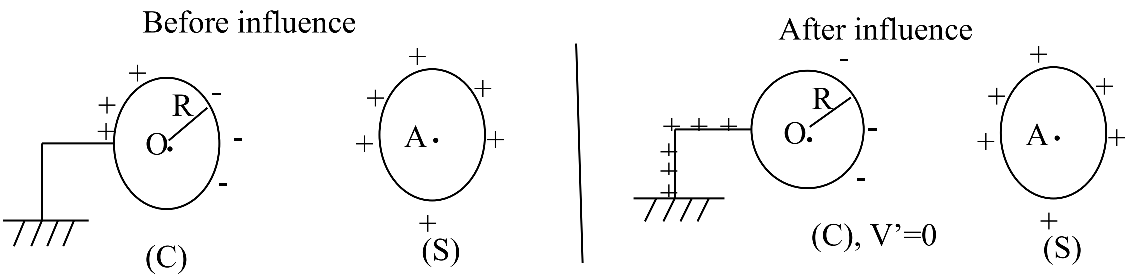
## Exercise 1




Before influence,




Neglecting the influence of (C) on (S), let's find the charge q of (C).
Remember that when the conductor is connected to the ground, positive charges flow towards the ground and the potential V=0.




After the influence, positive charges flow to ground and the conductor (C) will have a negative charge and zero potential. ***$V_C$'=0***

$V'_C = V_C + V_{S/C} = 0$

with $V_C$: is the potential of (C) before influence and VS/C: is the potential of (C) after influence of (S) on (C).

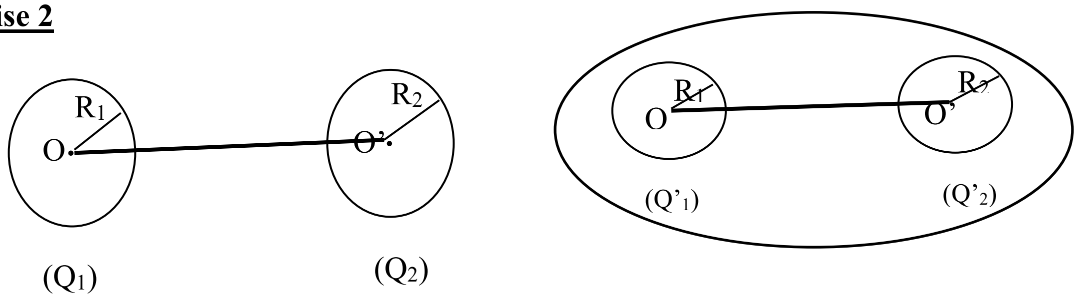
$\boldsymbol{V_C = \frac{kq_C}{R}}$

$\boldsymbol{V_{S/C} = \frac{kQ_S}{d}}$ **with ($Q_S$=+Q)**

So $\boldsymbol{V'_C = \frac{kq_C}{R} + \frac{kQ}{d} = 0}$

$\Rightarrow q_C = -\frac{QR}{d}$ with d= OA

## Exercise 2




Let's find Q1'and Q2' after influence:

By connecting the two conductors with a wire ; a single conductor is created with Q'1 and Q'2 are the charges of the two conductors.

**After influence** when this conductor is in electrostatic equilibrium:

- The potential is constant: $V'_1 = V'_2 \Rightarrow \frac{kQ'_1}{R_1} = \frac{kQ'_2}{R_2}$ $\quad So\ \frac{Q'_1}{R_1} = \frac{Q'_2}{R_2}$

- The total charge in the formed conductor is the sum of the charges of the two conductors, since the charge carried by the wire is neglected.

$Q'_1+Q'_2=Q_1+Q_2$

$$\begin{cases} \frac{Q'_1}{R_1} = \frac{Q'_2}{R_2} \\ Q'_1 + Q'_2 = Q_1 + Q_2 \end{cases} \Rightarrow \begin{cases} \frac{Q'_1}{2} = \frac{Q'_2}{3} \\ Q'_1 + Q'_2 = 25 \end{cases}$$

$$\Rightarrow \begin{cases} Q'_1 = 2\frac{Q'_2}{3} \\ 2\frac{Q'_2}{3} + Q'_2 = 25 \end{cases} \quad \text{so } Q'_2 = 15\mu C = Q_2 \text{ et } Q'_1 = 10\mu C = Q_1$$

The charges on the two conductors have not changed, so there has been no charge displacement, as the two conductors are far apart and the charge on the wire is negligible.

