Часть 1

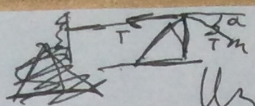
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21203251**

ID профиля: **849585**

Вариант 1

чистовик

3) 2 ЗН для клина:  Из (1)

$$T - T\cos\alpha = a_{кл}\cdot M \qquad m\,a_т = \frac{T\cos\alpha}{\cos\beta}$$

$$M\cdot a_{кл} = T(1-\cos\alpha)$$

$$M = \frac{T(1-\cos\alpha)}{a_{кл}} \qquad m = \frac{T\cos\alpha}{\cos\beta\cdot a_т}$$

$$\frac{m}{M} = \frac{\cancel{T}\cos\alpha\cdot a_{кл}}{\cos\beta\cdot a_т\cdot\cancel{T}(1-\cos\alpha)} = \frac{\cos\alpha\cdot\cancel{g}\cdot\frac{15}{2}}{\frac{g}{(tg\beta+tg\alpha)}(1-\cos\alpha)} =$$

$$\left(a_т = \frac{g}{(\sin\beta+\cos\beta\, tg\alpha)}\right) = \frac{\frac{\cancel{3}}{\cancel{5}}\cdot\frac{15}{2}}{\frac{\cancel{10\cdot 3}}{\cancel{10}}\cdot\frac{2}{\cancel{5}}} = 15.$$

4) $a_т\cdot\sin\beta\cdot\frac{t^2}{2} = H$

$$\frac{g}{\left(1+\frac{tg\alpha}{tg\beta}\right)}\cdot\frac{t^2}{2} = H \Rightarrow t = \sqrt{\frac{H\cdot 2\cdot\left(1+\frac{tg\alpha}{tg\beta}\right)}{g}} =$$

$$= \sqrt{\frac{H\cdot 2\left(1+\frac{4}{6}\right)}{10}} = \sqrt{\frac{H\cdot\cancel{10}/6\cdot 2}{\cancel{10}}} = \sqrt{\frac{H}{3}}.$$

Ответ: 1) $tg\beta = 2$ 2) $7{,}5$ м/с^2 3) 15 4) $\sqrt{\frac{H}{3}}$ с.

Чистовик

№2

$i = 3$ т.к. He

1) $C = \frac{\Delta Q}{\nu \Delta T}$

$$2R\frac{T}{T_0} = \frac{\Delta Q}{\nu \Delta T} \Rightarrow \Delta Q = \frac{2R\nu}{T_0}\cdot T\Delta T \quad (*)$$

Просуммируем * за всё время охлаждения

$$Q_{получ.} = \frac{2R\nu}{T_0}\sum T\Delta T = \nu\frac{2R}{T_0}\frac{\left(\left(\frac{5}{6}T_0\right)^2 - T_0^2\right)}{2} =$$

$$= \frac{\cancel{2}R\nu T_0^{\cancel{2}}\left(\frac{25}{36}-1\right)}{\cancel{T_0}\cdot\cancel{2}} = \nu R\cdot T_0\left(-\frac{11}{36}\right) = -\frac{11}{36}\nu R T_0 \Rightarrow$$

$$\Rightarrow Q_1 = \frac{11}{36}\nu R T_0.$$

2) $Q = \Delta U + A$

$$C_{(T)}\nu\Delta T = \frac{i}{2}\nu R\Delta T + A_{(T)} \Rightarrow A_{(T)} = \nu C_{(T)}\Delta T - \frac{i}{2}\nu R\Delta T =$$

$$= \Delta T\left(\nu C_{(T)} - \frac{i}{2}\nu R\right) = \nu\frac{2R}{T_0}\cdot T\Delta T - \frac{i}{2}\nu R\Delta T$$

$$A_{(T)} = \nu\frac{2R}{T_0}\cdot T\Delta T - \frac{i}{2}\nu R\Delta T \quad \#$$

Просуммируем # за всё время охлаждения

$$A = \nu\frac{\cancel{2}R}{T_0}\cdot\frac{T_K^2 - T_0^2}{\cancel{2}} - \frac{3}{2}\nu R(T_K - T_0) =$$

$$= \frac{\nu R}{T_0}\cdot T_K^2 - \frac{\nu R\cdot T_0^{\cancel{2}}}{\cancel{T_0}} - \frac{3}{2}\nu R T_K + \frac{3}{2}\nu R T_0 =$$

$$= \frac{\nu R}{T_0}T_K^2 - \frac{3}{2}\nu R T_K + RT_0\left(\frac{3}{2}\nu - \nu\right).$$

$T_K = \frac{-b}{2a}$

$$T_K = \frac{\frac{3}{2}\cancel{\nu R}}{2\cancel{\nu R}/T_0} = \frac{3}{4}T_0$$

$$A = \frac{\nu R}{T_0}\cdot\frac{9T_0^2}{16} - \frac{3}{2}\nu R\cdot\frac{3}{4}T_0 + \frac{3}{2}\nu R T_0 - \nu R T_0 =$$

чистовик

$$= \frac{9}{16}\nu^{\cancel{2}} RT_0 - \frac{9}{8}\nu RT_0 + \frac{3}{2}\nu RT_0 - \nu RT_0 =$$

$$= \cancel{\nu^2} RT_0\left(\frac{9}{16}\cancel{\nu^2} - \frac{9}{8}\nu + \frac{12}{8}\nu - \nu\right) =$$

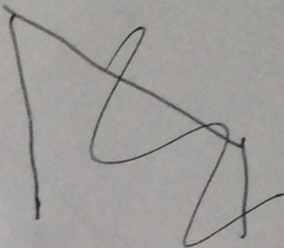
$$= \nu RT_0\left(\frac{9}{16}\cancel{\nu} + \frac{3}{8}\cancel{\nu} - 1\right) = \nu RT_0\left(\frac{9}{16} + \frac{6}{16} - \frac{16}{16}\right) = -\frac{\nu RT_0}{16}$$

