Часть 1

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

Шифр: **21201487**

ID профиля: **168144**

Вариант 4

№ 2. Чистовик.

$C(T) = \frac{9}{5}R \cdot \frac{T}{T_0}$;

$$Q_x = \int_{T_0}^{\frac{3}{4}T_0} C(T) \cdot \nu \cdot dT = \int_{T_0}^{\frac{3}{4}T_0} \frac{9}{5}R \cdot \frac{T}{T_0} \nu\, dT = \frac{9 \cdot R \cdot \nu}{T_0 \cdot 5} \int_{T_0}^{\frac{3}{4}T_0} T\, dT = \frac{9}{10} \frac{\nu R}{T_0} \int_{T_0}^{\frac{3}{4}T_0} T^2$$

$$= \frac{9}{10} \frac{\nu R}{T_0} \cdot \left(\frac{9}{16} T_0^2 - T_0^2 \right) = -\frac{7}{16} T_0^{\not 2} \cdot \frac{9}{10} \frac{\nu R}{\not T_0} = -\frac{63}{160} \nu R T_0$$

$$Q_1 = -Q_x = \frac{63}{160} \nu R T_0$$

$dQ = pdV + \frac{3}{2}\nu R dT$

$$\int_V pdV = \int_T dQ - \int_T \frac{3}{2}\nu R dT; \quad A = \int_{T_0}^{T_x} \frac{9}{5}R \cdot \frac{T}{T_0} \cdot \nu\, dT - \int_{T_0}^{T_x} \frac{3}{2}\nu R\, dT$$

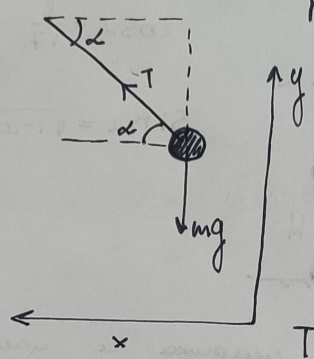
$$A = \frac{9}{5} \frac{\nu R}{T_0} \int_{T_0}^{T_x} T\, dT - \int_{T_0}^{T_x} \frac{3}{2}\nu R dT = \frac{9}{10} \frac{\nu R}{T_0} \Big|_{T_0}^{T_x} T^2 - \frac{3}{2}\nu R \Big|_{T_0}^{T_x} T$$

$= \frac{9}{10} \frac{\nu R}{T_0} (T_x^2 - T_0^2) - \frac{3}{2}\nu R (T_x - T_0)$; Возьмём производную по δT_x

$$0 = \frac{9}{10} \frac{\nu R}{T_0} \cdot 2T_x - \frac{3}{2}\nu R; \quad \frac{3}{2} = \frac{9}{5} \cdot \frac{T_x}{T_0} \Rightarrow \underline{T_x = \frac{15}{18} T_0}$$

$$A = \frac{9}{10} \frac{\nu R}{T_0} \left(\left(\frac{15}{18} T_0 \right)^2 - T_0^2 \right) - \frac{3}{2}\nu R \left(\frac{15}{18} T_0 - T_0 \right) = \underline{-\frac{\nu R T_0}{40}}$$

2)



2ой з-н Ньютона на ось x:

$ma_x' = T\cdot\cos\alpha$

1) $m\cdot\frac{9}{17}a_0 = T\cdot\cos\alpha = T\cdot\frac{8}{17}$

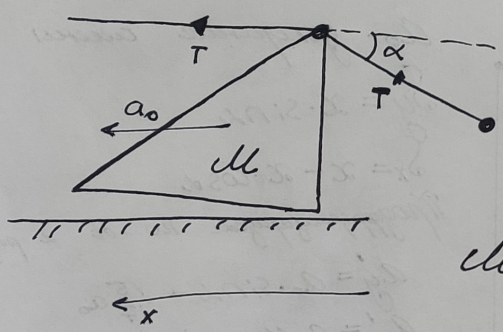
2ой з-н Ньютона на ось y

$ma_y' = mg - T\cdot\sin\alpha$

2) $m\cdot\frac{15}{17}a_0 = mg - T\cdot\sin\alpha = mg - \frac{15}{17}T$

$T = \frac{9ma_0}{8}$; $\frac{15}{17}ma_0 = mg - \frac{15}{17}\cdot\frac{9ma_0}{8}$

