Часть 1

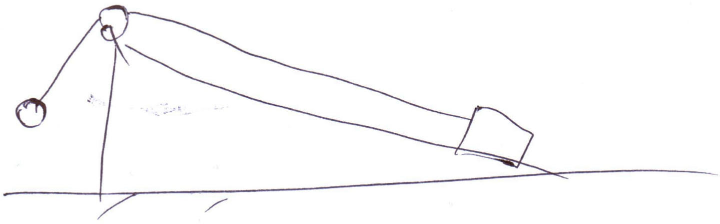
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21203037**

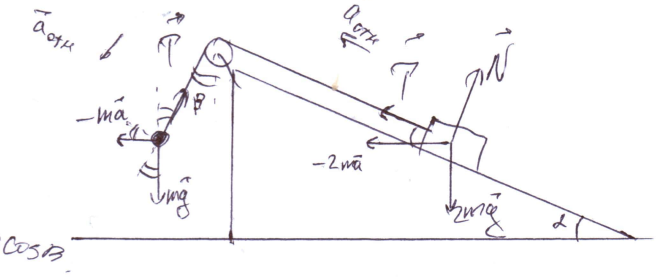
ID профиля: **164736**

Вариант 6

Черновик



$$\begin{cases} ma - T\sin\beta = ma_{отн}\sin\beta \\ mg - T\cos\beta = ma_{отн}\cos\beta \\ T + 2ma\cos\alpha - 2mg\sin\alpha = ma_{отн} \end{cases}$$



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

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

$$a = g\,tg\,\beta$$

$$f_m + f_{2m} = const$$

$$\Rightarrow a_m + a_{2m} = 0$$

$$a_m = -a_{2m}$$

$$\frac{858}{3\cdot 12\cdot 13} = \frac{143}{6\cdot 13} = \frac{143}{78}$$

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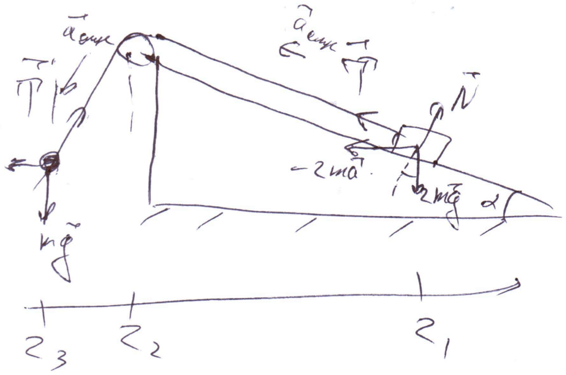
Черновик

$T\sin\beta = ma$? – неправда.

$\vec{T}$ 2m

$T + 2ma\cos\alpha - 2mg\sin\alpha = \cancel{a}$



$T + 2ma\cos\alpha - 2mg\sin\alpha = 2ma_{отн}$.

$N = mg\cos\alpha + 2ma\sin\alpha$.

~~$T\cos\beta - mg =$~~ $mg - T\cos\beta = ma_{отн}\cos\beta$.

$T\cos\beta - mg = ma_{отн}\cos\beta$.

$a_{отн}\cos\alpha = a_{отн}\sin\beta$. $\sin\beta = \frac{\sqrt{1\cdot 25}}{13} = \frac{5}{13}$

$l = \frac{(z_1 - z_2)}{\cos\alpha} + \frac{(z_2 - z_3)}{\sin\beta}$.

$0 = \frac{a_{1z}}{\cos\alpha} + \frac{a_{3z}}{\sin\beta}$ $a_{3z}\cos\alpha = a_{1z}\sin\beta$

Черновик

$$C_m = \frac{\delta Q}{\nu dT} \qquad \delta Q = pdV + dU \qquad pdV$$

$$dU = \nu C_{mV} dT$$

$p = const$: $$C_m = C_{mp} = \frac{\delta Q}{\nu dT} = \frac{\nu R dT + \frac{i}{2}\nu R dT}{\nu dT} = R + C_{mV}$$

$$pdV + Vdp = \nu R dT$$

$$\delta Q = \cancel{A} \; pdV + dU$$

$$C_m = \frac{pdV + dU}{\nu dT}$$

$$pdV + Vdp = \nu R dT \qquad dU = \frac{5}{2}\nu R dT$$

$$C_m = \frac{\cancel{Vdp}\; \nu R dT - Vdp + \frac{5}{2}\nu R dT}{\nu dT} = \frac{7}{2}\cancel{\nu} R - \frac{Vdp}{\nu dT}$$

$$C_m = \frac{pdV + \frac{5}{2}(pdV + Vdp)}{\frac{pdV + Vdp}{R}} = \frac{\frac{7}{2}pdV + Vdp}{pdV + Vdp} R =$$

$$= \frac{\frac{7}{2}p + V\frac{dp}{dV}}{p + V\frac{dp}{dV}}$$

$$\begin{array}{r|l} 7p + 5Vp_V' & p + Vp_V' \\ 7p + 7Vp_V' & 7 \\ \hline -2Vp_V' & \end{array}$$