Ответ: 1) $\frac{11}{36}\nu RT_0$ 2) $\frac{3}{4}T_0$ 3) $-\frac{\nu RT_0}{16}$

черновик

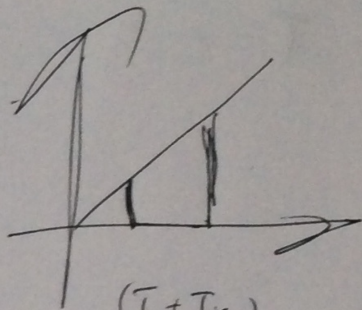
$$C(T) = 2R\frac{T}{T_0}$$

$$C = \frac{\Delta Q}{\Delta T}$$



$$2R\frac{T}{T_0} = \frac{\Delta Q}{\Delta T}$$

$$\Delta Q = \frac{2R}{T_0} T\Delta T$$



$$\frac{(T_н + T_к)}{2}$$

$$Q = \Delta U + A$$

$$Q = \frac{i}{2}\nu R\Delta T$$

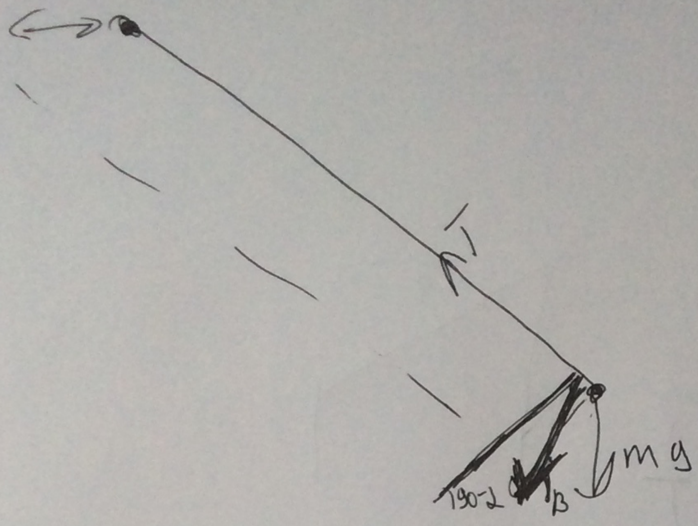
$$A(T) = \Delta T\left(\frac{2RT}{T_0} - \frac{i}{2}\nu R\right)$$

$$\frac{a_{кл}}{a_ш\cdot\sin\beta} = \frac{1}{\sin\alpha}$$

$$a_{кл} = \frac{g}{\left(1+\frac{tg\alpha}{tg\beta}\right)\cdot\sin\alpha} = \frac{10}{\left(1+\frac{4}{6}\right)\cdot\frac{4}{5}} =$$

$$= \frac{\cancel{10}\cdot 5\cdot \cancel{6}^{3}}{\cancel{10}\cdot \cancel{4}_{2}}$$

Черновик

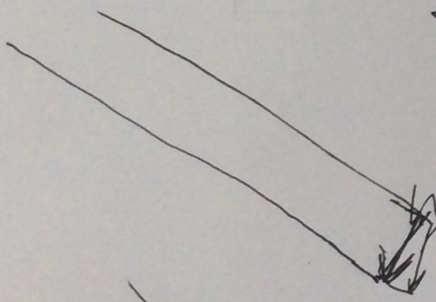


$\cancel{T = mg}$ $\cancel{T\sin\alpha - mg =}$

$mg - T\sin\alpha = ma\sin\beta$

$T\cos\alpha = ma\cos\beta$

$\cancel{mg - \frac{ma\cos\beta \cdot \sin\alpha}{\cos}}$

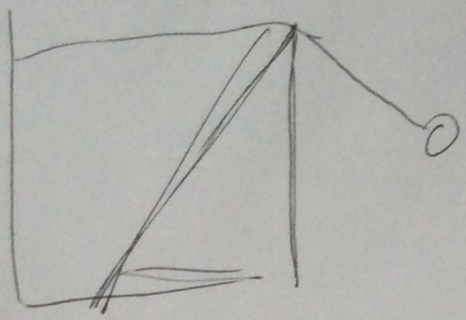


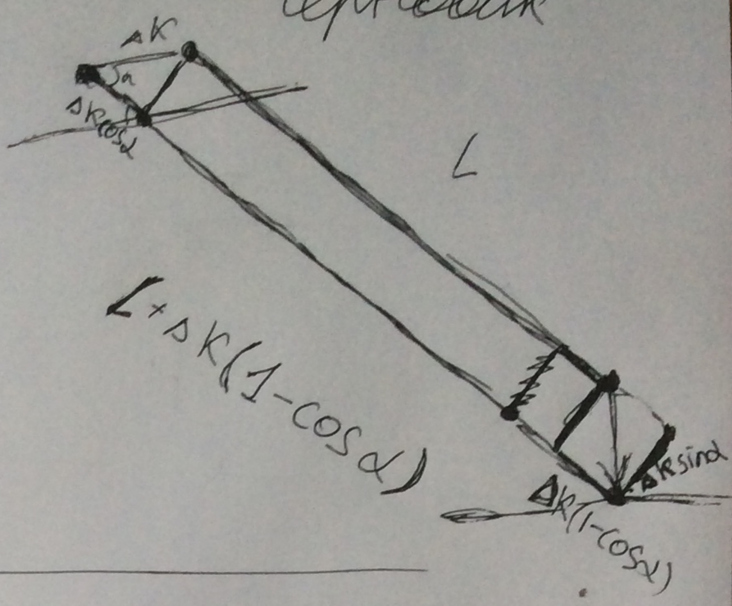
$mg - \cancel{m}a\cos\beta\, tg\alpha = \cancel{m}a\sin\beta$

