Часть 1

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

Шифр: **21202498**

ID профиля: **808359**

Вариант 8

№1. Чистовик ①

Дано:

$\cos\alpha = \frac{3}{5}$

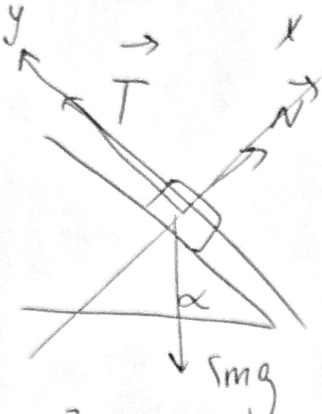
$\cos\beta = \frac{5}{13}$

$m, 5m, H$

$a - ?$

$a_{отн} - ?$

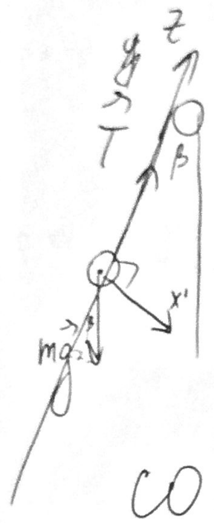
$T - ?$



$O_x: \ N = 5mg\sin\alpha$

$O_y: \ T - 5mg\cos\alpha = 5m a_ш$

$O_z: \ 5mg\cos\alpha + 5m a_ш - mg\cos\beta = = -m a_ш$

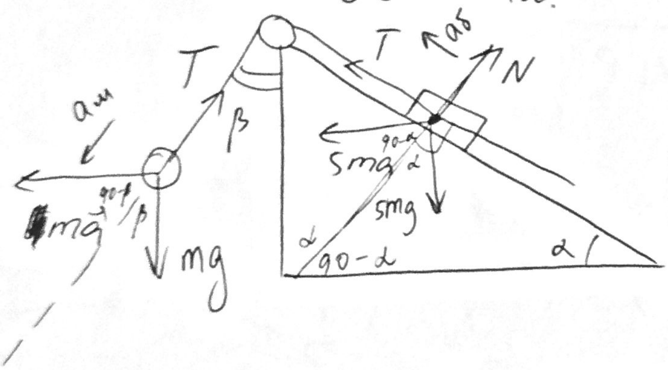


$\cancel{6m a_ш = mg\cos\beta - 5mg\cos\alpha}$

$\cancel{a_ш = \frac{1}{6} g(\cos\beta - 5\cos\alpha)}$

$\cancel{O_{x'}: \ mg\sin\beta = 0}$

СО клина:



$N - 5mg\cos\alpha - 5ma\sin\alpha = 0$

$T + 5ma\cos\alpha - 5mg\sin\alpha = 5m a_ш$

$T = 5m a_ш + 5mg\sin\alpha - 5ma\cos\alpha$

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

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

$(a = g\,tg\beta) = \frac{12}{5} g$

Нить нерастяжима

$a_ш = a_б$

2)
$$\begin{cases} T + 5m\overset{a}{g\,tg\beta}\cos\alpha - 5mg\sin\alpha = 5m a_ш \\ T - mg\cos\beta - ma\sin\beta = m a_ш \end{cases}$$

$5ma\cos\alpha - 5mg\sin\alpha + mg\cos\beta + ma\sin\beta = 4m a_ш$

$\frac{1}{4}(a(5\cos\alpha + \sin\beta) + g(\cos\beta - 5\sin\alpha)) = a_ш$

$a_ш = \frac{1}{4} g(5\cos\alpha\, tg\beta + \sin\beta\, tg\beta + \cos\beta - 5\sin\alpha)$

$a_ш = \frac{1}{4} g(3 \cdot \frac{12}{5} + \frac{12}{13} \cdot \frac{12}{5} + \frac{5}{13} - 4) = \frac{1}{4} g(3{,}2 + \frac{13}{5}) = 1{,}45g$

Чистовик

2

3) $S_{ш} = H : \cos\beta$

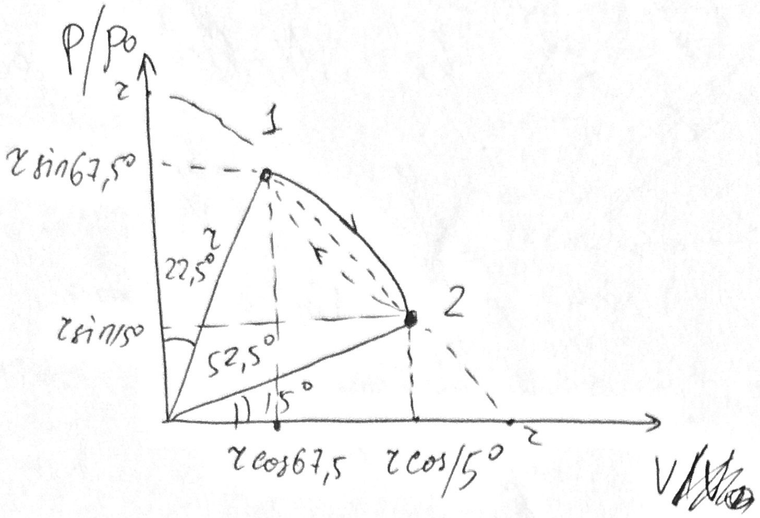
$S_{ш} = \frac{a_{ш}\tau^2}{2}$, $\tau = \sqrt{\frac{2H}{\cos\beta \cdot 1{,}45g}} =$