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Черновик

$\frac{dy}{dx} = -\frac{7}{5}$ ~~$\frac{y}{x}$~~

$x^2+y^2=R^2$

$y = \sqrt{R^2-x^2}$

$\frac{dy}{dx} = \frac{1}{2\sqrt{}} \cdot -2x = -\frac{x}{\sqrt{R^2-x^2}}$

$49-35=$

$$\begin{array}{r} 49 \\ -35 \\ \hline 14 \end{array}$$

$$\begin{array}{r} 49 \\ \times 35 \\ \hline 84 \end{array}$$

$$\begin{array}{r|l} 84 & 6 \\ -6 & 14 \\ 24 & \\ -24 & \\ 0 & \end{array}$$

$84 = 6 \cdot 14 = 6 \cdot 2 \cdot 7$

$\frac{84}{24} = \frac{12 \cdot 7}{12 \cdot 2}$

$y = \sqrt{R^2-x^2}$

$\int \sqrt{R^2-x^2}\,dx$

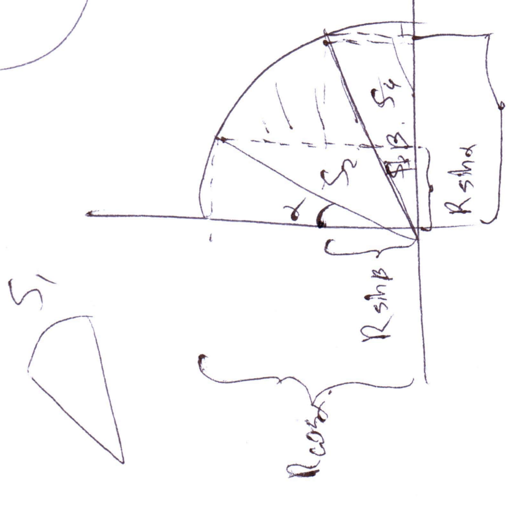
$dx = \frac{dt}{\sqrt{R^2-x^2}}$

$2R^2 - 2\pi$

$x - \alpha$

$x = \frac{\pi R^2 \alpha}{2\pi} = \frac{R^2 \alpha}{2}$

$S_1 = \frac{R^2\left(\frac{\pi}{2}-\alpha-\beta\right)}{2}$



$S_1 - S_2$

$S_1 - S_2 + S_3 + S_4$

$1{,}4^2$

$1{,}414\ 2/3$

Чистовик

Дано:

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

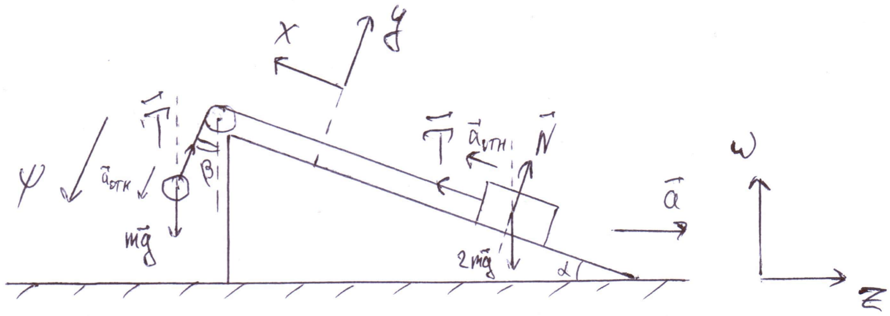
$\cos\beta = \frac{12}{13}$

$g = 10\ м/с^2$

$a = ?$

$a_{отн} = ?$

$T = ?$



~~Отн. Лабораторной СО запишем 2ЗН~~

$$\begin{cases} ИСО - Земля \\ ПСО - Клин \\ тело - шарик/брусок \end{cases} \Rightarrow \vec{a}_{абс} = \vec{a}_{отн} + \vec{a}$$

Запишем 2ЗН для бруска и шарика в С.О., связанной с клином:

$$\begin{pmatrix} \vec{F}_{ин_1} = -2m\vec{a} \\ \vec{F}_{ин_2} = -m\vec{a} \end{pmatrix}$$

$$\cancel{\begin{cases} Ox: & T + 2ma\cos\alpha - 2mg\sin\alpha = 2ma_{отн} \\ O\psi: & mg\cos\beta - T = ma_{отн} \end{cases}}$$

$+$

$\cancel{mg\cos\beta - T + ma\sin\beta = ma_{отн}}$

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

$\cancel{O\omega: \quad mg - T\cos\beta = ma_{отн}\cos\beta}$

$\cancel{T = mg\cos\beta - ma_{отн}}$ $\Rightarrow$ $\cancel{mg - mg\cos^2\beta + ma_{отн}\cos\beta}$

$$\begin{cases} Oz: \; ma - T\sin\beta = ma_{отн}\sin\beta \\ O\omega: \; mg - T\cos\beta = ma_{отн}\cos\beta \\ Ox: \; T + 2ma\cos\alpha - 2mg\sin\alpha = 2ma_{отн} \end{cases}$$

$\Rightarrow \dfrac{ma - T\sin\beta}{mg - T\cos\beta} = \dfrac{\sin\beta}{\cos\beta}$

$$ma\cos\beta - \cancel{T\sin\beta\cos\beta} = mg\sin\beta - \cancel{T\sin\beta\cos\beta}$$

$a = g\,tg\,\beta$; $\sin\beta = \sqrt{1-\cos^2\beta} = \sqrt{1 - \frac{12^2}{13^2}} = \frac{5}{13}$

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$\boxed{a = 10 \cdot \frac{5}{12} \approx 4{,}167\ м/с^2}$ $\Leftarrow$ $tg\,\beta = \dfrac{\sin\beta}{\cos\beta} = \dfrac{5}{12}$

Стр 1

Чистовик

Ещё раз запишем 2ЗН:

$$\begin{cases} T + 2ma\cos\alpha - 2mg\sin\alpha = 2ma_{отн} \\ Oy:\ mg\cos\beta - T + ma\sin\beta = ma_{отн} \end{cases} +$$

$\sin\alpha = \sqrt{1-\cos^2\alpha} = \sqrt{1 - \frac{16}{25}} = \frac{3}{5}$

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

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

$$= \frac{1}{3}\left(\frac{50}{12}\left(2\cdot\frac{4}{5} + \frac{5}{13}\right) + 10\left(\frac{12}{13} - 2\cdot\frac{3}{5}\right)\right) = \frac{1}{3}\left(\frac{50}{12}\cdot\frac{8\cdot 13 + 25}{5\cdot 13} + 10\,\frac{12\cdot 5 - 6\cdot 13}{13\cdot 5}\right) =$$

$$= \frac{1}{3}\left(\frac{\cancel{50}^{10}}{12}\cdot\frac{129}{\cancel{5}\cdot 13} + \cancel{10}^{2}\,\frac{-18}{13\cdot\cancel{5}}\right) = \frac{1}{3}\left(\frac{1290}{12\cdot 13} - \frac{36}{13}\right) = \frac{1}{3}\cdot\frac{858}{12\cdot 13} \approx 1{,}83\ м/с^2$$

