Часть 1

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

Шифр: **21202955**

ID профиля: **379356**

Вариант 4

Клин: Решение ②

$Oy: N - mg - T\sin\left(90 - \frac{\alpha}{2}\right) = 0$, $T = \sqrt{2}\, T_1 \sqrt{1 - \cos\alpha}$

$Ox: T\cos\left(90 - \frac{\alpha}{2}\right) = M a_{кл}$

шар:

$Oy:$ ~~$T_1 \sin\alpha - mg$~~ $mg - T_1 \sin\alpha = m a_ш \cos\frac{\alpha}{2}$

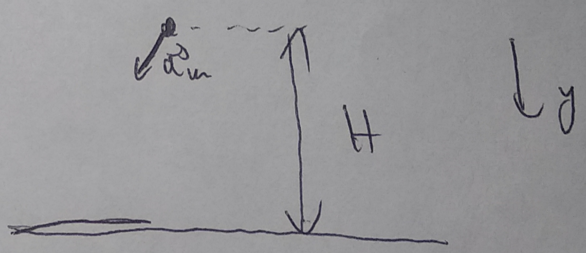
$Ox: T_1 \cos\alpha = m a_ш \sin\frac{\alpha}{2}$

Отсюда можно найти $a_{кл}$; $\frac{M}{m}$;

~~[illegible]~~ Рассмотрим шар

$Oy:$

$$H = \frac{a_{шy} \tau^2}{2}$$



$$a_{шy} = a_ш \cdot \cos\frac{\alpha}{2}$$

$$H = \frac{a_ш \tau^2 \cos\frac{\alpha}{2}}{2}$$

$$\tau^2 = \frac{2H}{a_ш \cos\frac{\alpha}{2}}$$

$$\tau = \sqrt{\frac{2H}{a_ш \cos\frac{\alpha}{2}}}$$

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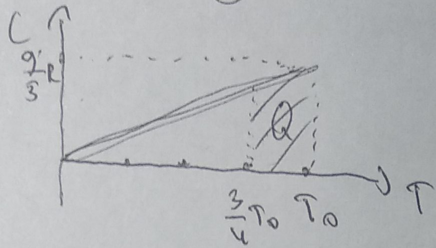
Дано:
ν; T_0;
$C(T) = \frac{9}{5} R \frac{T}{T_0}$;
Q_1 – ?
T_1 – ?
A_m – ?

Чистовик. (3)



Из опред-ия теплоемкости следует, что Q можно посчитать как площадь под графиком $C(T)$ умноженную на ν

$$Q_1 = -Q_1' = -\nu\left(\frac{3}{4}T_0 - T_0\right)\frac{\left(\frac{9}{5}R\frac{T_0}{T_0} + \frac{9}{5}R\cdot\frac{3}{4}\frac{T_0}{T_0}\right)}{2} =$$

$$Q_1 = \frac{63}{160}\nu R T_0$$ – Ответ 1

$$Q_2 = \Delta U + A_{min}; \quad A_{min} = Q_2 - \Delta U = \frac{\nu(T_1 - T_0)\left(\frac{9}{5}R\frac{T_0}{T_0} + \frac{9}{5}R\frac{T_1}{T_0}\right)}{2} - \frac{3}{2}\nu R(T_1 - T_0)$$

Возьмем производную от A и найдем так минимум

$$A_{min}'(T) = \left(\frac{\nu(T_1 - T_0)\left(\frac{9}{5}R\frac{T_0}{T_0} + \frac{9}{5}R\frac{T_1}{T_0}\right)}{2} - \frac{3}{2}\nu R(T_1 - T_0)\right)' = 0$$

Решив это получим $T_1 = \frac{5}{6}T_0$ – Ответ 2

и подставим в выражение для A_{min}

$$A_{min} = -\frac{\nu R T_0}{40}$$ – Ответ 3

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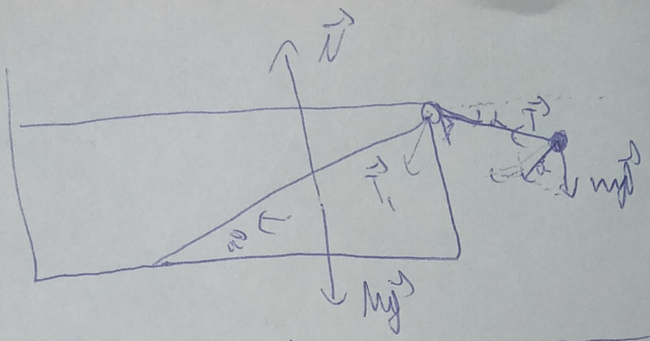
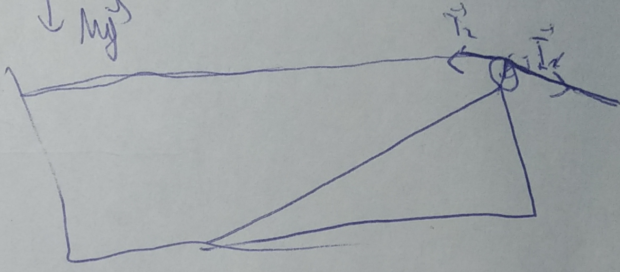
L, H;

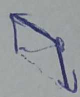
L_a - ?

