Часть 1

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

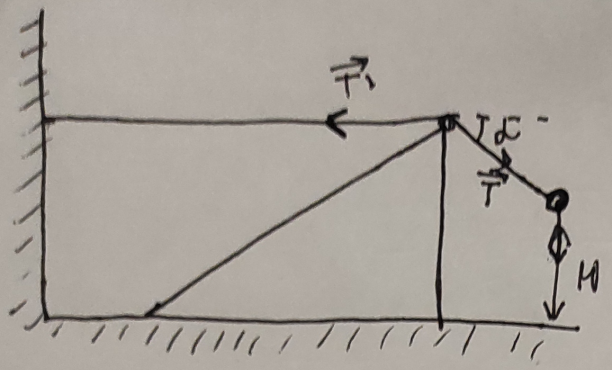
Шифр: **21202411**

ID профиля: **320402**

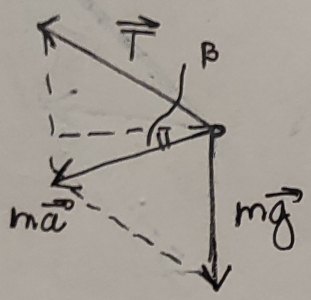
Вариант 1

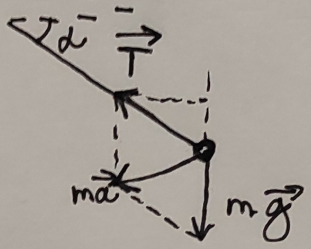
№1 Вариант 11-01 Чистовик (1)

$\cos\alpha = \frac{3}{5} \Rightarrow \sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{4}{5}$



1) Р-ии силы, действ. на шар.

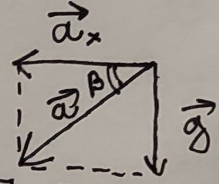




Запишем II з. Ньютона для шара: (масса шара)

$T\sin\alpha = mg$

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

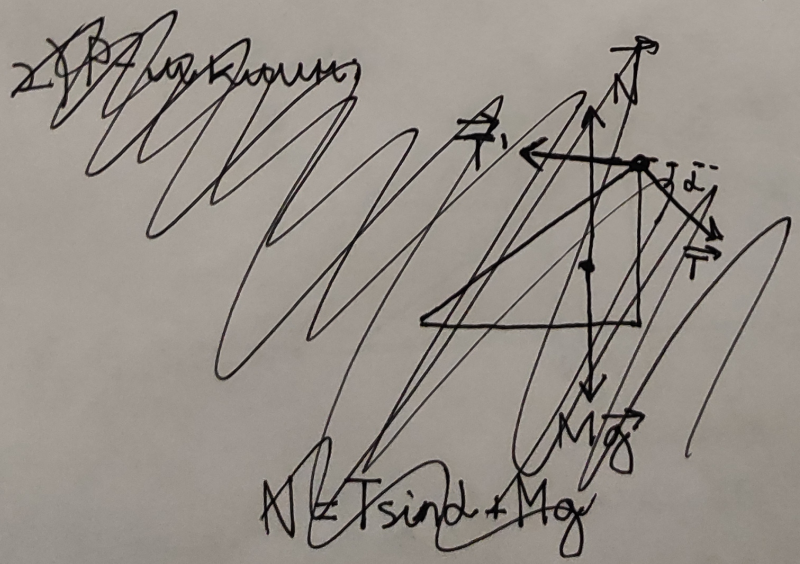


$T\cos\alpha = ma_x$

$a_x = \frac{3}{4}g$

$a = \sqrt{a_x^2 + g^2} = \frac{5}{4}g$

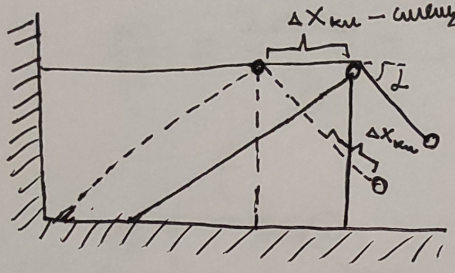
$\operatorname{tg}\beta = \frac{g}{a_x} = \frac{4}{3}$



