# Часть 1

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

Шифр: **21200897**

ID профиля: **368957**

Вариант 3

№2 Чистовик

$\nu, T_0$

$C(T) = 3R\frac{T}{T_0}$

1) $Q_1$ $(Q_1 > 0)$ -? $T_0$ до $\frac{3}{5}T_0$

2) $T(A_{min})$ -?

3) $A_{min}$ -?

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

$\delta Q(T) = 3R\frac{T}{T_0}\nu\Delta T$ (*)

Просуммируем соот. (*) от $T = T_0$ до $T = \frac{3}{5}T_0$

$$\sum \delta Q = \sum 3R\nu \frac{T\Delta T}{T_0}$$

$$Q = \frac{3R\nu}{T_0}\sum T\Delta T = \frac{3R\nu}{T_0}\cdot\left(\frac{\left(\frac{3}{5}T_0\right)^2}{2} - \frac{T_0^2}{2}\right)$$

$$Q = \frac{3R\nu}{T_0}\left(\frac{9T_0^2}{50} - \frac{25T_0^2}{50}\right) = \frac{-48\nu RT_0}{50} = \frac{-24\nu RT_0}{25}$$

$$Q_1 = -Q$$

$$Q_1 = \frac{24\nu RT_0}{25}$$

2) $Q = A(T) + \Delta U$

$$A(T) = Q - \Delta U$$

$$Q = \sum 3R\nu\frac{T\Delta T}{T_0} = \frac{3R\nu}{T_0}\left(\frac{T^2}{2} - \frac{T_0^2}{2}\right)$$

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

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

$$A(T) = 3\nu R\left(\frac{T^2 - T_0^2}{2T_0} - \frac{T - T_0}{2}\right) = 3\nu R\left(\frac{T^2 - T_0^2 - TT_0 + T_0^2}{2T_0}\right)$$

$$A(T) = \frac{3\nu R}{2T_0}\left(T^2 - TT_0\right)$$

$A = A_{min}$ при $T = \frac{T_0}{2}$ $\left(y = \frac{-b}{2a}\right)$

$$T(A_{min}) = \frac{T_0}{2}$$

3) $$A_{min} = \frac{3\nu R}{2T_0}\left(\left(\frac{T_0}{2}\right)^2 - \frac{T_0\cdot T_0}{2}\right) = \frac{3\nu R}{2T_0}\cdot\left(-\frac{T_0^2}{4}\right) = \frac{-3\nu RT_0}{8}$$

ОТВЕТ: 1) $Q_1 = \frac{24\nu RT_0}{25}$

2) $T = \frac{T_0}{2}$

3) $A_{min} = \frac{-3\nu RT_0}{8}$

№1 Чистовик

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

Н.

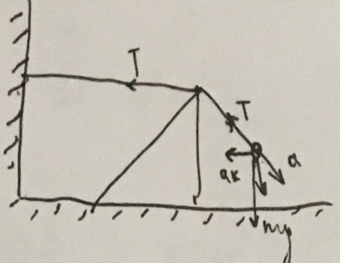
1) $\beta$ - ?

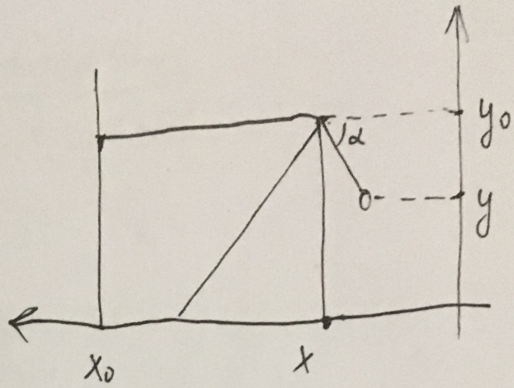
2) $a_к$ - ?

3) $\frac{m_ш}{m_к}$ - ?

4) $\gamma$ - ?

1)




$$L'' = x_0'' - x'' + \frac{y_0'' - y''}{\sin\alpha}$$

$$0 = -a_{к_x} + \frac{1}{\sin\alpha}\cdot(-a_{ш_x})$$

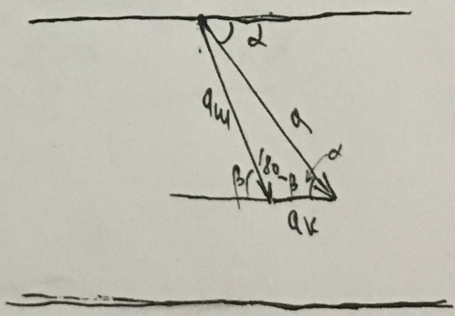
$$a_к = \frac{a_ш}{\sin\alpha} \quad (1)$$

