Часть 1

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

Шифр: **21201932**

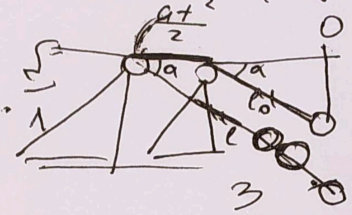
ID профиля: **269358**

Вариант 1

черновик $\frac{49}{8\cdot4} - \frac{2\cdot49}{4\cdot8} + \frac{3}{2} = \frac{49(1-2)}{4\cdot8} = -\frac{49}{4\cdot8}\cdot\frac{2\cdot8\cdot3}{2\cdot2\cdot8}$ 16 48

(1) $\frac{48-49}{32} =$

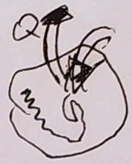
$tg\beta$ $\frac{2}{\sqrt5}$ 1

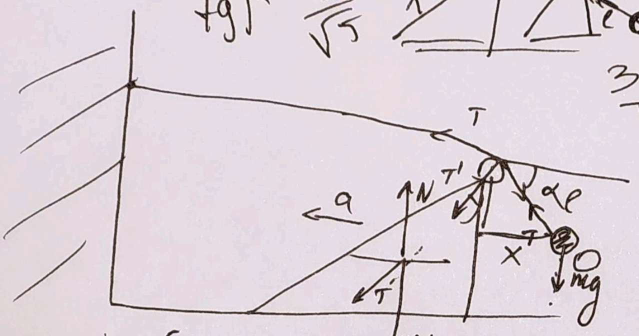


$l = l_0 + \frac{at^2}{2}$

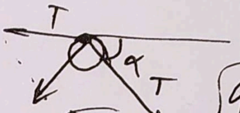
$4 + 0 = \frac{10}{3}$

$\frac{3}{4}$

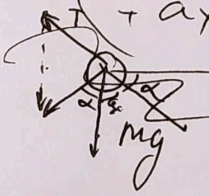




$\sqrt{g^2 - 2ga_x tg + (a_x tg\alpha)^2 + a_x^2} = a^2$

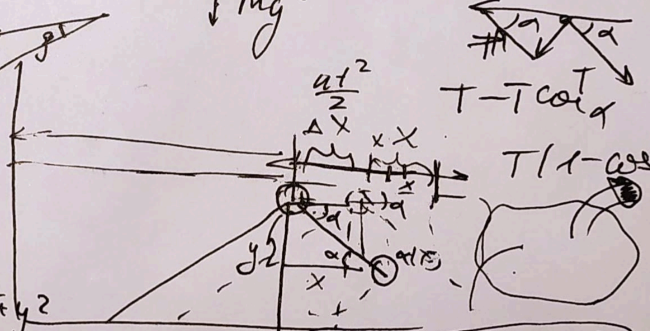


$x/\cos a$



$T - T\cos\alpha$

$T(1-\cos\alpha)$



$(x+\Delta x)^2 + (y+\Delta y)^2 = x^2 + y^2$

$2x\Delta x + \Delta x^2 + 2y\Delta y + \Delta y^2 = 0$

$t = \sqrt{\frac{2mgH}{M}\frac{1}{a}}$

$x + \Delta x$

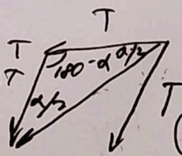
$\boxed{mgH = \frac{Mv^2}{2}}$

α

$5_1 - 4y + \Delta y$

$v = at$

$T'^2 = 2T^2 - 2T^2\cos(180-\alpha)$

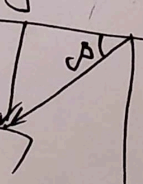


$\cos\beta = \left(\frac{2}{\sqrt5}\right)$

$\frac{2mgH}{M} = \frac{at^2}{2}$

$T' = \sqrt{2T^2 + 2T^2\cos\alpha}$

$\boxed{T' = T\sqrt{2+2\cos\alpha}}$



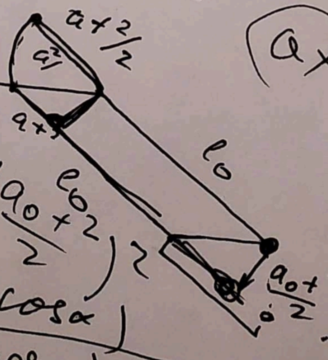
$T'_x = T'\cos\beta = \boxed{T'\cos\frac{\alpha}{2} = Mg}$

