Часть 1

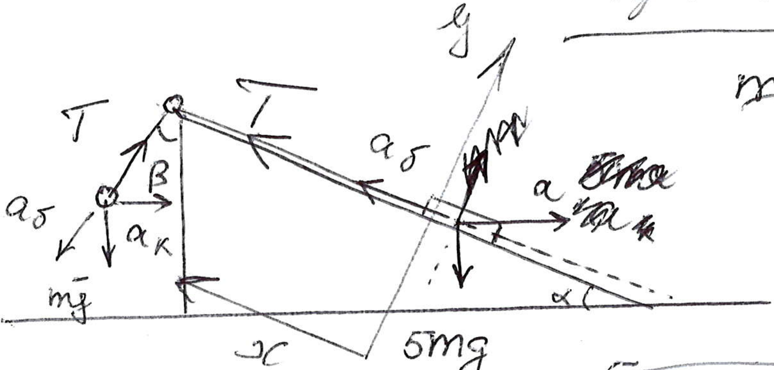
Олимпиада: **Физика, 11 класс (1 часть)**

Шифр: **21200690**

ID профиля: **297799**

Вариант 8

черновик



$\cancel{ma_б = mg\cos\beta - T}$

$\cancel{T = mg\cos\beta - ma_б}$

$\cancel{5ma_б = T - 5mg\sin\alpha - 5ma\cos\alpha}$

$\cancel{ma_б = ma_к}$

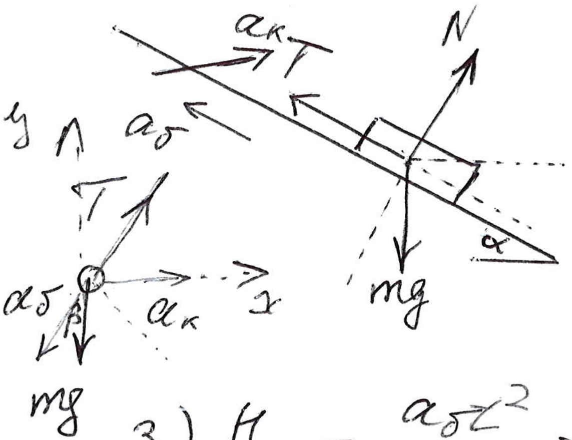
$5mg\cos\alpha = 5ma\sin\alpha$

$\cancel{N + 5ma\sin\alpha = 5mg\cos\alpha}$

$a = g\,ctg\,\alpha = \frac{3}{4}g$

$ctg\,\alpha = \frac{3}{4}$ $\quad \sin\alpha = \frac{4}{5}$

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



$\cancel{ma_к = T\sin\alpha}$

$\cancel{m(a_к - a_б\sin\beta) = T\sin\beta}$

$ma_б$

$\cancel{\Delta U = Q}$

$\Delta U = A$

3) $\frac{H}{\cos\beta} = \frac{a_б t^2}{2} \to t = \sqrt{\frac{2H}{g\cos\beta}}$

$5ma_к\sin\alpha = N - 5mg\cos\alpha$

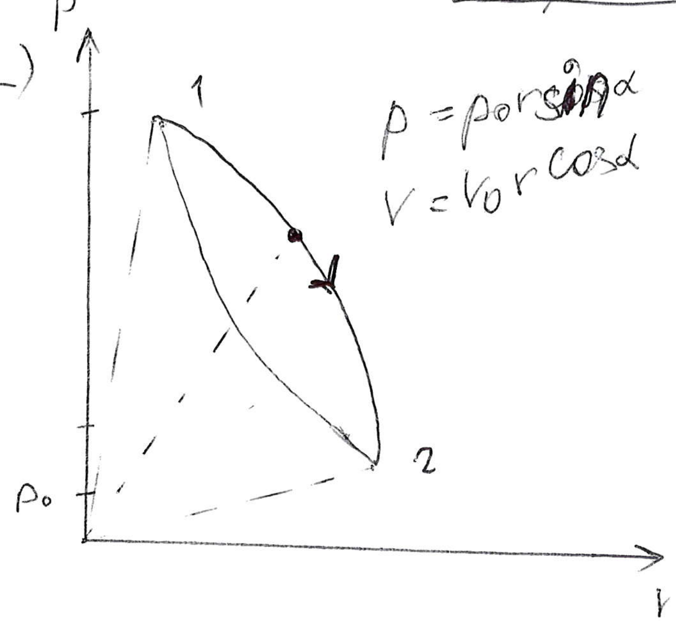
$5ma_б = T - 5mg\sin\alpha - 5ma_к\cos\alpha$

