Часть 1

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

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Вариант 5

Чистовик

~~$N = 13 mg \cdot \cos\alpha$~~

2) $q_{1\text{отн.}} = g \cdot (\cos\beta - 13 \cdot \sin\alpha) + \frac{3}{4} g \cdot (\sin\beta + 13\cos\alpha)$

$q_{1\text{отн.}} = g \cdot \left| 0.8 - 5 + \frac{3}{4} \cdot \left(\frac{3}{5} + 12\right)\right.$

$q_{1\text{отн.}} = 0.375 g$

Ответ: $0.375 g$

3) $H = \frac{q_{2y} t^2}{2}$

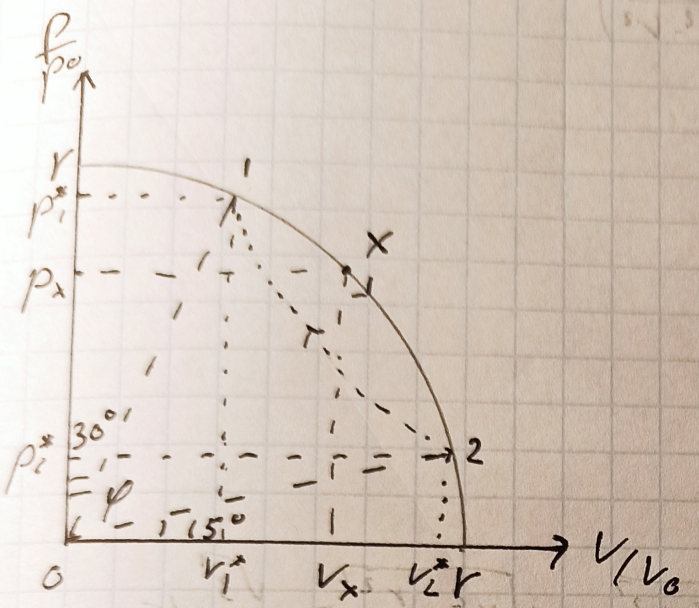
$q_{2y} = q_{1\text{отн}} \cdot \cos\beta$

$t = \sqrt{\frac{2H}{q_{2y}}} = \sqrt{\frac{2H}{0.375g \cdot 0.8}} =$

Ответ: $\sqrt{\frac{2}{0.375 \cdot 0.8}} \cdot \sqrt{\frac{H}{g}}$.

Частовик

2.



1) $p_1 = p_1^* \cdot p_0 = r \cdot \cos 30^\circ \cdot p_0$

$v_1 = v_1^* \cdot v_0 = r \cdot \sin 30^\circ \cdot v_0$

$p_2 = r \cdot \sin 15^\circ \cdot p_0$

$v_2 = r \cdot \cos 15^\circ \cdot v_0$

З-н Менделеева Клапейрона:

$p_1 v_1 = \nu R T_1$,

$p_2 v_2 = \nu R T_2$

$$\frac{T_1}{T_2} = \frac{p_1 v_1}{p_2 v_2} = \frac{r \cdot \cos 30^\circ \cdot p_0 \cdot r \cdot \sin 30^\circ \cdot v_0}{r \cdot \sin 15^\circ p_0 \cdot r \cdot \cos 15^\circ \cdot v_0} = \frac{\sin 60^\circ}{\sin 30^\circ} = \sqrt{3}.$$

Ответ: $\sqrt{3}$.

2) В точке x теплоёмкость равна 0.

$p_x \cdot dv_x = \frac{3}{2} \cdot (p_x \cdot dv_x + v_x \cdot dp_x)$

$-\frac{1}{2} p\, dv = \frac{3}{2} v\, dp$

$\frac{p}{v} = -3\frac{dp}{dv}$ || $p^2 + v^2 = r^2$

$p = \sqrt{r^2 - v^2}$

$\frac{dp}{dv} = \frac{1}{2\sqrt{r^2 - v^2}} \cdot (-2v) = -\frac{v}{\sqrt{r^2 - v^2}}$

3

Чистовик

$$\frac{\sqrt{r^2-v^2}}{v} = (-3)\cdot\left(-\frac{v}{\sqrt{r^2-v^2}}\right)$$

$$\frac{\sqrt{r^2-v^2}}{v} = \frac{3v}{\sqrt{r^2-v^2}}$$

$$r^2-v^2 = 3v^2$$

$$4v^2 = r^2$$

$$v^2 = \frac{r^2}{4}$$

$$v = \frac{r}{2}. \qquad p = \sqrt{r^2-v^2} = \sqrt{r^2-\frac{r^2}{4}} = \frac{\sqrt{3}}{2}r$$

$$\frac{p_x}{v_x} = \frac{\sqrt{3}}{2}r\cdot\frac{2}{r} = \sqrt{3}$$

$\alpha = \operatorname{arctg}\sqrt{3}$.

