Часть 1

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

Шифр: **21202485**

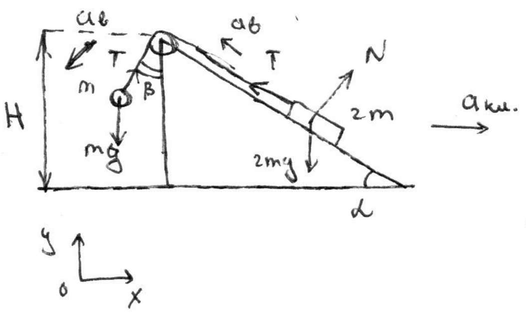
ID профиля: **144833**

Вариант 6

Чистовик.

Задача N 1.

$\cos\beta = \frac{12}{13}$ $\sin\beta = \frac{5}{13}$ $\cos\alpha = \frac{4}{5}$ $\sin\alpha = \frac{3}{5}$



1) $\vec{a_б} = \vec{a}_{кл} + \vec{a_в}$ ← ускорение верёвки, т.е. ускорение бруска (шарика) в системе отсчёта клина

2) $\begin{cases} ① \; T\cos\beta - mg = -ma_в\cos\beta \\ ② \; T\sin\beta = m(a_{кл} - a_в\sin\beta) \\ ③ \; T - 2mg\sin\alpha = 2m(a_в - a_{кл}\cos\alpha) \end{cases}$

— проекции на оси x и y для шарика (①, ②)

— на оси верёвки для бруска (③).

3) ~~$T = 2m(a_в - a_{кл}\cos\alpha$~~

Из ① и ② (①:②):

$$\mathrm{ctg}\,\beta = \frac{g - a_в\cos\beta}{a_{кл} - a_в\sin\beta}$$

$$a_{кл}\,\mathrm{ctg}\,\beta - a_в\cos\beta = g - a_в\cos\beta$$

$$a_{кл} = g\,\mathrm{tg}\,\beta = g\cdot\frac{5}{12} \approx 4{,}2\left(\frac{м}{с^2}\right)$$

4) Из ③ и т.к. $T = \frac{m}{\sin\beta}(a_{кл} - a_в\sin\beta)$:

$$m\left(\frac{a_{кл}}{\sin\beta} - a_в\right) = 2m(g\sin\alpha + a_в - a_{кл}\cos\alpha)$$

$$\frac{a_{кл}}{\sin\beta} - a_в = 2g\sin\alpha + 2a_в - 2a_{кл}\cos\alpha$$

$$a_в = \frac{1}{3}\left(\frac{a_{кл}}{\sin\beta} - 2g\sin\alpha + 2a_{кл}\cos\alpha\right) =$$

$$= \frac{1}{3}\left(g\frac{1}{\cos\beta} - 2g\sin\alpha + 2g\,\mathrm{tg}\,\beta\cos\alpha\right) =$$

$$= \frac{g}{3}\left(\frac{13}{12} - \frac{6}{5} + 2\cdot\frac{5}{12}\cdot\frac{4}{5}\right) = \frac{g}{3}\left(\frac{13}{12}^{\llcorner 5} - \frac{6}{5}^{\llcorner 12} + \frac{2}{3}^{\llcorner 20}\right) = \frac{g}{3}\cdot\frac{65 - 72 + 40}{60} =$$

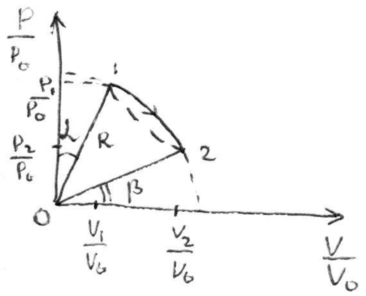
$= \frac{g}{3}\cdot\frac{33}{60} = \frac{11}{60}g \approx 1{,}8\left(\frac{м}{с^2}\right)$. – в системе клина у бруска ускорение верёвки

5) $H = \frac{a_в\cos\beta\, t^2}{2} \Rightarrow t = \sqrt{\frac{2H}{a_в\cos\beta}} = \sqrt{\frac{2H\cdot 60\cdot 13}{11g\cdot 12}} = \sqrt{\frac{130}{11}\frac{H}{g}} \approx 3{,}4\sqrt{\frac{H}{g}}$

Ответ: 1) $\frac{5}{12}g \approx 4{,}2\ \frac{м}{с^2}$; 2) $\frac{11}{60}g \approx 1{,}8\ \frac{м}{с^2}$; 3) ~~3,4~~ $\sqrt{\frac{130H}{11g}}$.

Чистовик.

Задача N 2.