$6ma_б = mg(\cos\beta - 5\sin\alpha) - 5ma_к\cos\alpha$

1) $m(a_к - a_б\sin\beta) = T\sin\beta$

2) $ma_б\cos\beta = mg$

черновик

2) 

$p = p_0 r \sin\alpha$

$V = V_0 r \cos\alpha$

① $\frac{p_1}{p_0} = r\cos 22{,}5$

$\frac{V_1}{V_0} = r\sin 22{,}5$

② $\frac{p_2}{p_0} = r \cancel{\cos} \sin 15$

$\frac{V_2}{V_0} = r\cos 15$

1) $p_0 r\cos 22{,}5 \, V_0 r \sin 22{,}5 = \nu R T_1$

$p_0 V_0 \frac{r^2}{2} \sin 45 = \nu R T_1$ $\quad$ $p_0 V_0 \frac{r^2}{2} \sin 30 = \nu R T_2$

$T_1 = \frac{p_0 V_0 r^2 \sin 45}{2\nu R}$ $\quad$ $T_2 = \frac{p_0 V_0 r^2 \sin 30}{2\nu R}$

$\frac{T_1 - T_2}{T_2} = \frac{T_1}{T_2} - 1 = \frac{\sin 45}{\sin 30} - 1 = \sqrt{2} - 1$

2) $C = 0$; $\quad Q = 0 \longrightarrow \Delta U = A$

$\frac{5}{2}\nu R \Delta T = A$ $\quad$ $pV^{\frac{C - C_p}{C - C_V}} = const$

3) $\cancel{pV^{\frac{C_p}{C_V}} = const}$ $\quad$ $pV^{\gamma} = const$

$\cancel{\gamma = \frac{0 - C_p}{0 - C_V}} = \cancel{\frac{C - \frac{5}{2}C}{C - \frac{7}{2}C}} = \cancel{\frac{-3/2}{-5/2}} = \frac{3}{5}$

$C_p = C_V + R = \frac{7}{2}R$

$\cancel{pV^{3/5} = const}$ $\quad$ $\cancel{C_p = \frac{5}{2}R \quad C_V = \frac{3}{2}R}$

$pV^{7/5} = const$ $\quad$ $\cancel{\frac{-3/2}{-1/2}}$ $\quad$ $\cancel{pV^{5/3} = const}$

$\cancel{p = p_0 \; p_0 r \cos}$

$p_0 r \sin\alpha \cdot (V_0 r\cos\alpha)^{7/5} = const$

$\eta = \frac{Q_H - Q_X}{Q_H}$

$\cancel{ma_к} = \quad m(a_к - a_б \sin\beta) = T\sin\beta$

$$m(a_б - a_к \sin\beta) = mg\cos\beta - T$$

$$\begin{cases} m\left(a_к - \frac{12}{13}a_б\right) = \frac{12}{13}T & (1) \\ m\left(a_б - \frac{12}{13}a_к\right) = \frac{5}{13}mg - T & (2) \\ m\left(a_б - \frac{3}{5}a_к\right) = T - \frac{3}{5}mg & (3) \end{cases}$$

$a_к - ?$ $\quad T = \frac{13}{12}ma_к - ma_б$ (из 1)

$$\cancel{ma_б} - \frac{12}{13}ma_к = \frac{5}{3}mg - \frac{13}{12}ma_к + \cancel{ma_б}$$

$$\left(\frac{13}{12} - \frac{12}{13}\right)a_к = \frac{5}{3}g \qquad \frac{25}{156}a_к = \frac{5}{3}g$$

