

Часть 1

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

Шифр: **21200502**

ID профиля: **285707**

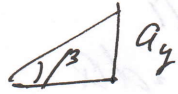
Вариант 3

репроблема

$$mg = T \cdot \frac{\sin(\alpha + \beta)}{\cos \beta}$$

$$m a_x = T \cos \alpha \quad (1)$$

$$m a_y = T \cdot \frac{\sin(\alpha + \beta)}{\cos \beta} - T \sin \alpha \quad (2)$$



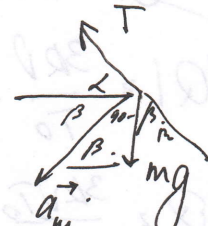
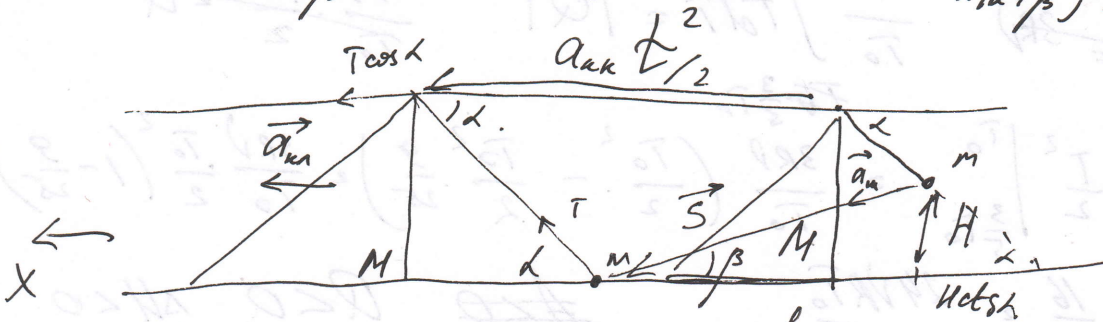
$$\text{ctg } \beta = \frac{\cos \alpha \cdot \cos \beta \cdot a_x}{\sin \beta \cdot \cos \alpha} = \text{ctg } \beta$$

$$m a_x = \frac{mg \cos \beta}{\sin(\alpha + \beta)} \cdot \cos \alpha$$

$$a_x = \frac{g \cos \beta \cos \alpha}{\sin(\alpha + \beta)}$$

(1) : (2)

$$\frac{a_x}{a_y} = \frac{\cos \alpha \cdot \cos \beta}{\sin(\alpha + \beta) - \sin \alpha \cdot \cos \beta}$$

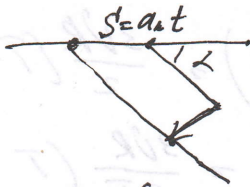


$$\cancel{mg \cos \beta = T} \quad \vec{S} = \frac{\vec{a} t^2}{2} L$$

$$y: H = \frac{a_{my} t^2}{2}$$

$$M a_{kx} = T \cos \alpha$$

$$M a_x = 1$$



$$\sin \alpha = \frac{H}{S} = \frac{5}{13}$$

$$\text{ctg } \alpha = \frac{5}{12}$$

$$\text{tg } \beta = \frac{2H}{a_x t^2}$$

$$\frac{a_{kx} t^2}{2} = \frac{a_x t^2}{2} + H \text{ctg } \alpha$$

$$L = \frac{a_x t^2}{2}$$

$$a_{kx} = \frac{T \cos \alpha}{M}$$

$$a_x = \frac{T \cos \alpha}{m}$$

$$\frac{a_{kx}}{a_x} = \frac{m}{M}, \quad a_{kx} = \frac{m}{M} a_x$$

$V_1 =$

$$\frac{\frac{m}{M} a_x t^2}{2} - \frac{a_x t^2}{2} = H \text{ctg } \alpha$$

$$\frac{\frac{m-M}{m} \cdot a_x t^2}{2} = H \text{ctg } \alpha$$

$$\frac{m-M}{m} \cdot \frac{2H}{\text{tg } \beta} = H \text{ctg } \alpha$$

$$\frac{m-M}{M} = \text{ctg } \alpha \cdot \text{tg } \beta$$

$$\frac{m}{M} = 1 - \text{ctg } \alpha \cdot \text{tg } \beta$$

$$1 - \frac{m}{M} = \text{ctg } \alpha \cdot \text{tg } \beta$$

$$\frac{m}{M} = \frac{1}{1 - \text{ctg } \alpha \cdot \text{tg } \beta}$$

$$\frac{mV^2}{2} - mgh = A_T = -T \sin \alpha \cdot H$$

$$V_{kx}^2 = a_{kx}^2 t^2$$

$$V_m^2 = a_x^2 t^2$$

$$mgh = \frac{M V_{kx}^2}{2} + \frac{m V_m^2}{2}$$

$$2mgh = M a_{kx}^2 t^2 + m a_x^2 t^2 = m(a_x^2 + a_{kx}^2) t^2$$

непробук

$$C(T) = 3R \frac{T}{T_0}$$

$$Q = A + \Delta U$$

$$\Delta U = \frac{3}{2} VR \Delta T = \frac{3}{2} VR \cdot \frac{2}{5} T_0 = \frac{3}{5} VR T_0$$

