Часть 1

Олимпиада: **Физика, 11 класс (1 часть)**

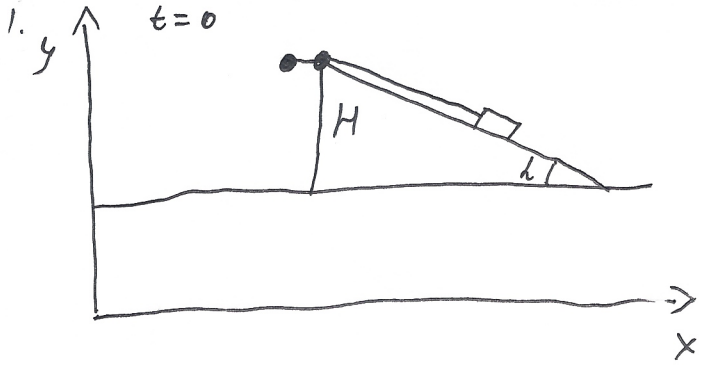
Шифр: **21200495**

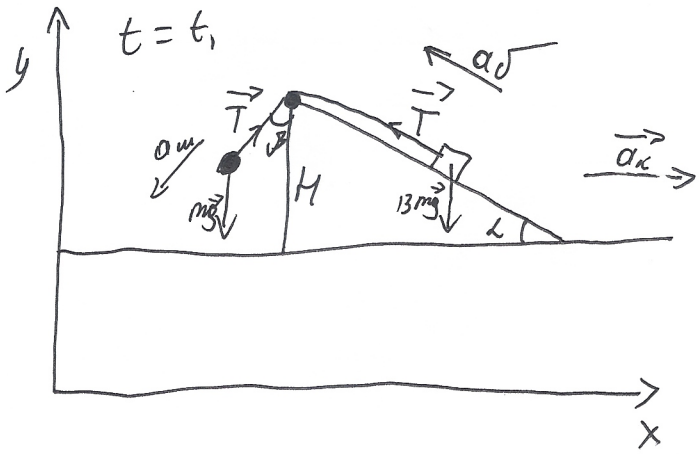
ID профиля: **105758**

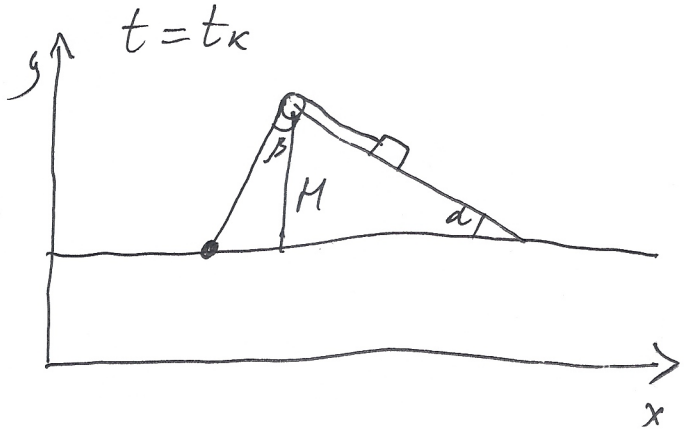
Вариант 5

Вариант 11-05 Чистовик

1.







на шарик:

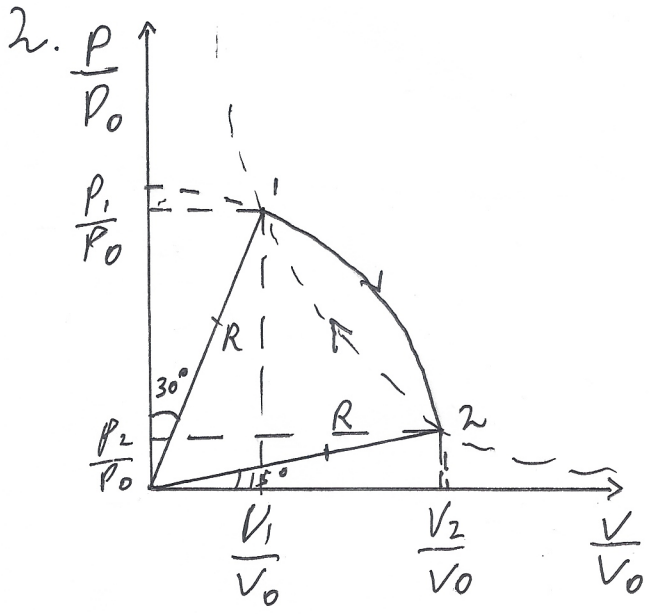
$mg \cdot \cos\beta - T = (a_ш - a_к \cdot \sin\beta)m$

на бруск

$13mg \cdot \sin\alpha - T = (a_б - a_к \cdot \cos\alpha) \cdot 13m$

$13mg \cdot \frac{\sqrt{5}}{13} - mg \cdot \frac{4}{5} = m(3a_б - a_ш + a_к(\sin\beta - 13\cos\alpha))$

Вариант 11-05 Чистовик

2. 