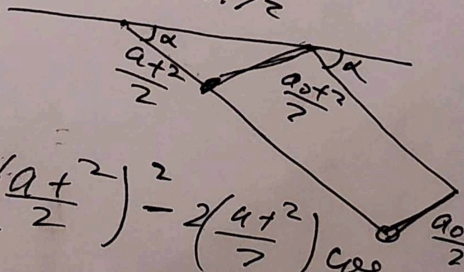
$\frac{5\cdot4}{60} = \frac{20}{60}$ $\frac{1}{3}$

$x_2 -$

$\frac{at^2}{2}$

a_x





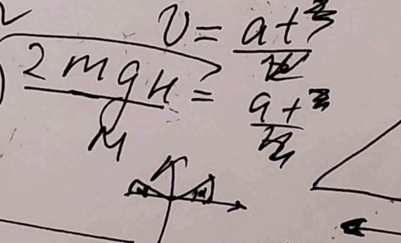
$2\left(\frac{at^2}{2}\right)^2\left(1 - 2\cos a\right) = \left(\frac{a_0t^2}{2}\right)^2$

$2\cdot\left(\frac{at^2}{2}\right)^2 - 2\left(\frac{at^2}{2}\right)\cos a = \left(\frac{a_0t^2}{2}\right)^2$

$\frac{a_0t^2}{2} = \sqrt2\,\frac{at^2}{2}(1 - 2\cos\alpha)$

$\boxed{a_0 = \sqrt2\,(1 - \cancel{2}\cos\alpha)\,a}$

$\sin\frac{\alpha}{2}$



$T =$

$\boxed{mg - ma_x tg\alpha = ma_y}$

$T\cos\alpha = ma_x$

$mg - T\sin\alpha = ma_y$

$\cos(90 - \alpha/2)$

$\sqrt{(g - a_x tg\alpha)^2 + a_x^2}$

и черновик ②

$$g^2-(2g\,tg\alpha)a_x+a_x^2(tg^2\alpha+1)=a_x^2\left(\frac{1}{\cos^2\alpha}\right)-(2g\,tg\alpha)a_x+(g^2+a^2)$$

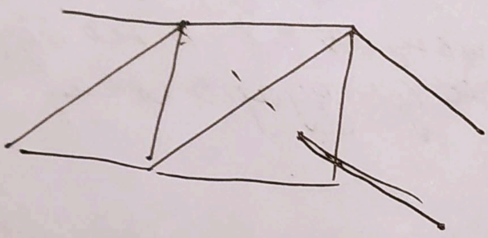
$$tg^2\alpha+1=\frac{1}{\cos^2\alpha} \qquad \frac{D}{4}=g^2tg^2-\frac{g^2-a^2}{\cos^2\alpha}$$

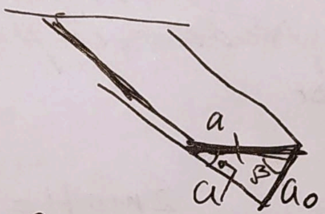
$$\cos^2\alpha+\cos^2\alpha\,tg^2\alpha=1$$

$$\cos^2\alpha\,(1+tg^2\alpha) \qquad a^2=2a^2(1-\cos\alpha)^2$$

$$(g\,tg\alpha)^2-\frac{g^2-2a^2(1-\cos\alpha)}{\cos^2\alpha}$$

$$a_x=\cos^2\alpha\,(g\,tg\alpha\pm\sqrt{g\,tg}$$





$$\frac{a_0}{\sin\alpha}=\frac{a}{\sin\beta}$$

$$\frac{a\sqrt{2(1-\cos\alpha)}}{\sin\alpha}=\frac{\alpha}{\sin\beta}$$

$$-\frac{7\cdot 2}{8\cdot 4}-\frac{3}{2}\cdot\left(\frac{-1}{8}\right)=A$$

$$\cancel{24} \quad \frac{-7+3\cdot 2}{8\cdot 4}=-\frac{1}{32}$$

$$T\cos\alpha=m a_0\cos\beta$$

$$mg-T\sin\alpha=m a_0\sin\beta$$

$$\frac{m(g-a_0\sin\beta)}{m\,a_0\cos\beta}=tg\beta \qquad \frac{g-\sin\beta}{\cos\beta}=tg\alpha \qquad g-\sin\beta=tg\alpha\cos\beta$$

$$\sin\alpha=1-\frac{9}{25}=\frac{16}{2}$$

№1 Чистовик лист 3

$$1-\cos\alpha = 1-3/5 = \frac{2}{5}$$

$$\frac{m}{M} = \frac{3/5}{\sqrt{2}\cdot\frac{2}{5}\cdot\sqrt{\frac{2}{5}}\cdot\frac{1}{\sqrt{5}}} = \frac{3/5}{\frac{2\cdot2}{5}\cdot\frac{1}{5}} = \frac{3\cdot25}{4\cdot5} = \frac{3\cdot5}{4} = \frac{15}{4}$$

