Часть 1

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

Шифр: **21203416**

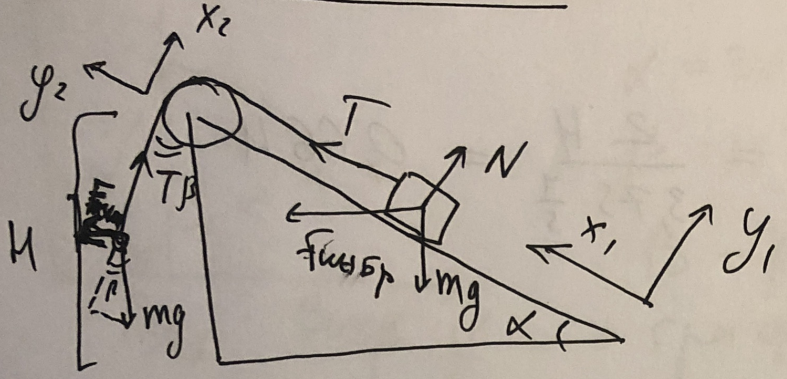
ID профиля: **369655**

Вариант 5

Чистовик

1

Задача №1



1) Перейдем в СО, связанную с клином. Тогда на брусок и на шарик будет действовать сила инерции

$\vec{F}_{ин.бр} = -13m\vec{a}$ $\vec{F}_{ин.ш} = -m\vec{a}$

II Закон Ньютона

$$\begin{cases} X_1: T + F_{ин.бр}\cos\alpha - 13mg\sin\alpha = 13ma_{отн} \ (1) \\ X_2: mg\cos\beta - T + F_{ин}\sin\beta = ma_{отн} \ (2) \\ Y_2: mg\sin\beta - F_{ин}\cos\beta = 0 \ (3) \end{cases}$$

$$\begin{cases} T + 13ma\cos\alpha - 13mg\sin\alpha = 13ma_{отн} \ (1) \\ mg\cos\beta - T + ma\sin\beta = ma_{отн} \ (2) \\ mg\sin\beta = ma\cos\beta \end{cases} \Rightarrow a = g\,\mathrm{tg}\,\beta = 7{,}5\ \frac{м}{с^2}$$

(1)+(2)

$13ma\cos\alpha - 13mg\sin\alpha + mg\cos\alpha + ma\sin\beta = 14ma_{отн}$

$$a_{отн} = \frac{13a\cos\alpha - 13g\sin\alpha + g\cos\alpha + a\sin\beta}{14} =$$

$= 3,75 \frac{м}{с^2}$

(2)

$$\frac{H}{\cos\beta} = \frac{a_{отн} t^2}{2}$$

$$t^2 = \frac{2H}{a_{отн}\cos\beta} = \frac{2H}{3,75 \cdot \frac{4}{5}} = 0,66H$$

$$t \approx 0,8\sqrt{H}$$

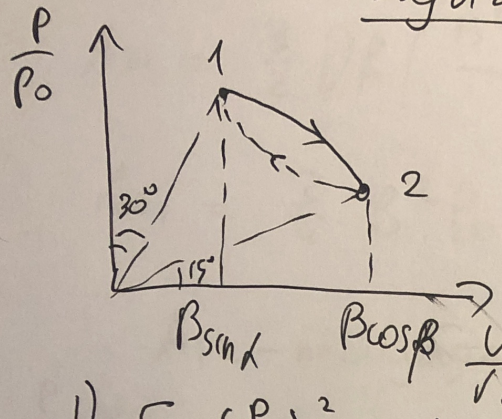
Ответ: $a = 7,5 \frac{м}{с^2}$

$a_{отн} = 3,75 \frac{м}{с^2}$

$t = 0,8\sqrt{H}$

(3) Чистовик

Задача 2



$P_1 = B\cos\alpha\, P_0$
$P_2 = B\sin\beta\, P_0$
$V_1 = B\sin\alpha\, V_0$
$V_2 = B\cos\beta\, V$

$\alpha = 30°$
$\beta = 15°$

B – разм. окр. на графике

1) $\begin{cases} \left(\frac{P}{P_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = B^2 \\ PV = \nu RT \Rightarrow P = \frac{\nu RT}{V} \end{cases}$

$$\left(\frac{\nu RT}{P_0 V}\right)^2 + \left(\frac{V}{V_0}\right)^2 = B^2$$

$$T = \frac{\sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}\, P_0 V}{\nu R}$$

$$T_1 = \frac{\sqrt{B^2 - \left(\frac{B\sin\alpha V_0}{V_0}\right)^2}\cdot P_0 B\sin\alpha V_0}{\nu R} \Rightarrow$$

$$T_1 = \frac{B^2 P_0 V_0 \sin\alpha\cos\alpha}{\nu R} = \frac{B^2 P_0 V_0 \sin 2\alpha}{2\nu R}$$

Аналогично

$$T_2 = \frac{B^2 P_0 V_0 \sin 2\beta}{2\nu R}$$

(14) $\frac{T_1}{T_2} = \frac{\sin 2\alpha}{\sin 2\beta} \overset{\text{числовые}}{=} \frac{\sin 60^\circ}{\sin 30^\circ} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{2}} = \sqrt{3} \approx 1{,}732$