1) $\frac{P_1}{P_0} = R\cos\alpha \qquad \frac{V_1}{V_0} = R\sin\alpha$

$\frac{P_2}{P_0} = R\sin\beta \qquad \frac{V_2}{V_0} = R\cos\beta$

2) $\frac{T_1}{T_2} = \frac{\nu R T_1}{\nu R T_2} = \frac{P_1 V_1}{P_2 V_2} = \frac{P_1 V_1}{P_0 V_0} \cdot \frac{P_0 V_0}{P_2 V_2} =$

$= R^2 \cos\alpha \sin\alpha \cdot \frac{1}{R^2 \sin\beta\cos\beta} = \frac{\sin 2\alpha}{\sin 2\beta} = \frac{1 \cdot 2}{\sqrt{2} \cdot 1} = \sqrt{2}.$

$\boxed{\frac{T_1}{T_2} = \frac{\sin 2\alpha}{\sin 2\beta} = \sqrt{2}} \approx 1,4.$

2) ур-е процесса 1-2:

$\frac{P^2}{P_0^2} + \frac{V^2}{V_0^2} = const$, т.к. $\frac{P}{P_0} = \frac{T V_0}{T_0 V} \Rightarrow$

$\Rightarrow \left(\frac{T}{V}\right)^2 \cdot \left(\frac{V_0}{T_0}\right)^2 + \frac{V^2}{V_0^2} = const = R^2$

3) Пусть искомая точка, где $C = 0$ существует:

$C = \frac{dQ}{dT} = C_V \nu + P\frac{dV}{dT} = C_V \nu + \frac{\nu R T}{V} \cdot \frac{dV}{dT} \Rightarrow$

$\Rightarrow \frac{T}{V}\frac{dV}{dT}$ – в какой-то точке равно $-\frac{5}{2}$

$\frac{T}{V} \cdot \frac{1}{\frac{d\frac{T}{T_0}}{d\frac{V}{V_0}}} = \frac{T}{V} \cdot \frac{\sqrt{R^2 \cdot \frac{V^2}{V_0^2} - \frac{V^4}{V_0^4}}}{2R^2\frac{V}{V_0^2} - 4\frac{V^3}{V_0^4}} = -\frac{5}{2}$

$$\boxed{\begin{gathered}\frac{T^2}{T_0^2} + \frac{V^4}{V_0^4} = R^2 \cdot \frac{V^2}{V_0^2} \\ \left(\frac{T}{T_0}\right)' = \left(\sqrt{R^2\left(\frac{V}{V_0}\right)^2 - \left(\frac{V^4}{V_0^4}\right)}\right)' = \frac{2R^2\frac{V}{V_0^2} - 4\frac{V^3}{V_0^4}}{\sqrt{R^2 \cdot \frac{V^2}{V_0^2} - \frac{V^4}{V_0^4}}}\end{gathered}}$$

$T \cdot \frac{\sqrt{\frac{R^2}{V_0^2} - \frac{V^2}{V_0^2}}}{2R^2\frac{V}{V_0^2} - 4\frac{V^3}{V_0^4}} = -\frac{5}{2}$

$\sin\gamma = \frac{V}{V_0 R}$

искомый

3) $A_{21} = -\Delta U_{21} = -C_V \nu T_2 (1 - \sqrt{2}) =$

Черновик.

$A_{12} = \cancel{\ }$

$S_{\triangle} = \frac{1}{2} R^2 \sin\gamma$ $S_{\frown} = \frac{R^2}{2}\left(\gamma - \frac{\sin\gamma}{2(1)}\right) p_0 V_0$

$\frac{\gamma}{2\pi} \cdot \pi R^2 = \frac{\gamma R^2}{2}$ $\cancel{R2}$

$U_{12} = C_V \nu R (T_2 - T_1) = C_V \nu R \cdot T_2 (1 - \sqrt{2}) =$

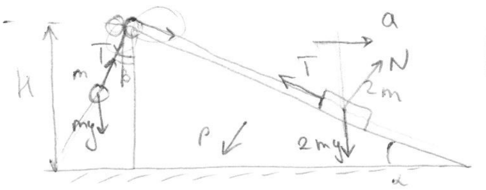
$= C_V \cdot P_2 V_2 (1 - \sqrt{2}) = C_V R^2 \sin\beta \cos\beta (1 - \sqrt{2})$

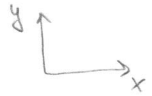
$\frac{P_1 + P_2}{2} (V_2 - V_1) = P_1 V_2$

Черновик

$\cos\alpha = \frac{4}{5}$

$\cos\beta = \frac{12}{13}$





На клине:

$\vec{a_б} = \vec{a} + \vec{a_{отн.}}$

$\sin\beta = \sqrt{1 - \frac{144}{169}} = \frac{5}{13}$

$\cancel{T\cdot\cos\beta - mg =}$

$\boxed{T - mg\cos\beta} = m a_{отн.}$

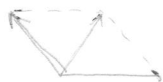
$\operatorname{tg}\beta = \frac{5}{13}\cdot\frac{13}{12} = \frac{5}{12}$

$\cancel{T - 2mg\sin\alpha = 2m a_{отн.}}$

$\cancel{m a_{отн.} + mg\cos\beta - 2mg\sin\alpha = 2m a_{отн.}}$

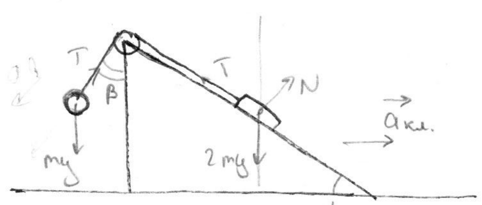
$\cancel{mg(\cos\beta - 2\sin\alpha) = m a_{отн.}}$