$\tau = \sqrt{\frac{2S_{ш}}{a_{ш}}}$ $= \sqrt{\frac{2H \cdot 13}{5 \cdot 1{,}45g}} = \sqrt{\frac{26H}{5 \cdot 1{,}45g}} \approx 1{,}9\sqrt{\frac{H}{g}}$

Ответ: 1) $a = g\,tg\beta = \frac{12}{5}g$ 2) $a_{ш} = 1{,}45g$ 3) $\tau = 1{,}9\sqrt{\frac{H}{g}}$

№2.

Чистовик (3)



1)

1: $r\sin 67{,}5° \cdot p_0 \cdot r\cos 67{,}5°\, V_0 = \nu R T_1$

2: $r\cos 15° \cdot p_0 \cdot r\sin 15° \cdot V_0 = \nu R T_2$

$\frac{(1)}{(2)}$: $$\frac{2\sin 67{,}5° \cdot \cos 67{,}5°}{2\cos 15° \cdot \sin 15°} = \frac{T_1}{T_2}$$

$$\frac{\sin 135°}{\sin 30°} = \frac{T_1}{T_2};$$

$$\frac{\frac{\sqrt2}{2}}{\frac{1}{2}} = \frac{T_1}{T_2}; \quad \sqrt2 = \frac{T_1}{T_2}; \quad \sqrt2 - 1 = \frac{T_1 - T_2}{T_2} \approx$$

2) $C = 0 \Rightarrow \delta Q = 0 \Rightarrow p \cdot V^{\frac{5}{3}} = const$ явл-ея $\approx 0{,}414$ кас-ой

$\cancel{p \cdot V^{\frac{5}{3}}}$

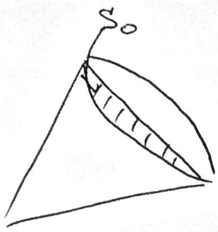
$$p = \frac{const}{V^{\frac{5}{3}}}$$

$$\left(\frac{p}{p_0} - r\right)^2 + \left(\frac{V}{V_0} - r\right)^2 = r^2$$

$$(\sin\alpha - 1)^2 + (\cos\alpha - 1)^2 = 1.$$

Чистовик (4)

3) $\eta = \frac{A}{Q_+}$



$A = S = 2S_0$

$S_0 = S_{сектора} - S_\Delta \qquad S_\Delta = r \cdot r \cdot \frac{1}{2} \cdot \sin 52{,}5^\circ$

$S_{сектора} = \pi r^2 \cdot \frac{52{,}5^\circ}{360^\circ}$

$S_0 = r^2\left(\pi \cdot \frac{52{,}5}{360} - \frac{1}{2}\sin 52{,}5\right) = r^2 \cdot 0{,}0613$

$A = r^2 \cdot 0{,}0613 \cdot 2 \cdot p_0V_0$

$1 \to 2: \quad Q = A + \Delta U = (S_{\square} + S_0) \cdot p_0V_0 + \frac{5}{2}(\nu RT_2 - \nu RT_1) =$

$S_{\square} = \frac{1}{2}(r\cos 15^\circ - r\cos 67{,}5^\circ)(r\sin 15^\circ + r\sin 67{,}5^\circ)$

$\nu RT_2 - \nu RT_1 = \nu RT_2 \cdot \left(-\frac{T_1 - T_2}{T_2}\right) = r^2\cos 15^\circ \sin 15^\circ p_0V_0(1-\sqrt{2})$

$Q = p_0V_0 \cdot r^2\Big(\frac{1}{2}(\overbrace{\cos 15^\circ - \cos 67{,}5^\circ}^{0{,}966 - 0{,}383})(\overbrace{\sin 15^\circ}^{0{,}26} + \overbrace{\sin 67{,}5^\circ}^{0{,}924}) + 0{,}0613 +$

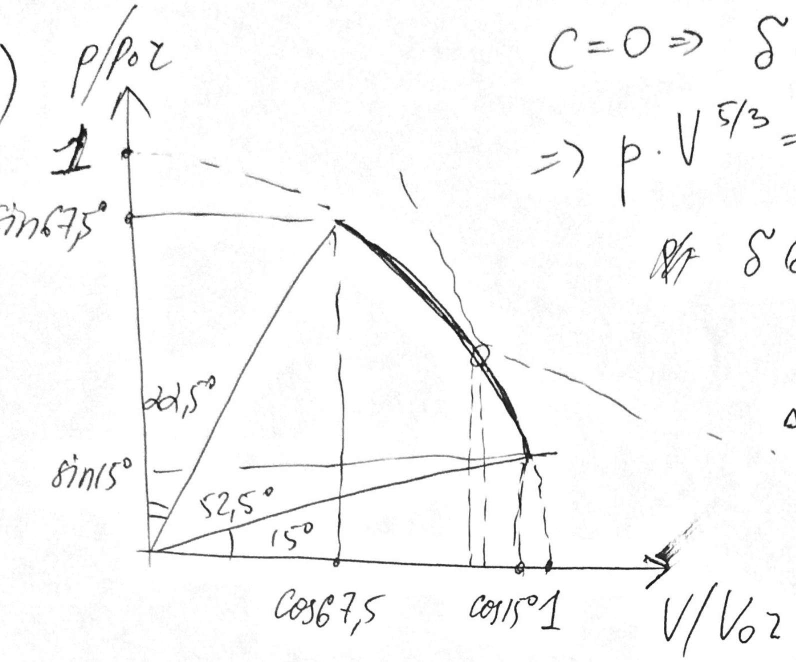
$+ \underbrace{\frac{5}{2}\cos 15^\circ \sin 15^\circ}_{=\frac{5}{8}}(1-\sqrt{2})\Big) = p_0V_0r^2\left(\frac{1}{2} \cdot 0{,}583 \cdot 1{,}2 + 0{,}0613 + \frac{5}{8}(1-\sqrt{2})\right) =$