2) $P = P_0 \sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}$

$$T = \frac{\sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}\, P_0 V}{\nu R} \Rightarrow$$

$$\frac{dT}{dV} = \frac{\frac{1}{2\sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}} \cdot \left(-\frac{2V}{V_0^2}\right) P_0 V + \sqrt{B^2 - \left(\frac{V}{V_0}\right)^2} P_0}{\nu R}$$

$$\frac{dT}{dV} = \frac{-\frac{P_0 V^2}{V_0^2} + \left(B^2 - \left(\frac{V}{V_0}\right)^2\right) P_0}{\nu R \sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}}$$

$$\frac{dT}{dV} = \frac{-P_0 V^2 + B^2 P_0 V_0^2 - V^2 P_0}{\nu R V_0^2 \sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}}$$

$$\frac{dT}{dV} = \frac{P_0 (B^2 V_0^2 - 2V^2)}{\nu R V_0^2 \sqrt{B^2 - \left(\frac{V}{V_0}\right)^2}}$$

По I закону Термодинамики

$\delta Q = dU + \delta A$

$\delta Q = 0$ (т.к $C = 0$)

(5) $dU = \frac{3}{2}\nu R dT$ — числовые

$\delta A = P dV$

$\frac{3}{2}\nu R dT = -P dV$

$\frac{3}{2}\nu R \frac{dT}{dV} = -P$

$\frac{3}{2}\frac{P_0(B^2V_0^2 - 2V^2)}{V_0^2\sqrt{B^2 - (\frac{V}{V_0})^2}} = -P$

$\frac{3}{2}\frac{P_0(B^2V_0^2 - 2V^2)}{V_0^2\sqrt{B^2 - (\frac{V}{V_0})^2}} = -P_0\sqrt{B^2 - (\frac{V}{V_0})^2}$

$3B^2V_0^2 - 6V^2 = -2V_0^2(B^2 - (\frac{V}{V_0})^2)$

$3B^2V_0^2 - 6V^2 = -2BV_0^2 + 2V^2$

$5B^2V_0^2 = 8V^2 \Rightarrow V = B_0V_0\sqrt{\frac{5}{8}}$

С другой стороны $V = BV_0\cos\gamma$

$\Rightarrow \cos\gamma = \sqrt{\frac{5}{8}} \approx 0{,}79$

3) $\frac{A_y}{A_{12}}$ - ?

$Q_{21} = 0$

$0 = \Delta U_{21} + A_{21}$

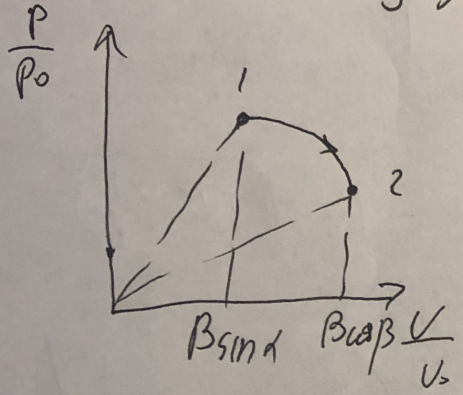
Числитель

⑥ $A_{21} = -\Delta U_{21} = -\frac{3}{2}\nu R(T_2 - T_1)$

$A_{21} = \frac{3}{2}\nu R\left(\frac{B^2 P_0 V_0 \sin 2\beta}{2\nu R} - \frac{B^2 P_0 V_0 \sin 2\alpha}{2\nu R}\right)$

$A_{21} = \frac{3}{4} B^2 P_0 V_0 (\sin 2\beta - \sin 2\alpha)$

A_{12} – площадь под гр 1–2 умн на



$S_{сект} = \frac{\alpha B^2}{360^\circ}(90^\circ - \alpha - \beta) - \frac{B^2 \sin(90^\circ - \alpha - \beta)}{2}$

$S_{трап} = \frac{B\cos\alpha + B\sin\beta}{2}(B\cos\beta - B\sin\alpha)$

$P_0 V_0$

$A_{12} = \left(\frac{\pi B^2}{360^\circ}(90^\circ - \alpha - \beta) - \frac{B^2 \sin(90^\circ - \alpha - \beta)}{2} + \right.$

$\left. + \frac{B^2(\cos\alpha + \sin\beta)(\cos\beta - \sin\alpha)}{2}\right) P_0 V_0$

$\frac{A_y}{A_{12}} = 1 + \frac{\frac{3}{4}(\sin 2\beta - \sin 2\alpha)}{\frac{\pi(90^\circ - 30^\circ - 15^\circ)}{360^\circ} - \frac{\sin(90^\circ - \alpha - \beta)}{2} + \frac{(\cos\alpha + \sin\beta)(\cos\beta - \sin\alpha)}{2}}$

$\frac{A_y}{A_{12}} = \frac{1 + 0{,}75\left(\frac{1}{2} - \frac{\sqrt{3}}{2}\right)}{\frac{3{,}14 \cdot 45^\circ}{300^\circ} - \frac{\sqrt{2}}{4} + \frac{\left(\frac{\sqrt{3}}{2} + \sin 15^\circ\right)\left(\cos 15^\circ - \frac{1}{2}\right)}{2}} = 0{,}5126$

