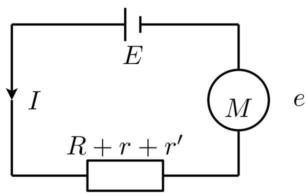
USTHB, ST, Sections 1 à 15 Corrigé Épreuve Finale de Physique 2 Année 2013/2014

Exercice 1

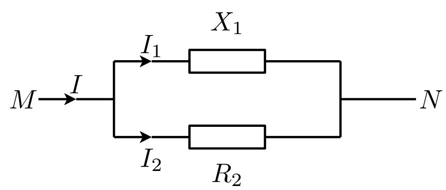
I) 1) Schéma équivalent :



Loi des mailles :$-E_1 + (R + r + r')I + e = 0$ **(0,5)**,

$I = \frac{E_1 - e}{r + r' + R} = 1\,\text{A}$ **(0,5)+(0,25)**, $V_M - V_N = RI = 30\,\text{V}$ **(0,25)**.

2) $R_2 = X_2 + \frac{X_2}{2} = \frac{3}{2}X_2$ **(0,5)** (figure ci-dessous). $I_2 = I - I_1 = 0,25\,\text{A}$. **(0,25)+(0,25)**



$V_M - V_N = X_1 I_1$ **(0,25)**, A.N. $X_1 = \frac{RI}{I_1} = 40\,\Omega$ **(0,25)**.

De même $V_M - V_N = \frac{3}{2}X_2 I_2$ **(0,25)**, $X_2 = \frac{2RI}{3I_2} = 80\,\Omega$ **(0,25)**

II) 1) Le courant est nul dans chaque branche, d'où $E_1 = \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$ **(0,5)**.

A.N. $Q_1 = 80\,\mu\text{C}$ **(0,25)** $Q_2 = 240\,\mu\text{C}$. **(0,25)**

2) $W_C = \frac{1}{2}\frac{Q_1^2}{C_1} + \frac{1}{2}\frac{Q_2^2}{C_2} = 12,8\,\text{mJ}$, **(0,5)+(0,25)**

3) $W_E = E_1(Q_1 + Q_2) = 25,6\,\text{mJ}$ **(0,5)+(0,25)**, $W_J = W_E - W_C = 12,8\,\text{mJ}$. **(0,5)+(0,25)**

III) 1) $P = eI_0 + (R + r')I_0^2$ **(01)**

2) $157,5 = 20I_0 + 40I_0^2$, **(0.25)**. Solution : $I_0 = 1.75\,\text{A}$ **(01)**. et $I_0 = -2.25\,\text{A}$ (non physique) **(0.25)**.

$E_2 = \frac{P}{I_0} = 90\,\text{V}$. **(0,5)+(0,25)**

Exercice 2

1) $\vec{E}_M = K\frac{q_1}{(r+\frac{a}{2})^2}\vec{i} + K\frac{q_2}{(r-\frac{a}{2})^2}\vec{i} = K\left[\frac{q_1}{(r+\frac{a}{2})^2} + \frac{q_2}{(r-\frac{a}{2})^2}\right]\vec{i}$ **(0,5)** $\quad \vec{E}_M = K\frac{q}{a^2}\vec{i}$ **(0,5)**

2) Conservation de l'énergie totale car la force électrique dérive d'un potentiel : $E_c(\frac{a}{2}) + E_p(\frac{a}{2}) = E_c(\frac{3a}{2}) + E_p(\frac{3a}{2})$ **(0,5)**

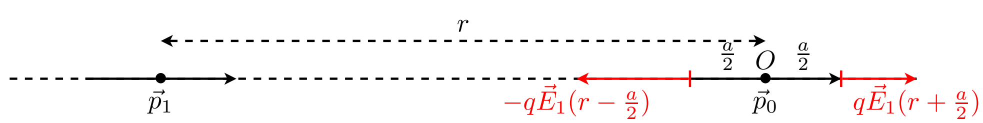
$E_c(\frac{a}{2}) = 0\,\text{J}$ **(0,25)**, $\quad E_p(\frac{a}{2}) = K\frac{q_1q_2}{a} = K\frac{3q^2}{4a}$ **(0,5)**,