$$Q = \frac{3RV T^2}{2 T_0} = \frac{3RV T^2}{2 T_0}$$

$$A = Q - \Delta U = 3RV$$

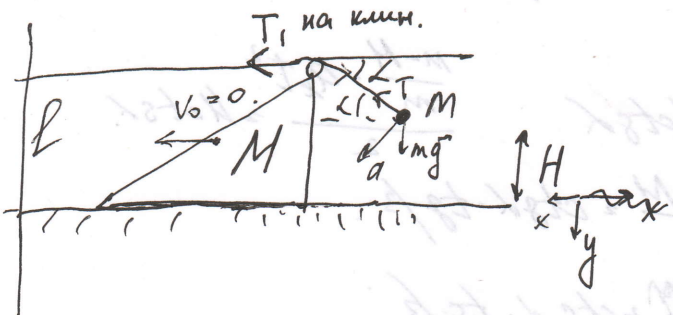
$$|Q| = \frac{3RV}{T_0} \cdot \frac{T^2}{2} \Big|_{\frac{3}{5} T_0}^{T_0}$$

$$Q = \frac{3RV T_0}{2} \cdot \frac{16}{25} = \frac{24VR T_0}{25}$$

$$A = Q - \Delta U = \frac{3RV}{T_0} \left(\frac{T^2}{2} - \frac{T_0^2}{2} \right) - \frac{3}{2} VR (T - T_0) = \frac{3RV}{2T_0} (T - T_0) \left(\frac{T + T_0}{T_0} - 1 \right) = \frac{3VR}{2} (T - T_0) \cdot \frac{T}{T_0}$$

$$A'(T) = \frac{3VR}{2T_0} (2T - T_0); \quad T = \frac{T_0}{2}$$

$$A\left(\frac{T_0}{2}\right) = \frac{3VR}{2} \left(\frac{T_0}{2} - T_0 \right) \cdot \frac{T_0}{2T_0} = \frac{3VR}{2} \cdot \left(-\frac{T_0}{2}\right) \cdot \frac{1}{2} = -\frac{3VR T_0}{8}$$



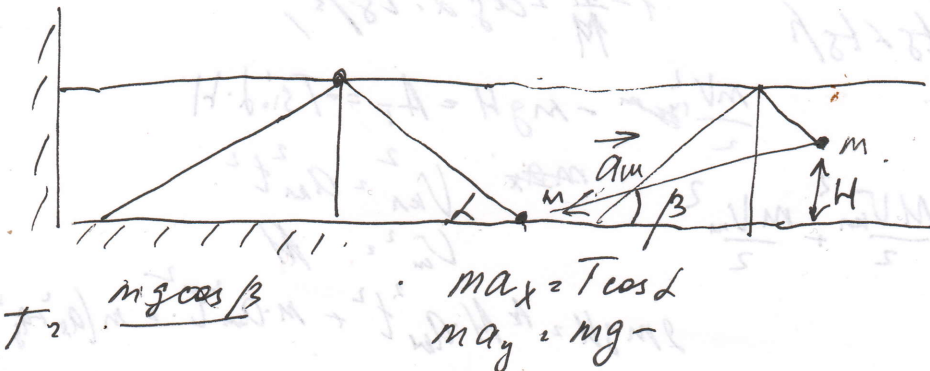
$$m \vec{a}_{\text{ном.}} = m \vec{g} + \vec{T}$$

$$x: m a_x = T \cos \alpha$$

$$y: m a_y = mg - T \sin \alpha$$

$$T_1 = T \cos \alpha$$

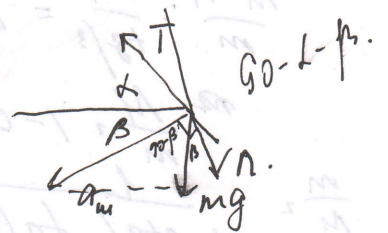
$$M_{\text{ном}} = T \cos \alpha$$



$$T_2 = \frac{mg \cos \beta}{\cos \beta}$$

$$a_x = T \cos \alpha$$

$$a_y = mg -$$



$$N: mg \cos \beta = T \cos(\alpha + \beta)$$

$$\frac{mg}{T} = \frac{\sin(\alpha + \beta)}{\cos \beta}$$

микробук.