$\cancel{g(\cos\beta - 2\sin\alpha) = a_{отн.}}$



$\cancel{2m a_{отн.}\sin\alpha = T\sin\alpha + N\cos\alpha - 2mg}$

$\cancel{2m(a + a_{отн.}\cos\alpha) =}$



$\cancel{T\sin\beta = m(a_{кл} + a_б\sin\beta)}$

$\cancel{T\cos\beta = m a}$

В СО клина:

$\cancel{T\cos\beta - mg = m a_б\cos\beta}$

$T\sin\beta = m(a_б\sin\beta + a_{кл.})$

$\overleftarrow{a_{кл.}}$

$\cancel{T\cos\beta - mg = m a_б\cos\beta}$

$\cancel{T\sin\beta = m(a_б\sin\beta + a_{кл})}$

$T - 2mg\sin\alpha = 2m(-a_{кл}\cos\alpha + a_б)$

$T - mg\cos\beta = m(a_{кл}\sin\beta - a_б)$

$T\sin\beta = m(a_{кл} - a_б\sin\beta)$

$\cancel{m}\frac{a_{кл}}{\sin\beta} - \cancel{m}a_б - \cancel{m}g\cos\beta = \cancel{m}(a_{кл}\sin\beta - a_б)$

$\frac{a_{кл}}{\sin\beta} - a_б - 2g\sin\alpha = -2a_{кл}\cos\alpha + 2a_б$

$\frac{a_{кл}}{\sin\beta} - \cancel{a} - g\cos\beta = a_{кл}\sin\beta$

$a_{кл} - g\sin\beta\cos\beta = a_{кл}\sin^2\beta$

$a_{кл} = g\frac{\sin\beta\cos\beta}{\cos^2\beta} = g\operatorname{tg}\beta$

$\boxed{a_{кл.} = g\operatorname{tg}\beta}$

$\boxed{a_{кл.} = \frac{5}{12}g}$

Черновик.

2)

$R^2 = x^2 + y^2$ $\qquad C = \frac{dQ}{dT} =$

$R^2 = \frac{V^2}{V_0^2} + \frac{P^2}{P_0^2} \qquad P = \frac{\nu R T}{V} \qquad = C_V$

$R^2 P_0^2 V_0^2 = V^2 \cdot P_0^2 + P^2 V_0^2$

$R^2 = \frac{V^2}{V_0^2} + \frac{(\nu R)^2 T^2}{P_0^2 V^2}$

$(R^2 \cdot V_0^2) P_0^2 V^2 = P_0^2 \cdot V^4 + (\nu R)^2 T^2 V_0^2$

$\frac{P_0^4 V_0^4 R^4}{4} - 4 P_0^2 V_0^2 (\nu R)^2$

$\nu R = \frac{P_0 V_0}{T_0} \qquad P_0^4 V_0^4 \left(R^4 - 4 \frac{1}{T_0^2}\right)$

$(\nu R)^2 = \left(\frac{P_0 V_0}{T_0}\right)^2 \qquad \boxed{T_1 = \sqrt{2}\, T_2}$

$P_1 V_0 \qquad P_0 V_1 \qquad T dT =$

$\frac{P_1}{P_0} = R \sin\alpha \qquad \frac{V_1}{V_0} = R \cos\alpha$

$\nu R \cdot \frac{T dT}{V_0 V} \cdot \frac{d^2 V}{dT} = \frac{5}{2}$

$\frac{P^2}{P_0^2} + \frac{V^2}{V_0^2} = \text{const}$

$\frac{d^2 V}{d^2 T}$

$V^2 \cdot P_0^2 + P^2 V_0^2 = \text{const}$

$V^2 \cdot P_0^2 + \frac{(\nu R)^2 V_0^2 T^2}{V^2} = \text{const} \qquad \frac{1}{\frac{d^2 T}{d^2 T}}$

$P \frac{dV}{dT} = -C_V \qquad V^2 + \frac{(\nu R)^2 V_0^2}{P_0^2} \cdot \frac{T^2}{V^2} = \text{const} \qquad \left(x\sqrt{x^2 - \alpha}\right)' =$

$\boxed{P \frac{dV}{dT} = -C_V \nu}$

$\frac{dx}{dy} = \sqrt{x^2 - \alpha} + \frac{x}{2\sqrt{x^2 - \alpha}}$

$y^2 + x^2 = r^2$

$\frac{V_0^2}{T_0^2} \cdot \frac{T^2}{V^2} + \frac{V^2}{V_0^2} = \text{const}$

$P = \frac{\nu R T}{V} \Rightarrow \frac{P}{P_0} = \frac{T V_0}{T_0 V}$

$P_0 = \frac{\nu R T_0}{V_0}$

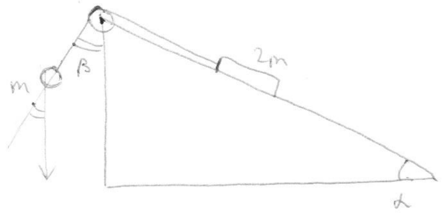
$V_0^4 \cdot T^2 + V^4 \cdot T_0^2 = \text{const} \cdot V^2$