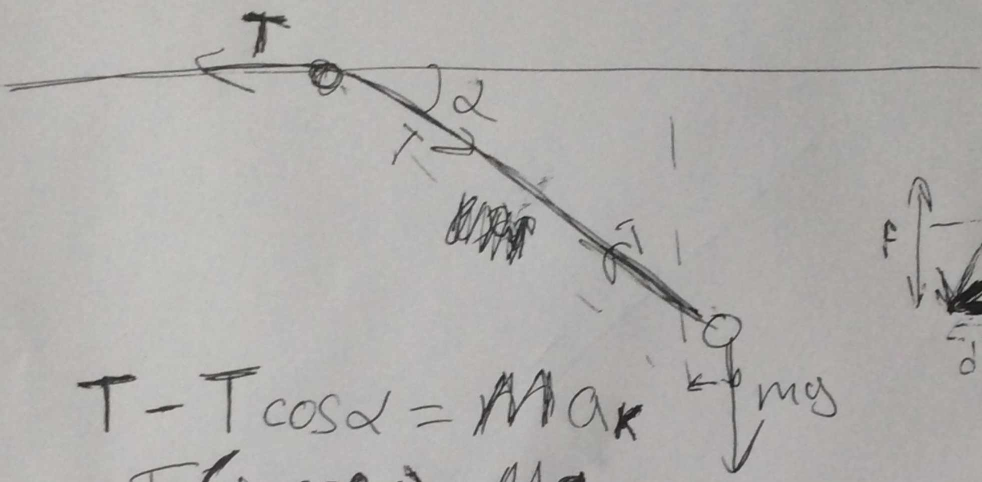
$$a = \frac{g}{(\sin\beta + \cos\beta\, tg\alpha)}$$

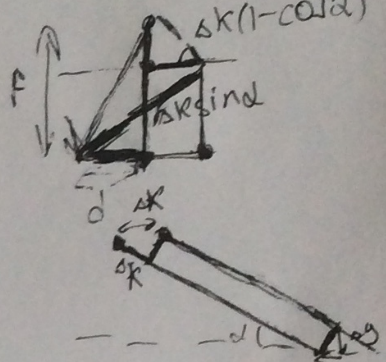
$acos\beta\, t^2$

Черновик



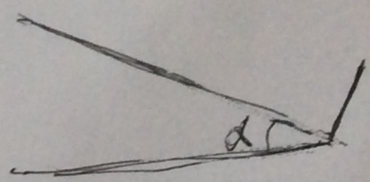






$$T - T\cos\alpha = Ma_k$$

$$T(1-\cos\alpha) = Ma_k$$

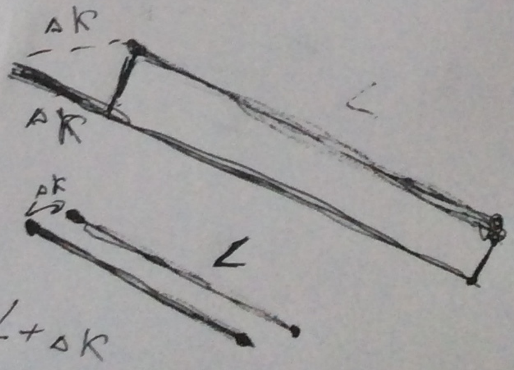


$$mg - T\sin\alpha = ma_y$$

$$T\cos\alpha = ma_x$$

$90^\circ - \alpha$

$$T = mg\cos\beta$$



$\Delta k \sin\alpha \cdot \cos(90 - \alpha)$

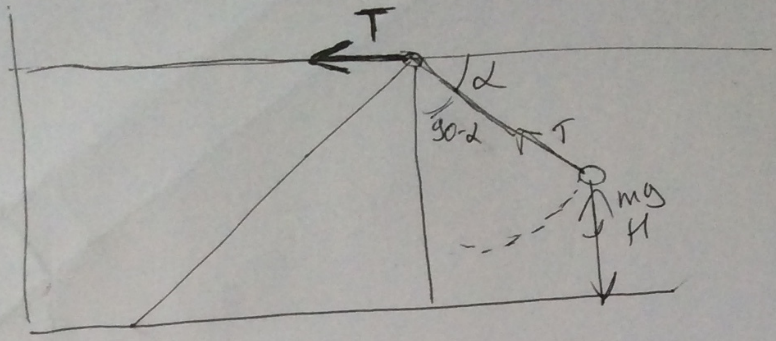
$\Delta k(1-\cos\alpha) \cdot \cos\alpha$

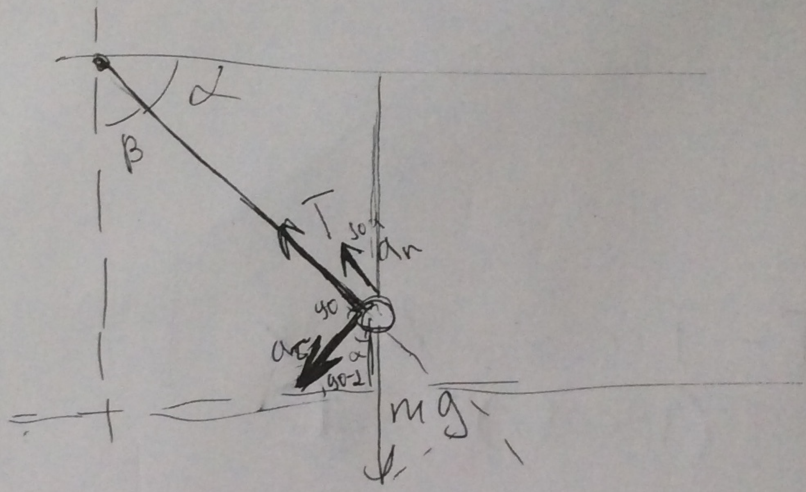
$\Delta k(\sin^2\alpha - \cos\alpha + \cos^2\alpha)$

$\Delta k(1-\cos\alpha)$

$F = \Delta k(1-\cos\alpha) \cdot \sin\alpha + \Delta k \sin\alpha \cdot \cos\alpha =$
$= \Delta k \sin\alpha ($

Черновик





$\cancel{mg\cos\beta = T}$

$$T - mg\cos\beta = \cancel{m}a_n \to 0$$

$$mg\sin\beta = m a_\tau$$

$$a_n = \frac{V^2}{L} \qquad T = mg\cos\beta$$

$$mg\sin\beta =$$

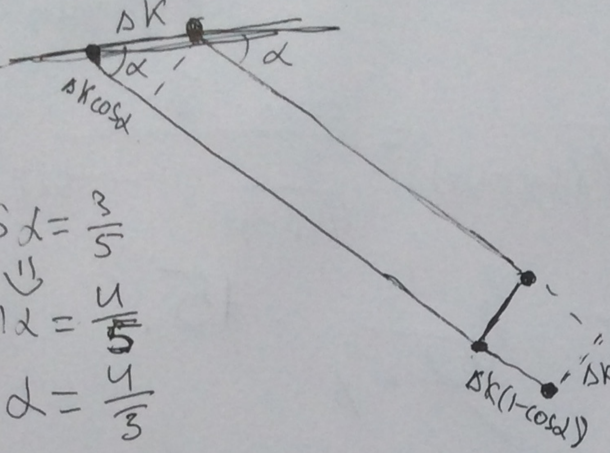
$$\sin(90-\alpha) = \cos\alpha = \frac{3}{5}$$

Г4

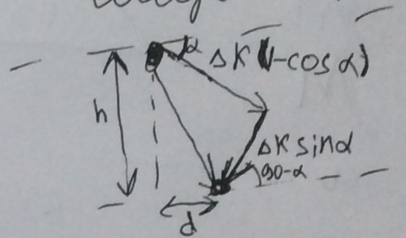
Чистовик

№1

1) Пусть клин сместился влево на расстояние ΔK, тогда длина нити увеличилась на длину ΔK.