Дано.
 $\cos \alpha = \frac{5}{13}$

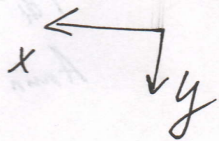
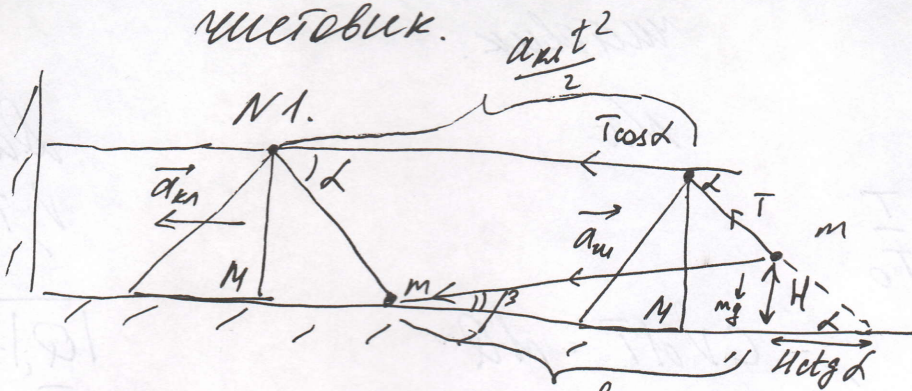
H

$\beta - ?$

$a_{\text{м}} - ?$

$\frac{m}{M}$

$t - ?$



$\text{tg} \beta = \frac{H}{l} = \frac{a_y}{a_x}$

$M a_x = T \cos \alpha$

$m a_y = mg - T \sin \alpha$

$\text{tg} \beta = \frac{mg - T \sin \alpha}{T \cos \alpha}$; $l = \frac{a_x t^2}{2}$; $2l = a_x t^2 = 2l$

$\frac{a_x t^2}{2} + H \text{ctg} \alpha = \frac{a_x t^2}{2}$

$M a_{\text{м}} = T \cos \alpha = m a_x$

$\frac{a_x \cdot \left(\frac{m}{M} - 1\right) t^2}{2} = H \text{ctg} \alpha$

$\frac{a_{\text{м}}}{a_x} = \frac{m}{M}$; $a_{\text{м}} = a_x \cdot \frac{m}{M}$

$\frac{m}{M} - 1 = \frac{2H \text{ctg} \alpha}{a_x t^2}$; $\frac{m}{M} = 1 + \frac{2H \text{ctg} \alpha}{a_x t^2} = 1 + \frac{H \text{ctg} \alpha}{l} = 1 + \text{tg} \beta \cdot \text{ctg} \alpha$

$a_{\text{м}} = a_x \cdot (1 + \text{tg} \beta \cdot \text{ctg} \alpha)$

$a_y = a_x \cdot \text{tg} \beta$; $H = \frac{a_y t^2}{2}$; $t = \sqrt{\frac{2H}{a_y}}$

$t = \sqrt{\frac{2H}{a_x \cdot \text{tg} \beta}}$

$W_1 = mgH$; $W_2 = \frac{m V_{\text{м}}^2}{2} + \frac{M V_{\text{м}}^2}{2}$

$V_{\text{м}} = a_{\text{м}} t$; $V_{\text{м}} = a_{\text{м}} t$

$V_{\text{м}}^2 = a_{\text{м}}^2 t^2 = (a_x + a_y)^2 t^2 = (a_x^2 + a_x^2 \text{tg}^2 \beta) t^2$

$2mgH = m \cdot a_x^2 (1 + \text{tg}^2 \beta) t^2 + M \cdot a_{\text{м}}^2 t^2$

числовок.

№2.

Дано:

$$V, T_0$$

$$C(T) = 3R \cdot \frac{T}{T_0}$$

$$C = \frac{dQ}{VdT}; \quad C V dT = dQ$$

$$3R \cdot \frac{T}{T_0} V dT = dQ$$

$$|Q_1| - ?$$

$$T_1 - ?$$

$$A_{min} - ?$$

$$Q_1 < 0$$

$$|Q_1| = \int_{\frac{3}{5}T_0}^{T_0} 3RV \frac{T}{T_0} dT = \frac{3RV}{T_0} \cdot \frac{T^2}{2} \Big|_{\frac{3}{5}T_0}^{T_0} =$$