$\left(\frac{T}{T_0}\right)^2 + \left(\frac{V}{V_0}\right)^4 = \text{const} \left(\frac{V}{V_0}\right)^2$

$y^2 + x^4 = \alpha x^2$

$x^4 - \alpha x^2 = y^2 \Rightarrow y = x\sqrt{x^2 - \alpha}$

Черновик.



1) $a_б = ?$

$\cancel{a_{кл} = a_б}$

$3a_б = \frac{a_{кл}}{\sin\beta} - 2g\sin\alpha + 2a_{кл}\cos\alpha$

$a_б = \frac{1}{3}\left(\frac{\cancel{a_{кл}}\,g}{\cos\beta} - 2g\sin\alpha + 2g\,tg\beta\cos\alpha\right) =$

2) $a_б = \frac{g}{3}\left(\frac{1}{\cos\beta} - 2\sin\alpha + 2\,tg\beta\cos\alpha\right) = \frac{11}{60}g$ $\boxed{a_б = \frac{11}{60}g}$

$\frac{13}{12} - 2\cdot\frac{3}{5} + 2\cdot\frac{\cancel{5}}{\cancel{12}}\cdot\frac{\cancel{4}}{\cancel{5}}$

$\frac{13}{12} - \frac{6}{5} + \frac{2}{3} = \frac{13+8}{12} - \frac{6}{5} =$

$\frac{T}{dT}$

$\frac{21\cdot5 - 6\cdot12}{60} = \frac{105 - 72}{60} = \frac{33}{60} = \frac{11}{20}$

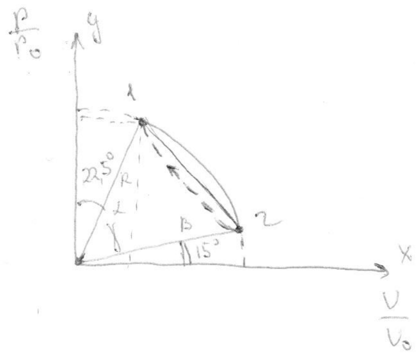
3) $\frac{a_б\cos\beta\, t^2}{2} = H$

$\nu = \frac{P_0V_0}{T_0R}$

$\frac{11\cdot4\,g}{60\cdot2\cdot5}t^2 = H \Rightarrow \boxed{t = \sqrt{\frac{150H}{11g}}}$

Ч

N2 $C_v = \frac{5}{2}R$



1) $P_0(R\cdot\cos\alpha) = P_1$

$V_1 = V_0(R\sin\alpha)$

$\frac{P_1V_1}{P_0V_0} = R^2\sin\alpha\cos\alpha$

$\frac{P_2V_2}{P_0V_0} = R^2\sin\beta\cos\beta$ $\Rightarrow$ $\boxed{\frac{T_1}{T_2} = \sqrt{2}}$

$\Rightarrow \frac{T_1}{T_2} = \frac{P_1V_1}{P_2V_2} = \frac{\sin\alpha\cos\alpha}{\sin\beta\cos\beta} \Rightarrow \frac{T_1}{T_2} = \frac{\sin2\alpha}{\sin2\beta} = \frac{1\cdot2}{\sqrt2\;1} = \sqrt2 =$

$\approx 1{,}41$

2) $C_1 = 0$

$C = \frac{dQ}{dT} = C_v + P\frac{dV}{dT}$

Черновик

$$\frac{T\,dV}{T\,dT}$$

$$\frac{V^4}{V_0^4} + \frac{T^2}{T_0^2} = const\ V^2 \quad \Big| \frac{d}{dT}$$

$\cancel{\mathcal{L}}$ T

Часть 2

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

Шифр: **21202485**

ID профиля: **144833**

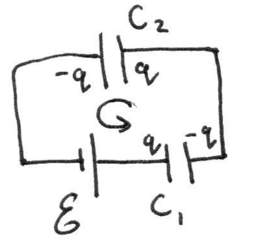
Вариант 6

Чистовик.

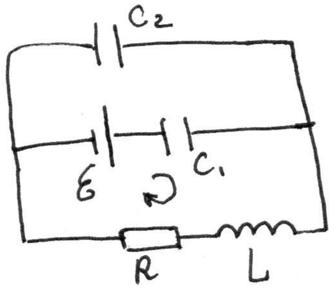
Вариант 11-06.

Задача № 3.