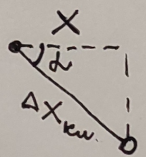
$N = T\sin\alpha + Mg$

Чистовик (2)

2) Р-м изменение положения системы за Δt:



$l_{нити} = const$



$\frac{X}{\Delta X_{кл}} = \cos\alpha$

$X = \Delta X_{кл} \cos\alpha = \frac{3}{5}\Delta X_{кл}$

$X' = \frac{3}{5}(\Delta X_{кл})'$

$v_x = \frac{3}{5} v_{кл}$

$v_x' = \frac{3}{5} v_{кл}'$

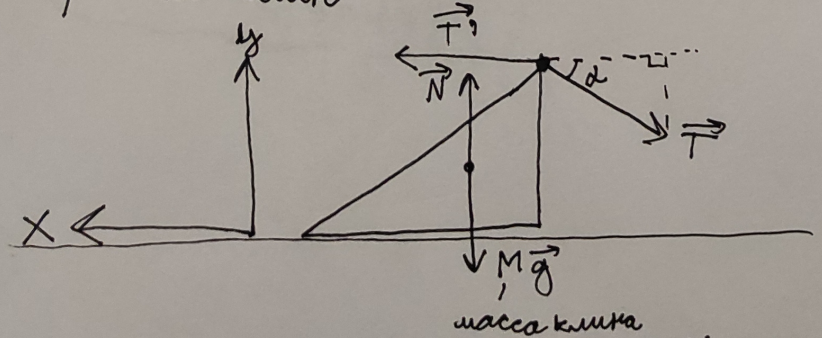
$a_x = \frac{3}{5} a_{кл}$

$\Downarrow$

$a_{кл} = \frac{5}{3} a_x = \frac{5}{3} \cdot \frac{3}{4} g =$

$= \boxed{\frac{5}{4} g = a_{кл}}$ 10)

3) Р-м клин:



Запишем II з. Ньютона: oy: $N = T\sin\alpha + Mg$

ox: $Ma_{кл} = T - T\cos\alpha$

$Ma_{кл} = T(1 - \cos\alpha)$

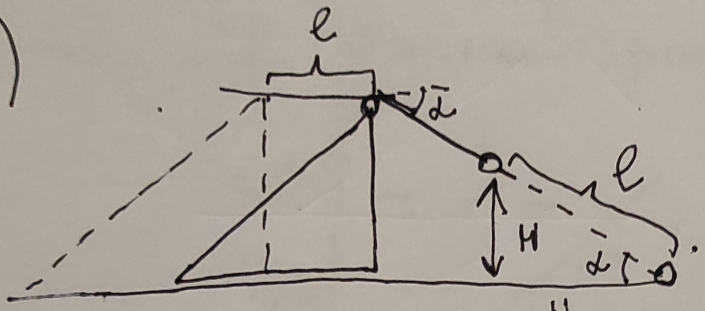
$T = \frac{5}{4} mg$ (из 1-го пункта)

Чистовик (3)

$M a_{кш} = \frac{5}{4} mg : \frac{2}{5} = \frac{mg}{2}$

$\frac{m}{M} = \frac{2 a_{кш}}{g} = \frac{2 \cdot \frac{5}{4} g}{g} = \frac{5}{2} = \frac{m}{M}$

4)



$\sin\alpha = \frac{H}{l} \Rightarrow l = \frac{H}{\sin\alpha} = \frac{5}{4} H$

нач. ск-ть

т.к. $v_0 = 0$ и $a = const$ $\quad l = \frac{a_{кш} t^2}{2}$ ~ момент достижения стола

$t = \sqrt{\frac{2l}{a_{кш}}} = \sqrt{\frac{2 \cdot 5H}{4 \cdot 5} \cdot \frac{4}{g}} = \sqrt{\frac{2gH}{g^2}} = t$

Ответ: 1) $tg\beta = \frac{4}{3}$
2) $a_{кш} = \frac{5}{4} g$
3) $\frac{m}{M} = \frac{5}{2}$
4) $t = \sqrt{2gH}$

Листовик (4)

