

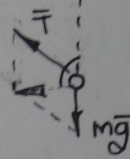
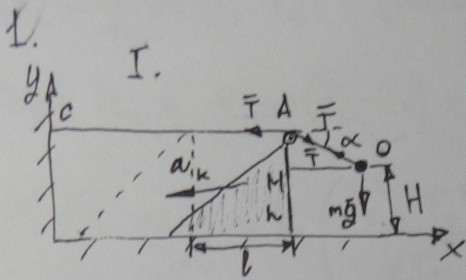
Часть 1

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

Шифр: **21201787**

ID профиля: **830868**

Вариант 2



$$\begin{aligned} \cos \alpha &= 0,8 \\ \sin \alpha &= 0,6 \\ \operatorname{tg} \alpha &= 0,75 \end{aligned}$$

$$MO = (h-H) \operatorname{tg} \alpha$$

$$l = OM + H \operatorname{tg} \alpha$$

$$ma_y = T \sin \alpha - mg$$

$$a_y = -\frac{T}{m} \sin \alpha + g$$

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

$$MO = l - H \operatorname{tg} \alpha$$

$$l = \frac{h}{\operatorname{tg} \alpha} = OM + \frac{H}{\operatorname{tg} \alpha}$$

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

$$H = \frac{a_y t^2}{2}$$

$$\Delta x = \frac{a_x t^2}{2}$$

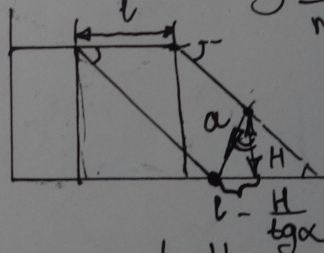
$$l = \frac{a_x t^2}{2}$$

$$\Rightarrow a_x = \frac{T - T \cos \alpha}{M} = \frac{T - \frac{4}{5}T}{M} = \frac{T}{5M}$$

$$\frac{OM}{\cos \alpha} + l = \frac{h}{\sin \alpha}$$

$$3 \frac{T}{m} \cos \alpha = \frac{T}{m} \sin \alpha + g$$

$$\frac{OM}{\cos \alpha} + H \operatorname{tg} \alpha = \frac{h}{\sin \alpha}$$



$$3 \cdot 0,8 \cdot \frac{T}{m} + \frac{T}{m} \cdot 0,6 = g$$

$$\frac{l - H \operatorname{tg} \alpha}{\cos \alpha}$$

$$AC + \frac{h-H}{\sin \alpha} = AC - l + \frac{h}{\sin \alpha}$$

$$\frac{l - H \operatorname{tg} \alpha}{\cos \alpha} + H = \frac{h}{\sin \alpha}$$

$$\frac{h-H}{\sin \alpha} + l = \frac{h}{\sin \alpha}$$

$$\begin{aligned} 3 \frac{T}{m} &= g \\ T &= \frac{mg}{3} \end{aligned}$$

$$\frac{2l}{a_x} = \frac{2H}{a_y}$$

$$a_x = \frac{l a_y}{H} = \frac{l}{H} \cdot 0,8 mg = \frac{h}{\sin \alpha} - \frac{H}{\sin \alpha} + l = \frac{h}{\sin \alpha}$$

$$= \frac{0,8 mg}{\sin \alpha} = \frac{4}{3} mg$$

$$l = \frac{H}{\sin \alpha}$$

$$l a_y = H a_x$$

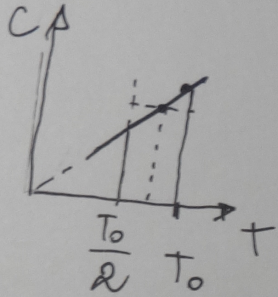
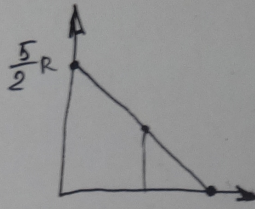
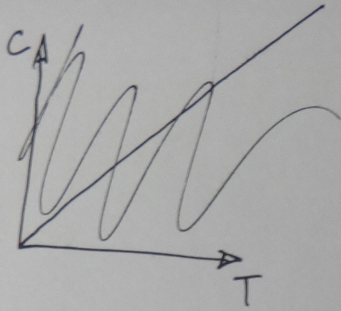
$$a_x = \frac{l \cdot a_y}{H} = \frac{H a_y}{H \sin \alpha} = \frac{a_y}{\sin \alpha}$$

