حل تمارين السلسلة الرابعة

ت 1

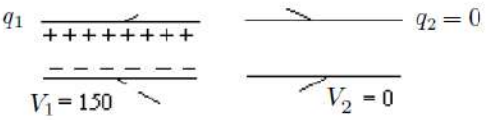
$$\begin{cases} q = C.V \\ C = \frac{\varepsilon_0.S}{d} \\ E = \frac{V}{d} \end{cases} \longrightarrow q = \frac{\varepsilon_0.S}{d}.E.d = \varepsilon_0.S.E$$

$$S = 210cm^2, E = 8.10^6 V/m, \varepsilon_0 = 8.85.10^{-12} F/m$$

$$q = 14.868.10^{-10} = 1.48nC$$

ت 2

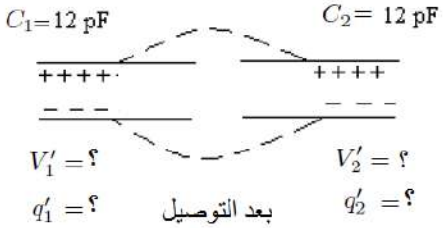
1- قبل التوصيل



قبل التوصيل

$$q_1 = C_1.V_1 = 12.10^{-12}.150 = 18.10^{-10}C$$

2- بعد التوصيل



مبدأ انحفاظ الشحنة

$$q_1 + q_2 = q_1' + q_2' \longrightarrow q_1 = q_1' + q_2'$$

المكثفتان على التوازي

$$V_1' = V_2' \longrightarrow \frac{q_1'}{C_1} = \frac{q_2'}{C_2} \longrightarrow q_1' = \frac{C_1}{C_2}.q_2'$$

نقوم بحل الجملة التالية

$$\begin{cases} q_1 = q_1' + q_2' \\ q_1' = \frac{C_1}{C_2}.q_2' \end{cases}$$

نجد

$$q_2' = \frac{q_1}{\frac{C_1}{C_2} + 1} = 9.10^{-10}C$$

$$q_1' = 9.10^{-10}C$$

$$V_1' = V_2' = 75Volt$$

2- الطاقة الداخلية للمجموعة

$$E_p = E_{p1} + E_{p2} = E_{p1} + 0 = \frac{1}{2}C_1.V_1^2 = 1.35.10^{-7}Joule$$

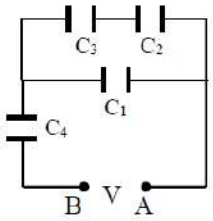
$$E_p' = E_{p1}' + E_{p2}' = \frac{1}{2}C_1.V_1'^2 + \frac{1}{2}C_2.V_2'^2$$

$$= 6.75.10^{-8}Joule = 0.675.10^{-7}Joule$$

نلاحظ أن طاقة الجملة قبل التوصيل أكبر مما هي بعد التوصيل

وهذا يعني أن جزءا من الطاقة قد تحول على كل شكل حرارة (فعل جول)

ت 3



-1

$$\frac{1}{C_{23}} = \frac{1}{C_2} + \frac{1}{C_3} \longrightarrow C_{23} = 30\mu F$$

$$C_{123} = C_{23} + C_1 \longrightarrow C_{123} = 90\mu F$$

$$\frac{1}{C_{eq}} = \frac{1}{C123} + \frac{1}{C_4} \longrightarrow C_{eq} = 25.71\ \mu F$$

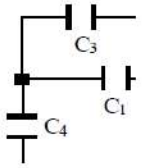
-2

$$q_2 = q_3 = 24\mu C \quad \text{(على التسلسل)}$$

$$V_1 = V_2 + V_3 \quad \text{(على التفرع)}$$

$$\longrightarrow \frac{q_1}{\cancel{C_1}} = \frac{q_2}{\cancel{C_2}} + \frac{q_3}{\cancel{C_3}}$$

$$q_1 = q_2 + q_3 = 48\mu C$$



من الشكل:

شحنة C_4 تساوي مجموع شحنتي C_1 و C_3

إذن يكون:

