Часть 1

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

Шифр: **21200405**

ID профиля: **849339**

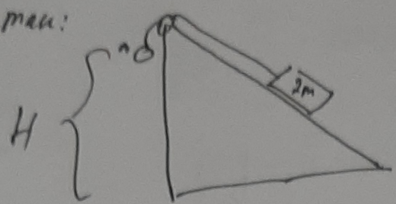
Вариант 6

N1 — Чистовик

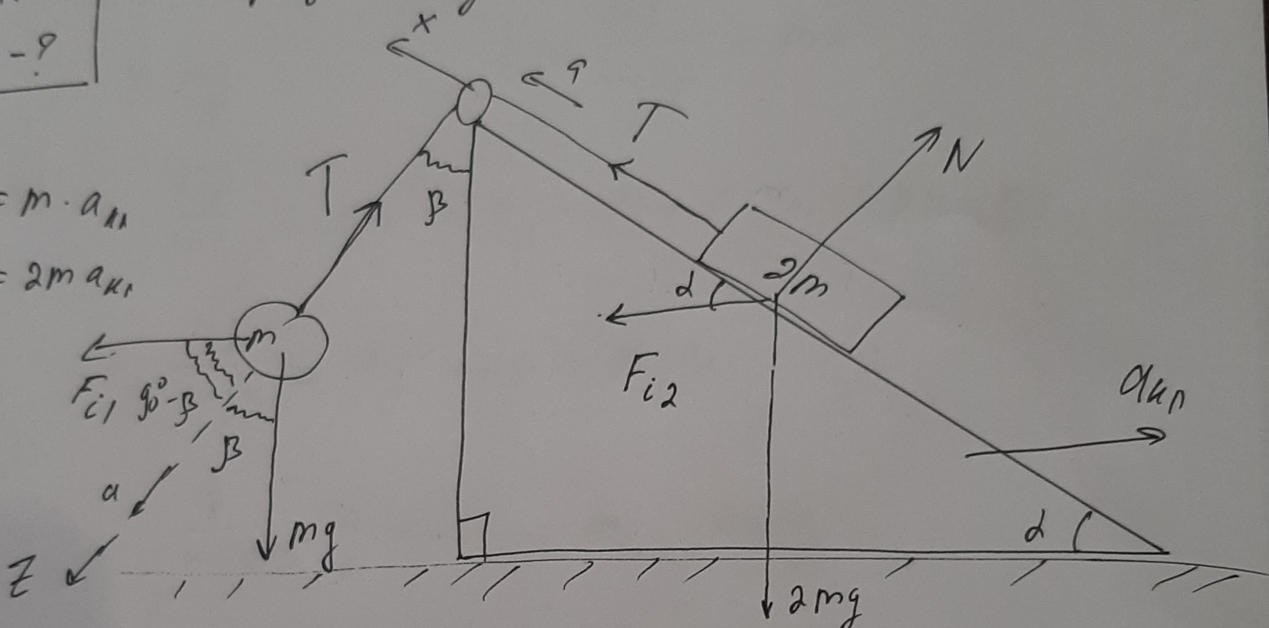
Дано:
$\cos\alpha = \frac{4}{5}$
$\cos\beta = \frac{12}{13}$

1) $a_{кл}$ — ?
2) $a_{бота}$ — ?
3) t — ?

Было так:



В процессе движения клина с $a_{кл} = const$



$F_{i1} = m \cdot a_{кл}$
$F_{i2} = 2m a_{кл}$

1) 2ЗН для „$\boxed{2m}$" $\quad x: 2ma = T + F_{i2} \cdot \cos\alpha$

$2ma = T + 2m a_{кл} \cdot \cos\alpha \quad T = 2ma - 2m a_{кл} \cdot \cos\alpha$

2) 2ЗН для „m" $\quad z: \quad ma = mg \cdot \cos\beta + m a_{кл} \cdot \sin\beta - T$

$T = mg \cdot \cos\beta + m a_{кл} \cdot \sin\beta - ma$

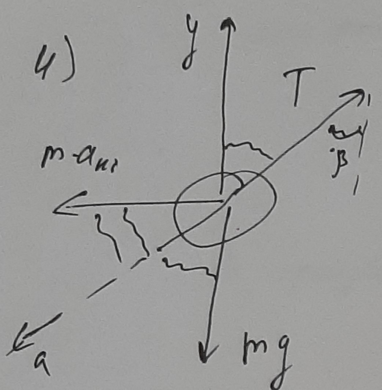
3) $2ma - 2m a_{кл} \cdot \cos\alpha = mg \cdot \cos\beta + m a_{кл} \cdot \sin\beta - ma$

$3ma - mg \cdot \cos\beta = m a_{кл} \cdot \sin\beta + 2m a_{кл} \cdot \cos\alpha$

1

$$3a - g\cdot\cos\beta = a_{кл}\cdot\sin\beta + 2a_{кл}\cdot\cos\alpha$$ Чистовик

4)



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

$$mg - T\cdot\cos\beta = ma\cdot\cos\beta$$

$$mg - ma\cdot\cos\beta = T\cdot\cos\beta$$

$$T = \frac{mg}{\cos\beta} - ma$$

5) $$\frac{mg}{\cos\beta} - \cancel{ma} = mg\cdot\cos\beta + m\cdot a_{кл}\cdot\sin\beta - \cancel{ma}$$

$$\frac{mg}{\cos\beta} = mg\cdot\cos\beta + m\cdot a_{кл}\cdot\sin\beta$$

$$\frac{g}{\cos\beta} = g\cdot\cos\beta + a_{кл}\cdot\sin\beta$$

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

$$a_{кл}\cdot\sin\beta\cdot\cos\beta = g\underbrace{(1-\cos^2\beta)}_{\sin^2\beta}$$

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

$$a_{кл}\cdot\cos\beta = g\cdot\sin\beta \qquad a_{кл} = g\,tg\,\beta$$

$$\cos\beta = \frac{12}{13} \qquad \sin\beta = \sqrt{1-\frac{144}{169}} = \frac{5}{13} \qquad tg\,\beta = \frac{5}{13}\cdot\frac{13}{12} = \frac{5}{12}$$

$$\cancel{a_{кл} = \frac{5}{13}g}$$

$$\boxed{a_{кл} = \frac{5}{12}g}$$

2

$$в)\ 3a = a_{кл}\cdot\sin\beta + 2a_{кл}\cdot\cos\alpha + g\cdot\cos\beta$$ **Чистовик**