Для шарика $|a_{абс\,\omega}| = |a_{отн\,\omega}| = a_{отн}\cos\beta$

$$\Rightarrow H = \frac{|a_{абс\,\omega}|\,\tau^2}{2} = \frac{a_{отн}\cos\beta\,\tau^2}{2};\quad \tau = \sqrt{\frac{2H}{a_{отн}\cos\beta}} = \sqrt{\frac{2H}{\frac{143}{\cancel{6}\cdot 13}\cdot\frac{\cancel{12}^{2}}{13}}} =$$

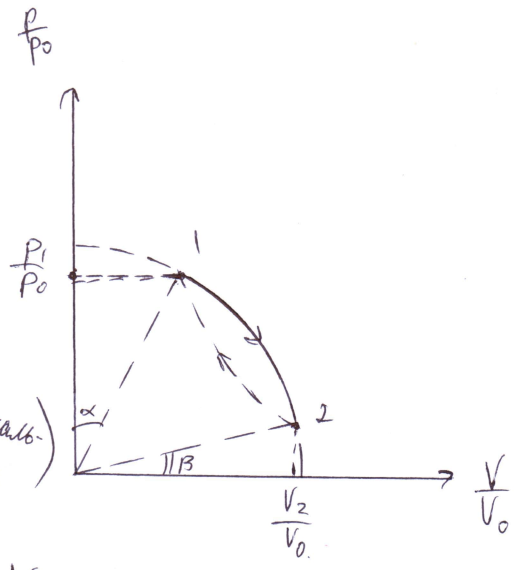
$$= 13\sqrt{\frac{H}{143}}\ с.$$

Ответ: $a \approx 4{,}167\ м/с^2$, $a_{отн} \approx 1{,}83\ м/с^2$; $\tau = 13\sqrt{\frac{H}{143}}\ с.$

Чистовик

Дано:
$i=5$
$\alpha=22{,}5^\circ$
$\beta=15^\circ$
$\frac{T_1}{T_2}=?$
$\psi=?\ (c_m=0)$
$\frac{A_{газа}}{A_{12}}=?$

Пусть радиус окружности равен R. Тогда:



$$\frac{p_1}{p_0}=R\cos\alpha\cdot K_1$$

$$\frac{p_2}{p_0}=R\sin\beta\cdot K_1$$

(K_{1-2} – коэффициенты пропорциональности)

$$\frac{V_1}{V_0}=R\sin\alpha\cdot K_2$$

$$\frac{V_2}{V_0}=R\cos\beta\cdot K_2 \Rightarrow \frac{V_1}{V_2}=\frac{\sin\alpha}{\cos\beta}$$

$$\frac{p_1}{p_2}=\frac{\cos\alpha}{\sin\beta}$$

По уравнению Менделеева-Клапейрона:

$$\left.\begin{aligned} p_1V_1=\nu RT_1\\ p_2V_2=\nu RT_2\end{aligned}\right\}\Rightarrow \frac{p_1V_1}{p_2V_2}=\boxed{\frac{T_1}{T_2}}=\frac{\sin\alpha\cos\alpha}{\sin\beta\cos\beta}=\frac{\sin2\alpha}{\sin2\beta}=$$

$$=\frac{\sin45^\circ}{\sin30^\circ}=\frac{\frac{\sqrt2}{2}}{\frac12}=\boxed{\sqrt2}$$

$$pV=\nu RT \Rightarrow pdV+Vdp=\nu RdT$$

$$c_m=\frac{\delta Q}{\nu dT};\quad \delta Q=pdV+dU;\quad dU=\frac52\nu RdT=\nu c_{mV}dT$$

$$c_m=\frac{pdV+dU}{\nu dT}= \qquad dU=\frac52\nu RdT=\frac52(pdV+Vdp)$$

$$=\frac{pdV+\frac52(pdV+Vdp)}{\frac{pdV+Vdp}{R}}=\frac{\frac72pdV+\frac52Vdp}{pdV+Vdp}R=$$

$$=\frac R2\,\frac{7pdV+5Vdp}{pdV+Vdp}=\frac R2\cdot\frac{7p+5V\frac{dp}{dV}}{p+V\frac{dp}{dV}}=\frac R2\left(7+\frac{-2Vp_V'}{p+Vp_V'}\right)$$

$$=\frac R2\left(7-\frac{2}{\frac{p}{Vp_V'}+1}\right)=0.$$

Чистовик

$$7 - \frac{2}{\frac{p}{Vp_V'} + 1} = 0.$$

$$\frac{7}{2} = \frac{1}{\frac{p}{Vp_V'} + 1}$$

$$\frac{p}{Vp_V'} + 1 = \frac{2}{7}; \quad \frac{p}{Vp_V'} = -\frac{5}{7}.$$

$$p_V' = \frac{dp}{dV} = \frac{d\frac{p}{p_0}}{d\frac{V}{V_0}} \cdot \frac{p_0}{V_0} = -\frac{7p}{5V}.$$

$$\Rightarrow \frac{d\left(\frac{p}{p_0}\right)}{d\left(\frac{V}{V_0}\right)} = -\frac{7}{5} \cdot \frac{\frac{p}{p_0}}{\frac{V}{V_0}}.$$ Пусть $x = \frac{V}{V_0}$; $y = \frac{p}{p_0}$