Ответ: $\operatorname{arctg}\sqrt{3}$.

3) $\beta = \dfrac{A_\varepsilon}{A_{12}}$ $\qquad A_{12} = \dfrac{\varphi_1 r^2}{2\cdot 4} - S_{01}v_1^* + S_{02}v_2^* =$

$$= \frac{\varphi_1}{8}r^2 - \frac{v_1^*\cdot p_1^*}{2} + \frac{v_2^*\cdot p_2^*}{2} \quad (3)$$

$$(3)\ \frac{\varphi_1}{8}r^2 - \frac{r^2\cdot\cos 30^\circ\cdot\sin 30^\circ}{2} + \frac{r^2\cdot\cos 15^\circ\cdot\sin 15^\circ}{2} =$$

$$= \frac{\varphi_1}{8}r^2 - r^2\cdot\frac{\sin 60^\circ}{4} + r^2\cdot\frac{\sin 30^\circ}{4} = r^2\cdot\left(\frac{\varphi_1}{8} - \frac{\sqrt{3}}{8} + \frac{1}{8}\right)$$

(4)

Числовик

$$|A_{21}| = |\Delta U_{21}| = \frac{3}{2}\nu R\Delta T^* = \frac{3}{2}(p_1^* V_1^* - p_1^* V_1^*) =$$

$$= \frac{3}{2}(r^2 \cdot \cos 30^\circ \cdot \sin 30^\circ - r^2 \cdot \sin 30^\circ \cdot \cos 30^\circ) =$$

$$= \frac{3}{4} \cdot r^2(\sin 60^\circ - \sin 30^\circ) = \frac{3}{4} r^2 \cdot \left(\frac{\sqrt{3}}{2} - \frac{1}{2}\right) =$$

$$= r^2 \cdot \frac{3(\sqrt{3}-1)}{8}$$

$$A_\Sigma = A_{12} + A_{21} = r^2 \cdot \frac{5_1 - \sqrt{3} + 1}{8} - r^2 \cdot \frac{3\sqrt{3} - 3}{8} =$$

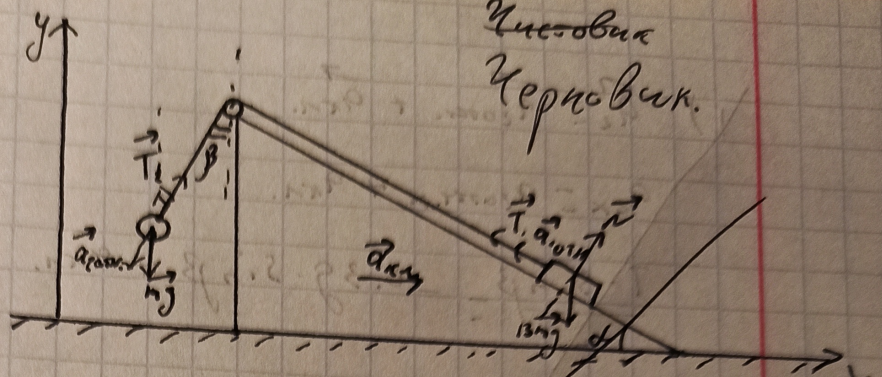
$$= r^2 \cdot \frac{5_1 - \sqrt{3} + 1 - 3\sqrt{3} + 3}{8} = r^2 \cdot \frac{5_1 - 4\sqrt{3} + 4}{8}.$$

$$\beta = \frac{A_\Sigma}{A_{12}} = \frac{r^2 \cdot \frac{5_1 - 4\sqrt{3} + 4}{8}}{r^2 \cdot \frac{5_1 - \sqrt{3} + 1}{8}} = \frac{5_1 - 4\sqrt{3} + 4}{5_1 - \sqrt{3} + 1}.$$

Ответ: $\frac{5_1 - 4\sqrt{3} + 4}{5_1 - \sqrt{3} + 1}$.

~~Числовик~~

Черновик.



1. $\cos\alpha = \frac{12}{13}$, $\sin\alpha = \frac{5}{13}$

m, $13m$

$\cos\beta = \frac{4}{5}$; $\sin\beta = \frac{3}{5}$

2) II З. Н.: $N = 13mg \cdot \cos\alpha$

$\vec{a}_1 = \vec{a}_{1отн.} + \vec{a}_{кл}$

$13m a_{1отн.} = T - 13mg \cdot \sin\alpha$

$m a_{2x} = T_2 \cdot \sin\beta$

$m a_{2y} = mg - T \cdot \cos\beta$

$m a_{2отн.} = mg \cdot \cos\beta - T$

$a_{2отн.} = a_{1отн.}$, т.к. ~~бере кнуб керастяжка~~:

$$\begin{cases} 13m a_{1отн.} = T - 13mg \cdot \sin\alpha \\ m a_{1отн.} = mg \cdot \cos\beta - T \end{cases}$$

$T = mg\cos\beta - m a_{1отн.}$

$13m a_{1отн.} = mg\cos\beta - m a_{1отн.} - 13mg\sin\alpha$

$14m a_{1отн.} = \frac{4}{5}mg - \frac{5}{5}mg$

$a_{1отн.} = 0.3g.$

Ответ: $0.3g$.