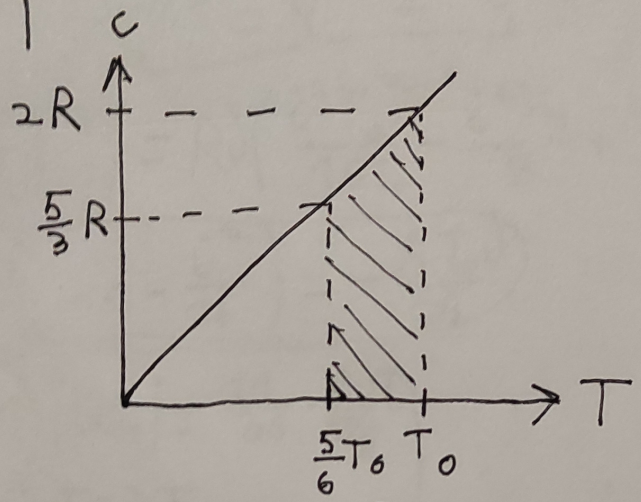
№2

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

1) $T_0 \to \frac{5}{6}T_0$

$\Delta Q = C\Delta T$, $Q = \Sigma \Delta Q$

Построим график $C(T)$



Заштрих. Площадь и будет являться $|Q_1|$

$$|Q_1| = \left(\frac{\frac{5}{3}R + 2R}{2}\right) \cdot \frac{1}{6}T_0 \cdot J = \frac{11}{36} \cdot RJT_0$$ (отдаёт тепло)

2) По I-му закону термодинамики:

$$\Delta Q = \Delta U + A$$

$$A = \Delta Q - C_V \Delta T = J\Sigma C\Delta T - \nu C_V (T - T_0) =$$

$$= \left(\frac{2R + 2R\cdot\frac{T}{T_0}}{2}\right) \cdot (T - T_0) \cdot J - C_V (T - T_0) \cdot J =$$

i – степень свободы тела

$$= J\left[R\left(1 + \frac{T}{T_0}\right)(T - T_0) - \frac{i}{2}R(T - T_0)\right] =$$

$$= RJ\left[\frac{T^2}{T_0} - T_0 - \frac{i}{2}T + \frac{i}{2}T_0\right] =$$

$$= RJ\left[\frac{T^2}{T_0} - \frac{i}{2}T + T_0\left(\frac{i}{2} - 1\right)\right] \to \min$$

Черновик (5)

$$T^2 - \left(\frac{i}{2}T_0\right)T + T_0^2\left(\frac{i}{2} - 1\right) \to \min$$

↑ Парабола, ветви вверх

$$T^* = \frac{iT_0}{4} = \frac{3}{4}T_0$$

3) $$A_{min} = A(T^*) = RV\left(\frac{i^2T_0^2}{16T_0} - \frac{i^2T_0}{8} + T_0\left(\frac{i}{2} - 1\right)\right) =$$

$$= RT_0V\left(\frac{i}{2} - 1 - \frac{i^2}{16}\right) = -\frac{RT_0V}{16}$$

Ответ: 1) $|Q_1| = \frac{11}{36} \cdot RVT_0$

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

3) $A_{min} = -\frac{RT_0V}{16}$

$C = \frac{\Delta Q}{\Delta T}$ $C_V =$ $CV = \nu R T$

$T =$

$PV = \nu RT$ $\frac{5}{6} \cdot 2$ $\frac{3}{2} - 1 - \frac{9}{16}$

$\frac{5}{2} \cdot 1 - \frac{25}{16}$ PV $\frac{5}{3}$

$A_{кш} = A$ $\frac{3}{2} - \frac{25}{16}$ $\frac{5}{3} + 2$ $\sqrt{\frac{2H}{\sin\alpha}}$

$\frac{9}{16}T_0 - \frac{9}{8}T_6 + \frac{3}{2}T_0 - T_0$ $\frac{5+6}{3}$ $\frac{11}{3} \cdot \frac{1}{6}$

$\frac{9}{16} - \frac{18}{18} + \frac{3}{2} - 1$ $\sqrt{\frac{2 \cdot 5H}{10 \cdot g}} = \sqrt{2gH}$ $\frac{11}{36} \cdot \frac{\Delta V}{T_6}$