$\frac{15}{17}a_0\left(1+\frac{9}{8}\right) = g \Rightarrow a_0 = \frac{8}{15}g$



2ой з-н Ньютона на ось x:

$Ma_0 = T - T\cos\alpha$

$Ma_0 = T(1-\cos\alpha) = T\cdot\frac{9}{17}$

$M\cdot\frac{8}{15}g = T\cdot\frac{9}{17}$

$m\cdot\frac{9}{17}\cdot\frac{8}{15}g = T\cdot\frac{8}{17} \Rightarrow T = \frac{9}{15}mg$

$M\cdot\frac{8}{15}g = \frac{9}{15}mg\cdot\frac{9}{17}$

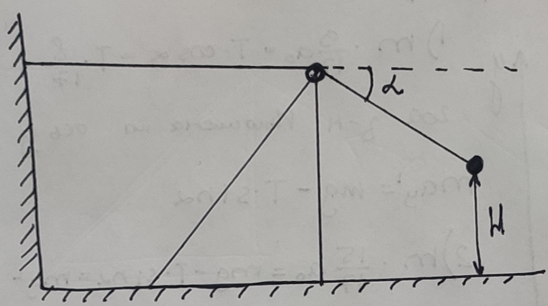
$8\cdot M = \frac{81}{17}m$; $\frac{m}{M} = \frac{17\cdot 8}{81} = \frac{136}{81}$

$H = \frac{a_y'\cdot t^2}{2} = \frac{15}{17}a_0\cdot\frac{t^2}{2} = \frac{15}{17}\cdot\frac{8}{15}g\cdot\frac{t^2}{2} = \frac{4}{17}gt^2$

$t = \sqrt{\frac{17H}{4g}}$

Чистовик. № 1 Вариант 11-04

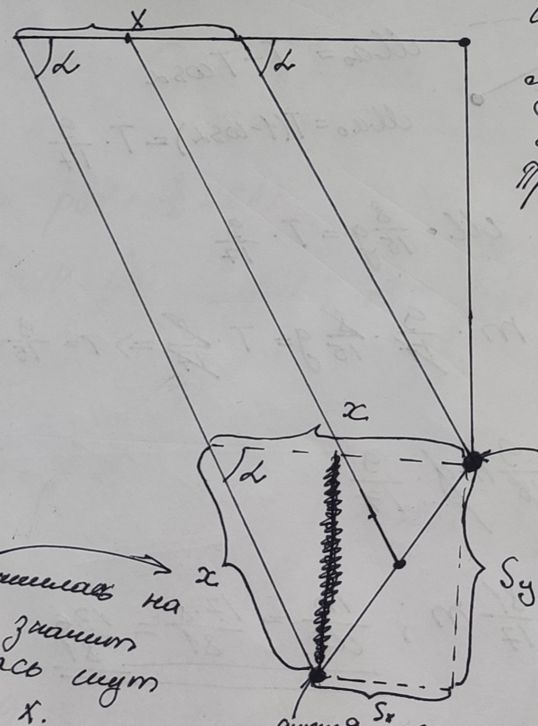
1)



$\cos\alpha = \frac{8}{17}$

$\sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{15}{17}$

Рассмотрим движение шарика и условие неизменности угла.



a_0 - ускорение клина

$S_y = x \cdot \sin\alpha$

$S_x = x - x \cdot \cos\alpha$

Продифференцируем по dt 2 раза.

