

PHY 112

QUIZ 03

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Q 3

a)

Given, $r_1 = 6 \text{ mm} = 6 \times 10^{-3} \text{ m}$

$$r_2 = 27 \text{ mm} = 27 \times 10^{-3} \text{ m}$$

$$L = 22 \text{ cm} = 22 \times 10^{-2} \text{ m}$$

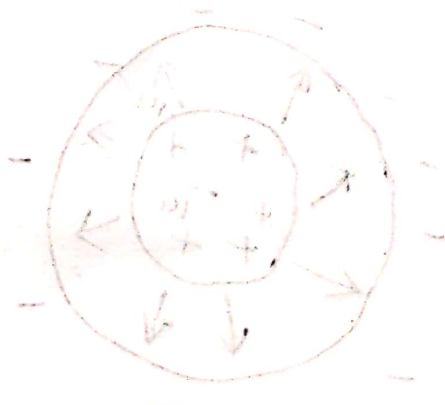
$$V = 11.1 \text{ Volts}$$

Now,

$$\text{Capacitance, } C = \frac{2\pi \epsilon_0 L}{\ln(r_2/r_1)}$$

$$= \frac{2\pi \times 8.85 \times 10^{-12} \times 22 \times 10^{-2}}{\ln\left(\frac{27 \times 10^{-3}}{6 \times 10^{-3}}\right)}$$

$$= 8.1334 \times 10^{-12} \text{ F}$$



b

As inner rod is positively charged so outer surface will be neg charged.

Here, $Q = C V_0$

$$= 8.1334 \times 10^{-12} \times 11.1$$

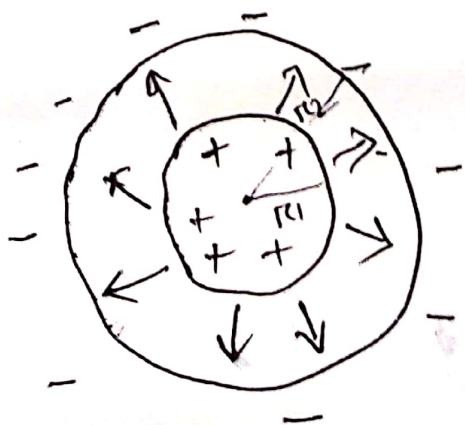
$$= 9.02807 \times 10^{-11} \text{ C/m}$$

Charge density,

$$\sigma = \frac{Q}{2\pi r_2 L}$$

$$= \frac{9.02807 \times 10^{-11}}{2\pi \times 12.7 \times 10^{-3} \times 22 \times 10^{-2}}$$

$$= 2.4190 \times 10^{-9} \text{ C/m}^2$$



C b

from a,

$$C_0 = 8.1334 \times 10^{-12} \text{ F}$$

After inserting material,

$$\begin{aligned} C &= k C_0 \\ &= 3.5 \times 8.1334 \times 10^{-12} \\ &= 2.8467 \times 10^{-11} \text{ F} \end{aligned}$$

$$\begin{aligned} U_{\text{stored}} &= \frac{1}{2} C V^2 \\ &= \frac{1}{2} \times 2.8467 \times 10^{-11} \times (11.1)^2 \\ &= 1.7537 \times 10^{-9} \text{ J} \end{aligned}$$

total energy stored $1.7537 \times 10^{-9} \text{ J}$

$$\underline{\underline{d}}$$

Given, $K = 3.5$

from, a, $C_0 = 8.1334 \times 10^{-12} \text{ F}$

$\mathcal{E} = 11.1 \text{ volts}$

We know,

$$C_0 = \frac{Q}{\mathcal{E}} \Rightarrow Q = C_0 \mathcal{E}$$

$$= 8.1334 \times 10^{-12} \times 11.1$$

$$= 9.028074 \times 10^{-11} \text{ C}$$

After placing dielectric,

$$C = C_0 K = 8.1334 \times 10^{-12} \times 3.5$$

$$= 2.84669 \times 10^{-11}$$

Now, $V = \frac{Q}{C} = \frac{9.028074 \times 10^{-11}}{2.84669 \times 10^{-11}}$

$$= 3.1719 \text{ volts}$$

Energy stored,

$$U_s = \frac{1}{2} C V^2$$

$$= \frac{1}{2} \times 2.84669 \times 10^{-11} \times 3.1714^2$$

$$= 9.514 \times 10^{-11} \text{ J}$$

The answers of (c) and (d) are different from each other because the battery was disconnected from the capacitor in (d). So in (c) the voltage was 11V where in (d) it became 3.171 volts. That's why it created a difference between these two stored energy calculations.