$-\frac{9}{16} + \frac{3}{2} - 1$ $3 \mid 5$

$\frac{10}{4}$ $-\frac{9}{16} + \frac{1}{2} = -\frac{9}{16} + \frac{8}{16}$ $\frac{1}{2} - \frac{i}{8} \cdot$

$\sqrt{\frac{2l}{a}}$ $-\frac{1}{16}$ $\times 6$ $i = 4$

$\frac{5}{2} - 1 - \frac{25}{16}$ $\frac{3}{2} - 1 - \frac{9}{16}$:

a $\frac{3}{2} - \frac{25}{16}$ $\frac{1}{2} - \frac{9}{16}$

$\frac{9}{16} + \frac{16}{16}$ $-\frac{1}{16}$ $A\sqrt{\ }$

5

$\frac{5}{4} mg \cdot \frac{2}{5}$ $\frac{m}{2} = M \cdot \frac{5}{4} \cdot g$

$Q = A + \Delta U$ $\frac{m}{M} = \frac{10}{4} = \frac{5}{2}$

$\int p dV$

$2R \cdot \frac{5}{6_3}$ $\frac{5}{3}R$ 1. $a_{кш} \sin\alpha = g$ $\frac{5}{4}g$

$\frac{i^2 T_0}{16} - \frac{iT_0}{8}$ $a_{кш} \frac{3}{5} = a_x$

$\Rightarrow$

$\Delta l \cos\alpha = \Delta x \frac{i^2 T_0}{16} + T_0 \left(\frac{i}{2} - 1\right)$

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

$\frac{5}{2} - 1 - \frac{25}{16}$

$2{,}5 - 1 -$

$1{,}5 - \frac{25}{16}$

$RT_0 \left(\frac{3}{2} - 1 - \frac{9}{16}\right)$

$RT_0 \left(\frac{1}{2} - \frac{9}{16}\right) =$

$= RT_0 \left(\frac{8-9}{16}\right)$

Часть 2

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

Шифр: **21202411**

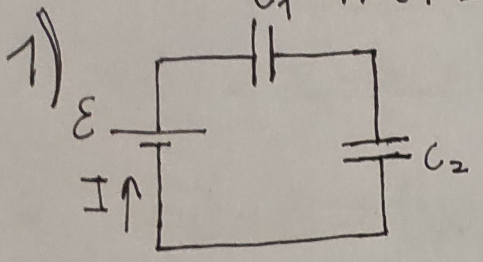
ID профиля: **320402**

Вариант 1

Вариант 11-01 №3

Чистовик (1)

1)



В уст. режиме $I = 0$

$\mathcal{E} = U_1 + U_2$

$C_1 U_1 = C_2 U_2$

$2\mathcal{E} U_1 = \mathcal{E} U_2 \Rightarrow U_1 = \frac{U_2}{2}$

$\Downarrow$

$\mathcal{E} = \frac{3}{2} U_2$

$U_2 = \frac{2}{3}\mathcal{E}$

$U_1 = \frac{1}{3}\mathcal{E}$

Сразу после замык. U_2 не успело поменяться.

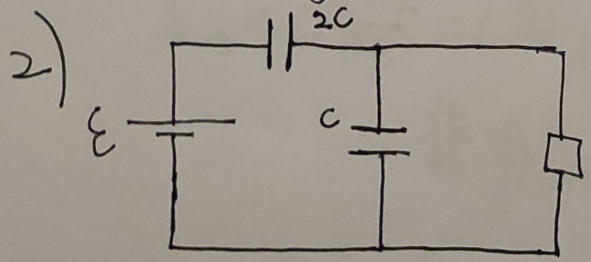
$\frac{2}{3}\mathcal{E} = U_2 = U_R$

напряж. на резисторе

$$I_R = \frac{U_R}{R} = \frac{2}{3}\frac{\mathcal{E}}{R}$$

ток через резистор

2)