Окружность с центром в $(0;0)$ задаётся уравнением:

$$x^2 + y^2 = R^2; \quad y = \sqrt{R^2 - x^2}$$

$$\cancel{\frac{dy}{dx} = -\frac{7}{5}\frac{y}{x}; \quad \frac{dy}{y} = -\frac{7}{5}\frac{dx}{x}; \Rightarrow \ln|y| = -\frac{7}{5}\ln|x|}$$

$$\cancel{e^{\ln|y|} = e^{-\frac{7}{5}\ln|x|}; \quad y = x^{-\frac{7}{5}}}$$

$$\cancel{y^2 = x^{-\frac{14}{5}} = R^2 - x^2.}$$

$\cancel{x^2 + x^{-\frac{14}{5}} = R^2 \Rightarrow}$ ~~Решение существует.~~

$$\cancel{\operatorname{tg}\alpha = \frac{y}{x}}$$

$$\frac{dy}{dx} = -\frac{7}{5}\frac{y}{x}; \quad \frac{dy}{dx} = \frac{1}{2\sqrt{R^2 - x^2}} \cdot (-2x) = -\frac{x}{\sqrt{R^2 - x^2}}$$

$$\frac{x}{\sqrt{R^2 - x^2}} = \frac{7y}{5x}; \quad y = \frac{5x^2}{7\sqrt{R^2 - x^2}}$$

$$y^2 = \frac{25x^4}{49(R^2 - x^2)}$$

Чистовик

$$x^2+\frac{25x^4}{49(R^2-x^2)}=R^2.$$

$$49R^2x^2-49x^4+25x^4=49R^2(R^2-x^2)$$

$$49R^2x^2-24x^4=49R^4-49R^2x^2.$$

$$24x^4-2\cdot 49R^2x^2+49R^4=0$$

$$D/4=49^2R^4-24\cdot 49R^4=49R^4(49-24)=25\cdot 49R^4$$

$$x^2=\frac{49R^2\pm 35R^2}{24}=\frac{14R^2}{24};\ \frac{84R^2}{24}=\frac{7R^2}{12};\ \frac{7}{2}R^2.$$

$$x=R\sqrt{\frac{7}{12}};\ R\sqrt{\frac{7}{2}}.$$

$\Downarrow$ подходит. $\vee$ $R => \varnothing$

$$y=\sqrt{R^2-\frac{7}{12}R^2}=R\sqrt{\frac{5}{12}}.$$

$$\boxed{tg\,\varphi=\frac{y}{x}=\frac{R\sqrt{\frac{5}{12}}}{R\sqrt{\frac{7}{12}}}=\sqrt{\frac{5}{7}}.}$$

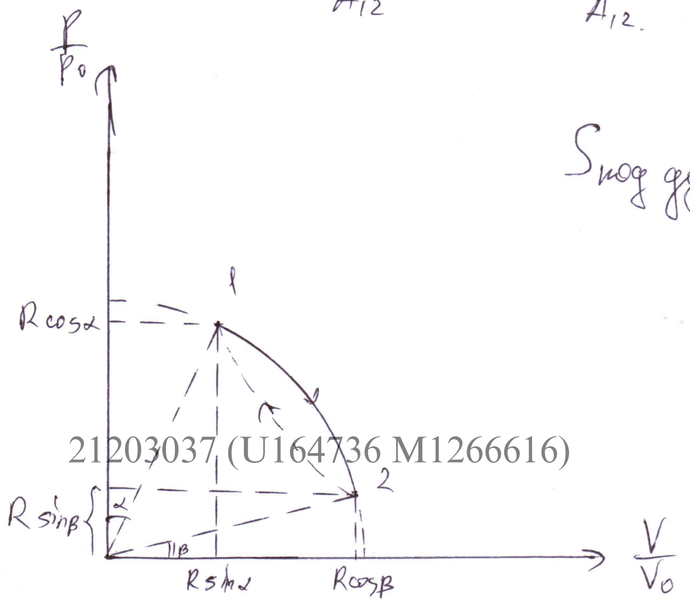
$$A_{цикла}=A_{12}-|A_{21}|$$

$$\Rightarrow \frac{A_{цикла}}{A_{12}}=1-\frac{|A_{21}|}{A_{12}}.$$

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

$$\Rightarrow \Delta U_{21}=-A_{21}=|A_{21}|$$

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



$$S_{под\ дугой\ 1-2}=\frac{R^2\left(\frac{\pi}{2}-\alpha-\beta\right)}{2}-\frac{R^2\sin\alpha\cdot\cos\alpha}{2}+$$

$$+\frac{R^2\sin\beta\cdot\cos\beta}{2}=$$

$$=\frac{R^2}{2}\left(\frac{\pi}{2}-\alpha-\beta-\frac{\sin 2\alpha}{2}+\frac{\sin 2\beta}{2}\right)$$

$$\Rightarrow A_{12}=S_{под\ дугой\ 1-2}\cdot p_0V_0k_1k_2$$

Чистовик

$$\frac{A_{газа}}{A_{12}} = 1 - \frac{\frac{5}{2}\cancel{p_0V_0K_1K_2}\frac{R^2}{2}(\sin 2\alpha - \sin 2\beta)}{\cancel{p_0V_0K_1K_2}\frac{R^2}{2}\left(\frac{\pi}{2} - \alpha - \beta - \frac{\sin 2\alpha}{2} + \frac{\sin 2\beta}{2}\right)}$$

$$= 1 - \frac{5(\sin 2\alpha - \sin 2\beta)}{\pi - 2(\alpha+\beta) - \sin 2\alpha + \sin 2\beta} =$$

~~$\alpha = \arcsin$~~

$$\alpha = 22{,}5^0 = \frac{22{,}5^0}{180^0}\cdot\pi = 0{,}125\pi$$

$$\beta = 15^0 = \frac{15^0}{180^0}\pi = \frac{1}{12}\pi$$

$$= 1 - \frac{5\left(\frac{\sqrt{2}}{2} - \frac{1}{2}\right)}{\pi - 0{,}25\pi - \frac{1}{6}\pi - \frac{\sqrt{2}}{2} + \frac{1}{2}} =$$

$$= 1 - \frac{\frac{5}{2}(\sqrt{2}-1)}{0{,}75\pi - \frac{1}{6}\pi - \frac{\sqrt{2}-1}{2}} = 1 - \frac{5(\sqrt{2}-1)}{1{,}5\pi - \frac{\pi}{3} - \sqrt{2}+1}$$

$$p_1V_1 = \nu RT_1$$

$$p_2V_2 = \nu RT_2.$$

$$p_1 = p_0 K_1 R\cos\alpha.$$

$$V_1 = V_0 R\sin\alpha\cdot K_2.$$

$$p_2 = p_0 K_1 R\sin\beta$$

$$V_2 = V_0 R\cos\beta\cdot K_2.$$

$$\Rightarrow \nu RT_1 = p_0V_0 K_1K_2\cdot\frac{R^2\sin 2\alpha}{2}.$$

$$\nu RT_2 = p_0V_0\cdot K_1K_2\cdot\frac{R^2\sin 2\beta}{2}.$$

$$\Rightarrow \Delta U_{21} = \frac{5}{2}p_0V_0K_1K_2\cdot\frac{R^2}{2}(\sin 2\alpha - \sin 2\beta)$$

$$A_{12} = \frac{R^2}{2}\left(\frac{\pi}{2} - \alpha - \beta - \frac{\sin 2\alpha}{2} + \frac{\sin 2\beta}{2}\right)\cdot p_0V_0\cdot K_1\cdot K_2$$