$a_y' = a_0 \cdot \sin\alpha = \frac{15}{17} a_0$

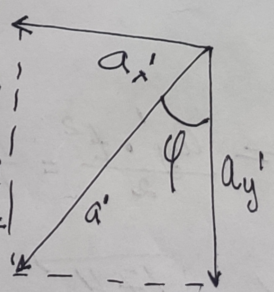
$a_x' = a_0(1-\cos\alpha) = \frac{9}{17} a_0$

начальное положение

Нить сместилась на x сверху, значит сместилась тут на x.

спустя какое-то время

$tg\varphi = \frac{a_x'}{a_y'} = \frac{9}{15} = \frac{3}{5}$



Часть 2

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

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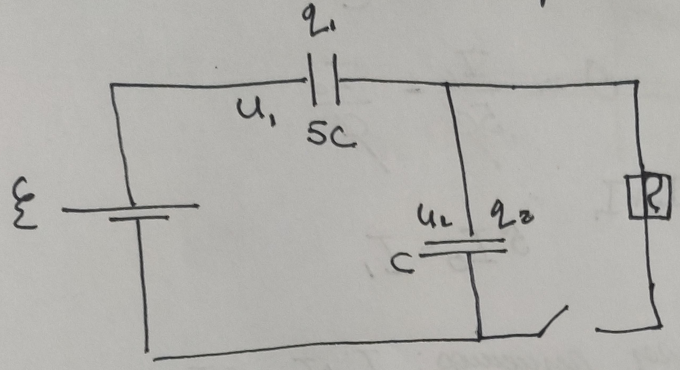
Вариант 4

Часть II. №3. Вариант 11-04.

ЗСЗ: $q_1 = q_2 = q$



В уст. режиме ток через конд. не идёт

$$\frac{q}{5C} + \frac{q}{C} = \mathcal{E}$$

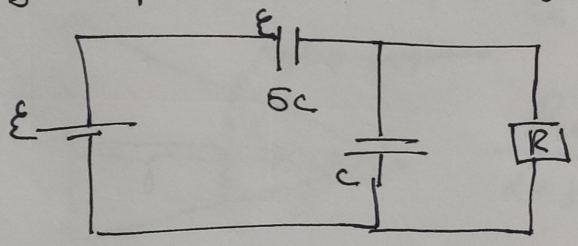
$$\frac{6q}{5C} = \mathcal{E} \Rightarrow q = \frac{5C\mathcal{E}}{6}$$

$$U_1 = \frac{5\mathcal{E}}{6}; \quad U_2 = \frac{5\mathcal{E}}{6};$$

Когда ключ замкнется: $U_2 = I_x R$ (в нач. момент)