Чистовик

Черновик.

1) $\vec{a_2} = \vec{a_{2отн.}} + \vec{a_{кл.}}$

$a_{2x} = a_{2отн.x} + a_{кл.}$

$\frac{T \cdot \sin\beta}{m} = -0.3g \cdot \sin\beta + a_{кл.}$

$a_{2y} = a_{2отн.y}$

$\frac{mg - T \cdot \cos\beta}{m} = 0.3g \cdot \cos\beta$

$T = \frac{mg - 0.3mg \cdot \cos\beta}{\cos\beta}$

$a_{кл.} = \frac{T \cdot \sin\beta}{m} + 0.3g \cdot \sin\beta$

$a_{кл.} = \frac{mg - 0.3mg\cos\beta}{m\cos\beta} \cdot \sin\beta + 0.3g \cdot \sin\beta$

Ответ: $\frac{3g}{4}$.

3) $a_{2y} = \frac{mg - T \cdot \cos\beta}{m} = g - \frac{mg - 0.3mg\cos\beta}{m \cdot \cos\beta} \cdot \cos\beta =$

$= g - g + 0.3g\cos\beta = 0.24g$

$H = \frac{a_{2y} t^2}{2}$ $\quad t = \sqrt{2\frac{H}{a_{2y}}} = \sqrt{\frac{2H}{0.24g}} = 5\sqrt{\frac{H}{3g}}$.

Ответ: $5\sqrt{\frac{H}{3g}}$.

2.

Черновик.

$$\begin{cases} N - 13mg \cdot \cos\alpha \\ 13m a_1 = T - 8mg \cdot \sin\alpha \end{cases}$$

$mg = T \cdot \cos\beta$

$m a_{2y} = mg - T \cdot \cos\beta$

$m a_{2x} = T \cdot \sin\beta$

$a_{2x} = a_{1x}$

$$a_{1x} = a_1 \cdot \cos\alpha = \frac{T - 13mg\sin\alpha}{13m} \cdot \cos\alpha$$

$$\frac{T - 13mg\sin\alpha}{13m} \cdot \cos\alpha = \frac{T \cdot \sin\beta}{m}$$

$$\frac{T - 13mg \cdot \frac{5}{13}}{13} \cdot \frac{12}{13} = T \cdot \frac{3}{5}$$

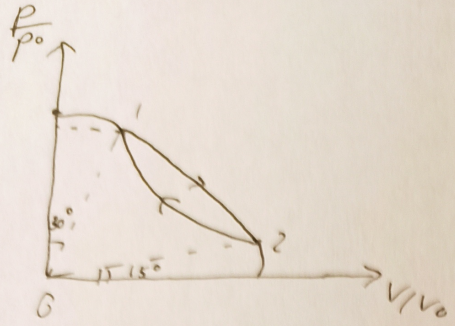
$$5 \cdot (T - 5mg) \cdot 12 = T \cdot 3 \cdot 13^2$$

$$60T - 25mg \cdot 12 = T \cdot 3 \cdot 13^2$$

$$T = \frac{25mg \cdot 12}{60 + 3 \cdot 13^2} = 0.529 \approx 0.5\ mg$$

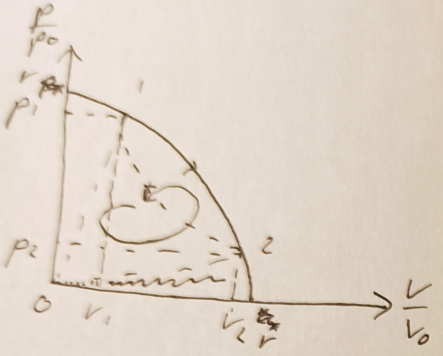
2

Черновик.