Рассмотрим перемещение шарика



$\cos\alpha = \frac{3}{5}$

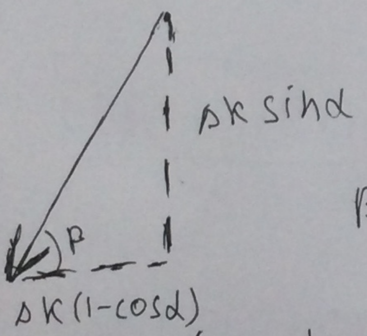
$\Downarrow$

$\sin\alpha = \frac{4}{5}$

$tg\,\alpha = \frac{4}{3}$

$h = \Delta K(1-\cos\alpha)\cdot\sin\alpha + \Delta K\sin\alpha\cdot\sin(90^\circ-\alpha) = \Delta K\cdot\sin\alpha.$

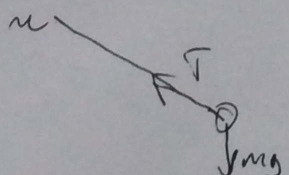
$d = \Delta K(1-\cos\alpha)\cdot\cos\alpha - \Delta K\cdot\sin\alpha\cdot\cos(90-\alpha) = \Delta K(\cos\alpha-\cos^2\alpha-\sin^2\alpha) = \Delta K(\cos\alpha-1)$



β – искомый угол

$$tg\,\beta = \frac{\cancel{\Delta K}\sin\alpha}{\cancel{\Delta K}(1-\cos\alpha)} = \frac{4/5}{1-\frac{3}{5}} = \frac{4/5}{2/5} = 2$$

2) 2 ЗН для шарика:



$$mg - T\sin\alpha = ma_w\sin\beta$$
$$T\cos\alpha = ma_w\cos\beta \quad (1)$$

$$\cancel{m}g - \cancel{m}a_w\cos\beta\, tg\,\alpha = \cancel{m}a_w\sin\beta$$

$$a_w = g/(\sin\beta+\cos\beta\, tg\,\alpha)$$

$$a_{кл}\cdot\frac{t^2}{2} = \Delta K \Rightarrow \frac{a_{кл}}{a_w\cdot\cos\beta} = \frac{1}{1-\cos\alpha} \Rightarrow a_{кл} = \frac{a_w\cdot\cos\beta}{(1-\cos\alpha)} =$$

$$a_w\cdot\cos\beta\cdot\frac{t^2}{2} = \Delta K(1-\cos\alpha)$$

$$= \frac{g\cos\beta}{(\sin\beta+\cos\beta\, tg\,\alpha)(1-\cos\alpha)} = \frac{g}{(tg\,\beta+tg\,\alpha)(1-\cos\alpha)} = \frac{g}{(2+\frac{4}{3})(1-\frac{3}{5})} =$$

$$= \frac{\cancel{g}\cdot 3\cdot 5}{\cancel{10}\cdot 2} = 7{,}5\ м/с^2$$

1

Часть 2

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

Шифр: **21203251**

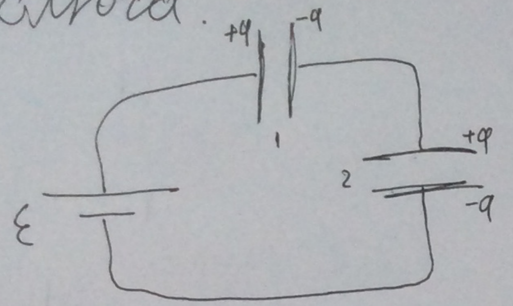
ID профиля: **849585**

Вариант 1

чистовик

№3

1) Рассмотрим цепь до замыкания ключа.



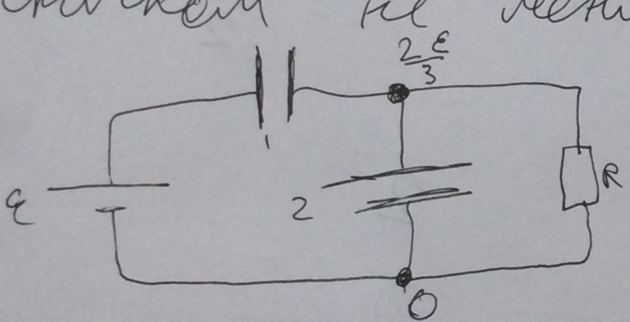
По ЗСЗ на конденсаторах одинаковый заряд q.

$q = 2CU_1 \Rightarrow U_1 = U$

$q = C \cdot U_2 \qquad U_2 = 2U$

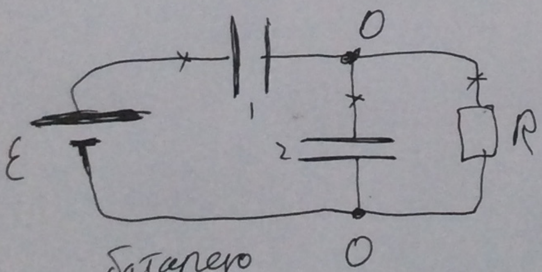
$\mathcal{E} - 3U = 0 \quad U = \frac{\mathcal{E}}{3} \Rightarrow q = \frac{2C\mathcal{E}}{3}$

2) Цепь сразу после замыкания ключа. Напряжение на конденсаторах скачком не меняется.



