

Часть 1

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

Шифр: **21201058**

ID профиля: **191427**

Вариант 2

11 класс

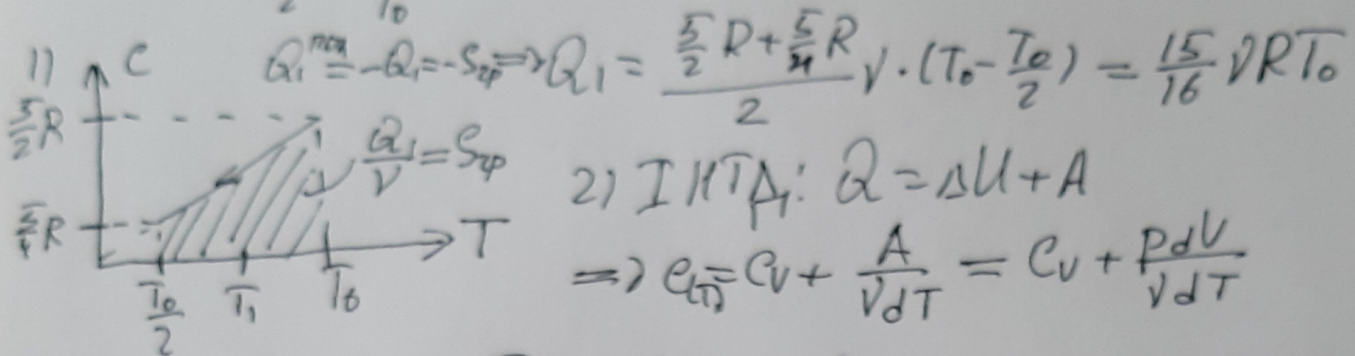
Чистовик.

Вариант 11-02

I. часть.

2.

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



Максимальная работа будет совершена при достижении экстремального значения объёма $\Rightarrow \frac{dV}{dT} = 0$

$$\Rightarrow \partial C(T, 1) = C_V = \frac{3}{2} R; \quad \frac{5}{2} R \frac{T_1}{T_0} = \frac{3}{2} R \Rightarrow T_1 = \frac{3}{5} T_0$$

$$3) \text{ ИИТД: } Q^* = \Delta U + A_{\min}$$

$$Q^* = \frac{V \frac{5}{2} R + \frac{3}{2} R}{2} \left(\frac{3}{5} T_0 - T_0 \right) = -\frac{2}{5} V R T_0$$

$$\Delta U = \frac{3}{2} V R \left| \frac{3}{5} T_0 - T_0 \right| = -\frac{3}{5} V R T_0$$

$$A_{\min} = Q^* - \Delta U = V R T_0 \left(\frac{3}{5} - \frac{2}{5} \right) = \frac{V R T_0}{5}$$

Ответ: 1) $Q_1 = \frac{15}{16} V R T_0$; 2) $T_1 = \frac{3}{5} T_0$; 3) $A_{\min} = \frac{V R T_0}{5}$

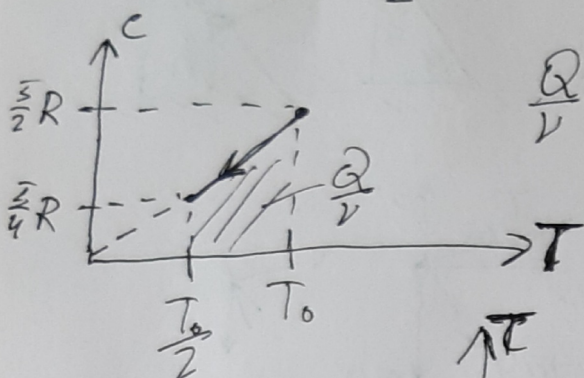
Черковик.

2.

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

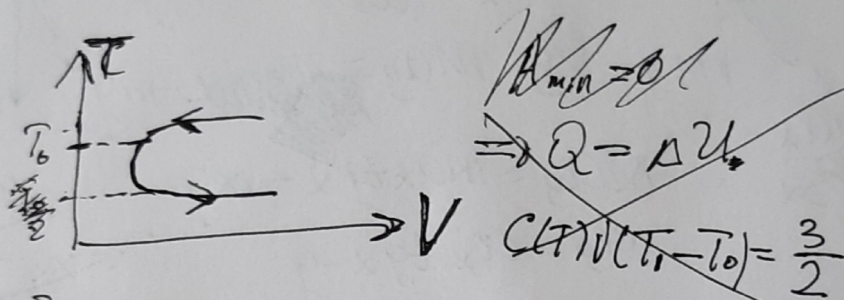
$$\frac{5}{2} + \frac{5}{4} = \frac{10}{4} + \frac{5}{4} = \frac{15}{4}$$