из п.3 $$a = \frac{1}{3}a_{кл}\cdot\sin\beta + \frac{2}{3}a_{кл}\cdot\cos\alpha + \frac{1}{3}g\cdot\cos\beta$$

$$a = \frac{1}{3}g\,tg\beta\cdot\sin\beta + \frac{2}{3}g\,tg\beta\cdot\cos\alpha + \frac{1}{3}g\cdot\cos\beta$$

$$a = \frac{1}{3}g\cdot\frac{\sin^2\beta}{\cos\beta} + \frac{2}{3}g\,tg\beta\cdot\cos\alpha + \frac{1}{3}g\cos\beta$$

$$a = \frac{g}{3}\left(\frac{\sin^2\beta}{\cos\beta} + 2\cdot tg\beta\cdot\cos\alpha + \cos\beta\right)$$

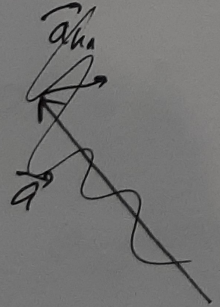
$$\frac{\sin^2\beta}{\cos\beta} = \frac{1-\cos^2\beta}{\cos\beta} = \frac{1}{\cos\beta} - \cos\beta$$

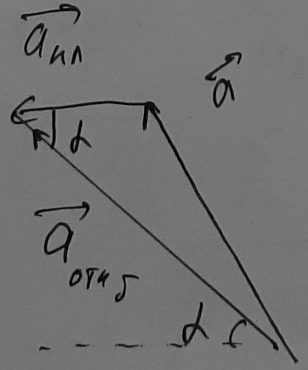
$$a = \frac{g}{3}\left(\frac{1}{\cos\beta} - \cancel{\cos\beta} + 2\,tg\beta\cdot\cos\alpha + \cancel{\cos\beta}\right)$$

$$a = \frac{g}{3}\left(\frac{13}{12} + 2\cdot\frac{\cancel{5}}{12}\cdot\frac{4}{\cancel{5}}\right) = \frac{g}{3}\left(\frac{13}{12} + \frac{8}{12}\right) = \frac{g}{\cancel{3}}\cdot\frac{\cancel{21}^{\,7}}{12}$$

$$a = \frac{7}{12}g$$

$$г)\ \vec{a} = \vec{a}_{кл} + \vec{a}_{отн} \qquad \vec{a}_{отн} = -\vec{a}_{кл} + \vec{a}$$





По Th cos.

$$a_{отн}^2 + a_{кл}^2 - 2a_{отн}\cdot a_{кл}\cdot\cos\alpha = a^2$$

$$a_{отн} = a_0$$

Чистовик

8) $a_0^2 + a_{кл}^2 - 2a_0 a_{кл} \cdot \cos\alpha = a^2$

$a_0^2 + a_{кл}^2 - 2a_0 a_{кл} \cdot \frac{4}{5} = a^2$

$a_0^2 - 2a_0 a_{кл} \cdot \cos\alpha + a_{кл}^2 - a^2 = 0$

$\frac{D}{4} = \left(\frac{2a_{кл} \cdot \cos\alpha}{2}\right)^2 - (a_{кл}^2 - a^2) = a_{кл}^2 \cdot \cos^2\alpha - a_{кл}^2 + a^2 =$

$\cancel{= a^2 + a_{кл}^2\left(1 - \frac{16}{25}\right)} = a_{кл}^2(\cos^2\alpha - 1) + a^2 =$

$= \left(\frac{5}{12}g\right)^2\left(\frac{16}{25} - 1\right) + \left(\frac{7}{12}g\right)^2 = \frac{25}{144}g^2 \cdot \left(-\frac{9}{25}\right) + \frac{49}{144}g^2 =$

$= \frac{-9}{144}g^2 + \frac{49}{144}g^2 = \frac{40}{144}g^2 \qquad \sqrt{\frac{D}{4}} = \frac{\sqrt{40}}{12}g$

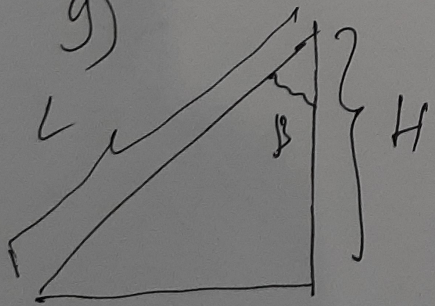
$a_0 = a_{кл} \cdot \cos\alpha \pm \frac{\sqrt{40}}{12}g = \frac{5}{12}g\cos\alpha \pm \frac{\sqrt{40}}{12}g =$

$= \frac{5}{12} \cdot \frac{4}{5}g \pm \frac{\sqrt{40}}{12}g; \quad a_0 > 0 \Rightarrow a_0 = \frac{4}{12}g + \frac{\sqrt{40}}{12}g =$

$= \frac{4+\sqrt{40}}{12}g = \frac{4+2\sqrt{10}}{12}g = \frac{2+\sqrt{10}}{6}g \approx 0{,}86g \approx 8{,}6\,\frac{м}{с^2}$

$\boxed{a_{отн} \approx 0{,}86g}$

9)



$L = \frac{H}{\cos\beta} \qquad L = \frac{at^2}{2}$

→

4

9) $L = \frac{at^2}{2}$ $L = \frac{H}{\cos\beta}$ $\frac{H}{\cos\beta} = \frac{7g}{12}\frac{t^2}{2}$

Чистовик

$\frac{H \cdot 13}{\cancel{12}} = \frac{7gt^2}{2 \cdot \cancel{12}}$ $26H = 7gt^2$ $t^2 = \frac{26H}{7g}$

$t = \sqrt{\frac{26H}{7g}}$

Ответ: 1) $a_{клина} = \frac{5}{12} g$

2) $a_{б\ отн} = \frac{2+\sqrt{10}}{6} g \approx 0{,}86 g$

3) $t = \sqrt{\frac{26H}{7g}}$

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Чистовик

№2

$C_V = \frac{5}{2}R$

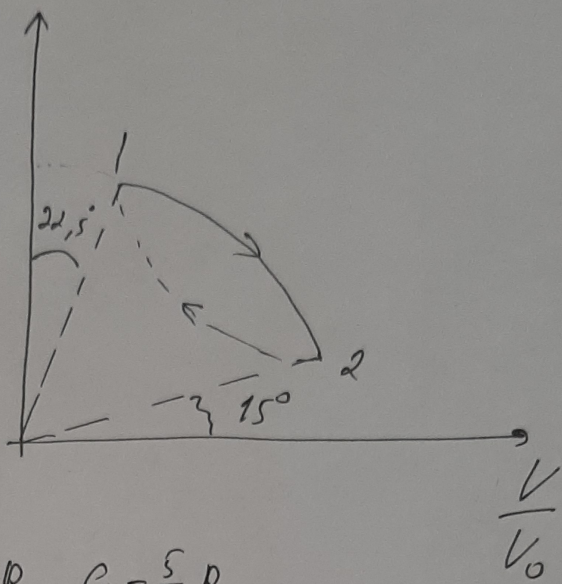
1) $\frac{T_1}{T_2}$

2)