Ответ: $\frac{T_1}{T_2} = \sqrt{2}$; $\operatorname{tg}\varphi = \sqrt{\frac{5}{7}}$; $\frac{A_{газа}}{A_{12}} = 1 - \frac{5(\sqrt{2}-1)}{1{,}5\pi - \frac{\pi}{3} - \sqrt{2}+1}$

Часть 2

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

Шифр: **21203037**

ID профиля: **164736**

Вариант 6

Черновик

$\frac{1}{x} + \frac{1}{f_0} = D.$

$\frac{1}{f_0} = D + D_1$

$\frac{1}{d_2} + \frac{1}{f_0} = D + D_2$

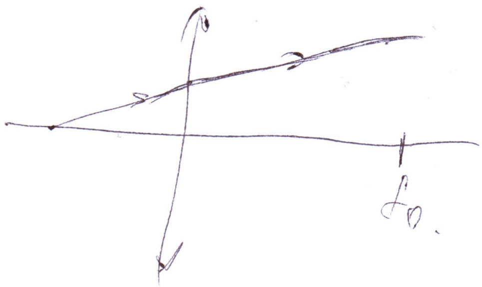
$\frac{1}{d_2} - \frac{1}{x} = D_2.$

$D_2 = \frac{7}{3} \cdot 3 = 7.$

$\frac{1}{x} = \frac{1}{0{,}25} - D_2 = 4 - 7$

$\cancel{\mathcal{E} + U_c}$

$\mathcal{E} + \mathcal{E}_2 = U_c + IR.$



$q_2 = C\mathcal{E}.$

$q_1 = q = \frac{3C\mathcal{E}}{4}.$ $\Rightarrow \Delta q = \frac{C\mathcal{E}}{4}$?

$q = CU_c.$

$\Rightarrow dq = C\dot{U}_c dt.$

$\mathcal{E} = U_{3c} + U_c.$

$U_{3c} + iR = -L\frac{di}{dt}.$

$L\dot{i} + iR + \frac{q}{3C} = 0.$

$\begin{cases} Z_C = \frac{1}{j\omega C} \\ Z_L = j\omega L. \\ Z_R = R. \end{cases}$

$\frac{q_2}{3C} = U_{C_2}$

$\frac{q_1}{C} = U_{C_1}$

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Черновик

$$\mathcal{E} = U_{C_1} + U_R + L\dot{I}_2$$

$$U_R + U_L = U_{C_2}$$

$$\mathcal{E} = U_{C_1} + U_{C_2}$$

$$U_{C_1} = \frac{q_1}{C}$$

$$U_{C_2} = \frac{q_2}{3C}$$

$$\frac{q_1}{C} = \frac{q_2}{3C}$$

$$I_0 +$$

$$\left(\frac{q_1^2}{2C} + \frac{q_2^2}{6C}\right)' + \left(\frac{L I_2^2}{2}\right)' + I_2^2 R = 0$$

$$I_1 = I_0 + I_2$$

$$U_{C_1} = \frac{q_1}{C}$$

$$U_{C_2} = \frac{q_2}{3C}$$

$$\frac{\cancel{2} q_1 \cdot I_1}{\cancel{2} C} + \frac{\cancel{2} q_2 \cdot I_0}{\cancel{6}_3 C} + \frac{\cancel{2} L I_2 \cdot \dot{I}_2}{\cancel{2}} + I_2^2 R = 0$$

$$\frac{q_1 I_1}{C} + \frac{q_2 I_0}{3C}$$

$$I_1 U_{C_1} + I_0 U_{C_2} + I_2 U_L + I_2^2 R = 0$$

$$\cancel{I_1 U_{C_1}} + I_0 U_{C_2} + I_2 U_L + I_2 U_R = \cancel{I_1 \mathcal{E}} \quad I_1 U_{C_2}$$

$$I_2 (U_L + U_R) = \cancel{I_1 (U_C} U_{C_2} (I_1 - I_0)$$

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Черновик

$$\frac{q^2}{2C}+\frac{q^2}{2\cdot 3C}=\frac{q^2}{2C}\cdot\frac{4}{3}=\frac{3}{4}\frac{3C\mathcal{E}^2}{16}\cdot\frac{4}{2\cdot 3}=\frac{3C\mathcal{E}^2}{8}$$