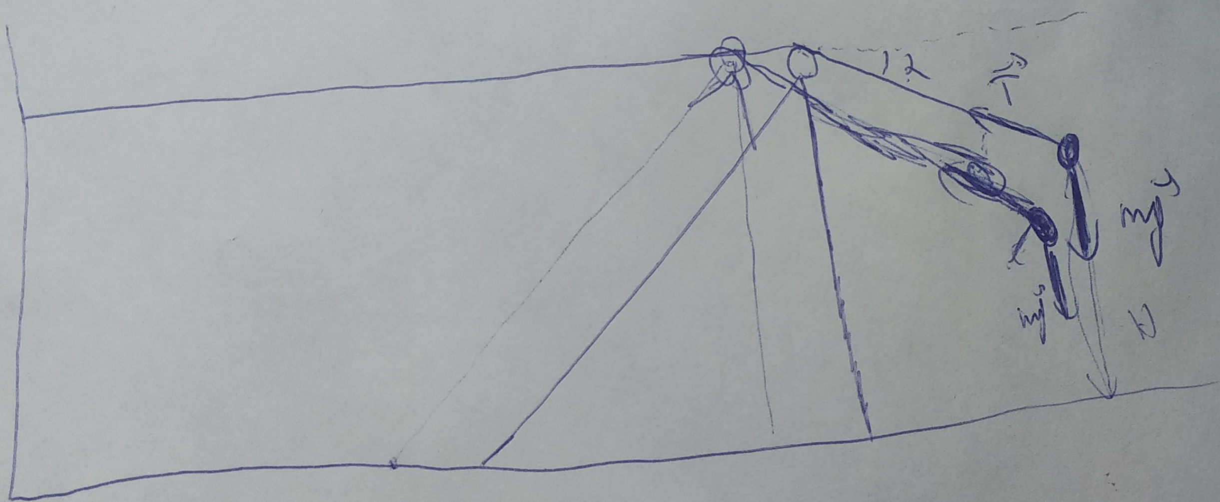
a_n - ?

T - ?









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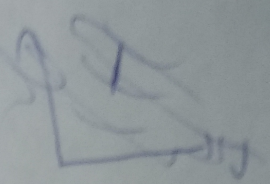
$\frac{9(T_0 - T_1)}{5T_0} = \frac{\frac{9}{5}(T_0 + T_1)}{T_0} + \frac{15T_0}{5T_0}$

$9T_0 - 9T_1 = 9T_0 + 9T_1 + 15T_0$

$18T_1 = -15T_0$

$Q_2 = \Delta U + A_m$

$A_m = Q_2 - \Delta U = \nu(T_0 \ldots)(T_1 - T_0)$



$A_m = \nu(T_1 - T_0)\left(\frac{\frac{9}{5}R\frac{T_0}{T_0} + \frac{9}{5}R\frac{T_1}{T_0}}{2}\right) - \frac{3}{2}\nu R(T_1 - T_0)$

$A = Q_{m} - Q_{m}$

$\frac{1}{2}\nu R(T_1 - T_0)\left(\frac{9}{5} + \frac{9}{5}\frac{T_1}{T_0} - 3\right) = \frac{1}{2}\nu R(T_1 - T_0)\left(\frac{9}{5}\left(1 + \frac{T_1}{T_0}\right) - 3\right)$

$A_m' = \left(\frac{1}{2}\nu R(T_1 - T_0)\left(\frac{9(T_0 + T_1)}{5T_0} - 3\right)\right)' = \frac{1}{2}\nu R\left((T_1 - T_0)' \cdot \frac{9(T_0 + T_1) - 15T_0}{5T_0} + (T_1 - T_0)\left(\frac{9(T_0 + T_1) - 15T_0}{5T_0}\right)'\right)$

$= \frac{1}{2}\nu R\left(\frac{9T_0 + 9T_1 - 15T_0}{5T_0} + (T_1 - T_0)\frac{1}{5T_0}(9T_0 + 9T_1 - 15T_0)'\right) =$

$\frac{1}{2}\nu R\left(\frac{9T_1 - 6T_0}{5T_0} + \frac{(T_1 - T_0)}{5T_0} \cdot 9\right) = 0$

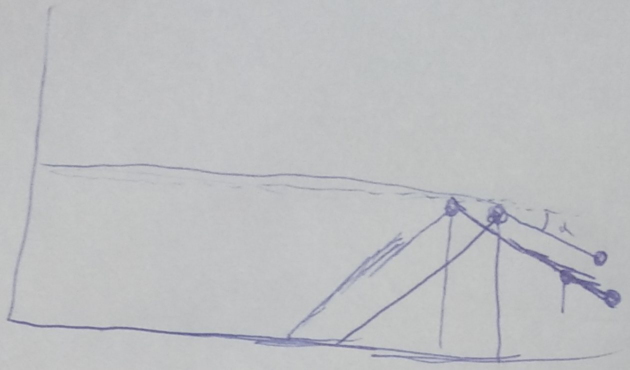
$\frac{9T_1 - 6T_0}{5T_0} + \frac{9T_1 - 9T_0}{5T_0} = 0$

$18T_1 = 15T_0$

$T_1 = \frac{15}{18}T_0 = \frac{5}{6}T_0$

$A_m = \frac{1}{2}\nu R\left(\frac{5}{6}T_0 - T_0\right)\left(\frac{9}{5T_0}\cdot\left(T_0 + \frac{5}{6}T_0\right) - 3\right) = \frac{1}{2}\nu R\left(-\frac{1}{6}T_0\right)\cdot\left(\frac{9}{5T_0}\cdot\frac{11}{6}T_0 - 3\right)$