$I_H = \frac{\frac{2\mathcal{E}}{3} - 0}{R} = \frac{2\mathcal{E}}{3R}.$

3) Рассмотрим цепь в уст. состоянии. Тока в цепи нет. (т.к. тока через конденсатор нет).



$q_1 = 2C\mathcal{E}$

$q_2 = 0$

Через батарею $\mathcal{E}$ протёк заряд: $2C\mathcal{E} - \frac{2C\mathcal{E}}{3} = \frac{4C\mathcal{E}}{3}$

$A_б = \Delta W + Q \Rightarrow Q = A_б - \Delta W =$

$= \frac{4C\mathcal{E}^2}{3} - \left(\left(\frac{\cancel{2}C \cdot (\mathcal{E})^2}{\cancel{2}} - \frac{\cancel{2}C(\frac{\mathcal{E}}{3})^2}{\cancel{2}}\right) - \left(\frac{C \cdot 0^2}{2} - \frac{C(\frac{2\mathcal{E}}{3})^2}{2}\right)\right) =$

$= \frac{4C\mathcal{E}^2}{3} - \left(C\mathcal{E}^2 - \frac{C\mathcal{E}^2}{9} + \frac{C \cdot 2\mathcal{E}^2}{9}\right) = \frac{4C\mathcal{E}^2}{3} - C\mathcal{E}^2 + \frac{C\mathcal{E}^2}{9} - \frac{2C\mathcal{E}^2}{9} =$

1

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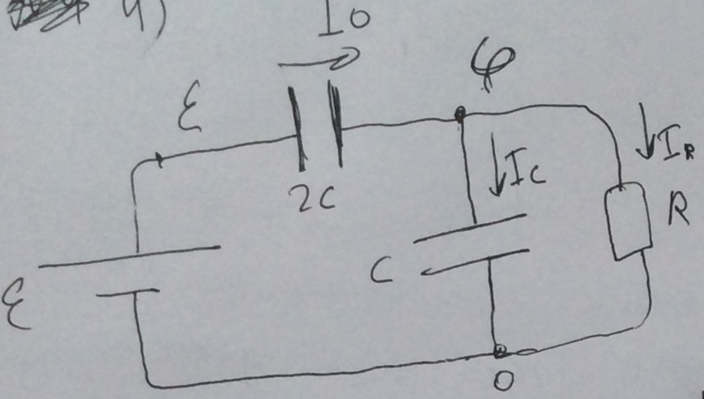
$$= \frac{4C\varepsilon^2}{3} - C\varepsilon^2 - \frac{C\varepsilon^2}{9} = \frac{12C\varepsilon^2 - 9C\varepsilon^2 - C\varepsilon^2}{9} =$$

$$= \frac{2C\varepsilon^2}{9}$$

4)



$$I_0 = \left(2C(\varepsilon - \varphi)\right)' = (2C\varepsilon - 2C\varphi)' = (-2C\varphi)' = -2(C\varphi)' = -2I_C$$

$$\Downarrow$$

$$I_C = -\frac{I_0}{2}$$

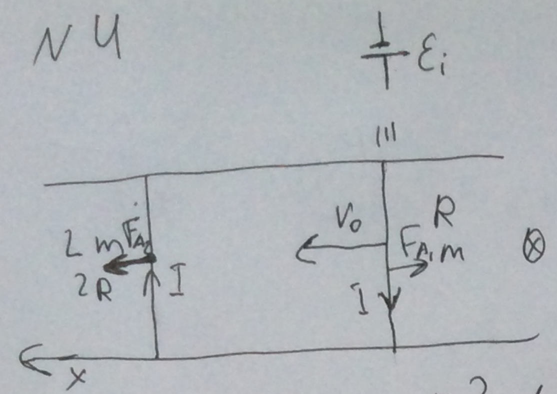
$$I_C = \left(C(\varphi - 0)\right)' = (C\varphi)'$$

ЗСЗ: $I_R = I_0 + \frac{I_0}{2} = \frac{3I_0}{2}$

Ответ: 1) $\frac{2\varepsilon}{3R}$ 2) $\frac{2C\varepsilon^2}{9}$ 3) $\frac{3I_0}{2}$

чистовик.

№ 4 Чистовик



1) $\varepsilon_i = E\cdot L = BV_0L$

$Eq = qV_0B$

$$I = \frac{\varepsilon_i}{3R} = \frac{BV_0L}{3R}$$

$$F_{A_2} = BIL = \frac{B^2V_0\cdot L^2}{3R}$$

$$F_{A_2} = 2ma_н \Rightarrow a_н = \frac{F_A}{2m} = \frac{B^2V_0\cdot L^2}{6Rm}$$

2) ~~V_1 через продолжительный промежуток времени будет равно 0, т.к. F_{A_1} против V_0.~~

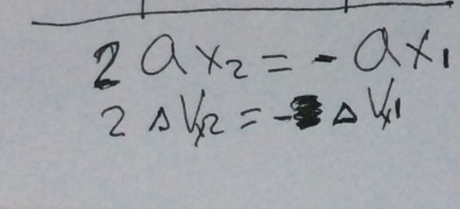
~~$a_1 = \frac{F_{A_1}}{}$~~

~~$a_{x_1} = -\frac{F_{A_1}}{m} = -\frac{B^2V_0L^2}{3Rm}$~~

~~V_1 через продолжительный t будет равно 0, т.к. F_{A_1} против V_0.~~

Через продолжительный промежуток времени перемычки будут двигаться с постоянными равными скоростями V.