~~$$Q = \Delta U + A = \frac{3}{2} VR(T_1 - T_0) + A$$~~



$$\frac{Q_1}{V} = \frac{\frac{T_0}{2} + T_0}{2} \cdot \frac{\frac{5}{2}R + \frac{5}{4}R}{2} \cdot \frac{T_0}{2} = \frac{15}{8} R \frac{T_0}{2} = \frac{15}{16} T_0 R$$

$$\Rightarrow \delta Q_1 = \frac{15}{16} VR T_0$$



~~$$C(T) \cdot (T_1 - T_0) = \frac{3}{2}$$~~

$$\delta Q = \Delta U + dA = \frac{3}{2} VR dT + p dV = \frac{3}{2} (dpV) + p dV$$

$$\delta Q = \frac{3}{2} dpV + \frac{3}{2} p dV + p dV = \frac{3}{2} dpV + \frac{5}{2} p dV$$

~~необходимо~~ A_{min} - работа, необходимая для осуществления V_{min}

$$C = C_V + \frac{A}{V dT} = C_V + \frac{p dV}{V dT} \Rightarrow V = V_{min} \text{ при } \frac{dV}{dT} = 0$$

$$\Rightarrow \delta C = C_V = \frac{3}{2} R; \quad \frac{5}{2} R \frac{T_1}{T_0} = \frac{3}{2} R; \quad T_1 = \frac{3}{5} T_0$$

$$C(T_1) = \frac{3}{2} R$$

~~$$Q = \Delta U + A$$~~
$$Q^* = \Delta U + A_{min}$$

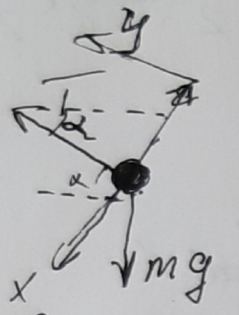
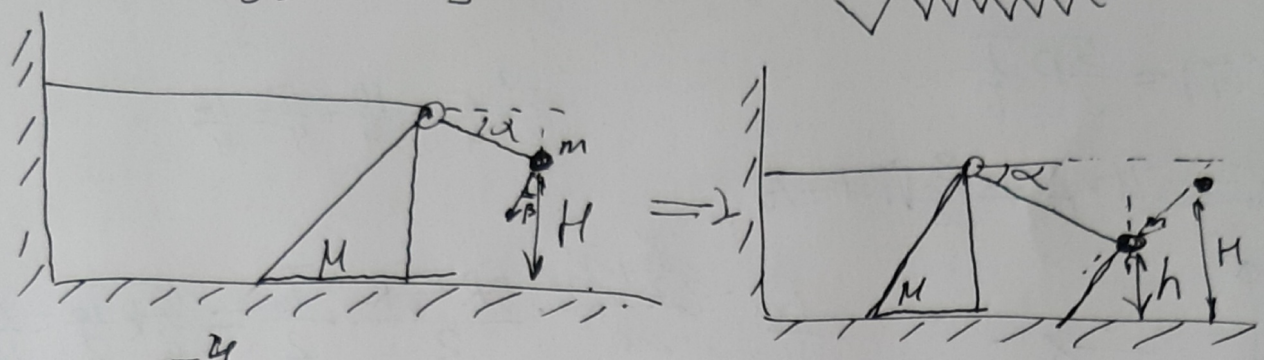
$$Q^* = V \frac{\frac{5}{2} R + \frac{3}{2} R}{2} \cdot \left(\frac{3}{5} T_0 - T_0 \right) = 2VR \cdot \left(-\frac{2}{5} T_0 \right) = -\frac{2}{5} VR T_0$$

$$\Delta U = \frac{3}{2} VR \left(\frac{3}{5} T_0 - T_0 \right) = \frac{3}{2} VR \left(-\frac{2}{5} T_0 \right) = -\frac{3}{5} VR T_0$$

$$-\frac{2}{5} VR T_0 = -\frac{3}{5} VR T_0 + A_{min}; \quad \underline{A_{min} = VR T_0 \left(\frac{3}{5} - \frac{2}{5} \right) = \frac{VR T_0}{5}}$$

1. $\cos \alpha = \frac{4}{5}; \sin \alpha = \frac{3}{5}$

Упробук



$\sum \vec{F} = 0$
 $m a_x = T \cos \alpha$

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

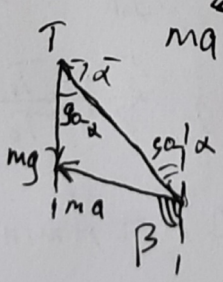
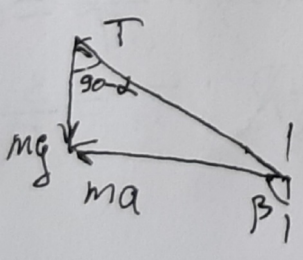
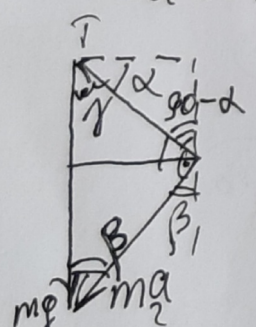
$T = \frac{m a_x}{\cos \alpha}; m a_y = m a_x \tan \alpha - m g$
 $a_y = a_x \tan \alpha - g$