Ответ:
1) 1,732
2) $\arccos(0{,}79)$
3) 0,5126

Часть 2

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

Шифр: **21203416**

ID профиля: **369655**

Вариант 5

Чистовик

Задача №3

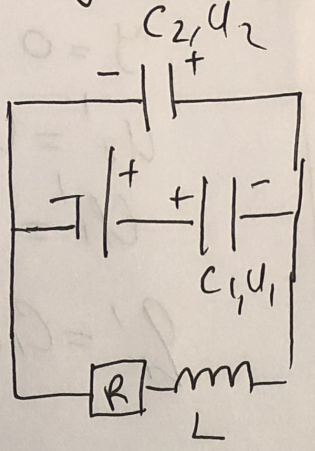
$C_1 = C$

$C_2 = 2C$

$\mathcal{I} - ?$

$Q - ?$

$\mathcal{I}_L - ?$



а) До замыкания ключа

$$U_1 + U_2 = \mathcal{E}$$

$$\frac{q}{C} + \frac{q}{2C} = \mathcal{E}$$

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

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

$$U_1 = \frac{2}{3}\mathcal{E}$$

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

1) Сразу после замыкания ключа ток через резистор нет.

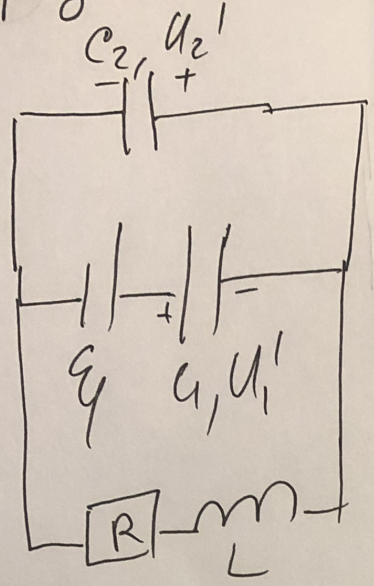
$$\mathcal{E} - \frac{2}{3}\mathcal{E} = L\dot{\mathcal{I}}$$

$$\boxed{\dot{\mathcal{I}} = \frac{\mathcal{E}}{3L}}$$

2) Через большое время

Чистовик

(2)



$I = 0$

$U_2' = U_R + U_L = 0$

$U_1' = \mathcal{E}$

$q_1' = C_1 U_1' = C\mathcal{E}$

$$\begin{cases} A_{ист} = W_{конд} - W_{кат} + Q \\ W_{конд} = \frac{C\mathcal{E}^2}{2} \\ A_{ист} = \mathcal{E}(q_1' - q_1) = \mathcal{E}\left(C\mathcal{E} - \frac{2}{3}C\mathcal{E}\right) = \frac{C\mathcal{E}^2}{3} \\ W_{кат} = \frac{C_1 U_1^2}{2} + \frac{C_2 U_2^2}{2} = \frac{C \cdot \mathcal{E}^2}{18} + \frac{2C \cdot \mathcal{E}^2}{18} = \frac{C\mathcal{E}^2}{3} \end{cases}$$

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

$$\boxed{Q = \frac{C\mathcal{E}^2}{6}}$$

3) В момент времени, когда ток через C_1 = I_0

$\mathcal{E} = U_1 + U_2 \Rightarrow \mathcal{E} = \frac{q_1}{C} + \frac{q_2}{2C} \Rightarrow 2C\mathcal{E} = 2q_1 + q_2$

$2dq_1 + dq_2 = 0$

$\frac{dq_1}{dt} = I_0$; $-\frac{dq_2}{dt} = I_2$

- в данный момент

$2I_0 - I_2 = 0$

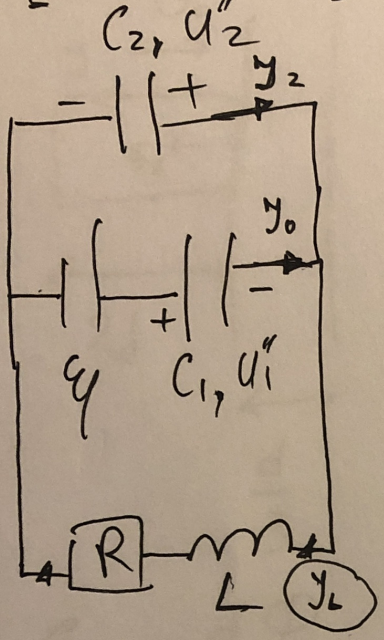
$2I_0$

По I правилу Кирхгофа

Листовик

(3)

$$\mathcal{Y}_L = \mathcal{Y}_0 + \mathcal{Y}_2 = 3\mathcal{Y}_0$$



Ответ:

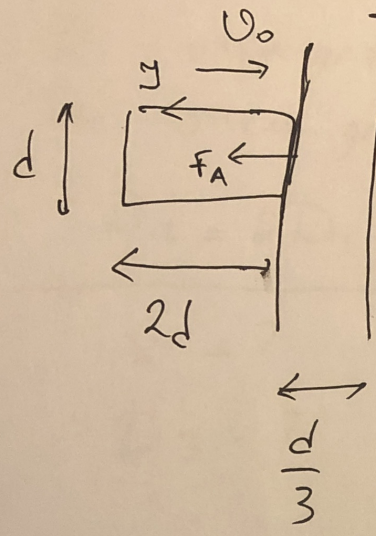
$$j = \frac{q}{3L}$$

$$Q = \frac{Cq^2}{6}$$

$$\mathcal{Y}_L = 3\mathcal{Y}_0$$

Чистовик (4)

