Physique 2
Corrigé de TD N° 3 – 2022 / 2023

Phys 2, Corrigé type TD n° 3.

EXERCICE 1

$\iint_{S_1} \vec{E}\cdot\vec{n}\,dS_1 = \frac{1}{\varepsilon_0}\sum Q_{int}$

$E \times 4\pi r^2 = \frac{1}{\varepsilon_0} Q$

$E = \frac{Q}{4\pi\varepsilon_0 r^2}$, $dV = -E\,dr$

$V = -\int E\,dr + Cte \Rightarrow V = \frac{Q}{4\pi\varepsilon_0 r} + cte$

$V(\infty) = 0 \Rightarrow Cte = 0 \Rightarrow V = \frac{Q}{4\pi\varepsilon r}$

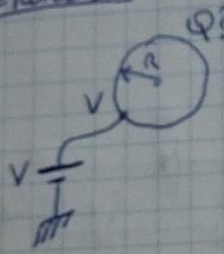
$V = V(r=R) \Rightarrow \boxed{V = \frac{Q}{4\pi\varepsilon R}}$

$C = \frac{Q}{V} \Rightarrow \boxed{C = 4\pi\varepsilon_0 R}$

$dQ = \sigma\,dS \Rightarrow Q = \sigma . S \Rightarrow \sigma = \frac{Q}{S}$

$\boxed{\sigma = \frac{Q}{4\pi R^2}}$

EXERCICE 2

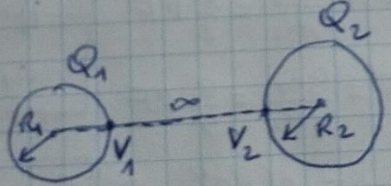


$V = \frac{Q}{4\pi\varepsilon R}$

$\Rightarrow \boxed{Q = 4\pi\varepsilon_0 R V}$

EXERCICE 3

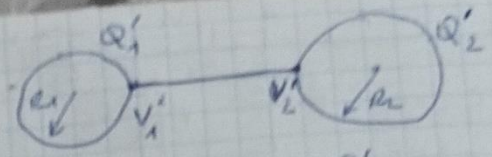
1°)



$V_1 = \frac{Q_1}{4\pi\varepsilon_0 R_1}$, $V_2 = \frac{Q_2}{4\pi\varepsilon_0 R_2}$

initialement, pas d'influence entre les deux sphères.

2°)



$V'_1 = \frac{Q'_1}{4\pi\varepsilon_0 R_1}$, $V'_2 = \frac{Q'_2}{4\pi\varepsilon_0 R_2}$

$V'_1 = V'_2 \Rightarrow \frac{Q'_1}{R_1} = \frac{Q'_2}{R_2}$

d'autre part, la loi de C.D.L.C.

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

Ces deux dernières éq. nous donnent :

$\boxed{Q'_1 = \frac{R_1}{R_1+R_2}(Q_1+Q_2)}$ $\boxed{Q'_2 = \frac{R_2}{R_1+R_2}(Q_1+Q_2)}$

et les potentiels :

$\boxed{V'_1 = V'_2 = \frac{K}{R_1+R_2}(Q_1+Q_2)}$, $K = \frac{1}{4\pi\varepsilon_0}$

3°) $C = \frac{Q}{V}$, $Q = Q_1 + Q_2$

$V = V'_1 = V'_2$

On obtient : $\boxed{C = \frac{R_1+R_2}{K}}$

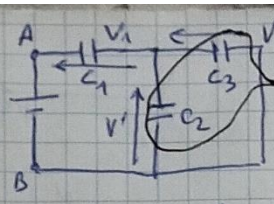
EXERCICE 4

a) $C_{AB} = 5\,MF$

b) $C_{AB} = 30\,MF$

c) $C_{AB} = 2.5\,MF$

EXERCICE 5



$C_1 = C_2 = 1\,MF$

$C_3 = 2\,MF$

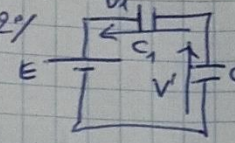
$E = 4V$

1°/ Calcul de C_{AB} : $C' = C_2 + C_3$

$C' = 3\,MF$

$$C_{AB} = \frac{C_1 C'}{C_1 + C'} = \boxed{\frac{3}{4}\,MF}$$

2°/



C_1 et C' sont en série alors $Q_1 = Q'$

$V'_2 = V_2$

$$E = V_1 + V' = \frac{Q_1}{C_1} + \frac{Q'}{C'}$$

$$Q_1 = \frac{C_1 C'}{C_1 + C'} E = C_{AB} E \Rightarrow \boxed{Q'_1 = 3\,MC}$$

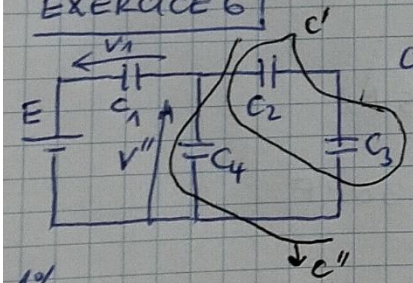
$$V_1 = \frac{Q_1}{C_1} \Rightarrow \boxed{V_1 = 3V}$$