$$tg\,30^\circ = \frac{\frac{V_1}{V_0}}{\frac{P_1}{P_0}}, \quad tg\,15^\circ = \frac{\frac{V_2}{V_0}}{\frac{P_2}{P_0}}$$

$$\frac{tg\,30^\circ}{tg\,15^\circ} = \frac{V_1 P_2}{V_2 P_1} = \frac{\frac{1}{\sqrt{3}}}{2-\sqrt{3}} = \frac{1}{2\sqrt{3}-3} \Rightarrow$$

$$\frac{V_1}{V_2} = \frac{1}{2\sqrt{3}-3}\frac{P_1}{P_2} = \frac{1}{2\sqrt{3}-3}\cdot\frac{\cos 30}{\cos 15} \approx \frac{0{,}8965}{2\sqrt{3}-3}$$

$$R\cdot\cos 30 = \frac{P_1}{P_0} \qquad R\cdot\cos 15 = \frac{P_2}{P_0}$$

$$R\cdot\sin 30 = \frac{V_1}{V_0} \qquad R\cdot\sin 15 = \frac{V_2}{V_0}$$

1) $$\frac{T_1}{T_2} = \frac{P_1 V_1}{P_2 V_2} = \frac{P_0 V_0 R^2 \cos 30 \sin 30}{P_0 V_0 R^2 \cos 15 \sin 15} =$$

$$= \frac{\cos 30 \sin 30}{\cos 15 \cdot \sin 15} = \frac{\sin 60}{\sin 30} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3} \approx$$

$$\approx 1{,}73.$$

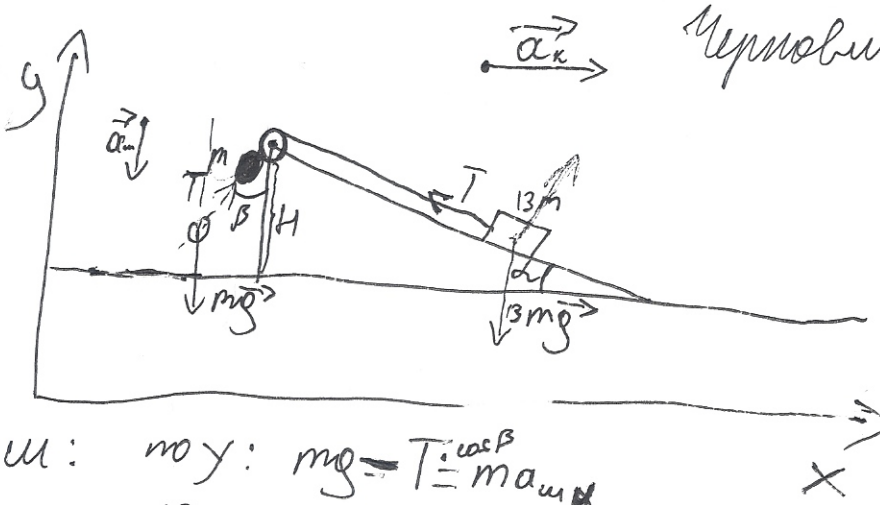
процесс 2-1: т.к. $Q \to 0$, то это адиабатический процесс $\Rightarrow$

$$PV^k = const \Rightarrow P_1 V_1^k = P_2 V_2^k \Rightarrow \frac{P_1}{P_2}\cdot\left(\frac{V_1}{V_2}\right)^k = 1 \Rightarrow \left(\frac{V_1}{V_2}\right)^k = \frac{P_2}{P_1} \Rightarrow k = \frac{\ln\frac{P_2}{P_1}}{\ln\frac{V_1}{V_2}} =$$

$$= \frac{\ln\left(\frac{1}{0{,}8965}\right)}{\ln\left(\frac{0{,}8965}{2\sqrt{3}-3}\right)} = \frac{0{,}109257}{0{,}660738} = 0{,}16536 \approx \frac{1}{6} \Rightarrow PV^6 = const.$$

3) $$\frac{A_{121}}{A_{12}} = \frac{A_{12} - A_{21}}{A_{12}} = 1 - \frac{A_{21}}{A_{12}}$$, где $A_{21} = \Delta U = \nu R(T_2 - T_1)$, а (2)

$$A_{12} = \int_{V_1}^{V_2} P(V)\,dV$$, где $P(V) = \sqrt{R^2 - \left(\frac{V}{V_0}\right)^2}\cdot P_0$



$\vec{a}_к$ — человек

$\cos\alpha = \frac{12}{13}$ $\sin\alpha = \frac{5}{13}$

$\cos\beta = \frac{4}{5}$ $\sin\beta = \frac{3}{5}$

1) a_c — ?

2) $a_{бк}$ — ?

3) $t_м$ — ?

