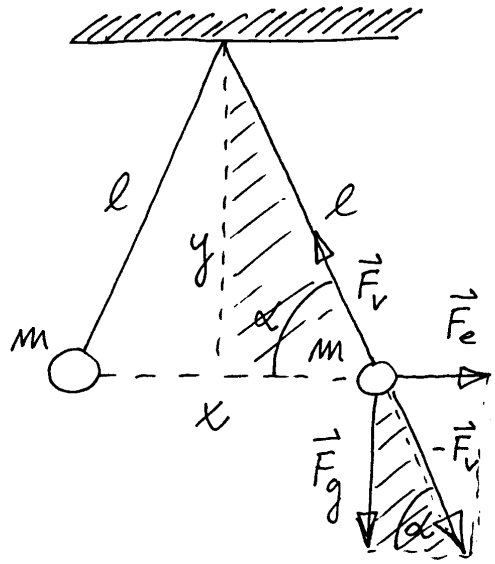
① $m = 10\,g$

$\ell = 30\,cm$

$x = 10\,cm$

$Q = ?$



$$\vec{F}_v + \vec{F}_g + \vec{F}_e = 0$$

$$\vec{F}_g + \vec{F}_e = -\vec{F}_v$$

$$\tan\alpha = \frac{F_g}{F_e} = \frac{y}{x/2} \qquad \left(\frac{x}{2}\right)^2 + y^2 = \ell^2$$

$$y^2 = \ell^2 - \left(\frac{x}{2}\right)^2$$

$$F_e = F_g \frac{x}{2y} \qquad y = \sqrt{\ell^2 - \left(\frac{x}{2}\right)^2} = 29{,}6\,cm$$

$$\frac{Q^2}{4\pi\varepsilon_0 x^2} = mg\frac{x}{2y} \qquad \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,\frac{N\,m^2}{(As)^2}$$

$$Q^2 = 4\pi\varepsilon_0 mg\frac{x^3}{2y}$$

$$Q = \sqrt{\frac{10^{-2}\,kg\cdot 10\,m\cdot 10^{-3}\,m^3}{s^2\;9\cdot10^9\,N\,m^2\,0{,}6\,m}(As)^2} = 13{,}6\times10^{-8}\,As$$

(2) $C = 10\,mF$

$U_0 = 12\,V$

$R_1 = 500\,\Omega$

$U_1 = 10\,V$

$U_2 = 4\,V$

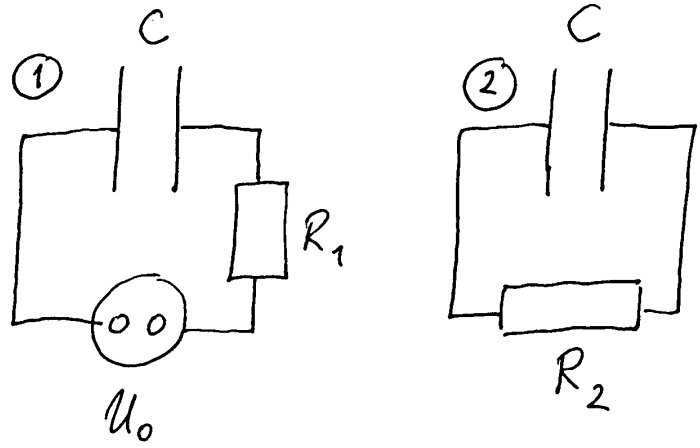
$t_2 = 5\,s$

$t_1 = ?$

$R_2 = ?$

$t_1 = 9\,s$

$R_2 = 555\,\Omega$



① $U_1 = U_0 \left(1 - e^{-\frac{t_1}{R_1 C}}\right)$

$e^{-\frac{t_1}{R_1 C}} = 1 - \frac{U_1}{U_0}$

$t_1 = -R_1 C \ln \frac{U_0 - U_1}{U_0}$

$t_1 = -500 \frac{V}{A} \cdot 10^{-2} \frac{As}{V} \ln \frac{2}{12}$

$t_1 = -5{,}0\,s \cdot (-1{,}8) = 9{,}0\,s$

② $U_2 = U_1 e^{-\frac{t_2}{R_2 C}}$

$\frac{U_2}{U_1} = e^{-\frac{t_2}{R_2 C}}$

$\frac{t_2}{R_2 C} = -\ln \frac{U_2}{U_1}$

$R_2 = \frac{t_2}{-C \cdot \ln \frac{U_2}{U_1}} = \frac{5\,s \cdot V}{-10^{-2} As (-0{,}9}$