2ЗН: $mg\sin\alpha - T = ma$

$T\cos\alpha = ma_к \Rightarrow T = \frac{ma_к}{\cos\alpha}$

$$g\sin\alpha - \frac{a_к}{\cos\alpha} = a$$

$$a = g\sin\alpha\cos\alpha - a_к \quad (3)$$




$a\sin\alpha = a_ш\sin\beta \quad (1)$

$a\cos\alpha = a_к + a_ш\cos\beta \quad (2) \Leftarrow$

$(1) \Rightarrow (2)$ $\quad a\cos\alpha = \frac{a_ш}{\sin\alpha} + a_ш\cos\beta$

$$\frac{a}{a_ш} = \frac{1 + \sin\alpha\cos\beta}{\sin\alpha\cos\alpha}$$

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

$$\frac{\sin\beta}{\cancel{\sin\alpha}} = \frac{1+\sin\alpha\cos\beta}{\cancel{\sin\alpha}\cos\alpha}$$

$\sin\beta\cos\alpha = 1 + \sin\alpha\cos\beta$

$\sin(\beta-\alpha) = 1 \Rightarrow \beta - \alpha = \frac{\pi}{2} \Rightarrow \beta = \frac{\pi}{2} + \alpha \Rightarrow$ искомый угол $= 180 - \alpha = \frac{\pi}{2} - \alpha$

2) ~~$a_ш$~~ $(3) \Rightarrow \quad a = g\sin\alpha\cos\alpha - a_к$

$a_к = \frac{a_ш}{\sin\alpha}$

$a\cos\alpha = \frac{a_ш}{\sin\alpha} + a_ш\cos\beta \qquad \Rightarrow$

Черновик

$$a = g\sin\alpha\cos\alpha - \frac{a_ш}{\sin\alpha} \quad (5)$$

$$a\cos\alpha = a_ш\left(\frac{1+\sin\alpha\cos\beta}{\sin\alpha}\right) \Rightarrow a_ш = \frac{a\cos\alpha\sin\alpha}{1+\sin\alpha\cos\beta}$$

$$(4) \Rightarrow \frac{a}{a_ш} = \frac{\sin\beta}{\sin\alpha} \Rightarrow a = a_ш\frac{\sin\beta}{\sin\alpha} \quad (6)$$

$$a_к = \frac{a_ш}{\sin\alpha}$$

$$(6) \Rightarrow (5): \quad a_ш\frac{\sin\beta}{\sin\alpha} = g\sin\alpha\cos\alpha - \frac{a_ш}{\sin\alpha}$$

$$\sin\beta = \sin\left(\frac{\pi}{2}+\alpha\right) = \cos\alpha$$

$$a_ш\left(\frac{\cos\alpha}{\sin\alpha} + \frac{1}{\sin\alpha}\right) = g\sin\alpha\cos\alpha$$

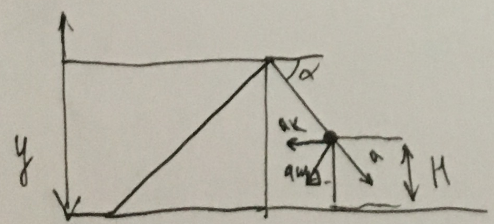
$$a_ш = \frac{g\sin^2\alpha\cos\alpha}{\cos\alpha+1}$$

$$a_к = \frac{g\sin\alpha\cos\alpha}{\cos\alpha+1}$$

3) 2ЗН: $\begin{cases} T = m_к\cdot a_к \\ T\cos\alpha = m\cdot a_к \end{cases}$, где $m = m_ш$

$$\frac{m_к}{m_ш} = \frac{1}{\cos\alpha} \Rightarrow \frac{m_ш}{m_к} = \cos\alpha$$

4)



~~$H = g\,a_{шx}$~~ $\quad H = \frac{(a_{шy})\cdot t^2}{2}$

$$2H = a_{шy}\cdot t^2 \Rightarrow t^2 = \frac{2H}{a_{шy}}$$

$$a_{шy} = a_ш\cdot\sin\left(\frac{\pi}{2}-\alpha\right) = a_ш\cdot\cos\alpha = \frac{g\sin^2\alpha\cos^2\alpha}{\cos\alpha+1}$$

$$t = \sqrt{\frac{2H\cdot(\cos\alpha+1)}{g\sin^2\alpha\cos^2\alpha}} = \sqrt{\frac{2H(\cos\alpha+1)}{g\sin^2\alpha\cos^2\alpha}}$$

ОТВЕТ: 1) $\beta = \frac{\pi}{2}-\alpha$; 2) $a_к = \frac{g\sin\alpha\cos\alpha}{\cos\alpha+1}$; 3) $\frac{m_ш}{m_к} = \cos\alpha$; 4) $t = \sqrt{\frac{2H(\cos\alpha+1)}{g\sin^2\alpha\cos^2\alpha}}$ 3

№1

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

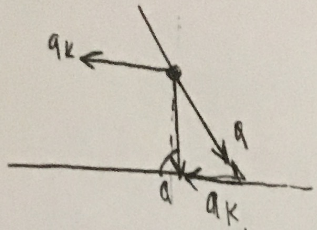
$\mu$

1) $\beta$ ($a_ш$)

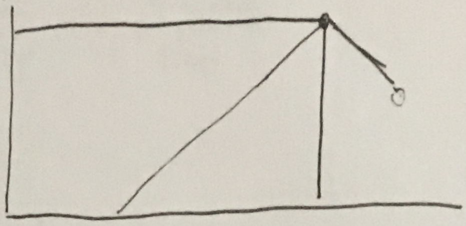
2) $a_к$ - ?