$= p_0V_0r^2\left(0{,}4111 - (\sqrt{2}-1) \cdot \frac{5}{8}\right) = p_0V_0r^2 \cdot 0{,}152$

$Q_{21} < 0, \quad Q_{21} = -Q_-$

$\eta = \frac{p_0V_0 \cdot r^2 \cdot 2 \cdot 0{,}0613}{p_0V_0r^2 \cdot 0{,}152} = 0{,}80658 \approx 81\%$

Чистовик 5

2) 

$C=0 \Rightarrow \delta Q = 0 \Rightarrow$

$\Rightarrow p \cdot V^{5/3} = const$ явл-ся кас.-ой $\left(\frac{const}{V^{5/3}}\right)' = \sqrt{(V_0\tau)^2 - V^2}'$

$\delta Q = \Delta U + \delta A = 0$

$\Delta U = -\delta A$

$\Delta U = \frac{5}{2} \nu R \Delta T = \frac{5}{2} \Delta(pV) =$

$= \frac{5}{2} \Delta p \cdot V + \frac{5}{2} p \cdot \Delta V$

$\delta A = \left(p + \frac{\Delta p}{2}\right) \cdot \Delta V$

$\frac{5}{2} V \Delta p + \frac{5}{2} p \Delta V = p \Delta V + \frac{1}{2} \underbrace{\cancel{\Delta p \Delta V}}_{=0}$

$\frac{\Delta p}{p} = p' = \cos\alpha$

$\Delta p = p \cdot p' = \cos\alpha \cdot \sin\alpha \, p_0\tau$

$\frac{5}{2} V \Delta p + \frac{3}{2} p \Delta V = 0 \; | : p_0 V_0 \tau^2$

$\frac{5}{2} \cos\alpha \cdot \cancel{\cos\alpha \sin\alpha} + \frac{3}{2} \sin\alpha (-\cancel{\sin\alpha) \cos\alpha} = 0;$ $\frac{\Delta V}{V} = V' = -\sin\alpha$

$\Delta V = V'V = -\sin\alpha \, V_0 \tau \cos\alpha$

$\frac{5}{2} \cos\alpha - \frac{3}{2} \sin\alpha = 0;$

$5\cos\alpha - 3\sin\alpha = 0$

$5\cos\alpha = 3\sin\alpha;$

$\boxed{tg\,\alpha = \frac{5}{3}} \Rightarrow \alpha \approx 59° \Rightarrow$ да

Ответ: 1) $\sqrt{2} - 1 = \frac{T_1 - T_2}{T_2}$; 2) $tg\,\alpha = \frac{5}{3}$ 3) $\eta \approx 81\%$

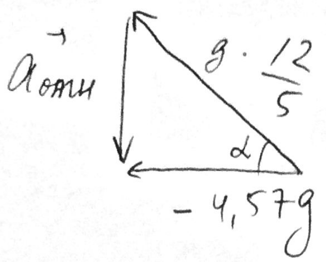
$$\eta = \frac{\left(\pi \cdot \frac{52,5}{360} - \frac{1}{2}\sin 52,5°\right) \cdot 2}{\frac{1}{2}(\cos 15° - \cos 67,5°)(\sin 15° + \sin 67,5°) + \frac{5}{2}(\cos 15° \sin 15° (1 - \sqrt{2})) + \left(\frac{\pi \cdot 52,5}{360} - \frac{1}{2}\sin 52,5°\right)}$$

$$= g \cdot \frac{16 - \frac{48}{25 - \frac{5}{13}}}{3} = \boxed{4{,}57g = 45{,}7 \text{ м/с}^2}$$