$$I_x = \frac{U_2}{R} = \frac{5\mathcal{E}}{6R}$$

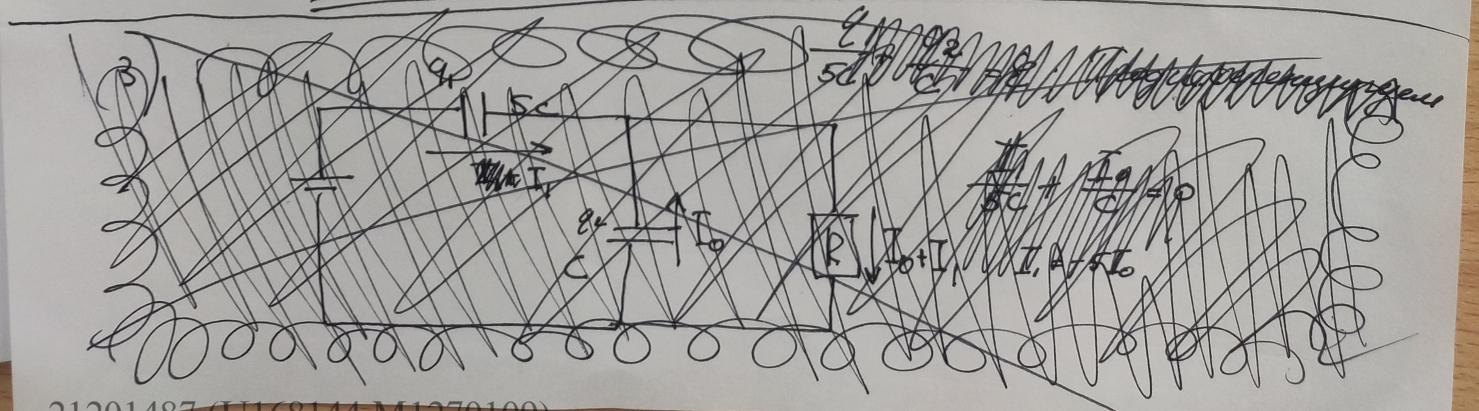
2) В уст. режиме после замыкания



$$\mathcal{E}\left(5C \cdot \mathcal{E} - 5C \cdot \frac{\mathcal{E}}{6}\right) + \frac{q^2}{2 \cdot 5C} + \frac{q^2}{2 \cdot C} = Q + \frac{5C\mathcal{E}^2}{2}$$

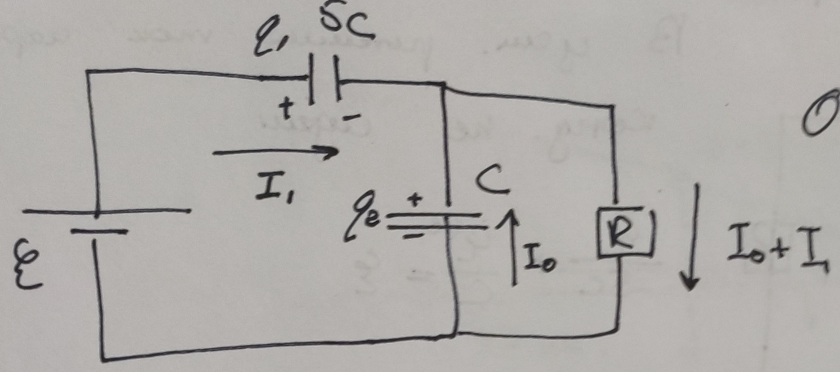
$$5C\mathcal{E}^2 - \frac{5}{6}C\mathcal{E}^2 + \frac{5}{72}C\mathcal{E}^2 + \frac{25}{72}C\mathcal{E}^2 = Q + \frac{5}{2}C\mathcal{E}^2$$

$$Q = \frac{150}{72}C\mathcal{E}^2 = \frac{25}{12}C\mathcal{E}^2$$



№3 - продолжение. Исаичкин

3)



$$\mathcal{E} = \frac{q_1}{5C} + \frac{q_2}{C}$$

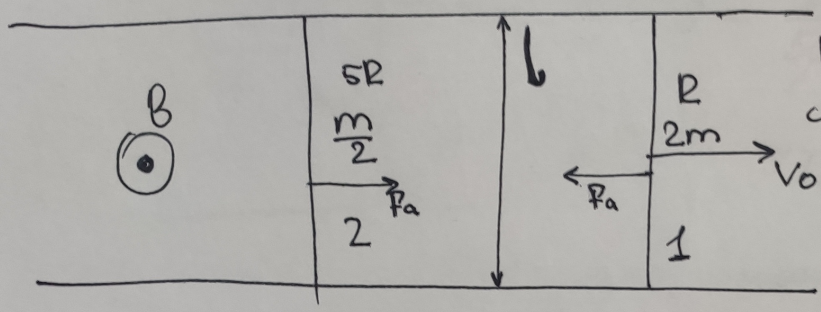
$$0 = \frac{I_1}{5C} - \frac{I_0}{C}$$

$$5I_0 = I_1$$

Ток через резистор: $I_0 + I_1 = 6I_0$

№4. Чесноков.

