DPP - 03

SOLUTION

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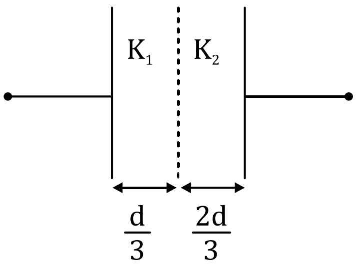
1 $c = \frac{A\varepsilon_o}{d} = 9PF \ \ [Air]$



After filled dielectric

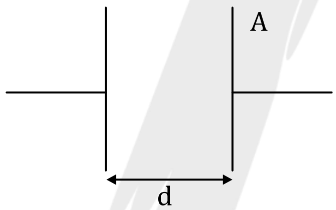
$$C^1 = \frac{A\varepsilon_o}{d - \left(\frac{d}{3} + \frac{2d}{3}\right) + \frac{d}{3k_1} + \frac{2d}{3k_2}}$$

$$C^1 = \frac{A\varepsilon_o}{\frac{d}{9} + \frac{d}{9}} = 4.5 \frac{A\varepsilon_o}{d}$$

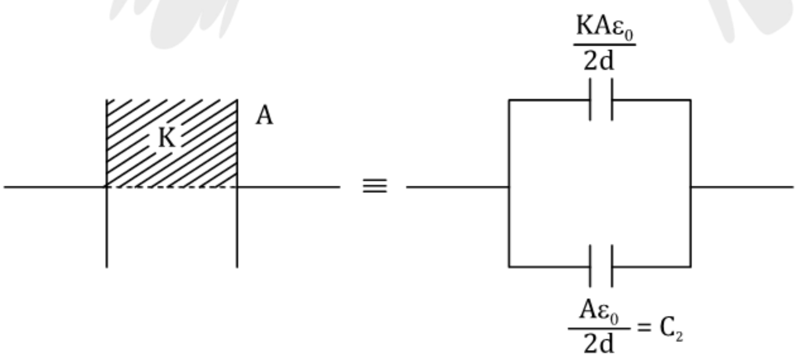
$$C^1 = 4.5 \times 9$$

$$C^1 = 40.5PF$$

2.



$C = \frac{A\varepsilon_o}{d}$ [Air]



$$Ceq = C_1 + C_2 = \frac{KA\varepsilon_o}{2d} + \frac{A\varepsilon_o}{2d}$$

$$= \frac{A\varepsilon_0}{2d}(K+1)$$

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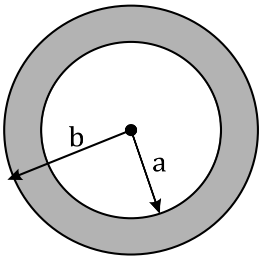
$$=\frac{C(k+1)}{2}$$

3. $a=0.5m$

$b=0.6m$



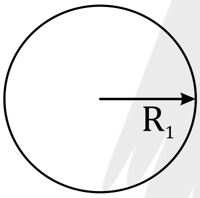
$$C=\frac{4\pi\varepsilon_0 K}{\left(\frac{1}{a}-\frac{1}{b}\right)}$$

$$C=\frac{1\times 6}{9\times 10^{9}\left(\frac{10}{5}-\frac{10}{6}\right)}$$

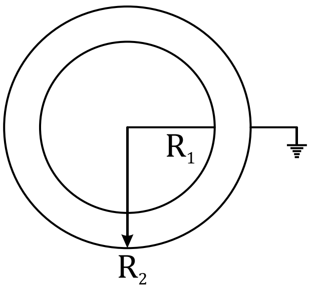
$$=\frac{6}{9\times 10^{10}\times\frac{1}{30}}$$

$$\frac{2}{10^{9}}=2\times 10^{-9}F$$

4



$C_1=4\pi\varepsilon_0 R_1$



$$C_2=4\pi\varepsilon_0\left(\frac{R_1R_2}{R_2-R_1}\right)$$

$$C_2=\eta c_1$$

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$$4\pi\varepsilon_0\left(\frac{R_1R_2}{R_2-R_1}\right)=\eta 4\pi\varepsilon_0 R_1$$

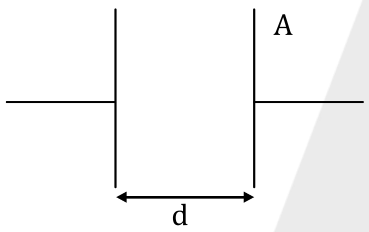
$$\frac{R_1R_2}{R_2-R_1}=\eta R_1$$

$$R_1R_2=\eta R_1R_2-\eta R_1^2$$

$$\eta R_1^{\cancel{2}}=(\eta-1)\cancel{R_1}R_2$$

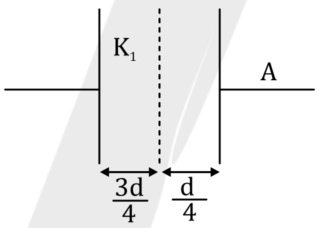
$$\boxed{\frac{R_2}{R_1}=\frac{\eta}{\eta-1}}$$