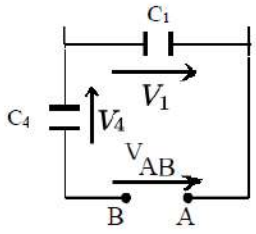
$$q_4 = q_1 + q_3 = 72\ \mu C$$

$$V_1 = \frac{q_1}{C_1} = 0.8Volt$$

$$V_2 = \frac{q_2}{C_2} = 0.4Volt$$

$$V_3 = \frac{q_3}{C_3} = 0.4Volt$$

$$V_4 = \frac{q_4}{C_4} = 2Volt$$



$$V_{AB} = V_4 + V_1$$

$$= 2 + 0.8 = 2.8Volt$$

3 - الطاقة المخزنة

$$E_p = \frac{1}{2}q_4 V_{AB}$$

$$= \frac{1}{2} \times 72 \times 10^{-6} \times 2.8$$

$$= 100.8 \times 10^{-6} Joule$$

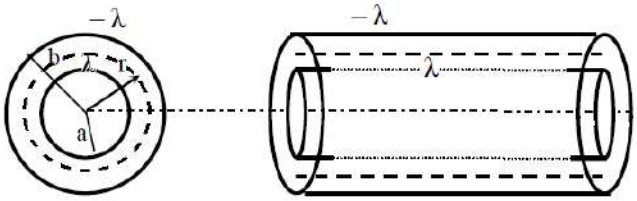
ت 4:

$$E_p = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\frac{q^2}{\frac{\varepsilon_0 S}{d}} = \frac{1}{2}\frac{q^2 d}{\varepsilon_0 S}$$

$$= \frac{1}{2} \times \frac{(300.10^{-6})^2 \times 2.10^{-3}}{8.85.10^{-12} \times (9.10^{-2})^2}$$

$$= 0.37 joule$$

ت 5:



مظهر علوي مظهر جانبي

أ- باستعمال نظرية غوص يمكن أن نجد:

$$E = \begin{cases} 0 & : r < a \\ \frac{\lambda}{2\pi\varepsilon_0 r} & : a < r < b \\ 0 & r > b \end{cases}$$

$$dV = -Edr$$

$r \le a$: $dV = 0 \to V = C^{te} = V(a)$

$a \le r \le b$: $dV = \frac{-\lambda}{2\pi\varepsilon_0}\frac{1}{r}dr$

$$V(r) = \frac{-\lambda}{2\pi\varepsilon_0}\ln r + C^{te}$$

$$V(b) = \frac{-\lambda}{2\pi\varepsilon_0}\ln(b) + C^{te}$$

$$C^{te} = V(b) + \frac{\lambda}{2\pi\varepsilon_0}\ln(b)$$

$$V(r) = \frac{-\lambda}{2\pi\varepsilon_0}\ln(r) + V(b) + \frac{\lambda}{2\pi\varepsilon_0}\ln(b)$$

$$V(r) = \frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{r}\right) + V(b)$$

$r \ge 0$: $dV = 0 \to V = C^{te} = V(b)$

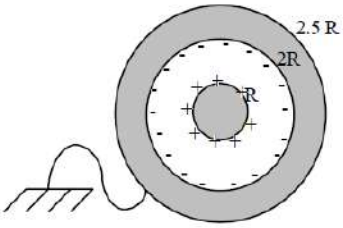
ب-

$$C = \frac{q}{V(a) - V(b)} = \frac{\lambda l}{\frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)}$$

$$C = \frac{2\pi\varepsilon_0 . l}{\ln\left(\frac{b}{a}\right)}$$

$$E_p = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\frac{\lambda^2 . l^2}{\frac{2\pi\varepsilon_0 . l}{\ln\left(\frac{b}{a}\right)}} = \frac{\lambda^2 . l}{4\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)$$

ت 6:



أ- الحقل الكهربائي:

$R \le r \le 2R$

$$E.4\pi.r^2 = \frac{Q_{int}}{\varepsilon_0}$$

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

$r > 2R$

$$E.4\pi.r^2 = \frac{Q - Q}{\varepsilon_0} = 0 \longrightarrow E = 0$$

ب-

$$dV = -Edr = -\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}dr$$

$$\longrightarrow \int_{V_1}^{V_2} dV = \frac{Q}{4\pi\varepsilon_0}\int_R^{2R} -\frac{1}{r^2}dr$$

$$\longrightarrow V_2 - V_2 = \frac{Q}{4\pi\varepsilon_0}[\frac{1}{r}]_R^{2R}$$

$$\longrightarrow V_2 - V_2 = V = \frac{Q}{8\pi\varepsilon_0 R}$$

ومنه:

$$E_p = \frac{1}{2}QV = \frac{Q^2}{16\pi\varepsilon_0 R}$$

جـ -

$$E_p = \frac{1}{2}\frac{Q^2}{C} = \frac{Q^2}{16\pi\varepsilon_0 R}$$

$$\longrightarrow C = 8\pi\varepsilon_0 R$$