$$\operatorname{tg} \beta = \frac{l - H \operatorname{tg} \alpha}{H}$$

$$= \frac{\frac{H}{\sin \alpha} - \frac{H}{\operatorname{tg} \alpha}}{H}$$

$$= \frac{1}{\sin \alpha} - \frac{1}{\operatorname{tg} \alpha} = \frac{1 - \cos \alpha}{\sin \alpha}$$

Мерновик



$$C = \frac{Q}{\Delta T}$$

$$C_{\text{нч}} = \frac{5}{2}R \frac{T_0}{4T_0} = \frac{5}{8}R$$

$$\frac{Q}{\nu \cdot \Delta T} = \frac{5}{8}R$$

$$Q = \Delta U + A_r$$

$$\Delta U = -\frac{3}{2} \nu R \frac{T_0}{2}$$

$$A_r = -\nu R \frac{T_0}{2}$$

$$Q = -\frac{5}{2} \nu R \frac{T_0}{2}$$

$$\frac{Q}{-\nu \cdot \frac{T_0}{2}} = \frac{5}{8}R$$

$$Q = -\frac{5 \nu T_0}{16 R}$$

①

Дано:

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

H

- 1) β - ?
- 2) a_k - ?
- 3) $\frac{m}{M}$ - ?
- 4) t - ?

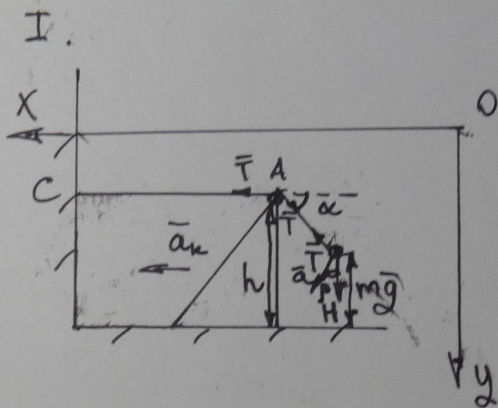


рис. 1.1

II.

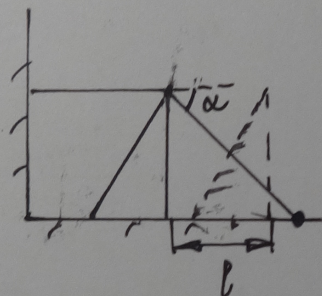


рис. 1.2

Решение:

1. Длина нити неизменна

Пусть h - высота кшина, l - расст., пройденное кшином до падения шарика

$$\Rightarrow AC + \frac{h}{\sin \alpha} - \frac{H}{\sin \alpha} = AC - l + \frac{h}{\sin \alpha}$$

$$\Rightarrow l = \frac{H}{\sin \alpha}$$

$$\operatorname{tg} \beta = \frac{x}{H} \quad (\text{см. рис. 2})$$

$$x = l - \frac{H}{\operatorname{tg} \alpha} = \frac{H}{\sin \alpha} - \frac{H}{\operatorname{tg} \alpha} = H \left(\frac{1 - \cos \alpha}{\sin \alpha} \right)$$

$$\Rightarrow \operatorname{tg} \beta = \frac{H \left(\frac{1 - \cos \alpha}{\sin \alpha} \right)}{H} = \frac{1 - \cos \alpha}{\sin \alpha} = \frac{1 - 0,8}{0,6} = \frac{1}{3}$$