$$= \frac{3RV}{2T_0} \left(\frac{T_0^2}{2} - \frac{9}{25} \cdot \frac{T_0^2}{2} \right) = \frac{3RV}{2T_0} \left(T_0^2 - \frac{9}{25} T_0^2 \right) = \frac{3RV}{2} \cdot \frac{16}{25} T_0 = \frac{24}{25} VR T_0$$

$$Q_1 = -\frac{24}{25} VR T_0 \quad \text{т.к. газ отдает тепло}$$

$$Q_2 = A + \Delta U; \quad A = Q - \Delta U; \quad \Delta U < 0; \quad Q(T) = \frac{3RV}{2T_0} (T^2 - T_0^2) < 0$$

$$A = Q(T) = \frac{3RV}{2T_0} (T^2 - T_0^2) - \frac{3}{2} VR (T - T_0)$$

$$A = \frac{3}{2} VR (T - T_0) \left(\frac{T + T_0}{T_0} - 1 \right) = \frac{3}{2} VR (T - T_0) \cdot \frac{T}{T_0} = \frac{3}{2} VR \cdot \frac{1}{T_0} (T^2 - T \cdot T_0)$$

$$T - T_0 < 0 \Rightarrow A < 0$$

$$A'(T) = \frac{3VR}{2T_0} (2T - T_0); \quad T = \frac{T_0}{2} \quad \text{— м. минимума}$$

$$A_{min} = A\left(\frac{T_0}{2}\right) = \frac{3VR}{2T_0} \left(\frac{T_0^2}{4} - \frac{T_0^2}{2} \right) = -\frac{3VR T_0}{8}$$

Ответ: 1. $|Q_1| = \frac{24}{25} VR T_0$

2. $T = \frac{T_0}{2}$

3. $A_{min} = -\frac{3VR T_0}{8}$

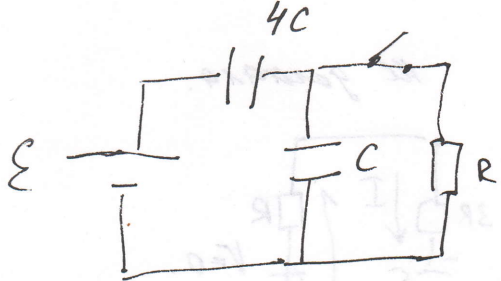
Часть 2

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

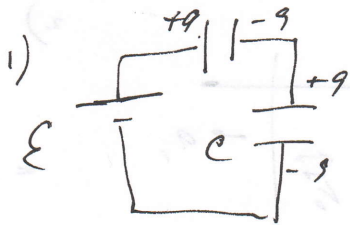
Шифр: **21200502**

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Вариант 3



первонач

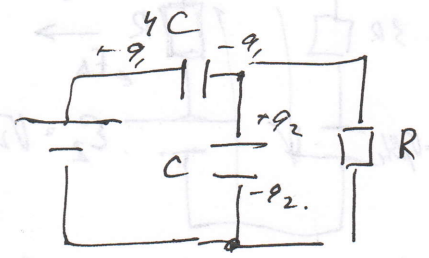


$$\mathcal{E} = \frac{q}{4C} + \frac{q \cdot 59}{C \cdot 4C}$$

$$U_C = \frac{q}{C} = \frac{4}{5} \mathcal{E}$$

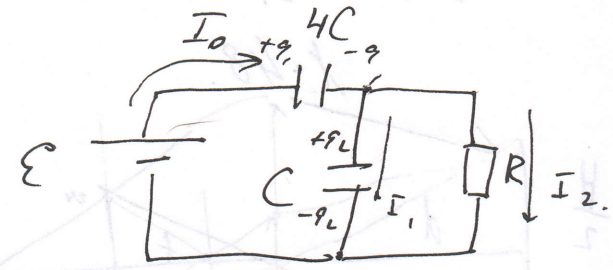
$$U_R = U_C = \frac{4}{5} \mathcal{E}$$

$$\bar{I}_R = \frac{4\mathcal{E}}{5R}$$



$$\mathcal{E} = \frac{q_2}{4C}$$

$$\mathcal{E} = \frac{q_2}{4C} - \frac{q_2}{C} = 0$$



$$W_1 = \frac{q^2 C U_2^2}{2} + \frac{4C U_1^2}{2}$$

$$= \frac{C \cdot \frac{16}{25} \mathcal{E}^2}{2} + \frac{4C \cdot \frac{\mathcal{E}^2}{25}}{2} = \frac{CE^2}{50} (16+4) = \frac{CE^2 \cdot 2}{5}$$