Задача №9



m
d
b = 2d
V_0
R
$\mu = \frac{d}{3}$

$a_0 - ?$
$V_1 - ?$
$V_2 - ?$

$$\mathcal{E}_i = \frac{d\Phi}{dt} = \frac{d(BS)}{dt} = \frac{B \cdot d \cdot dx}{dt} = Bd \cdot V$$

1) В момент времени $V = V_0$

$\mathcal{E}_{i0} = BdV_0$

Ток в рамке: $y_{i0} = \frac{\mathcal{E}_{i0}}{R} = \frac{B \cdot d \cdot V_0}{R}$

$F_{Amp.0} = B y_{i0} \cdot d = \frac{B^2 \cdot d^2 V_0}{R}$

По II закону Ньютона

$F_{Amp.0} = ma_0 \Rightarrow \boxed{a_0 = \frac{B^2 d^2 V_0}{mR}}$

2) При выходе правой стороны рамки из поля

$F_A = B \cdot y_i d$

$y_i = \frac{\mathcal{E}_i}{R}$

$\mathcal{E}_i = BVd$

$a = \frac{-dV}{dt}$

По II закону Ньютона

$F_A = ma$

$\frac{B^2 d^2 V}{R} = ma$

5

$$\frac{B^2 \cdot d^2}{mR} V = -\frac{dV}{dt}$$

$$\frac{B^2 d^2 V}{mR} = -\frac{dV}{dx} \cdot V$$

$$\frac{-B^2 \cdot d^2 \cdot dx}{mR} = dV$$

$$\Delta V = -\frac{B^2 d^2}{mR} \cdot \Delta x$$

$$V_1 - V_0 = -\frac{B^2 d^2}{mR} H$$

$$\boxed{V_1 = V_0 - \frac{B^2 d^3}{3mR}}$$

3) После выхода рамки из поля

Аналогично

$$\Delta V = -\frac{B^2 d^2}{mR} \cdot \Delta x$$

$$V_2 - V_1 = \frac{-B^2 d^2}{mR} \cdot \frac{d}{3}$$

$$V_2 - V_1 = \frac{-B^2 d^3}{3mR}$$

$$\boxed{V_2 = V_0 - \frac{2B^2 d^3}{3mR}}$$

Ответ:

$$a_0 = \frac{B^2 d^2 V_0}{mR}$$

$$V_1 = V_0 - \frac{B^2 d^3}{3mR}$$

$$V_2 = V_0 - \frac{2B^2 d^3}{3mR}$$

⑥ Листовик Задача 5

$d_0 = 25$ см

D_2 – очки для дали

D_1 – очки для близи

$D_2 = 2D_1$ (*)

По формуле тонк. линз для стекла

(1) $D_{гл} + D_1 = \frac{1}{d_0} + \frac{1}{f}$

(2) $D_{гл} = \frac{1}{x} + \frac{1}{f}$

(3) $D_2 + D_{гл} = \frac{1}{\infty} + \frac{1}{f}$ ← для удал. предмета

$f = const$ – расстояние от хрусталика до сетчатки

$x - ?$

$D_3 - ?$

(1) – (2)

$D_1 = \frac{1}{d_0} - \frac{1}{x}$

$\frac{1}{x} = \frac{1}{d_0} - D_1$ (4)

$x = \frac{d_0}{1 - D_1 d_0}$

* → 3

$2D_1 + D_{гл} = \frac{1}{f}$

$2D_1 + \frac{1}{x} + \frac{1}{f} = \frac{1}{f}$

$D_1 = -\frac{1}{2x}$ (5)

$D_1 = \frac{-1}{2 \cdot 0{,}25} = -4$ Дптр

(5) → (4)

$\frac{1}{x} = \frac{1}{d_0} + \frac{1}{2x}$

$\frac{1}{2x} = \frac{1}{d_0} \Rightarrow \boxed{x = \frac{d_0}{2} = 12{,}5 \text{ см}}$

Для очков с расстояния $d = 50$ см

$D_{гл} + D_3 = \frac{1}{d} + \frac{1}{f}$

$D_{гл} + D_3 = \frac{1}{d} + D_2 + D_{гл}$

(7)