3)

$p_0 = const$

$V_0 = const$



1) т.к. $C_V = \frac{5}{2}R$, то

~~[illegible]~~

$Q = \Delta U + \cancel{A}$ $V = const$

A_0

$Q = \Delta U$

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

$Q = C_V \nu \Delta T$

$C_V \cancel{\nu} \cancel{R} \cancel{\Delta T} = \frac{i}{2}\cancel{\nu}\cancel{R}\cancel{\Delta T}$ $C_V = \frac{i}{2}R$ $C_V = \frac{5}{2}R$

$i = 5 \Rightarrow$ газ двухатомный

2) Пусть радиус окружности r

$\sin\varphi = \frac{V_1}{V_0 r}$

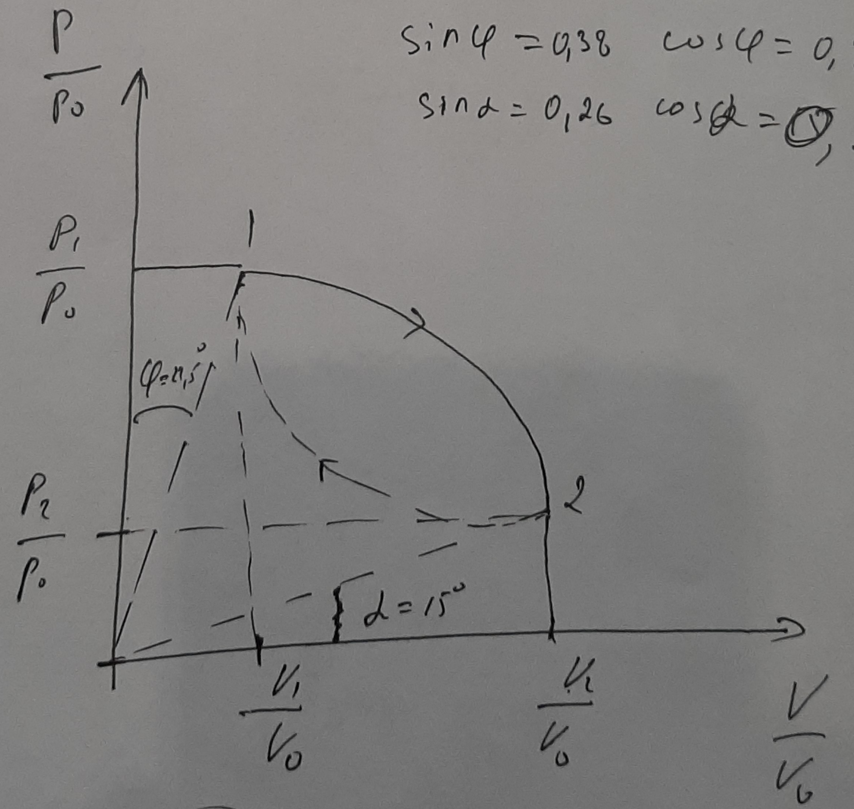
$\cos\alpha = \frac{V_2}{V_0 r}$

$\sin\alpha = \frac{P_2}{P_0 r}$

$\cos\varphi = \frac{P_1}{P_0 r}$

$\sin\varphi = 0,38$ $\cos\varphi = 0,92$

$\sin\alpha = 0,26$ $\cos\alpha = 0,96$



~~$V_0 r = \sin\varphi V_1$~~

~~$V_0 r = \cos$~~

$\sin\varphi \cdot V_0 r = V_1$

$r = \frac{V_1}{\sin\varphi V_0}$

$r = \frac{V_2}{\cos\alpha V_0}$

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$\cdot\ \eta = \dfrac{V_1}{\sin\varphi V_0}$ $\cdot\ \eta = \dfrac{V_2}{\cos\alpha V_0}$

$\rho_0 \eta \cdot \sin\alpha = \rho_2$

$\cdot\ \eta = \dfrac{\rho_2}{\rho_0 \sin\alpha}$

$\cdot\ \eta = \dfrac{\rho_1}{\rho_0 \cos\varphi}$

3) $\dfrac{V_1}{\sin\varphi\, \cancel{V_0}} = \dfrac{V_2}{\cos\alpha\, \cancel{V_0}}$ $V_1 \cdot \cos\alpha = V_2 \cdot \sin\varphi$ $V_2 = V_1 \cdot \dfrac{\cos\alpha}{\sin\varphi}$

$\dfrac{\rho_2}{\cancel{\rho_0} \sin\alpha} = \dfrac{\rho_1}{\cancel{\rho_0} \cdot \cos\varphi}$ $\rho_2 \cdot \cos\varphi = \rho_1 \sin\alpha$ $\rho_2 = \rho_1 \dfrac{\sin\alpha}{\cos\varphi}$

4) $p_1 V_1 = \nu R T_1$ $p_2 V_2 = \nu R T_2$ $V_1 p_1 \dfrac{\cos\alpha}{\sin\varphi} \cdot \dfrac{\sin\alpha}{\cos\varphi} = \nu R T_2$

$p_1 V_1 = \nu R T_1$ $p_1 V_1 \dfrac{\cos\alpha}{\sin\varphi} \cdot \dfrac{\sin\alpha}{\cos\varphi} = \nu R T_2$