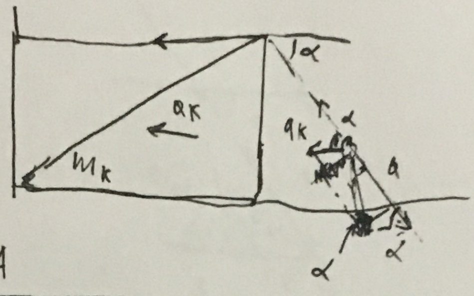
3) $\frac{m_ш}{m_к}$

4) $\tau$




$\sin\beta =$



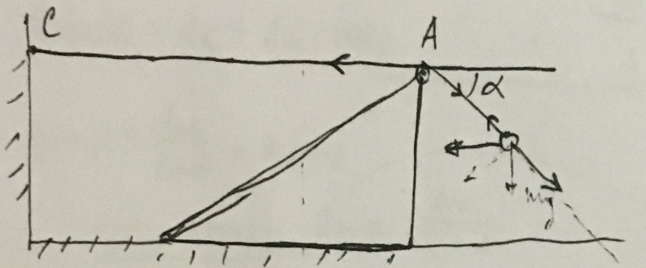



$\cancel{mg}$

$mg\sin\alpha - T = ma_ш$

$T\cos\alpha = ma_к$

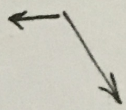
$T = \frac{ma_к}{\cos\alpha}$

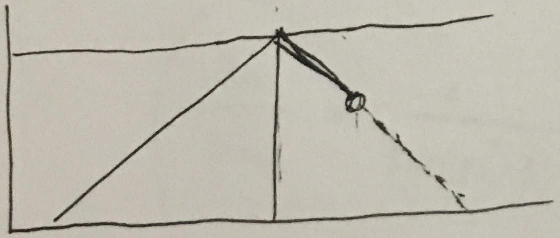



$g\sin\alpha - \frac{a_к}{\cos\alpha} = a$

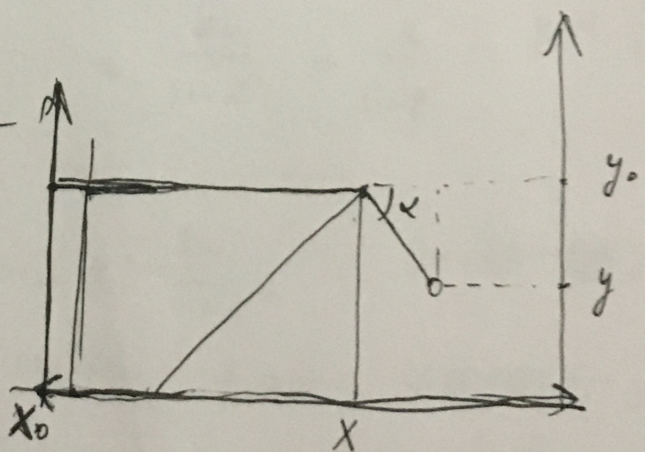
$g\sin\alpha\cos\alpha - a_к = a\cos\alpha$

$\boxed{g\sin\alpha\cos\alpha = a\cos\alpha + a_к}$





$\sin\alpha =$



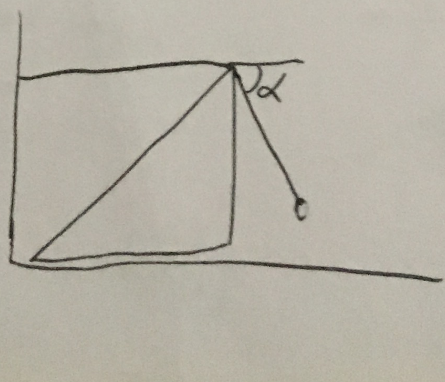

$(y_0'' - y'')\frac{1}{\sin\alpha}$

$\frac{1}{4} - \frac{1}{2} = -\frac{1}{4}$

$L'' = X_0'' - X'' + \frac{y_0'' - y''}{\sin\alpha}$

$0 = -a_к + \frac{1}{\sin\alpha}(-a_ш)$

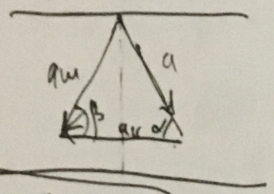
$|a_к| = \frac{a_ш}{\sin\alpha}$



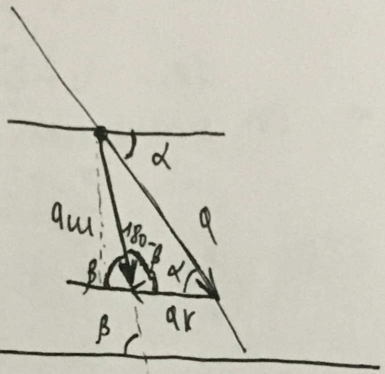
$a_K = g\sin\alpha$

$\frac{1}{\sin\alpha} + \frac{\sin\alpha\cos\alpha}{\sin\alpha}$

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




$a_K = a\cos\alpha + a_m\cos\beta$




$a\sin\alpha = a_m \cdot \sin\beta$

$\cancel{a_m\cos\alpha = a_K}$

$a\cos\alpha = a_K + a_m \cdot \cos\beta$

$a\cos\alpha = \frac{a_m}{\sin\alpha} + a_m\cos\beta$

$\frac{a}{a_m} = \frac{\left(\frac{1}{\sin\alpha} + \cos\beta\right)}{\cos\alpha}$ $\quad a_K = \frac{a_m}{\sin\alpha}$