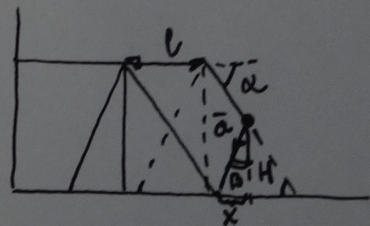


рис. 2

$$\textcircled{1} \quad \left. \begin{aligned} H &= \frac{a_y t^2}{2} \\ l &= \frac{a_x t^2}{2} \end{aligned} \right\} \text{ ур-е РУД, } v_0 = 0, a_y - \text{проекц. } a \text{ на } O_y$$

$$\Rightarrow \frac{2H}{a_y} = \frac{2l}{a_x}$$

$$\operatorname{tg} \beta = \frac{a_x}{a_y}$$

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

$$a_y = g - \frac{T}{m} \sin \alpha \quad \left. \vphantom{a_x} \right\} \text{ из II 3-на Ньютона}$$

$$\Rightarrow \frac{T}{m} \cos \alpha = \operatorname{tg} \beta \cdot \left(g - \frac{T}{m} \sin \alpha \right)$$

$$\frac{T}{m} \frac{\cos \alpha}{\operatorname{tg} \beta} = g - \frac{T}{m} \sin \alpha$$

$$2 \cdot \frac{T}{m} \cdot 0,8 = g - \frac{T}{m} \cdot 0,6$$

$$\Rightarrow g = 3 \frac{T}{m}$$

$$a_x = \frac{l \cdot a_y}{H} = \frac{a_y}{\sin \alpha} = \frac{g - \frac{g \sin \alpha}{3}}{\sin \alpha} = \frac{g - \frac{2 \cdot 0,6}{3}}{0,6} = \frac{4}{3} g$$

$$a_x = \frac{T - T \cos \alpha}{M} = \frac{T(1 - \cos \alpha)}{M} = \frac{T(1 - 0,8)}{M} = \frac{T}{5M}$$

$$\Rightarrow M = \frac{T}{5a_x} = \frac{mg}{15a_x} = \frac{m}{20}$$

$$\Rightarrow \frac{m}{M} = 0,05$$

$$\textcircled{1} \quad H = \frac{a_y t^2}{2}$$

$$\Rightarrow t = \sqrt{\frac{2H}{a_y}} = \sqrt{\frac{2H}{g - \frac{I}{m} \sin \alpha}} = \sqrt{\frac{2H}{g - \frac{g}{3} \sin \alpha}} = \sqrt{\frac{2H}{g(1 - \frac{0.6}{3})}} =$$

$$= \sqrt{\frac{2H}{0.8g}} = \sqrt{\frac{2.5H}{g}}$$

Ответ: 1) $\text{tg} \beta = \frac{1}{3}$; 2) $a_k = \frac{4}{3}g$; 3) $\frac{m}{M} = 0.05$; 4) $t = \sqrt{\frac{2.5H}{g}}$

②

Дано:

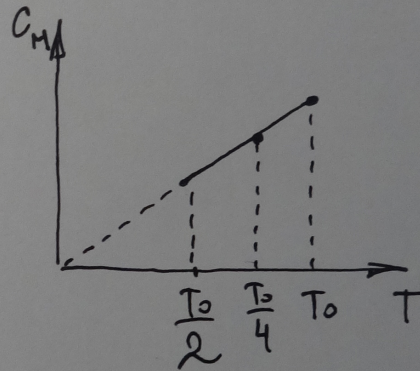
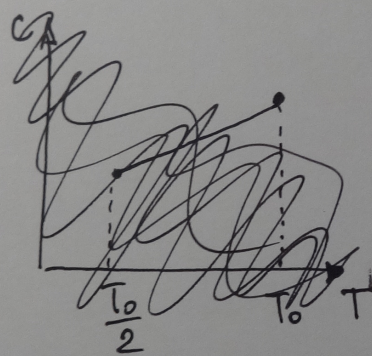
$$C_M(T) = \frac{5}{2} R \frac{T}{T_0}$$

