Часть 1

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

Шифр: **21201632**

ID профиля: **832627**

Вариант 1

Тестовик ①

2) Дано:
ν; T_0;
$C(T) = 2R\frac{T}{T_0}$
$\frac{5}{6}T_0$; He

1) Q_1 – ?
2) T_{min} – ?
3) A_{min} – ?

Решение:
Рассмотрим малейшее изменение температуры:

1) $dQ = C\nu dT = \frac{2R\nu}{T_0} dT$

$$\int_0^{Q_1} dQ = \frac{2R\nu}{T_0} \int_{T_0}^{\frac{5}{6}T_0} T\,dT$$

$$\Leftrightarrow$$

$$Q_1 = \frac{2R\nu}{T_0}\left(\frac{T^2}{2} \Big|_{T_0}^{\frac{5}{6}T_0} \right)$$

$$Q_1 = \frac{2R\nu}{T_0}\left(\frac{25T_0^2}{36 \cdot 2} - \frac{T_0^2}{2} \right)$$

$$Q_1 = \frac{2R\nu T_0^2}{2T_0}\left(\frac{25 - 36}{36} \right)$$

$$Q_1 \; \nu RT_0 \cdot \left(-\frac{11}{36} \right)$$

$$Q_1 = \frac{-11\nu RT_0}{36}$$ (минус означает, что тепло отделилось)

$$|Q_1| = \frac{11\nu RT_0}{36}$$

2) т.к $A = Q - \Delta U \to A = 0$

Если $Q = \Delta U$

$$\Rightarrow \frac{2R\nu}{T_0}\left(T_{min} - T_0\right) = \frac{3}{2}\nu R\left(T_{min} - T_0\right)$$

см. дальше

$A = Q - \Delta U$

$A = 0 \Rightarrow Q = \Delta U$

$Q = \frac{2RVT}{T_0}(T - T_0)$

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

$dQ = \frac{-2RVdT}{T_0}$

$dQ = \frac{-2RVT}{T_0}dT$

$dQ = \frac{2RV}{T_0}TdT$

$Q_1 = \frac{2RV}{T_0}\int_{T_0}^{\frac{5}{6}T_0} TdT = \frac{T^2}{2}\Big|_{T_0}^{\frac{5}{6}T_0} =$

$= \frac{25T_0^2}{36 \cdot 2} - \frac{T_0^2}{2} = \frac{T_0^2}{2}\left(\frac{25}{36} - 1\right) =$

$= \frac{25 - 36}{36} = \frac{-11}{36}$

$T_0 \rightarrow \frac{5T_0}{6}$

$\Delta T = -\frac{T_0}{6}$

$Q = \frac{-2RVT}{6}$

$Q = -\frac{RVT}{3}$

dQ

Черновик

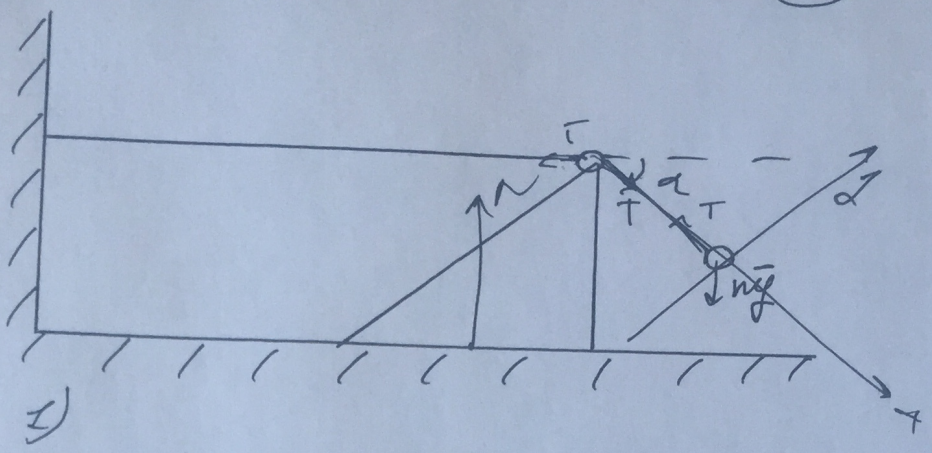
4

~~Чистовик~~ ② Черновик

1) Дано:
$\cos\alpha = \frac{3}{5}$
H

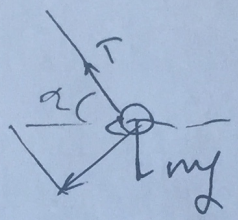
$t/в - ?$

Решение: ②



1)

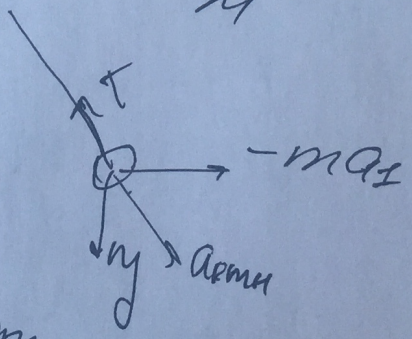
~~$ma = mg + N$~~ Нить, $g_T = 0$



$T \cdot \sin\alpha$

$T(1-\cos\alpha) = ma_1$

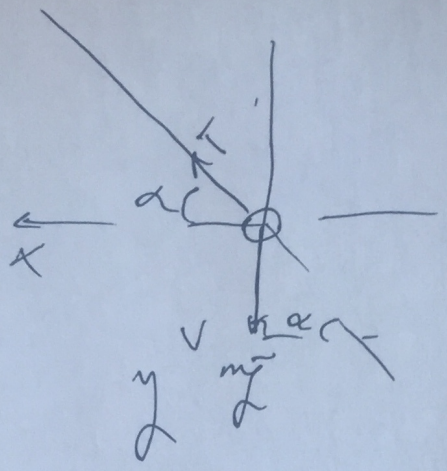
$a_1 = \frac{T(1-\cos\alpha)}{m}$



$-ma_1 = T$

~~$ma_1 - T = ma_{отн}$~~

$ma_1 + mg - T = ma_{отн}$



$180 - 90 - \alpha = 90 - \alpha$

~~ma~~ ~~mg~~ T

$$\begin{cases} ma_x = T\cos\alpha \\ ma_y = mg - T\sin\alpha \end{cases}$$

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

$a_y = g - a_x \cdot \operatorname{tg}\alpha$

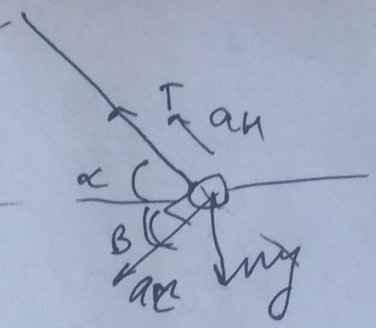
$a_y = a_x \cdot \operatorname{tg}\beta$