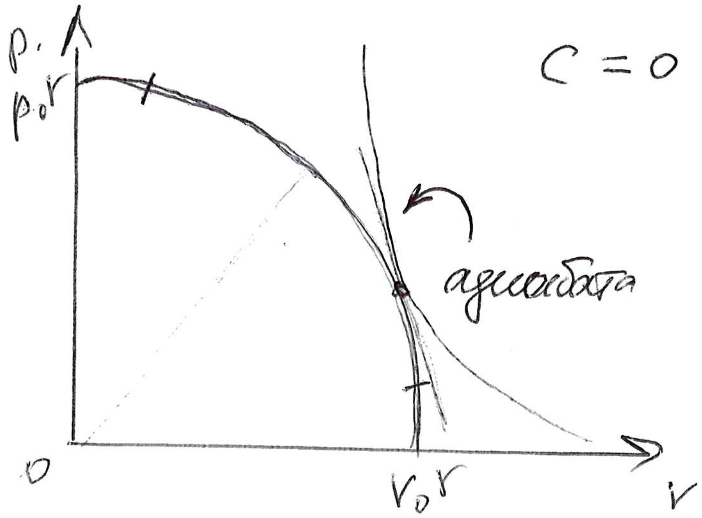
$$a_к = \frac{3\cdot 25}{156\cdot 5} = \frac{5}{52}g$$

$$T = \frac{13}{12}m\cdot\frac{5}{52}g - ma_б$$

$$T = \frac{5}{48}g - ma_б$$

$$m\left(a_б - \frac{3}{52}g\right) = \frac{5}{48}mg - ma_б - \frac{3}{5}mg$$

$$2ma_б = mg\left(\frac{3}{52} + \frac{5}{48} - \frac{3}{5}\right)$$



$C = 0$ $\quad pV^{\frac{c_p}{c_v}} = const$

$pV^{\frac{7}{5}} = const$

$\frac{5}{2}\nu R\, dT = \quad p'V^{\frac{7}{5}} + p\frac{7}{5}V'V^{\frac{2}{5}} = 0$

$\cancel{p^2 + R} \quad p^2 + V^2 = const$

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

$2pp'\frac{1}{p_0^2} + 2VV'\frac{1}{V_0^2} = \cancel{0} \quad p'V^{\frac{7}{5}} + \frac{7}{5}V'V^{2/5} = 0$

$p'\left(\frac{2p}{p_0^2} - V^{\frac{7}{5}}\right) + V'\left(\frac{2}{V_0^2} - \frac{7}{5}\right.$ $\qquad \frac{p}{p_0} = r \quad \frac{V}{V_0} = r$

$\frac{5}{2}(p\,dV + V\,dp) =$

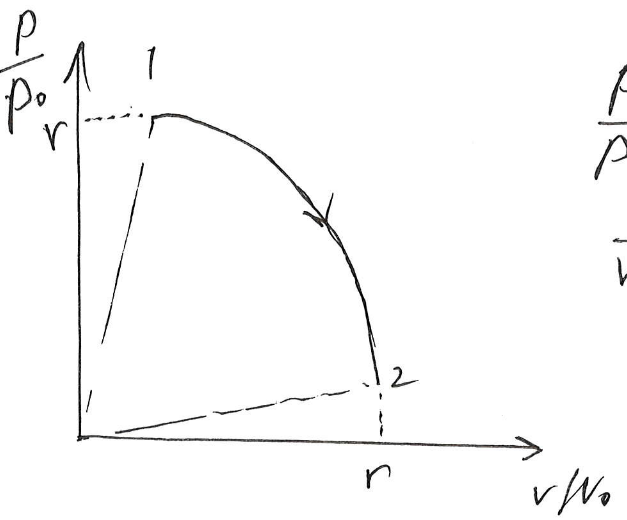
$A_{21} = \Delta U_{21} = \frac{5}{2}\nu R \cdot \frac{p_0V_0r^2}{2\nu R}\left(\sin 30 - \sin 45\right) = \frac{5}{2}p_0V_0r^2\left(\frac{1}{2} - \frac{\sqrt{2}}{2}\right)$

$p = const\, V^{-7/5}$ $\qquad \frac{p_{max}}{p_0} = \frac{V_{max}}{V_0} = r$

$p_0 r\,\cancel{\cos\alpha}\,\sin\alpha = const\, V_0 r \cos\alpha$

$\Delta U = A$

№ 2



$\frac{p_1}{p_0} = r\cos 22{,}5 \quad p_1 = p_0 r \cos 22{,}5$

$\frac{V_1}{V_0} = r\sin 22{,}5 \quad V_1 = V_0 r \sin 22{,}5$

$p_2 = p_0 r \sin 15$

$V_2 = p_0 r \cos 15$

1) $p_1 V_1 = \nu R T_1$; $p_0 V_0 r^2 \frac{\sin 45}{2} = \nu R T_1 \to T_1 = \frac{p_0 V_0 r^2 \sin 45}{2 \nu R}$