$a_y^2 = a_x^2 \tan^2 \alpha + g^2 - 2 a_x g \tan \alpha$
 $a^2 = a_y^2 + a_x^2$

$m a \cos \beta = m g \cos \alpha$

$m a \sin \beta = T - m g \sin \alpha$

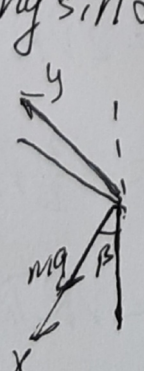
$a \cos \beta = g \cos \alpha$



$180 = 90 - \alpha + (180 - 90 + \alpha - \beta)$
 $\Rightarrow 180 - (90 - \beta)$

$(m a)^2 = (m g)^2 + T^2 - 2 T m g \sin \alpha$

$H = \frac{a \cos \beta t^2}{2}$



Часть 2

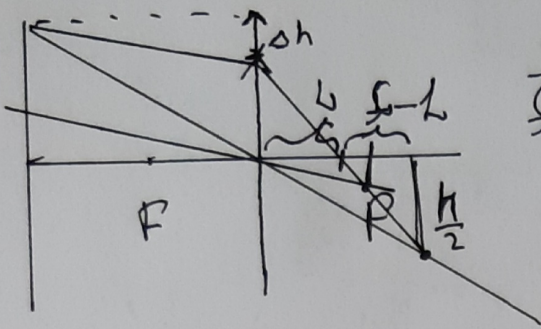
Олимпиада: **Физика, 11 класс (2 часть)**

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Вариант 2

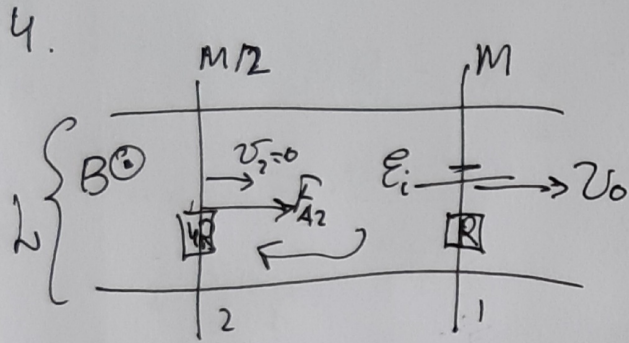
Упробітук



$$\frac{L}{5-L} = \frac{P \sin \alpha}{D \sin \alpha} = \frac{5}{3}$$

$$3L = 5(5-L); 8L = 25$$

$$L = \frac{25}{8} = 3.125 \text{ м}$$

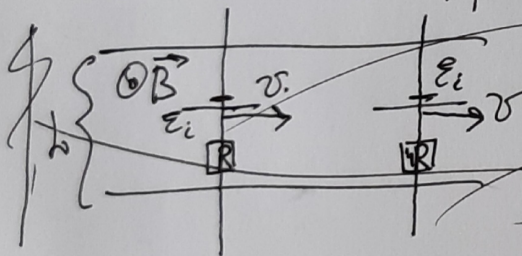


$$I_0 = \frac{E I_0}{5R} = \frac{B V_0 L}{5R}$$

$$F_{A_2} = B I_0 L = \frac{B^2 L^2 V_0}{5R}$$

$$F_{A_2} = \frac{m}{2} a_{02}; a_{02} = \frac{2 B^2 L^2 V_0}{5 m R}$$

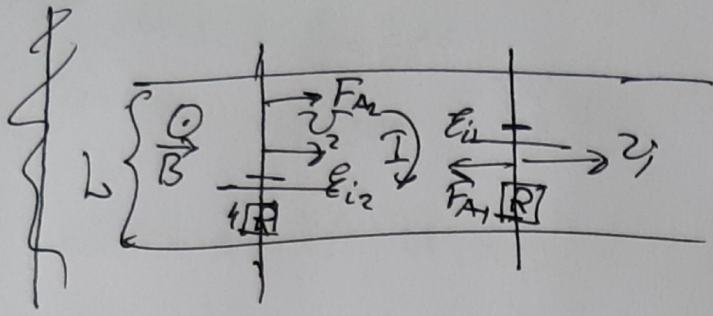
Прозв. мом:



$$F_{A_1} = m a_1 = m \frac{\Delta v_1}{\Delta t_1}$$

$$B I L = m \frac{\Delta v_1}{\Delta t_1}; I = \frac{B L (v_1 - v_2)}{5 R}$$

Упробав



$$I = \frac{B \mathcal{E}_{i1} - \mathcal{E}_{i2}}{5R}$$

$$I = \frac{B(v_1 - v_2)l}{3R}$$

$$-F_{A1} = ma_1 = m \frac{\Delta v_1}{\Delta t}$$

$$-B I L = \frac{m \Delta v_1}{\Delta t}; \quad -\frac{B^2 l^2 (v_1 - v_2) \Delta t}{5mR} = \Delta v_1$$

$$-\frac{B^2 l^2 S}{5mR} = v - v_0; \quad \frac{B^2 l^2 S}{5mR} = v_0 - v$$

$$F_{A2} = \frac{m}{2} a_2 = \frac{m}{2} \frac{\Delta v_2}{\Delta t}; \quad \frac{2B I L}{m} \Delta t = \Delta v_2; \quad \frac{2B^2 l^2}{5mR} S = v - 0$$

$$v_0 = \frac{3}{5} \frac{B^2 l^2}{mR} S; \quad S = \frac{5}{3} \frac{mR v_0}{B^2 l^2}$$

$$v = \frac{2B^2 l^2}{5mR} \cdot \frac{5}{3} \frac{mR v_0}{B^2 l^2} = \frac{2}{3} v_0$$

З.С. Э: $\Delta\sigma = \Delta W + Q$

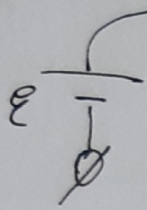
Черковик.

$$\Delta\sigma = +E q_{np} = \epsilon \cdot \frac{9}{4} c \epsilon = \frac{9}{4} c \epsilon^2$$

было: $3c \cdot \frac{\epsilon}{4} = \frac{3}{4} c \epsilon$

стало: $3c \cdot \epsilon = 3c \epsilon$

$$\Rightarrow q_{np} = c \epsilon (3 - \frac{3}{4}) = \frac{9}{4} c \epsilon$$



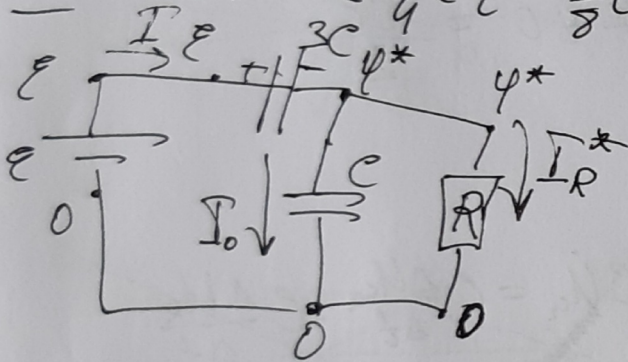
$$\Delta W = W_2 - W_1; W_2 = \frac{3c \cdot \epsilon^2}{2}; W_1 = \frac{3c \cdot (\frac{\epsilon}{4})^2}{2} + \frac{c \cdot (\frac{3}{4}\epsilon)^2}{2}$$

$$W_1 = \frac{3}{8} c \epsilon^2$$

$$\Delta W = (\frac{3}{2} - \frac{3}{8}) c \epsilon^2 = \frac{9}{8} c \epsilon^2$$

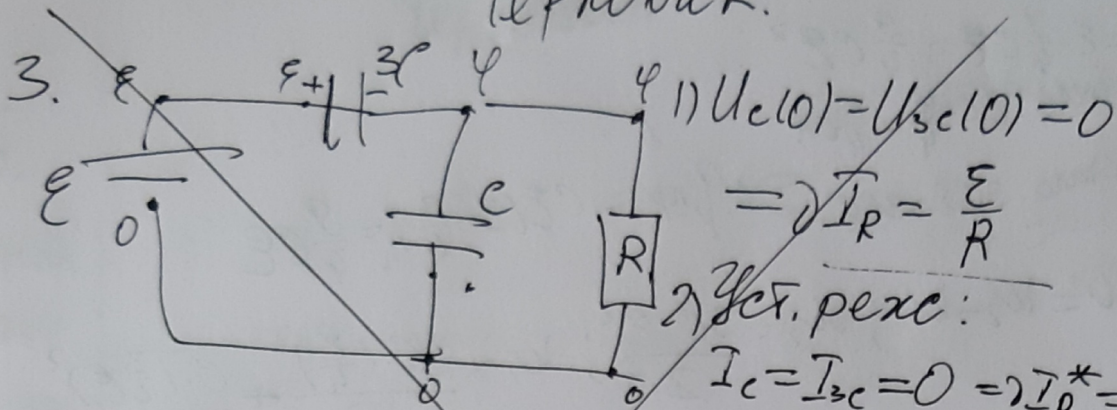
$$\oplus \frac{3c\epsilon^2}{16 \cdot 2} + \frac{9c\epsilon^2}{16 \cdot 2} = \frac{12c\epsilon^2}{32} = \frac{3c\epsilon^2}{8}$$