$a_x(\operatorname{tg}\alpha + \operatorname{tg}\beta) = g$

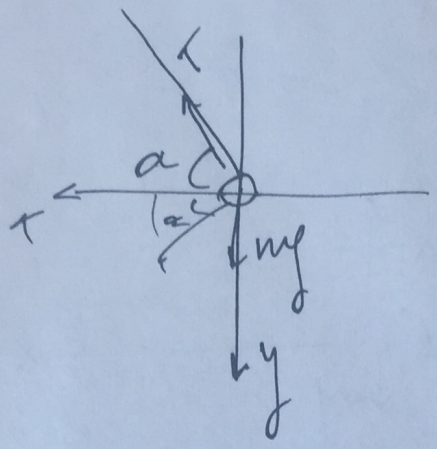
Черновик (3)

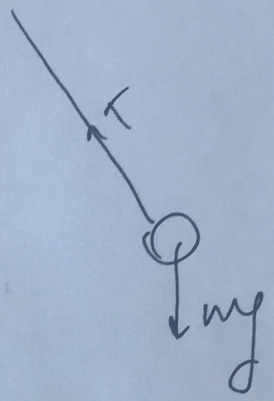
a_x - Черновик

4



a_x =





$ma_x = mg - T\sin\alpha$

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

$ma_x = mg - ma_y \cdot \operatorname{tg}\alpha$

$a_x = g - a_y \cdot \operatorname{tg}\alpha$

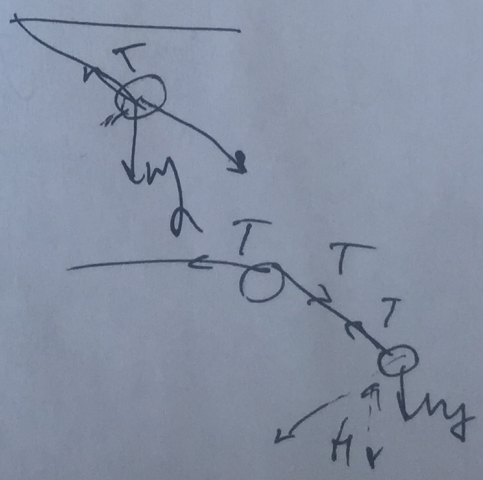
~~$a_x^2 + a_y^2 =$~~

$a \cdot \cos\beta = g - a\sin\beta \cdot \operatorname{tg}\alpha$

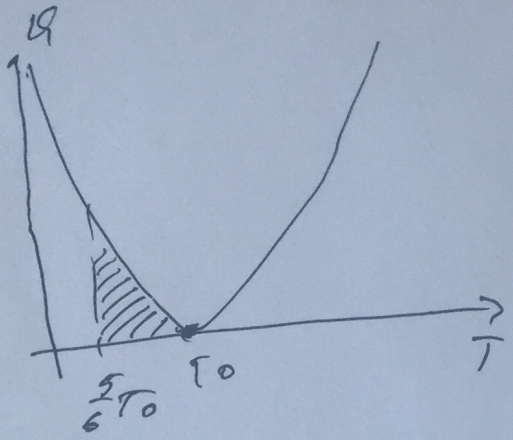
$a_x = a\cos\beta$

$a_y = a \cdot \sin\beta$

$a(\cos\beta$



$A = Q - \Delta U$ $\quad Q = 2R\frac{T}{T_0}CV($ $\quad Q \sim C \sim T$



$Q = 2R\frac{T}{T_0} \cdot V \cdot (T - T_0)$

$Q = \frac{2RTV}{T_0}$

$Q = \frac{2RV}{T_0}(T^2 - TT_0)$

$A = Q - \Delta U$

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

$\Delta U = 0 \rightarrow T = T_0$ $\quad \frac{3}{2}\nu R(T - T_0) = \frac{2RV}{T_0}(T^2 - T_0T)$

$Q = C\nu\Delta T = 2R\nu\frac{T}{T_0}(T - T_0)$

$Q = \frac{2R\nu}{T_0}(T^2 - TT_0)$ $\quad \frac{3}{2}(T - T_0) = \frac{2T}{T_0}(T - T_0)$

$Q = 0 \rightarrow T = T_0$ $\quad \frac{3}{2} = \frac{2T}{T_0}$

$Q\left(\frac{3T_0}{4}\right) = \frac{2R\nu \cdot 3T_0}{T_0 \cdot 4}\left(\frac{3T_0}{4} - T_0\right) \Leftrightarrow 4T = 3T_0$

$T = \frac{3T_0}{4}$

Черновик

(7)

Дано:
$\nu; T_0$

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

$T_k = \frac{5}{6}T_0$

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

$Q = 2R\frac{T}{T_0}\cdot C\nu\cdot\frac{T_0}{6}$

~~$Q = 2R$~~

$Q = \frac{R\cdot\nu}{3}\cdot T$

$dQ = \frac{R\nu}{3}dT$

$\int_0^{Q_1} dQ = \frac{R\nu}{3}\cdot\int_{T_0}^{\frac{5}{6}T_0} dT$

$Q = \frac{R\nu}{3}\left(\frac{5}{6}T_0 - T_0\right) = \frac{1}{6}T_0\cdot\frac{R\nu}{3}$

$Q = \frac{T_0 R\nu}{18}$ Дж

$Q = \Delta U + A$

$Q = \frac{3}{2}\nu R\Delta T + A$

$A = Q - \frac{3}{2}\nu R\Delta T$

$A = C\nu\Delta T - \frac{3}{2}\nu R\Delta T$

~~$A = \Delta T($~~

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

$A = \nu(T_1 - T_0)\left(C - \frac{3}{2}R\right)$

$A = \nu(T_1 - T_0)\left(2R\frac{T_0}{T_0} - \frac{3}{2}R\right)$

2)

$A = \nu R(T_1 - T_0)\left(2\right.$

$A = \nu R(T_1 - T_0)\frac{4T - 3T_0}{2T_0}$

$A = \frac{\nu R(T_1 - T_0)}{2T_0}\cdot(4T - 3T_0)$

Черновик (8)

$\frac{3}{5}\quad\frac{4}{5}$

$\frac{\frac{4}{5}}{\frac{3}{5}} = \frac{4}{3}$

$\frac{2T_{min}}{T_0} = \frac{3}{2} \Leftrightarrow T_{min} = \frac{3T_0}{4}$

Exercice 2

(2)