$g\sin\alpha\cos\alpha = a\cos\alpha + a_K$

$\frac{a_m}{\sin\alpha} = \frac{a}{\sin(180^\circ-\beta)} = \frac{a_m}{\sin\alpha} = \frac{a}{\sin\beta}$

$g\sin\alpha\cos\alpha = a\cos\alpha + \frac{a_m}{\sin\alpha}$

$g\sin^2\alpha\cos\alpha = a\cos\alpha\cdot\sin\alpha + a_m$

$\cancel{a_m = g\sin\alpha\cos\alpha(\sin\alpha - 1)}$

$a_m = \sin\alpha\cos\alpha(g\sin\alpha - a)$

$a\cos\alpha = \frac{a_m}{\sin\alpha} + a_m\cos\beta$

$\frac{\sin\beta}{\sin\alpha} = \frac{\cos\beta + \sin\alpha\cos\beta}{\sin\alpha\cos\alpha}$

$\frac{\sin\beta}{\sin\alpha} = \frac{1+\sin\alpha\cos\beta}{\cancel{\sin\alpha}\cos\alpha}$

$\sin\beta\cos\alpha = 1 + \sin\alpha\cos\beta$

$\sin\beta\cos\alpha - \sin\alpha\cos\beta = 1$

$\sin(\beta-\alpha) = 1$

$\beta - \alpha = \frac{\pi}{2}$

$\beta = \frac{\pi}{2} + \alpha$

$\sin(\cancel{60} - \cancel{30})$

$\sin 60\cos 30 - \sin 30\cos 60 =$

$= \frac{\sqrt3}{2}\cdot\frac{\sqrt3}{2} - \frac{1}{4}$

$= \cancel{\frac{3}{4} - \frac{1}{4}} = \frac{1}{2}$

№2

$\nu,\ T_0$

$C(T) = 3R\frac{T}{T_0}$

1) $Q_1\ (Q_1 > 0)$

$T_0$ до $\frac{3}{5}T_0$

2) $T\ (A_{min})$

3) $A_{min}$ - ?

1) $\delta Q = \delta A + \Delta U$

$\Delta U = \frac{3}{2}\nu R\Delta T$

$\delta A = p\,dV$

$pV = \nu RT$

$\delta Q(T) = C\nu\Delta T$

$\delta Q(T) = 3R\frac{T}{T_0}\nu(T - T_0)$

$\delta Q = 3R\frac{T\Delta T}{T_0}\nu \quad (*)$

Просуммируем соотношения $(*)$ от $T = T_0$ до $T = \frac{3}{5}T_0$

$\sum\delta Q = \sum 3R\nu\frac{T\Delta T}{T_0}$

$Q = \frac{3R}{T_0}\sum T\Delta T = \frac{3R}{T_0}\nu\left(\frac{(\frac{3}{5}T_0)^2}{2} - \frac{(T_0)^2}{2}\right)$

$Q = \frac{3R}{T_0}\nu\left(\frac{9T_0^2}{50} - \frac{T_0^2}{2}\right)$

$Q = \frac{3R}{T_0}\nu\left(\frac{9T_0^2}{50} - \frac{25T_0^2}{50}\right) = -\frac{3R}{\cancel{T_0}}\nu\cdot\frac{16T_0^{\cancel{2}}}{50} = \frac{-48\nu RT_0}{50}$

$Q = \frac{-24\nu RT_0}{25}$

$Q_1 = -Q = \frac{24\nu RT_0}{25}$

$-\frac{2}{5}$

$\frac{-24}{25} = A + \frac{3}{2}\cdot -\frac{2}{5}$

$A = -\frac{24}{25} + \frac{3}{5}$

$\frac{-24}{25} + \frac{15}{25}$

$\frac{-9}{25}$

$-\frac{9}{25} \quad -\frac{3}{8}$

$\frac{9}{25} \quad \frac{3}{8}$

$72 < 75$

2) $Q = A_{min} + \Delta U$

$A_{min} = Q - \Delta U = \sum 3R\nu\frac{T\Delta T}{T_0} - \frac{3}{2}\nu R\Delta T$

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

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

$A(T) = \frac{3R\nu}{2}(T - T_0)(T + T_0 - 1)$

$((T - T_0)(T + T_0 - 1))'_T = 0$

$(T - T_0)'(T + T_0 - 1) + (T - T_0)(T + T_0 - 1)' = 0$

$(1 - 0)(T + T_0 - 1) + (T - T_0)\cdot 1 = 0$

$T + \cancel{T_0} - 1 + T - \cancel{T_0} = 0$

21200897 (U368957 M1267186)

# Часть 2

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

Шифр: **21200897**

ID профиля: **368957**

Вариант 3

№3 Чистовик

$C_2 = C$

$C_1 = 4C$

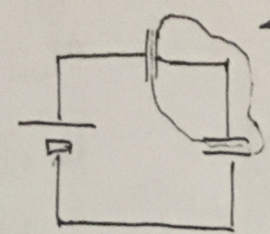
1) $I_R$ – ?