$$Q = \Delta\sigma - \Delta W = \frac{9}{4} c \epsilon^2 - \frac{9}{8} c \epsilon^2 = 9c\epsilon^2 (\frac{1}{4} - \frac{1}{8}) = 9c\epsilon^2 (\frac{1}{8}) = \frac{9}{8} c \epsilon^2$$



$$I_0 + I_R^* = I$$

Цепочки.



$$1) U_{c1}(0) = U_{c2}(0) = 0$$

$$\Rightarrow I_R = \frac{\varepsilon}{R}$$

2) Уст. реж:

$$I_c = I_{3c} = 0 \Rightarrow I_R^* = 0 \Rightarrow \varphi = 0$$

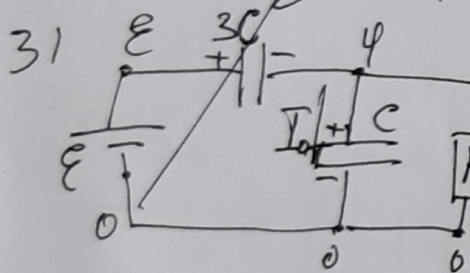
$$\Rightarrow U_c = 0 \Rightarrow U_{3c} = \varepsilon$$

з.е.э: $A_{\Sigma} = \Delta W + Q$

$$A_{\Sigma} = \varepsilon \cdot 3C\varepsilon = 3C\varepsilon^2$$

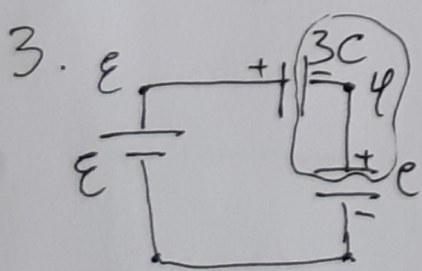
$$\Delta W = W_2 - W_1; W_1 = 0; W_2 = \frac{3C \cdot U_{3c}^2}{2} + 0 = \frac{3C\varepsilon^2}{2}$$

$$3C\varepsilon^2 = \frac{3C\varepsilon^2}{2} + Q; Q = \frac{3}{2}C\varepsilon^2$$



$$I_0 = \dot{q}_c = C \dot{U}_c = C \frac{\Delta U_c}{\Delta t} = C \frac{\Delta U_R}{\Delta t}$$

$$I_0 \Delta t = C \Delta U_R$$



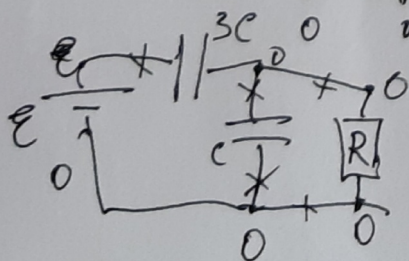
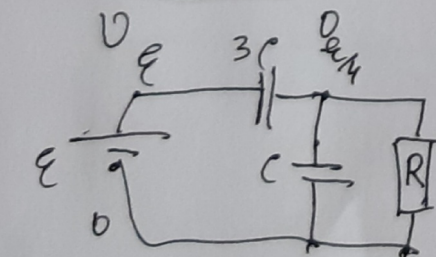
з.е.з: $-3\varepsilon(\varepsilon - \varphi) + \varepsilon(\varphi - 0) = 0$

$$-3\varepsilon + 3\varphi + \varphi; \varphi = \frac{3}{4}\varepsilon$$

$$U_{c1}(0) = \frac{\varepsilon}{4}; U_{c2}(0) = \frac{3}{4}\varepsilon$$

$$U_R(0) = U_{c2}(0) = \frac{3}{4}\varepsilon$$

$$I_R = \frac{U_R(0)}{R} = \frac{3}{4} \frac{\varepsilon}{R}$$



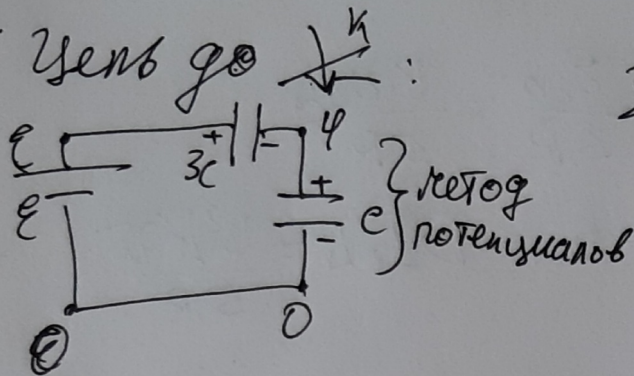
Уст. реж $\Rightarrow I_{c1}(t_{уст}) = I_{c2}(t_{уст}) = I_R(t_{уст}) = 0$

$$\Rightarrow U_R(t_{уст}) = U_{c2}(t_{уст}) = 0$$

$$\Rightarrow U_{c1}(t_{уст}) = \varepsilon$$

1.