3) $A = Q - \Delta U$

$dA = dQ - \frac{3}{2} nR\,dT$

$dA = \frac{2RnT}{T_0} dT - \frac{3}{2} nR\,dT$

$dA = nR\left(\frac{2T}{T_0} - \frac{3}{2}\right) dT$

$\int_0^{A_{min}} dA = nR \int_{T_0}^{T_{min}} \left(\frac{2T}{T_0} - \frac{3}{2}\right) dT$

$A_{min} = nR \left(\frac{T^2}{T_0} - \frac{3}{2}T\right)\Big|_{T_0}^{T_{min} = \frac{3T_0}{4}}$

$A_{min} = nR\left(\left(\frac{T_{min}^2}{T_0} - \frac{3}{2}T_{min}\right) - \left(T_0 - \frac{3}{2}T_0\right)\right)$

$A_{min} = nR\left(\left(\frac{9T_0^2}{16T_0} - \frac{3}{2}T_0\right) + \frac{1}{2}T_0\right)$

$A_{min} = nR\left(\left(-\frac{15}{16}T_0\right) + \frac{1}{2}T_0\right)$

$A_{min} = nRT_0\left(\frac{-15+8}{16}\right)$

$A_{min} = \frac{-7nRT_0}{16}$

$|A_{min}| = \frac{7nRT_0}{16}$

Ainsi : $Q = Q_1 = \frac{11nRT_0}{36}$; $T_{min} = \frac{3T_0}{4}$;

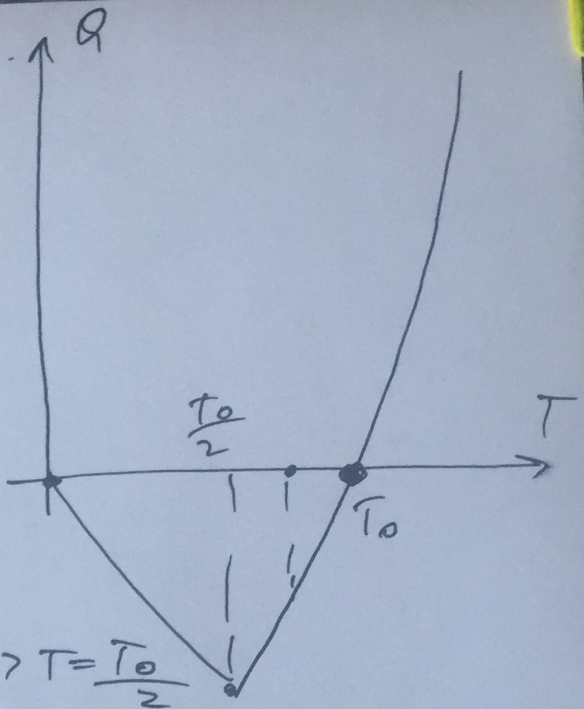
$A_{min} = \frac{7nRT_0}{16}$

$Q = \frac{2RTV}{T_0}(T - T_0)$

$= \frac{2RV}{T_0}(T^2 - TT_0)$

$x_B =$

$x_B = \frac{T}{2}$



$Q' = \frac{2RV}{T_0}(2T - T_0)$

$Q' = 0 \Rightarrow \frac{2RV}{T_0}(2T - T_0) \Leftrightarrow T = \frac{T_0}{2}$

$Q\left(\frac{T_0}{2}\right) = \frac{2R\frac{T_0}{2}V}{2T_0}\left(-\frac{T_0}{2}\right) = -\frac{RVT_0}{2}$

$T^2 - TT_0 = 0$

$T = 0$ и $T = T_0$

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

$\Delta U = 0 \Rightarrow T = T_0$

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

$= \frac{3\nu RT_0}{4}$

$\frac{RVT_0}{2} < \frac{3\nu RT_0}{4}$

Черновик (6)

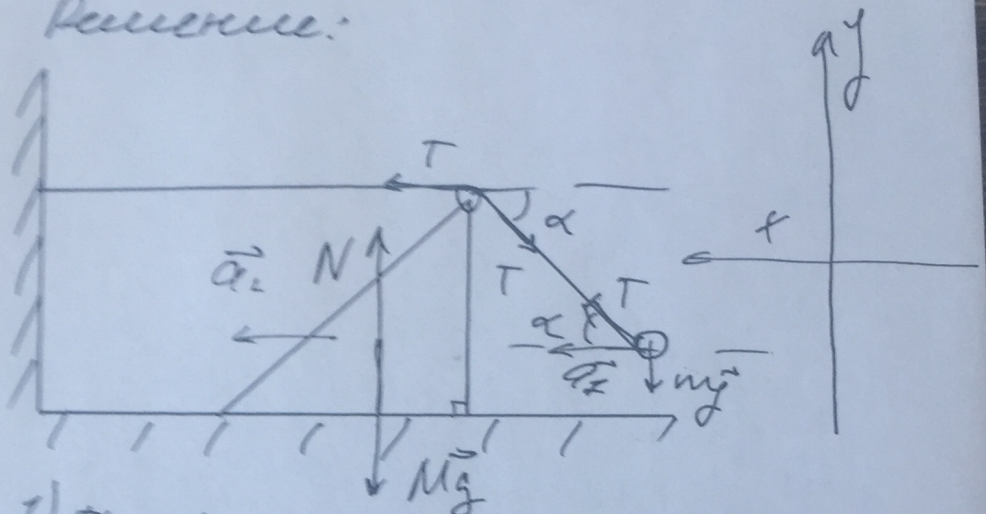
~~Дано:~~

Четвёрка (3)

1) Дано:
$M; \cos\alpha = \frac{3}{5}$

1) β - ?
2) a_2 - ?

Решение:



1) т.к. угол наклона нити к горизонту неизменен

$\Rightarrow$ $\underline{\beta = \alpha} \Rightarrow \underline{\cos\beta = \cos\alpha = \frac{3}{5}}$

2) По второму з-ну Ньютона:

Ox: $Ma_2 = T(1 - \cos\alpha)$

Oy: $ma_1 = T \cdot \cos\alpha$; Oy: $mg = T \cdot \cos\alpha$

Чтобы угол не изменился

$\Rightarrow$ $\underline{a_1 = a_2}$

$\Rightarrow$ ~~M~~ $\Rightarrow$ $\frac{T \cdot \sin\alpha}{g} a_1 = T\cos\alpha$