## Exercise 3

1- equivalent capacity

$C_1$ and $C_2$ in *paralelle*

$C_{12}=C_1+C_2=1+2=3\ \mu F$

$1/Ceq = 1/C_{12} + 1/C_3 + 1/C_4 = 1/3+1/3+1/3=1$

so $Ceq=1\ \mu F$

The charge on each capacitor

We have $Q_{eq}= Q_{12} = Q_3 = Q_4 = C_{eq}\,.\,U= 12.1=12\ \mu C$

so $Q_3 = Q_4=12\ \mu C$

we have also $C_1$ and $C_2$ in *paralelle* so $U_{12}=U_1=U_2 \Rightarrow Q_{12} / C_{12} = Q_1/ C_1 = Q_2/ C_2$

$Q_{eq}= Q_{12} =12\mu C \quad \Rightarrow U_{12} = Q_{12}/ C_{12} =12.\ 10^{-6}/ 3.10^{-6} =4\ V$

so $\quad Q_1 /C_1 =4V \ \Rightarrow Q_1=4.C_1=4\mu C$

In the same way $Q_2 /C_2 =4 \quad \Rightarrow Q_2=4.C_2=8\mu C$

2- Potential difference across each capacitor (direct method)

$U_1=U_2=U_{12}=Q1 /C_1=4V$ and $U_3=Q_3 /C_3=4V$ then $U_4=Q_4 /C_4=4V$

3- Energy stored in the capacitor $C_2$

$Ec_2 =(1/2)\ Q_2.U_2 =(1/2)\ .\ 8.\ 4 \ \Rightarrow \ Ec_1=16\ \mu j$

**Exercise 4**

1) The capacity of the two capacitors in parallel, $C_{23} = C_2 + C_3 = 6$ mF
and the capacity of the entire circuit:

$$\frac{1}{C_{ab}} = \frac{1}{C_1} + \frac{1}{C_{23}}$$

$$C_{eq} = 2{,}0 \; m\,F$$

2) The charge on the first capacitor is the same as the charge on the whole combination, because it's the only thing to which the left wire is connected. This charge can be found from the capacity.

$$Q_{eq} = Q_1 = C_{eq}.V_{eq} = 12 \; m\,C$$

There is a charge Q 1 on the opposite side of the first capacitor, which must also come from the next capacitors as they are equal to each other. Therefore,

$$Q_2 = Q_3 = (1/2)\, Q_1.$$

$$Q_1 = 12 \; m\,C,\; Q_2 = Q_3 = 6{,}0 \; m\,C$$

2) We have $V_i = Q_i / C_i$. hence $V_1 = (Q_1/C_1) = 4{,}0\; V$

*And* $V_2 = V_3 = (Q_2/C_2) = 2{,}0\; V$

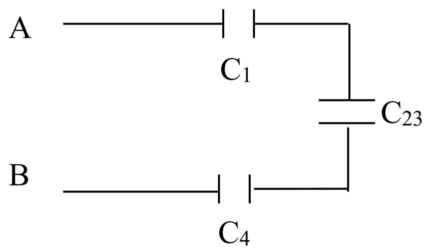
4) the capacity is:

$$C = \frac{Q}{V} = \frac{Q}{Ed}$$ so $C = 2.0\; 10^{-2}\; F$

5) Energie is :

$E_p = \frac{1}{2} C U^2 = \frac{1}{2}.QU$ so $E_p = 18\; 10^{-9}\; J$

**Supplementary exercise 1:**




A 1- Equivalent capacity

$$C_{23} = C_2 + C_3 = 10 + 4 = 14\;\mu F$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_{23}} + \frac{1}{C_4} = \frac{1}{2} + \frac{1}{14} + \frac{1}{7} = \frac{10}{14} \Rightarrow C_{eq} = 1{,}4\mu F$$

2- Charges carried by capacitors

**In a series connection: $Q_{AB} = Q_{C1} = Q_{C23} = Q_{C4}$ avec $Q_{AB} = C_{eq}\, U_{AB}$ $U_{AB} = U_{C1} + U_{C23} + U_{C4}$**

$Q_{eq} = C_{eq} U \Rightarrow Q_{eq} = 1{,}4x12 = 16{,}8\mu C$ $U = U_{AB} = 12$ volt

$$Q_{eq} = Q_{C_1} = Q_{C_4} = Q_{C_{23}} = 16{,}8\mu C$$

And $\boldsymbol{U_{23}} = \boldsymbol{U_2} = \boldsymbol{U_3} \Rightarrow \frac{Q_{C_{23}}}{C_{23}} = \frac{Q_{C_2}}{C_2} = \frac{Q_{C_3}}{C_3}$