$$q_1 = q =$$

$$q_2 = \frac{4}{5} \mathcal{E} C$$

$$q_1 = \frac{4}{5} \mathcal{E} C$$

$$q_2 = 4 \mathcal{E} C$$

$$\mathcal{E} = \frac{q_1}{4C} + \frac{q_2}{C}$$

$$\mathcal{E} = \frac{q_1}{4C \cdot 2}$$

$$\mathcal{E} = \frac{q}{4C} + \bar{I}_R R$$

грано. $\mathcal{E} = \frac{q_1}{4C} + \bar{I}_R R$

$$A_{\text{вн}} = \Delta W_{\text{кон}} + Q$$

$$\mathcal{E} (q_2 - q_1) = \frac{q_2^2}{2 \cdot 4C} - \frac{2}{5} CE^2 + Q$$

$$\mathcal{E} \cdot \frac{16}{5} \mathcal{E} C = \frac{16 \mathcal{E}^2 C^2}{8C} - \frac{2}{5} CE^2 + Q$$

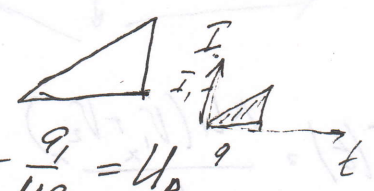
$$\frac{16}{5} \mathcal{E}^2 C = 2 \mathcal{E} C - \frac{2}{5} CE^2 + Q = \frac{8}{5} CE^2 + Q$$

$$Q = \frac{8}{5} \mathcal{E}^2 C$$

$$q = \int I dt$$

$$I_0 = I_1 + I_2$$

$$I_2 R = \frac{q_2}{C} = \mathcal{E} - \frac{q_1}{4C} = U_R$$



$$P = I_0 U_{4C}$$

$$W = \frac{I_0 t U_{4C}}{\mathcal{E}}$$

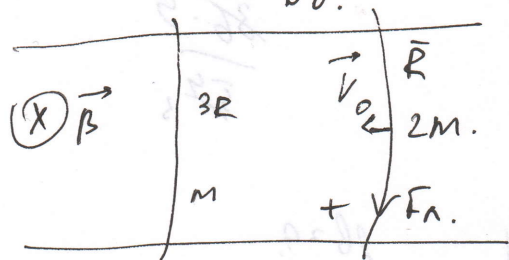
$$\mathcal{E} = B v L$$

$$I = \frac{B v L}{4R}$$

$$2m a = I B L = \frac{B^2 v L^2}{4R}$$

$$W_{\text{к}} = \frac{C U^2}{2} = \frac{q^2}{2C} = \frac{(I t)^2}{2C}$$

$$q = \int I dt \quad q_1 = \frac{I t}{2}$$



$$a_1 = \frac{(BL)^2 v_0}{4mR}$$

$$a_{\text{нп}} = \frac{(BL)^2 v_0}{8mR}$$

$$a_1 > a_{\text{нп}}$$

Дано:

числовик

$\epsilon; C; R$

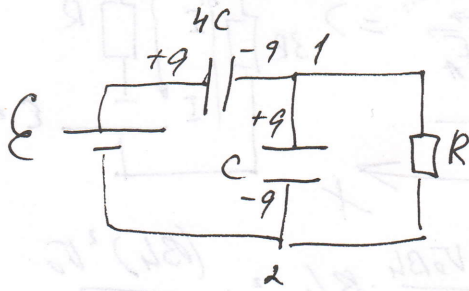
№3.

в момент замыкания напряжение на конденсат. не изменилось

$I_R - ?$

$Q - ?$

$U_R - ?$



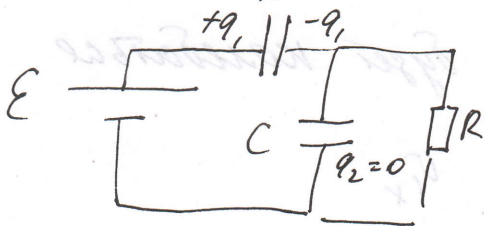
$$I_R = \frac{U_{12}}{R}$$

$$\epsilon = \frac{q}{4C} + \frac{q}{C} = \frac{5q}{4C}; \quad \frac{q}{C} = \frac{4}{5}\epsilon$$

$$U_{12} = \frac{q}{C} = \frac{4}{5}\epsilon, \quad q = \frac{4}{5}\epsilon C$$

$$I_R = \frac{4\epsilon}{5R}$$

прошло время t_{4C} ; тока в цепи нет



$$\epsilon = \frac{q_1}{4C} + \bar{I} \cdot R = \frac{q_1}{4C}; \quad q_1 = 4\epsilon C$$

$$\epsilon = \frac{q_1}{4C} + \frac{q_2}{C} \Rightarrow q_2 = 0$$

Энергия сразу после замыкания

$$W_1 = \frac{q^2}{2 \cdot 4C} + \frac{q^2}{2 \cdot C} = \frac{q^2}{2C} \left(\frac{1}{4} + 1 \right) = \frac{5}{4} \cdot \frac{q^2}{2C} = \frac{5q^2}{8C} = \frac{5 \cdot 16\epsilon^2 C^2}{8C \cdot 25} = \frac{2}{5} \epsilon^2 C$$