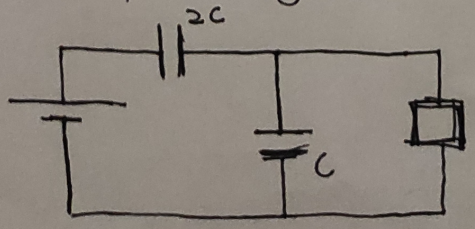
$A_{ист} = \Delta W + Q$

$\Delta q \mathcal{E}$

$q_0 = \frac{2}{3} C\mathcal{E}$

р-м установившийся режим:

Тока в цепи не будет



$\Downarrow$

$U_R = 0 = U_{C_2}$

$U_{C_1} = \mathcal{E}$

Листовик (2)

$q_1 = C_1 U_{C_1} = 2C\mathcal{E}$

$\Delta q = 2C\mathcal{E} - \frac{2}{3}C\mathcal{E} = \frac{4}{3}C\mathcal{E}$

$\Delta q\mathcal{E} = Q + (W_K - W_0)$

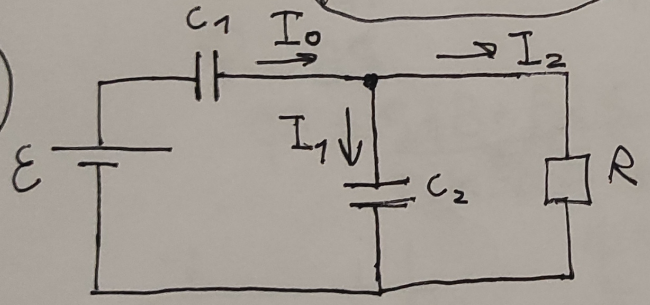
$\frac{4}{3}C\mathcal{E}^2 = Q + \frac{C_1 \cdot \mathcal{E}^2}{2} - \frac{C_1 \cdot \mathcal{E}^2}{18} - \frac{C_2 \cdot 4\mathcal{E}^2}{18}$

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

$\Downarrow$

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

3)



$I_0 = I_1 + I_2 \Rightarrow q_0 = q_1 + q_2$

$I = \frac{dq}{dt}$

$\mathcal{E} = U_1 + U_2$

$U_2 = I_2 R$

$I_0 = C_1 \cdot (U_{C_1})' = 2C \cdot \frac{dU_1}{dt}$

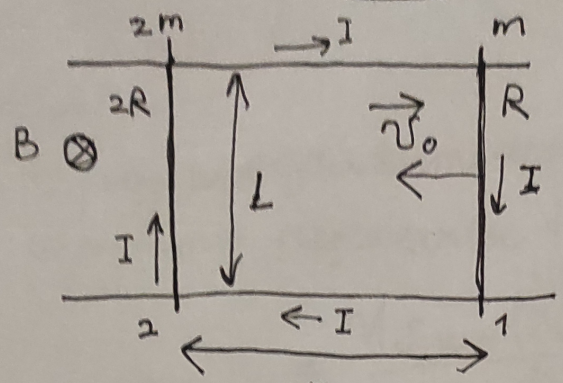
$I_1 = C\frac{dU_2}{dt} = C\frac{d(\mathcal{E} - U_1)}{dt} = C \cdot \frac{dU_1}{dt} = \frac{I_0}{2}$

$\frac{d\mathcal{E}}{dt} = 0$ т.к. $\mathcal{E} = const$

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

Чистовик (3)

№4



S_0

переменное магнитное поле порождает вихревое электрическое

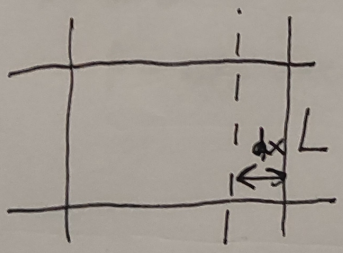
$$I = \frac{\mathcal{E}_i}{2R+R}$$

$$\mathcal{E}_i = -\frac{d\Phi}{dt} = -\Phi' = |\Phi'|$$

$$\Phi = BS$$

$$\Phi' = S\,dB + B\,dS$$

т.к. $B = const$, то $S\,dB$ и



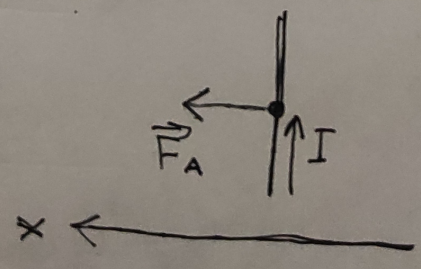
$$\Phi' = \frac{B\,dS}{dt} = \frac{B\cdot(-dx\cdot L)}{dt} = -vBL$$