$p_2 V_2 = \nu R T_2$; $p_0 V_0 r^2 \frac{\sin 30}{2} = \nu R T_2 \to T_2 = \frac{p_0 V_0 r^2 \sin 30}{2 \nu R}$

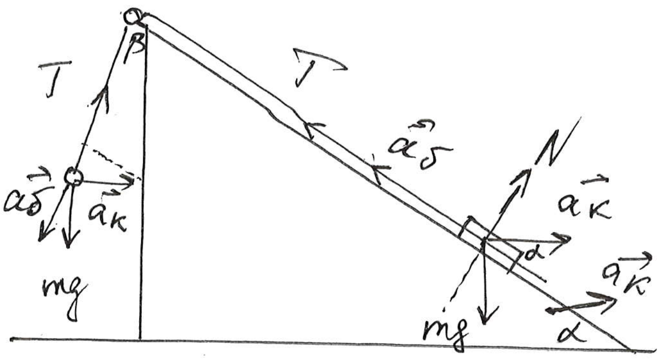
$\frac{T_1 - T_2}{T_2} = \frac{T_1}{T_2} - 1 = \frac{\sin 45}{\sin 30} - 1 = \sqrt{2} - 1$

2) $C = 0 \to$ адиабата $\Delta U = A$

$pV^{\frac{C_p}{C_V}} = const \qquad C_p = C_V + R = \frac{7}{2}R$

$pV^{7/5} = const$

По св. окр.: $\left(\frac{p}{p_0}\right)^2 + \left(\frac{V}{V_0}\right)^2 = const$



По II закону Ньютона для шарика:

на ось сонапр. с $\vec{a_к}$:

$$m(a_к - a_б \sin\beta) = T\sin\beta$$

на ось сонапр. с $\vec{a_б}$:

$$m(a_б - a_к \sin\beta) = mg\cos\beta - T$$

Подставим $\cos\alpha = \frac{3}{5}$, $\cos\beta = \frac{5}{13}$; $\sin\alpha = \frac{4}{5}$; $\sin\beta = \frac{12}{13}$

$$m\left(a_к - \frac{12}{13}a_б\right) = \frac{12}{13}T \quad (1)$$

$$m\left(a_б - \frac{12}{13}a_к\right) = \frac{5}{13}mg - T \quad (2)$$

из (1): $T = \frac{13}{12}ma_к - ma_б \rightarrow (2)$:

$$\cancel{ma_б} - \frac{12}{13}ma_к = \frac{5}{13}mg - \frac{13}{12}ma_к + \cancel{ma_б}$$

$$\frac{25}{12\cdot 13}a_к = \frac{5}{13}g \rightarrow a_к = \frac{12}{5}g$$ ← Ответ на п1

По II закону Ньютона для бруска:

на ось сонапр. с $\vec{a_б}$:

$$m\left(a_б - \frac{3}{5}a_к\right) = T - \frac{4}{5}mg \qquad \left(\cos\alpha = \frac{3}{5}\right) \left(\sin\alpha = \frac{4}{5}\right)$$

$$T = \frac{13}{12}\cdot\frac{12}{5}mg - ma_б = \frac{13}{5}mg - ma_б$$

$$ma_б - \frac{3}{5}ma_к = \frac{13}{5}mg - ma_б - \frac{4}{5}mg$$

$$2ma_б = \frac{36}{25}mg + \frac{13}{5}mg - \frac{4}{5}mg$$

$$2ma_б = \frac{-9}{25}mg \rightarrow |a_б| = \frac{9}{50}g$$ ← Ответ на п2

3) $$\frac{H}{\cos\beta} = \frac{(a_б\cos\beta)t^2}{2} \rightarrow t = \frac{1}{\cos\beta}\sqrt{\frac{2H}{a_б}} =$$ ← Ответ на п3

$$= \frac{13}{5}\cdot\sqrt{\frac{100Hg}{9}} = \frac{13\cdot 10}{5\cdot 3}\sqrt{Hg} = \frac{26}{3}\sqrt{Hg}$$