Черновик

$$\vec{a}_{отн} = \vec{a}_1 - \vec{a}_2$$

по т. cos:



$$\frac{a_{отн}^2}{g^2} = \left(\frac{12}{5}\right)^2 + 4{,}57^2 - 2 \cdot \frac{12}{5} \cdot 4{,}57 \cdot \cos\alpha;$$

$$\frac{a_{отн}^2}{g^2} = 5{,}76 + 20{,}885 - 13{,}1616$$

$$\frac{a_{отн}^2}{g^2} = 13{,}4834$$

$$a_{отн} = 3{,}672g = 36{,}72 \text{ м/с}^2$$

$$S_ш = \frac{H}{\cos\beta} = \frac{13}{5} H.$$

$$a_ш = g\,tg\beta = \frac{12}{5} g$$

$$S_ш = \frac{a_ш \tau^2}{2} \quad (v_0 = 0)$$

$$\frac{2S_ш}{a_ш} = \tau^2; \quad \tau = \sqrt{\frac{2S_ш}{a_ш}} = \sqrt{\frac{2 \cdot H}{\cos\beta \cdot g \cdot tg\beta}} = \sqrt{\frac{2H}{g \sin\beta}} = \sqrt{\frac{2H \cdot 13}{g \cdot 12}} =$$

$$= \sqrt{\frac{13H}{6g}}$$

Ответ: 1) $a = 4{,}57g$ 2)

$$\frac{1}{2} \cdot \frac{1}{2} - \sin 15 \cos 67{,}5^\circ + \cos 15^\circ \sin 67{,}5 - \frac{1}{2} \cdot \frac{\sqrt{2}}{2} =$$

$$= \frac{1}{4} - \frac{\sqrt{2}}{4} + \sin 52{,}5 = \frac{1}{4} - \frac{\sqrt{2}}{4} + 0{,}8 = 1{,}043 - \frac{\sqrt{2}}{4}$$

$$\frac{1}{2}\left(\frac{1-\sqrt{2}}{4} + \sin 52{,}5^\circ\right) + \frac{5}{8}(1-\sqrt{2}) +$$

№1

~~Чистовик~~

Черновик

Дано:

$\cos\alpha = \frac{3}{5}$

$\cos\beta = \frac{5}{13}$

$m,\ 5m$

H

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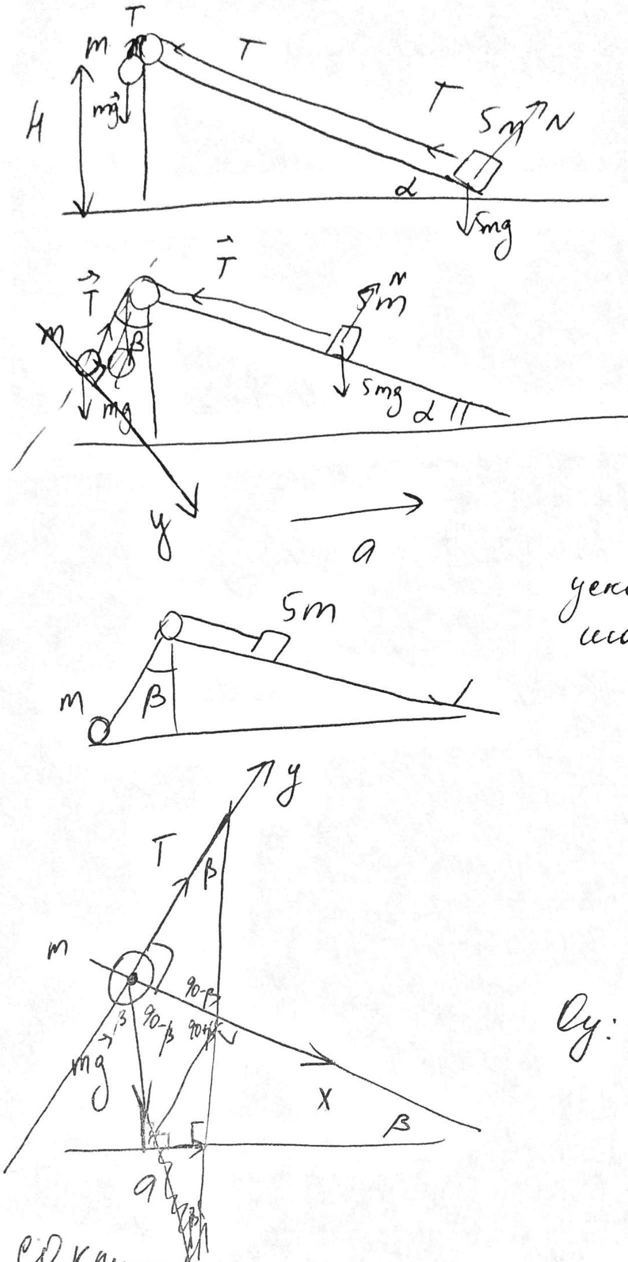
a — ?

$a_{отн}$ — ?