$$D_3 = \frac{1}{d_2} + 2D_1$$

$$D_3 = \frac{1}{0,5} + 2 \cdot (-4) = -6 \text{ Дптр}$$

Ответ: $x = 12,5$ см

$D_3 = -6$ Дптр

$$D_2 = \frac{1}{f}$$

$$D_2 + \frac{1}{x} + \frac{1}{f} = \frac{1}{f}$$

$$D_2 = -\frac{1}{x}$$

$$2D_1 + D_{rn} = \frac{1}{f}$$

$$2D_1 + \frac{1}{x} + \frac{1}{f} = \frac{1}{f}$$

$$D_1 = -\frac{1}{2x}$$

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

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

По уровню баланса

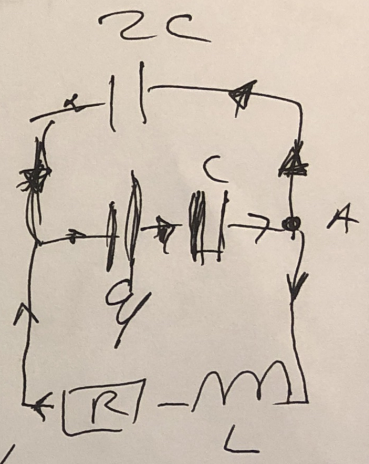
$Q = W$ на катушке

$$Q = \frac{LJ^2}{2}$$

$$\frac{LJ^2}{2} = \frac{CU^2}{2}$$

$$\mathcal{E} - \mathcal{E}_{\text{индукции}} = J_0 R$$

~~$\mathcal{E} - L\dot{J} = J_0 R$~~



$$\varphi_A + U_{K2} + \mathcal{E} - U_{K1} = \varphi_A$$

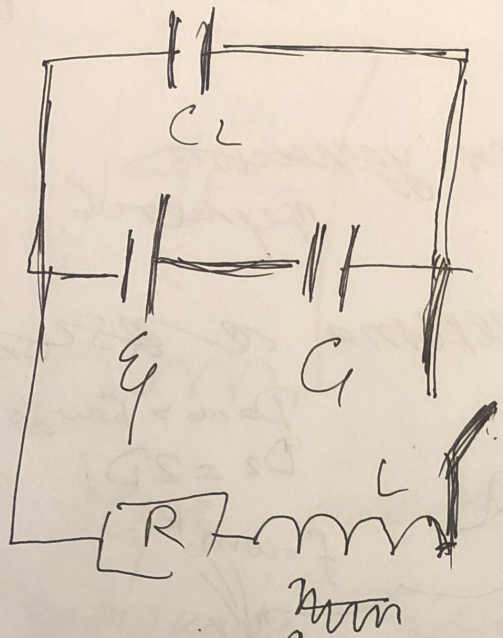
$$\mathcal{E} = U_{K1} + U_{K2}$$

$$C \cdot \frac{\left(\frac{2}{3}\mathcal{E}\right)^2}{2}$$

$$\frac{C}{2} \cdot \frac{4\mathcal{E}}{9} = \text{~~конденсатор~~}$$

$$\frac{2\mathcal{E}C}{9}$$

N3

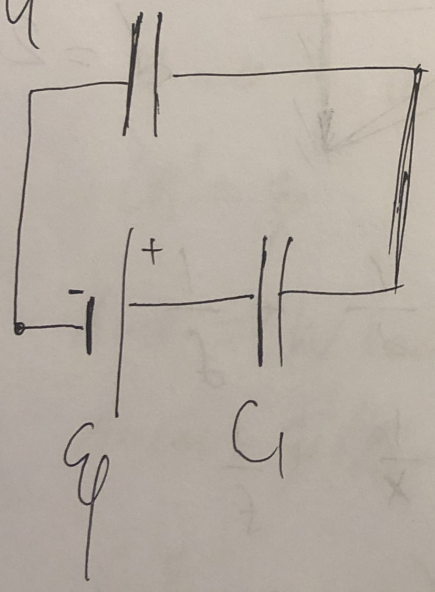


$C = C$

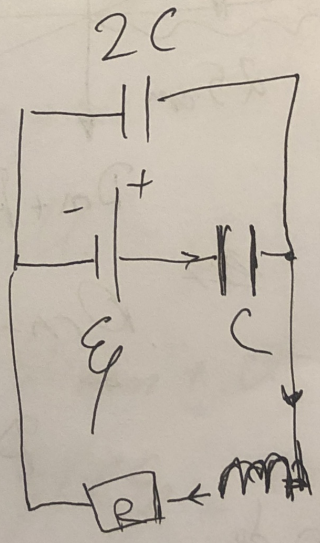
$C_2 = 2C$

$\mathcal{E}$

$2C = \frac{q}{U}$ C_2 $U = \frac{q}{2C}$



$\Rightarrow$



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

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

$\mathcal{E} + \frac{2}{3}\mathcal{E} = \gamma R + L\dot{\gamma}$

$\frac{5}{3}\mathcal{E} = \gamma R + \dot{\gamma} L$ ($\dot{\gamma} = 0$)

