L2SPI - UE4CC1 - 20/10/2014

(A) [1] $u = 1,2\,V$

[2] $q = 2000\,mAh$

$= 2A \times 3600\,s$

$= 7,2\,kC$

[3] $\mathcal{E} = qu = 1,2 \times 7,2\,kJ$

$= 8,64\,kJ$

(B) [1] $\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0} q_1 q_2 \frac{1}{r_{12}^2} \vec{u}_{12}$

* Amplitude $F_{12} = \frac{1}{4\pi\varepsilon_0} q_1 q_2 \frac{1}{r_{12}^2}$

* Direction : La droite passant par les deux charges

* Sens : $q_1 q_2 > 0 \Rightarrow$ répulsion

$q_1 q_2 < 0 \Rightarrow$ attraction

[2] $\vec{E}_1(O) = \frac{q_1}{4\pi\varepsilon_0} \frac{\vec{P_1O}}{P_1O^3}$

$\vec{P_1O} = \begin{vmatrix} -1\,cm \\ -1\,cm \\ -1\,cm \end{vmatrix}$ $\quad P_1O = \sqrt{3}\,cm \approx 1,73\,cm$

$$\frac{q_1}{4\pi\varepsilon_0} \simeq 9\times10^{9}\times10^{-8} = 90 \quad SI$$

$$\frac{\overrightarrow{P_1O}}{P_1O^3} = 3^{(-3/2)}\times10^{4}\times\begin{vmatrix}-1\\-1\\-1\end{vmatrix} \quad SI$$

$$90\times3^{(-3/2)}\times10^{4} \simeq 173205$$

$$E_{1x}(O) = E_{1y}(O) = E_{1z}(O) = -173205 \text{ V/m}$$

3 $E_{2x}(O) = 241495$ V/m

$E_{2y}(O) = 0$ V/m

$E_{3y}(O) = 482991$ V/m

4 $E_{3x}(O) = -257716$ V/m

$E_{3y}(O) = -85905$ V/m

$E_{3z}(O) = -171811$ V/m

5 $\vec{F} = Q(\vec{E_1}(O) + \vec{E_2}(O) + \vec{E_3}(O))$

$F_x = 3,788$ mN

$F_y = 5,182$ mN

$F_z = -2,759$ mN

(c)

1 $V_P(M) = \frac{1}{4\pi\varepsilon_0}\frac{+q}{\sqrt{(x-d/2)^2+y^2}}$

$V_N(M) = \frac{1}{4\pi\varepsilon_0}\frac{-q}{\sqrt{(x+d/2)^2+y^2}}$

2 $V_P(M) + V_N(M) \simeq V(M) = \frac{px}{4\pi\varepsilon_0 r^3}$

lorsque $r = \sqrt{x^2+y^2} \gg d$ (approximation dipolaire)

3 $E_y = -\frac{\partial V}{\partial y} = \frac{-px}{4\pi\varepsilon_0}\frac{\partial 1/r^3}{\partial y}$

$= \frac{-px}{4\pi\varepsilon_0}\frac{-3}{r^4}\frac{\partial r}{\partial y} = \frac{px}{4\pi\varepsilon_0}\frac{+3}{r^4}\frac{y}{r}$

$= \frac{+p}{4\pi\varepsilon_0}\frac{3xy}{r^5}$

4 $E_x = -\frac{\partial V}{\partial x} = \frac{-p}{4\pi\varepsilon_0}\left(\frac{1}{r^3} + x\frac{\partial 1/r^3}{\partial x}\right)$

$= \frac{-p}{4\pi\varepsilon_0}\left(\frac{1}{r^3} - \frac{3x^2}{r^5}\right) = \frac{+p}{4\pi\varepsilon_0}\frac{2x^2-y^2}{r^5}$