$$\mathcal{E}_i = \frac{d\Phi}{dt} = \frac{B \cdot dS}{dt} = \underline{B \cdot L \cdot V_{отн}}$$

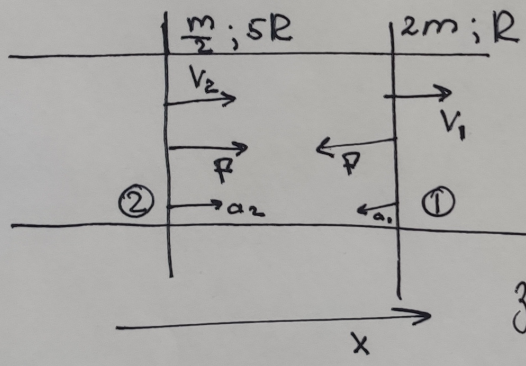


В начальный момент скорость у 2ой перемычки = 0, поэтому $V_{отн} = V_0$

$$\mathcal{E}_i = BL \cdot V_0$$

$$I = \frac{\mathcal{E}_i}{R+5R} = \frac{BL \cdot V_0}{6R}$$

$$2m\,a_0 = I \cdot BL \Rightarrow a_0 = \frac{IBL}{2m} = \boxed{\frac{(BL)^2 \cdot V_0}{12mR}}$$



На 1 и 2 перемычку действуют силы F в разные стороны, других сил нет, поэтому мы можем записать ЗСИ на ось x:

$$2mV_0 = 2mV_1 + \frac{m}{2}V_2$$

$$\underline{4V_0 = 4V_1 + V_2}$$

Когда пройдет большое кол-во времени $\mathcal{E}_i = 0$; $V_{отн} = 0$.

Значит $\boxed{V_1' = V_2' = \frac{4}{5}V_0}$

$$\Delta V_1 = -\frac{1}{5}V_0; \quad \Delta V_2 = \frac{4}{5}V_0$$

$$a_1 = \frac{(BL)^2 \cdot (V_1 - V_2)}{12mR} = \frac{(BL)^2 (5V_1 - 4V_0)}{12mR}; \quad a_0\,dt = dV; \quad V \cdot dt = dS; \quad t_x \to \infty$$

$$\Delta V_1 = \frac{(BL)^2}{12mR} \cdot 5S_1 - \frac{(BL)^3}{3mR} \cdot V_0 t_x$$

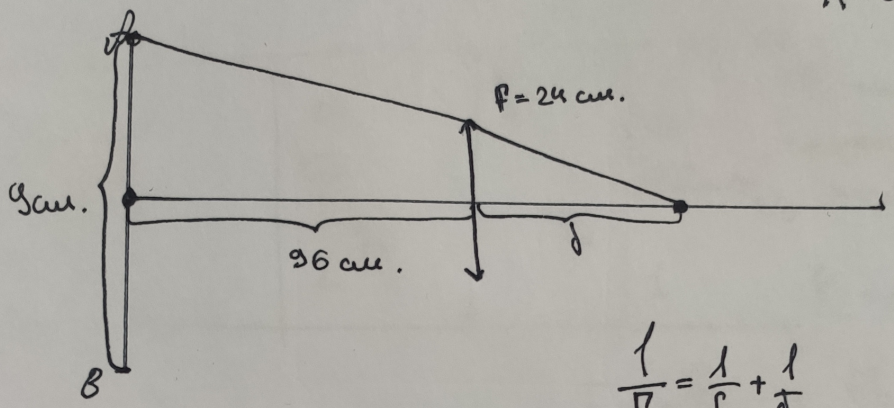
$$a_2 = \frac{(BL)^2 (V_1 - V_2)}{3mR} = \frac{(BL)^2 (V_0 - \frac{5}{4}V_2)}{3mR}; \quad \Delta V_2 = \frac{(BL)^2}{3mR} \cdot V_0 t_x - \frac{5}{12}\frac{(BL)^2}{mR} \cdot S_2$$

$$\Delta V_2 + \Delta V_1 = \frac{5}{12}\frac{(BL)^2}{mR}(S_1 - S_2); \quad S_1 - S_2 = \frac{12mR(\Delta V_2 + \Delta V_1)}{5(BL)^2} = \boxed{\frac{36mR}{25(BL)^2}}$$

№4. Чертёж.