из (1)

$$tg\alpha = \frac{g}{a_0\cos\beta} - tg\beta \Rightarrow a_0 = \frac{g}{\cos\beta(tg\alpha+tg\beta)} = \frac{g}{\frac{1}{\sqrt{5}}\cdot(\frac{4}{3}+2)} = \frac{g\cdot\sqrt{5}\cdot3}{10}$$

$$a = \frac{a_0}{\sqrt{2}\sqrt{1-\cos\alpha}} = \frac{g\cdot\sqrt{5}\cdot3}{10\cdot\sqrt{2}\cdot\sqrt{\frac{2}{5}}} = g\cdot\frac{5\cdot3}{10\cdot2} = \frac{10\cdot5\cdot3}{10\cdot2} = \frac{15}{2} = 7{,}5\ м/с^2$$

5. Т.к указано, что шар упадёт раньше, то после падения шара на стол сил, толкающих клин не будет, он будет двигаться равномерно до удара о стену

ЗСЭ до момента удара

$$mgH = \frac{Mv^2}{2} + \frac{mv_0^2}{2}$$

$$v_0 = a_0t\ ;\ v = at$$

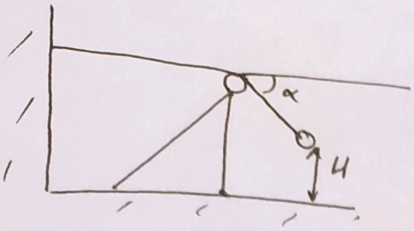
$$\Rightarrow 2mgH = Ma^2t^2 + ma_0^2t^2$$

$$t = \sqrt{\frac{2mgH}{Ma^2+ma_0^2}} = \sqrt{\frac{2\frac{m}{M}gH}{a^2+\frac{m}{M}a_0^2}} \Rightarrow$$

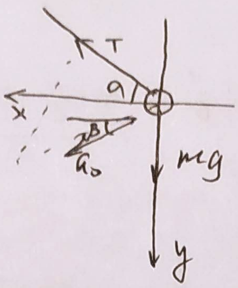
$$t = \sqrt{\frac{2\cdot\frac{15}{4}\cdot10\cdot H}{(\frac{15}{2})^2+\frac{15}{4}\cdot(3\sqrt{5})^2}} = \sqrt{\frac{\cancel{2}\,15\cdot5H}{15(\frac{15}{4}+\frac{45}{4})}} = \sqrt{\frac{5H}{\frac{60}{4}}} = \frac{H}{\sqrt{3}}$$

3

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



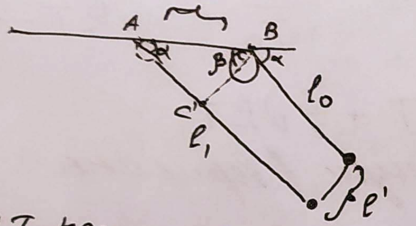
1. Рассмотрим силы, действующие на шарик



2ЗН для шарика:

$$\begin{cases} T\cdot\cos\alpha = ma_x \\ mg - T\sin\alpha = ma_y \end{cases} \Rightarrow \begin{cases} T\cos\alpha = ma_0\cos\beta \\ T\sin\alpha = m(g - a_0\sin\beta) \end{cases} \Rightarrow tg\alpha = \frac{g - a_0\sin\beta}{a_0\cos\beta}$$

2. Т.к нить нерастяжима, то её длина не изменяется



$l = \frac{at^2}{2}$, a - ускорение клина

$l' = \frac{a_0t^2}{2}$; a_0 - ускорение шарика

$l_1 = l_0 + l$

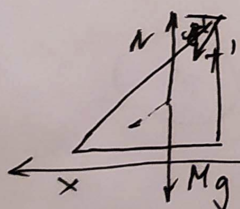
$BC' = l'$ (|| перенос в т. B)