$a_1 = g \cdot \mathrm{ctg}\,\alpha$

т.к $\cos\alpha = \frac{3}{5} \Rightarrow \mathrm{ctg}\,\alpha = \frac{4}{3}$

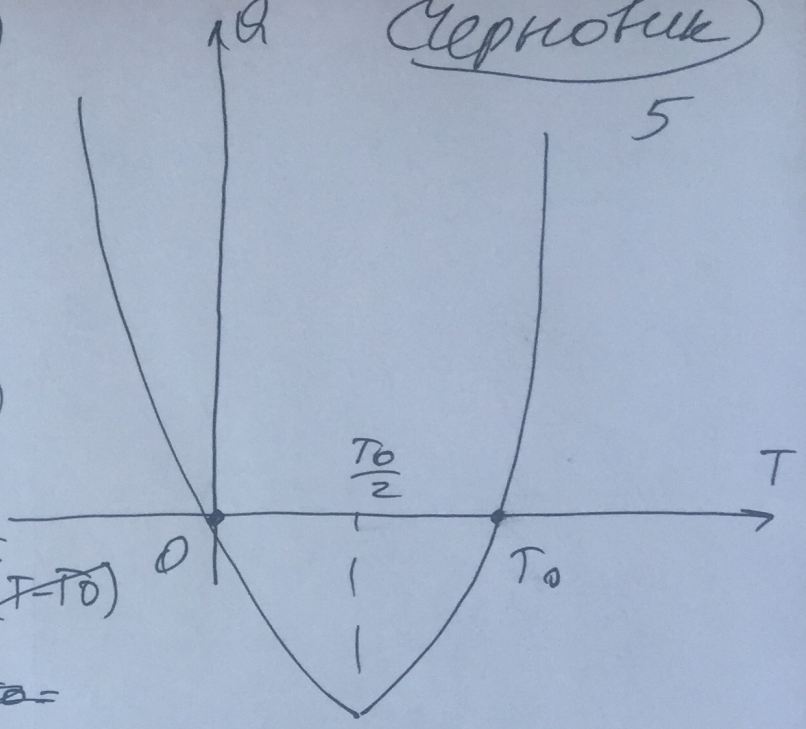
$\Rightarrow$ $\underline{a_1 = \frac{4}{3}g = a_2}$

Ответ: $\cos\beta = \frac{3}{5}$; $a_2 = \frac{4}{3}g$

Черновик

5

$Q = \frac{2RJT}{T_0}(T - T_0)$



$Q = A + \Delta U$

$A = Q - \Delta U$

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

$\frac{3}{2}JR(T - T_0) = \frac{2RJT}{T_0}(T - T_0)$

$\frac{3}{2} = \frac{2T}{T_0} \Leftrightarrow$

$T = \frac{3T_0}{4}$

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

$\Delta U = \frac{3}{2}\frac{T_0}{6}RJ$

$A = 2R.$

$Q = \frac{T_0RJ}{18}$

$A =$

$A =$ $Q +$

Часть 2

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

Шифр: **21201632**

ID профиля: **832627**

Вариант 1

Чистовик (1)

3) Дано:

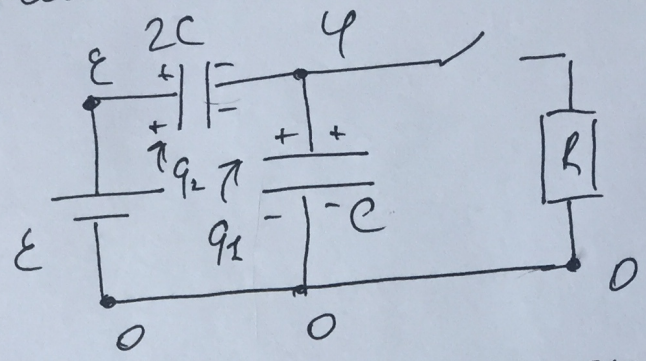
$C_1 = 2C$

$C_2 = C$

1) I_{R_0}?

2) Q – ?

Решение:



1) т.к режим установился $\Rightarrow$ оба конденсатора полностью заряжены $\Rightarrow$ после размыкания ключа, в начале, $\underline{I_{R_0} = 0}$

2) По ЗСЗ:

$q_1 - q_2 = 0 \Leftrightarrow \underline{q_1 = q_2 = q}$

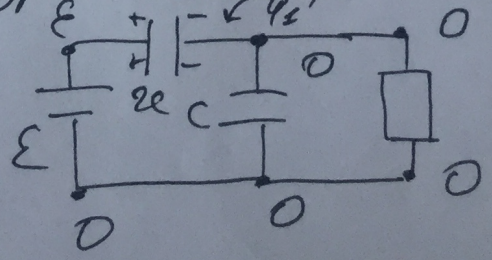
$$\Rightarrow + \begin{cases} \mathcal{E} - \varphi = \frac{q}{2C} \\ \varphi - 0 = \frac{q}{C} \end{cases} \Leftrightarrow \mathcal{E} = \frac{q}{2C} + \frac{q}{C} = \frac{3q}{2C}$$

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

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

После размыкания ключа в конденсатор C будет разряжаться, тоже $\varphi - 0 = 0$

$\Rightarrow$



Чистовик

(2)

$\Rightarrow q_1' = 2C\mathcal{E} \Rightarrow$ по ЗСЭ:

$$\left(2C\mathcal{E} - \frac{2C\mathcal{E}}{3}\right)\mathcal{E} = \Delta W + Q$$

$$\mathcal{E}\left(2C\mathcal{E} - \frac{2\mathcal{E}C}{3}\right) = 0 - \frac{4C\mathcal{E}^2}{9\cdot 2} + \frac{2C\mathcal{E}^2}{2} - \frac{2C\mathcal{E}^2}{9\cdot 2} + Q$$

$$\frac{C\mathcal{E}^2}{3} = Q + \frac{9C\mathcal{E}^2 - C\mathcal{E}^2 - 4C\mathcal{E}^2}{18}$$

$$\frac{4C\mathcal{E}^2}{3} = Q + \frac{18C\mathcal{E}^2 - 2C\mathcal{E}^2 - 4C\mathcal{E}^2}{18}$$

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

$$\frac{2}{3}C\mathcal{E}^2 = Q$$

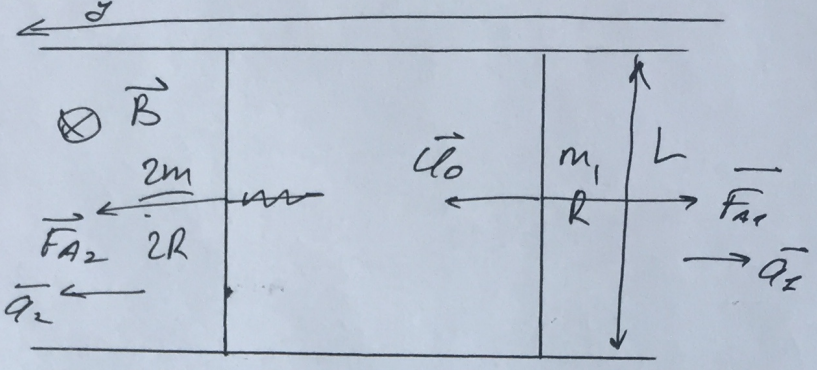
Ответ: $I_{R0} = 0$; $Q = \frac{2}{3}C\mathcal{E}^2$