$\cos 2x = 2\cos^2 x - 1$

$\sqrt{1+\frac{\sqrt{3}}{2}}$

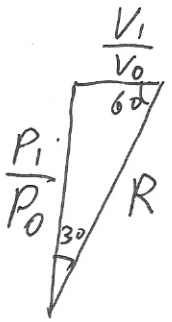
м: по y: $mg = T\cos\beta + ma_{мy}$

по x: $T\cdot\sin\beta = m(a_к - a_{мx})$

б: по y: $13mg - T\cdot\cos\alpha = 13ma_{бy}$

по x: $T\cdot\sin\alpha = 13m(a_к + a_{бx})$

$R = \sqrt{\frac{P_1^2}{P_0^2} + \frac{V_1^2}{V_0^2}}$



$V^6 - V = 0$

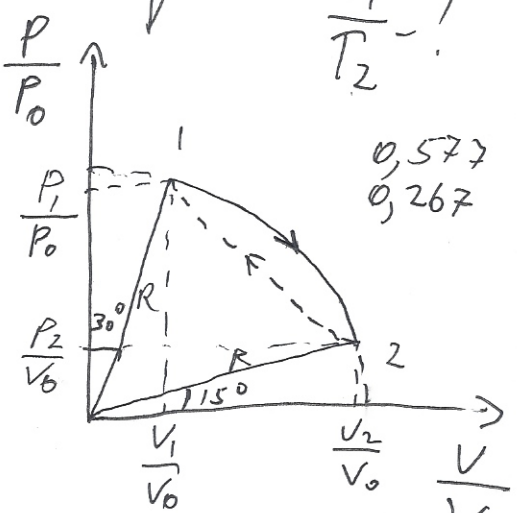
$V^5 - 1 = 0$

$V^5 = 1$

$V = 1$

$R = \sqrt{\frac{P_2^2}{P_0^2} + \frac{V_2^2}{V_0^2}}$

$\frac{T_1}{T_2}$ — ?



$\operatorname{tg}30° = \frac{1}{\sqrt{3}} = \frac{2\operatorname{tg}15}{1-\operatorname{tg}^2 15}$

$1 - \operatorname{tg}^2 15 = 2\sqrt{3}\operatorname{tg}15$

$a^2 + 2\sqrt{3}a - 1 = 0$

$D_4 = 3 + 1 = 4 = 2^2$

$a = \frac{-\sqrt{3} \pm 2}{1} =$

$= 2 - \sqrt{3}$

$\frac{1}{2\sqrt{3}-3}$

$\operatorname{tg}30° = \frac{\frac{P_1}{P_0}}{\frac{V_1}{V_0}} = \frac{P_1 V_0}{P_0 V_1}$

$\operatorname{tg}15° = \frac{P_2 V_0}{P_0 V_2}$

$\frac{\operatorname{tg}30°}{\operatorname{tg}15°} = \frac{P_1 V_2}{P_2 V_1} \approx 2{,}154$

$\frac{P_1 V_1}{P_2 V_2} = \frac{\nu R T_1}{\nu R T_2} \Rightarrow \frac{T_1}{T_2} = 2{,}154\left(\frac{V_1}{V_2}\right)^2$

$\frac{P_1^2}{P_0^2} + \frac{V_1^2}{V_0^2} = \frac{P_2^2}{P_0^2} + \frac{V_2^2}{V_0^2}$

$\frac{P_1}{P_2} = 2{,}154\frac{V_1}{V_2}$

$\sin 30 = \frac{\frac{V_1}{V_0}}{R}$

$\sin 15 = \frac{\frac{V_2}{V_0}}{R}$ $\Rightarrow \frac{V_1}{V_2}$

$\frac{T_1}{T_2} = 2{,}154 \cdot (3{,}732023 = 8{,}038 \approx 8$

1,931844

0,5177

0,2677

0,25882

Черновик

Процесс 2–1: $Q \to 0 \Rightarrow$ 2-1 – адиабата $\Rightarrow PV^k = const$

$P_1V_1^k = P_2V_2^k =$

$A_{21} = \frac{3}{2}\nu R T_{21}$

$\frac{P_1}{P_2} \cdot \left(\frac{V_1}{V_2}\right)^k = 1$

$\left(\frac{V_1}{V_2}\right)^k = \frac{P_2}{P_1}$

$\left(\frac{P}{P_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = R^2$

$k \ln\left(\frac{V_1}{V_2}\right) = \ln\frac{P_2}{P_1}$

$\left(\frac{P}{P_0}\right)^2 = R^2 - \left(\frac{V}{V_0}\right)^2$

$\frac{P}{P_0} = \sqrt{R^2 - \left(\frac{V}{V_0}\right)^2}$

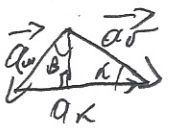
$k = \log_{\frac{V_1}{V_2}} \frac{P_2}{P_1} = \log_{1,931844} 0,240316 = \frac{-1,4258}{0,658475} = -2,165 \approx$