2) $Q$ – ?

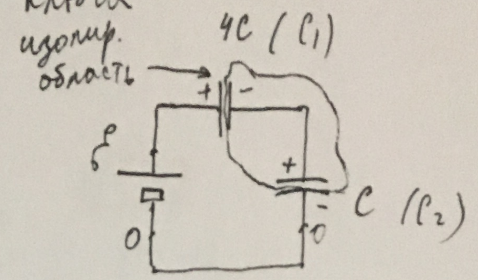
3) $U$ – ?

$(I_0 = I_{C1})$

1) • Рассм. цепь до замыкания ключа



нач. момент.



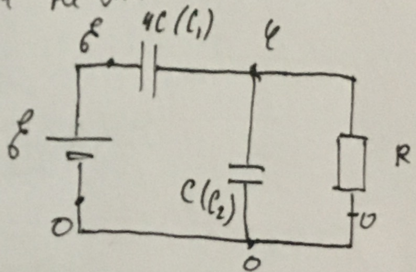

$t = t_{уст.}$

$$\begin{cases} 0 = -4C \cdot U_1 + CU_2 \\ \mathcal{E} = U_1 + U_2 \end{cases}$$

$4C_1 = U_2$

$$\mathcal{E} = 5U_1 \Rightarrow \left[\begin{array}{l} U_1 = \frac{\mathcal{E}}{5} \\ U_2 = \frac{4\mathcal{E}}{5} \end{array}\right.$$

• Рассм цепь после замыкания ключа. Напряж. на конд. скачком не меняется



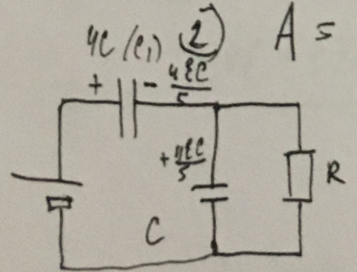

$I_R = \frac{\varphi}{R}$

$\mathcal{E} - \varphi = U_1 = \frac{\mathcal{E}}{5}$

$\varphi = \frac{4\mathcal{E}}{5}$

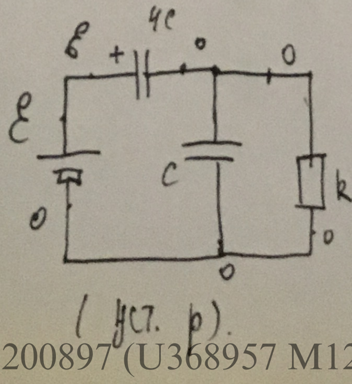
$$I_R = \frac{4\mathcal{E}}{5R}$$

(2) $A = Q + \Delta W \Rightarrow Q = A - \Delta W$




(сразу после K)

$$\left[\begin{array}{l} q_1(0) = -(4C \cdot U_1) = \frac{-4\mathcal{E}C}{5} \\ W_{10} = \frac{4CU_1^2}{2} = \frac{4C \cdot \mathcal{E}^2}{50} = \frac{2C\mathcal{E}^2}{25} \\ W_{20} = \frac{CU_2^2}{2} = \frac{8C \cdot 16\mathcal{E}^2}{50} = \frac{8C\mathcal{E}^2}{25} \end{array}\right.$$




(уст. р).

$$\left[\begin{array}{l} W_1 = \frac{4C \cdot \mathcal{E}^2}{2} = 2C\mathcal{E}^2 \\ W_2 = 0 \\ q^*_1 = 4C \cdot \mathcal{E} \end{array}\right.$$

$Q = \mathcal{E} \cdot q^*_1 - (W_1 + W_2 - (W_{10} + W_{20}))$

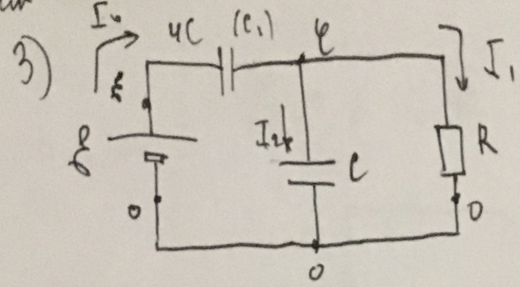
$\Rightarrow Q = 4C\mathcal{E}^2 - \left(2C\mathcal{E}^2 - \frac{10C\mathcal{E}^2}{25}\right)$