v_a

$$|\Phi'| = vBL$$

$$I = \frac{vBL}{3R}$$

В начале $v = v_0$



$$2ma_2 = F_A = IBL$$

$$2ma_2 = \frac{v_0(BL)^2}{3R}$$

$a_2 = \frac{v_0 (BL)^2}{6mR}$

Чистовик (4)

2) Через продолжительный промежуток скорости перемычек будут постоянными $\Rightarrow a = 0$

$$0 = a = \frac{u_{сближ} (BL)^2}{6mR} \Rightarrow u_{сближ} = 0$$

$u_{сближ}$ - то сближения перемычек

$\Downarrow$

$v_1 = v_2 = u$

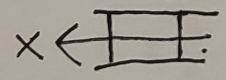
~~ЗСЭ: $\frac{mv_0^2}{2} = \frac{2mu^2}{2} + \frac{mu^2}{2}$~~

~~Выполняется (1)+(2).~~

Р-ю систему "1+2": сила ампера на перемычки действует в разные стороны

$\Downarrow$

в системе "1+2" внешняя сил по оси OX не действует



$\Downarrow$ $p = const$

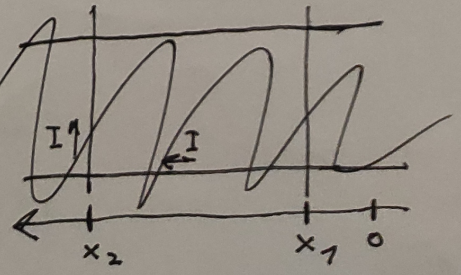
ЗСИ: $mv_0 = 2mu + mu$

$\Downarrow$

$u = \frac{v_0}{3} = v_1 = v_2$

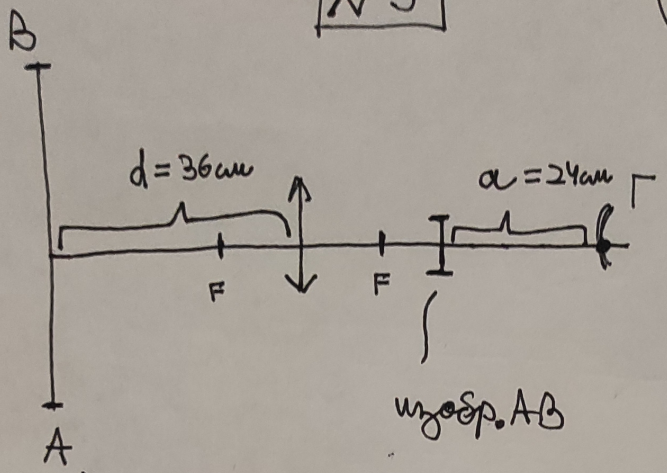
~~3) ЗСЭ~~ $m_2 a = \frac{v(BL)^2}{3R}$

$m_2 a = \frac{(v_1 - v_2)(BL)^2}{3R}$



№5

Чистовик (5)



изобр. AB

1) По формуле тонкой линзы:

$$\begin{cases} \frac{1}{d} + \frac{1}{f} = \frac{1}{F} \\ f = x - a \end{cases}$$