Часть 2

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

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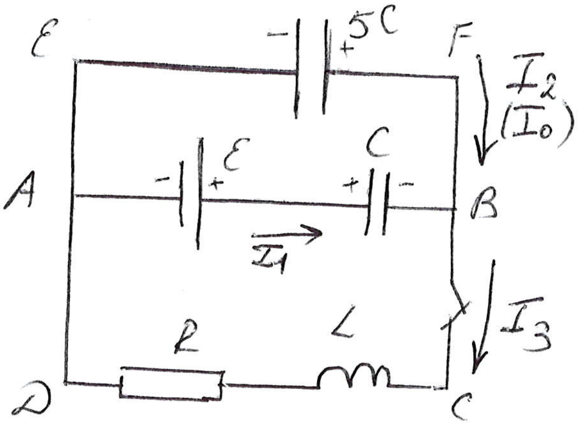
Вариант 8

№3



До замыкания ключа:

$\frac{1}{C_{общ}} = \frac{1}{C} + \frac{1}{5C}$; $C_{общ} = \frac{5}{6}C$

(батарея у конд)

$q = \frac{5}{6}C\mathcal{E} = 5CU_2 = CU_1$

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

(т.к. конд. соединены послед.)

После замыкания:

Для ABCD: $\mathcal{E} = \frac{5\mathcal{E}}{6} + LI_3' + \cancel{I_3}^{0} R \to LI_3' = \frac{\cancel{5}\,\mathcal{E}}{6}$

Через длительное время после $I_3' = \frac{\mathcal{E}}{6L}$ ← ответ на п1

замыкания ключа ток в цепи прекратится,

$U_2' = 0$; $U_1' = \mathcal{E}$

По ЗСЭ: $W_1 + W_2 + \Delta q\,\mathcal{E} = W_1' + \cancel{W_2'}^{0} + Q + \cancel{W_L}^{0}$

$W_1 = \frac{CU_1^2}{2} = \frac{25C\mathcal{E}^2}{72}$; $W_2 = \frac{C\mathcal{E}^2}{72}$; $\Delta q = C\mathcal{E} - \frac{5}{6}C\mathcal{E} = \frac{C\mathcal{E}}{6}$

$\frac{25C\mathcal{E}^2}{72} + \frac{C\mathcal{E}^2}{72} + \frac{C\mathcal{E}^2}{6} = \frac{C\mathcal{E}^2}{2} + Q \to Q = \frac{C\mathcal{E}^2}{36}$ ← ответ на п2

Для ABFE: $\mathcal{E} = U_1 + U_2 \to \dot{U}_1 + \dot{U}_2 = 0 \to \dot{U}_1 = -\dot{U}_2$

($\dot{U}_1 > 0$)

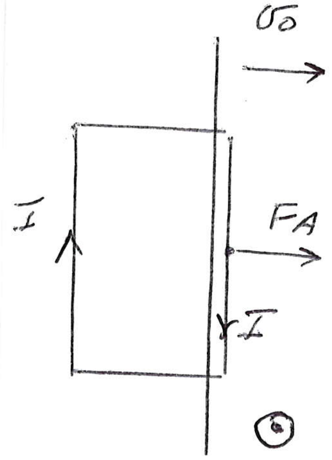
$q_1 = CU_1 \to I_1 = C\dot{U}_1$

$q_2 = 5CU_2 \to I_2 = 5C\dot{U}_2$ } $\frac{I_1}{I_2} = \frac{1}{-5} \to I_1 = -\frac{I_2}{5}$

($I_2 \uparrow\downarrow I_1$)

если $I_2 = I_0$, то $I_1 = \frac{I_0}{5}$

$I_3 = I_1 + I_2 = \frac{6I_0}{5} \to U_R = I_3R = \frac{6I_0R}{5}$ ← ответ на п3



1) После вхождения в однородное поле в рамке возникает $\mathcal{E}$ индукции.
Сразу после вхождения в поле:

$$\mathcal{E} = \dot{\Phi} = B\dot{S} = Bd\cdot v_0$$

$$I = \frac{\mathcal{E}}{R} = \frac{Bdv_0}{R}$$ (напр. I определяем по правилу буравчика)

⊙ на правую ~~сторону~~ сторону действует сила Ампера

$$F_A = IBd = ma_0 \to a_0 = \frac{IBd}{m} = \boxed{\frac{B^2d^2v_0}{mR}}$$ ответ на п1