До замыкания ключа:



После замыкания ключа:



1) Т.к. изначально конденсаторы не заряжены, то при установлении равновесного состояния заряды на обкладках равны ⇒

$$\mathcal{E} = \frac{q}{C_1} + \frac{q}{C_2}$$

$$\mathcal{E} = \frac{q}{C} + \frac{q}{3C} \to q = \frac{3}{4}\mathcal{E}C$$

2) Сразу после замыкания ключа заряды конденсаторов не успевают изменится, а через R ещё нет тока ⇒

⇒ по правилу Кирхгофа

$$\mathcal{E} = \frac{q}{C_1} + L\dot{I}$$

$$\mathcal{E} = \frac{3}{4}\mathcal{E} + L\dot{I}$$

$$\boxed{\dot{I} = \frac{\mathcal{E}}{4L}}$$ — скорость возрастания тока сразу после замыкания ключа.

3) Найдём I_m — макс. ток через катушку: $(L\dot{I} = 0)$

$$\mathcal{E} = I_m R + \frac{q}{C_1} \xrightarrow[\text{при разряженноя } C_1]{I_m} \mathcal{E} = I_m R$$

$$\boxed{I_m = \frac{\mathcal{E}}{R}}$$

4) В установившемся состоянии C_2 — разряжен, тока через R — нет: → $\mathcal{E} = \frac{q_1}{C_1} \Rightarrow q_1 = \mathcal{E}C$

5) По закону Джоуля-Ленца

1

$$\mathcal{E}\left(+\mathcal{E}C - \frac{3}{4}\mathcal{E}C\right) = \underbrace{\left(\frac{\mathcal{E}^2C^2}{2C} - \frac{9\mathcal{E}^2C^2}{16\cdot 2C}\right)}_{\text{для } C_1} + \underbrace{\left(0 - \frac{9\mathcal{E}^2C^2}{16\cdot 6C}\right)}_{\text{для } C_2} + \underbrace{\left(0 - \frac{LI_m^2}{2}\right)}_{\text{для } L} + Q$$

Чистовик.

Вариант 11-06.

Задача №3.

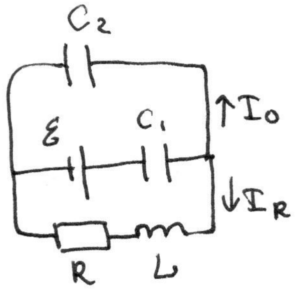
$$+\mathcal{E}\cdot\frac{1}{4}\mathcal{E}C = \left(\frac{1}{2}-\frac{9}{32}\right)\mathcal{E}^2C - \frac{3}{32}\mathcal{E}^2C - \frac{L\mathcal{E}^2}{2R^2} + Q$$

$$+\frac{1}{4}\mathcal{E}^2C = \frac{7}{32}\mathcal{E}^2C - \frac{3}{32}\mathcal{E}^2C - \frac{L\mathcal{E}^2}{2R^2} + Q$$

$$\frac{L\mathcal{E}^2}{2R^2} + \left(\frac{4}{32}+\frac{1}{4}\right)\mathcal{E}^2C = Q$$

$$\boxed{\frac{L\mathcal{E}^2}{2R^2} + \frac{3}{8}\mathcal{E}^2C = Q}$$

б)



Рассмотрим малый промежуток времени Δt:

$$\cancel{\mathcal{E} = \frac{(I_0+I_R)\Delta t}{C}}$$

$$\cancel{0 = -\frac{(I_0+I_R)\Delta t}{C} + L\frac{I_R}{\Delta t} + RI_R}$$

$$\begin{cases} \dfrac{I_0\Delta t}{3C} = \dfrac{I_R}{\Delta t}L + \cancel{I_R R} \rightarrow \cancel{\dfrac{I_0}{3C}\cdot\Delta t^2 \xrightarrow{} 0 = I_R L + I_R R\Delta t} \\ 0 = \dfrac{(I_0+I_R)\Delta t}{C} + \dfrac{I_0\Delta t}{3C} \end{cases}$$

$$\cancel{\Delta t^2}$$

$$\frac{I_0+I_R}{1} = -\frac{I_0 \cancel{\Delta t}}{3}$$

$$3I_0 + I_R = -I_0$$

$$4I_0 = -I_R \rightarrow I_R = -4I_0 \rightarrow U_R = I_R R = 4I_0R.$$

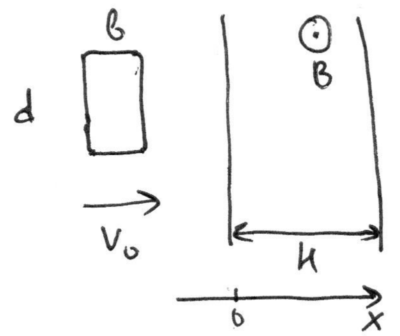
Ответ: 1) $\dot{I} = \frac{\mathcal{E}}{4L}$ 2) $Q = \frac{L\mathcal{E}^2}{2R^2} + \frac{3\mathcal{E}^2C}{8}$

3) $U_R = 4I_0R$

Чисто вик

Вариант 11-06.

Задача №4.