$E_p(\frac{3a}{2}) = K\frac{q_1q_2}{2a} = K\frac{3q^2}{8a}$ **(0,5)**, $\quad$ alors $E_c(\frac{3a}{2}) = K\frac{3q^2}{8a}$ **(0,5)**

3) i) $\vec{E}_0 = 2K\frac{\vec{p}}{r^3} + 2K\frac{\vec{p}}{r^3} = 4K\frac{\vec{p}}{r^3}$ **(0,5)**

ii) $E_{p0} = -\vec{p}.\vec{E}_0 = -4K\frac{p^2}{r^3} = -36\,10^{-21}\,\text{J}$ **(0,5)+(0,25)**

iii) Champ créé par $\vec{p}_1$: $\vec{E}_1(r) = 2K\frac{\vec{p}}{r^3}$. Force $\vec{F} = -q\vec{E}_1(r-\frac{a}{2}) + q\vec{E}_1(r+\frac{a}{2})$ **(0,5)**



$\vec{F} = -q2K\frac{\vec{p}}{(r-\frac{a}{2})^3} + q2K\frac{\vec{p}}{(r+\frac{a}{2})^3} = 2Kq\vec{p}\left[\frac{1}{(r+\frac{a}{2})^3} - \frac{1}{(r-\frac{a}{2})^3}\right]$ **(0,5)**.

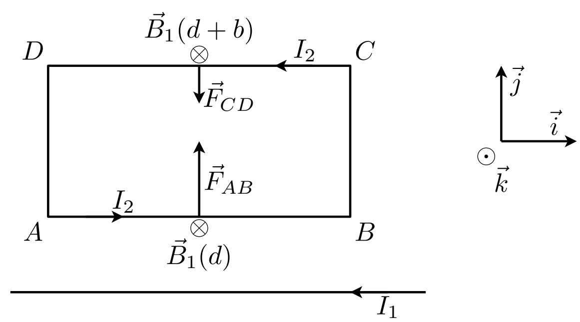
(Notons que $\vec{F} \simeq -\frac{6Kq\vec{p}}{r^4}$)

$\vec{F}$ est dirigée vers $\vec{p}_1$ car $\left[\frac{1}{(r+\frac{a}{2})^3} - \frac{1}{(r-\frac{a}{2})^3}\right] < 0$ **(0,5)**. De même la force exercée par $\vec{p}_0$ sur $\vec{p}_1$ est dirigée vers $\vec{p}_0$ (action-réaction) **(0,5)**. L'interaction est donc attractive. **(0,5)**

Exercice 3

1) $\vec{F}_{AB} = \int_A^B I_2\vec{dl} \wedge \vec{B}_1(y=d)$ **(0,25)**. Donc $\vec{F}_{AB} = \frac{\mu_0 a I_1 I_2}{2\pi d}\vec{j}$. **(0,75)**

$\vec{F}_{CD} = \int_C^D I_2\vec{dl} \wedge \vec{B}_1(y=b+d)$ **(0,25)**. Donc $\vec{F}_{CD} = -\frac{\mu_0 a I_1 I_2}{2\pi(b+d)}\vec{j}$. **(0,75)**



$\vec{F} = \vec{F}_{AB} + \vec{F}_{CD} = \frac{\mu_0 I_1 I_2}{2\pi}\left[\frac{ab}{(b+d)d}\right]\vec{j}$ **(0,25)**

2) Équilibre : $N\frac{\mu_0 I_1 I_2}{2\pi}\left[\frac{ab}{(b+d)d}\right] = mg$ **(0,5)**. A.N. $m = \frac{\mu_0 N I_1 I_2}{2\pi g}\left[\frac{ab}{(b+d)d}\right] \simeq 1429\,\text{kg}$ **(0,25)**