$$\frac{1}{d} + \frac{1}{x-a} = \frac{1}{F}$$

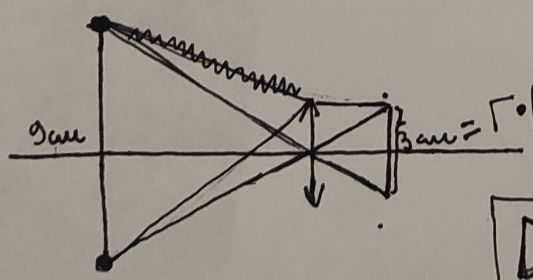
$$\frac{1}{x-a} = \frac{d-F}{Fd}$$

$$x = \frac{Fd}{d-F} + a = 36\text{см}$$

$$f = 12\text{см}$$

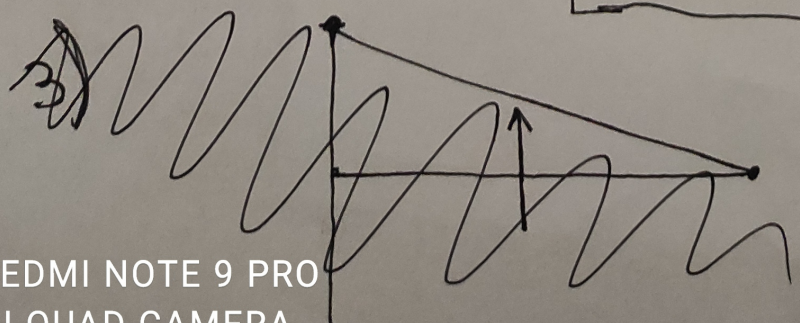
$$\Gamma = \frac{f}{d} = \frac{1}{3}$$

2)



$$D_M = \Gamma \cdot H = 3\text{см}$$

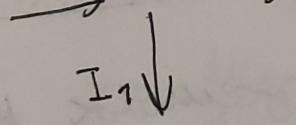
3)