2) Во время вхождения рамки в магнит. поле на стороны в также действуют F_A, но эти силы скомпенсированы

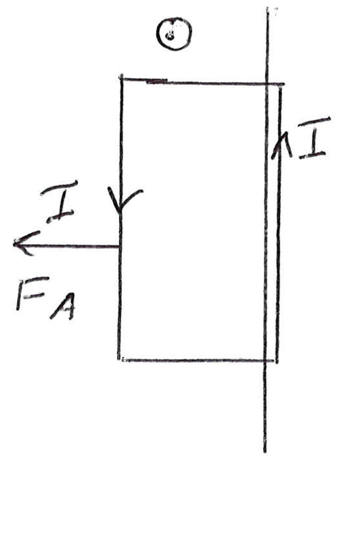
$$a\Delta t = \frac{B^2d^2v\Delta t}{mR} \text{ (по п1)} \to \Delta v = \frac{B^2d^2\Delta r}{mR}; \quad \Delta r = b$$

(Δr – пройденное расст.)

$$v_1 - v_0 = \frac{B^2d^2\cdot b}{mR}$$

$$v_1 = v_0 + \frac{B^2d^2b}{mR} = \boxed{v_0 + \frac{2B^2d^3}{3mR}}$$ ← ответ на п2

3) $b < H \to$ рамка целиком войдет в магнит. поле и будет двигаться в нем равномерно со скоростью v_1 (т.к. $\mathcal{E}_{инд} = 0 \to I = 0$, $\to F_A = 0$). При выходе рамки из поля на нее вновь будет действовать F_A, но теперь на левую ст. рамки (см. рис.)



$$\Delta v = \frac{B^2d^2\Delta r}{mR} \to v_2 - v_1 = \frac{-B^2d^2b}{mR}$$

(по п2) (т.к. рамка замедляется)

$$v_2 = v_1 - \frac{B^2d^2b}{mR} = \boxed{v_0}$$ ← ответ на п3

№5

Пусть $d_1 = 25$ см. ; D_1 – ~~для~~ очки для удал. предметов

D_2 - очки для текста

По формуле тонкой линзы:

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

$\frac{1}{d_1} + \frac{1}{f} = D_2 \qquad \frac{1}{d_1} + D_1 = D_2 \qquad \frac{D_2}{D_1} = 5 \to 5D_1 = D_2$

$\frac{1}{d_1} = 5D_1 - D_1 = 4D_1 \to D_1 = \frac{1}{4d_1} = 1$ Дптр

ответ на п 1

Черновик

$(\dot{u}_1 > 0)$

$-\dot{u}_2 = \dot{u}_1$ $\left.\begin{array}{l}\cancel{I_2 = 5C\dot{u}_2}\\ \cancel{I_1 = C\dot{u}_1}\end{array}\right\}$ $\cancel{I_1 = -\frac{I_2}{5}}$

$q_1 = 5Cu_1$

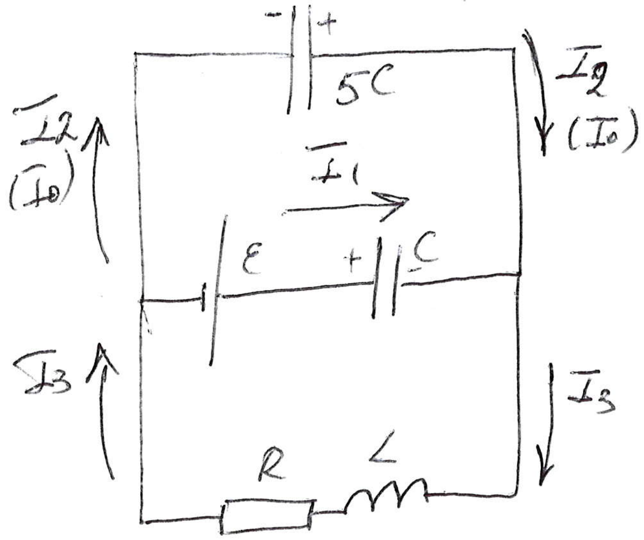
$\Delta q_1 = 5C\Delta u_1$

$I_1 = 5C\dot{u}_1$ $\quad I_2 = 5C\dot{u}_2$

$\cancel{I_3} = \cancel{u_1} = \mathcal{E} = u_1 + u_2$

$\dot{u}_1 + \dot{u}_2 = 0 \rightarrow \dot{u}_1 = -\dot{u}_2$ $\quad I_1 = \frac{-I_2}{5}$