Чистовик (3)

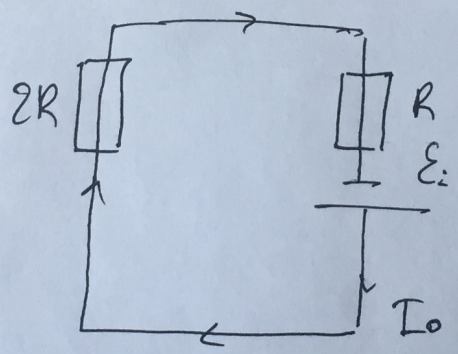
4) Дано:
$L; m;$
$R; U_0$

I) $a_{20} - ?$
2) $U_{1,2} - ?$
3) $S - ?$

Решение:



Две перемычки и рельсы образуют замкнутый контур. В цепи возникает ток, т.к. перемычка 1 двигается.



По закону Ома:

$$\mathcal{E}_i = 3I_0R \Leftrightarrow I_0 = \frac{\mathcal{E}_i}{3R}$$

По второму закону Ньютона:

Oy: $2ma_{20} = F_{A_2}$

$2ma_{20} = BI_0L$

Источник (4)

$\Rightarrow$ $q_{20} = \frac{BI_0L}{2m}$

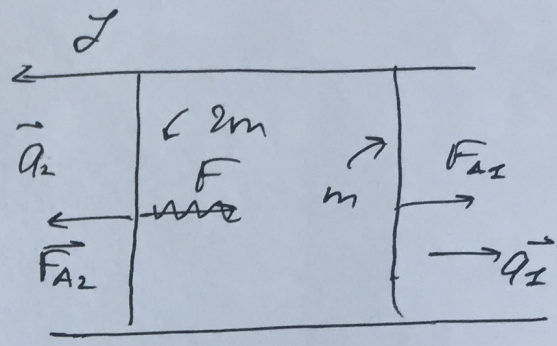
$\Rightarrow$ $q_{20} = \frac{B^2 U_0 L^2}{6mR}$

По второму закону Ньютона:

Оу:

$2m\vec{a}_2 = \vec{F}_{A2}$

$m\vec{a}_1 = \vec{F}_{A1}$



Очевидно что:

$2\vec{a}_2 = -\vec{a}_1$ выполняется всегда:

$\Rightarrow$ $\frac{2d\vec{U}_2}{dt} = -\frac{d\vec{U}_1}{dt} \Leftrightarrow 2\int_0^{U_1} d\vec{U}_2 = -\int_{U_0}^{U_1} d\vec{U}_1$

$\Leftrightarrow 2U_1 = U_0 - U_1 \Leftrightarrow U_1 - \frac{U_0}{3} = U_2$

т.к в таком случае ток в замкнутом контуре станет равен 0 $\rightarrow$ Сил ампера не возникнет. Перемычки будут двигаться равномерно.

Системы. (5)

~~$mg_1 - BI_1L = \frac{B^2L^2v_1}{3R}$~~

$$\begin{cases} ma = BIL = \frac{B^2L^2v_1'}{3R} \\ 2ma = \frac{B^2L^2v_2'}{3R} \end{cases} \quad (4)$$

$$\begin{cases} \frac{m\,dv_1}{dt} = \frac{B^2L^2v_1'}{3R} \\ \frac{2m\,dv_2}{dt} = \frac{B^2L^2v_2'}{3R} \end{cases} \Leftrightarrow \begin{cases} m\,dv_1 = \frac{B^2L^2}{3R}v_1'\,dt \\ 2m\,dv_2 = \frac{B^2L^2}{3R}v_2'\,dt \end{cases}$$

$$\Leftrightarrow m\int_{v_0}^{v_1=\frac{v_0}{3}} dv_1 = -\frac{B^2L^2}{3R}\int_0^{S_1} dS_1 \qquad 2m\int_0^{v_2=\frac{v_0}{3}} dv_2 = \frac{B^2L^2}{3R}\int_0^{S_2} dS_2$$

$$m\left(\frac{v_0}{3} - v_0\right) = -\frac{B^2L^2}{3R}\cdot S_1 \qquad \Leftrightarrow \quad 2\cdot\frac{2mv_0}{3} = \frac{B^2L^2}{3R}S_2$$

$$\frac{2mv_0}{3} = \frac{B^2L^2}{3R}S_1$$

$$\Leftrightarrow \begin{cases} S_1 = \frac{2mv_0R}{B^2L^2} \\ S_2 = \frac{2mv_0R}{B^2L^2} \end{cases} \Leftrightarrow S_1 = S_2$$

$$S' = S_0 - S_1 + S_2 = S_0$$

Ответ: $q_{20} = \frac{B^2L^2v_0}{6mR}$; $v_1 = v_2 = \frac{v_0}{3}$; $S' = S_0$

Чистовик (6)

5) Дано:
$H = 9\,см$
$F = 9\,см$
$d = 2 \cdot 36\,см$
$f = 24\,см$

Найти:
1) $x - ?$

Решение:

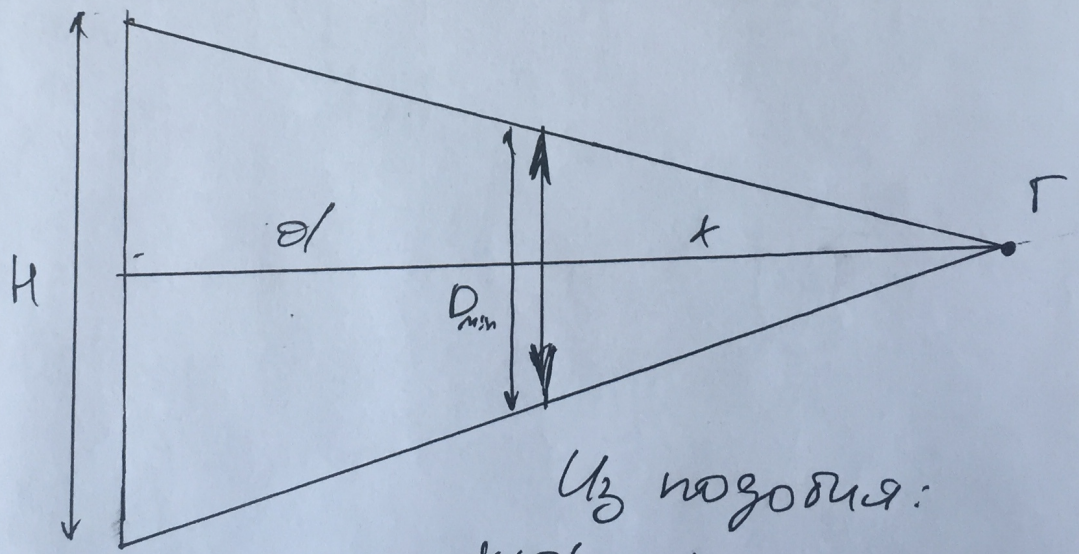
т.к $d > 2F \Rightarrow$ изображение действительное и уменьшенное.