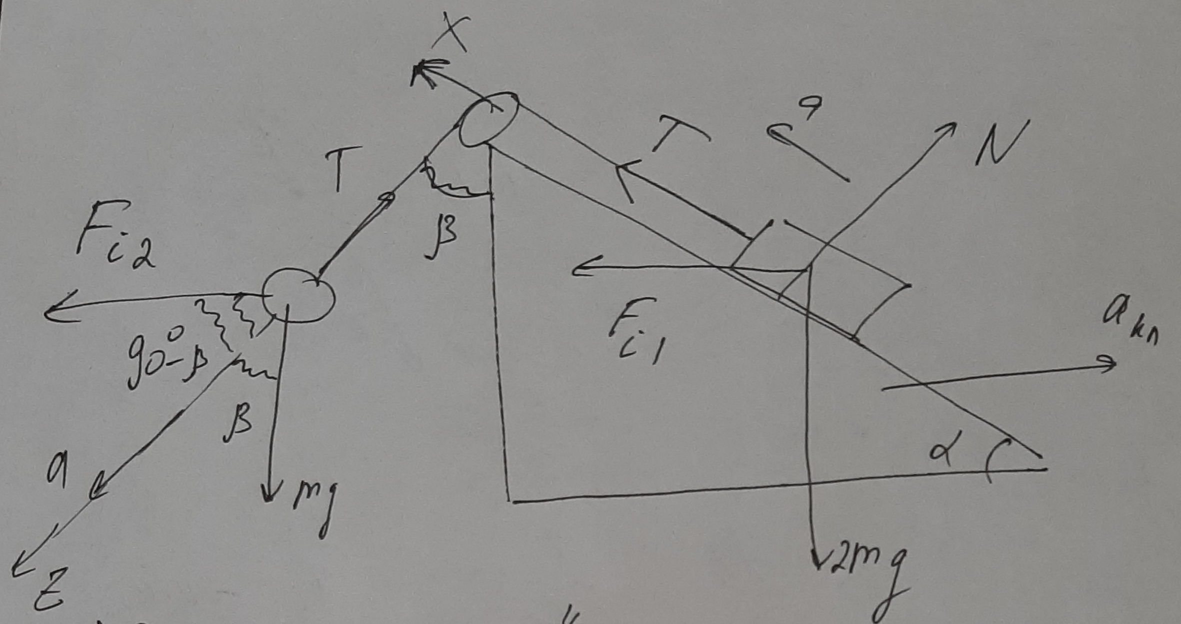
$$\frac{T_1}{T_2} = \frac{\sin\varphi \cdot \cos\varphi}{\cos\alpha \sin\alpha} = \frac{0,38 \cdot 0,92}{0,26 \cdot 0,96} = \frac{0,3496}{0,2496} \simeq 1,4$$

$$\boxed{\frac{T_1}{T_2} \simeq 1,4}$$

Ответ: $\dfrac{T_1}{T_2} \simeq 1,4$

Чистовик

8



2 3Н для „$\boxed{2m}$“ $\quad X: \; 2ma = T + F_{i1} = T + 2ma_{кл}\cdot\cos\alpha$

$$ma = -T + ma_{кл}\cdot\cos(90^\circ-\beta) + mg\cdot\cos\beta$$

$$ma = -T + ma_{кл}\cdot\sin\beta + mg\cdot\cos\beta$$

$$T = ma_{кл}\cdot\sin\beta + mg\cdot\cos\beta - ma$$

$$T = 2ma - 2ma_{кл}\cdot\cos\alpha$$

$$2ma - 2ma_{кл}\cdot\cos\alpha = ma_{кл}\cdot\sin\beta + mg\cdot\cos\beta - ma$$

$$3ma - mg\cdot\cos\beta = ma_{кл}\cdot\sin\beta + 2ma_{кл}\cdot\cos\alpha$$

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

$$3a - g\cdot\cos\beta = a_{кл}\cdot\sin\beta$$

Часть 2

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

Шифр: **21200405**

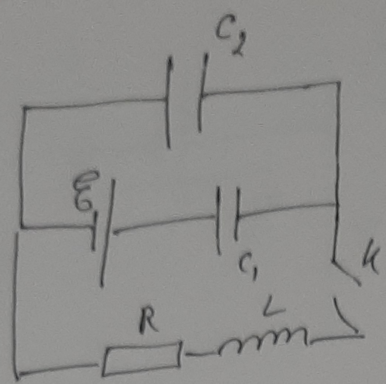
ID профиля: **849339**

Вариант 6

№3 Шистович

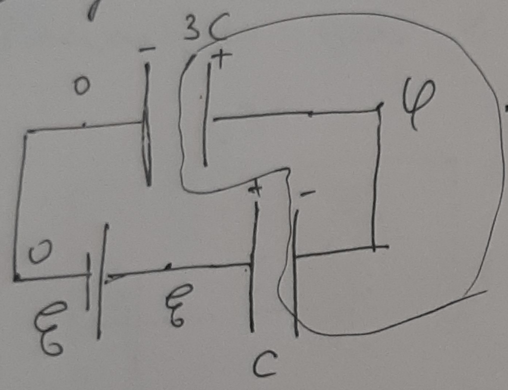
$C_1 = C$
$C_2 = 3C$

1) $I_L'(0)$
2) $Q - ?$
3) U_R - ?; max
$I_{C_2} = I_0$



1) Рассмотрим цепь до замыкания ключа, а точнее верхний фрагмент цепи без катушки и резистора. Цепь в уст режиме при (—K— —) разомкнутом ключе $\Rightarrow$ $I_{C_2} = 0$ и $I_{C_1} = 0$

метод узловых потенциалов

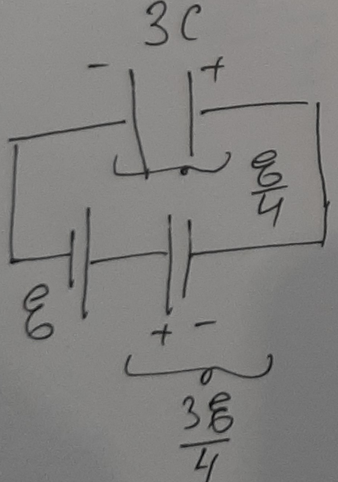


→ изолированная область

ЗСЗ:

$$(\varphi - 0)\cdot 3C - (\mathcal{E} - \varphi)C = 0$$

$$3\varphi = \mathcal{E} - \varphi \qquad \varphi = \frac{\mathcal{E}}{4}$$

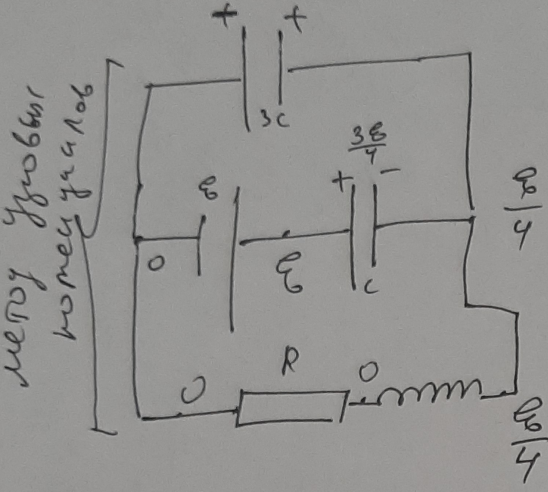


$$W = \frac{C\left(\frac{3\mathcal{E}}{4}\right)^2}{2} + \frac{3C\left(\frac{\mathcal{E}}{4}\right)^2}{2} =$$