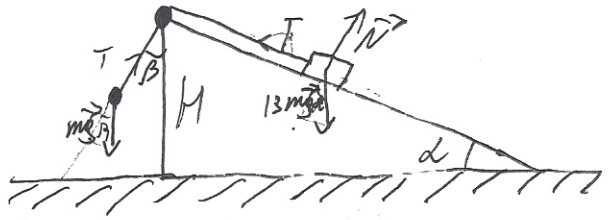
$\approx -2,2$

$\frac{A_{121}}{A_{12}} = \frac{\int_{V_1}^{V_2} \sqrt{R^2 - \left(\frac{V}{V_0}\right)^2}\, dV - A_{21}}{\int_{V_1}^{V_2} \sqrt{R^2 - \left(\frac{V}{V_0}\right)^2}\, dV} = 1 - \frac{A_{21}}{V_0 \arcsin\left(\frac{V}{V_0 R}\right)\Big|_{V_1}^{V_2}} = 1 - \frac{\frac{3}{2}\nu R T_{21}}{V_0 \arcsin\left(\frac{V_2}{V_0 R}\right) - V_0 \arcsin\left(\frac{V_1}{V_0 R}\right)}$

Черновик

$\vec{a_к}$





$\cos\alpha = \frac{12}{13}$

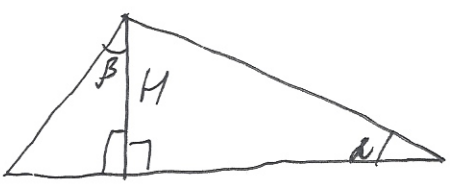
$\sin\alpha = \frac{5}{13}$

$\cos\beta = \frac{4}{5}$

$\sin\beta = \frac{3}{5}$

$mg\cos\beta - T = a_м m$

$T - 13mg\sin\alpha = a_б \cdot 13m$



$mg \cdot \frac{4}{5} - T = a_м m$

$T - 5mg = 13 a_б m$

$\frac{4}{5} mg - T = a_м m - a_к m \cdot \frac{3}{5}$

$T - 5mg = 13 a_б m - a_к 13m \cdot \frac{12}{13}$

$a_к 12m$

$\frac{a_м}{a_к} = \sin\beta$

$a_м = \frac{3}{5} a_к$

$\frac{4}{5} mg - T = a_м m - a_к \cdot \frac{3}{5} m$

$T - 5mg = a_б m - a_к 12m$

Часть 2

Олимпиада: **Физика, 11 класс (2 часть)**

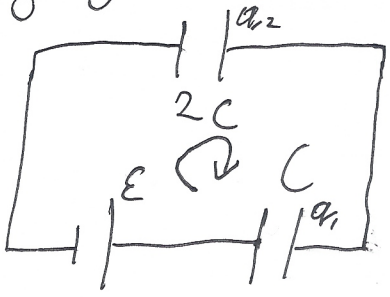
Шифр: **21200495**

ID профиля: **105758**

Вариант 5

Вариант 11-05 Читовик

3. до замыкания:

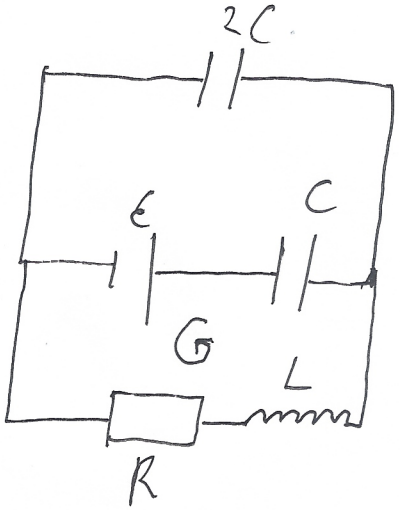


т.к. первоначально конденсаторы не заряжены, то заряды на них равны:

$q_1 = q_2 = q \Rightarrow CU_C = 2CU_{2C} \Rightarrow U_C = 2U_{2C}$

$\mathcal{E} = U_{2C} + U_C = 3U_{2C} \Rightarrow U_{2C} = \frac{1}{3}\mathcal{E};\ U_C = \frac{2}{3}\mathcal{E}$

сразу после замыкания:

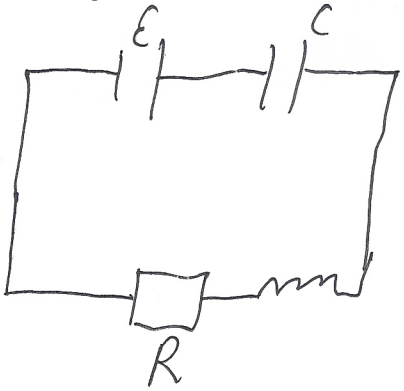


т.к. ключ только замкнули, то ~~ток~~ тока через резистор и катушку нет: $I_1 = 0$

$$\mathcal{E} = \underset{\|\ 0}{I_1 \cdot R} + L\frac{dI}{dt} + U_C \Rightarrow \frac{dI}{dt} = \frac{\mathcal{E} - U_C}{L} = \frac{\mathcal{E}}{3L}$$

Примечание: далее идут обозначения вида U_C', q_C', q_C'', q_{2C}''. ~~Штрих~~ Штрих обозначает не производную, а используется как отличительный знак.