$AC' = l_1 - l_0 = l = \frac{at^2}{2}$

по т. косинусов △ABC:

$$\left(\frac{a_0t^2}{2}\right)^2 = 2\left(\frac{at^2}{2}\right)^2 - 2\left(\frac{at^2}{2}\right)^2\cos\alpha \Rightarrow \frac{a_0t^2}{2} = \sqrt{2}\,\frac{at^2}{2}\sqrt{1-\cos\alpha} \Rightarrow a_0 = \sqrt{2}\,a\sqrt{1-\cos\alpha}$$

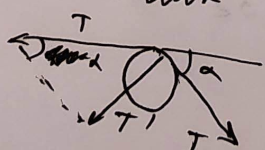
3. Рассмотрим силы действующие на клин.



2ЗН для клина

$O_x: T'\cos\beta = Ma$

Силы на блок



$$(T')^2 = 2T^2 - 2T^2\cos\alpha \Rightarrow T' = \sqrt{2}\,T\sqrt{(1-\cos\alpha)}$$

$$T'\cos\beta = T_x = T - T\cos\alpha = T(1-\cos\alpha) \Rightarrow T(1-\cos\alpha) = Ma$$

4. по т. синусов △ABC'

$$\frac{\frac{a_0t^2}{2}}{\sin\alpha} = \frac{\frac{at^2}{2}}{\sin\beta} \Rightarrow \frac{a\sqrt{2}\sqrt{1-\cos\alpha}}{\sin\alpha} = \frac{a}{\sin\beta} \Rightarrow \sin\beta = \frac{\sin\alpha}{\sqrt{2}\sqrt{1-\cos\alpha}} = \frac{4/5}{\sqrt{2}\sqrt{1-\frac{3}{5}}}$$

$$\sin\beta = \frac{4/5}{\sqrt{2}\sqrt{2/5}} = \frac{4\cdot\sqrt{5}}{5\cdot 2} = \frac{2\sqrt{5}}{5} \approx 0{,}89$$

2

из (1) $T = \frac{ma_0\cos\beta}{\cos\alpha}$; в (3) $\frac{ma_0\cos\beta(1-\cos\alpha)}{\cos\alpha} = Ma$

$$\frac{m\cancel{a_0}\cos\beta(1-\cos\alpha)}{\cos\alpha} = M\frac{\cancel{a_0}}{\sqrt{2}\cdot\sqrt{1-\cos\alpha}} \Rightarrow \frac{m}{M} = \frac{\cos\alpha}{\sqrt{2}\cos\beta(1-\cos\alpha)\sqrt{1-\cos\alpha}}$$

№2 чистовик лист 1

1) $Q = \nu C \Delta T$

$C = 2R\frac{T}{T_0}$ $\Bigg| \Rightarrow Q = \nu \cdot 2R\frac{\frac{5}{6}T_0}{T_0}\left(\frac{5}{6}T_0 - T_0\right)$

$Q_1 = -Q \Rightarrow Q_1 = \nu 2R \cdot \frac{5}{6_3} \cdot \frac{1}{6}T_0 = \underline{\frac{5}{18}\nu R T_0}$

2) по первому началу т.д.

$Q = \Delta U + A$

$\Delta U = \frac{i}{2}\nu R \Delta T = \frac{3}{2}\nu R (T - T_0)$

$Q = \nu C \Delta T = 2R\frac{T}{T_0}\cdot\nu\cdot(T - T_0)$ $\Bigg| \Rightarrow 2\nu R \frac{T}{T_0}(T - T_0) = \frac{3}{2}\nu R (T - T_0) + A$

$\Rightarrow A = \frac{2\nu R T^2}{T_0} - \frac{2\nu R T T_0}{T_0} - \left(\frac{3}{2}\nu R T - \frac{3}{2}\nu R T_0\right) = \frac{2\nu R T^2}{T_0} - 2\nu R T - \frac{3}{2}\cdot$

$\cdot \nu R T + \frac{3}{2}\nu R T_0 = \frac{2\nu R}{T_0}T^2 - \left(2\nu R + \frac{3}{2}\nu R\right)T + \frac{3}{2}\nu R T_0$ —

квадратное ур-ние отн-но T $\Rightarrow$ минимум в вершине

$T_m = \dfrac{-\left(-\left(2\nu R + \frac{3}{2}\nu R\right)\right)}{2\cdot\frac{2\nu R}{T_0}} = \dfrac{\frac{7}{2}\nu R}{4\nu R}T_0 = \underline{\frac{7}{8}T_0}$