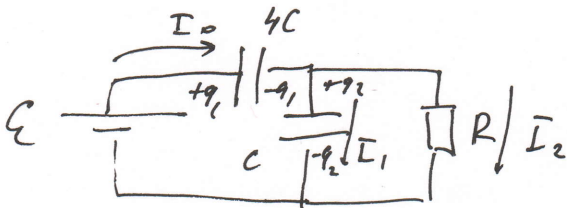
Энергия после установления режима

$$W_2 = \frac{q_1^2}{2 \cdot 4C} = \frac{16\epsilon^2 C^2}{8C} = 2\epsilon^2 C$$

$$\text{Ансамбль} = \epsilon \Delta q = \epsilon (q_1 - q) = \epsilon \cdot (4\epsilon C - \frac{4}{5}\epsilon C) = \frac{16}{5} \epsilon^2 C$$

$$\text{Ансамбль} = W_2 - W_1 + Q$$

$$\frac{16}{5} \epsilon^2 C = 2\epsilon^2 C - \frac{2}{5} \epsilon^2 C + Q; \quad Q = \frac{8}{5} \epsilon^2 C$$



$$\bar{I}_0 = \bar{I}_1 + \bar{I}_2$$

$$\epsilon = \frac{q_1}{4C} + \frac{q_2}{C}; \quad \frac{q_2}{C} = U_R = \epsilon - \frac{q_1}{4C}$$

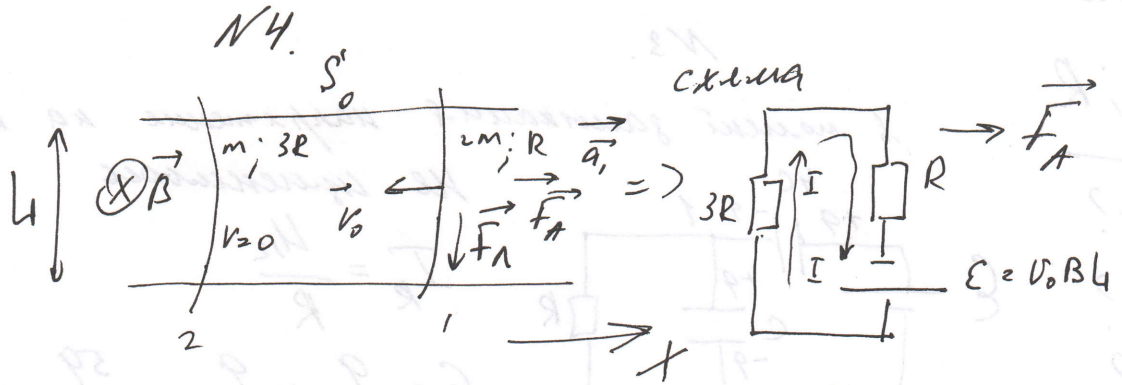
Ответ: 1. $I_R = \frac{4\epsilon}{5R}$

2. $Q = \frac{8}{5} \epsilon^2 C$

милливатт

Дано:
 $B; L; m; R$
 $v_0; S_0$

$a_1 - ?$
 $v_1 - ?$
 $v_2 - ?$
 $S - ?$

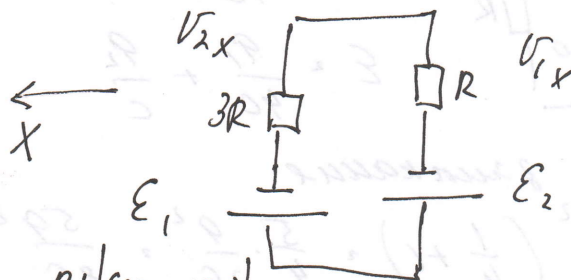


$$F_A = I B L = \frac{\epsilon}{4R} B L = \frac{v_0 B L}{4R} \cdot B L = \frac{(B L)^2 v_0}{4R}$$

$$x: 2m a_1 = F_A = \frac{(B L)^2 v_0}{4R}$$

$$a_1 = \frac{(B L)^2 v_0}{8mR}$$

Схема будет колебательная



$$I(t) = \frac{|\epsilon_1 - \epsilon_2|}{4R} = \frac{B L (v_{1x} - v_{2x})}{4R}$$