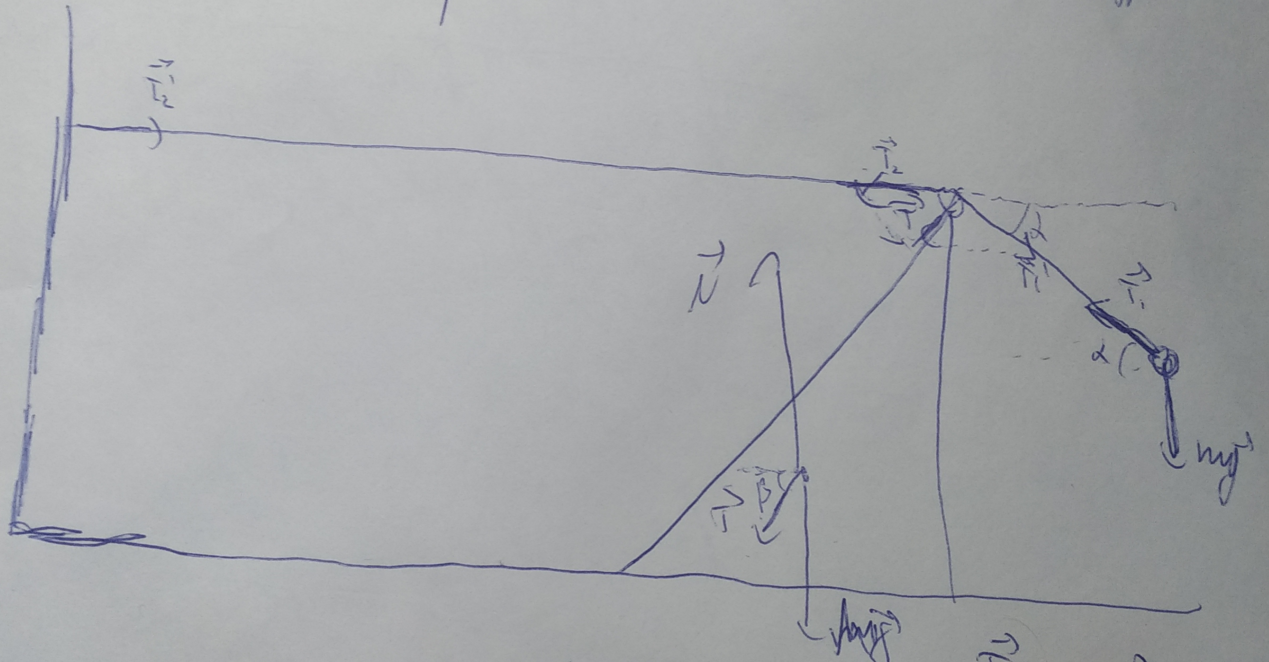
$= -\frac{1}{12}\nu R T_0 \cdot \left(\frac{33}{10} - \frac{30}{10}\right) = -\frac{1}{12}\nu R T_0 \cdot \frac{3}{10} = -\frac{\nu R T_0}{40}$



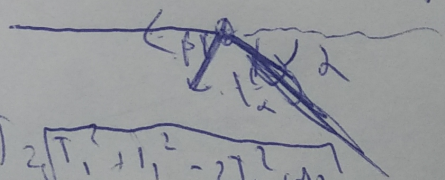
$\cos 2\alpha = \cos^2\alpha - \sin^2\alpha = 2\cos^2\alpha - \cos^2\alpha - \sin^2\alpha$
$= 2\cos^2\alpha - 1$
$\cos\alpha = \sqrt{\frac{1+\cos 2\alpha}{2}}$

$\sqrt{\frac{1+\frac{8}{17}}{2}} = \sqrt{\frac{17+8}{2\cdot 17}} = \sqrt{\frac{25}{34}} = \frac{5}{\sqrt{34}}$

На сколько перемещается клин, настолько же удлиняется правая часть вер-ки



в ИСО кл



$T = \sqrt{T_1^2 + T_1^2 - 2T_1^2\cos\alpha}$

$180 - \alpha - \left(\frac{180-\alpha}{2}\right) =$

$\beta = 180 - \alpha - 90 + \frac{\alpha}{2} = \left(90 - \frac{\alpha}{2}\right)$

$\vec T_1 + m\vec g = m\vec a_1$

$Ox: T_1\cos\alpha = ma_x$

$Oy: mg - T_1\sin\alpha = ma_y$

$\vec N + M\vec g + \vec T = M\vec a_к$

$Oy: N - Mg - T_y = 0$

$Ox: T_x = Ma_к$

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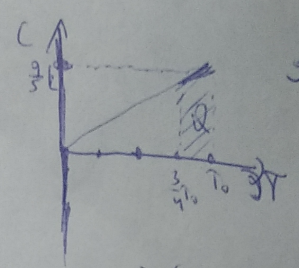
$\nu, T_0,$

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

$C = \frac{Q}{\nu \Delta T}$



$\Sigma\, C(t) \Delta T =$

$\Delta T < 0$, $C > 0$ $\Big\}$ $Q < 0$

$\frac{9}{5} \cdot \frac{3}{4} = \frac{27}{20}$

$$Q_1 = \frac{\nu \left(T_0 - \frac{3}{4} T_0\right) \cdot \left(\frac{9}{5} R \frac{T_0}{T_0} + \frac{9}{5} R \frac{\frac{3}{4} T_0}{T_0}\right)}{2}$$

$$Q_1 = \frac{1}{8} T_0 \cdot \frac{9}{5} R \left(\frac{4}{4} + \frac{3}{4}\right) = \frac{9}{40} T_0 R \frac{7}{4} =$$