Произвольный момент времени:



2ЗН:

$$2ma_{x_2} = \frac{B^2(V_1-V_2)L^2}{3R} \quad (1)$$

$$ma_{x_1} = -\frac{B^2(V_1-V_2)\cdot L^2}{3R}$$

$2a_{x_2} = -a_{x_1}$

$2\Delta V_{x2} = -\Delta V_{x1}$

$\Rightarrow 2(V-0) = -(V-V_0) \Rightarrow 3V = V_0$

$$V = \frac{V_0}{3}$$

чистовик.

$$\Delta V_2 = \frac{B^2 \cdot S_{12} \cdot l^2}{6RM}$$

$$\frac{V_0}{3} = \frac{B^2 \cdot S_{12} \cdot l^2}{6RM} \Rightarrow S_{12} = \frac{\cancel{6}^{2} RMV_0}{\cancel{3} B^2 l^2} = \frac{2RMV_0}{B^2 l^2}$$

d - искомое расстояние.

$$d = S_0 - S_{12} = S_0 - \frac{2RmV_0}{B^2 l^2}$$

Ответ: 1) $\frac{B^2 V_0 l^2}{6RM}$ 2) $\frac{V_0}{3}$ 3) $S_0 - \frac{2RmV_0}{B^2 l^2}$

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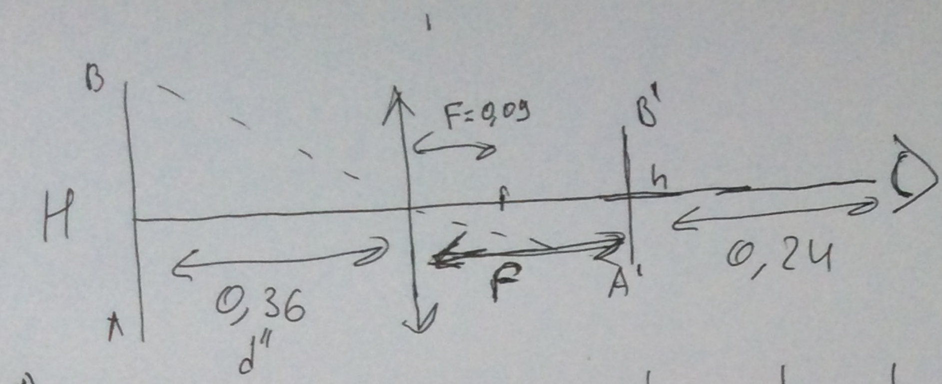
№5 Листовик



1) $\frac{1}{d}+\frac{1}{f}=\frac{1}{F} \Rightarrow \frac{1}{f}=\frac{1}{F}-\frac{1}{d}=\frac{d-F}{dF}$

$f=\frac{dF}{d-F}=\frac{0,36\cdot\cancel{0,09}}{\cancel{0,27}\,3}=0,12м.=12см.$

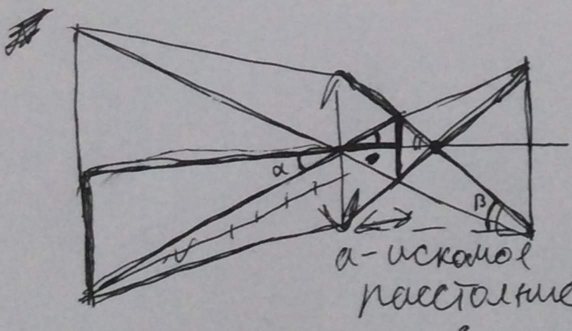
$X=0,24+f=0,36м.=\underline{\underline{36см.}}$

2) Минимальный Dм линзы — высота изображения картины.

$\frac{h}{H}=\frac{f}{d} \Rightarrow h=H\cdot\frac{f}{d}=0,09\cdot\frac{12}{36}=0,03м=\underline{\underline{3см.}}$

$h = D_м$

3)