Очевидно что:

$x = f + f$ где $f = \frac{dF}{d-F}$

по формуле тонкой линзы т.к $n_1 = n_{01} = 1$

$\Rightarrow x = 24\,см + \frac{36\,см \cdot 9\,см}{27\,см} = 36\,см$



Из подобия:

$\frac{x+d}{x} = \frac{H}{D_{лин}}$

$\Rightarrow D_{лин} = \frac{Hx}{x+d}$

$D_{лин} = \frac{36\,см \cdot 9\,см}{72\,см} = 4{,}5\,см$

Ответ: $x = 36\,см$; $D_{лин} = 4{,}5\,см$

Черновик

(2)

$$q_2 = \frac{B^2L^2U_0}{6mR} = \frac{d\Phi_2}{dt}$$

$$q_2 = \frac{B^2L^2U_0}{3mR} = \frac{d\Phi_2}{dt}$$

$$\frac{\Delta\Phi}{\Delta t}$$

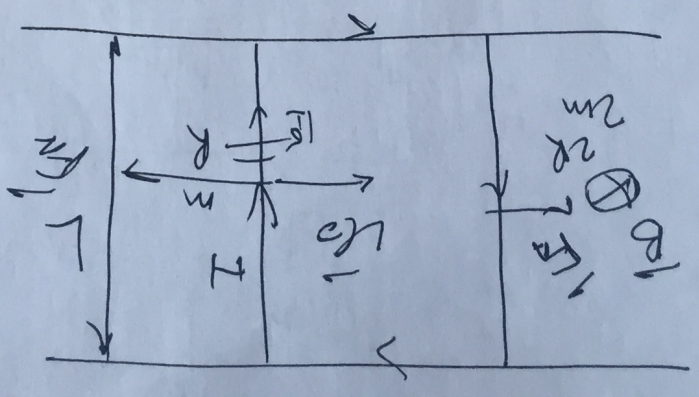
$$\frac{\frac{d\Phi_2}{dt}}{\frac{d\Phi_2}{dt}} = B^2L^2U_0$$

$$ma = BIL =$$

$$ma = \frac{BLU}{3R} = \frac{B^2L^2U}{}$$

$$Fa = b$$

$$ma = Fa = BIL.$$



$$\varepsilon_i =$$

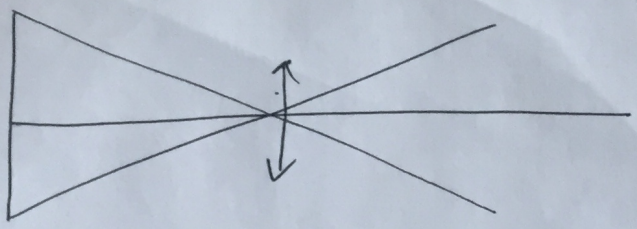
$$U = BUL = \varepsilon_i$$

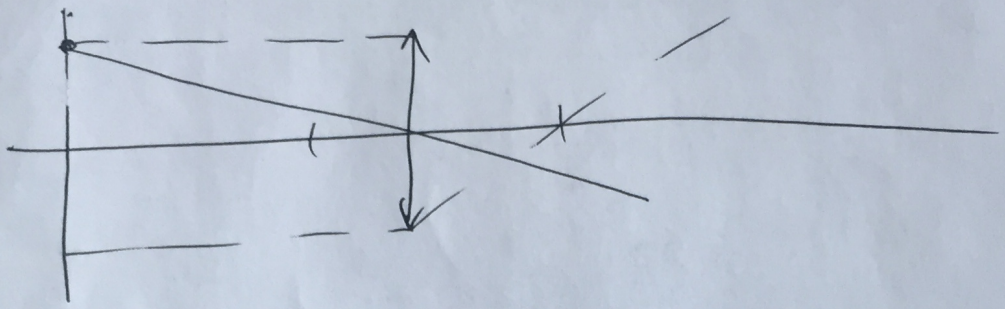
$$3RI = U$$

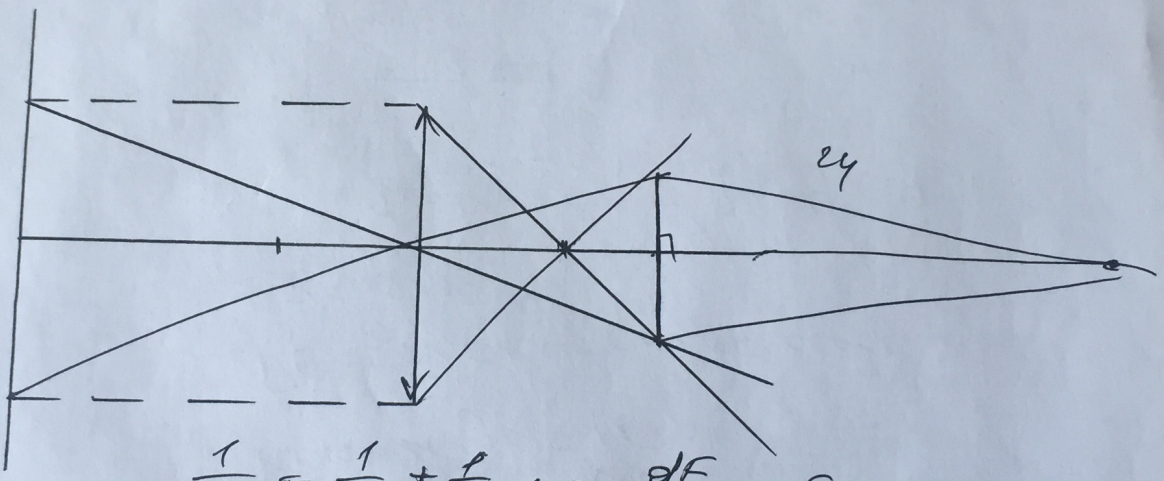
$$I = \frac{U}{3R} = \frac{BUL}{3R}$$

Черновичок

(3)