$Q = 4C\mathcal{E}^2 - \frac{40C\mathcal{E}^2}{25} = \frac{60C\mathcal{E}^2}{25}$

$$Q = \frac{12C\mathcal{E}^2}{5}$$

чистовик

3)




$$q_1 = 4C\cdot(\mathcal{E}-\varphi) = I_0\cdot\Delta t$$
$$q_2 = C\cdot\varphi = I_2\cdot\Delta t$$
$$\Rightarrow \frac{I_0}{I_2} = \frac{4(\mathcal{E}-\varphi)}{\varphi}$$

$$I_2 = I_0 - I_1$$
$$I_1 = \frac{\varphi}{R}$$
$$\Rightarrow I_2 = I_0 - \frac{\varphi}{R}$$

$$\frac{I_0}{I_0 - \frac{\varphi}{R}} = \frac{4(\mathcal{E}-\varphi)}{\varphi}$$

$$I_0\cdot\varphi = 4(\mathcal{E}-\varphi)\left(I_0 - \frac{\varphi}{R}\right)$$
$$I_0\varphi = 4\left(\mathcal{E}I_0 - \varphi I_0 - \mathcal{E}\frac{\varphi}{R} + \frac{\varphi^2}{R}\right)$$
$$I_0\varphi = 4\mathcal{E}I_0 - 4\varphi I_0 - 4\mathcal{E}\frac{\varphi}{R} + 4\frac{\varphi^2}{R}$$
$$4\varphi^2 - 4\mathcal{E}\varphi - 4\varphi I_0 R + 4\mathcal{E}I_0 R - I_0\varphi R = 0$$
$$\cancel{4\varphi^2 - 4\varphi(\mathcal{E}}$$
$$4\varphi^2 - \varphi(4\mathcal{E} + 5I_0R) + 4\mathcal{E}I_0R = 0$$
$$D = 16\mathcal{E}^2 + 40\mathcal{E}I_0R + 25I_0^2R^2 - 64\mathcal{E}I_0R = 16\mathcal{E}^2 - 24\mathcal{E}I_0R + 25I_0^2R^2$$
$$\varphi = \frac{4\mathcal{E} + 5I_0R \pm\sqrt{16\mathcal{E}^2 - 24\mathcal{E}I_0R + 25I_0^2R^2}}{8}$$

ОТВЕТ: 1) $I_R = \frac{4\mathcal{E}}{5R}$

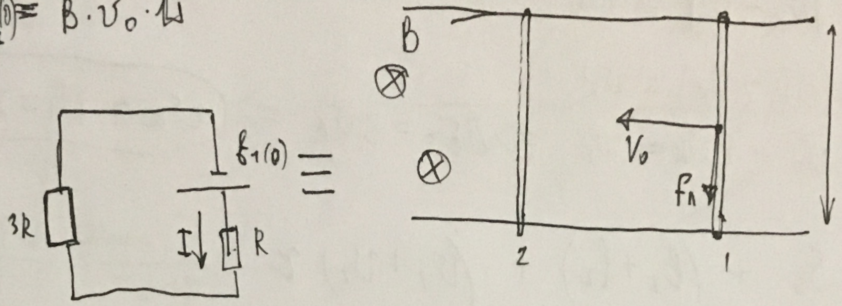
2) $Q = \frac{12C\mathcal{E}^2}{5}$

3) $\varphi = \frac{4\mathcal{E} + 5I_0R \pm\sqrt{16\mathcal{E}^2 - 24\mathcal{E}I_0R + 25I_0^2R^2}}{8}$

④ Чистовик

$L$, $S_0$
$2m$, $R$, $V_0$
$m$, $3R$
1) $Q_{10}$ - ?
2) $v$ - ?
3) $S$ - ?

1) $\mathcal{E}_1(0) = B \cdot v_0 \cdot L$




Скорость 2 перемычки в нач. момент $= 0$, т.к она скачком не меняется $\Rightarrow F_A$

т.к $F_{Л_1}(0) = B v_0 q = E \cdot q = \frac{\mathcal{E}_1}{l} \cdot q$

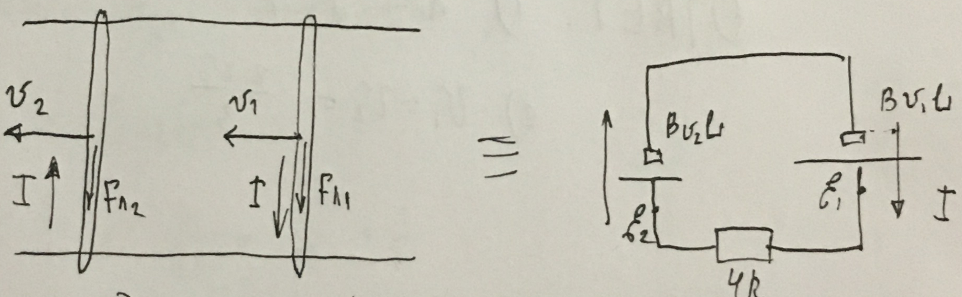
$\mathcal{E}_1(0) = B v_0 L$

$$I = \frac{\mathcal{E}_1(0)}{4R} = \frac{B v_0 L}{4R}$$

$$F_A = BIL = \frac{B^2 l^2 \cdot v_0}{4R}$$

2ЗН: $F_A = 2ma \Rightarrow a = \frac{F_A}{2m} = \frac{B^2 L^2 \cdot v_0}{8mR}$

2)




Через продолжительный промежуток времени ск-ти перемычек станут постоянными

В какой-то момент ск-ти перемычек сравняются, тогда $\mathcal{E}_2 = \mathcal{E}_1 \Rightarrow I = 0 \Rightarrow F = 0 \Rightarrow a = 0$