Цепь до t_0

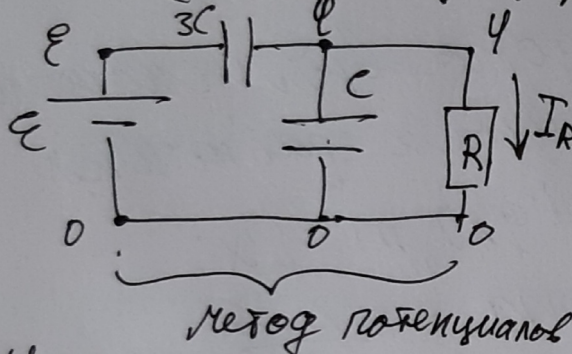


з.п.з: $-3C(\epsilon - \varphi) + C(\varphi + 0) = 0$

$\Rightarrow \varphi = \frac{3}{4}\epsilon \Rightarrow U_{C_1(0)} = \frac{\epsilon}{4}$

$U_{C_2(0)} = \frac{3}{4}\epsilon$

Сразу после t_0

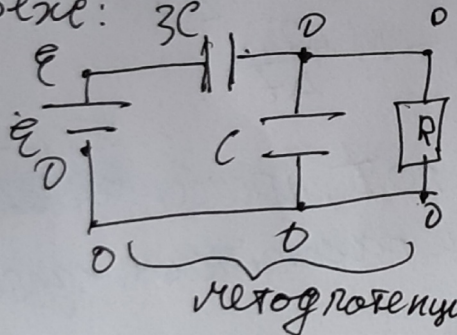


Напр. на конденсаторах скачком не изменились.

$U_R = I_{R(t_0)} \cdot R = U_{C_2} = U_{C_2(0)}$

$\Rightarrow I_{R(t_0)} = \frac{U_{C_2(0)}}{R} = \frac{3}{4} \frac{\epsilon}{R}$

Уст. реж.



В уст. реж. $I_{C_1} = I_{C_2} = 0 \Rightarrow I_R(t_{уст}) = 0$

$\Rightarrow U_{C_2}(t_{уст}) = 0 \Rightarrow U_{C_1}(t_{уст}) = \epsilon$

з.п.з: $A\delta = \Delta W + Q$

$A\delta = +\epsilon \cdot q_{np} = \epsilon(3C\epsilon - \frac{3}{4}C\epsilon) = \frac{9}{4}C\epsilon^2$

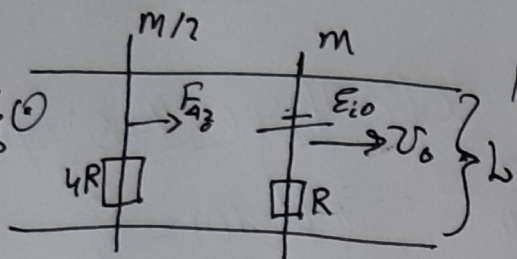
$\Delta W = W_2 - W_1 = \frac{3C\epsilon^2}{2} - \frac{3C(\frac{\epsilon}{4})^2}{2} - \frac{C(\frac{3}{4}\epsilon)^2}{2} = \frac{9}{8}C\epsilon^2$

$Q = A\delta - \Delta W = \frac{9}{4}C\epsilon^2 - \frac{9}{8}C\epsilon^2 = \frac{9}{8}C\epsilon^2$

Ответ: $I_{R(t_0)} = \frac{3}{4} \frac{\epsilon}{R}$; $Q = \frac{9}{8}C\epsilon^2$