Чертёж.

№5. $X = 24$ см.



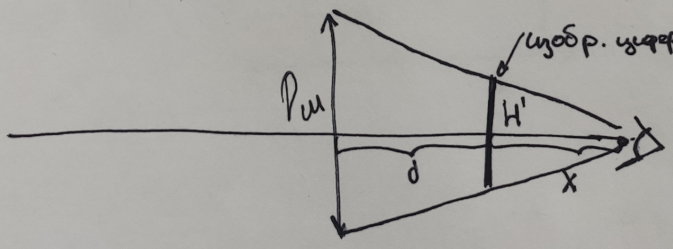
$$\frac{1}{F} = \frac{1}{f} + \frac{1}{d}$$

$$\frac{1}{24} = \frac{1}{96} + \frac{1}{d}; \quad \underline{d = 32 \text{ см}}$$

На рассм. d находится изображение часов, экраном глаз находится на расстоянии $\underline{d + X = 56 \text{ см}}$;

(d − X) не подходит, т.к. он не увидит изобр. в этом случае

$$\Gamma = \frac{32}{96} = \frac{1}{3}; \quad H' = \frac{1}{3} \cdot 9 = 3 \text{ см}$$

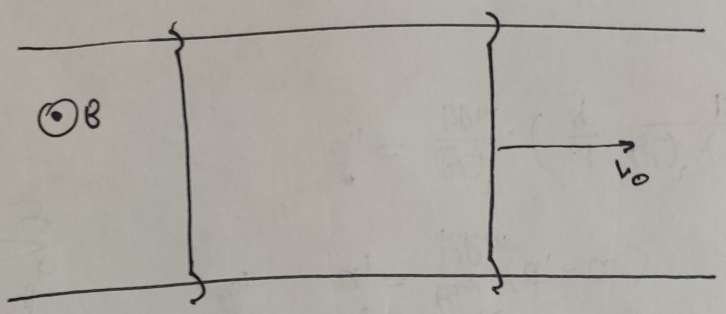


$$\frac{P_{см}}{d + X} = \frac{H'}{X}$$

$$P_м = H' \cdot \frac{d + X}{X} = 3 \cdot \frac{56}{24} = \underline{7 \text{см}}$$

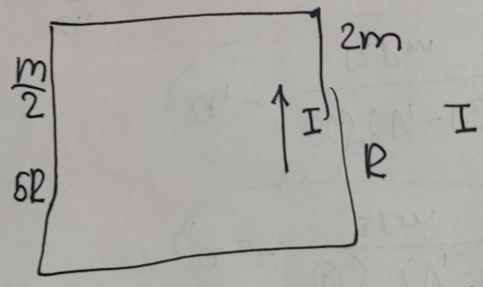
3)

№4. Чертежик.