$I_3 = I_1 + I_2 = \frac{6I_0}{5}$



№ 5

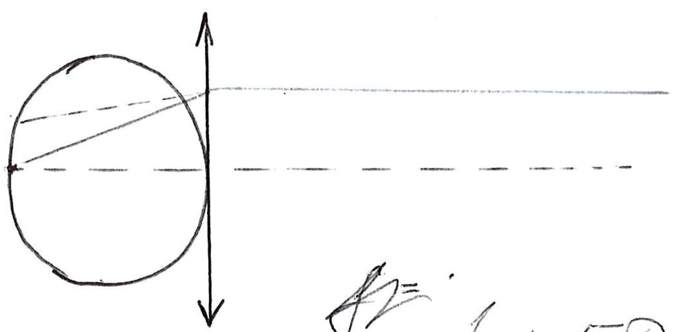
$\frac{1}{x} + \frac{1}{f_2} = \frac{1}{F_2}$ $\quad d_1 = 25$ см

D_1 – уд $\quad D_2$ – текст

$\cancel{\frac{1}{f_2} = D_1}$ $\quad \frac{1}{f} = D_1$

$\frac{1}{d_1} + \frac{1}{f} = D_2$

$\frac{D_1}{D_2} = 5$, $D_1 = 5D_2$



$\frac{1}{d_1} + 5D_2 = D_2$ $\quad 4D_2 = \frac{1}{d_1} \rightarrow D_2 = \frac{1}{4d_1} = 1$ Дптр

$D_1 = 5$ Дптр

черновик

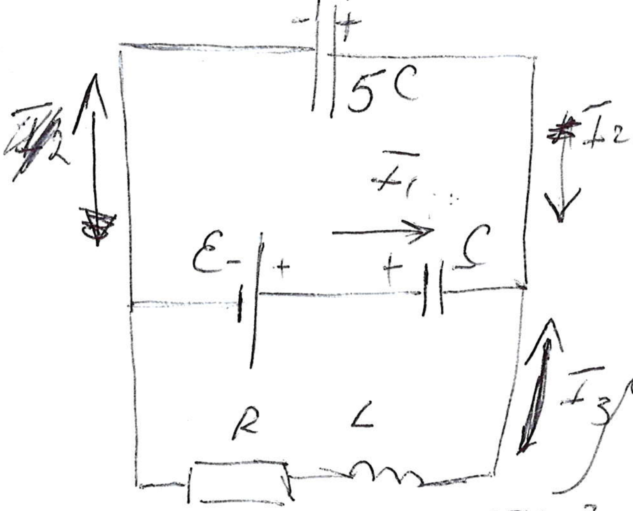
В3) $C_{общ} = \frac{C\cdot 5C}{C+5C} = \frac{5}{6}C$; $\frac{5}{6}C\mathcal{E} = Q = CU_1 = 5CU_2$

1) $\mathcal{E} = U_1 + LI'$ $\qquad U_1 = \frac{5}{6}\mathcal{E}$ $\quad U_2 = \frac{\mathcal{E}}{6}$

$$I' = \frac{\mathcal{E} - U_1}{L} = \frac{\mathcal{E} - \frac{5}{6}\mathcal{E}}{L} = \frac{\mathcal{E}}{6L}$$

2) $\cancel{\mathcal{E} = U_1 + U_2 + I_3R =}$ $\quad \cancel{\mathcal{E} = LI' + U_1 + I_3R}$

$\cancel{\Delta q\mathcal{E} = \Delta W_1 + \Delta W_2}$ $\quad \cancel{U_2 = LI' + I_3R}$