$r = r \cdot \cos 30°$

$r = \sin 30$



$p^2 + v^2 = r^2$

$p(v) = \sqrt{r^2 - v^2}$

$p_1 v_1 = \nu R T_1$

$p_2 v_2 = \nu R T_2$

$\int_{v_1}^{v_2} p(v) \cdot dv = \int_{v_1}^{v_2} \sqrt{r^2 - v^2} \cdot dv$

$Q = 0 \quad A = \Delta U$

$S = \frac{\pi r^2}{4}$

$p_1 = r \cdot \cos 30° \cdot p_0$

$v_2 = r \cdot \cos 15° \cdot V_0$

$V_1 = r \cdot \sin 30° \cdot V_0$

$p_2 = r \cdot \sin 15° \cdot p_0$

$\frac{T_2}{T_1}$

$\left(\sqrt{r^2 - v^2}\right)' = \left((r^2 - v^2)^{\frac{1}{2}}\right)' =$

$= \frac{1}{2} \cdot (r^2 - v^2)^{-\frac{1}{2}} \cdot (-2v)$

$\frac{1 \cdot -2v}{2\sqrt{r^2 - v^2}} = \frac{-v}{\sqrt{r^2 - v^2}} =$

0.866025

0.4330127

0.0005038

$\sin 15° = 0.258819045$

$= \frac{p}{v}$

1.6730326008

$\cos 15° = 0.965$

$\frac{\sqrt{r^2 - v^2}}{v} = -\frac{v}{\sqrt{r^2 - v^2}} =$

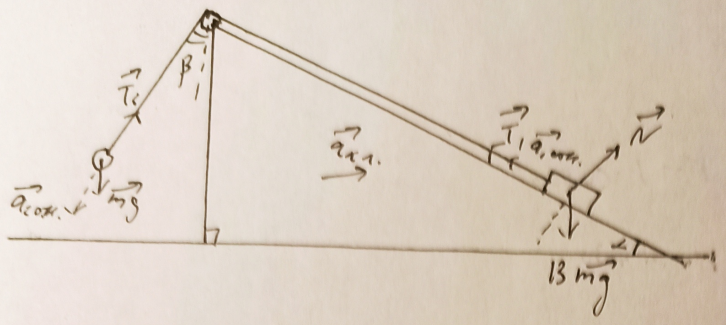
$r^2 - v^2 = -v^2$

$2v^2 = r^2$

$v^2 = \frac{r^2}{2}$

Часовик.

1.



II

$13ma_{1отн.} = T - 13mg\cdot\sin\alpha + 13ma_{кл.}\cdot\cos\alpha$

$ma_{1отн.} = mg\cdot\cos\beta - T + ma_{кл}\cdot\sin\beta$

$a_{1отн.} = a_{2отн}$, т.к. нить нерастяжимая

$T = mg\cdot\cos\beta + ma_{кл.}\cdot\sin\beta - ma_{2отн.}$

$13ma_{1отн.} = mg\cdot\cos\beta + ma_{кл}\cdot\sin\beta - ma_{1отн.} - 13mg\sin\alpha + 13ma_{кл}\cdot\cos\alpha$

$14ma_{1отн.} = mg(\cos\beta - 13\sin\alpha) + ma_{кл.}\cdot(\sin\beta + 13\cos\alpha)$

$ma_{2отн}\cdot\cos\beta = mg - T_2\cdot\cos\beta$

$ma_{1отн.}\cdot\cos\beta = mg - T\cdot\cos\beta$

$$\begin{cases} ma_{1отн.} = mg\cdot\cos\beta + ma_{кл}\cdot\sin\beta - \dfrac{mg - ma_{1отн.}\cdot\cos\beta}{\cos\beta} \\ 14a_{1отн.} = g(\cos\beta - 13\sin\alpha) + a_{кл}\cdot(\sin\beta + 13\cos\alpha) \end{cases}$$

$a_{1отн.} = g\cos\beta + a_{кл}\cdot\sin\beta - \dfrac{g}{\cos\beta} + a_{1отн.}$

$$\frac{\frac{g}{\cos\beta} - g\cdot\cos\beta}{\sin\beta} = a_{кл} = g\cdot\frac{\frac{5}{4}^{15} - \frac{4}{5}^{14}}{\frac{3}{5}} = \frac{25-16}{20}\cdot\frac{5}{3}g = \frac{3}{\cancel{4}\cdot\cancel{5}}\cdot\frac{\cancel{5}}{\cancel{3}}g = \frac{3}{4}g.$$

Ответ: $\frac{3}{4}g$.

(1)

Часть 2

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

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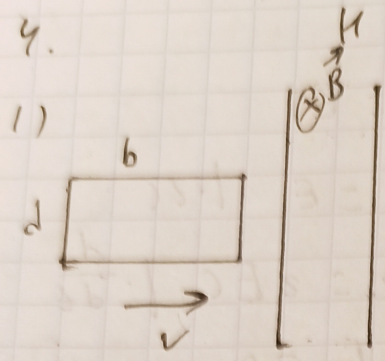
ID профиля: **284691**

Вариант 5

Часовик.

4.

1) 

$$\mathcal{E} = -\frac{d\Phi}{dt} = -B \cdot d \cdot v$$

$$I = \frac{B \cdot d \cdot v}{R}$$

$$F = B \cdot d \cdot I = \frac{B^2 d^2 \cdot V}{R}$$

$$ma = F$$

$$a = \frac{F}{m} = \frac{B^2 d^2 V_0}{mR}$$

Ответ: $\frac{B^2 d^2 v_0}{mR}$.