$R_2 = 555\,\Omega$

(3) $d = 1\,m$

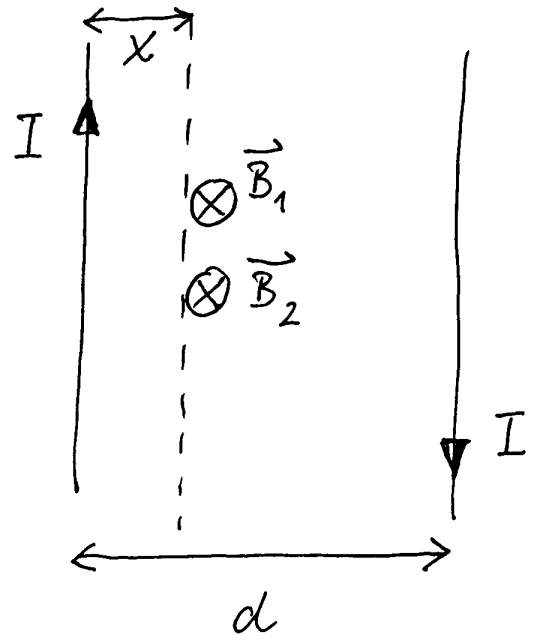
$I = 2A$

$x = 25\,cm$

$B = ?$

$\ell = d - x = 75\,cm$

$\ell = 3x$



$$B = B_1 + B_2$$

$$B = \frac{\mu_0 I}{2\pi x} + \frac{\mu_0 I}{2\pi \ell} = \frac{\mu_0 I}{2\pi}\left(\frac{1}{x} + \frac{1}{3x}\right)$$

$$B = \frac{\mu_0 I \cdot 2}{2\pi x \cdot 3} = \frac{2\mu_0 I}{3\pi x} = \frac{8\pi \cdot 10^{-7} Vs \cdot 2A}{Am \cdot 3\pi \cdot 0{,}25\,m}$$

$$B = 2{,}1 \cdot 10^{-6} \frac{Vs}{m^2}$$

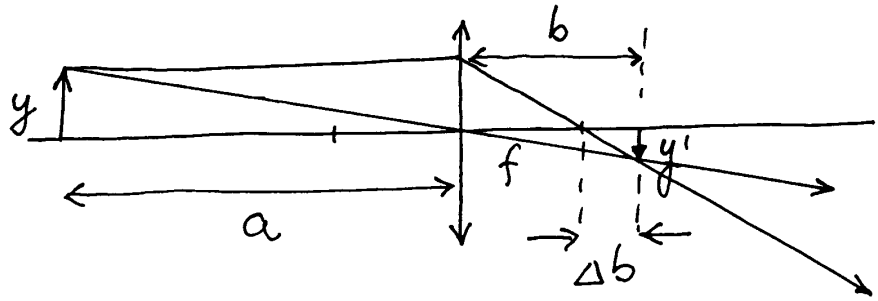
④ $f = 100\,мм$

$y = 60\,см$

$a = 2{,}1\,м$

$\Delta b = ?$

$y' = ?$



$$\Delta b = b - f$$

$$\frac{1}{f} = \frac{1}{a} + \frac{1}{b} \;\Big|\; a \cdot b \cdot f$$

$$ab = bf + af$$

$$b(a-f) = af \Rightarrow b = \frac{a \cdot f}{a-f} = 10{,}5\,см$$

$$\Delta b = 105\,мм - 100\,мм = 5\,мм$$

$$\frac{y}{a} = \frac{y'}{b} \Rightarrow y' = y\frac{b}{a} = 60\,см\,\frac{10{,}5}{210}$$

$$y' = 3\,см$$