через $t \to \infty$: $U_{2C} = 0,\ I = 0 \Rightarrow \mathcal{E} = U_C'$ |·C



$U_C' \cdot C = q_C' = C\mathcal{E}$

$\Delta q = C\mathcal{E} - CU_C = C\mathcal{E} - \frac{2}{3}C\mathcal{E} = \frac{C\mathcal{E}}{3}$

$A_{ист} = \Delta W_C + Q$

$\mathcal{E}\cdot\Delta q = \frac{CU_C'^2}{2} - \frac{CU_C^2}{2} - \frac{2CU_{2C}^2}{2} + Q$

$Q = \frac{C\mathcal{E}^2}{3} - \frac{C\mathcal{E}^2}{2} + \frac{4C\mathcal{E}^2}{9\cdot 2} + \frac{C\mathcal{E}^2}{9} =$

$= \frac{C\mathcal{E}^2}{6}$

Когда $I_C = I_0$: $\mathcal{E} = \frac{q_C''}{C} + \frac{q_{2C}''}{2C}$ продифф-м обе части

$0 = \frac{I_0}{C} + \frac{I_{2C}}{2C} \Rightarrow I_{2C} = -2I_0.$

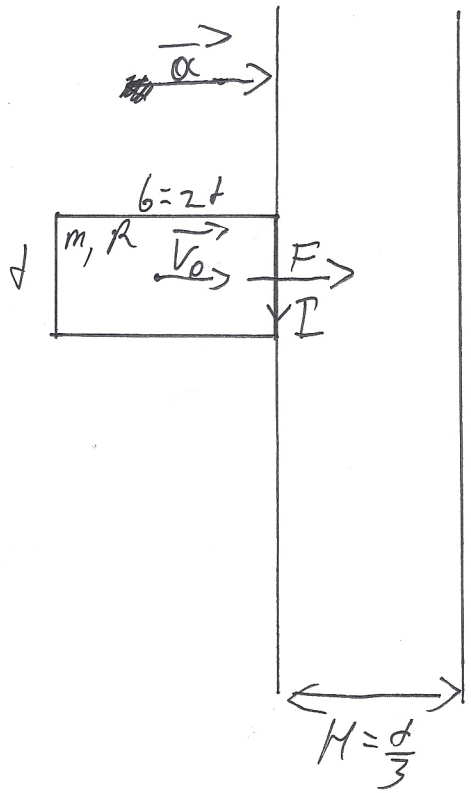
$I_L = I_R = I_1 + I_2 = I_0 - 2I_0 = -I_0$

Ответ: 1) $\frac{dI}{dt} = \frac{\mathcal{E}}{3L}$; 2) $Q = \frac{C\mathcal{E}^2}{6}$; 3) $I_L = -I_0$.

(1)

Вариант 11-05 Чистовик

4.



$\mathcal{E}_i = B v_0 d \Rightarrow I = \frac{\mathcal{E}_i}{R} = \frac{B v_0 d}{R}$

$ma = BId \Rightarrow a = \frac{BId}{m} = \frac{B^2 v_0 d^2}{mR}$

$H = v_0 t + \frac{at^2}{2} = \frac{d}{3}$

$\frac{at^2}{2} + v_0 t - \frac{d}{3} = 0$

$t = \underline{\quad -v_0 \quad}$

(2)

Вариант 11-05 Чистовик

5. В очках стоят рассеивающие линзы, поэтому

$-\frac{1}{F_1} = -D_1 = \frac{1}{0,25} - \frac{1}{x}$; $\frac{D_2}{D_1} = 2 \Rightarrow D_2 = 2D_1$

$-\frac{1}{F_2} = -D_2 = \frac{1}{L} - \frac{1}{x}$, где $L \to \infty \Rightarrow \frac{1}{L} \to 0 \Rightarrow D_2 = \frac{1}{x} \Rightarrow D_1 = \frac{1}{2x}$