2) ~~$H = v_0 t + \frac{at^2}{2}$~~

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

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

Ответ: $\sqrt{v_0^2 + \frac{2mR}{3B^2 d v_0}}$

(4)

Числовик

3) От выхода правой стороны рамки до входа левой стороны в поле рамка движется равномерно с скоростью v_1, затем с ускорением $\frac{B^2 d^2 v_0}{mR}$.

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

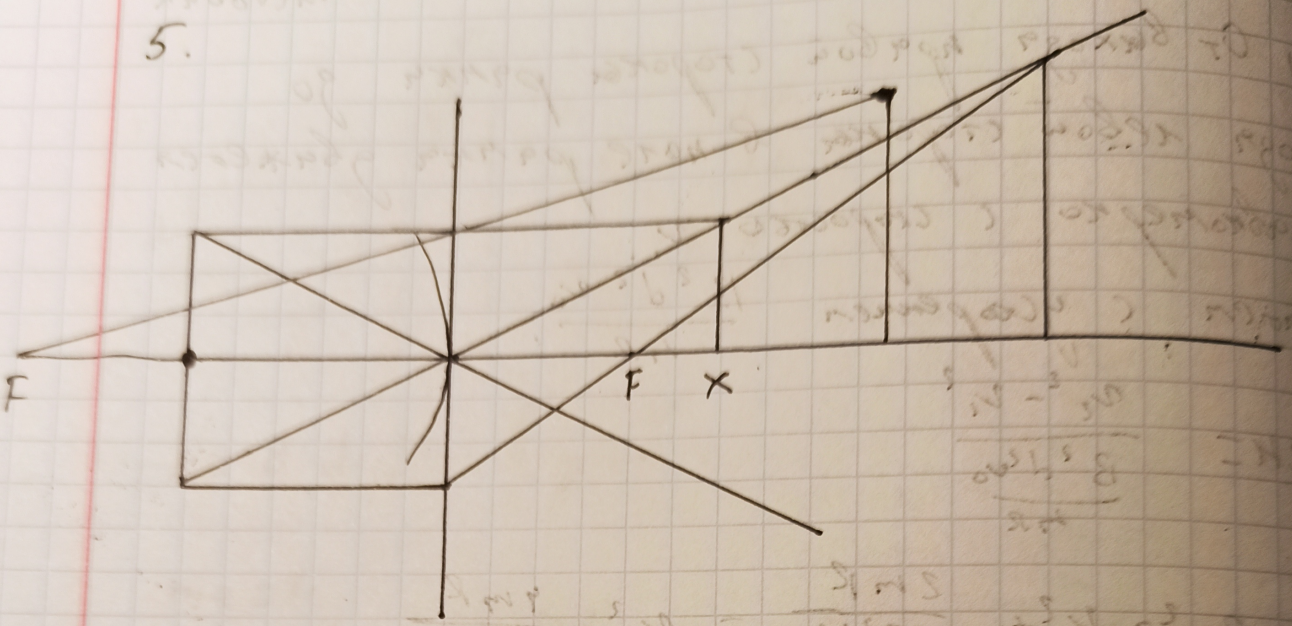
$$v_2^2 = v_1^2 + \frac{2mR}{3B^2 d v_0} = v_0^2 + \frac{4mR}{3B^2 d v_0}.$$

Ответ: $\sqrt{v_0^2 + \frac{4mR}{3B^2 d v_0}}$.

5

Числовик.

5.



$\frac{1}{d} + \frac{1}{0.25\,м} = D_2$

$\frac{1}{d} + \frac{1}{\cancel{0}\,a} = D_1$, где d – расстояние от линзы до сетчатки

$d = \frac{1}{D_1}$ $\quad \frac{d}{x} = \frac{D_2}{D_1}$, $x = \frac{D_2}{D_1} \cdot d = 0.125\,м$

$\left|\frac{D_2}{D_1}\right| = 2$, $\quad \frac{1}{d} = \frac{1}{0.25\,м}$ $\quad D_3 = \frac{1}{d} + \frac{1}{0.5\,м} = 6$ Дптр.