$A_{min} = \frac{2\nu R}{T_0}\left(\frac{7}{8}\right)^2 T_0^2 - \frac{7}{2}\nu R\cdot\frac{7}{8}T_0 + \frac{3}{2}\nu R T_0 = \left(\frac{\cancel{2}\cdot 49}{8\cdot \cancel{8}_4} - \frac{49}{2\cdot 8} + \frac{3}{2}\right)\nu R T_0 =$

$= -\frac{1}{32}\nu R T_0$

Ответ: 1) $\frac{5}{18}\nu R T_0$; 2) $\frac{7}{8}T_0$; 3) $-\frac{1}{32}\nu R T_0$

1

21201932 (U269358 M1263857)

Часть 2

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

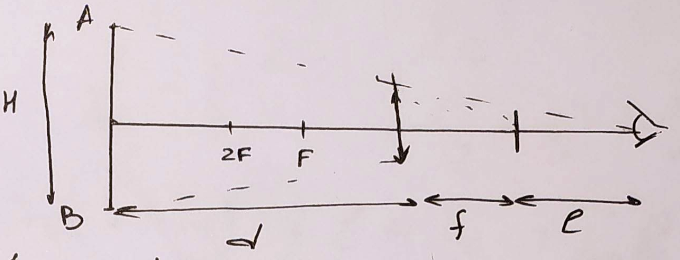
Шифр: **21201932**

ID профиля: **269358**

Вариант 1

№5 Чистовик лист 3

$F = 9$ см
$H = 9$ см
$d = 36$ см
$l = 24$ см



1) $\frac{1}{F} = \frac{1}{d} + \frac{1}{f} \Rightarrow \frac{1}{f} = \frac{d-F}{dF} = \frac{36-9}{36\cdot 9} = \frac{27}{36\cdot 9} = \frac{3}{36} = \frac{1}{12} \Rightarrow$

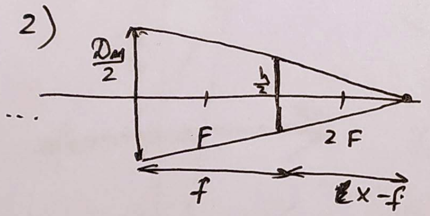
$f = 12$ см.

$x = l + f = 24 + 12 = \underline{36 \text{ см}}$

$\Gamma = \frac{f}{d} = \frac{12}{36} = \frac{1}{3}$

$h = \Gamma \cdot H = \frac{9}{3} = 3$ см

2)



$\frac{l}{\cancel{f+l}\; x} = \frac{h}{D_L} \Rightarrow D_M = h\frac{\cancel{f+l}\; x}{l} = 3 \cdot \frac{\cancel{12+24}\; 36}{24}$

$D_M = \underline{4{,}5 \text{ см}}$

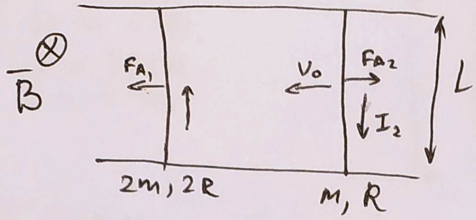
3) Экран нужно поместить между линзой и изображением

3

Ответ: 1) 36 см; 2) 4,5 см.

№ 4 Чистовик лист 2

1)



в начальный момент.
когда 2 перемычка двиг V_0, а 1 покоится

$F_{A_2} = BI_2 L$

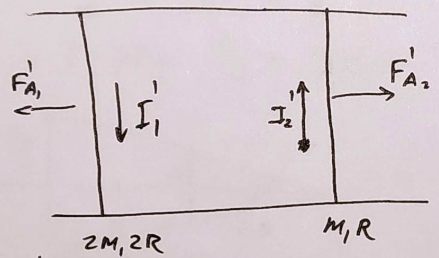
$\mathcal{E}_{2i} = BV_0 L$
$\mathcal{E}_{2i} = I_2 \cdot R$ $\Rightarrow I_2 = \frac{BV_0 L}{R}$

$F_{A_1} = BI_2 L = \frac{B^2 V_0 L^2}{R}$

2ЗН для 1 перем:

$F_{A_1} = 2ma_{01} \Rightarrow a_{01} = \frac{F_{A_1}}{2m} = \frac{B^2 L^2 V_0}{2mR}$