1) Площадь ~~рав~~ рамки в поле:

$S(x) = dx \Rightarrow$

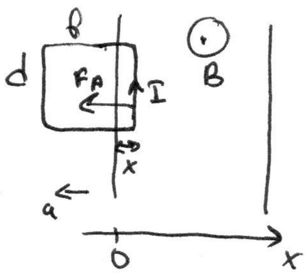
$\Rightarrow \Phi = Bdx \Rightarrow$

$\Rightarrow |I| = \cancel{\frac{\dot{\Phi}}{R}} = \frac{\mathcal{E}}{R} = \frac{\dot{\Phi}}{R} = \frac{Bd}{R}$

2) $ma = F_A$

$ma = \frac{Bd}{R} B \cdot d$

$$\boxed{a = \frac{B^2 d^2}{R}}$$



3) Внутри поля рамка движется без ускорения $\Rightarrow$

$\Rightarrow V_1$ такая же, как и при полном влёте.

4) Т.к. рамка влетает с постоянным ускорением a:

$$b = -\frac{at^2}{2} + V_0 t$$

$$t = \frac{V_0 \pm \sqrt{V_0^2 - ab}}{a}$$

$$V_1 = V_0 - at = V_0 - V_0 + \sqrt{V_0^2 - ab} = \sqrt{V_0^2 - \frac{B^2 d^3}{4R}}$$

$$\boxed{V_1 = \sqrt{V_0^2 - \frac{B^2 d^3}{4R}}}$$

5) Т.к. рамка выталкивается с таким же ускорением, что и вх. начале $\Rightarrow V_2 = V_0$

Ответ: 1) $a = \frac{B^2 d^2}{R}$; 2) $V_1 = \sqrt{V_0^2 - \frac{B^2 d^3}{4R}}$

3) $V_2 = V_0$

3

Чистовик

Вариант 11-06.

Задача N5.

Дано: $l = 25 см$; $\frac{D_1}{D_2} = \frac{7}{3}$; D_1 - для удал. пр.

D_2 - для текста с раст 25см

По формуле линзы

1) $D_2 = -\frac{1}{x} + \frac{1}{l}$

$D_1 = -\frac{1}{x} + \frac{1}{a}$ т.к. $a \to \infty$, $\frac{1}{a} \to 0$

$$\frac{D_1}{D_2} = \frac{\frac{1}{x}}{-\frac{1}{l} + \frac{1}{x}} = \frac{1}{-\frac{x}{l}+1} = \frac{l}{l-x} = \frac{7}{3}$$

$3l = 7l - 7x$

$$\boxed{x = \frac{4}{7} l \approx 14,3 (см)}$$

2) $D_1 = -\frac{1}{x} = -\frac{7}{4l} = -7$ дптр.

3) $D_3 = \frac{1}{l_2} - \frac{1}{x}$

$$D_3 = \frac{x - 2l}{2lx} = \frac{\left(\frac{4}{7} - 2\right) l}{\frac{8}{7} l^2} = \frac{(4-14)}{8l} = -\frac{10}{8l} = -\frac{5}{4l} =$$

$= -5$ дптр.

Ответ:

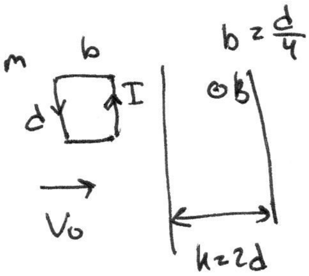
1) $x = \frac{4}{7} l \approx 14,3$ (см)

2) $D_1 = -\frac{7}{4l} = -7$ (дптр.)

3) $D_3 = -\frac{5}{4l} = -5$ (дптр.)

4

Черновик.



$b = \frac{d}{4}$

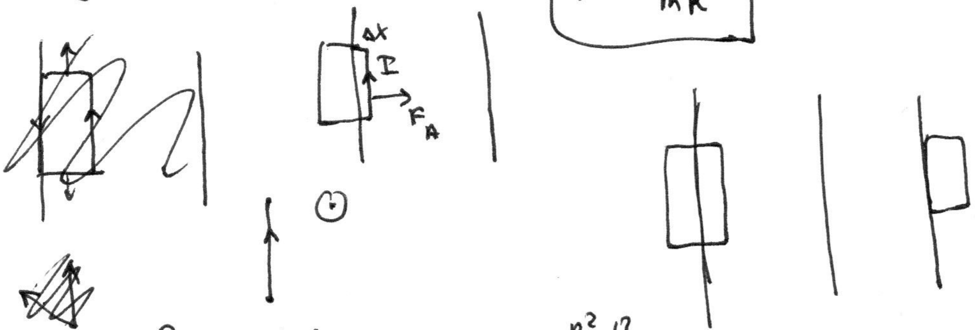
R

1) $a = ?$

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

$$\boxed{a = -\frac{B^2 d^2}{mR}}$$

$I \; B \times l$



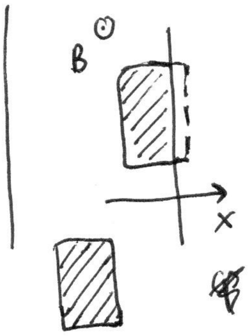
$$F_A = IBl = IB\cdot d = -\frac{B^2 d^2}{R}$$