$$V_2 = V_3 = V' = E - V_1 \Rightarrow \boxed{V_2 = V_3 = 1V}$$

$$Q_2 = C_2 V_2 \Rightarrow \boxed{Q_2 = 1\,MC}$$

$$Q_3 = C_3 V_3 \Rightarrow \boxed{Q_3 = 2\,MC}$$

EXERCICE 6



$C_1 = 3\,MC$, $C_2 = C_4 = 1\,MF$

$C_3 = 2\,MF$

$E = 14V$.

1°/

$$C' = \frac{C_2 C_3}{C_2 + C_3} = \frac{2}{3}\,MF$$

$$C'' = C_4 + C' = \frac{5}{3}\,MF$$

$$C_{AB} = \frac{C_1 C''}{C_1 + C''} \Rightarrow \boxed{C_{AB} = \frac{15}{14}\,MF}$$

2°/ $E = V_1 + V''$, $V'' = V_4 = V_2 + V_3$

C_1 et C'' en série $\Rightarrow Q_1 = Q''$

$$E = \frac{Q_1}{C_1} + \frac{Q''}{C''} = Q_1 \left(\frac{C_1 + C''}{C_1 C''}\right)$$

$$Q_1 = \frac{C_1 C''}{C_1 + C''} E = C_{AB} E \Rightarrow \boxed{Q_1 = 15\,MC}$$

d'où $V_1 = \frac{Q_1}{C_1} \Rightarrow \boxed{V_1 = 5V}$

$V_4 = V'' = E - V_1 \Rightarrow \boxed{V_4 = 9V}$

$Q_4 = C_4 V_4 \Rightarrow \boxed{Q_4 = 9\,MC}$

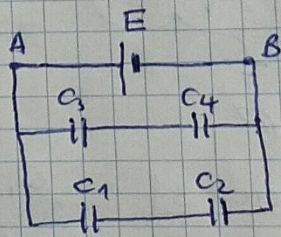
$V_4 = V_2 + V_3 = \frac{Q_2}{C_2} + \frac{Q_3}{C_3}$ $(Q_2 = Q_3)$

$\Rightarrow Q_2 = \frac{C_2 C_3}{C_2 + C_3} V_4 = C' V_4 \Rightarrow \boxed{Q_2 = 6\,MC}$

$V_2 = \frac{Q_2}{C_2} \Rightarrow \boxed{V_2 = 6V}$ $\boxed{Q_3 = Q_2 = 6\,MC}$

$V_3 = \frac{Q_3}{C_3} \Rightarrow \boxed{V_3 = 3V}$

EXERCICE 7



$C_1 = C_2 = 1\,MF$

$C_3 = 2\,MF$

$C_4 = 3\,MF$

$E = 5V$

$$C' = \frac{C_1 C_2}{C_1 + C_2} = \frac{1}{2}\,MF$$

$$C'' = \frac{C_3 C_4}{C_3 + C_4} = \frac{6}{5}\,MF$$

1°/ $C_{AB} = C' + C'' \Rightarrow \boxed{C_{AB} = \frac{17}{10}\,MF}$

$Q_1 = Q_2$ et $Q_3 = Q_4$

$E = V_1 + V_2 = V_3 + V_4$

$$\frac{Q_1}{C_1} + \frac{Q_2}{C_2} = \frac{Q_3}{C_3} + \frac{Q_4}{C_4}$$

.../...

Suite de l'exo. 7

$E = Q_1\left(\frac{1}{C_1} + \frac{1}{C_2}\right) \Rightarrow Q_1 = C' E$

$\boxed{Q_1 = 2.5\ mC} \Rightarrow V_1 = \frac{Q_1}{C_1}$

$\boxed{V_1 = 2.5\ V}$ $\boxed{Q_2 = 2.5\ mC}$

$\boxed{V_2 = 2.5\ V}$

$E = Q_3\left(\frac{1}{C_3} + \frac{1}{C_4}\right) \Rightarrow Q_3 = C'' E$

$\boxed{Q_3 = 6\ mC} \Rightarrow V_3 = \frac{Q_3}{C_3}$

$\boxed{V_3 = 3\ V}$ $\boxed{Q_4 = 6\ mC}$

$V_4 = \frac{Q_4}{C_4} \Rightarrow \boxed{V_4 = 2\ V}$