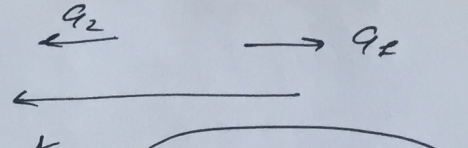


$$\frac{1}{F} = \frac{1}{3c} + \frac{1}{f} \Leftrightarrow \frac{dF}{d-F} = f$$

12

=15

$q_1 = 2q_2$



Черновик

(4)

$\vec{q}_1 = -2\vec{q}_2$

$\frac{\Delta \vec{U}_1}{\Delta t} = \frac{-2\Delta \vec{U}_2}{\Delta t}$

$\int$ $\quad 2\vec{q}_2 = -\vec{q}_1$

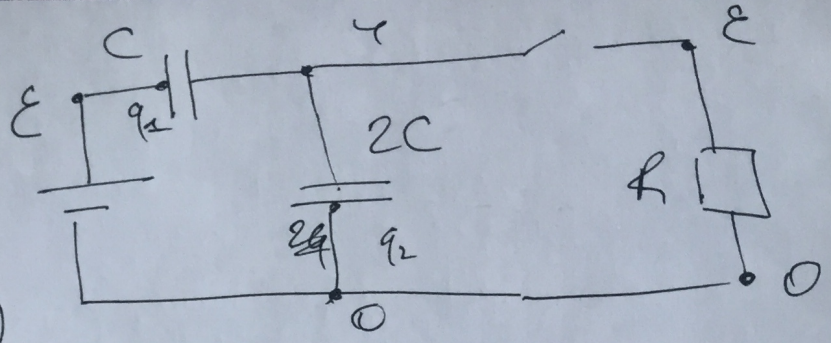
$\frac{2d\vec{U}_2}{dt} = -\frac{d\vec{U}_1}{dt}$

$2\int_0^{U_1} d\vec{U}_2 = -\int_{U_0}^{U_1} dU_1$

$2U_1 = U_0 - U_1 \Leftrightarrow U_1 = \frac{U_0}{3}$

~~3) Дано:~~

I)



Чернобик

(5)

$\frac{\varepsilon}{R} = I_{нач}$

$q_1 = C(\varepsilon - \psi)$

$q_2 = 2C(\psi - 0)$

$U_C = U_R$

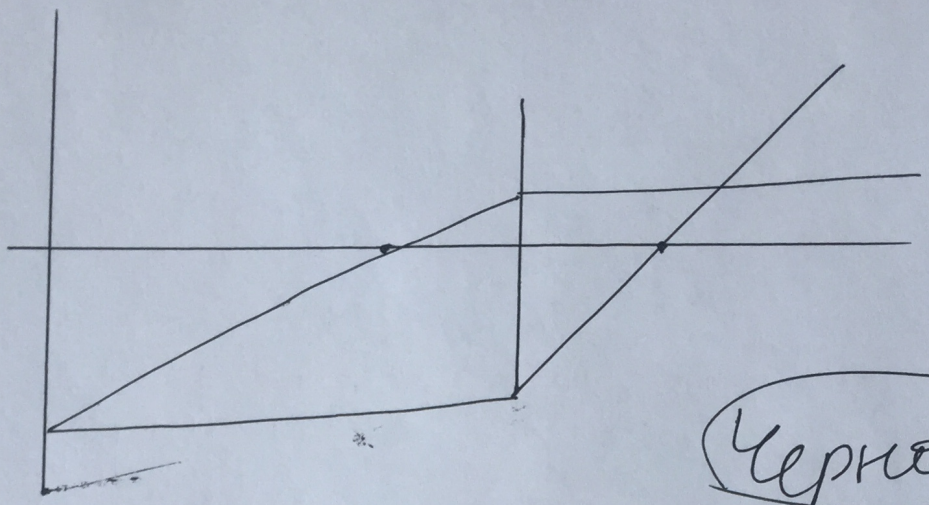
I_{2C}.

~~Q =~~

$(q_1+q_2)\varepsilon = \frac{C(\varepsilon-\psi)^2}{2} + ~~2C(\varepsilon$

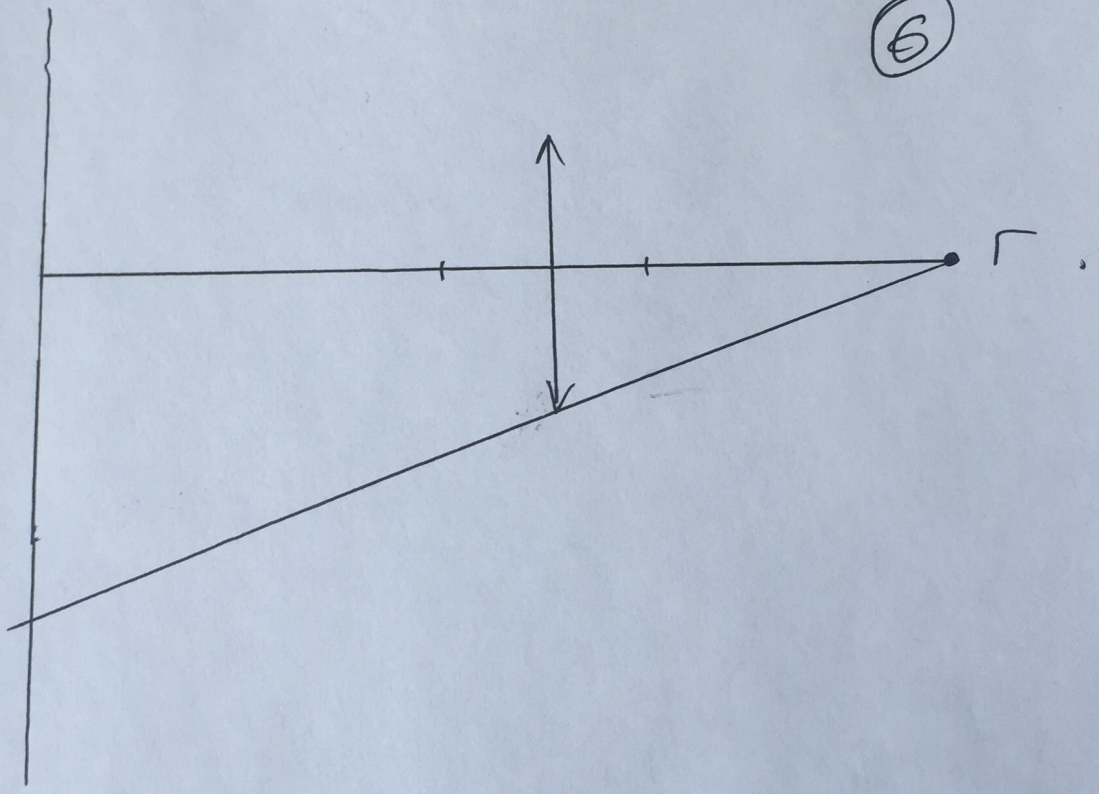
$(q_1+q_2)\varepsilon = \frac{C(\varepsilon-\psi)^2}{2} + \frac{2C\psi^2}{2} + q$