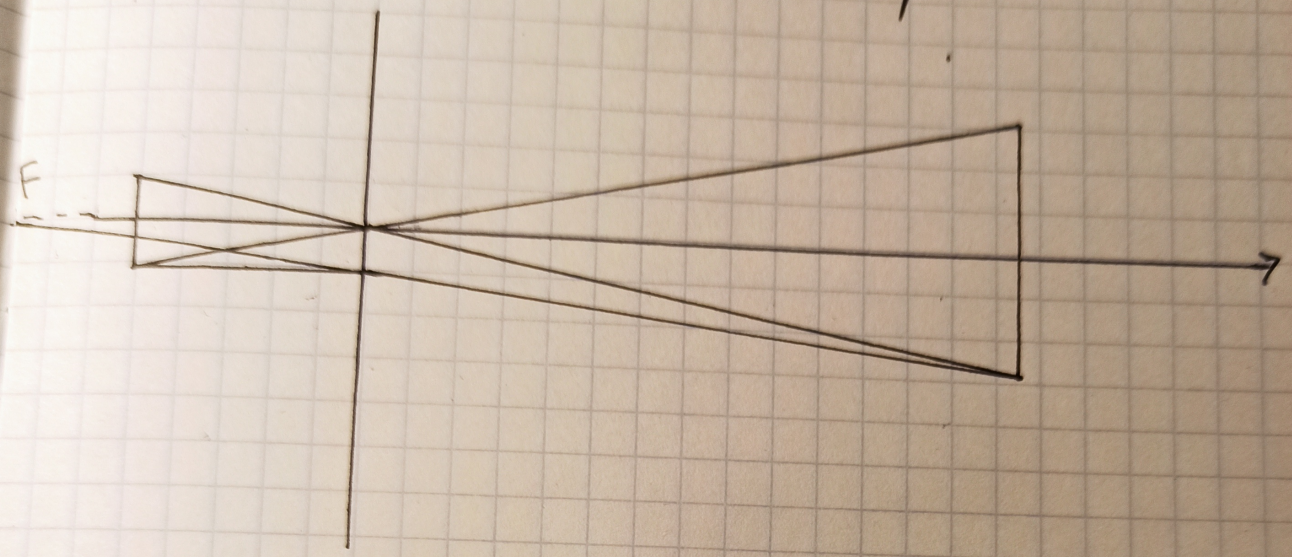
$D_1 = 4$ Дптр.

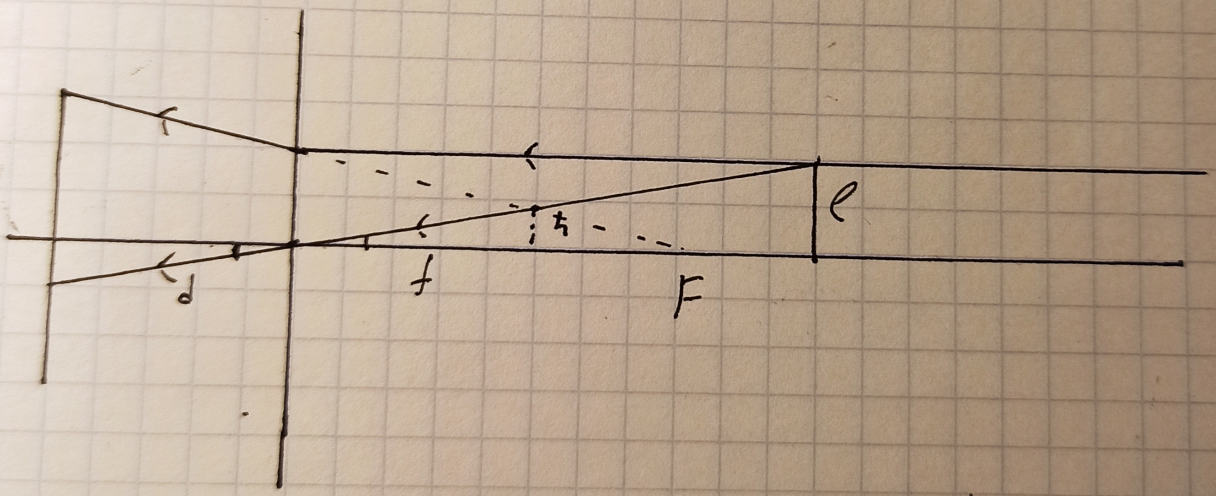
1) ~~4 Дптр~~ Ответ: 4 Дптр, 12.5 см.

2) ~~6 Дптр~~. Ответ: 6 Дптр.

(6)

Черновик.

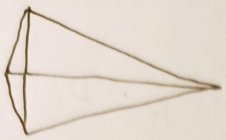




1 размер сетчатки $2y$: $\frac{y}{h} = \frac{F+d}{F-f}$

$\frac{h}{e} = \frac{f}{0.25M}$

Черковик.



