William Batista Couto dos Santos

(Questão 1:)

$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$, para $r > R$

Logo,

$$U(r) = -\int_{\infty}^{R} E\,dr$$

$$U(r) = -\int_{\infty}^{R} \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}\,dr$$

$$\frac{-q}{4\pi\varepsilon_0}\int_{\infty}^{R} \frac{1}{r^2}\,dr$$

$$\frac{-q}{4\pi\varepsilon_0}\left(\frac{-1}{r}\Big|_{\infty}^{R}\right.$$

$$\frac{-q}{4\pi\varepsilon_0}\left(\frac{-1}{R} - \frac{1}{\infty}^{0}\right)$$

$$\frac{q}{4\pi\varepsilon_0} \cdot \frac{1}{R}$$

(Questão 2)

$V(x,y) = -q(x^2+y)y$,

$(x,y) = (2,1)$

$E = -\nabla V$

$\nabla V = \left(\frac{\partial V}{\partial x}, \frac{\partial V}{\partial y}\right)$

$\frac{\partial V}{\partial x} = -2qxy$

$\frac{\partial V}{\partial y} = -2x^2 - 2yq$

$E_x = 2qxy \quad E_y = q(x^2+2y)$

substituindo x e y

$E_x = 4q \quad E_y = 6q$

$|E| = \sqrt{(4q)^2 + (6q)^2}$

$|E| = \sqrt{16q^2 + 16q^2}$

$|E| = \sqrt{52q^2}$

$|E| = |q|\sqrt{52} = 2\sqrt{12}\,|q|$

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Questao 3)

A capacitância é dada por: $C = \frac{\varepsilon A}{d}$

$$C_1 = \frac{K\varepsilon_0 A}{d/3} = \frac{3K\varepsilon_0 A}{d}$$

$$C_2 = \frac{\varepsilon_0 A}{\frac{2d}{3}} = \frac{3\varepsilon_0 A}{2d}$$

A capacitância equivalente C é dada por:

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_{11}}$$

$$\frac{1}{C} = \frac{1}{\frac{3K\varepsilon_0 A}{d}} + \frac{1}{\frac{3\varepsilon_0 A}{2d}}$$

$$\frac{1}{C} = \frac{d}{3K\varepsilon_0 A} + \frac{2d}{3\varepsilon_0 A}$$

$$\frac{1}{C} = \frac{d}{3\varepsilon_0 A}\left(\frac{1}{K} + 2\right)$$

$$C = \frac{3\varepsilon_0 A}{d} \cdot \frac{1}{\frac{1}{K} + 2} \text{ logo}$$

$$C = \frac{3\varepsilon_0 A}{d\left(\frac{1}{K} + 2\right)}$$

Questão 4

$$C_{eq1} = \frac{C_1}{2} = \frac{10\,MF}{2} = 5\,MF$$

Capacitancia equivalente total:

$$C_{eq2} = C_{eq1} + C_3 = 5\,MF + 2\,MF = 1\,MF$$

$$C_{Total} = \frac{C_2 C_{eq2}}{C_2 + C_{eq2}} = \frac{(5\,MF)(1\,MF)}{5\,MF + 1\,MF} = \frac{5}{1}$$

a diferença potencial é:

$$Q = C_{total} V$$

$$10\,mC = (2,92\,MF) \cdot V$$

$$V = \frac{10}{2,92} \approx 3,42\,V$$

C_2 é $Q = 10\,mC$, como $Q = C_2 V$

$$V_2 = \frac{Q}{C_2} = \frac{10\,mC}{5\,MF} = 2\,V$$