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

1) $Q_{1 \text{ орг.}}$

2) $T_2 - ?$

3) $A_2 - ?$



Решение:

Зависимость $C_M(T)$ линейная

$$C_M = \frac{Q}{\Delta T \nu} \quad (\text{по опр.})$$

$$\Rightarrow Q = C_{M, \text{cp}} \cdot \Delta T \nu$$

$$C_{M, \text{cp}} = C_M(T_{\text{cp}}) = C_M\left(\frac{T_0 + \frac{T_0}{2}}{2}\right) = C_M\left(\frac{3T_0}{4}\right)$$

$$\Rightarrow Q_1 = \Delta T \cdot \nu \cdot C_M\left(\frac{3T_0}{4}\right) = \Delta T \cdot \nu \cdot \frac{5}{2} R \cdot \frac{3T_0}{4T_0} = \Delta T \nu \cdot \frac{5}{2} \cdot \frac{3}{4} R =$$

$$= \frac{15}{8} \nu R \Delta T = \frac{15}{8} \nu R \left(\frac{T_0}{2} - T_0\right) = -\frac{15}{16} \nu R T_0$$

$$\Rightarrow Q_{1 \text{ орг.}} = |Q_1| = \frac{15}{16} \nu R T_0$$

$$Q_2 = A_{r_2} + \Delta U_2 \quad (\text{I начало термодинамики})$$

Чистовик
лист 4.

$$\Delta U_2 = \frac{3}{2} \nu R (T_2 - T_0) \quad (\text{гелий - одноатомный})$$

$$\cancel{Q_2} \quad Q_2 = \nu \cdot (T_2 - T_0) \cdot C_{H(T_{cp.2})} = \nu (T_2 - T_0) \cdot \frac{5}{2} R \left(\frac{T_2 + T_0}{2T_0} \right)$$

$$\Rightarrow A_{r_2} = \frac{5}{2} \nu R \left(\frac{T_2^2 - T_0^2}{2T_0} \right) - \nu R (T_2 - T_0) = \cancel{\frac{5}{2} \nu R (T_2 - T_0)} \cdot$$

$$\cdot \left(\frac{5}{2} \cdot \frac{T_2 + T_0}{2T_0} - 1 \right) = \frac{5 \nu R (T_2^2 - T_0^2)^2}{2 \cdot 2T_0} = \frac{5}{4} \frac{\nu R (T_2 - T_0)^2}{T_0}$$

$$\text{Ответ: } 1) \quad Q_{1, \text{отг.}} = \frac{15}{16} \nu R T_0$$

Часть 2

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

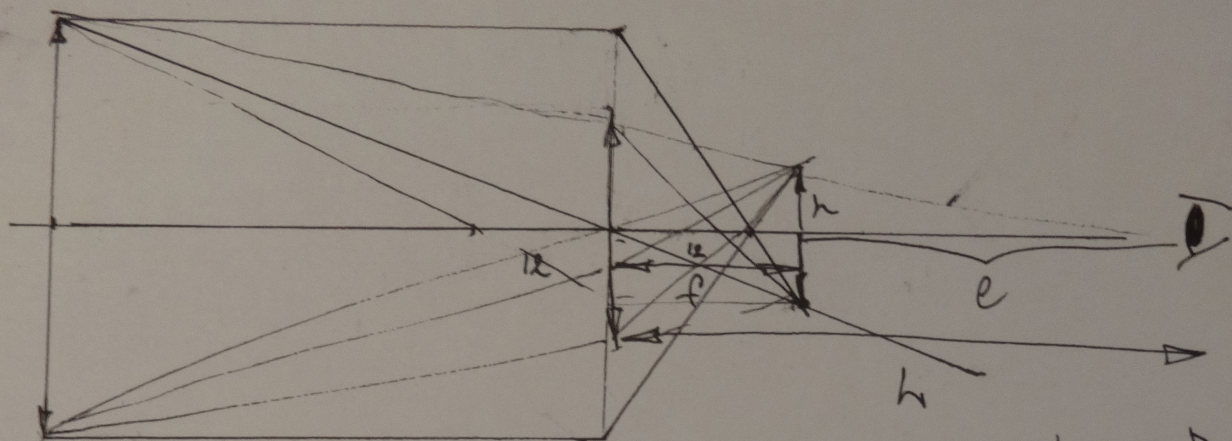
Шифр: **21201787**

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Вариант 2

5.