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

$Q_2 = \Delta U + A_m$

$$A_m = Q_2 - \Delta U = \frac{\nu (T_0 - T_1)\left(\frac{9}{5} R \frac{T_0}{T_0} + \frac{9}{5} R \frac{T_1}{T_0}\right)}{2} - \frac{3}{2} \nu R (T_1 - T_0)$$

$$A_m = \frac{\nu (T_0 - T_1) \frac{9}{5} R \left(1 + \frac{T_1}{T_0}\right)}{2} + \frac{3}{2} \nu R (T_0 - T_1) =$$

$$A_m = \frac{1}{2} \nu R (T_0 - T_1) \left(\frac{9}{5}\left(1 + \frac{T_1}{T_0}\right) + 3\right) =$$

$$A_m = \frac{1}{2} \nu R (T_0 - T_1) \left(\frac{9}{5} \cdot \frac{T_0 + T_1}{T_0} + 3\right)$$

$$A_m'(T_1) = \left(\frac{1}{2} \nu R (T_0 - T_1)\right)' \left(\frac{9}{5} \cdot \left(\frac{T_0 + T_1}{T_0}\right) + 3\right) + \left(\frac{1}{2} \nu R (T_0 - T_1)\right) \left(\frac{9}{5} \left(\frac{T_0 + T_1}{T_0}\right) + 3\right)' =$$

$$\left(\frac{1}{2} \nu R T_0 - \frac{1}{2} \nu R T_1\right)' \left(\frac{9}{5} \frac{T_0 + T_1}{T_0} + 3\right) + \left(\frac{1}{2} \nu R (T_0 - T_1)\right) \left(\frac{9}{5} + \frac{9}{5 T_0} T_1 + 3\right)' =$$

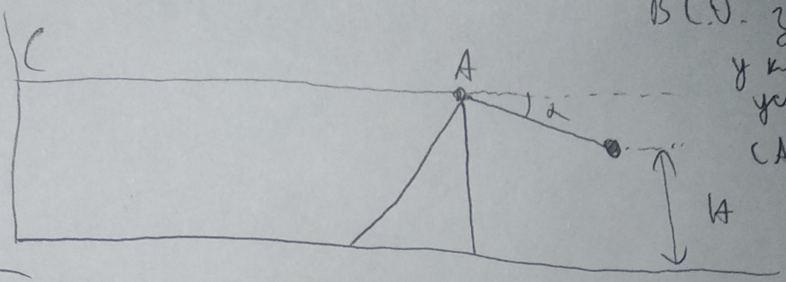
$$= -\frac{1}{2} \nu R \left(\frac{9}{5} \frac{T_0 + T_1}{T_0} + 3\right) + \frac{1}{2} \nu R (T_0 - T_1) \cdot \frac{9}{5 T_0} = 0$$

$$\frac{1}{2} \nu R (T_0 - T_1) \cdot \frac{9}{5 T_0} = \frac{1}{2} \nu R \left(\frac{9}{5} \frac{T_0 + T_1}{T_0} + 3\right)$$

Дано: α; H;

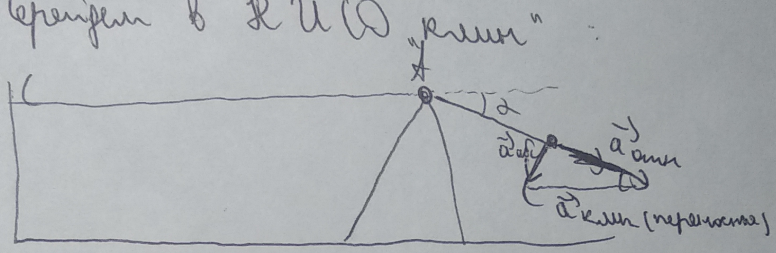
$a_{отн}$ – ?
$a_к$ – ?
$\frac{m}{M}$ – ?
T – ?

Чистовик (1)

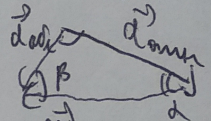


В С.О. Земли у клина есть ускорение, угол CA укорачивается

Перейдем в НИСО „клин“:

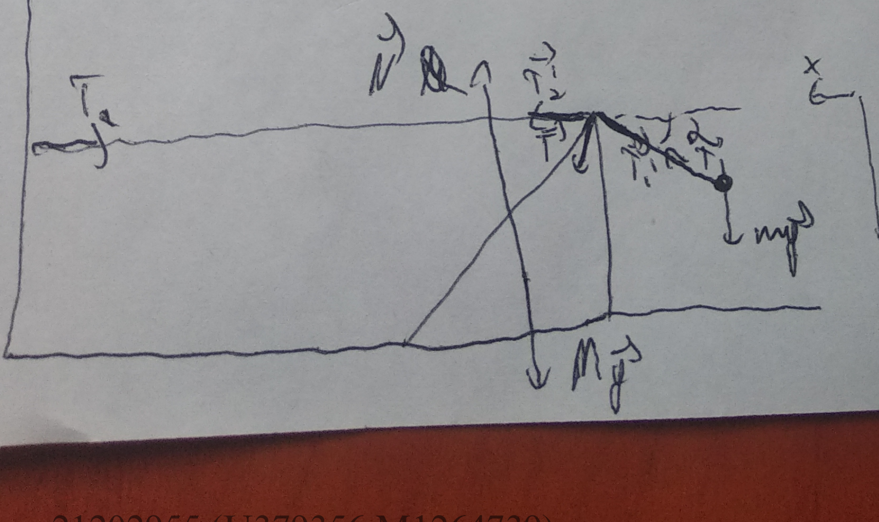


$\vec{a}_{отн}$ (1) т.к. CA укорачивается, а $\alpha = const$, ускорение шара направлено вдоль нити и равно по модулю ускорению клина в С.О. Земли. (иначе нить бы сжалась или порвалась). по З.С.У. $\vec{a}_{абс} = \vec{a}_{отн} + \vec{a}_{перен}$, где $\vec{a}_{перен} = \vec{a}_{кл}$ в С.О. Земли