между линзой и изображением

$a\cdot tg\alpha=(F-a)\cdot tg\beta$

$a\cdot\frac{4,5}{36}=(9-a)\cdot\frac{\cancel{3}}{\cancel{12}\,4}$

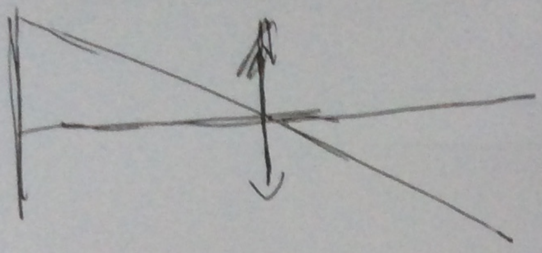
$\frac{a}{8}=\frac{9}{4}-\frac{a}{4}$

$\frac{3a}{8}=\frac{9}{4}$ $a=6см.$

Ответ:
1) 36 см
2) 3см
3) 6см от линзы между линзой и изображением

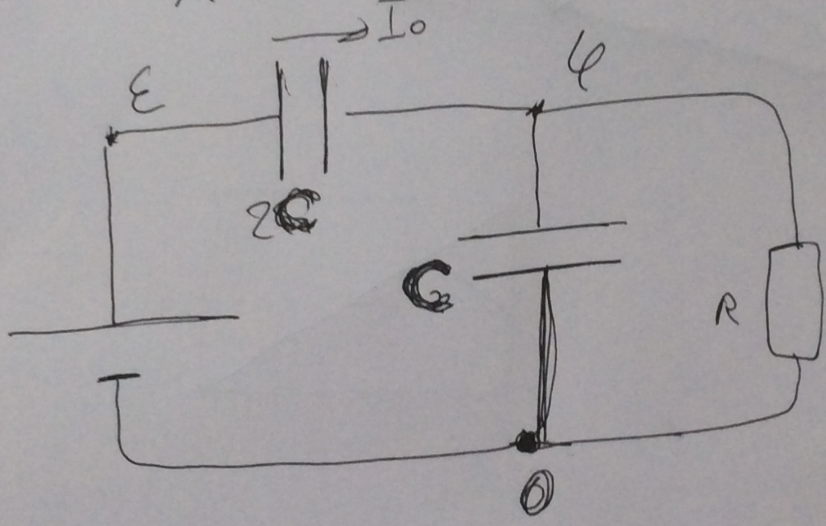
5

черновик



$\frac{1}{d}$ $\qquad$ $\frac{1}{36} + \frac{1}{f} = \frac{1}{F}$

$x = f + 24$



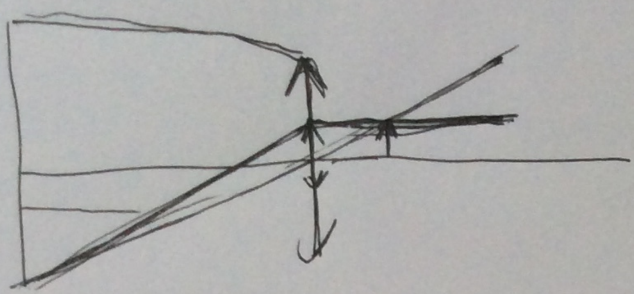
$(2C(\varepsilon - \varphi))' = I_0$

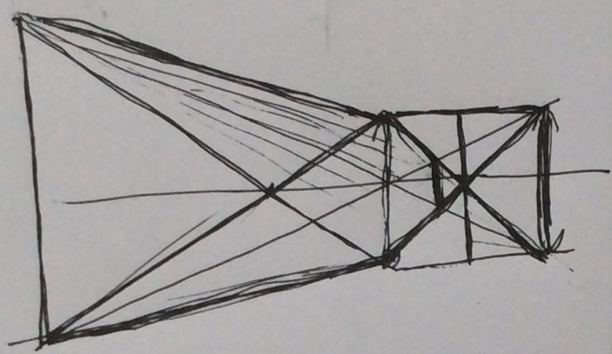
$C \cdot \varphi' = I_C$

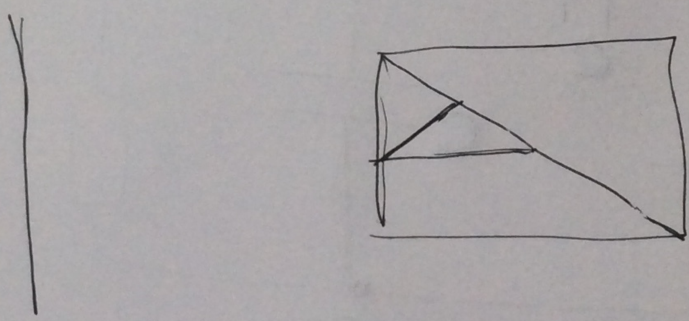
$(2C\varepsilon - 2C\varphi)' = -2C\frac{\Delta\varphi}{\Delta t} = I_0$

$-2I$

Черновик.





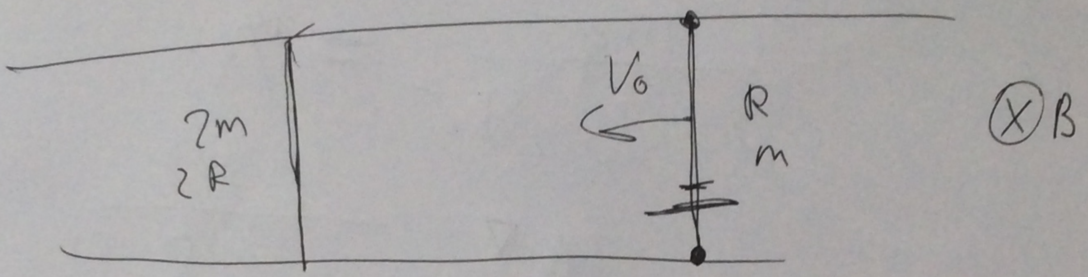


3а

черновик

$$\frac{2C(\mathcal{E} - I_R \cdot R)}{\Delta t} = I_R + \frac{C I_R \cdot R}{\Delta t}$$

$$\frac{2C\mathcal{E} - 3CI_R R}{\Delta t} = I_R$$



$\mathcal{E}_i = BV_0 l$

$ma_1 =$

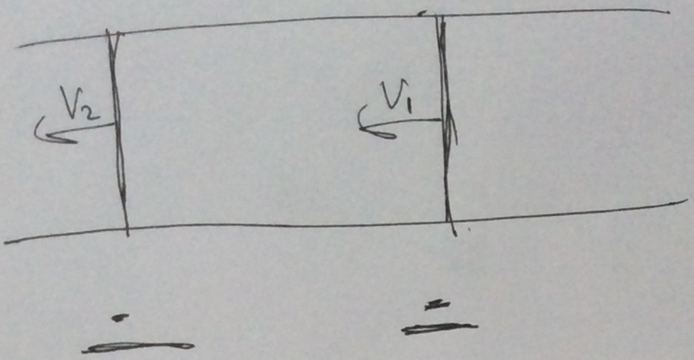
$\frac{F_{A_1}}{m} =$

ΔV_{x_1}

$$\frac{B^2 V_x(t)\, l^2}{3RM} \cdot t = V_0$$

$V_{2x} =$

Черновик



$$\frac{B(V_1-V_2)\cdot l}{3R}$$

$$2ma_{x2} = +\frac{B^2(V_1-V_2)\cdot l^2}{3R}$$

$$\cancel{2}\,ma_{x1} = -\frac{B^2(V_1-V_2)\cdot l^2}{3R}$$

$$\frac{B^2\cdot S_{\text{отн}_{12}}\cdot l^2}{6Rm} = \Delta V_2$$

$$\Delta V_{x1} = -\frac{B^2\cdot S_{\text{отн}_{12}}\cdot l^2}{3Rm}$$

$$\frac{\Delta V_{x2}\cdot \overset{2}{\cancel{6}}\cancel{Rm}}{\cancel{B^2}\cdot\cancel{l^2}} = -\frac{\Delta V_1\cdot\cancel{3Rm}}{\cancel{B^2}\cdot\cancel{l^2}}$$

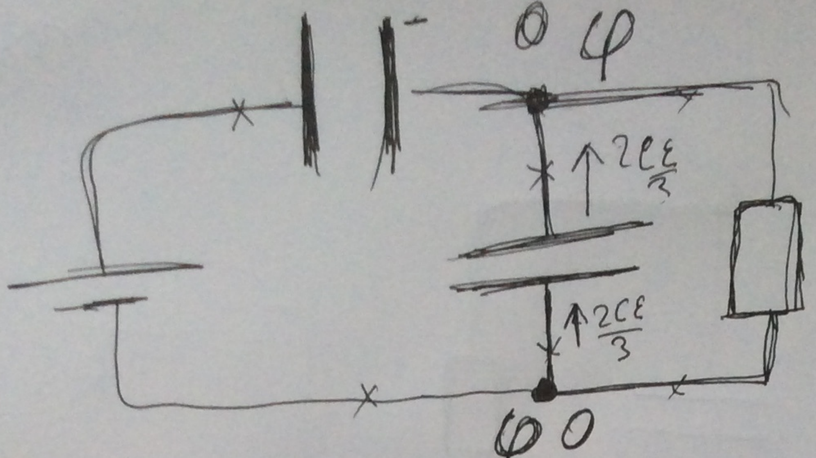
$$\Delta V_{x2} = -2\Delta_x V_1$$

$$V = -2(V-V_0)$$

$$V = 2V_0$$

21203251 (U849585 M1263230)