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

$\frac{1}{d} + \frac{1}{0.25} = D_2$

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

$\frac{1}{d} = 2D_2$

$2D_2 + \frac{1}{0.25} = D_2$

$D_2 = \frac{1}{0.25} = -4.$

$\frac{1}{d} + \frac{1}{0.25} = D_2$

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

$\frac{1}{d} + \frac{1}{0.5} = D_3$

$D_2 = -4$

$D_1 = -8$

$d = -\frac{1}{8}$

$-\frac{1}{8} + \frac{1}{0.25} = D_2$

$\frac{d\int B\,ds}{dt} = -\mathcal{E}$

$B \cdot d \cdot v_0 = -\mathcal{E}$

$\mathcal{E} = I \cdot R$

$F = qvB$

~~$F = q \cdot \frac{dq}{dt} B = IlB$~~

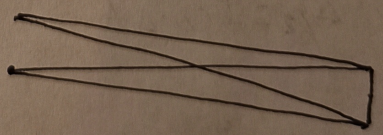
~~$\frac{1}{d} = D_2$~~

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

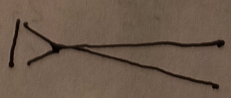
$\frac{1}{d} + 4 = D_2$

$\frac{2}{d} = \frac{1}{d} + 4$

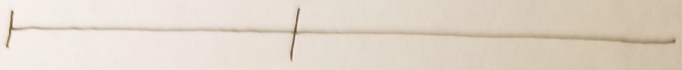
$d = 25$ см.



$\frac{24RH}{B^2 d^2 v_0} \frac{7}{4} v_0^2$ $v_0^3 \geq \frac{2mRH}{B^2 d^2}$



Черновик.



$\frac{1}{h} + \frac{1}{H} = D_1$

$\frac{h}{H} \cdot \frac{d}{\cos\alpha}$ $\frac{1}{H} + \frac{1}{h} = D_2$

$\frac{1}{d} + \frac{1}{\cos} = D_2$

$\frac{1}{d} + \frac{1}{0.25} = D_1$

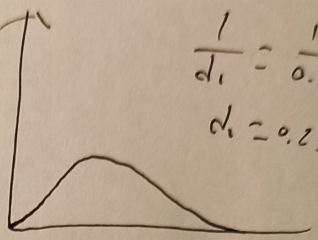
$\frac{1}{d} + \frac{1}{0.25} = \frac{1}{d_1}$

$E + U_1 = U_2$

$E + U_1 = I R + L \cdot \frac{dI}{dt}$

$E = U_1$

$U_2 = 0$



$\frac{1}{d_1} = \frac{1}{0.25}$

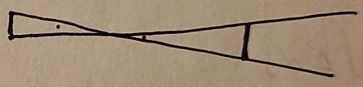
$d_1 = 0.25$

$D_2 = \frac{1}{\frac{h}{\cos\alpha}}$

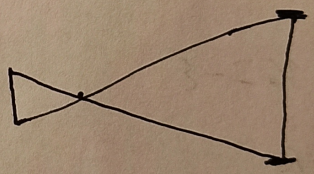
$D_1 = \delta$.

$E - U = I \cdot R + L \cdot \frac{dI}{dt}$

$E - \frac{q_1}{C} = I \cdot R + L \cdot \frac{dI}{dt}$



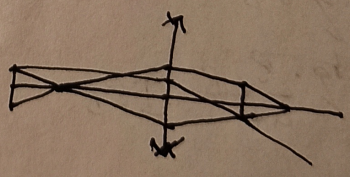
$I - \frac{dq_1}{dt} \cdot \frac{1}{C} = \frac{dI}{dt} R + L \cdot \dot{I}$



$\frac{1}{d} + \frac{1}{0.25} = D_3$

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

$\mathcal{E} \cdot \Delta q + \frac{CU^2}{2} + \frac{LI^2}{2}$



$\Delta q_1 = I_1 \cdot \Delta t$

$\Delta q_2 = I_{C2} \cdot \Delta t$

$-L \cdot \frac{dI}{dt}$

$E - \frac{q_1}{C} = \frac{q_2}{2C} \mid \cdot 2C$

$-2\frac{dq_1}{dt} = \frac{dq_2}{dt}$

$2EC - 2q_1 = q_2$

$-2I_{C1} = I_{C2}$

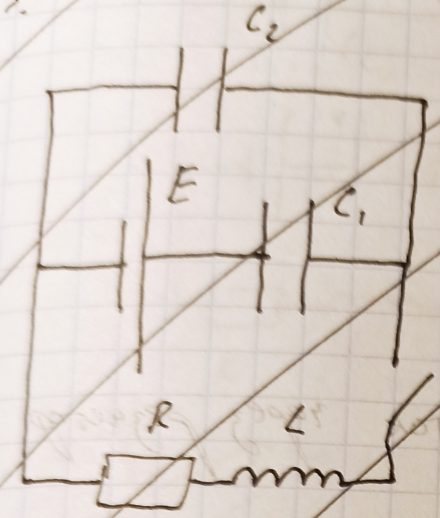
$2EC - 2q_1 = q_2$

$\frac{dq_2}{dt} + \frac{dq_1}{dt} = I$

$2I_{C2} + I_{C2} = 0$

$I_{C2} =$

3.