Δ ускорений равнобедренный (т.к. $a_{отн} = a_{пер}$) а угол при вершине равен α, значит углы при основании равны $\beta = \frac{180 - \alpha}{2} = 90 - \frac{\alpha}{2}$; но один из них является углом между ускорением шара и пов-тью земли. А значит угол между ускорением шара и вертикалью равен $90 - \beta = 90 - 90 + \frac{\alpha}{2} = \frac{\alpha}{2}$

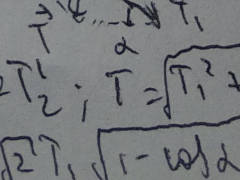
$\cos\frac{\alpha}{2} = \sqrt{\frac{1+\cos\alpha}{2}} = \frac{5}{\sqrt{34}}$ ——— Ответ 1



$\vec{T} + m\vec{g} = m\vec{a}_ш$

$\vec{N} + M\vec{g} + \vec{T}' = M\vec{a}_{кл}$

$\vec{T}' = \vec{T}_1' + \vec{T}_2'$



$T_1' = T_2'$; $T = \sqrt{T_1^2 + T_1^2 - 2T_1T_1\cos\alpha}$

$T = \sqrt{2}T_1\sqrt{1-\cos\alpha}$

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Часть 2

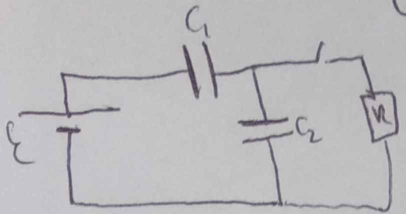
Олимпиада: **Физика, 11 класс (2 часть)**

Шифр: **21202955**

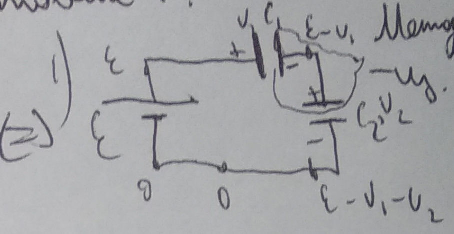
ID профиля: **379356**

Вариант 4

Чистовик 1.



1) (≥)



Метод потенциалов: $-U_2$ одинаковые

$$\begin{cases} \varepsilon - U_1 - U_2 = 0 \\ -C_1 U_1 + C_2 U_2 = 0 \end{cases}$$

$U_2 = \varepsilon - U_1$

$-5CU_1 + C(\varepsilon - U_1) = 0$

$-5CU_1 + C\varepsilon - CU_1 = 0$

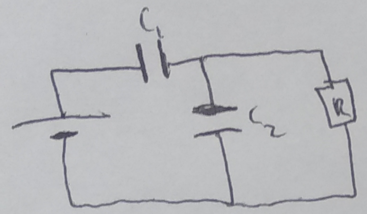
$U_1 = \frac{\varepsilon}{6}$

$U_2 = \varepsilon - \frac{\varepsilon}{6} = \frac{5}{6}\varepsilon$

$q_1 = 5CU_1 = \frac{5C\varepsilon}{6}$

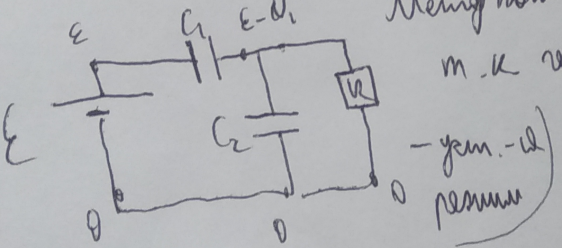
$q_2 = q_1 = \frac{5C\varepsilon}{6}$

2)



C_2 и R соединены пар-но, значит $U_R = U_2$; $\frac{5}{6}\varepsilon = I_R R$; $I_R = \frac{5\varepsilon}{6R}$ — Ответ 1

Метод пот-лов



т.к. через R не течет ток в уст. режиме, то $U_R = 0$, а значит и $U_2' = 0$, значит $U_1' = \varepsilon$; $q_1' = 5CU_1' = 5C\varepsilon$; Δq – заряд протекший через источник после замыкания ключа

$\Delta q = q_1' - q_1 = 5C\varepsilon - \frac{5C\varepsilon}{6} = \frac{25}{6}C\varepsilon$

ЗСЭ: $A_{пот}^{0} + A_{ист} = \Delta W + Q^{0}$; $A_{ист} = \Delta q \cdot \varepsilon = \frac{25C}{6}\varepsilon^2$

$\Delta W = W_2 - W_1 = \left(\frac{5C\varepsilon^2}{36 \cdot 2} + \frac{C \cdot 25\varepsilon^2}{36 \cdot 2} - \frac{5C\varepsilon^2}{6 \cdot 2}\right) = \frac{75C\varepsilon^2}{36}$