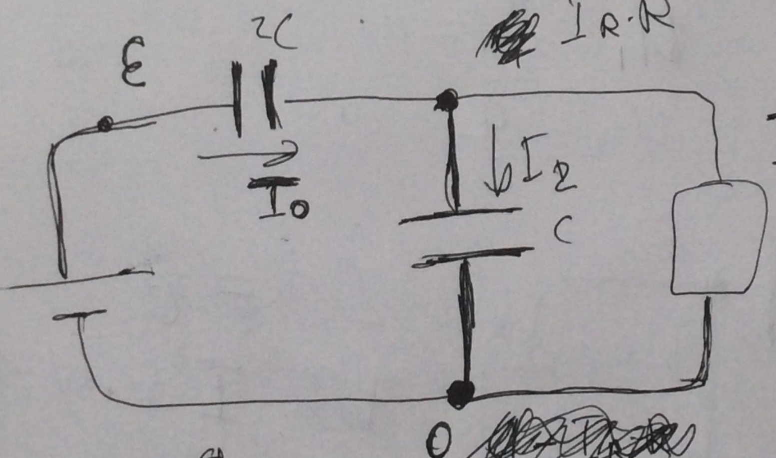
Черновик



$$(\varepsilon - \varphi) = \frac{q_1}{2C}$$

$$2C\varepsilon - \frac{2C\varepsilon}{3} = \frac{4C\varepsilon}{3}$$

$$\frac{4C\varepsilon^2}{3} = \Delta W + \quad I_R \cdot R$$



$$\frac{2C\,(\varepsilon - I_R \cdot R)}{\Delta t} = I_0$$

$$I_2 \cdot R = \cancel{C U_2}$$

$$2C\,U_1' = I_0$$

$$C U' = I_1$$

$$I_0 = I_2 + I_R$$

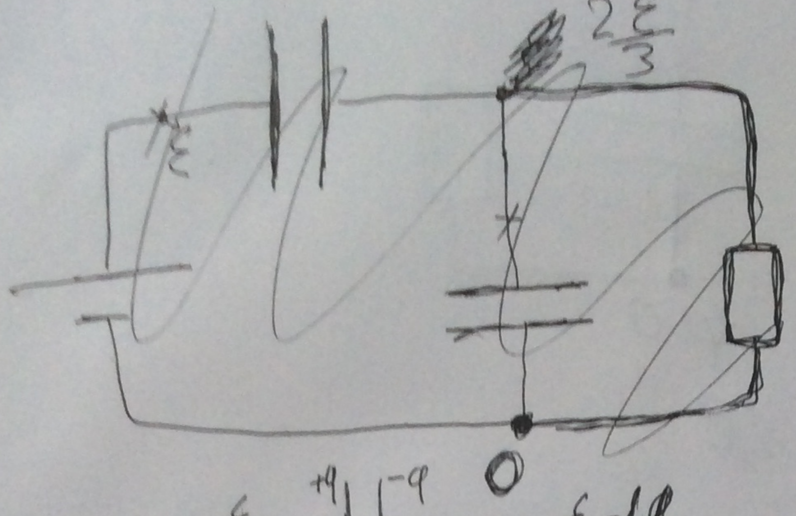
$$\frac{C \cdot I_R \cdot R}{\Delta t} = I_2$$

$$I_2 = \frac{C\,\Delta U_2}{\Delta t}$$

$$q_2 =$$

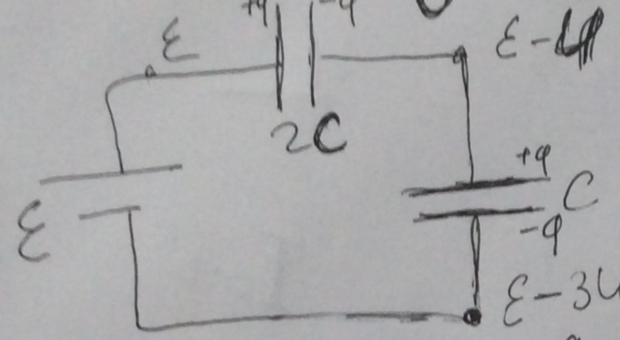
№3

черновик



$I = \frac{2\varepsilon}{3R}$

$\frac{2C\varepsilon}{3}$



$\varepsilon - 3U = 0$

$U = \frac{\varepsilon}{3}$

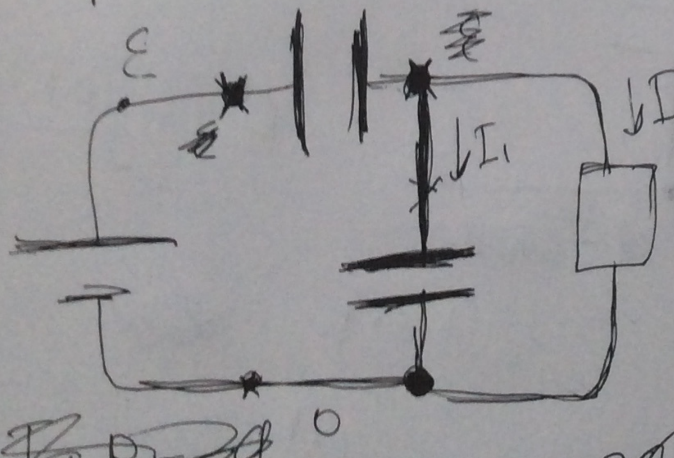
$q = 2C \cdot U_1$

$q = C \cdot U_2$

$U_1 = \frac{q}{2C} = U$

$U_2 = \frac{q}{C} = 2U$

$\frac{2C\varepsilon}{3}$



$I^2 \cdot R \cdot \Delta t =$

$U_{(t)} = \frac{q_{(t)}}{C}$

$I_R(t) \cdot R = \frac{q(t)}{C}$

$\frac{q(t)}{C} = I(t) \cdot R$

$2CU_1' =$

$= CU_2' + I_R$

$2C\Delta U_1 =$

$= C\Delta U_2 + I_R \cdot \Delta t$