Ⓛ

2.
нах.
мом.
B



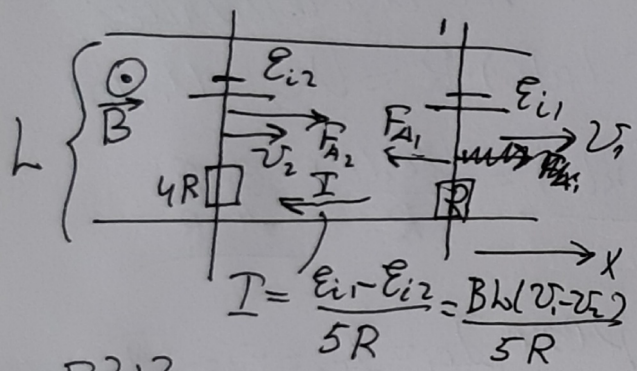
$$I_0 = \frac{\mathcal{E}_{i0}}{5R} = \frac{Bv_0L}{5R}$$

$$\frac{m a_{02}}{2} = F_{A02} = B I_0 L = \frac{B^2 L^2 v}{5R}$$

$$a_{02} = \frac{2B^2 L^2 v_0}{5mR}$$

произв. мом. вр:

через. долж. врем. скорости
перемычки сравняются.



И з. Н глв "м" Ох:

$$-F_{A1} = m a_{1x} = m \frac{\Delta v_{1x}}{\Delta t}$$

$$-B I L = m \frac{\Delta v_{1x}}{\Delta t}$$

$$-\frac{B^2 L^2 (v_1 - v_2) \Delta t}{5mR} = \Delta v_1 - \text{просум. по } t, \text{ придем } \sum (v_1 - v_2) \Delta t = \Delta v_1$$

$$-\frac{B^2 L^2 S}{5mR} = v_1 - v_0 \quad ; \quad \frac{B^2 L^2}{5mR} S = v_0 - v_1$$

Аналогично глв 2-й перемычки: $F_{A2} = \frac{m}{2} a_2 = \frac{m \Delta v_2}{\Delta t}$

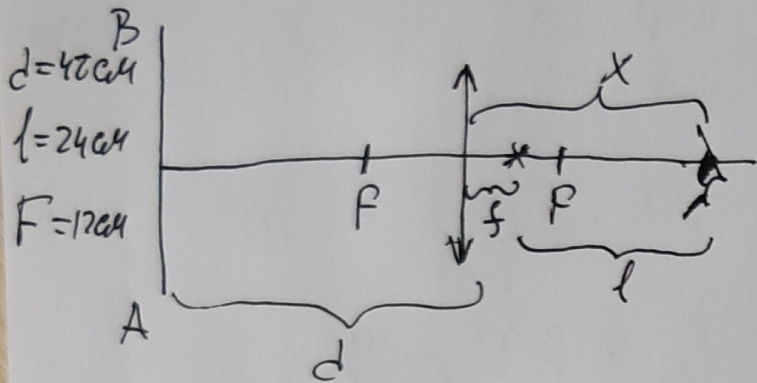
$$\Rightarrow \frac{2BIL}{m} \Delta t = \Delta v_2; \quad \frac{2B^2 L^2}{5mR} S = v_2 - 0$$

$$v_0 = \frac{2}{3} \frac{B^2 L^2}{mR} S = \frac{2}{3} S = \frac{5}{3} \frac{mR v_0}{B^2 L^2} \Rightarrow v = \frac{2B^2 L^2}{5mR} \cdot \frac{5}{3} \frac{mR v_0}{B^2 L^2} = \frac{2}{3} v_0$$

Ответ: $a_{02} = \frac{2B^2 L^2 v_0}{5mR}; v = \frac{2}{3} v_0; S = \frac{5}{3} \frac{mR v_0}{B^2 L^2}$

Чертежи.

5.