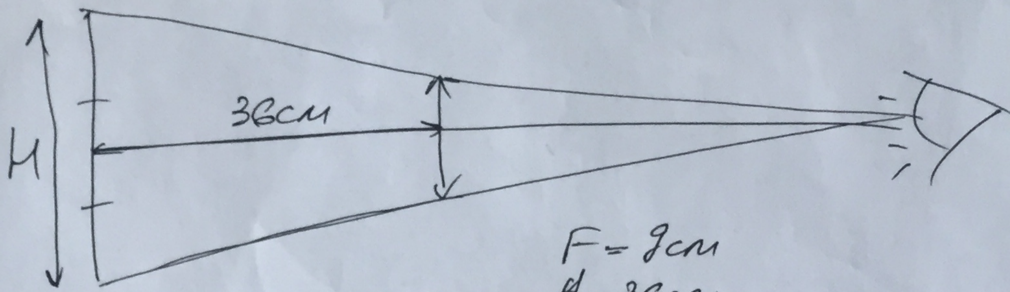
$\psi = \frac{q_2}{2C}$ $\quad q = CU <=> U = \frac{q}{C}$



Черновик

б)



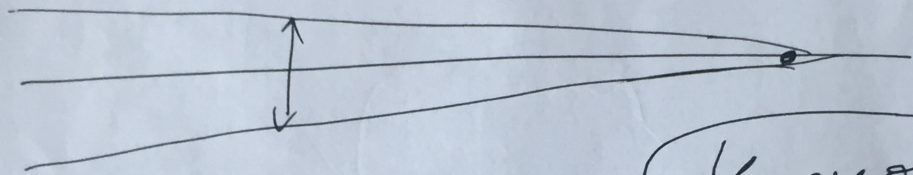


$F = 9$ см

$d = 36$ см

$H = 9$ см

$f = 24$ см

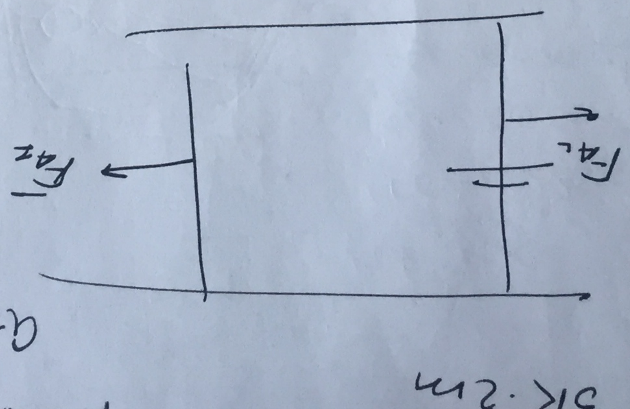


Черновик (7)

$$\frac{B U_0 L \cdot B \cdot L}{3R \cdot 2m}$$

$m a_1 = BIL$

$a_1 =$



$\mathcal{E}_{i1} = \mathcal{E}_{i2}$

$\mathcal{E}_{i1} - \mathcal{E}_{i2} = 3IR$

$I = 0$

$\mathcal{E}_{i1} = \mathcal{E}_{i2}$

$U_1 = U_2$

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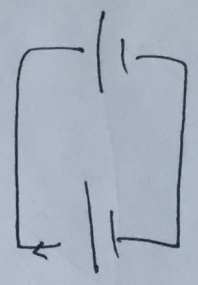
1. (1)
2. (123)
3. (12)
4. (23)
5. (1)

$\mathcal{E}_{i1} = \mathcal{E}_{i2} = BUL$

U $\quad$ $\frac{U}{2}$



$q_2 = \frac{B^2L^2U_0}{6mR}$

$B U_1 \Delta = B U_2 \Delta$

$U_1 = U_2$

5×1
4×2
3×2

~~$mq_1 = BIL =$~~

$mq_1 = B^2L^2 \cdot U_1$

$mq_1 = BIL$

$I =$

$I = \frac{\mathcal{E}_1 - \mathcal{E}_2}{3R}$ $\quad$ $I =$

$mq_1 = \frac{B^2L^2 \cdot (\mathcal{E}_1 - \mathcal{E}_2)}{3R}$

$mq_1 = B^2L^2 \cdot I_1$ $\quad$ $I_1 = \frac{U_1}{3R}$ ⇔?

$mq_1 = \frac{B^2L^2U_1}{3R} = \frac{B^2L^2U}{3R}$ $\quad U_1 = BUL$

$\frac{m\Delta U}{\Delta t} = \frac{B^2L^2U}{3R}$

$m\Delta U = \frac{B^2L^2}{3R}\Delta S$

mU

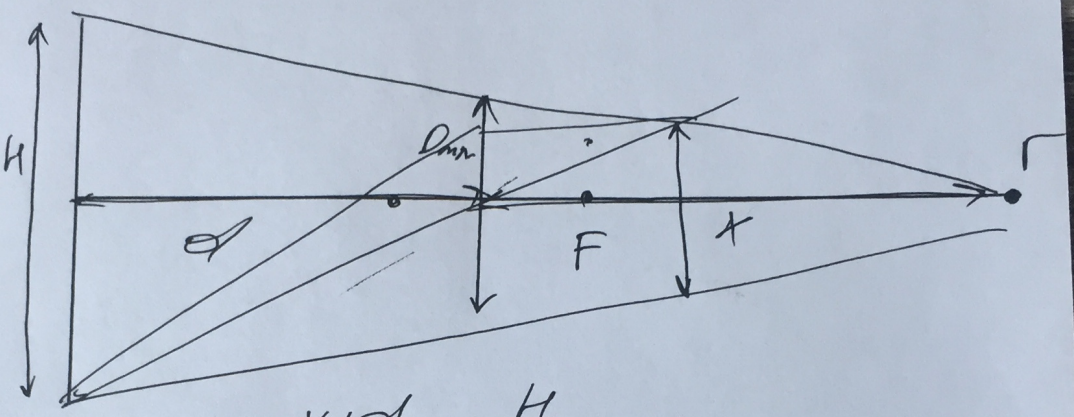
Черновик (8)

~~Чистовик~~ ~~Б~~ Черновик 1

5) Дано:
H = 9см
d = 36см
y = 4см
F = 9см

1) x

Решение:
т.к. $d > 2F \Rightarrow$ изображение действительное и уменьшенное



$$\frac{x+0{,}1}{x} = \frac{H}{2D}$$

$$D = \frac{xH}{x+0{,}1} =$$