2)

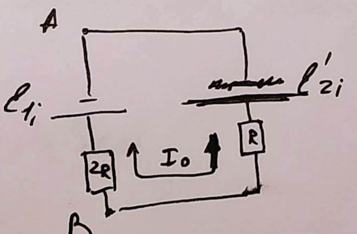


ч/з продолжительный промежуток времени.
~~во~~ первой также возникает ЭДС индукции

$\mathcal{E}_{1i} = BV_1 L$

$\mathcal{E}'_{2i} = BV_2 L$

ЭКВ. схема:



$\varphi_B - \varphi_A = I_0 \cdot 2R + \mathcal{E}_{1i}$
$\varphi_B - \varphi_A = -I_0 R + \mathcal{E}'_{2i}$ $\Rightarrow$

$\mathcal{E}'_{2i} - \mathcal{E}_{1i} = 2I_0 R + IR \Rightarrow BL(V_2 - V_1) = 3I_0 R$

~~$I_0 = I_2' = I_1' = \frac{\mathcal{E}_{2i}'}{2R}$~~

2ЗН для 1 и 2.

$F'_{A_2} = ma_2$
$F'_{A_1} = 2ma_1$ $\Rightarrow$ $BLI_0 = ma_2$
$BLI_0 = 2ma_1$

3) ~~$\mathcal{E}_{in} = \frac{d\Phi}{dt}$~~ $|\mathcal{E}_{ind}| = \frac{d\Phi}{dt} = \frac{dBSL}{dt} = \frac{LBdS}{dt}$ $\Rightarrow$ $V_2 - V_1 = \frac{dS}{dt}$ $|\cdot dt$

$\mathcal{E}_{ind} = \mathcal{E}'_{2i} - \mathcal{E}_{1i} = BL(V_2 - V_1)$

$V_2 dt - V_1 dt = dS$

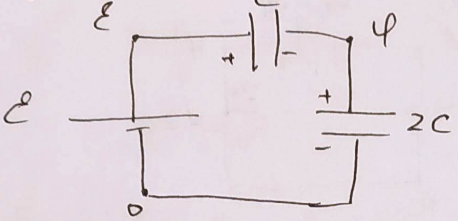
l - расстояние м/у перемычками ч/з дл. пром врем.
$l = S_0 + S_1 + S_2$

2

Ответ: $\frac{B^2 L^2 V_0}{2mR}$

№3 Чистовик лист 1

до замыкания ключа



$q_1 = q_2 = q$

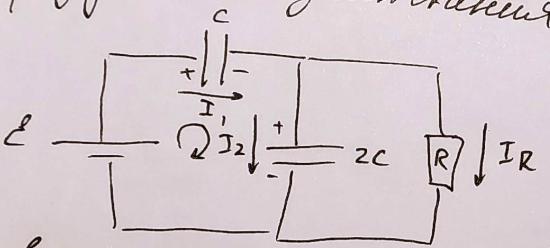
МУП:

$$\begin{cases} \mathcal{E} - \varphi = \frac{q}{C} \\ \varphi = \frac{q}{2C} \end{cases} \Rightarrow \begin{cases} \mathcal{E} = \frac{3q}{2C} \\ \varphi = \frac{q}{2C} \end{cases} \Rightarrow \varphi = \frac{\mathcal{E}}{3}$$

$U_{10} = \frac{q}{C} = \frac{2}{3}\mathcal{E}$

$U_{20} = \frac{q}{2C} = \frac{\mathcal{E}}{3} \Rightarrow q = \frac{2}{3}\mathcal{E}C$

сразу после замыкания ключа.



U_c не успело поменяться.

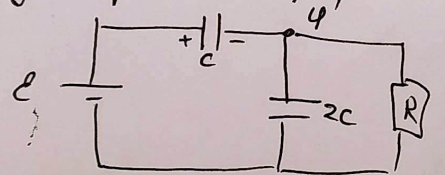
п. Киргофа:

$I_1 = I_2 + I_R$

для ~~...~~ контура: „внешнего"

$\mathcal{E} = U_{10} + I_R R \Rightarrow \mathcal{E} = \frac{2}{3}\mathcal{E} + I_R R \Rightarrow I_R = \frac{\mathcal{E}}{3R}$

уст. режим:



$U_2 = 0$

$U_1 = \mathcal{E}$; $U_1 = \frac{q'}{C} \Rightarrow q' = C\mathcal{E}$

$A_{ист} = \Delta W_C + Q$; $\Delta W_C = -\left(\frac{CU_{10}^2}{2} + \frac{2CU_{20}^2}{2}\right) + \frac{CU_1^2}{2} + \frac{2CU_2^2}{2} \Rightarrow$

$\Delta W_C = \frac{C\mathcal{E}^2}{2} - \frac{C\frac{4}{9}\mathcal{E}^2}{2} - \frac{2C\cdot\frac{\mathcal{E}^2}{9}}{2} = \frac{C\mathcal{E}^2}{6}$

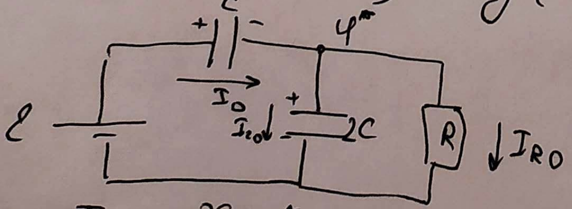
$A_{ист} = \mathcal{E}\Delta q$

$\Delta q = C\mathcal{E} - \frac{2}{3}C\mathcal{E} = \frac{1}{3}C\mathcal{E}$ $\Rightarrow A_{ист} = \frac{C\mathcal{E}^2}{3}$ $V_0 - V$ $\frac{dV}{dt}$

$Q = A_{ист} - \Delta W_C = \frac{C\mathcal{E}^2}{3} - \frac{C\mathcal{E}^2}{6} = \frac{C\mathcal{E}^2}{6}$

в момент I, когда 4/3 c, ток I_0

1



$q^* = CU_1^*$ (U_1^* – напряжение на C_1)

$I_0 = CU_1^*$; $U_1^* = \mathcal{E} - \varphi^*$

$U_2^* = \varphi^*$

$I_{20} = 2CU_2^* \Rightarrow \begin{cases} I_0 = C\mathcal{E} - C(\varphi^*)' \\ I_{20} = 2C\varphi^{*\prime} \end{cases} \Rightarrow \begin{cases} I_0 = C\mathcal{E} - \frac{I_{20}}{2} \\ I_{20} = 2C\varphi^{*\prime} \end{cases} \Rightarrow I_{20} = (C\mathcal{E} - I_0)\cdot 2$

~~...~~ зсз:

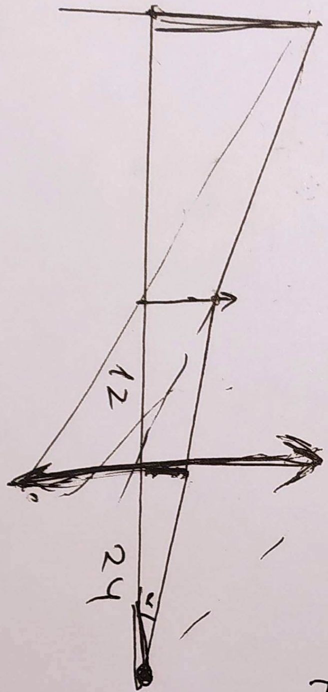
$I_{R0} = I_0 - I_{20} \Rightarrow I_{R0} = I_0 - 2C\mathcal{E} + 2I_0 = 3I_0 - 2C\mathcal{E}$.

Ответ: 1) $\frac{\mathcal{E}}{3R}$; 2) $\frac{C\mathcal{E}^2}{6}$; 3) $3I_0 - 2C\mathcal{E}$

$\frac{2a}{2C} + \frac{a}{2C}$

$\ell - S_0 - \frac{2}{6}S' - \frac{1}{6} = \qquad 1 - \left(\frac{4}{9} + \frac{2}{9}\right) = \frac{9}{9} - \frac{6}{9} = \frac{3}{9} = \frac{1}{3}$