τ — ?



$$\vec T + m\vec g = m\vec a_{ш}$$

$$\vec T + 5m\vec g + \vec N = 5m\vec a_{б}$$

Ox: $mg\cos(90-\beta) = m a_{ш}\cos\beta$

$\cancel{m}g\sin\beta = \cancel{m}a_{ш}\cos\beta$

ускорение шарика → $a_{ш} = g\,tg\beta = \frac{12}{5}g$

Нить нерастяжима:

$\Delta S_{ш} = \Delta S_{б}$

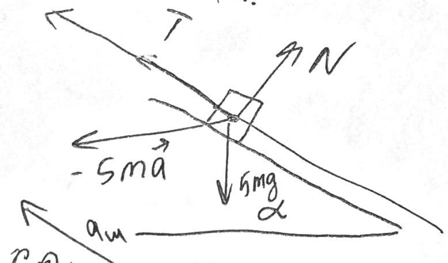
$\Delta v_{ш} = \Delta v_{б}$

$a_{ш} = a_{б} = a_1.$

Oy: $T - mg\cos\beta = m a_{ш}\sin\beta$

$T = mg\cos\beta + m a_{ш}\sin\beta = mg(\cos\beta + tg\beta\sin\beta)$

СО клина:



$\vec F_{ин} = -5m\vec a$

СО:

Oz: $T + 5ma\cos\alpha - 5mg\sin\alpha = 5m a_{ш}$

$\cancel{m}g\cos\beta + \cancel{m}a_{ш}\sin\beta + 5\cancel{m}a\cos\alpha - 5\cancel{m}g\sin\alpha = 5\cancel{m}a_{ш};$

$g\cos\beta - 5g\sin\alpha + 5a\cos\alpha = 5a_{ш} - a_{ш}\sin\beta;$

$5a\cos\alpha = a_{ш}(5-\sin\beta) + g(5\sin\alpha - \cos\beta)$

$$\boxed{a = \frac{a_{ш}(5-\sin\beta) + g(5\sin\alpha - \cos\beta)}{5\cos\alpha}} = \frac{g(tg\beta(5-\sin\beta) + 5\sin\alpha - \cos\beta)}{5\cos\alpha} = \frac{g\left(\frac{12}{5}\left(5-\frac{4}{5}\right) + 4 - \frac{5}{13}\right)}{\cancel{5}\cdot\frac{3}{\cancel{5}}} = \frac{g\left(12 - \frac{48}{25} + 4 - \frac{5}{13}\right)}{3}$$

Часть 2

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

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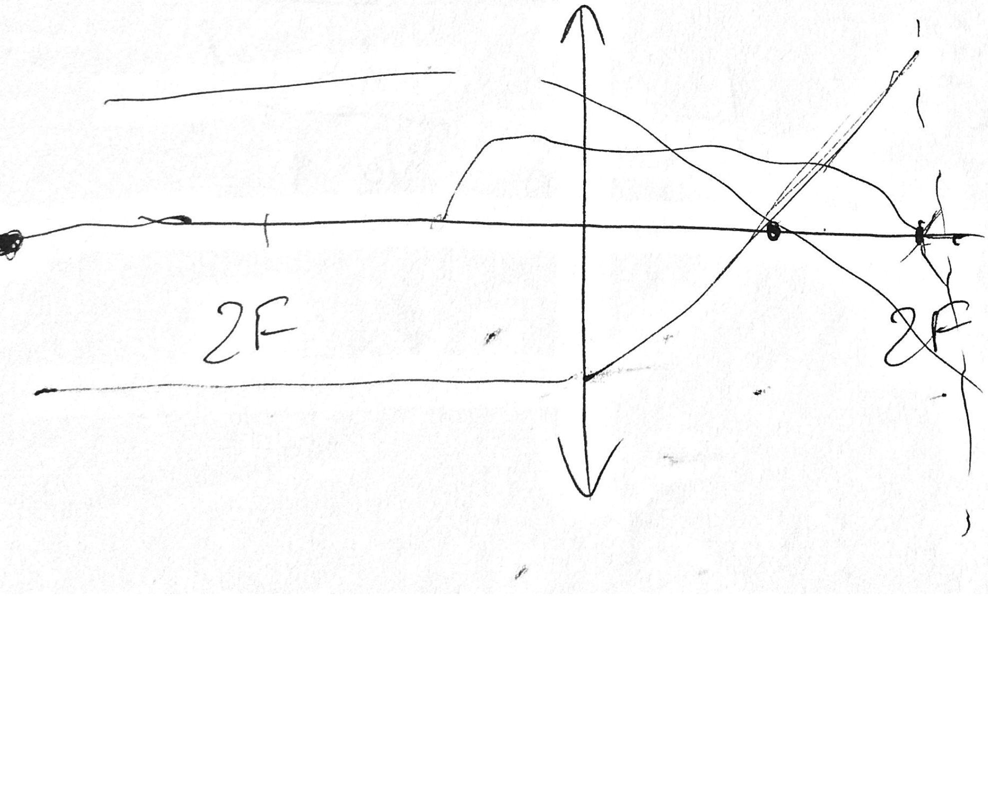
Вариант 8



$$4 + \frac{1}{C} = \frac{1}{F} - 5D$$

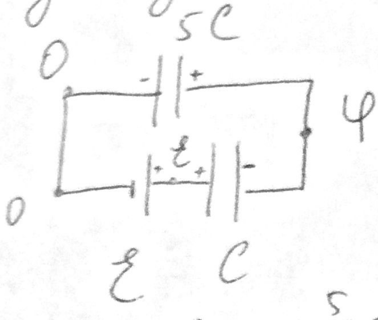
$$\frac{1}{C} = \frac{1}{F} - D$$

$$4 = -4D$$

$$D = -1.$$

№3 Чистовик 1

1) до замыкания:



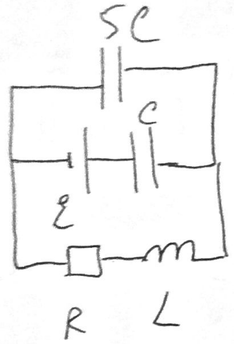
$$-\cancel{C}(\mathcal{E}-\varphi)+5\cancel{C}(\varphi-0)=0 \text{ (з. с. з.)}$$

$$\varphi-\mathcal{E}+5\varphi=0; \quad U_{5C}=\frac{\mathcal{E}}{6},$$

$$6\varphi=\mathcal{E} \quad U_C=\frac{5}{6}\mathcal{E}$$

$$q_1=+\frac{5}{6}\mathcal{E}C \quad \varphi=\frac{\mathcal{E}}{6}.$$

$t=0$:



Т.к. ток в катушке скачком не меняется, как и напр. на конденс., то:

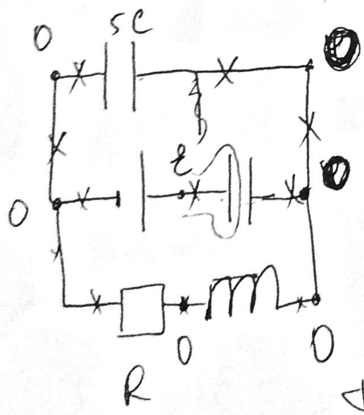
$$J_L(0)=0 \Rightarrow J_R=0 \Rightarrow U_R=0$$

$$U_{5C}(0)=\frac{\mathcal{E}}{6}$$

$$U_{5C}=U_{RL} \Rightarrow U_L=U_{5C}=\frac{\mathcal{E}}{6}=L\frac{\Delta J}{\Delta t},$$

$$\frac{\Delta J}{\Delta t}(0)=\frac{\mathcal{E}}{6L}$$

2) $t=\tau$ (уст. режим)



$J=0$ (через конд. ток не течёт)

$$W(\tau)=W_C(\tau)+W_{5C}(\tau)$$

~~$W_C(\tau)=W_C(0)$ т.к. [illegible] заряд~~

~~$U_{5C}(\tau)=U_{5C}(0)$~~

Т.к. $J_L=\text{const}$, $U_L=0$; $J=0 \Rightarrow U_R=0 \Rightarrow U_{5C}=U_{RL}=0$

$\Rightarrow U_C=\mathcal{E}$

$A_{ист} = W_2 - W_1 + Q$ Чистовик 2

$A_{ист} = \mathcal{E}\,\Delta q = \mathcal{E}\cdot\frac{1}{6}C\mathcal{E}$

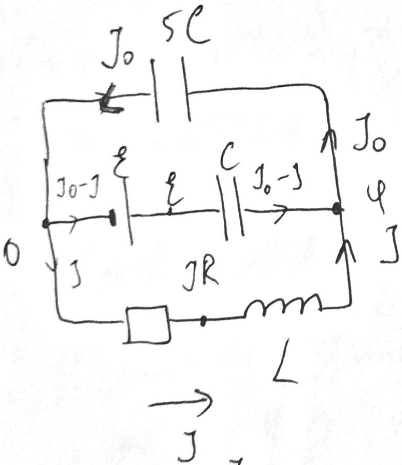
$$\frac{1}{6}\mathcal{E}^2\cdot C = \frac{C\mathcal{E}^2}{2} - \left(\frac{5C}{2}\cdot\frac{\mathcal{E}^2}{36} + \frac{C}{2}\cdot\frac{25\mathcal{E}^2}{36}\right) + Q,$$

$$Q = \frac{C\mathcal{E}^2\cdot 6}{36} - \frac{18C\mathcal{E}^2}{36} + \left(\frac{5C\mathcal{E}^2}{72} + \frac{25C\mathcal{E}^2}{72}\right) = -\frac{12C\mathcal{E}^2}{36} + \frac{15C\mathcal{E}^2}{36} =$$
$$= +\frac{3C\mathcal{E}^2}{36} = \frac{C\mathcal{E}^2}{12}$$

3) $t = t$

$q = 5C\cdot U_{5C}$ $\quad J_{5C} = 5C\cdot(U'_{5C}) = 5C\cdot\frac{\Delta U_{5C}}{\Delta t}$

$J_0 = (5C\cdot U_{5C})' = 5C\cdot(U'_{5C})$



$L\frac{dJ}{\Delta t} + JR = \mathcal{E} - U_C = U_{5C}$

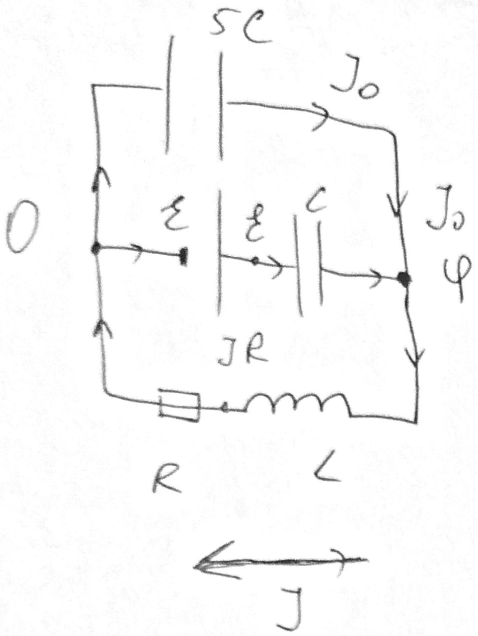
$L\frac{\Delta J}{\Delta t} + JR = U_{5C}$