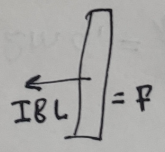
$$\mathcal{E}_i = \frac{B \cdot dS}{dt}$$

$$\mathcal{E}_i = B \cdot L \cdot V_{отн}$$



$$I \cdot 6R = Bl\, V_{отн.}$$

$$I \cdot 6R = BL \cdot V_{отн}$$

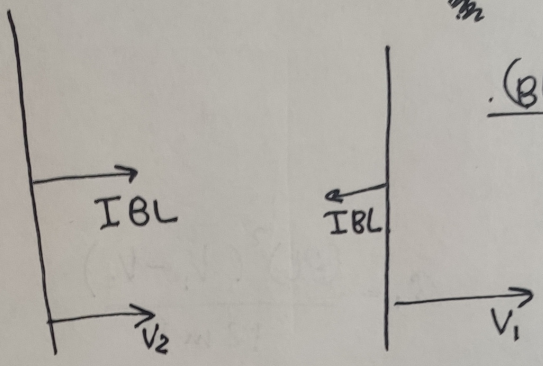


$$ma = \qquad v_2 =$$

$$\frac{m}{2} \cdot a_2 = IBL$$

$$a_1 = \frac{(BL)^2 (v_1 - v_2)}{12 \omega R}$$

Чертёжик



$\frac{(BL)^2(V_1-V_2)}{6R}$

$\frac{BLV_{отн}}{6R} = I \quad U_2 = IR \quad \frac{5e}{6R}$

P. $2m\frac{V_0^2}{2} = \left(\frac{m}{2}+2m\right)\frac{V_x^2}{2}$

$2V_0^2 = 2{,}5V_x^2$

$V_x = \frac{2}{2{,}5} = \frac{4}{5}V_0^2$

$V_x = \frac{2}{\sqrt{5}}V_0$

$a_2 \quad a_1$

$2m a_1 = \frac{(BL)^2 \cdot V_{отн}}{6R}$

$\frac{150}{72} = \frac{75}{36} = \frac{25}{12}$

$\frac{m}{2} a_2 = \frac{(BL)^2 \cdot V_{отн}}{6R}$

$a_2 = \frac{(BL)^2 \cdot (V_1-V_2)}{3Rm}$ (4

$a_1 = \frac{(BL)^2(V_1-V_2)\cdot}{12Rm}$

a_1

$4V_0 = 5V_1$

$a_1 = \frac{(BL)^2}{12Rm}(a_1 - a_2)$

$a_1 = \frac{(BL)^2}{12Rm} \cdot \left(\frac{1}{4}\frac{(BL)^2 \cdot (V_1-V_2)}{12Rm}\right)$

$2mV_0 = 2{,}5mV_x$

$\frac{360}{72} - \frac{60}{72} + 5+25$ $\frac{C \cdot 25\mathcal{E}^2}{72}$

390

$360 - 60 + 30 - 180$

$\frac{5C \cdot \mathcal{E}^2}{72}$

$\frac{5C \cdot \mathcal{E}^2}{72}$

$\mathcal{E}^2$

$\frac{25C^2\mathcal{E}^2}{360}$

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

$q = \frac{5}{6}C\mathcal{E}$

$\mathcal{E} = U_1 + U_2$

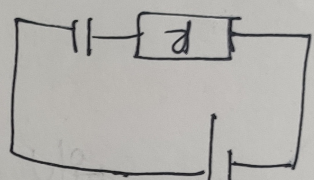
$IR = U_2$

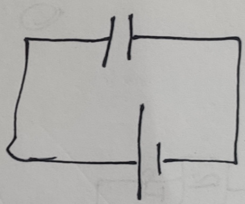
$\mathcal{E} q = \frac{CU^2}{2}$

$\mathcal{E} \cdot q = \frac{CU^2}{2} + Q$

$\mathcal{E} \cdot C\mathcal{E}$

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





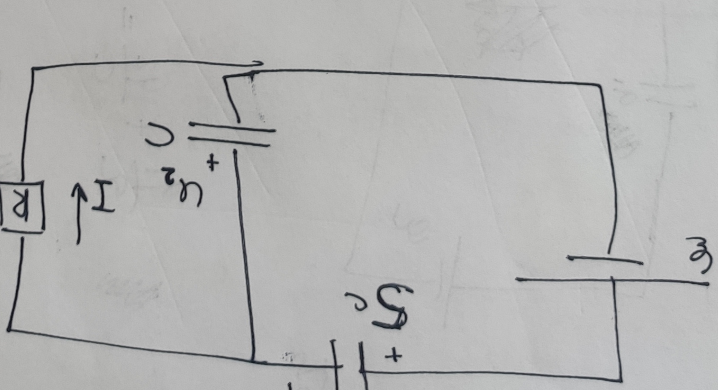
$\mathcal{E}(5C\mathcal{E} - 5C \cdot \frac{\mathcal{E}}{6})$