$$= \frac{C \cdot 9\mathcal{E}^2}{32} + \frac{3C\mathcal{E}^2}{32} = \frac{12C\mathcal{E}^2}{32} =$$

$$= \frac{3C}{8}\mathcal{E}^2$$

2) Рассмотрим цепь сразу после замыкания ключа, $U_{C_2}(0)=\frac{\mathcal{E}}{4}$ $U_{C_1}(0)=\frac{3\mathcal{E}}{4}$, напряжения на конденсаторах скачком не меняются, ток на катушке скачком не меняется $I_L(0)=0$



$$U_L = I_L' \cdot L$$

$$I_L'(0) = \frac{U_L(0)}{L} = \frac{\mathcal{E}}{4L}$$

$$\boxed{I_L'(0) = \frac{\mathcal{E}}{4L}}$$

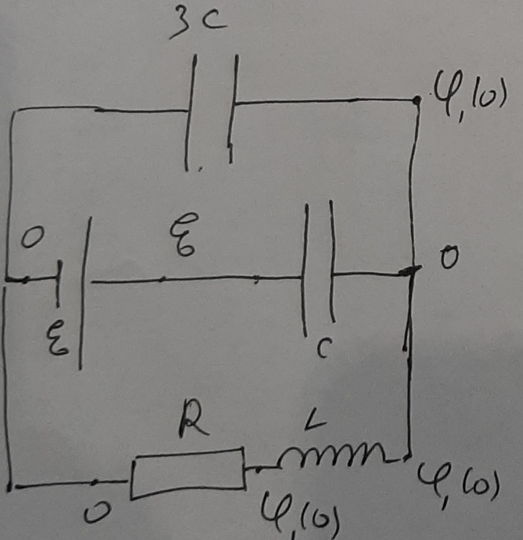
W(p) = W

3) Рассмотрим цепь в уст режиме при К.

$I_{C_1}=0$; $I_{C_2}=0$. $U_L=0$. $I_L(t_{уст})=0$, т.к. катушка последовательно соединена с R ⇒

$\Rightarrow \varphi_1=0$

$U_{C_1}(t_{уст})=\mathcal{E}$ $U_{C_2}(t_{уст})=0$



4) ЗСЭ:

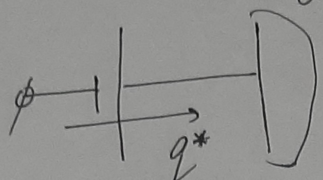
$$A_{\mathcal{E}} = \Delta W + Q$$

Чистовик

2

Черновик

АБ:



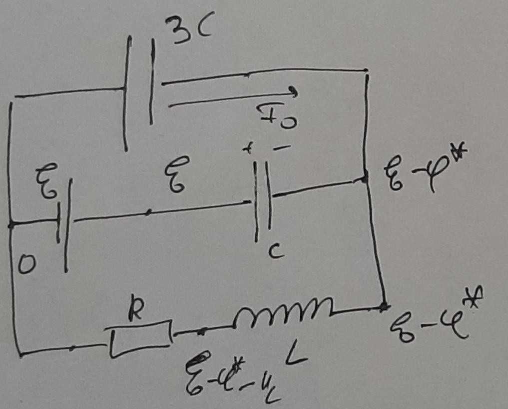
$q^* = \frac{C\mathcal{E}}{4}$

$A_Б = +\frac{C\mathcal{E}^2}{4}$

$\frac{C\mathcal{E}^2}{4} = W(t_{уст}) - W(0) + Q$ $\qquad \cancel{\frac{C\mathcal{E}^2}{4}} = \cancel{\frac{C\mathcal{E}^2}{4}} - \frac{3C\mathcal{E}^2}{8} + Q$

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

5) Рассмотрим цепь в момент, когда $I_L = I_0$



Черновик

Чистовик

Ответы: 1) $I'(0) = \frac{\mathcal{E}}{4L}$

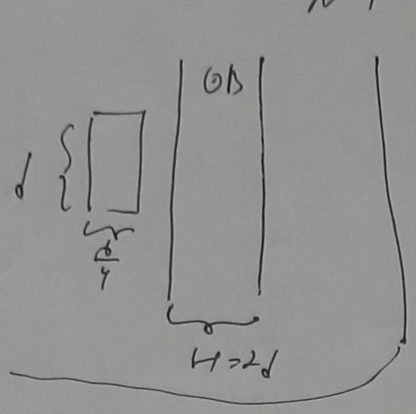
2) $Q = \frac{3}{8} C\mathcal{E}^2$

(чистовик)

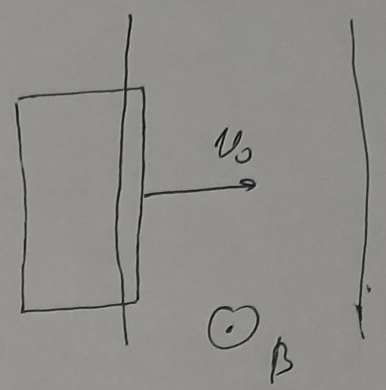
№4

d, m, v_0, R, B

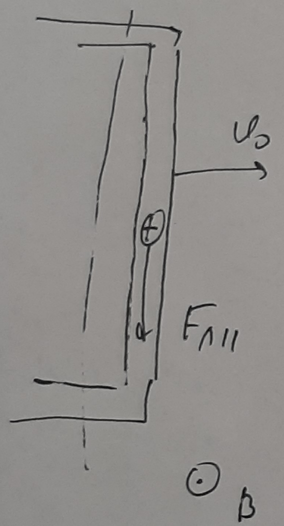
1) a_0 - ?
2) v_1 - ?
3) v_2 - ?