$$D_2+D=\frac{1}{d_2}+\frac{1}{f_0}$$

$$D_1+D=\frac{1}{f_0}$$

$$D_2>D_1$$

$$f=\left(D-\frac{1}{d}\right)^{-1}$$

$$\left(D_1-\frac{1}{d}\right)^{-1}\vee\left(D_2-\frac{1}{d}\right)^{-1}$$

$$D_2-\frac{1}{d}\vee D_1-\frac{1}{d}$$

$$D_2>D_1$$

$$\Rightarrow f_1>f_2$$

$$D_2>D_1$$

$$f_2<f_1$$

$$\mathcal{E}_i(0)=Bv_0d$$

$$F_A=BYl$$

$$\vec{Yl}\times\vec{B}$$

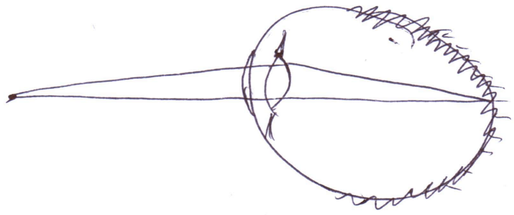
$$Y=\frac{\mathcal{E}_i}{R}$$

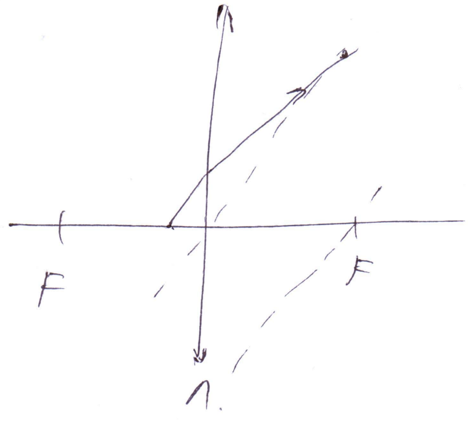
$$\Rightarrow F_A=0\Rightarrow a=0$$

D

$$\frac{1}{d_2}+\frac{1}{f}=D$$

$$\frac{1}{d_2}\to D$$





$$\frac{1}{f}=D-\frac{1}{d_2}$$

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$$f=\left(D-\frac{1}{d_2}\right)^{-1}>f_0$$

$$\Rightarrow D-\frac{1}{d_2}<\frac{1}{f_0};\ \boxed{D<\frac{1}{f_0}+\frac{1}{d_2}}$$

Чистовик

Дано:

$C_1 = C$

$C_2 = 3C$; $L, \mathcal{E}, R$

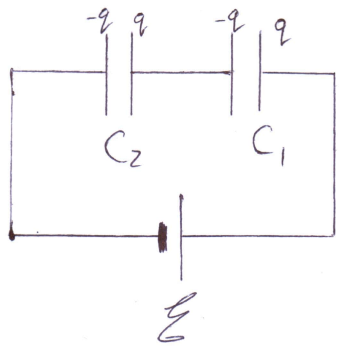
$\dot{J}_R(0) = ?$

$Q = ?$

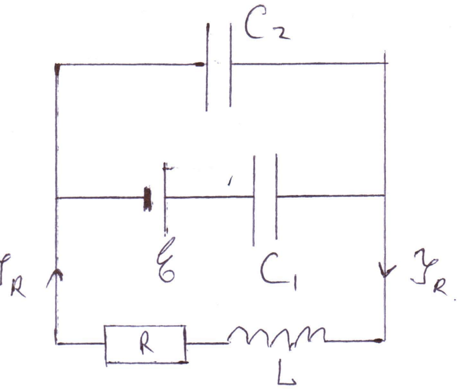
$U_R = ?$ $J_{C_2} = J_0$

№3

I



II.



I: $\frac{1}{C_{общ_I}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{C} + \frac{1}{3C} = \frac{4}{3C}$

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

II: $J_R(0) = 0$ (идеальная катушка)

По II-му правилу Кирхгофа:

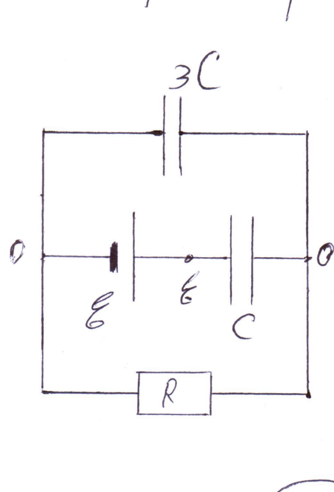
$\mathcal{E} + \mathcal{E}_i = U_{C_1} + J_R \cdot R = U_{C_1}$, где $U_{C_1} = \frac{q}{C} = \frac{3\mathcal{E}}{4}$

$\frac{\mathcal{E}}{4} = -\mathcal{E}_i = L\dot{J}_R(0) \Rightarrow \boxed{\dot{J}_R(0) = \frac{\mathcal{E}}{4L}}$

С L последовательно подключено R => колебания рано или поздно затухнут, установится стационарный режим!

$\Rightarrow W_1 = \frac{q^2}{2C} + \frac{q^2}{2\cdot 3C} = \frac{q^2}{2C}\left(1 + \frac{1}{3}\right) = \frac{q^2}{\cancel{2}C}\cdot\frac{\cancel{4}^2}{3} = \frac{2q^2}{3C}$

$W_2 = \frac{C\mathcal{E}^2}{2}$



$W_1 = W_2 + Q$ (~~3C~~ Энергетический баланс)

$\Delta q\mathcal{E} + \frac{2}{\cancel{3}C}\cdot\frac{\cancel{9}^3(C\mathcal{E})^2}{\cancel{16}_8} = \frac{C\mathcal{E}^2}{2} + Q$

$\Delta q\mathcal{E} + \frac{3C\mathcal{E}^2}{8} = \frac{C\mathcal{E}^2}{2} + Q$, Δq – заряд, протекший через источник

Чистовик

$\Delta q = q_2 - q_1$, где $q_{1,2}$ – заряды на C_1 вначале замыкания и в стационарном режиме

$q_1 = q = \frac{3C\mathcal{E}}{4}$; $q_2 = C\mathcal{E}$

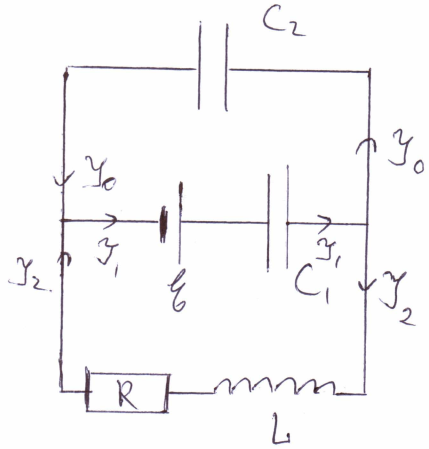
$\Delta q = C\mathcal{E} - \frac{3C\mathcal{E}}{4} = \frac{C\mathcal{E}}{4}$.