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

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

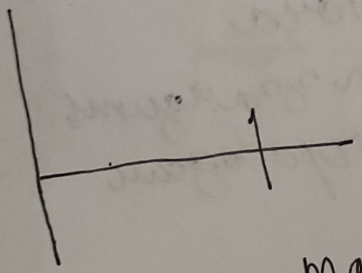
$I = c(U)$



$f = 12$

$\frac{3}{36} = \frac{1}{f}$

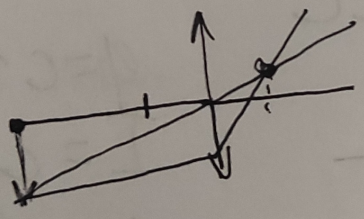
$\frac{1}{9} - \frac{1}{36}$



$\nu_{C_2} = I_R R$

$\frac{1}{36} + \frac{1}{f} = \frac{1}{9}$

$ma = kx$



$\frac{1}{F} - \frac{1}{d}$

$\frac{d+F}{Fd}$

IBL

Fat

$\frac{9 \cdot 36}{36-9} + 24$

12+

2

$\frac{9 \cdot 36}{27} = \frac{3^2 \cdot 3 \cdot 12}{3^3}$

$mv_0 = 3mu$

v

$mv_0 = 3mu$

$u = \frac{v_0}{3}$

$\frac{mv_0^2}{2} = 2mu^2 + \frac{mu^2}{2}$

$2mv_0^2 = 4$

$mv_0^2 = 2mu^2 + 2mu^2$

Пусть $\frac{(BL)^2}{3R} = \alpha$

$2m\ddot{x}_2 = (\dot{x}_1 - \dot{x}_2)\alpha$

$-m\ddot{x}_1 = (\dot{x}_1 - \dot{x}_2)\alpha$

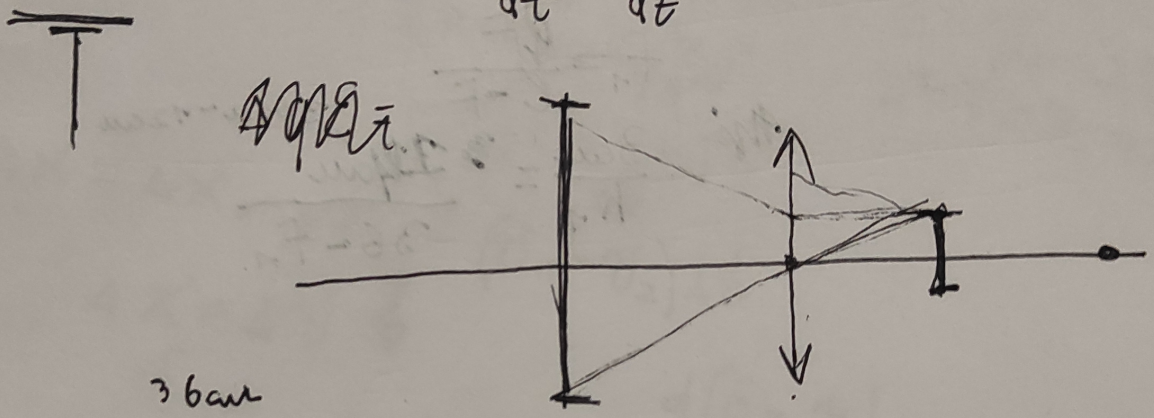
$2a_2 = a_1$

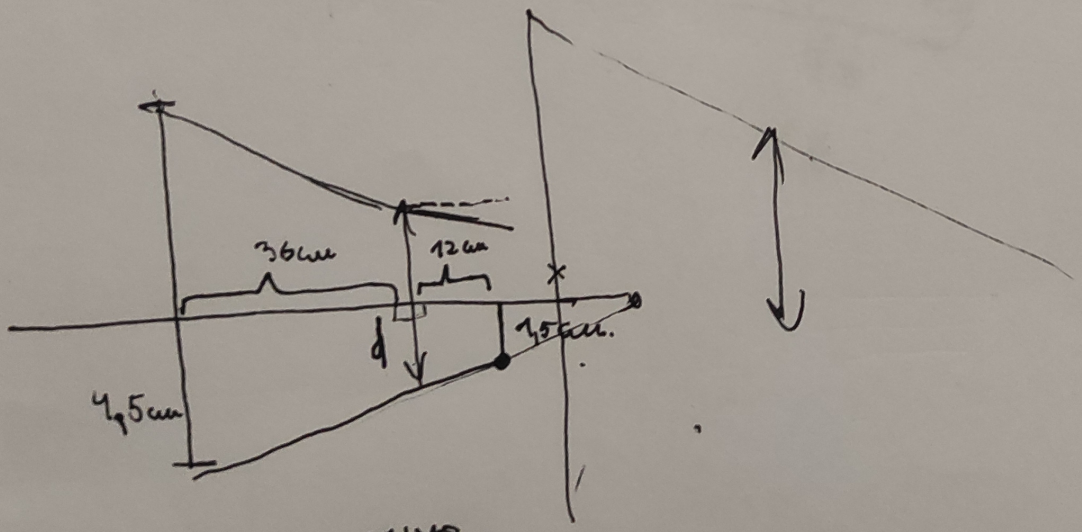
$\Delta X = |\Delta X_1 - \Delta X_2|$

$\frac{dq_2}{dt} = I$

$\frac{U_2}{R}$

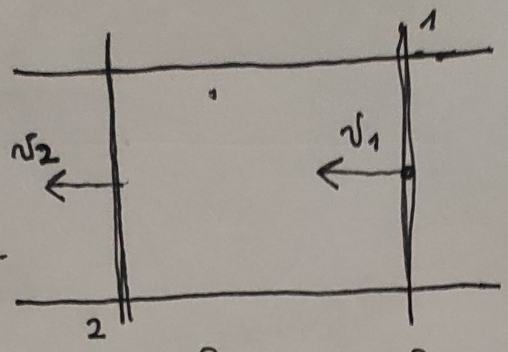
$I_0 = \frac{dq_1}{dt} + \frac{dq_2}{dt}$





$\frac{x+18см}{x} = 3$

$x = 24см$



ЗСИ: $2mv_2 + mv_1 = mv_0$

$2v_2 + v_1 = v_0 \Rightarrow v_1 = v_0 - 2v_2$

$2ma_2 = \frac{v'(BL)^2}{3R}$ $\quad v' = v_1 - v_2 = v_0 - 3v_2$

$ma_1 = \frac{v'(BL)^2}{3R}$

$\Delta X = \Delta X_1 - \Delta X_2 = (v_1 - v_2)\Delta t$

$\Delta X = \Delta v \cdot$

$v_1 =$

$\frac{d(\varepsilon - v_1)}{dt}$

$d\varepsilon$

dp

m

$T_{sind} = mg$

$T_{sind} = mg$