Черновик



48

$$\frac{h}{e} = \frac{D_M}{2L}$$

$$\frac{1}{12} = \frac{1}{48} + \frac{1}{f}$$

$$D_M = \frac{1}{3} \frac{HL}{e} = 5 \text{ см}$$

$$\frac{H}{3e} = \frac{D_M}{2L}$$

$$\frac{4}{48} - \frac{1}{48} = \frac{1}{f}$$

$$\Gamma = \frac{f}{d} = \frac{1}{3}$$

$$\frac{D_M}{H} =$$

$$\frac{3}{48} = \frac{1}{f}$$

$$\frac{H}{L+d} = \frac{h}{L}$$

$$\frac{D_M}{H} =$$

$$\frac{1}{16} = \frac{1}{f}$$

$$= \frac{h_1}{h} = \frac{D_M}{3h}$$

$$f = 16 \text{ см}$$

$$h = \frac{eH}{L+d}$$

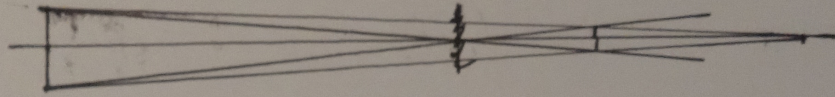
$$h_1 = \Gamma D_M =$$

$$L = l + f = 24 \text{ см} + 16 \text{ см} = 40 \text{ см}$$

$$= \frac{D_M}{3}$$

$$\frac{2L}{D_M} = \frac{2(L+d)}{H} = D_M = \frac{HL}{L+d} = \frac{9 \text{ см} \cdot 40 \text{ см}}{40 \text{ см} + 48 \text{ см}} \approx 4,1 \text{ см}$$