$\varphi = JR + L\frac{\Delta J}{\Delta t}$

$J_0 = 5C\cdot\left(L\frac{\Delta J}{\Delta t} + JR\right)'$

$\frac{J_0}{5C} = \left(L\frac{\Delta J}{\Delta t} + JR\right)'$

$\frac{J_{5C}}{5C}\cdot\Delta t = \Delta\left(L\frac{\Delta J}{\Delta t} + JR\right);$



$\varphi = JR + L\frac{\Delta J}{\Delta t}$ ~3. Чистовик ③

$J_{5C} = 5C\cdot U'_{5C}$

$U_{5C} = \varphi = JR + \frac{L\Delta J}{\Delta t}$

$J_{5C} = 5C\cdot\frac{\Delta\left(JR + \frac{L\Delta J}{\Delta t}\right)}{\Delta t}$

$J_{5C}\cdot\Delta t = 5C\cdot\Delta\left(JR + \frac{L\Delta J}{\Delta t}\right)$

$J_{5C}\cdot t = 5C\cdot\left(JR + \frac{L\Delta J}{\Delta t} - \frac{5}{6}C\mathcal{E}\right)$

$J_0 = 5C\cdot\frac{\Delta U_{5C}}{\Delta t}$

$J_{5C} = 5C\cdot\frac{\Delta U_{5C}}{\Delta t}$

$J_{5C}\Delta t = 5C\cdot\Delta U_{5C}$

$J_0\cdot t = 5C\cdot\left(JR + \frac{L\Delta J}{\Delta t} - \frac{1}{6}\mathcal{E}\right)$

$J_0\Delta t = 5C\cdot\Delta U_{5C}$

$J_0\cdot t = 5C\left(\varphi - \frac{1}{6}\mathcal{E}\right)$

$t = \frac{5C}{J_0}\left(\varphi - \frac{1}{6}\mathcal{E}\right)$

$J_0 = 5C\cdot(J'R + LJ'')$

$J'R + LJ'' = \frac{J_0}{5C}$

$(JR + LJ')' = \frac{J_0}{5C}$

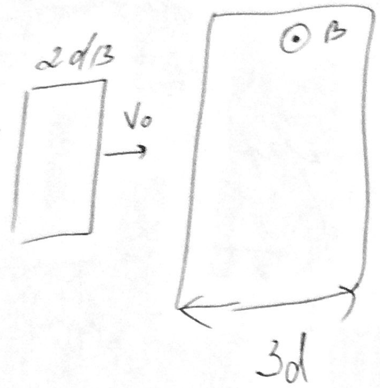
$JR + LJ' = \frac{J_0}{5C}\cdot t + \frac{\mathcal{E}}{6}$

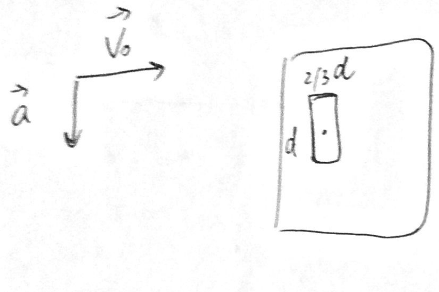
$LJ' = \frac{J_0 t}{5C} + \frac{\mathcal{E}}{6} - JR$

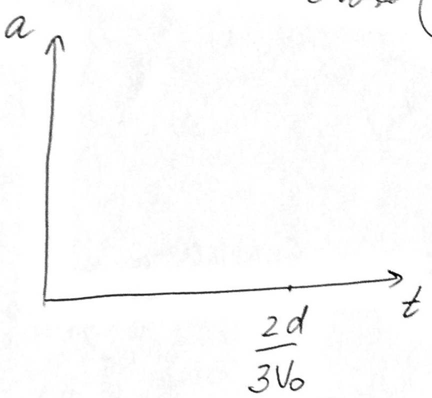
$J' = \frac{J_0 t}{5CL} + \frac{\mathcal{E}}{6L} - \frac{JR}{L}$

$\cancel{J = \frac{J_0 t^2}{2\cdot 5CL} + \frac{\mathcal{E}t}{6L} - \frac{R}{L}}$

¼ стойки (4)







$$\Phi = B \cdot S \cdot \cos\alpha$$

$$\mathcal{E} = \frac{B \cdot \Delta S}{\Delta t} = B \cdot d \cdot V$$

$$F = B \cdot J \cdot l = B \cdot l \cdot \frac{\mathcal{E}}{R} = B \cdot l(t) \cdot \frac{\mathcal{E}(t)}{R}$$

$$Тл \cdot м^2 \cdot м/с = \frac{Н}{\cancel{м/с} \cdot Кл} \cdot м^2 \cdot \cancel{м/с} = \frac{Н \cdot м^2}{Кл}$$