$\frac{C\mathcal{E}^2}{4} + \frac{3C\mathcal{E}^2}{8} - \frac{C\mathcal{E}^2}{2} = \boxed{Q = \frac{5C\mathcal{E}^2}{8} - \frac{4C\mathcal{E}^2}{8} = \frac{C\mathcal{E}^2}{8}}$

По I правилу Кирхгофа:

$I_0 + I_2 = I_1$

По II правилу Кирхгофа:



$\mathcal{E} + \mathcal{E}_i = U_{C_1} + I_2 R$

$\mathcal{E} = U_{C_1} + I_2 R + L\dot{I}_2$

$\mathcal{E} = U_{C_1} + U_R + L\dot{I}_2$

$\mathcal{E} = U_{C_1} + U_{C_2} = \frac{q_1}{C} + \frac{q_2}{3C}$ $\Big/ \frac{d}{dt} \Rightarrow \frac{I_1}{C} = \frac{I_0}{3C}$, $3I_1 = I_0$.

$I_1 = \frac{I_0}{3}$

$I_0 + I_2 = I_1$

$I_1 \mathcal{E} = I_2 U_R + I_2 U_L + I_1 U_{C_1} + I_0 U_{C_2} \Rightarrow I_1 U_{C_2} = I_0 U_{C_2}$

Ответ $\dot{I}_R(0) = \frac{\mathcal{E}}{4L}$; $Q = \frac{C\mathcal{E}^2}{8}$;

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Чистовик

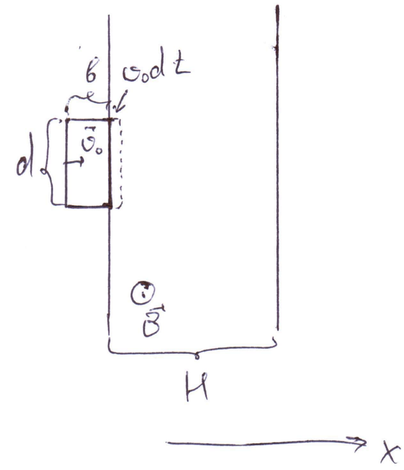
Дано:
$m,\ d,$
$b = d/4,$
$\vartheta_0,\ R,$
$B,\ H=2d,$
$\vec{B} \perp \vec{\vartheta}.$
$a_0 = ?$
$\vartheta_1 = ?$
$\vartheta_2 = ?$

№4.

При вхождении рамки в поле $\vec{B}$ по закону ЭМИ в ней возникает ЭДС индукции:

$$\mathcal{E}_i = -\frac{d\Phi}{dt};\quad d\Phi = B\,dS = B\vartheta\,dt\cdot d;$$

$$|\mathcal{E}_i| = \left|-\frac{B\vartheta\,dt\cdot d}{dt}\right| = B\vartheta d$$



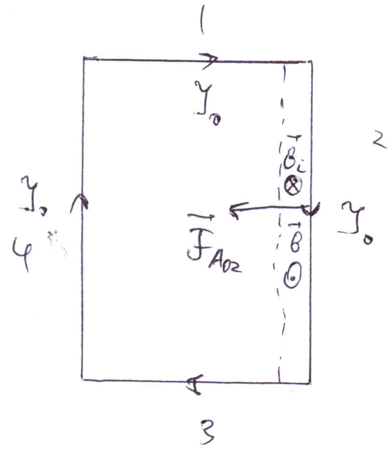
$$\Rightarrow |\mathcal{E}_i|(0) = B\vartheta_0 d.$$

$$I_0 = \frac{|\mathcal{E}_i|}{R}\ (\text{по з-ну Ома}) = \frac{B\vartheta_0 d}{R}$$

На каждую сторону рамки действует

$F_A = B I_0 l$ (При $t=0$ только на правую)

$$F_{A02} = B I_0 d = Bd\cdot\frac{B\vartheta_0 d}{R} = \frac{(Bd)^2\vartheta_0}{R}$$



Запишем 2ЗН на ось ox:

$$-F_{A02} = -ma_0$$

$$\Rightarrow \boxed{a_0 = \frac{F_{A02}}{m} = \frac{(Bd)^2\vartheta_0}{mR}}$$

Весь процесс представляет собой 3 части:

I. Вхождение в ~~рамку~~ поле $\vec{B}$

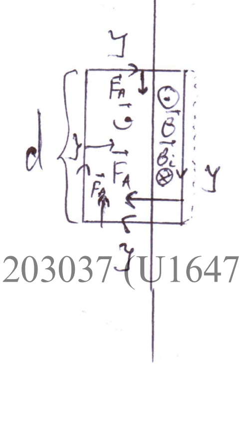
$$|\mathcal{E}_i| = \left|-\frac{d\Phi}{dt}\right| = B\vartheta d$$

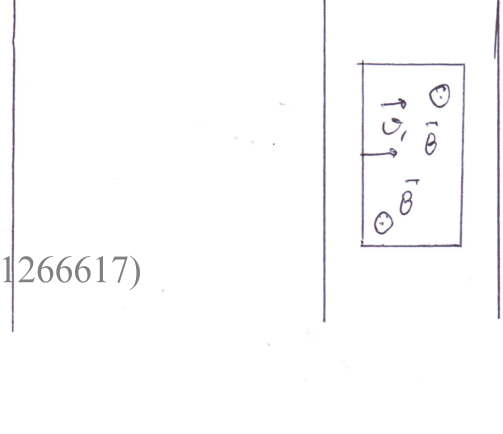
II. Движение в поле $\vec{B}$

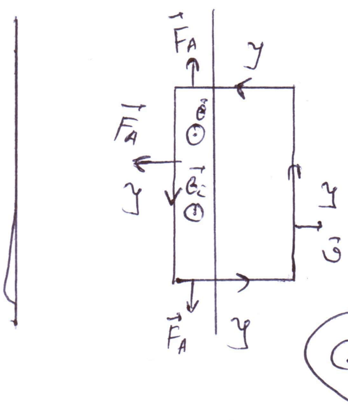
$$|\mathcal{E}_i| = \left|-\frac{d\Phi}{dt}\right| = 0$$