$q_2 = 5CU_2$

$I_2 = 5C\dot{U}_2$

$\cancel{\mathcal{E} = L(I_1' - I_2') + U_1 + (I_1 - I_2)R}$

$\cancel{U_2 = L(I_1' - I_2') + (I_1 - I_2)R}$

$W_1 + W_2 + \Delta q\mathcal{E} = W_1' + Q \cancel{+ \Delta q\mathcal{E}}$

$\Delta q = \frac{C\mathcal{E}}{6} \rightarrow \frac{25C\mathcal{E}^2}{72} + \frac{1C\mathcal{E}^2}{72} + \cancel{\frac{C\mathcal{E}^2}{2}}\ \frac{C\mathcal{E}^2}{6} = \frac{C\mathcal{E}^2}{2} + Q$

$\frac{C\mathcal{E}^2}{36} = Q$

$I_1 = I_2 + I_3$

$\Delta q_1 = \Delta q_2 + \Delta q_3$

$\frac{D_1}{D_2} = 5 \quad \frac{F_1}{F_2} = 5$ $\quad d = 25$, $\ d = \infty$

$\cancel{\frac{1}{d}} \rightarrow 0 + \frac{1}{f} = \frac{1}{F_1} \quad f = F_1$

$\frac{1}{d} + \frac{1}{f} = \frac{1}{F_2}$

$\frac{1}{d} + \frac{1}{f} = \frac{5}{f} \quad \frac{1}{d} = \frac{4}{f} \quad f = 4d = 100см$

Черновик

$\cancel{\frac{1}{d} + \frac{1}{f} = \frac{1}{F_1}}$

$\cancel{0 + \frac{1}{f} = \frac{1}{F_2} \rightarrow f = F_2 \quad \frac{F_2}{F_1} =}$

$\frac{1}{d} + \frac{1}{f} = D_1$

$\frac{1}{f} = D_2$

$D_1 > D_2$

$\frac{D_1}{D_2} = 5$

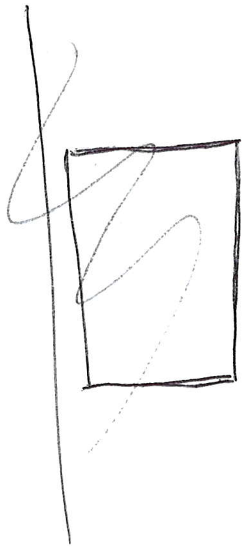
$D_1 = 5D_2$

$\frac{1}{d} + \frac{1}{f} = \frac{5}{f}; \quad \frac{1}{d} = \frac{4}{f} \rightarrow f = 4d = 100 \text{ см}$

$\cancel{\frac{1}{x} + \frac{1}{f}} \quad \frac{1}{x} + \frac{1}{f} = \frac{1}{F_0}$

$\frac{1}{25} + \frac{1}{f} = \frac{1}{F_0}$

черновик

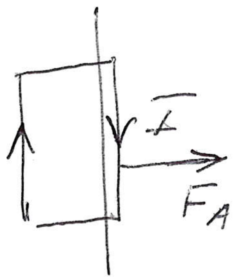


$$\mathcal{E} = B\dot{S} = B b v_0$$

$$I = \frac{\mathcal{E}}{R} = \frac{B b v_0}{R}$$

$$F_A = IB\cdot d = \frac{B^2 b d v_0}{R} = \frac{B^2 2d^2 v_0}{3R}$$

$$a_1 = \frac{F_A}{m} = \frac{B^2 2d^2 v_0}{3mR}$$



$$\cancel{b = \frac{v_1^2 - v_0^2}{2a}}$$

$$v_1 - v_0 = \frac{B^2 2d^2 \cdot b}{3mR}$$

$$v_1 = v_0 + \frac{4}{9}\frac{B^2 d^3}{mR}$$

$$v_1^2 = v_0^2 + 2ab$$

$$v_1 = \sqrt{v_0^2 + \frac{4}{3}\frac{B^2 d^2 v_0}{mR} b} =$$

$$= \sqrt{v_0^2 + \frac{8}{9}\frac{B^2 d^3 v_0}{mR}}$$

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

$$v_2 = v_1 - \frac{4}{9}\frac{B^2 d^3}{mR} = v_0$$

3) $\cancel{v_2 = v_0}$

$$a_2 = \frac{B^2 2d^2 v_1}{3mR}$$

$$b = \frac{v_2^2 - v_1^2}{-2a_2} \longrightarrow v_2 = \sqrt{v_1^2 - 2a_2 b} =$$

$$= \sqrt{v_1^2 - \frac{8}{9}\frac{B^2 d^3 v_0}{mR}}$$