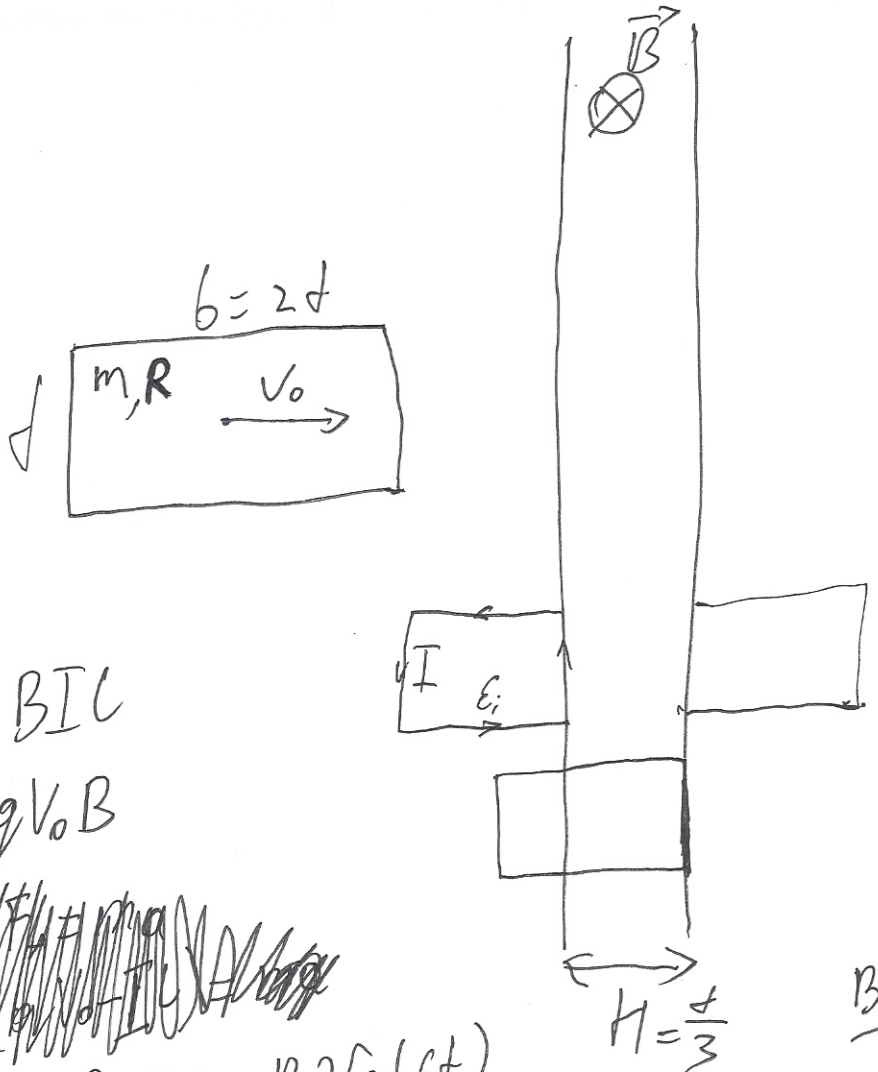
$-\frac{1}{2x} = \frac{1}{0,25} - \frac{1}{x} \Rightarrow \frac{1}{2x} = \frac{1}{0,25} \Rightarrow x = 0,125\ м = 12,5\ см \Rightarrow D_2 = \frac{1}{x} = 8$ дптр

$-D_3 = \frac{1}{0,5} - \frac{1}{x} \Rightarrow D_3 = \frac{1}{x} - \frac{1}{0,5} = 8 - 2 = 6$ дптр

Ответ: 1) 12,5 см ; 8 дптр 2) 6 дптр

Черновик

4.



$F_A = BIL$

$F_A = qv_0B$

$\mathcal{E}_i = Bv_0L = Bv_0(6d)$

$I = \frac{\mathcal{E}_i}{R} = \frac{6Bv_0d}{R}$

$ma = BIL \Rightarrow a = \frac{BIL}{m} = \frac{BI \cdot 36d^2}{m}$

$H = \frac{d}{3} = \frac{v_1^2 - v_0^2}{2a}$

$\frac{BId^3}{m} = \frac{6Bv_0d}{R} \cdot \frac{Bd^3}{m} = \frac{6B^2v_0d^4}{Rm}$

$24 \times 6 = 144$ $\quad 168 \times 6 = 1008$

$\frac{7 \cdot 2 \cdot 36}{3} = 168$ $\quad 24 = 140 + 28$, $2 = 11$

$v_1 = \sqrt{\frac{2}{3}da + v_0^2} = \sqrt{\frac{24BId^3}{m} + v_0^2} = \sqrt{\frac{144B^2v_0d^4}{Rm} + v_0^2}$

$v_2 = \sqrt{\left(\frac{d}{3} + 2d\right)\frac{BI \cdot 36d^2}{m} + v_0^2} = \sqrt{\frac{168BId^3}{m} + v_0^2} = \sqrt{\frac{1008B^2v_0d^4}{Rm} + v_0^2}$

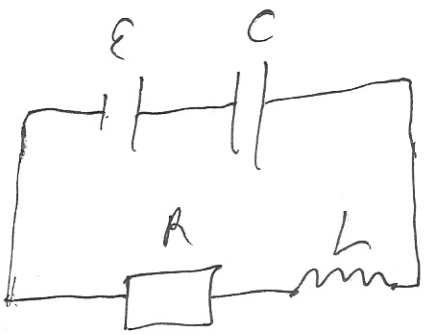
Чупов

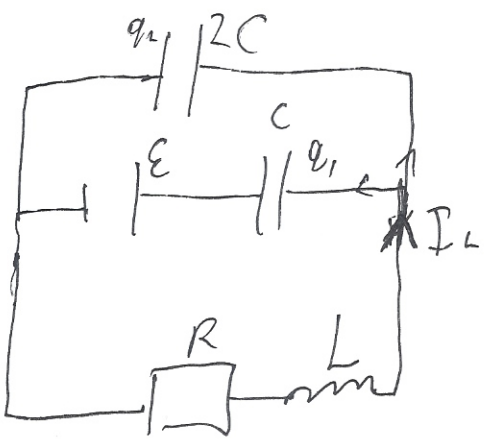
$t \to \infty \Rightarrow U_{2C} = 0,\ I = 0 \Rightarrow \mathcal{E} = U_C' \mid \cdot C$

$\mathcal{E}C = U_C' \cdot C = q_C' \Rightarrow q_C' = C\mathcal{E}$

$\Delta q_1 = q_C' - q_C = C\mathcal{E} - \frac{2}{3}C\mathcal{E} = \frac{C\mathcal{E}}{3}$