$$I = \frac{\mathcal{E}}{R} = +\frac{\dot{\varphi}}{R} = -\frac{Bd}{R}$$

$B~~\times~~d \quad B\times d$

$V_2 = ?$

2) $v_1 = ?$



$\varphi = B$

$B(b - x)d$

$-\dot{\varphi} = +Bd$

$I = 0$

$F_A = 0$

$\cancel{V_0 - at =}$

$$b = -\frac{at^2}{2} + V_0 t$$

$$0 = \cancel{\frac{at^2}{2}} + at^2 \pm 2V_0 t + b = 0$$

$$t = \frac{V_0 \pm \sqrt{V_0^2 - ab}}{a}$$

$$V_1 = V_0 - V_0 + \sqrt{V_0^2 - ab} = \sqrt{V_0^2 - \frac{B^2 d^2}{mR}\cdot\frac{d}{4}} = \sqrt{V_0^2 - \frac{B^2 d^3}{4mR}}$$

$$V_2 = \sqrt{V_1^2 + ab} =$$

$$= \sqrt{V_0^2 - ab + ab} = V_0$$

$$b = \frac{at^2}{2} + v_1 t$$

$$at^2 + 2v_1 t - b = 0$$

$$\frac{-v_1 \pm \sqrt{v_1^2 + ab}}{a}$$

$$V_2 = V_1 + at = V_1 - V_1 + \sqrt{V_1^2 + ab} =$$

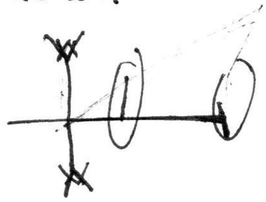
$$= V_0$$

Черновик.

(5) D_1 − даль D_2 − чтение

$\frac{D_1}{D_2} = \frac{7}{3}$ $l = 25$ см. $l_2 = 50$ см

(1) $x = ?$ $D_1 = ?$



$D_1 = \frac{7}{3} D_2$

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

$D_1 = -\frac{1}{x} + \frac{1}{\infty}$

$\frac{D_1}{D_2} = \frac{-\frac{1}{x}}{\frac{1}{l} - \frac{1}{x}} = \frac{-1}{\frac{x}{l} - 1} = \frac{1}{1 - \frac{x}{l}} =$

$= \frac{l}{l - x} = \frac{7}{3}$

$3l = 7l - 7x$

$-4l = -7x$

$x = \frac{4}{7} l \approx 0{,}57 l = 14{,}\cancel{28}3$ (см)

$D_1 = -\frac{1}{x} = -0{,}07 \frac{1}{см} = -7$ дптр.

$D_2 = -3$ дптр.

(2) $D_3 = \boxed{\frac{1}{l_2} - \frac{1}{x}}$

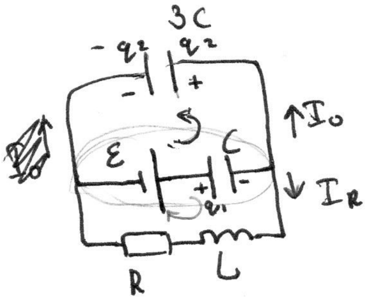
$D_3 = \frac{x - l_2}{x l_2} = \frac{-\frac{10}{7} l}{\frac{8}{7} l^2} = -\frac{5}{4 \cdot l} = -10^2 \cdot \frac{5}{100}$ дптр. $= -5$ дптр.

$\frac{4}{7} - 2 = -\frac{10}{7}$

Ответ: 14,3 см ; −7 дптр. ; −5 дптр.

Черновик:

$\frac{I_0 \Delta t}{C_2}$ ~~q~~ =



$$\mathcal{E} = \frac{q_1}{C} + \underbrace{L\dot{I}}_{=0} + I_m R$$

$$\mathcal{E} = \frac{q_1}{C} + \frac{q_2}{3C}$$

$$\frac{\mathcal{E}}{R} = I_m \qquad \mathcal{E}\cdot 3C = q_2$$

$$\Delta W_2 = \frac{9\mathcal{E}^2C^2}{2\cdot 3C} - \frac{9\cdot\mathcal{E}^2C^2}{16\cdot 3C\cdot 2} = \left(\frac{3}{2} - \frac{3}{32}\right)\mathcal{E}^2C = \frac{45}{32}\mathcal{E}^2C$$