$F_1 = 2ma_1 = 2m \frac{\Delta V}{\Delta t}$

$F_1 = BIL$; $\Rightarrow I = \frac{\mathcal{E}_1 - \mathcal{E}_2}{4R} = \frac{Bv_1 L - Bv_2 l}{4R} = \frac{Bl}{4R}(v_1 - v_2)$

$F_2 = m \cdot a_2 = BIl = \frac{Bl}{4R}(v_1 - v_2)$

$F_1 = F_2$

$2|a_1| = |a_2|$

$2\left|\frac{\Delta V_1}{\Delta t}\right| = \left|\frac{\Delta V_2}{\Delta t}\right| \Big| \cdot \Delta t \Rightarrow 2|\Delta V_1| = |\Delta V_2|$ (A)

Просуммируем (*) чистовик

$2|v_k - v_0| = v_k$

$2(v_0 - v_k) = v_k$

$2v_0 - 2v_k = v_k \Rightarrow 2v_0 = 3v_k \Rightarrow v_k = v_1 = v_2 = \frac{2v_0}{3}$

3) $S = S_0 + (l_1 + l_2) + (v_1 + v_2)\tau$

$\frac{\Delta v_1}{\Delta t} = \frac{B^2 l^2 (v_1 - v_2)}{8mR}$

$|\Delta v_1| = B^2 l^2 (v_1 - v_2)/8mR \cdot \Delta t = B^2 l^2/8mR\,(\Delta S_1 - \Delta S_2)$ (**)

$\Delta v_2 = B^2 l^2 (v_1 - v_2)/4mR \cdot \Delta t = \frac{B^2 l^2}{4mR}(\Delta S_1 - \Delta S_2)$ (***)

Просумм (**) и (***)

$\frac{v_0}{3} = 8B^2 l^2 mR (S_1 - S_2)$

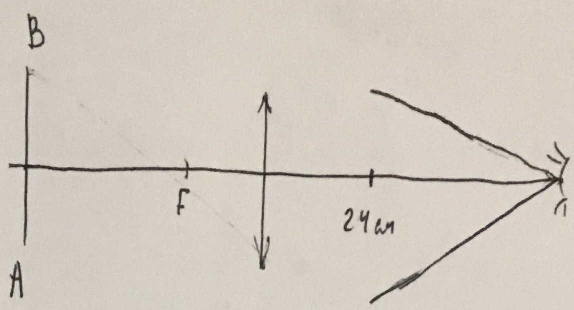
ОТВЕТ: 1) $a = \frac{B^2 L^2 v_0}{8mR}$

2) $v_1 = v_2 = \frac{2v_0}{3}$

№5 Чистовик

$F = 18$ см
$H = 9$ см
$d = 72$ см
$l = 24$ см

1) $x$
2) $D_м$
3) $r$




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

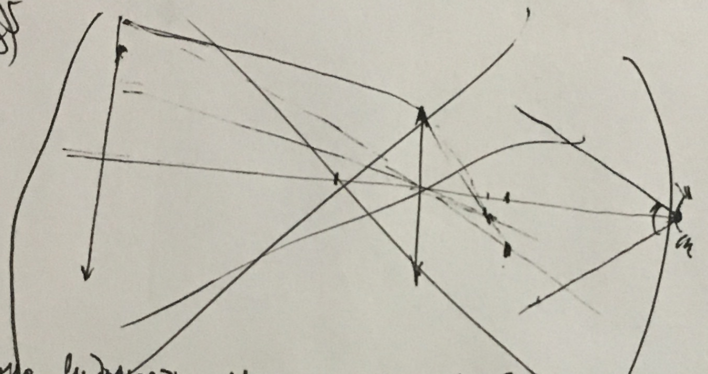
$\frac{d-F}{Fd} = \frac{1}{f}$

$f = \frac{F \cdot d}{d - F} = \frac{18 \cdot 72}{72 - 18}$

$f = \frac{18 \cdot 72}{54} = 24$ см

$x = l + f = 48$ см

2)



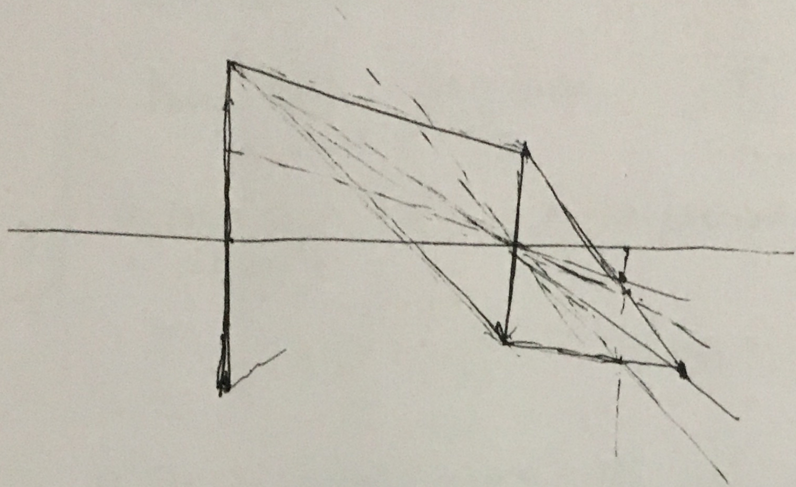
Зона видимости глаза $\alpha \approx 45°$

2) $D_м \geq D_{изобр.}$

$\Gamma = \frac{f}{d} = \frac{24}{72} = \frac{3}{9} = \frac{1}{3}$

$D_{изб} = AB \cdot \Gamma = D_{мин} = 9 \cdot \frac{1}{3} = 3$ см

Ответ: 1) $x = 48$ см
2) $D_{min} = 3$ см.