Черновик



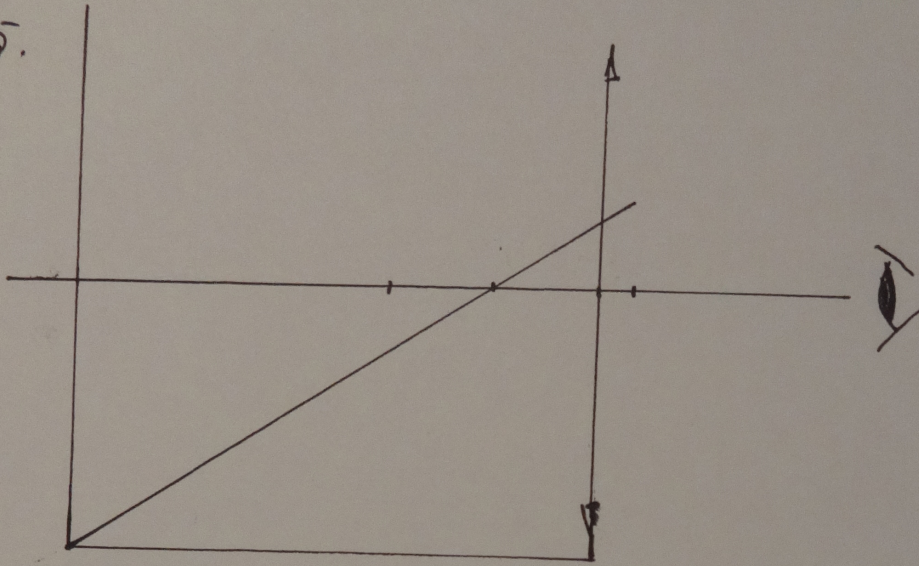
Мерников

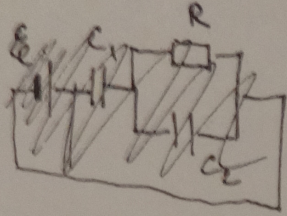
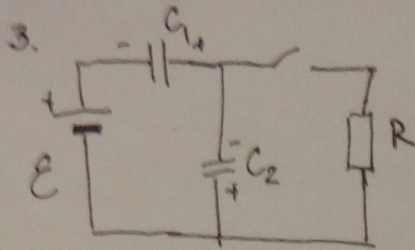
~~Мерников~~

19/12

19/12

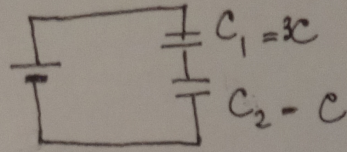
5.





$$\varepsilon = U_1 + U_2$$

I.



$$U_1 + U_2 = \varepsilon$$

$$U_1 = \frac{q}{C_1} = \frac{q}{3C}$$

$$U_2 = \frac{q}{C_2} = \frac{q}{C}$$

$$\Rightarrow \frac{4}{3} \frac{q}{C} = \varepsilon$$

$$q = \frac{3}{4} C \cdot \varepsilon$$

$$U_R = U_2 = \frac{q}{C_2} = \frac{\frac{3}{4} C \cdot \varepsilon}{C} = \frac{3}{4} \varepsilon$$

$$I_R = \frac{U_R}{R} = \frac{\frac{3}{4} \varepsilon}{R} = \frac{3\varepsilon}{4R}$$

$$Q = I^2 R t = W_1 + W_2$$

$$q_2 = \frac{3}{2} C \varepsilon$$

$$U_2 = \varepsilon$$

$$Q = W_1 \cdot \frac{C_1 - C_2}{C_2} = W_1 \cdot \frac{3C - C}{C} = \frac{1}{2} W_1 = \frac{1}{2} \frac{CU_1^2}{2} =$$

$$= \frac{3CU_1^2}{4} = \frac{3C(\mathcal{E} - U_2)^2}{4} = \frac{3C\mathcal{E}^2}{64}$$

Ответ: 1) $\frac{3\mathcal{E}}{4R}$; 2) $\frac{3C\mathcal{E}^2}{64}$

Числовое
лист 3

$$2L = 3f + d$$

$$L = \frac{3}{2}f + \frac{d}{2} = \frac{3}{2} \cdot 16 \text{ см} + \frac{48 \text{ см}}{2} = 48 \text{ см}$$

$$\frac{L-f}{h} = \frac{L}{D_M}$$

$$D_M = \frac{hL}{L-f} = \frac{Hh}{3(L-f)} = \frac{9 \text{ см} \cdot 48 \text{ см}}{3 \cdot (48 \text{ см} - 16 \text{ см})} = 4,5 \text{ см}$$

Ответ: 1) 40 см; 2) 4,5 см

3.

Дано:

$$C_1 = 3C$$

$$C_2 = C$$

R

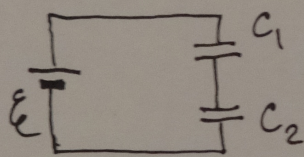
\mathcal{E}, I_0

1) I_R - ?

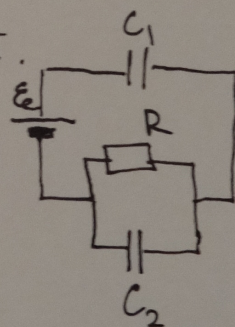
2) Q - ?

3) U_R - ?

I.



II.