нах в поле

$$F = B \cdot \frac{l}{R} \cdot B \cdot d \cdot V$$

$$a(t) = B \cdot \left(d + \frac{2d}{3}\right) \cdot 2 \cdot \frac{B \cdot d \cdot V_0}{R} =$$

$$= B^2 \cdot \frac{5d}{3} \cdot 2 \cdot d \cdot \frac{V_0}{R}$$

$$t_{проходa} = \frac{3d + \frac{2}{3}d}{V_0}$$

№5. Чистовик

(5)

$f < 0{,}25$ м

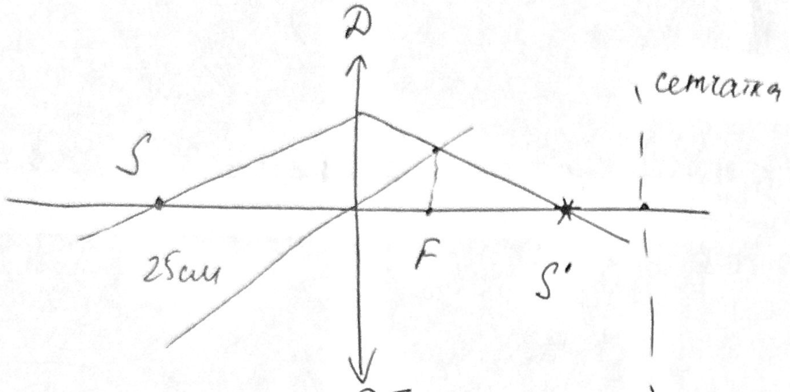
$D = \frac{1}{F}$

Близорукий => И формируется до сетчатки => ему нужны рассеив. очки

$\frac{1}{F} - \frac{1}{F_1} = D_{бс}$

$\frac{1}{0{,}25} + \frac{1}{c} = D_{бс}$

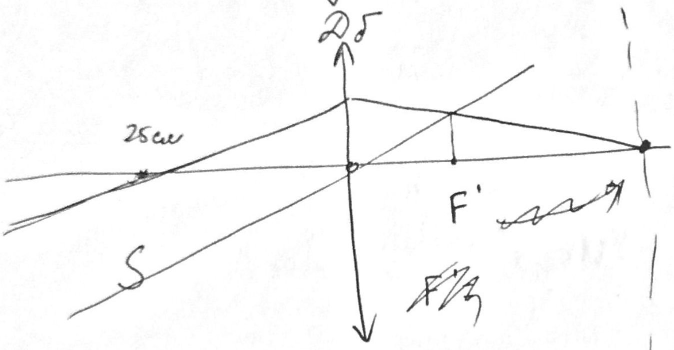
расст. до сетч.

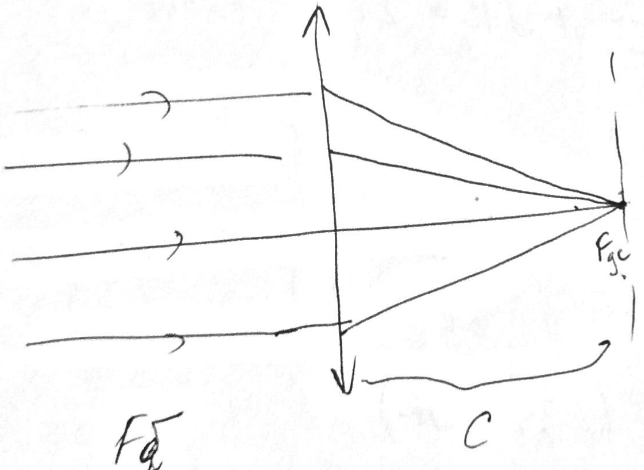


Для удален. предметов И формируется в фокусе

$F_д = c$

$D_{дс} = \frac{1}{c}$





$\frac{D_д}{D_б} = 5 \Rightarrow \frac{F_б}{F_д} = 5$

$F_б = 5F_д$

$4 + \frac{1}{c} = D_{бс}$; $D_{дс} = \frac{1}{c}$

$4 + \frac{1}{c} = \frac{-1}{F_д} + \frac{1}{F}$

$\frac{1}{c} = -\frac{1}{F_б} + \frac{1}{F}$

−5 дптр

Чистовик

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$$\frac{1}{F_g} + \frac{1}{C} = \frac{1}{F} \qquad \frac{1}{x} = \frac{1}{F} - \frac{1}{C}$$

$$x = F_g = \frac{1}{5}м = 20\ см$$

2) $$\frac{1/2}{x} + \frac{1}{C} = \frac{1}{F} + D'$$

$$\frac{1/2}{x} = \frac{1}{x} + D'$$

$$D' = -\frac{1/2}{x} = -\frac{1}{0{,}4} = -2{,}5\ дптр$$

Ответ: 1) 20 см; −5 дптр; 2) −2,5 дптр.

$$\boxed{\begin{aligned} &4 + \frac{1}{C} = -D + \frac{1}{F} \\ &\frac{1}{C} = -5D \\ &4 = +4D \\ &D = +1 \Rightarrow -5D = -5\ дптр \end{aligned}}$$