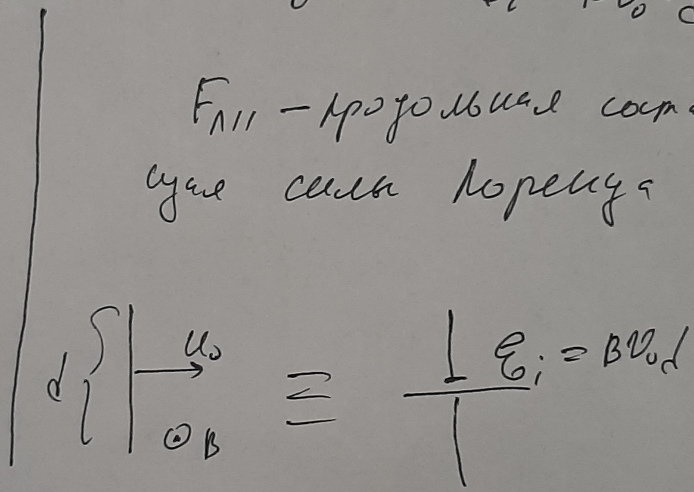
1) Нулевой момент времени



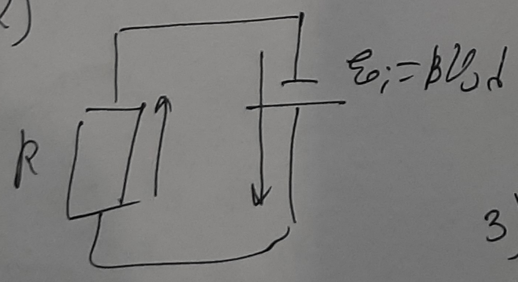
Из-за движения проводника в МП на его концах возникает $\mathcal{E}_i = B v_0 \cdot d$



$F_{Л\parallel}$ — продольная составляющая силы Лоренца

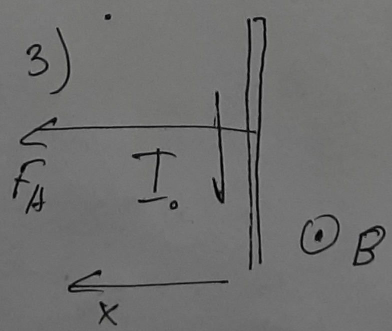


2)



$$I_0 = \frac{\mathcal{E}_i}{R} = \frac{B v_0 d}{R}$$

3)



$\cancel{F_A = B}$

$$F_A = B I_0 d$$

по 2ЗН: $\vec{F_A} = m\vec{a}$

$$F_A = m a_0$$

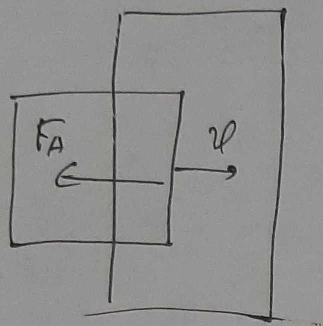
$$\frac{B^2 v_0 d^2}{R} = m a_0 \qquad \boxed{a_0 = \frac{B^2 v_0 d^2}{mR}}$$

5

(чистовик)

4) Рассмотрим вход рамки, до того момента, как она не зашла полностью

$$v = \frac{dS}{dt}$$



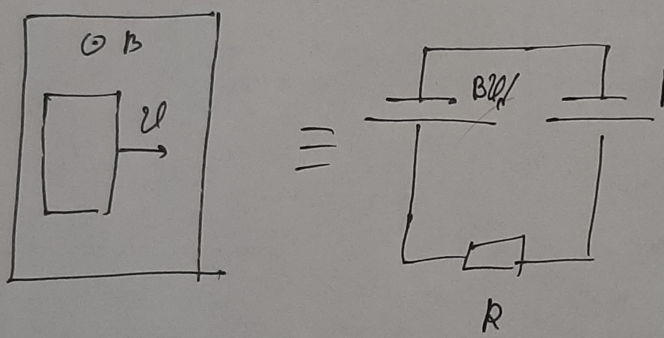
$$F_A = ma \qquad \frac{B^2d^2}{R}v = ma \qquad a = -\frac{dv}{dt}$$

$$\frac{B^2d^2}{R}\cdot\frac{dS}{dt} = -m\frac{dv}{dt}$$

$$\frac{B^2d^2}{mR}\cdot\int_0^{d} dS = -\int_{v_0}^{v^*} dv$$

$$\frac{B^2d^2}{mR}\cdot\frac{d}{4} = -(v^* - v_0) \qquad \frac{B^2d^3}{4mR} = v_0 - v^* \qquad v^* = v_0 - \frac{B^2d^3}{4mR}$$

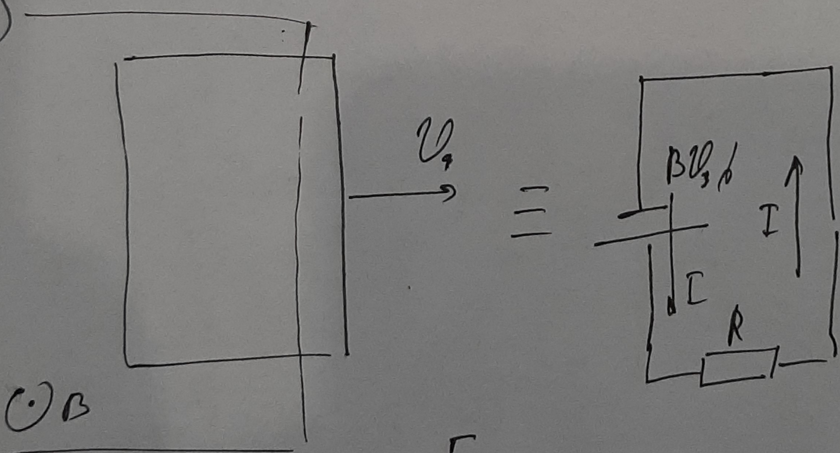
5)



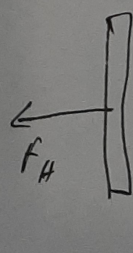
$$I = 0 \Rightarrow F_A = 0 \Rightarrow$$

$$v_1 = v^* = v_0 - \frac{B^2d^3}{4mR}$$

6)



$$I = \frac{Bv_1d}{R}$$



$$F_A = \frac{B^2d^2v_1}{R}$$

$$F_A = ma$$

$$\frac{B^2d^2}{R}\cdot\frac{dS}{dt} = \cancel{m}\cdot\left(-\frac{dv}{dt}\right)$$

$\longrightarrow$

чистовик

$$\frac{B^2 d^2}{mR}\cdot\int_0^{d} dS = -\int_{v_1}^{v_2} dv \qquad \frac{B^2 d^3}{4Rm} = -(v_2 - v_1)$$

$$v_2 = v_1 - \frac{B^2 d^3}{4Rm}$$

$$v_2 = v_0 - \frac{B^2 d^3}{2mR}$$

Ответ:

1) $a_0 = \frac{B^2 d^2}{mR} v_0$

2) $v_1 = v_0 - \frac{B^2 d^3}{4mR}$

3) $v_2 = v_0 - \frac{B^2 d^3}{2mR}$

Дано:

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

$F_1 = 25$ см

---

1) x

2) D - ?