$\Rightarrow Q_{C_2} = \frac{Q_{C_{23}} x\, C_2}{C_{23}} = \frac{16,8x10}{14} = 12\mu C$ and $Q_{C_3} = \frac{Q_{C_{23}} x\, C_3}{C_{23}} = \frac{16,8x4}{14} = 4,8\mu C$

1- Capacitors voltage

$U_1 = \frac{Q_{C_1}}{C_1} = \frac{16,8}{2} = 8,4Volt$ and $U_4 = \frac{Q_{C_4}}{C_4} = \frac{16,8}{7} = 2,4Volt$
and $U_3 = U_2 = 12 - 8,4 - 2,4 = 1,2Volt$

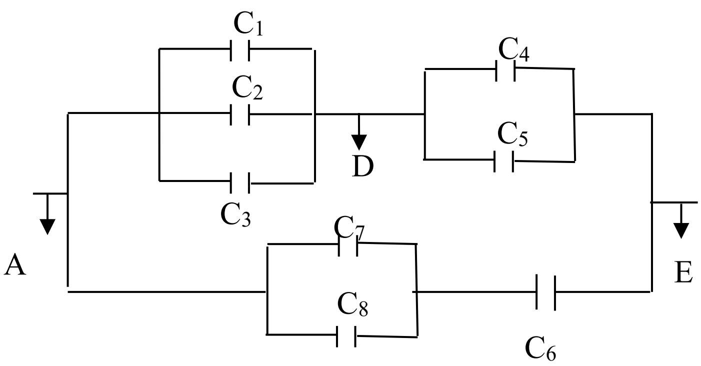
B. The capacity of capacitor
$V = \int Edl = E\int_A^B dl = Ed$

$C = \frac{Q}{V} = \frac{Q}{Ed}$ so $C = \frac{30x10^{-3}}{100x0,015}$ =20. $10^{-3}$ $F$

C. The energie is :

$E_p = \frac{1}{2}CU^2 = \frac{1}{2}.QU$ so $E_p$=18 $10^{-9}$ $J$

**<u>Supplimentary exercise 2:</u>**




1. $Q_{C1} = C_1U_{AD} \Rightarrow U_{AD} = \frac{Q_{C1}}{C_1} = \frac{10}{4}$
$\Rightarrow U_{AD} = 2.5\, Volt$

2. $Q_{C2} = C_2U_{AD} = 3.5x2.5 = 8.75\mu c$
$Q_{C3} = C_3U_{AD} = 2.5x2.5 = 6.25\mu c$

3. $U_{BD} = 2\, Volt$
$Q_{C4} = C_4U_{BD} = 5x2 = 10\mu C$

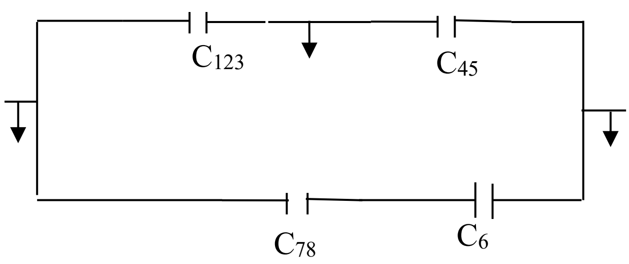
and $Q_{C5} = C_5U_{BD} = 5x2 = 10\mu C$

4. Let's calculate $C_{eq}$ :

$C_{123}=C_1+C_2+C_3=4+3,5+2,5=10\mu F$

$C_{45}=C_4+C_5=5+5=10\mu F$

$C_{78}=C_7+C_8=5+5=10\mu F$




$\frac{1}{C_{eq1}} = \frac{1}{C_{123}} + \frac{1}{C_{45}} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} \Rightarrow C_{eq1} = 5\mu F$

$$\frac{1}{C_{eq2}} = \frac{1}{C_{78}} + \frac{1}{C_6} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} \Rightarrow C_{eq2} = 5\mu F$$

$C_{eq}=C_{eq1}+C_{eq2}=5+5=10\ \mu F$

5. Energy stored in the capacitor $C_1$ :
$E_{C1} = \frac{1}{2}C_1U_{AD}^2 = \frac{1}{2}4\,(2,5)^2 = 12,5\mu j$