1) Правило Кирхгофа:

$E = L\frac{dI}{dt} + I \cdot R + U_{C_1}$

$\frac{dI}{dt} = \frac{E}{L}$

Ответ: $\frac{E}{L}$.

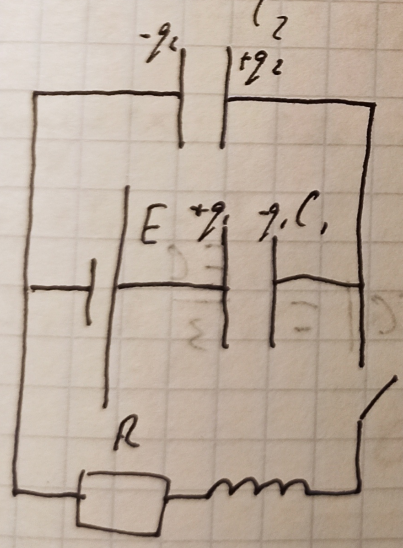
2) $U_2 = E + U_1$

$E + U_1 = I \cdot R + L \cdot \frac{dI}{dt}$

Учитовик.

3.

1)



В установившемся режиме до замыкания:

$q_1 = q_2$

$U_1 + U_2 = E$

$\frac{q'}{C} + \frac{q_2}{2C} = E$

$q = E / (\frac{1}{C} + \frac{1}{2C})$

$q = \frac{2EC}{3}$, т.е. $U_1 = q/C = \frac{2E}{3}$

(1)

Чистовик.

После замыкания ключа ток через резистор 0:

$$E - \frac{2E}{3} = L \cdot \frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{E}{3L}.$$

Ответ: $\frac{E}{3L}$.

г) В установившемся режиме ток через резистор не течёт, а значит:

$$E - U_1 = U_2 = I\cancel{R}^{0} + L \cdot \cancel{\frac{dI}{dt}}^{0} = 0.$$

$$U_1 = E$$

$$W_0 = \frac{2CU_{20}^2}{2} + \frac{C \cdot U_{10}^2}{2} = \frac{2C \cdot E^2}{2 \cdot 3^2} + \frac{C \cdot 4E^2}{2 \cdot 9} =$$

$$= \frac{CE^2}{9} + \frac{2CE^2}{9} = \frac{CE^2}{3}.$$

$$W_{кон.} = \frac{C \cdot E^2}{2}$$

$$A = \Delta q \cdot E; \quad \Delta q = \left| \frac{2EC}{3} \cdot 2 - EC \right| = \frac{EC}{3}$$

$$W_0 + A = W_{кон} + Q$$

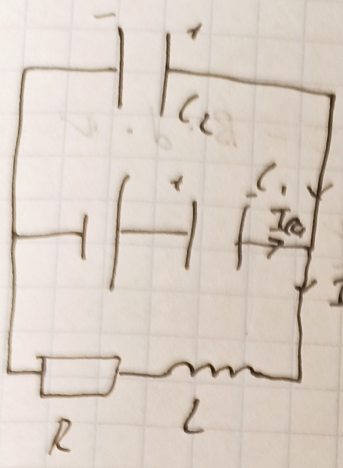
$$\frac{2CE^2}{3} = \frac{CE^2}{2} + Q$$

$$Q = \frac{2CE^2 \cdot 2}{3} - \frac{CE^2 \cdot 3}{2} = \frac{CE^2}{6}.$$ Ответ: $\frac{CE^2}{6}$.

(2)

Часовая

3)



$U_1 + U_2 = E$

$\frac{q_1'}{C} + \frac{q_2'}{2C} = E \quad | \cdot 2C$

$2q_1 + q_2 = 2EC \quad | \frac{d}{dt}$

$2I_{C_1} + I_{C_2} = 0$

$2I_{C_1} = -I_{C_2}$ (q_1 - возрастает, q_2 - убывает)

$E - U_1 = I \cdot R + L \cdot \frac{dI}{dt}$

$I_{C_2} + I_{C_1} = I$

$E - \frac{q_1'}{C} = I \cdot R + L \cdot \frac{dI}{dt}$

$E - \frac{q_1'}{C} = (I_{C_1} + I_{C_2}) R + L \cdot \frac{d(I_{C_1} + I_{C_2})}{dt}$

$E - \frac{q_1'}{C} = \left(\frac{dq_1'}{dt} + \frac{dq_2}{dt}\right) R + L \cdot \left(\frac{d^2 q_1}{dt^2} + \frac{d^2 q_2}{dt^2}\right)$

В модулях: $2I_{C_1} = I_{C_2}$

$I_{C_2} + I_{C_1} = I$

$3I_{C_1} = I$, т.е. $I = 3I_0$

Ответ: $3I_0$.

(3)