$u = S_0 - S' + S_1 + S_2 \qquad \mathcal{E} = u_c + I R$



$CU \quad S_2 - S' - S_1 \qquad \mathcal{E} = u_c + u_{2C}$

$I \qquad u_{2C} = IR$

$I \frac{dq}{dt} = \ell \qquad -u = \frac{q}{C}$

$\dot{q} = (CU) \qquad I = Cu_c' \quad \dot{q}$

$I = Cu' \qquad I_0 = Cu_c'$

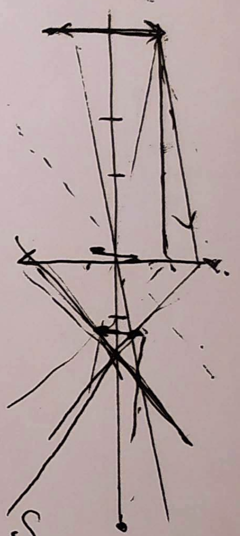
$\boxed{u_c' = \frac{I_0}{C}}$

$I_{20} = Cu_2'$

$I_0 \quad C(\varepsilon - \varphi')' \qquad (\ell - \varphi)' = I_0/C$

$I_{20} = C \varphi' \qquad (\mathcal{E} - IR)' = \frac{I_0}{C}$

$I_0 = C\mathcal{E} - \frac{I_{20}}{C} \qquad \mathcal{E} - \frac{\dot{I}}{t}R = \frac{I_0}{C}$

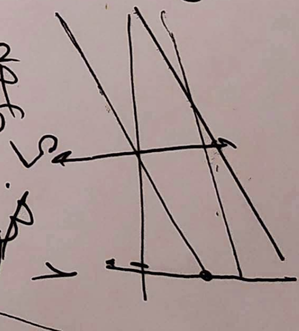


B_0

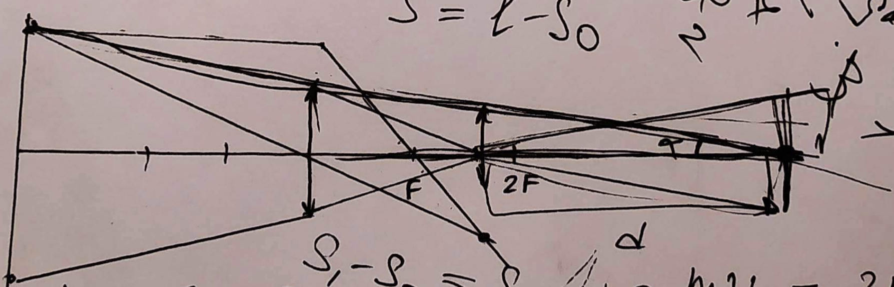
S

$I_{20} = C\mathcal{E} - I_0 \qquad \ell = S_0 + S_1 + S_2$

$2 I_R = \qquad S_1 - S_2 \qquad \frac{S_0}{2}$



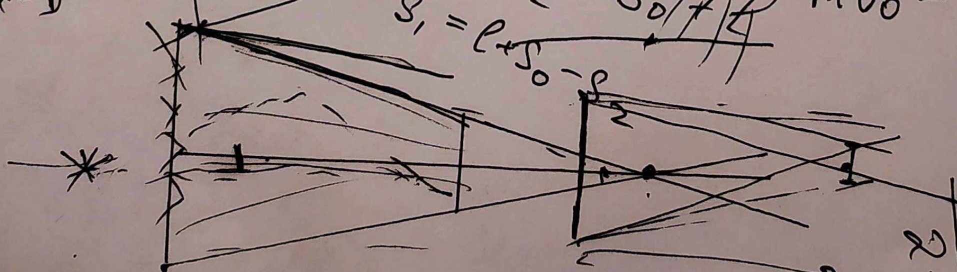
$S = \ell - S_0$

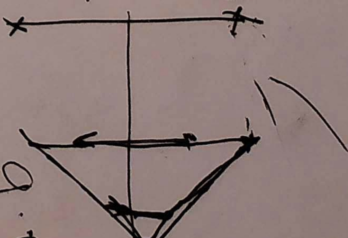


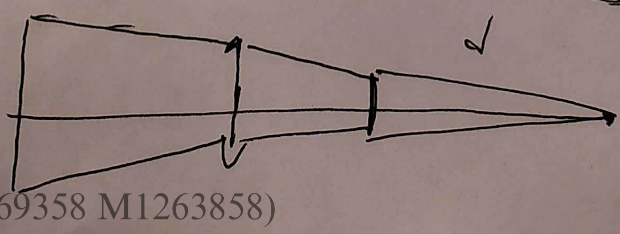
$(R+r)^2 \qquad \frac{2}{2R}$

$S_1 - S_2 = S_0 / \ell \qquad mV_0 = 2mV_1 + mV_2$

$S_1 = \ell + S_0 - S_2$







$\ell = S_0$

$\ell + S_0 - 2S_1 = \ell - S_0$