III. Выход из поля $\vec{B}$.

$$|\mathcal{E}_i| = \left|-\frac{d\Phi}{dt}\right| = B\vartheta d$$







Чистовик

I. Запишем 2ЗН на ось Ox:

$$\left.\begin{aligned} ma_x &= -F_A = -BId \\ I &= \frac{Bvd}{R} \end{aligned}\right\} \Rightarrow ma_x = -BId = -\frac{(Bd)^2 v}{R}.$$

$$a_x = \frac{dv}{dt};\quad v = \frac{dx}{dt} \Rightarrow m\frac{dv}{\cancel{dt}} = -\frac{(Bd)^2 dx}{R\cancel{dt}}$$ (x – длина вошедшей части)

$$m\,dv = -\frac{(Bd)^2}{R}dx;\quad m\int_{v_0}^{v_1} dv = -\frac{(Bd)^2}{R}\int_0^b dx$$

$$m(v_1 - v_0) = -\frac{(Bd)^2}{R}\cdot b = -\frac{(Bd)^2}{R}\cdot\frac{d}{4}$$

$$m(v_0 - v_1) = \frac{B^2 d^3}{4R};\quad v_0 - v_1 = \frac{B^2 d^3}{4mR};\quad \boxed{v_1 = v_0 - \frac{B^2 d^3}{4mR}}$$

II: $v_1 = const.$ ($a_x = 0$, т.к. $F_A = BId = 0$)

III: Запишем 2ЗН на ось Ox:

$$\left.\begin{aligned} ma_x &= -F_A = -BId \\ I &= \frac{Bvd}{R} \end{aligned}\right\} \Rightarrow ma_x = -\frac{(Bd)^2 v}{R};$$

$$m\,dv = -\frac{(Bd)^2}{R}dx;\quad \int_{v_1}^{v_2} dv = \frac{-(Bd)^2}{mR}\int_0^b dx$$ (x – длина вышедшей части)

$$v_2 - v_1 = \frac{-(Bd)^2}{mR}\cdot b = -\frac{B^2 d^3}{4mR}$$

$$v_2 = v_1 - \frac{B^2 d^3}{4mR} = v_0 - \frac{B^2 d^3}{2mR}$$

Ответ: $a_0 = \frac{(Bd)^2 v_0}{mR}$; $v_1 = v_0 - \frac{B^2 d^3}{4mR}$; $v_2 = v_0 - \frac{B^2 d^3}{2mR}$

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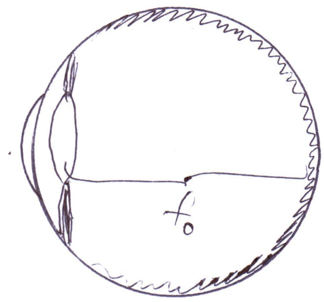
Чистовик

Дано:
$d_2 = 25$ см
$\cancel{\frac{D_2}{D_1}}$ $\frac{D_1}{D_2} = \frac{7}{3}$
$x = ?$
$D_1 = ?$
$D_3 = ?$
$d_3 = 50$ см.

№5

Практически нулевой предел аккомодации глаза =>



$\Rightarrow \frac{1}{d} + \frac{1}{f} = \frac{1}{F}$ (по ф-ле тонкой линзы)

Пусть D — опт. сила глаза. Тогда

$D + D_1 = \frac{1}{d} + \frac{1}{f}$, где $d \to \infty$

$\Rightarrow D + D_1 = \frac{1}{f}$

$D + D_2 = \frac{1}{d_2} + \frac{1}{f} = \frac{1}{d_2} + D + D_1$

$D_2 = \frac{1}{d_2} + D_1$

$\frac{D_1}{D_2} = \frac{7}{3}$, $\frac{3}{7} D_1 = D_2$ $\Big\} \Rightarrow$

$D + D_1 = \frac{1}{d_1} + \frac{1}{f_0}$, где $d_1 \to \infty$; $D + D_1 = \cancel{\frac{1}{d_1}} \frac{1}{f_0}$

$D + D_2 = \frac{1}{d_2} + \frac{1}{f_0}$

$D + D_2 = \frac{1}{d_2} + D + D_1$, где $D_2 = \frac{7}{3} D_1$ (вблизи лучи расходятся, глаз уже не собирает $\Rightarrow \frac{D_2}{D_1} > 1 = \frac{7}{3}$)

$\frac{7}{3} D_1 = \frac{1}{d_2} + D_1$

$\frac{4}{3} D_1 = \frac{1}{d_2}$; $D_1 = \frac{3}{4 d_2} = \frac{3}{4 \cdot 0{,}25} = 3$ дптр.

$\begin{cases} \cancel{\frac{1}{d}} \frac{1}{x} + \frac{1}{f_0} = D \\ \frac{1}{f_0} = D + D_1 \end{cases} \Rightarrow \frac{1}{x} + D + D_1 = D$

Чистовик

$$\begin{cases} \dfrac{1}{x} + \dfrac{1}{f_0} = D \\ \dfrac{1}{f_0} = D - D_1 \\ \dfrac{1}{d_2} + \dfrac{1}{f_0} = D - D_2 \end{cases}$$ — по ф-ле тонкой линзы

$$\frac{1}{d_2} = D_1 - D_2. \qquad D_1 = \frac{7}{3} D_2; \; D_2 = \frac{3}{7} D_1$$

$$\frac{1}{d_2} = \frac{4}{7} D_1; \quad \boxed{D_1 = \frac{7}{4 d_2} = \frac{7}{4 \cdot 0{,}25} = 7 \text{ дптр.}}$$

$$D_2 = \frac{3}{7} \cdot 7 = 3 \text{ дптр.}$$

$$\frac{1}{x} = D_1; \quad \boxed{x = \frac{1}{D_1} = \frac{1}{7} = 0{,}143 \text{ м} = 14{,}3 \text{ см}}$$

$$\frac{1}{d_3} + \frac{1}{f_0} = D - D_3$$

$$\frac{1}{d_3} + D - D_1 = D - D_3; \quad D_3 = D_1 - \frac{1}{d_3} = 7 - \frac{1}{0{,}5} = 7 - 2 = 5 \text{ дптр}$$

Ответ: $x \approx 14{,}3$ см; $D_1 = 7$ дптр; $D_3 = 5$ дптр.