Решение:

I) Конденс. заряжаются

$$C_{12} = \frac{C_1 C_2}{C_1 + C_2} = \frac{3}{4} C \quad (\text{послед. ноги.})$$

$$U_{12} = \mathcal{E}$$

$$q = C_{12} U_{12} = \frac{3}{4} C \mathcal{E}$$

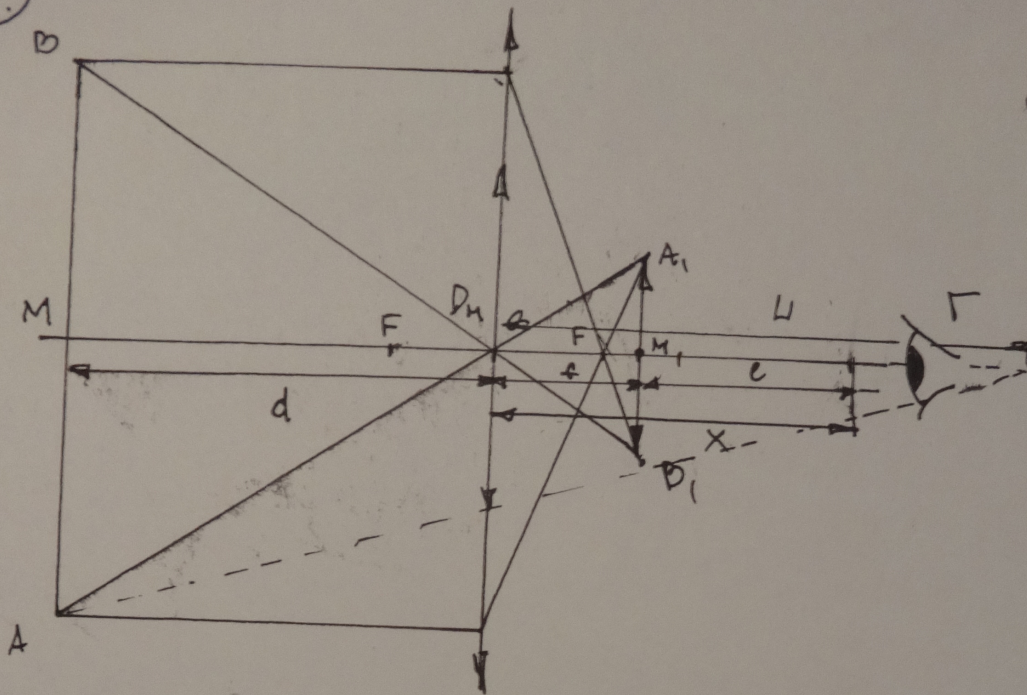
II) конденс. разряжаются

$$U_R = U_2 \quad (\text{паралл. ноги.})$$

$$U_2 = U_R = \frac{q}{C_2} = \frac{\frac{3}{4} C \mathcal{E}}{C} = \frac{3}{4} \mathcal{E}$$

$$I_R = \frac{U_R}{R} = \frac{3\mathcal{E}}{4R}$$

5.



Дано:
 $F = 12 \text{ см}$
 $d = 48 \text{ см}$
 $H = 9 \text{ см}$
 $l = 24 \text{ см}$

1) x - ?
 2) D_n - ?
 3) l_2 - ?

Решение:

$$\frac{1}{F} = \frac{1}{f} + \frac{1}{d} \quad (\text{ф-ла тонкой линзы})$$

$$\Rightarrow f = \frac{Fd}{d-F} = \frac{12 \text{ см} \cdot 48 \text{ см}}{48 \text{ см} - 12 \text{ см}} = 16 \text{ см}$$

$$x = f + l = 16 \text{ см} + 24 \text{ см} = 40 \text{ см}$$

$$\frac{L-f}{M_1 A_1} = \frac{L+d}{MB}$$

пусть $M_1 A_1 = \frac{h}{2}$ $MB = \frac{H}{2}$

$$\frac{L-f}{h} = \frac{L+d}{H}$$

$$\gamma = \frac{f}{d} = \frac{16 \text{ см}}{48 \text{ см}} = \frac{1}{3}$$

$$\Rightarrow \frac{H}{h} = 3$$

$$\Rightarrow 3L - 3f = l + d$$