$3\cdot 16 = 48$

$$\Delta W_1 = 0 - \frac{9\mathcal{E}^2C^2}{16\cdot 2C} = -\frac{9}{32}\mathcal{E}^2C$$

$$\Delta W_L = \frac{LI_m^2}{2} = \frac{L\mathcal{E}^2}{2R^2}$$

$\Delta q =$

$\frac{3}{4}\mathcal{E}C \to 0$

$\cancel{\frac{3}{4}\mathcal{E}C = \frac{45}{32} - \frac{9}{32} - \frac{L\mathcal{E}^2}{2R^2}}$

$$\frac{3}{4}\mathcal{E}^2C = \frac{36}{32}\mathcal{E}^2C - \frac{L\mathcal{E}^2}{2R^2} + Q \qquad \left(\frac{36}{32} = \frac{9}{8}\right)$$

$$\frac{L\mathcal{E}^2}{2R^2} + \left(\frac{6}{8} - \frac{9}{8}\right)\mathcal{E}^2C = Q$$

$$\boxed{\frac{L\mathcal{E}^2}{2R^2} - \frac{3}{8}\mathcal{E}^2C = Q}$$

$\cancel{(I_0 + I_R)\Delta t}$

$\cancel{L\dot{I}_R + I_R R = q_1}$

$\cancel{L\dot{I} + I_R R = \frac{q}{2C}}$ $\quad -\frac{(I_0 + I_R)\Delta t}{C}$

$$0 = -\frac{L\mathcal{E}^2}{2R^2} - + L\frac{I_R}{\Delta t} + RI_R$$

$$\frac{q}{C_2} = \mathcal{E} \qquad q = 3\mathcal{E}C$$

$\cancel{\frac{I\Delta t}{C}}$

$$\frac{(I_R + I_0)\Delta t}{C} + \frac{I_0\Delta t}{3C} = \mathcal{E}$$

$$u_{3C} = L\dot{I}_R + I_R R$$

3

~~$u_C + u_R + u_L = \mathcal{E}$~~ $\quad I_R = ?$

$u_R = I_R R$

$$u_C + L\dot{I}_R + I_R R = \mathcal{E}$$

$$u_C + u_{3C}'' = \mathcal{E} \qquad \frac{u_C}{3} = u_{3C}$$

$$\frac{q_1}{C} + \frac{q_2}{3C} = \mathcal{E}$$

$$\frac{I_R}{\Delta t}L + I_R R = \frac{(I_R + I_0)\Delta t}{C}$$

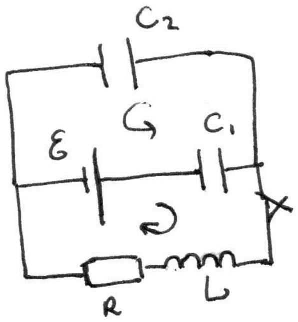
$$\boxed{I_R = \frac{R\mathcal{E}C}{L} - \frac{4}{3}I_0}$$

$$3(I_R + I_0)\frac{L}{R} + I_0\cdot\frac{L}{R} = \mathcal{E}\cdot 3C$$

$$I_R L = I_R R\Delta t \qquad \Delta t = \frac{L}{R}$$

$$I_R\frac{3L}{R} = 3\mathcal{E}C - 4I_0\frac{L}{R}$$

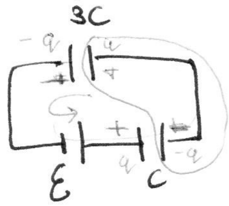
Черновик.



$C_1 = C$

$C_2 = 3C$

1) До замыкания.



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

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

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

2) После замыкания:

$\dot{I} = ?$ - сразу после...

$\mathcal{E} = L\dot{I} + \frac{q}{C_1} \Rightarrow \mathcal{E} = L\dot{I} + \frac{3}{4}\frac{\mathcal{E}C}{C} \Rightarrow$

$\frac{1}{4}\mathcal{E} = L\dot{I} \rightarrow \boxed{\dot{I} = \frac{\mathcal{E}}{4L}}$

3) $Q = ?$

$C_2: \quad \mathcal{E} = \frac{q_2}{C_2} \rightarrow q_2 = 3\mathcal{E}C.$ на $\mathcal{E}$ Δq: $0 - \frac{3}{4}\mathcal{E}C = -\frac{3}{4}\mathcal{E}C$

$q_1 = 0$

катушка $W_н = 0$ $W_к = \frac{LI_m^2}{2}.$

$I_m = ?$

$\mathcal{E} = I_m R + \frac{q}{C_1}$

$\frac{\mathcal{E}}{R} - \frac{q}{CR} = I_m \rightarrow \boxed{I_m = \frac{\mathcal{E}}{R}}$

$\mathcal{E} \cdot -\frac{3}{4}\mathcal{E}C = \frac{9\mathcal{E}^2C^2}{2\cdot 3C} - \frac{9\mathcal{E}^2C^2}{16\cdot 2\cdot 3C} \cancel{+} - \frac{9\mathcal{E}^2C^2}{16\cdot 2C} + \frac{L\mathcal{E}^2}{2R^2} + Q$

$+\frac{3}{4}\mathcal{E}^2C = \cancel{2}\left(\frac{3}{2} - \frac{3}{32} - \frac{9}{32}\right)\mathcal{E}^2C + \frac{L\mathcal{E}^2}{2R^2} + Q$

$\frac{48-3-9}{32} = \frac{36}{32} = \frac{9}{8}$

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

$\left(\frac{6}{4} - \frac{9}{4}\right)C - \frac{L\mathcal{E}^2}{R^2} = Q$