FIZ 2 1. KOLOKVIJ 9.4.2009

1. a) $I = \frac{U}{R} = \frac{12V}{9000\,\Omega} = 1{,}33\,mA$

$C = 5\,\mu F$
$R = 9\,k\Omega$
$U = 12V$

$I = ?$
$t = ?$

b) $W_{el} = \frac{W_{el0}}{2}$

$$\frac{\cancel{C}(U_0 \cdot e^{-\frac{t}{\tau}})^2}{\cancel{2}} = \frac{\cancel{C}\,U_0^2}{\cancel{2} \cdot 2}$$

$$(U_0 \cdot e^{-\frac{t}{\tau}})^2 = \frac{U_0^2}{2} \quad / \sqrt{}$$

$$\cancel{\sqrt{(U_0 \cdot e^{-\frac{t}{\tau}})^2}} = \cancel{\sqrt{\frac{U_0^2}{2}}}$$

$$\cancel{U_0} \cdot e^{-\frac{t}{\tau}} = \frac{\cancel{U_0}}{\sqrt{2}} \quad / \frac{\sqrt{2}}{\sqrt{2}}$$

$$e^{-\frac{t}{\tau}} = \frac{\sqrt{2}}{2}$$

$$\frac{t}{\tau} = \ln\frac{\sqrt{2}}{2}$$

$$t = \tau \ln\frac{\sqrt{2}}{2}$$

$$t = 15{,}59\,ms$$

$\tau = RC$

$\tau = 9000 \cdot 5 \cdot 10^{-6}$

$\tau = 45 \cdot 10^{-3}\,s$

2. $d = 20\,m$

$r_1 = 5\,cm$

$Q_1 = -4 \cdot 10^{-5}\,As$

$r_2 = 10\,cm$

$Q_2 = 20 \cdot 10^{-6}\,As$

$E = ?$

$\Delta Q_1 = ?$

a) $E = \frac{Q}{4\pi\varepsilon_0 R^2}$

$$E_1 = \frac{Q_1}{4\pi\varepsilon_0 R^2} = \frac{-4 \cdot 10^{-5}\,As}{4\pi \cdot 8{,}85 \cdot 10^{-12} \cdot 10^2}$$

$R = \frac{d}{2}$

$$E_1 = -3596{,}72\ \frac{V}{m}$$

$$E_2 = \frac{Q_2}{4\pi\varepsilon_0 R^2} = \frac{20 \cdot 10^{-6}}{4\pi \cdot 8{,}85 \cdot 10^{-12} \cdot 10^2} = 1798{,}36\ \frac{V}{m}$$

$$E = E_1 + E_2 = \underline{\underline{5394{,}3\ \frac{V}{m}}}$$

b) $Q = Q'$

$V_1' = V_2'$

$$\frac{Q_1'}{\cancel{4\pi\varepsilon_0} r_1} = \frac{Q_2'}{\cancel{4\pi\varepsilon_0} r_2}$$

$$Q_1' = \frac{Q_2' r_1}{r_2}$$

$$Q_1' = \frac{1{,}33 \cdot 10^{-5} \cdot 5}{10}$$

$$Q_1' = 6{,}65 \cdot 10^{-6}\,As$$

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$$Q = Q_1 + Q_2 = -20\,\mu As$$

$$Q = Q_1' + Q_2'$$

$$Q = Q_2' \frac{r_1}{r_2} + Q_2'$$

$$Q = Q_2' \left(1 + \frac{r_1}{r_2}\right)$$

$$Q_2' = \frac{Q}{1 + \frac{r_1}{r_2}}$$

$$Q_2' = \frac{-20 \cdot 10^{-6}\,As}{1 + \frac{5}{10}}$$

$$Q_2' = -1{,}33 \cdot 10^{-5}\,As$$

$$Q = 4 \cdot 10^{-5} - 6{,}65 \cdot 10^{6}$$

$$Q = \underline{\underline{33{,}3\,\mu As}}$$

3. $a = 2\ cm$

$f = 16\ Hz$

$B = 0{,}2\ T$

$t = 1{,}5\ ms$

$R = 0{,}07\ \Omega$

U_i

$I_0 = ?$

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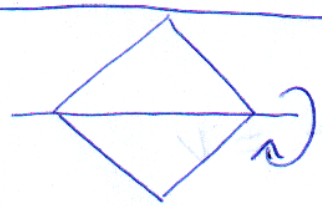