$v_k = 2v$

$F = Bqv$

$\varepsilon = $

$F = E \cdot$

$E = \frac{\varepsilon}{l}$

$Bqv = q\frac{\varepsilon}{l} =$

$$\begin{array}{r} 72 \\ -\,18 \\ \hline 54 \end{array}$$

№3

$C_2 = C$

$C_1 = 4C$

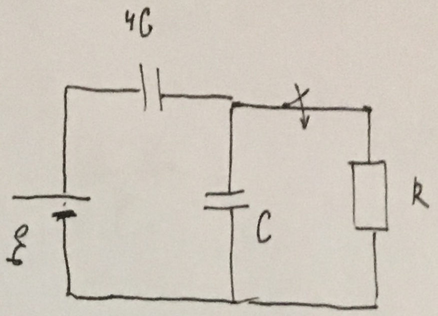
1) $I_R$ - ?

2) $Q$ - ?

3) $U$ - ?

($I_0 = I_{C_1}$)

1) Рассм процесс до

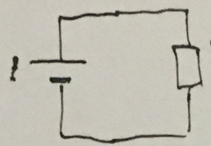



$U_{C_1} = U_{C_2} = 0$, т.к $q = 0$

Рассм. момент сразу после замыкания

$U_{C_1}(0) = U_{C_2}(0) = 0$, т.к напряжение на конд. скачком не меняется.

⇒




$I_R(0) = \frac{\mathcal{E}}{R}$

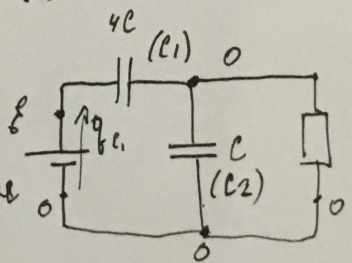
2) До замыкания ключа $W_{C_1} = W_{C_2} = 0$

Сразу после $W_{C_1}(0) = W_{C_2}(0) = 0$, т.к $U(0) = 0$

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

Рассм. цепь в уст. режиме

Исп. метод узловых потенциалов;




Ток через резистор не течёт т.к уст. состояние

⇒ $U_R = 0$

$W_{C_2}(t_{уст}) = \frac{CU_2^2}{2} = 0$

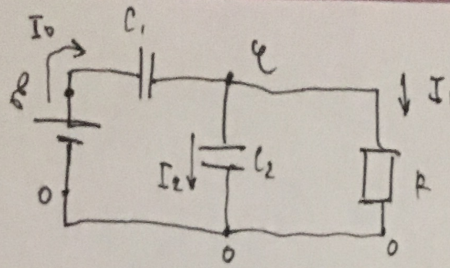
$W_{C_1}(t_{уст}) = \frac{4C\mathcal{E}^2}{2} = 2C\mathcal{E}^2$

$q_{C_1} = C_1U_1 = 4C\cdot\mathcal{E}$ ⇒ $A = \mathcal{E}\cdot q_{C_1}$

$q_{C_2} = C_2\cdot U_2 = C_2\cdot 0 = 0$

$Q = A - (W_{C_1} + W_{C_2} - 0) =$

3)




$q_1 = C_1 \cdot (\mathcal{E} - \varphi)$ $\qquad$ $q_1 = I_0 \cdot \Delta t$
$q_2 = C_2 \cdot \varphi$ $\qquad$ $q_2 = I_2 \cdot \Delta t$ $\quad \Rightarrow \quad \dfrac{I_0}{I_2} = \dfrac{\mathcal{E} - \varphi}{\varphi}$

$$\left.\begin{aligned} I_2 &= I_0 - I_1 \\ I_1 &= \frac{\varphi}{R} \end{aligned}\right\} \Rightarrow I_2 = I_0 - \frac{\varphi}{R}$$

$$\frac{I_0}{I_0 - \frac{\varphi}{R}} = \frac{\mathcal{E} - \varphi}{\varphi}$$

$$I_0 \cdot \varphi = (\mathcal{E} - \varphi)\left(I_0 - \frac{\varphi}{R}\right)$$

$$I_0 \varphi = I_2 (\mathcal{E} - \varphi)$$

$$I_2 = \frac{I_0 \varphi}{\mathcal{E} - \varphi}$$

$$\frac{I_0 \varphi}{\mathcal{E} - \varphi} = I_0 - \frac{\varphi}{R}$$

$$I_0 \varphi R = I_0 \mathcal{E} R - I_0 \varphi R - \mathcal{E}\varphi + \varphi^2$$

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