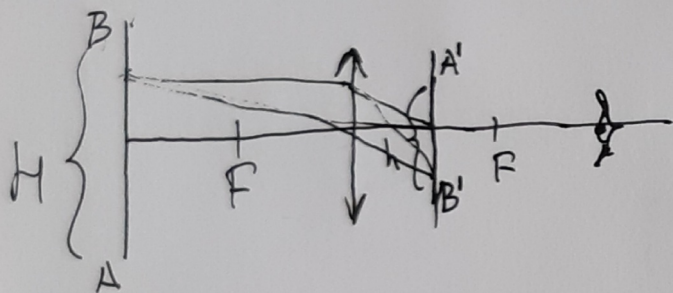


$$\frac{1}{4F} + \frac{3}{4F} = \frac{1}{F}$$

$$\frac{1}{d} + \frac{1}{l} = \frac{1}{F}; f = \frac{Fd}{d-F} = 16 \text{ см}$$

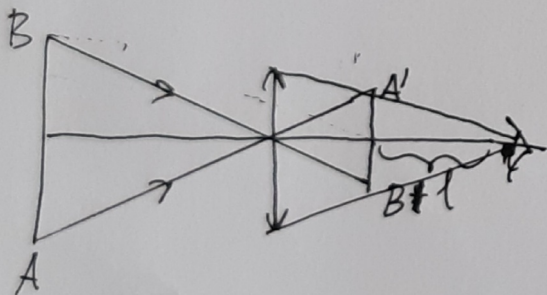
$$F = \frac{f}{d} = \frac{1}{3}$$

$$X = f + l = 40 \text{ см.}$$



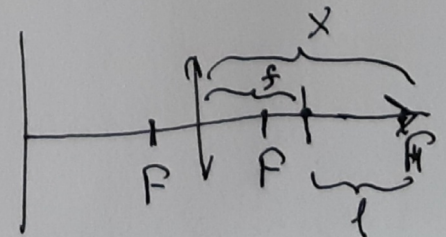
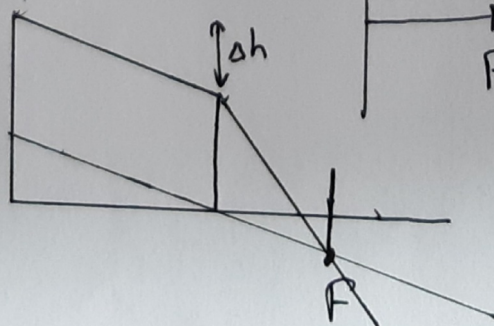
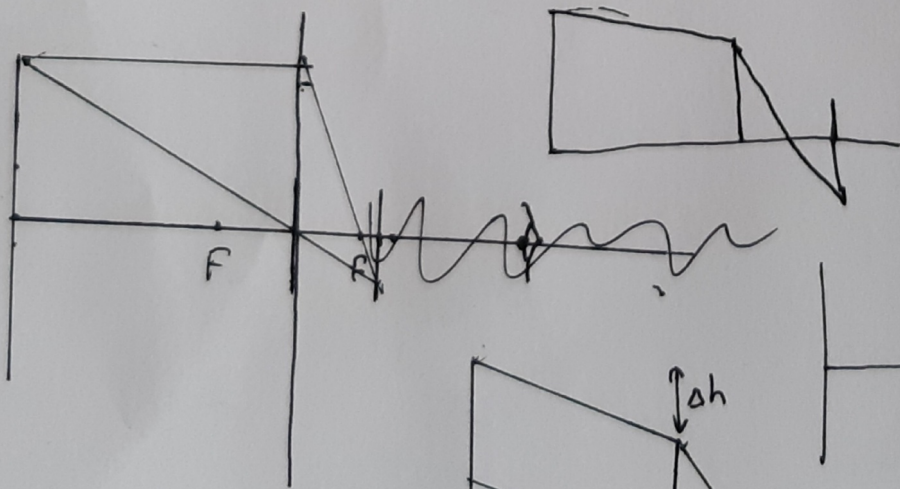
Условию удовлетворяет и вып. усл.
вып. усл. $P_M \geq h$

$$\frac{h}{H} = M = \frac{1}{3}; h = \frac{H}{3} = \frac{11}{3} = 3.67 \text{ см}$$



$$\frac{h}{P_M} = \frac{l}{X} = \frac{1}{3}; D_M = \frac{H}{3} \cdot \frac{1}{1} = 3 \cdot \frac{40}{24}$$

$$D_M = 5 \text{ см.}$$

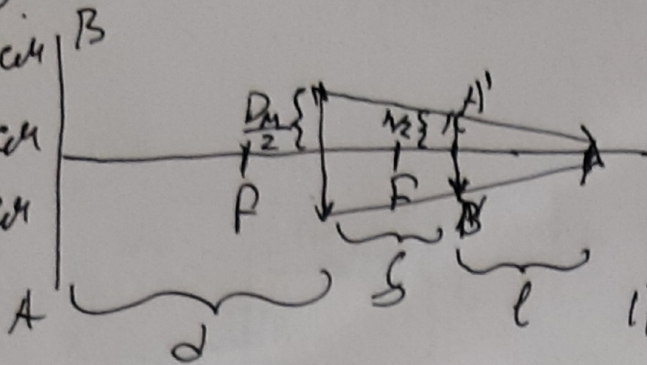


№3.

$d = 48 \text{ см}$

$l = 24 \text{ см}$

$F = 12 \text{ см}$



$$\frac{1}{d} + \frac{1}{s} = \frac{1}{f}; \quad f = \frac{Fd}{d-F} = 16 \text{ см}$$

$$F = \frac{1}{3}$$

$x = s + l = 40 \text{ см}$ - ответ

$\frac{h}{H} = \Gamma$ - h-диаметр. изобр.

$D_m = h = \frac{H}{3} = 3 \text{ см}$

из. подобия тр:

$\frac{h}{s-h} = \frac{D_m/2}{h/2} = \frac{5}{3}; \quad 3h = 5s - 5h = 2h = \frac{5}{8}s = 10 \text{ см}$ - ответ

2) $D_m = 3 \text{ см}$ - ответ