№5 (Чистовик)

1) Ни с какого расстояния человек не может прочитать текст без очков, т.к. человек очень близорукий с критическим уровнем предела аккомодации $X=0$

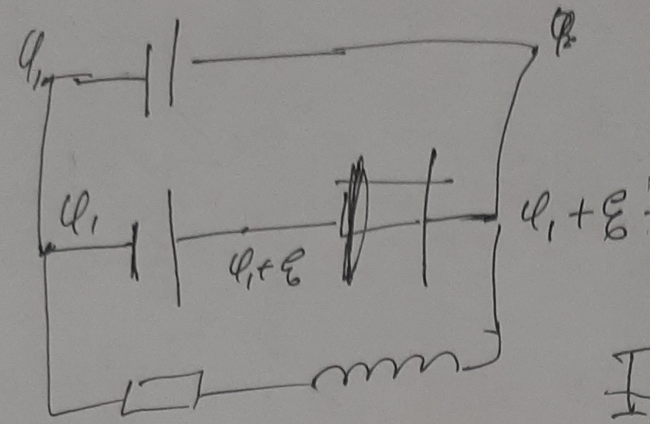
2) $D_1 = \frac{1}{F_1} = \frac{1}{0,25} = 4$ дптр.

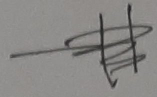
3) $D = 2D_1 = 8$ дптр.

Ответ: 1) $X=0$

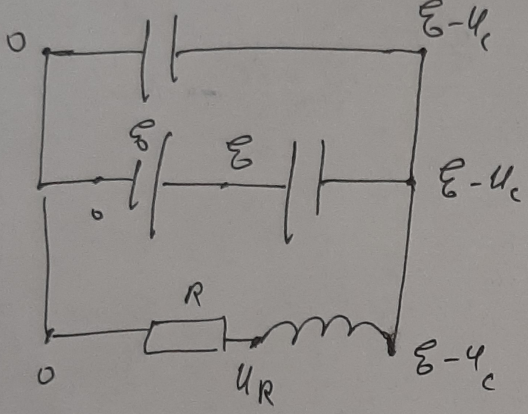
2) $D = 8$ дптр

8





$$I_{C_2}(t)=\frac{dU_1}{dt}$$

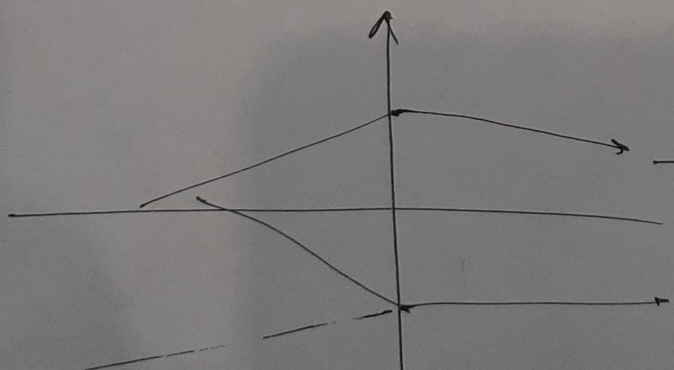


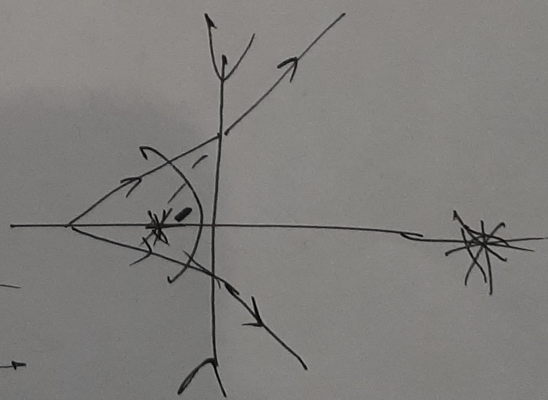
$$I_{C_2}=\frac{dU_2}{dt}\,3C$$

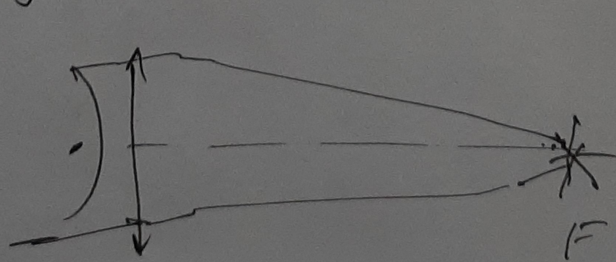
$$I_{C_1}=\frac{dU_1}{dt}\cdot C$$

$$I_{C_1}=I_{C_2}+I_L$$

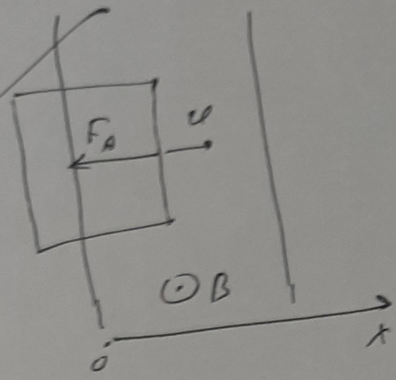
$$I_C=I_{C_1}+$$







4) Рассмотрим рамку пока только одна верт. часть в МП.



$$F_{A_x} = ma \qquad \frac{B^2 d^2}{R} v_x = m a_x$$

$$v_x = \frac{dx}{dt} \qquad a_x = \frac{dv_x}{dt}$$

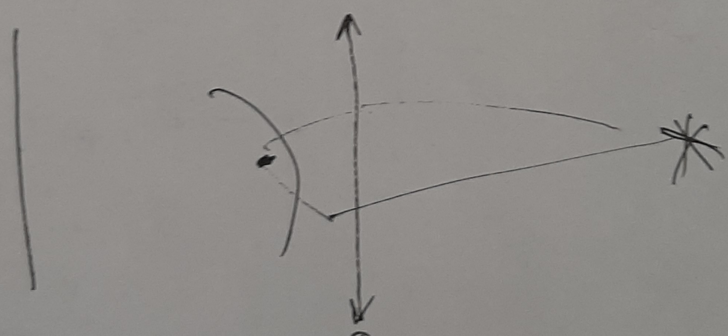
$$\frac{B^2 d^2}{R} \cdot \int_0^b dx = m \cdot \int_{v_0}^{v^*} dv_x$$