$Q = A_{ист} - \Delta W = \frac{25C}{6}\varepsilon^2 - \frac{75C\varepsilon^2}{36} = \frac{75C\varepsilon^2}{36}$ — Ответ 2

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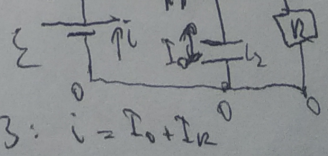
3. С.Э. продифференцируем по t



$P_{пот}^{0} + P_{ист} = W_{C_1}' + W_{C_2}' + P_R$

ЗСЗ: $i = I_0 + I_R$

$$\begin{cases} \varepsilon i = iU + I_0(\varepsilon - U) + I_R U \\ i = I_0 + I_R \end{cases}$$

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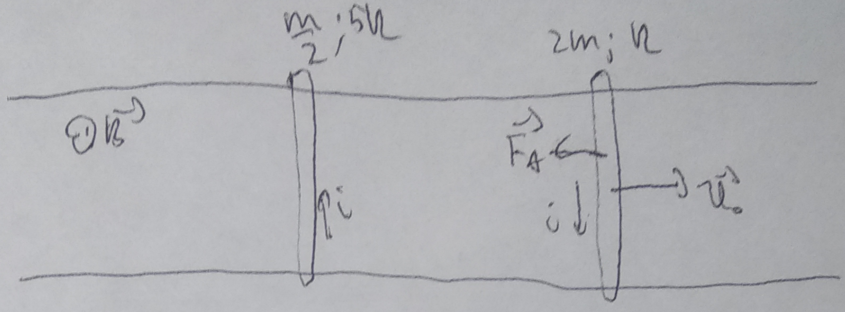
Условие 2

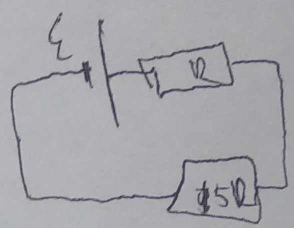
$B; L; m; v_0;$



~~$\mathcal{E} = -\Phi'$~~

$\Phi = B L \Delta x$

$\mathcal{E} = -\Phi' = -BLv_0$



$I_0 = \dfrac{BLv_0}{6R}$

$F_A = I_0 B L = \dfrac{BLv_0}{6R} \cdot BL = \dfrac{B^2L^2v_0}{6R}$

$F_A = 2m a_0$

$$a_0 = \frac{B^2L^2v_0}{12mR}$$ — Ответ 1

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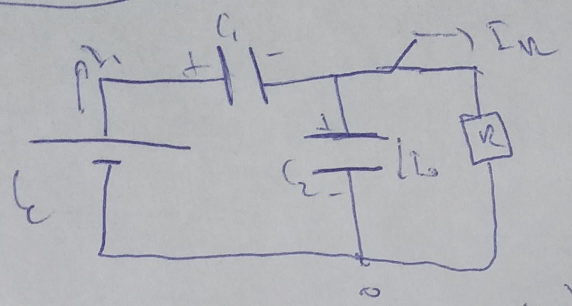
$B;\ L,\ m,\ v_0$

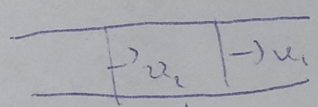


$I_1 = I_0 + I_R$ $\qquad$ $I'\,\Delta t$

$U_2 = U_R = I_R R$

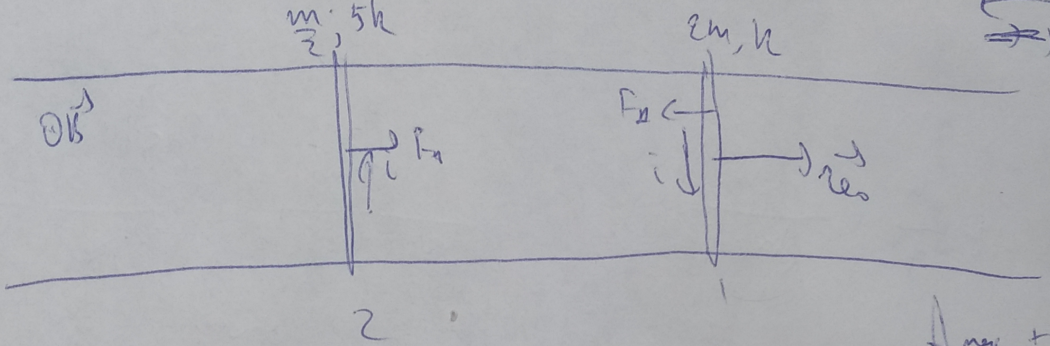
$U_2 = \frac{q_2}{C} = I_R \cdot R$

$\frac{I_0}{C} = R I'$



$U_2' =$

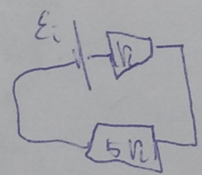
$= \frac{1}{C} q_2' = \frac{1}{C} I_0$ $\qquad$ $I_R' \cdot R = R \cdot I_R'$ $\qquad$ $\frac{I_0 \Delta t}{C} = R I' \Delta t$



$\varphi = B L \Delta x$

$\varphi' = B L v_0$

$A_{mex} + A_{[illegible]} = Q$



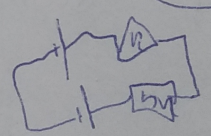
$i = \frac{B L v_0}{6R}$

$\mathcal{E}_i = -\varphi' = -B L v_0$ $\qquad$ $F_A = B i L = \frac{B^2 L^2 v_0}{6R} = 2 m a_0$