$A_{ист} = \Delta W_C + Q + \Delta W_L$, по т.к. $I_0 = 0,\ I_K = 0 \Rightarrow \Delta W_L = 0$





$\mathcal{E} \cdot \Delta q = \frac{CU_C'^2}{2} + \frac{CU_C^2}{2} - \frac{2CU_{2C}^2}{2} + Q$

$Q = \frac{C\mathcal{E}^2}{3} - \frac{C\mathcal{E}^2}{2} + \frac{4 \cdot C\mathcal{E}^2}{9 \cdot 2} + \frac{C\mathcal{E}^2}{9} =$

$= -\frac{2C\mathcal{E}^2}{3} - \frac{C\mathcal{E}^2}{2} = C\mathcal{E}^2\left(\frac{2}{3} - \frac{1}{2}\right) =$

$= C\mathcal{E}^2\left(\frac{4}{6} - \frac{3}{6}\right) = \frac{C\mathcal{E}^2}{6}$

$I_{ист} = I_0$

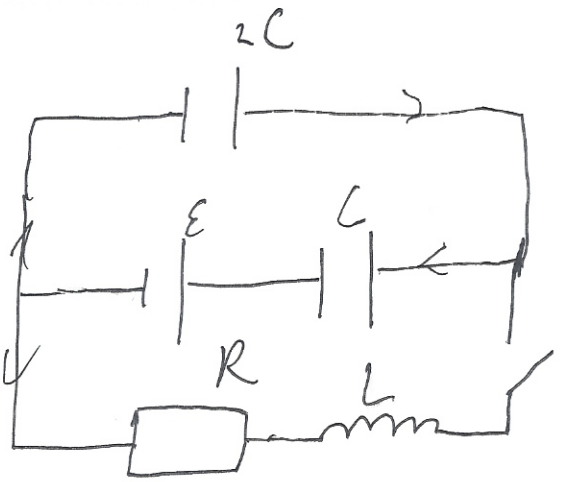
$\mathcal{E} = \frac{q_1}{C} + \frac{q_2}{2C}$, продиф. обе части

$0 = \frac{I_1}{C} + \frac{I_2}{2C} \Rightarrow I_0 + \frac{I_2}{2} = 0 \Rightarrow I_0 \cdot (-2) = I_2 \Rightarrow I_2 = -2I_0$

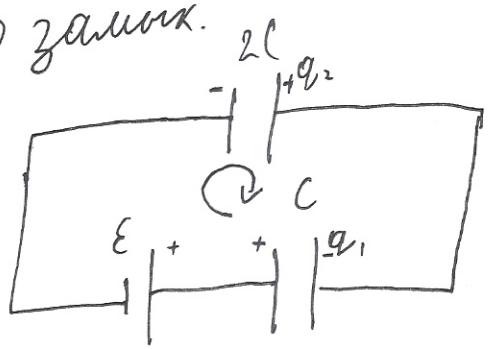
$I_L = I_R = I_1 + I_2 = I_0 - 2I_0 = -I_0$

Черновик

3.



до замык.



$q_1 + q_2 = 0 \Rightarrow \cancel{U_C = 2U_{2C}}$

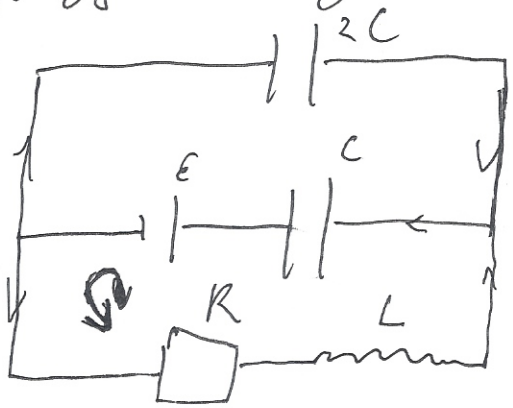
$U_C = 2U_{2C}$

$\mathcal{E} = U_{2C} + U_C$

$U_{2C} = \frac{\mathcal{E}}{3}$

$U_C = \frac{2}{3}\mathcal{E}$

сразу после замык:



$\mathcal{E} = L\frac{\Delta I}{\Delta t} + U_C$

$\Downarrow$

$L\frac{\Delta I}{\Delta t} = \mathcal{E} - U_C$

$\boxed{\frac{\Delta I}{\Delta t} = \frac{1}{3}\frac{\mathcal{E}}{L}}$

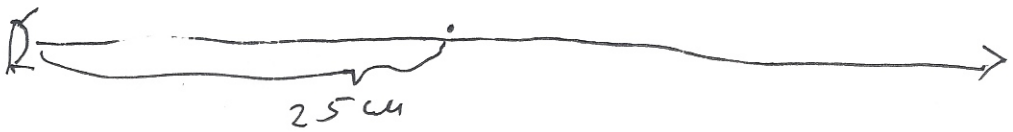
$A_{ист} = \Delta W_C + \Delta W_L + Q$

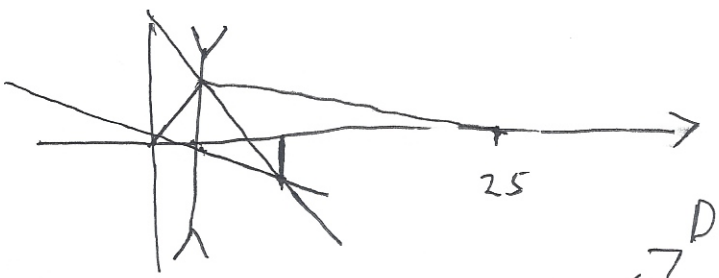
$\mathcal{E} = I_m R + U_C'$

$0 = I_m R - U_{C2}' \Rightarrow U_{C2}' = I_m R \Rightarrow \mathcal{E} = U_{C1}' + U_{C2}'$

5.

Черновик





$D_2 = 8$

$D_1 = 4$

$\frac{D_2}{D_1} = 2$

$D_2 = 4 + D_1$

$\frac{F_1}{F_2} = 2$

$X = \frac{1}{D_2} = \frac{1}{8} = 12{,}5$ см

$D_1 = \frac{1}{0{,}25} + \frac{1}{X}$

$D_2 = \frac{1}{L} - \frac{1}{X}$

$L \to \infty$

$-D_3 = \frac{1}{0{,}5} - 8$

$D_3 = 6$ дптр.

$\frac{1}{F} = \frac{1}{25} - \frac{1}{F}$

$\frac{2}{F} = \frac{1}{25}$

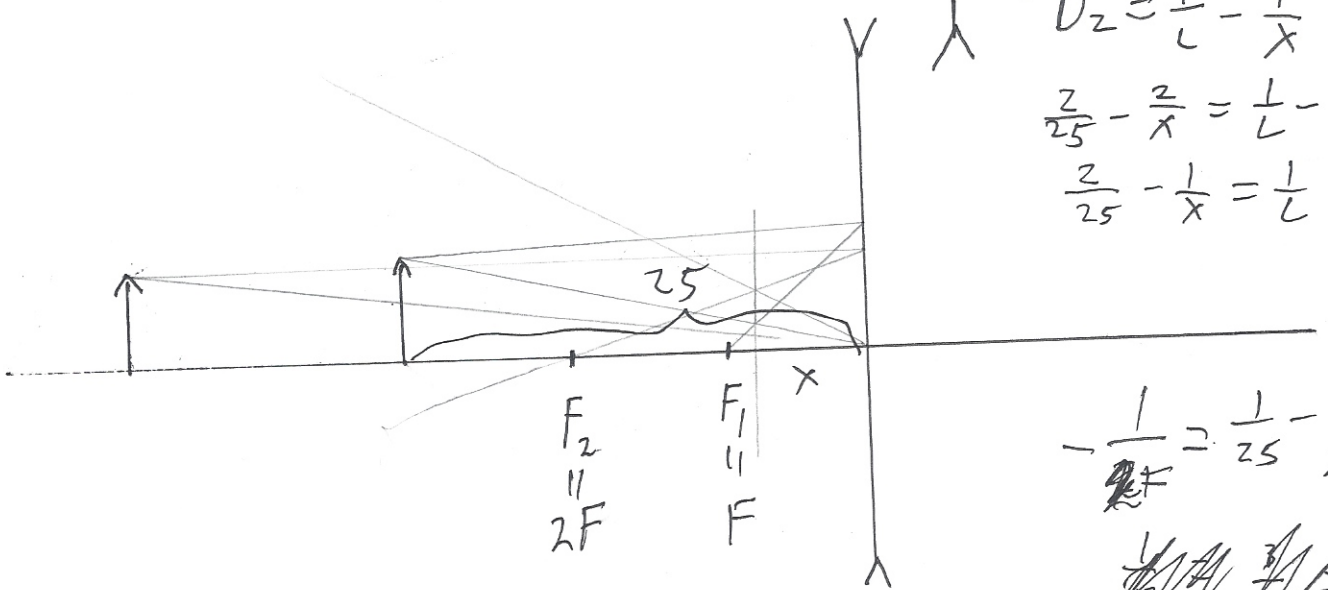
$F = 50$ см

$-D_1 = \frac{1}{25} - \frac{1}{X}$

$D_2 = \frac{1}{L} - \frac{1}{X}$

$\frac{2}{25} - \frac{2}{X} = \frac{1}{L} - \frac{1}{X}$

$\frac{2}{25} - \frac{1}{X} = \frac{1}{L}$



$-\frac{1}{F} = \frac{1}{25} - \frac{1}{2F}$

$\frac{1}{2F} = \frac{1}{25}$

$F = 12{,}5$ см

$-\frac{1}{F'} = \frac{1}{50} - \frac{4}{50}$

$F' = \frac{50}{3}$ см

$D' = \frac{1}{F'} = \frac{3}{50} \cdot 100 = 6$ дптр

$D_2 = \frac{1}{F} = \frac{1}{0{,}125} = 8$ дптр