$$U_i = -B \cdot S \cdot \omega \cdot \sin(\omega t)$$

$$U_i = -0{,}2T \cdot 0{,}02^2\ m^2 \cdot 2\pi \cdot 16\ Hz \cdot \sin(2\pi \cdot 16\ Hz \cdot 1{,}5 \cdot 10^{-3}\ s)$$

$$U_i = 1{,}208\ mV$$

$$I = \frac{U_i}{R} \qquad I = I_0 \sin(\omega t)$$

$$\frac{I}{\sin(\omega t)} = I_0$$

$$I_0 = 115\ mA$$

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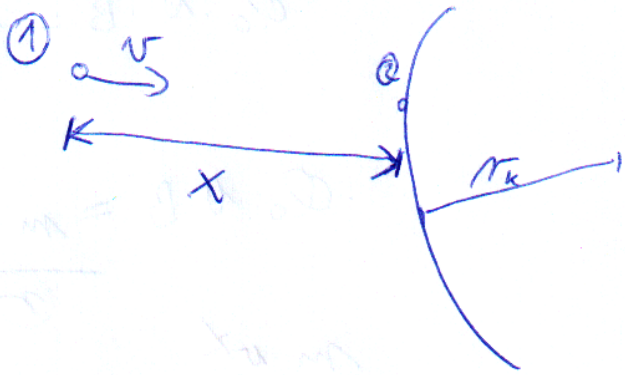
4. $Q_1 = 2 \cdot 10^{-5}\ As$

$Q_k = 10^{-5}\ As$

$r_k = 5\ cm$

$x = 2{,}8\ m$

$W_k = ?$



$$W_{①} = W_{k_1} + W_{Q_{p_1}}$$

$$W_{②} = \overset{=0}{W_{k_2}} + W_{Q_{p_1}}$$

$$W_{①} = W_{②}$$

$$W_{k_1} + Q_1 V_1 = Q_1 \cdot V_2$$

$$W_{k_1} = Q_1 (V_2 - V_1) = Q_1 \left(\frac{Q_k}{4\pi\varepsilon_0 r} - \frac{Q_k}{4\pi\varepsilon_0 (x+r)} \right) =$$

$$= \frac{Q_1 Q_k}{4\pi\varepsilon_0} \left(\frac{1}{r} - \frac{1}{x+r} \right) = 35{,}3\ J$$

5. $v = 20\,km/s$
$B = 10^{-2}\,T$

$U = ?$

$r = ?$

$\gamma = ?$

$m_p = 1{,}67 \cdot 10^{-27}\,kg$

$Q_0 = 1{,}6 \cdot 10^{-19}\,As$

a) $W_{elpot} = Q \cdot U$

$$\frac{W_{elp}}{Q} = U$$

$W_{elpot} = W_{kin}$

$W_{elp} = \frac{m v^2}{2}$

$$\frac{m v^2}{2Q} = U$$

$$\frac{1{,}67 \cdot 10^{-27}\,kg \cdot 20000^2 \left(\frac{m}{s}\right)^2}{2 \cdot 1{,}6 \cdot 10^{-19}\,As} = U$$

$$2\,V = U$$

b) $F = m \cdot a$

$F_{el} = m \cdot a_{RADIALNI}$

$Q_0 \cdot v \cdot B = m \cdot a_R$

$a_R = \frac{v^2}{r}$

$$Q_0\, v\, B = \frac{m \cdot v^2}{r} \quad / : m \cdot v^2$$

$$\frac{m \cdot \cancel{v}}{Q_0\, \cancel{v}\, B} = r$$

$$r = \underline{\underline{20{,}9\,mm}}$$

c) $$t_0 = \frac{s}{v} = \frac{2\pi r}{v} = \frac{2\pi \cdot 20{,}9 \cdot 10^{-3}\,m}{20000\,\frac{m}{s}} =$$

$$f = \frac{1}{t_0} = \underline{\underline{152\,kHz}}$$