$a_0 = \frac{B^2 L^2 v_0}{12 R m}$

$v_1 = v_2$ $\qquad$ $\mathcal{E}_1 = B L v_1$

$\mathcal{E}_2 = B L v_2$



$F_A = \frac{B L v_1 - B L v_2}{6R} \cdot B L = \frac{B^2 L^2 (v_1 - v_2)}{6R}$

$a_1 = \frac{B^2 L^2 (v_1 - v_2)}{12 R m}$ $\qquad$ $a_1 + a_2 = a = \frac{5}{12} \frac{B^2 L^2 (v_1 - v_2)}{R m}$ ($v_{[illegible]}$)

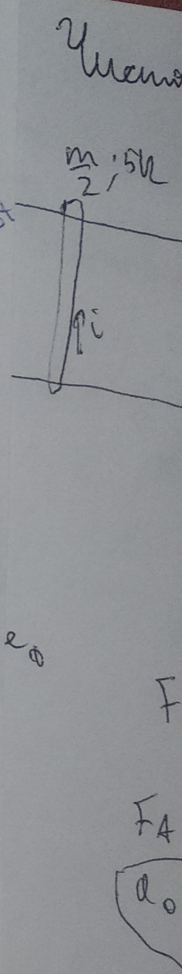
$\frac{1}{12} + \frac{1}{3} =$ $\qquad$ $a_2 = \frac{B^2 L^2 (v_1 - v_2)}{3 R m}$

$\frac{1+4}{12} = \frac{5}{12}$

$a = \frac{5}{12} \frac{B^2 L^2 v}{R m} \quad | \cdot \Delta t$

$\sum a \Delta t = \sum \frac{5}{12} \frac{B^2 L^2 v \Delta t}{R m}$

$v_0 = \frac{5}{12} \frac{B^2 L^2 \Delta s}{R m}$



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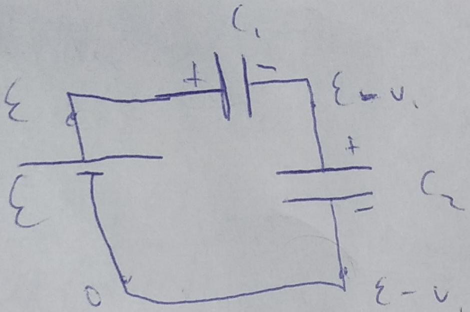
$$= \frac{30C\varepsilon^2}{72} - \frac{5C\varepsilon^2}{2} = \frac{30-5\cdot 36}{72} = \frac{180-030}{72} = \frac{150}{72} = \frac{75}{36}C\varepsilon^2$$



$\varepsilon = V_1 + V_2$

$q_1 + q_2 = 0$

$\varepsilon - V_1 - V_2 = 0$

$$\begin{cases} C_1V_1 + C_2V_2 = 0 \\ V_1 + V_2 = \varepsilon \end{cases}$$

$V_1 = \varepsilon - V_2$

$C_1(\varepsilon - V_2) + C_2V_2 = 0$

$C_1\varepsilon - C_1V_2 + C_2V_2 = 0$

$V_2 = \frac{C_1\varepsilon}{C_1 - C_2}$

$V_1 = \varepsilon - \frac{C_1\varepsilon}{C_1 - C_2} =$

$V_1 = \frac{C_1\varepsilon - C_2\varepsilon - C_1\varepsilon}{C_1 - C_2}$

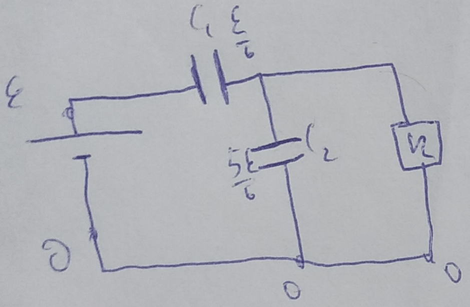
$V_2 = \frac{5C\varepsilon}{4C} = \frac{5}{4}\varepsilon$

$V_1 = -\frac{C\varepsilon}{4C} = -\frac{\varepsilon}{4}$

$\frac{C_1C_2}{C_1+C_2} = \frac{5C\cdot C}{6C} =$

$\frac{\frac{5C}{6}\varepsilon}{5C}$

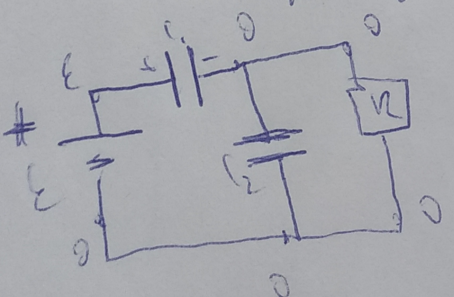
$\frac{5C\varepsilon}{6C}$



$IR = V_2 = \frac{5}{6}\varepsilon$

$I = \frac{5\varepsilon}{6R}$

$q_1 = \frac{5C\varepsilon}{6}$



$C_1\varepsilon = 5C\varepsilon$

$q_1' = 5C\varepsilon$

$\Delta q = q_1' - q_1 = 5C\varepsilon - \frac{5C\varepsilon}{6} = 5C\varepsilon\left(1 - \frac{1}{6}\right) = \frac{25C\varepsilon}{6}$