$\frac{5}{3}\mathcal{E} = \dot{\gamma} L$

$\dot{\gamma} = \frac{5\mathcal{E}}{3L}$

№5

$l = 25$ см

Близко

1 очки) Для удаленных предметов D_1

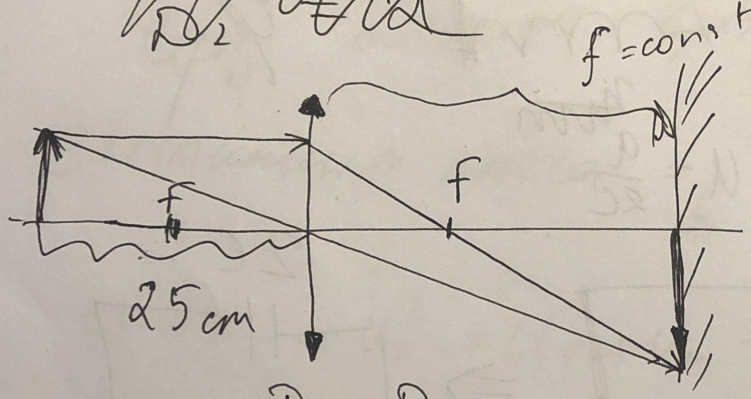
2 очки) текста D_2

Дано > близко

$D_2 = 2D_1$

Дано

D_2 4/2



$d = 25$ см

$D_{лн} + D_1$

$$D_{лн} + D_1 = \frac{1}{d} + \frac{1}{f}$$

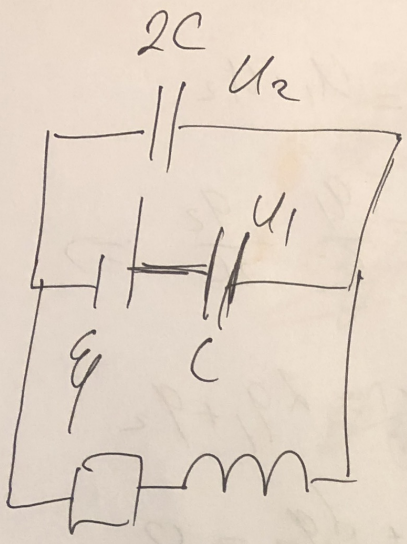
$$D_{лн} = \frac{1}{x} + \frac{1}{f}$$

$$\frac{1}{d_0} - \frac{D_1 d_0}{d_0} = \frac{1 - D_1 d_0}{d_0}$$

$$\frac{1}{x} + \frac{1}{f} + D_1 = \frac{1}{d} + \frac{1}{f}$$

$$\frac{1}{x} = \frac{1}{d} - D_1 = \frac{1}{0{,}25} - D_1$$

$$\frac{d_0}{1 - D_1 d_0}$$



$$\mathcal{E} - \frac{2}{3}\mathcal{E} = L\dot{J}$$

$$\dot{J} = \frac{\mathcal{E}}{3L}$$

$$\frac{\mathcal{E}}{3} = L\dot{J}$$

Через большое время после замыкания ключа

$$\frac{C_1 \cdot 4\mathcal{E}^2}{6} + \frac{2C_1\mathcal{E}^2}{6} =$$

$$= \frac{C_1 \cdot \mathcal{E}^2 \cdot 4}{18} + \frac{2C}{\frac{6}{18}}$$

$J = 0 \qquad U_2' = U_R + U_L = 0$

$U_1' = \mathcal{E} \qquad q_1' = C_1 U_1' = \mathcal{E}$

$A_{ист} = W_{кон} - W_{нач} + Q$

$A_{ист} = \mathcal{E}(q_1' - q_1) = \mathcal{E}\left(C\mathcal{E} - \frac{2C\mathcal{E}}{3}\right) =$

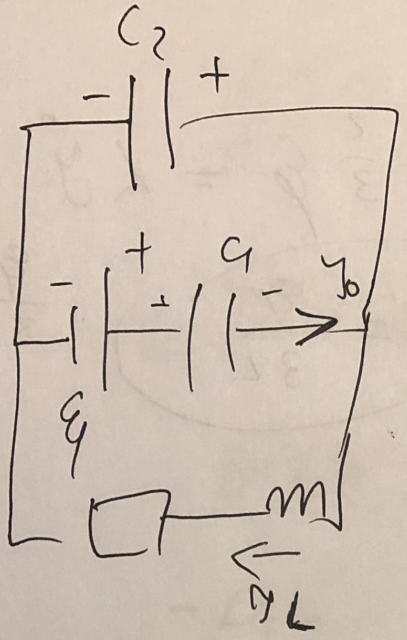
$= \frac{C\mathcal{E}^2}{3}$

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

$Q = \frac{C\mathcal{E}^2}{6}$

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

$= \frac{2C\mathcal{E}^2}{3} - \frac{C\mathcal{E}^2}{2} = \frac{4C\mathcal{E}^2 - 3C\mathcal{E}^2}{6} = \frac{C\mathcal{E}^2}{6}$



$$\mathcal{E} = U_1 + U_2$$

$$\mathcal{E} = \frac{q_1}{C} + \frac{q_2}{2C} \Rightarrow$$

$$2C\mathcal{E} = 2q_1 + q_2$$

$$2dq_1 + dq_2 = 0$$

$$2\frac{dq_1}{dt} + \frac{dq_2}{dt} = 0 \qquad \frac{dq_1}{dt} = v_0$$

$$2v_0 - v_2 = 0 \qquad \frac{dq_2}{dt} = v_2$$

$$v_2 = 2v_0$$

По I Правилу Кирхгофа (Дарвина элемент)