5



$$C=\frac{A\varepsilon_0}{d}$$

Finally

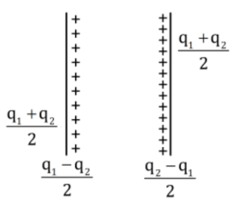


$$C^1=\frac{A\varepsilon_0}{d-\frac{3d}{4}+\frac{3d}{4K}}$$

$$C^1=\frac{A\varepsilon_0}{\frac{d}{4}+\frac{3d}{4K}}+\frac{4A\varepsilon_0}{d\left[\frac{K+3}{K}\right]}$$

$$=\frac{4C_0K}{K+3}$$

6



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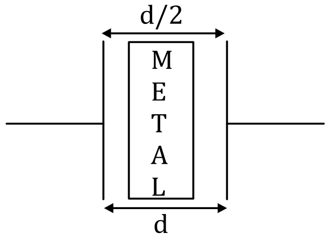
$$q = cv$$

$$\Rightarrow \left(\frac{q_1 - q_2}{2}\right) = cv$$

$$V = \frac{q_1 - q_2}{2c}$$

7



$$C_{Air} = \frac{A\varepsilon_0}{d} = \text{Cinitial}$$

$$C_{Final} = \frac{A\varepsilon_0}{d - \frac{d}{2} + \frac{d}{2K}}$$

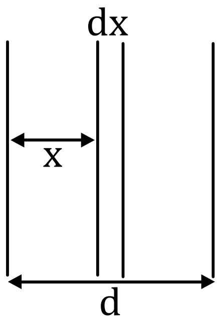
$K = \infty$ For methal / conductor

$$C_{Final} = \frac{A\varepsilon_0}{d/2} = \frac{2A\varepsilon_0}{d}$$

$$\frac{C_{net}}{C_{original}} = \frac{2A\varepsilon_0}{d \bullet \frac{A\varepsilon_0}{d}} = 2:1$$

8 Area = A

Seperation = d



$$\varepsilon(x) = \varepsilon_0 + Kx\left(0 < x \le \frac{d}{2}\right)$$

$$dc = \frac{(\varepsilon_0 + Kx)A}{dx}$$

$$dc^1 = \frac{\varepsilon_0 + K(d-x)A}{dx}$$

$$\frac{1}{C} = \frac{1}{A}\int_0^d \frac{dx}{\varepsilon_0 + Kx}$$

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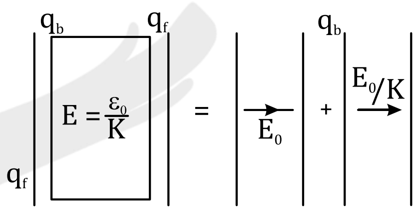
$$\frac{1}{C^1}=\frac{1}{KA}\ell n\left(\frac{\varepsilon_0+\frac{Kd}{2}}{\varepsilon_0}\right)$$

$$\frac{1}{C^1}=\frac{1}{KA}\ell n\left(\frac{\varepsilon_0+\frac{Kd}{2}}{\varepsilon_0}\right)$$

$$Ceq=\frac{CC^1}{C+C^1}=\frac{KA}{2\ell n\left(\frac{2\varepsilon_0+Kd}{2\varepsilon_0}\right)}$$

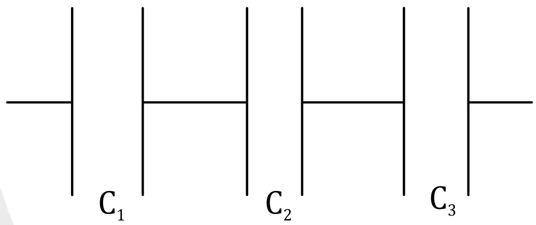
9 The electric field inside dielectric is $\frac{\varepsilon_0}{K}$



$$q_b=q_f-\frac{q_f}{K}$$

$$q_b=q_f\left(1-\frac{1}{K}\right)$$

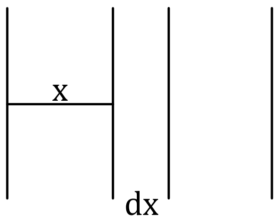
10 $C_2=\frac{3KA\varepsilon_0}{2d}$ $C_3=\frac{5KA\varepsilon_0}{3d}$



$$\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$$

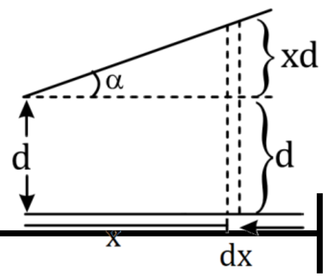
$$C=\frac{15}{34}\frac{K\varepsilon_0A}{d}$$

11 $\frac{1}{C}=\sum\frac{1}{C_1}=\int_0^d\frac{dx}{K(1+dx)\varepsilon_0A}$



$$C=\frac{K\varepsilon_0A}{d}\left(1+\frac{d}{2}\right)$$

12 $dc=\frac{\varepsilon_0adx}{d+xa}$



$$C = \int_0^a \frac{\varepsilon_0 a dx}{d + x\alpha} = \frac{\varepsilon_0 a}{d} \cdot \frac{d}{\alpha}\left[\ell n\left(1 + \frac{x\alpha}{d}\right)\right]_0^a \quad C = \frac{\varepsilon_0 a^2}{d}\left(1 - \frac{da}{2d}\right)$$