Questão 1:

1

a) Força sobre q2

$$\vec{F}_{1,2} = \frac{K q_1 q_2}{r_{1,2}^2} \hat{r}_{1,2} = \frac{(8,99 \times 10^9 \frac{Nm^2}{C^2})(4\mu C)(6\mu C)}{(8m)^2} \hat{\imath}$$

$$\vec{F}_{1,2} = \frac{0,21576 \, N.m^2}{64 \quad m^2} = (0,0033 \, N) \hat{\imath}$$

b) Campo $\vec{E}$ em $x = -2m$ e $x = 10m$

$$E(x) = \vec{E}_{q_1}(x) + \vec{E}_{q_2}(x) = \frac{K q_1}{x^2} \hat{r}_{q_1,P} + \frac{K q_2}{(8m - x)^2} \hat{r}_{q_2,P}$$

$$E(-2m) = 8,99 \times 10^9 \frac{N.m^2}{C^2} \left[\frac{4\mu C}{(-2m)^2} (-\hat{\imath}) + \frac{6\mu C}{(10m)^2} (-\hat{\imath}) \right]$$

$$E(-2m) = 8,99 \times 10^9 \frac{N.m^2}{C^2} \left[1 \times 10^{-6} \frac{\mu C}{m^2} (-\hat{\imath}) + 6 \times 10^{-8} (-\hat{\imath}) \right]$$

$$E(-2m) = -9529 \frac{N}{C}$$

$$E(10m) = 8,99 \times 10^9 \frac{N.m^2}{C^2} \left[\frac{4\mu C}{(10m)^2} (\hat{\imath}) + \frac{6\mu C}{(2m)^2} (\hat{\imath}) \right]$$

$$E(10m) = 8,99 \times 10^9 \frac{Nm^2}{C^2} \left[4 \times 10^{-8} \frac{\mu C}{m^2} (\hat{\imath}) + 1,5 \frac{\mu C}{m^2} (\hat{\imath} \right]$$

$$E(10m) = 13844 \frac{N}{C}$$

c) r = 2,38 cm

c)

$$\vec{E}(0) = \vec{E}_{5\mu c} + \vec{E}_{-8\mu c} + \vec{E}_{6\mu c} = 0$$

2

$$\frac{Kq_5}{r_5^2}\hat{r}_5 + \frac{Kq_6}{r_6^2}\hat{r}_6 + \frac{Kq_{-8}}{r_8^2}\hat{r}_{-8} = 0$$

$$\frac{Kq_5}{r_5^2}\hat{\imath} + \frac{Kq_6}{r_6^2}(-\hat{\imath}) + \frac{Kq_{-8}}{r_{-8}^2}(-\hat{\imath}) = 0$$

$$\frac{q_5}{r_5^2} - \frac{q_6}{r_6^2} - \frac{q_{-8}}{r_{-8}^2} = 0$$

$$\frac{5}{(3cm)^2} - \frac{6}{r_6^2} - \frac{-8}{(4cm)^2} = 0$$

$$\underline{\underline{r_6 = 2,88cm}}$$

Questão 2:

a) $Q = \rho V = \frac{4}{3}\pi r^3 \rho$

$Q = \frac{4}{3}\pi (0{,}06\,m)^3 (550\,\frac{nC}{m^3}) = 4{,}97 \times 10^{-10}\,C$

Lei de Gauss $\oint_S E_n dA = \frac{Q_{int}}{\epsilon_0}$

$E_n = \frac{K Q_{int}}{r^2}$

dentro da esfera: $\frac{Q}{V} = \frac{Q_{int}}{V'}$ V' = volume sup gaussiana

$Q_{int} = \frac{QV'}{V} = \frac{Q\,\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3} = \frac{Q r^3}{R^3}$

p/ $r < R$ $E_n = \frac{KQ}{R^3} r$

a) $r = 2\,cm$

$E_n = 413{,}7\,N/C$

b) $r = 5{,}9\,cm$

$E_n = 1220\,N/C$

$r > R$ $E_n = \frac{K}{r^2} Q_{int}$

c) $r = 6{,}1\,cm$ $E_n = 1200{,}8\,N/C$ Comporta-se como carga pontual.

d) $r = 11\,cm$ $E_n = 369{,}2\,N/C$

Lei de Coulomb $E_n = \frac{KQ}{r^2}$ Mesmo resultado item (d)

Questão 3

③

$$\sigma = \frac{Q}{A} = \frac{Q}{\pi R^2} \Rightarrow Q = \pi \sigma R^2$$

$$V(r) = 2\pi k\sigma\left(\sqrt{x^2+R^2} - x\right)$$

$$80 = 2\pi k\sigma\left(\sqrt{(0{,}6m)^2+R^2} - 0{,}6m\right) \quad (1)$$
$$40 = 2\pi k\sigma\left(\sqrt{(1{,}5m)^2+R^2} - 1{,}5m\right) \quad (2)$$

dividir (1) por (2):

$$2 = \frac{\sqrt{(0{,}6m)^2+R^2} - 0{,}6m}{\sqrt{(1{,}5m)^2+R^2} - 1{,}5m}$$

$$2\left(\sqrt{2{,}25m^2+R^2}\right) - 3m = \sqrt{0{,}36m^2+R^2} - 0{,}60m$$

$$2\left(\sqrt{2{,}25m^2+R^2}\right) = \sqrt{0{,}36m^2+R^2} + 2{,}40m$$

elevando os dois termos ao quadrado

$$9m^2 + 4R^2 = 0{,}36m^2 + R^2 + 5{,}76m^2 + 4{,}8\sqrt{0{,}36m^2+R^2}$$

$$0{,}6m^2 + 0{,}625R^2 = \left(\sqrt{0{,}36m^2+R^2}\right)$$

elevando novamente ao quadrado ambos os lados

$$0{,}390625R^4 = 0{,}25R^2$$

$$R^2 = 0{,}64 \qquad R = 0{,}80m$$

$$E_x = 2\pi k\sigma\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right) \Rightarrow \sigma = \frac{E_x}{2\pi k\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right)}$$