$$v_L = v_0 + v_2 = 3v_0$$

$D_{лз} + D_1 = \frac{1}{d} + D_{лз} + 2D_1$

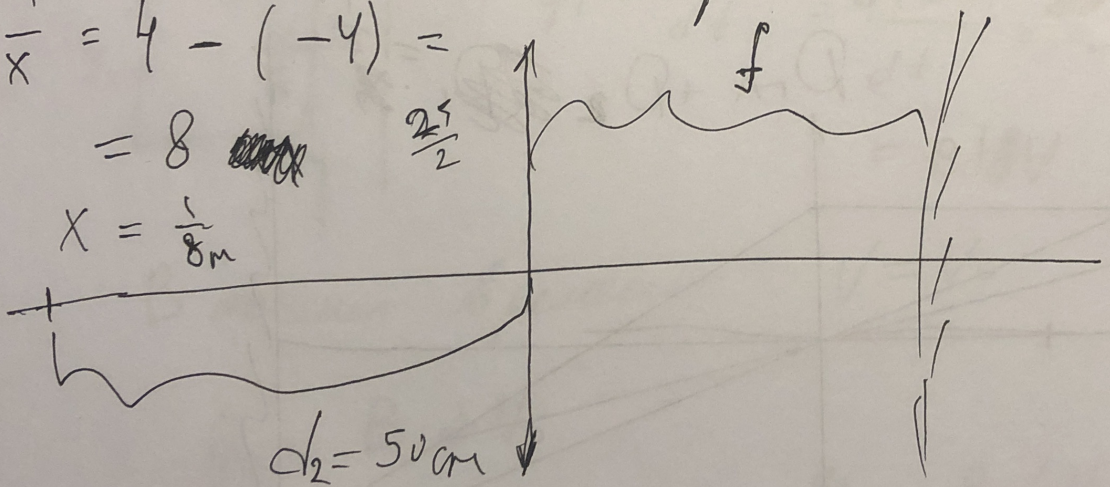
$-D_1 = \frac{1}{d}$

$D_1 = -\frac{1}{d} = -4\ Dпр$

$D_2 = -8\ Dпр$

$\frac{1}{x} = 4 - (-4) = 8$

$x = \frac{1}{8}м$



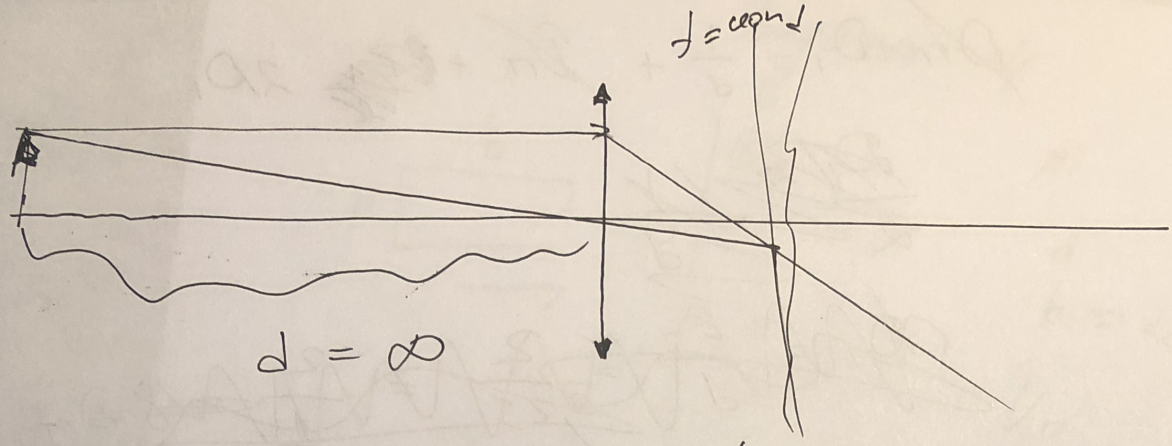
$D_{лз} + D_3$

$D_{лз} + D_3 = \frac{1}{d_2} + \frac{1}{f}$ $\quad 2 - 8 =$

$D_{лз} + D_3 = \frac{1}{d_2} + D_{лз} + 2D_1$

$D_3 = \frac{1}{d_2} + 2D_1 = \frac{1}{0,5} - 8 = 2 - 8 = -6Dm$

Ответ:
8 см
$-6\ Dпр$

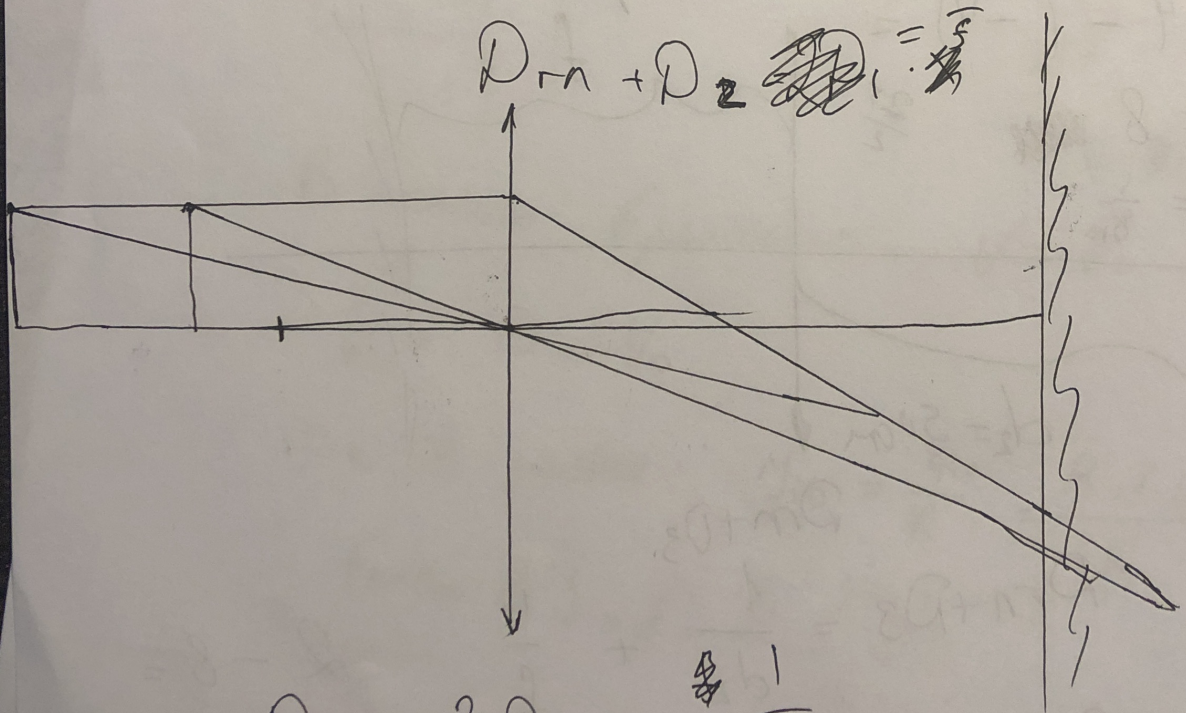


$$D_{rn} + D_2 = \frac{1}{d} + \frac{1}{f'}$$

$$D_{rn} + D_2 = \frac{1}{\infty} + \frac{1}{f'}$$

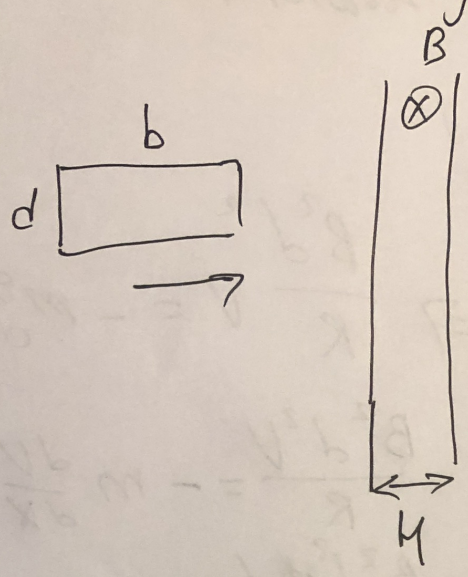
$$D_{rn} + D_2 = \frac{1}{f'} = D \cdot x$$

$$D_{rn} + D_2 = \frac{1}{f'}$$



$$D_{rn} + 2D_1 = \frac{1}{f'}$$

Задача 4



m

d

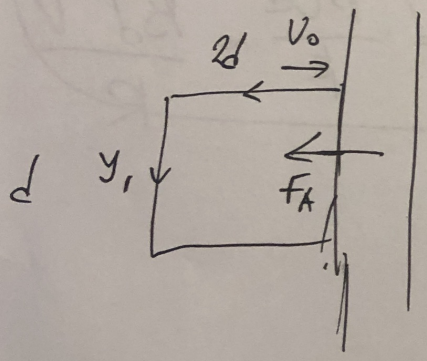
$b = 2d$

V_0

R

$H = \frac{d}{3}$

$a - ?$



$$\mathcal{E}_i = \frac{d\Phi}{dt} = \frac{d(BS)}{dt} = \frac{B \cdot d \cdot dx}{dt}$$

$$= Bd\dot{V}$$

В момент времени $V = V_0$