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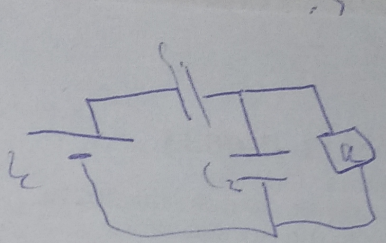
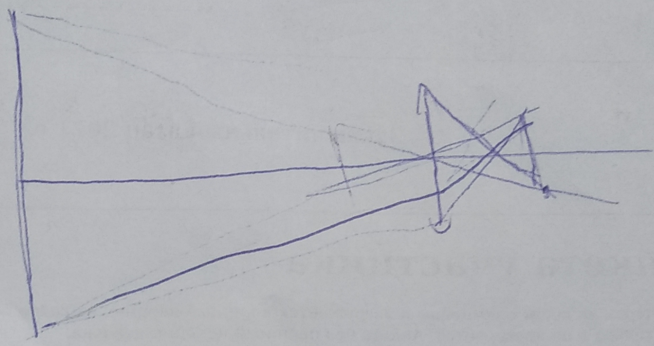


$\frac{5\cdot 36}{2}$

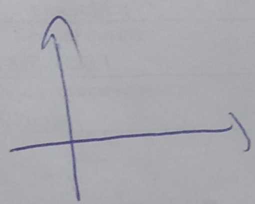
$\frac{75}{36}C\mathcal{E}^2$



$A_{ист} = \frac{m v_1^2}{2} = \frac{m}{2}\cdot\frac{v_1^2}{2} - \frac{m v_0^2}{2}$

$A_{ист} = \mathcal{E}\cdot\Delta q$

$Q = I^2 R_0 t =$



$U' = \left(\frac{q}{C}\right)' = \frac{1}{C} i$

$P_{ист} = \mathcal{E} i$

$\frac{\Delta W_1}{\Delta t} = \left(\frac{qU}{2}\right)' = \frac{1}{2}\left(iU + q\frac{i}{C}\right) =$

$\frac{1}{2}\left(iU + \frac{qi}{C}\right) = \frac{i}{2}\left(U + \frac{q}{C}\right) = \frac{1}{2} i U_1$

iU

$\mathcal{E} i = iU + I_0(\mathcal{E} - U) + P_R$

$Q = I_R^2 R = \frac{U_R}{R} I_R$

$\mathcal{E} i = iU + I_0\mathcal{E} - I_0 U + I_R\mathcal{E} - I_R U$

$i = I_0 + I_R$

$\mathcal{E}(I_0 + I_R) = U(I_0 + I_R) + I_0\mathcal{E} - I_0 U + I_R\mathcal{E} - I_R U$

$\mathcal{E} I_0 + \mathcal{E} I_R = U I_0 + U I_R\ \ U I_0 + U I_R - I_0 U - I_R U$

$\mathcal{E} I_0 + \mathcal{E} I_R = I_0\mathcal{E} + I_R\mathcal{E}$

$\mathcal{E}(I_R + I_0) = (I_R + I_0)U + I_0(\mathcal{E} - U) + I_R(\mathcal{E} - U)$

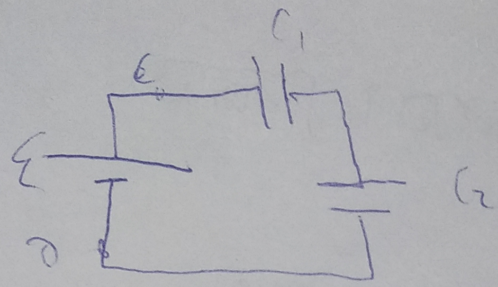
$\mathcal{E} I_R + \mathcal{E} I_0 = I_R U + I_0 U + I_0\mathcal{E} - I_0 U + I_R\mathcal{E} - I_R U$

$\frac{\mathcal{E}}{-C_2}$

$\frac{C_2\mathcal{E} - k}{-C_2}$

$\frac{5}{4}\mathcal{E}$

$= \frac{\mathcal{E}}{4}$



~~C_1V_1~~

$5CV_1 + CV_2 = 0$

$\varepsilon - V_1 - V_2 = 0$

$V_2 = \varepsilon - V_1$

$5CV_1 + C\varepsilon - CV_1 = 0$

$4CV_1 = C\varepsilon$

$V_1 = -\frac{\varepsilon}{4}$ $\quad -\frac{5C\varepsilon}{4}$

$V_2 = \varepsilon + \frac{\varepsilon}{4} = \frac{5}{4}\varepsilon$ $\quad \frac{3}{4}$

$\frac{1}{C_0} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{C_2 + C_1}{C_1 C_2}$

$\frac{C_1 C_2}{C_2 + C_1} = \frac{5C \cdot C}{C + 5C} = \frac{5C}{6} = \frac{5C}{6}$

$C_0 \varepsilon = \frac{5C\varepsilon}{6}$

$V_1 = \frac{\varepsilon}{6}$

$V_2 = \frac{5\varepsilon}{6}$

$-5CV_1 + CV_2 = 0$

$-5CV_1 + C\varepsilon - CV_1 = 0$

$V_1 + V_2 = \varepsilon$

$-5CV_1 + CV_2 = 0$

$-5CV_1 + C\varepsilon - CV_1 = 0$

$+6CV_1 = C\varepsilon$

$V_1 = \frac{\varepsilon}{6}$

$V_2 = \varepsilon - V_1 = \varepsilon - \frac{\varepsilon}{6} = \frac{5\varepsilon}{6}$

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