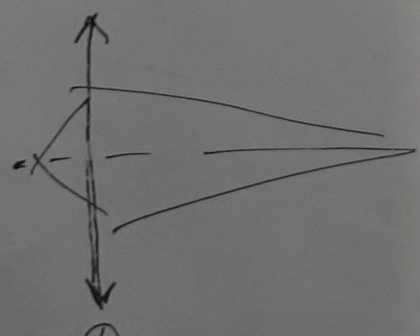
$$\frac{B^2 d^2}{R} \cdot \frac{d}{4} = m\,(v^* - v_0) \qquad \frac{B^2 d^3}{4R} = m v^* - m v_0$$

$$\frac{B^2 d^3}{4mR} + v_0 = v^*$$

---

4)





21200405 (U849339 M1269673)

(Черновик)

№3

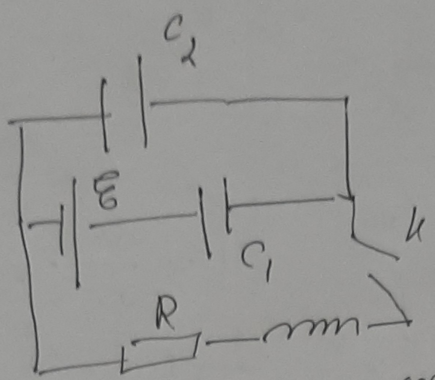
$C_1 = C$

$C_2 = 3C$

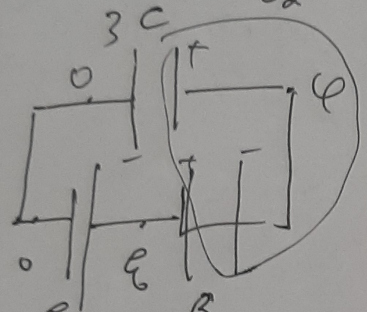
1) $I'_L(0)$

2) $Q - ?$

3) $U_R - ?$



1) Рассмотрим фрагмент цепи до замыкания ключа. $I_{C_2} = I_{C_1} = 0$. Уст режим при —/—

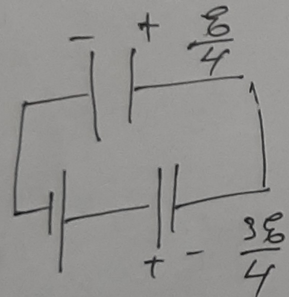


ЗСЗ:

$$\varphi \cdot 3C - (\varphi + \mathcal{E})C = 0$$

$$3C\varphi - (\mathcal{E} - \varphi)C = 0$$

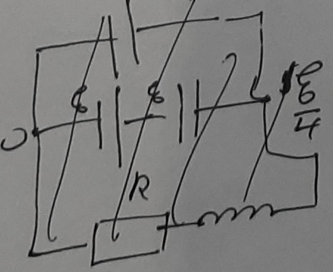
$$3\varphi = (\mathcal{E} - \varphi) \quad 4\varphi = \mathcal{E} \quad \varphi = \frac{\mathcal{E}}{4}$$

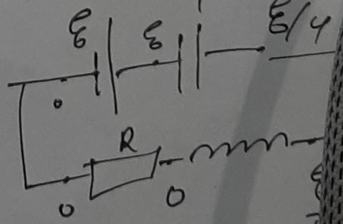


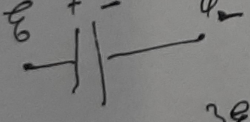
$$W(0) = \frac{3C\left(\frac{\mathcal{E}}{4}\right)^2}{2} + \frac{C\left(\frac{3\mathcal{E}}{4}\right)^2}{2} =$$

$$= \frac{3C \cdot \mathcal{E}^2}{32} + \frac{9C\mathcal{E}^2}{32} = \frac{12C\mathcal{E}^2}{32} = \frac{3C\mathcal{E}^2}{8}$$

2) $I_L(0) = 0$





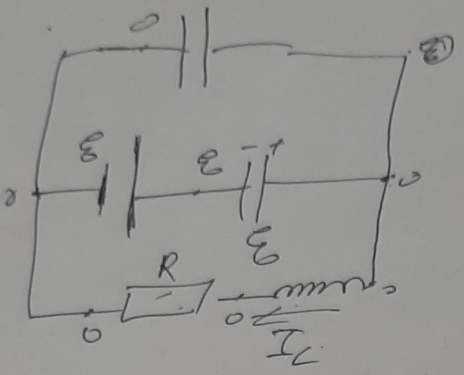


$$\varphi_+ - \varphi_- = \frac{3\mathcal{E}}{4}$$

$$\mathcal{E} - \varphi_- = \frac{3\mathcal{E}}{4} \quad \frac{\mathcal{E}}{4}$$

$$U_L = I'_L \cdot L \quad I'_L(0) = \frac{\mathcal{E}}{4L}$$

3) Уст. режим:

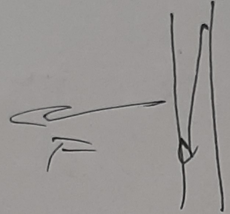


$$I = \frac{dq}{dt} \cdot x$$

$$I\int_0^{t} dt = 3c\int_0^{q} dq$$

$$\mathcal{E}_i = B v l.$$

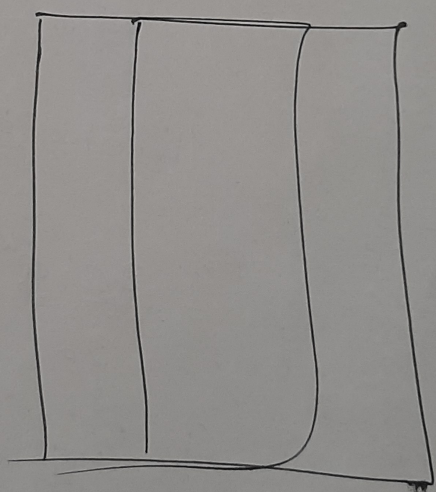
$$\cancel{ma_0 = \frac{B v_0 d}{R}}$$

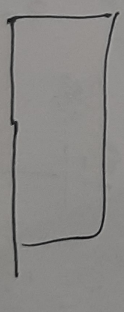


$$I = \frac{B v_0 d}{R}$$

$$m a_0 = \frac{B v_0 d}{R} \cdot B d$$

$$a_0 = \frac{B^2 d^2 v_0}{m R}$$





чистовик

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Ответ:

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