$$\mathcal{E}_{i0} = B \cdot d \cdot V_0$$

Ток в рамке: $y_{i0} = \frac{\mathcal{E}_{i0}}{R} = \frac{B \cdot d \cdot V_0}{R}$

$$F_{AMP0} = B y_{i0} \cdot d = \frac{B^2 d^2 V_0}{R}$$

$$F_{AMP0} = ma_0$$

$$a_0 = \frac{B^2 d^2 V_0}{mR}$$

2) По II закону Ньютона

$$\begin{cases} f_A = ma \\ f_A = B y_i d \\ y_i = \frac{\varepsilon_i}{R} \\ \varepsilon_i = BVd \\ a = \frac{-dV}{dt} \end{cases} \Rightarrow \frac{B^2 d^2}{R} V = -m\frac{dV}{dt}$$

$$\frac{B^2 d^2 V}{R} = -m\frac{dV}{dx}\cdot V$$

$$\Rightarrow \frac{-B^2 d^2 dx}{mR} = dV$$

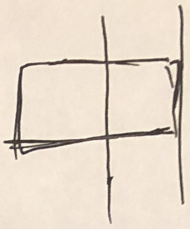
$$f_A = B y_i d = Bd\frac{\varepsilon_i}{R} = Bd\cdot\frac{BVd}{R} = \frac{B^2 d^2 V}{R}$$

$$\Delta V = \frac{-B^2 d^2}{mR}\cdot\Delta x$$

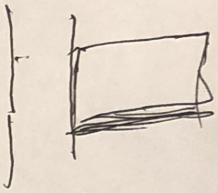
$$V_1 - V_0 = -\frac{B^2 d^2}{mR}\cdot\frac{d}{3}$$

$$V_1 = V_0 - \frac{B^2 \cdot d^3}{3mR}$$

$$\Delta V = \frac{-B^2 d^2}{mR} \Delta x$$



$$V_2 - V_1 = \frac{-B^2 d^2}{mR} 4$$



$$V_2 = V_1 - \frac{B^2 d^3}{3mR}$$

$$V_2 = V_0 - 2\frac{B^2 d^3}{3mR}$$