$\longrightarrow$

$$\sigma = \frac{2\epsilon_0 E x}{1 - \frac{x}{\sqrt{x^2+R^2}}} = \frac{2(8{,}85 \times 10^{-12}\, C^2/Nm^2)(85{,}5\, V/m)}{1 - \frac{1{,}5m}{\sqrt{(1{,}5m)^2 + (0{,}8m)^2}}}$$

$$\sigma = \frac{6{,}28 \times 10^{-10}}{1 - 0{,}88} = 5{,}23\, nC/m^2$$

então $Q = \pi \sigma R^2 = \pi (5{,}23\, nC/m^2)(0{,}8m)^2$

$$\boxed{Q = 10{,}5\, nC}$$

Questão 4

a) $Q = Q_1 = Q_2 = C_{eq} V$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{(5\mu F)(5\mu F)}{5\mu F + 5\mu F} = 2{,}5\mu F$$

$$Q_1 = Q_2 = (2{,}5\mu F)(25V) = 62{,}5\,\mu C$$

b) $U = \frac{1}{2} C_{eq} V^2 = \frac{1}{2}(2{,}5\mu F)(25V)^2 = 781\,\mu J$

c) $Q' = Q_1' = Q_2' = C_{eq}' V$

$$C_{eq}' = \frac{C_1' C_2'}{C_1' + C_2'}$$

$C_1' = K C_1$ $\qquad$ $C_2' = C_2$

$$C_{eq}' = \frac{K C_1 C_2}{K C_1 + C_2} = \frac{130\,\mu F}{31\,\mu F} = 4{,}19\,\mu F$$

$$Q_1' = Q_2' = (4{,}19\mu F)(25V) = 104{,}8\,\mu C$$

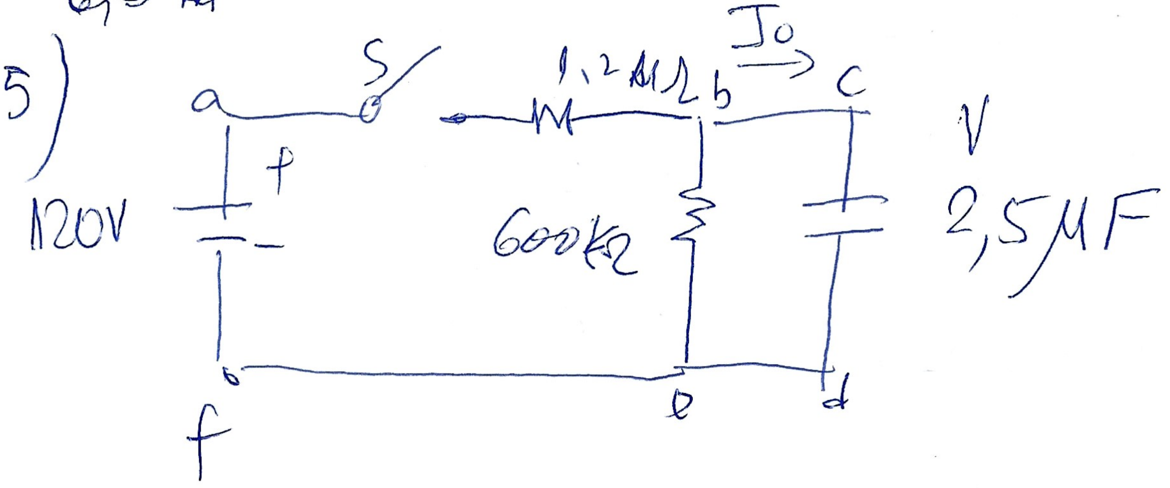
$$V_1' = \frac{Q_1'}{C_1'} = \frac{Q_1'}{K C_1} = \frac{104{,}8\mu C}{5{,}2(5\mu F)} = 4{,}03\,V \longrightarrow$$

$$V_2' = \frac{Q_2'}{C_2'} = \frac{Q_2'}{C_2} = \frac{104{,}8\,\mu C}{5\,\mu F} = 20{,}96\,V$$

d) $U = \frac{1}{2} C_{eq}' V^2 = \frac{1}{2}(4{,}19\,\mu F)(25V)^2 = 1309\,\mu J$

6,25

5)



a b c d e f a

$$\mathcal{E} - (1{,}2\,M\Omega)I_0 - V_{c0} = 0$$

$t = 0$ cap. está descarregado $V_{c0} = 0$

$$I_0 = \frac{\mathcal{E}}{1{,}2\,M\Omega} = \frac{120V}{1{,}2M\Omega} = 0{,}100mA$$

b) $I_{c\infty} = 0$

$$\mathcal{E} - (1{,}2M\Omega)I_\infty - (600k\Omega)I_\infty = 0$$

$$I_\infty = \frac{\mathcal{E}}{1.2M\Omega + 600k\Omega}$$

$$I = \frac{120V}{1{,}2M\Omega + 600\,k\Omega} = 66{,}7\mu A$$

c) $V_{c\infty} = I_\infty R_{600k\Omega} = (66{,}7\mu A)(600\,k\Omega) = 40{,}0V$