Ответ: 1. $a_1 = \frac{(B L)^2 v_0}{8mR}$

Дано:

$F = 18 \text{ см}$

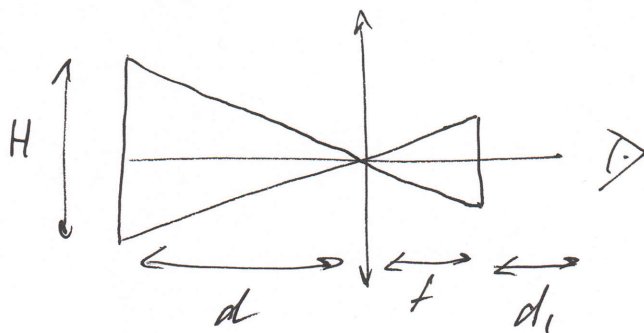
$H = 9 \text{ см}$

$d = 72 \text{ см}$

$d_1 = 24 \text{ см}$

Кустовик

№5.



$f + d_1 = x$

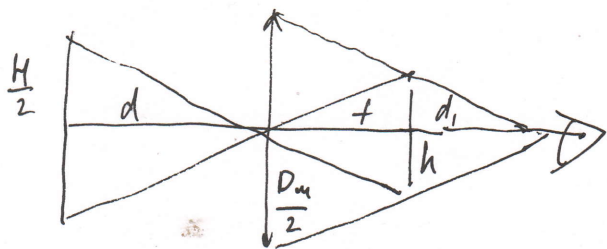
$x = ?$

$D_m = ?$

$L = ?$

$$\frac{1}{F} = \frac{1}{d} + \frac{1}{f} ; f = \frac{dF}{d-F} = 24 \text{ см}$$

$$x = d_1 + \frac{dF}{d-F} = 24 + \frac{72 \cdot 18}{54} = 48 \text{ см}$$

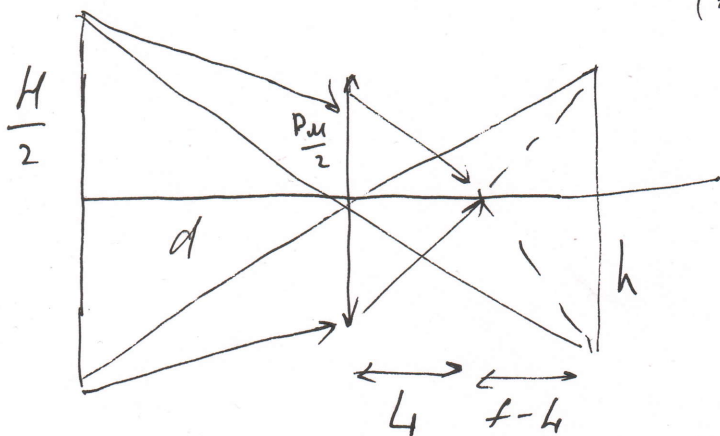


$$\frac{h}{\frac{H}{2}} = \frac{f}{d}$$

$$h = \frac{f}{d} \cdot \frac{H}{2} = \frac{dF}{(d-F)d} \cdot \frac{H}{2} = \frac{FH}{2(d-F)}$$

$$\frac{h}{\frac{D_m}{2}} = \frac{d_1}{x} ; D_m = \frac{2hx}{d_1} = \frac{2 \cdot FH}{2(d-F)d_1} \cdot \left(d_1 + \frac{dF}{d-F}\right) =$$

$$= \frac{18 \cdot 9}{(72-18) \cdot 24} (24+24) = \frac{18 \cdot 9 \cdot 48}{54 \cdot 24} = \frac{18}{3} = 6 \text{ см}$$



$$\frac{h}{\frac{D_m}{2}} = \frac{f-L}{L} ; 2hL = D_m(f-L)$$

$$L(2h + D_m) = D_m f$$

$$L = \frac{D_m f}{2h + D_m} = \frac{6 \cdot 24}{3 + 6} = \frac{6 \cdot 24}{9} = 16 \text{ см}$$