$\mathcal{E}(5C\mathcal{E} - 5C \cdot \frac{\mathcal{E}}{6})$

$\frac{5C}{2} \cdot \frac{\mathcal{E}^2}{36} = \frac{5C\mathcal{E}^2}{72}$

$\frac{C \cdot 25\mathcal{E}}{36}$

$\frac{5C \cdot \mathcal{E}^2}{2}$

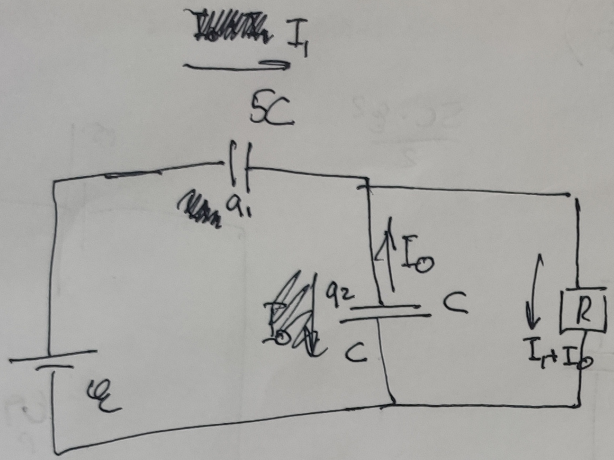


Черновик.

21201487 (U168144 M1270109)

$\frac{V_1}{2} V_1 + 2m V_2 = 2m V_0$

I_1



$\mathcal{E} =$

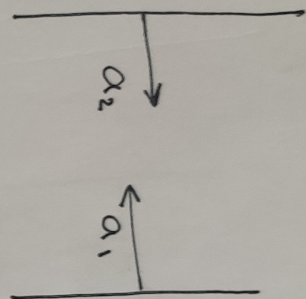
$I_1 + 5I_0 = 0$

$I_1 = -5I_0$

$\mathcal{E} = U_1 + U_2$

$\mathcal{E} = \frac{q_1}{5C} + \frac{q_2}{C}$

$0 = \frac{I_0 + I_1}{5C} + \frac{I_0}{C}$



Шарики

$I_1 = -5I_0$

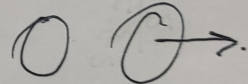
$\frac{q_1}{5C} + \frac{q_2}{C} = \mathcal{E}$

$I_0 + I_1 + 5I_0 = 0$

$6I_0 = -I_1$

$I_1 = -6I_0$

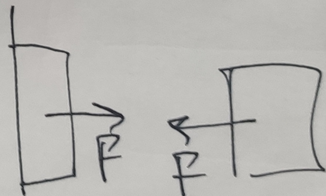
$V_1 + 4V_2 = 4V_0$



$\frac{I_1}{5C} - \frac{I_0}{C} = 0$

$5I_0 = I_1$

$V_1 = 4V_0 - 4V_2$



$V_2 - 4V_0 - 4V_1$

$a_1 = \frac{(BL)^2}{12mR}(5V_1 - 4V_0)$

$a_1 dt = dV_1$

$dV_1 = \frac{(BL)^2}{12mR}(5dS_1 - 4V_0 dt)$

$V_{отн} = V_1 - V_2 = 5V_1 - 4V_0$

$V_2 - V_1$

$V_2 - 4V_0 + 4V_2$

$5V_2 - 4V_0$