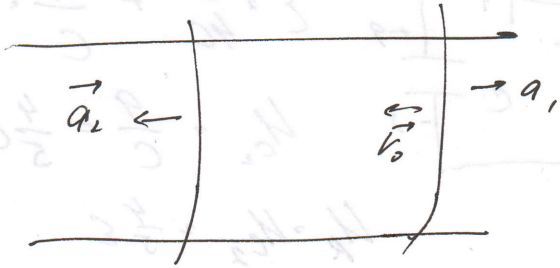
Ответ: 1. $x = 48 \text{ см}$

2. $D_m = 6 \text{ см}$

3. $L = 16 \text{ см}$ справа от линзы

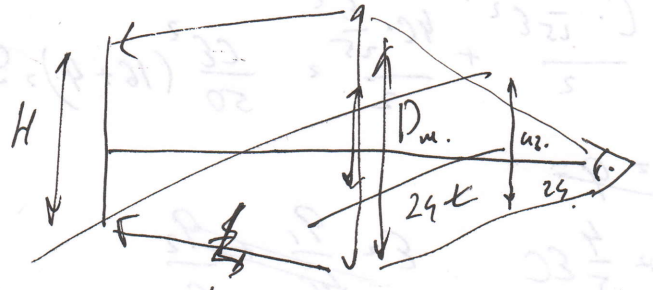
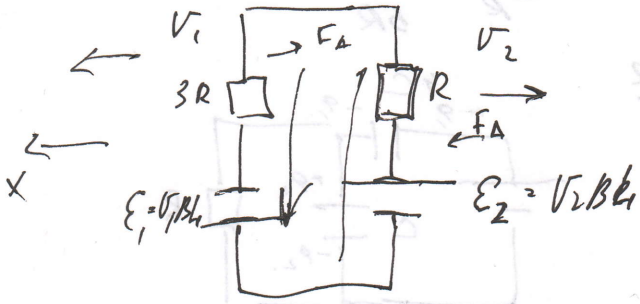
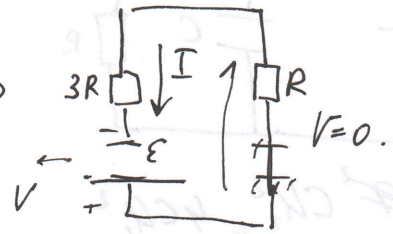
репродук

1)



2)

не гомогенно.

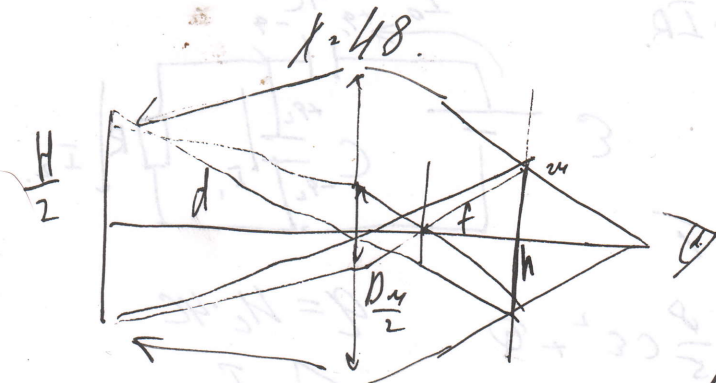


$$f = \frac{dF}{d-F} = \frac{72 \cdot 18}{543} = 24.$$

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

$$f = \frac{dF}{d-F} = \frac{24 \cdot 18}{8} = 72 \text{ см.}$$

$$k = d$$



$$\frac{2h}{H} = \frac{f}{d}$$

$$h = \frac{4f}{2d} = \frac{H \cdot dF}{(d-F)2d} = \frac{4F}{2(d-F)}$$

$$\frac{D_{m2}}{2} = 2h = \frac{4HF}{2(d-F)} = \frac{2HF}{d-F}$$

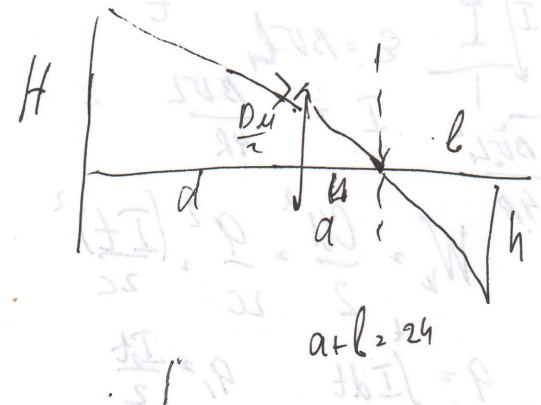
$$= \frac{2 \cdot 9 \cdot 18}{543} = 6 \text{ см.}$$

$$I(t) = \frac{Bl(v_{1x} + v_{2x})}{4R}$$

константа

$$Q_n = \frac{(Bl)^2 (v_{1x} + v_{2x})}{m \cdot 4R} ; Q_{mp} = \frac{(Bl)^2 (v_{1x} + v_{2x})}{8Rm}$$

$$\frac{2 \cdot 36 \cdot 9}{543}$$



$$\frac{h}{\frac{D_{m2}}{2}} = \frac{b}{a} = \frac{1}{2}$$

$$2b = a$$

$$3b = 24$$

$$b = 8$$

$$a = 16$$