

Часть 1

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

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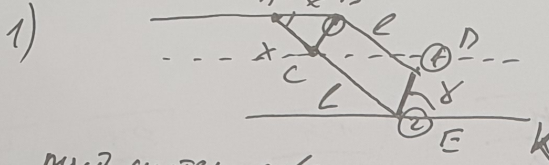
Вариант 3

Чистовик.

①

$$\cos d = \frac{5}{13}$$

$$\sin d = \frac{12}{13}$$



лучи света сходятся на X - значит угловое смещение \Rightarrow
 \Rightarrow шаг тоже сдвинется из положения ① - в положение ② \Rightarrow
 \Rightarrow блэк угловое направление из ① бо ② \Rightarrow как гайка
 по час. К розгоуду γ

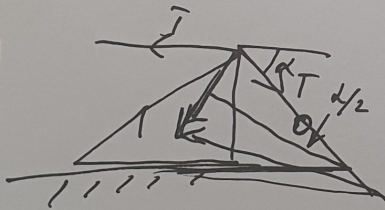
$\triangle ABC$ - р/с с основ. BC; $\angle A = d$

$\angle DEK = \gamma = \angle CBA$, т.к. AB и EK \parallel и BDEC - параллелограмм

$$\Rightarrow \boxed{\gamma = \frac{180 - d}{2} = 90 - \frac{d}{2}}$$

$$\cos \gamma \approx \cos\left(90^\circ - \frac{\arccos\left(\frac{5}{13}\right)}{2}\right) \approx 0,55$$

2)



$$2T \sin \frac{d}{2} \cdot \sin \frac{d}{2} = 2T \sin^2 \frac{d}{2} =$$

$$= F = M a_m \quad \begin{array}{l} M - \text{масса камня} \\ a_m - \text{ускорение камня} \end{array}$$

$$\sin^2 \frac{d}{2} = \frac{1 - \cos d}{2} = \frac{1 - 5/13}{2} = \frac{4}{13}$$

$$M a_m = T \cdot \frac{2 \cdot 4}{13} = \frac{8}{13} T$$

$$\Rightarrow \cos d T = mg = \frac{5}{13}$$

$$2) \frac{a_m}{a_m} = \frac{8}{13} \Rightarrow a_m = \frac{13g}{8} \quad ; \quad \frac{13g}{8} \cdot \frac{m}{M} = \frac{5 \cdot 13}{8 \cdot 8} = \frac{75}{64}$$

$$u) \quad \frac{H}{x} = \frac{12}{13} = \sin \alpha$$

$$x = \frac{13H}{12}$$

$$x = \frac{a_M t^2}{2}$$

$$t = \sqrt{\frac{2x}{a}} = \sqrt{\frac{13H}{6 \cdot a_M}} = \sqrt{\frac{13H}{6 \cdot \frac{13g}{8}}} = \sqrt{\frac{8H}{6g}} = \sqrt{\frac{4H}{3g}}$$

① Diken: 1) $\gamma = 90 - \frac{\alpha}{2}$; $\cos \gamma = 0,55$

2) $a_M = \frac{13g}{8}$

3) $\frac{m}{M} = \frac{75}{64}$

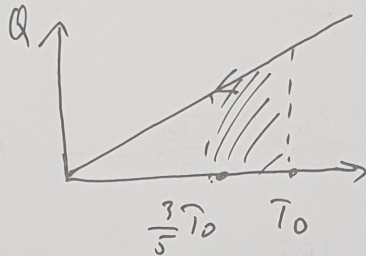
4) $t = \sqrt{\frac{8H}{6g}} = \sqrt{\frac{4H}{3g}}$

Учебник.

②

$$1) C = \frac{\Delta Q}{\sqrt{\Delta T}} = 3R\bar{T}$$

$$\Delta Q = \sqrt{3R\bar{T}} dT$$



$$\Delta Q = \int_{T_0}^{\frac{3}{5}T_0} \sqrt{3R\bar{T}} d\bar{T} = \sqrt{3R} \frac{1}{\sqrt{T_0}} \frac{T^2}{2} \Big|_{T_0}^{\frac{3}{5}T_0} =$$

$$= \sqrt{\frac{3}{5}} \sqrt{3R} \frac{1}{\sqrt{T_0}} \cdot \frac{1}{2} \left(\left(\frac{3}{5} T_0 \right)^2 - T_0^2 \right) = \sqrt{3R} \frac{\bar{T}_0^2}{2T_0} \left(\frac{9}{25} - 1 \right)$$

$$\Delta Q = \sqrt{3R} \bar{T}_0 \left(-\frac{8}{25} \right) = \boxed{\frac{-24}{25} \sqrt{R\bar{T}_0}}$$

$$2) \Delta Q = \int_{\bar{T}_0}^{\bar{T}} \sqrt{3R\bar{T}} d\bar{T} = \sqrt{3R} \frac{1}{\sqrt{T_0}} \int_{\bar{T}_0}^{\bar{T}} T dT = \sqrt{3R} \frac{1}{\sqrt{T_0}} \frac{T^2}{2} \Big|_{\bar{T}_0}^{\bar{T}} =$$

$$= \sqrt{3R} \frac{1}{\sqrt{T_0}} \frac{1}{2} (T^2 - \bar{T}_0^2) = \frac{3}{2} \sqrt{R} \frac{T^2 - \bar{T}_0^2}{\sqrt{T_0}}$$

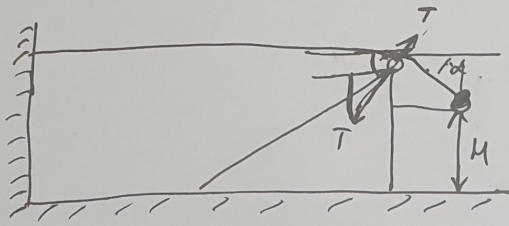
$$\Delta Q = \Delta U + A_{\text{раб}} \Rightarrow A_{\text{раб}} = \Delta Q - \Delta U = \frac{3}{2} \sqrt{R} \frac{T^2 - \bar{T}_0^2}{\sqrt{T_0}} - \frac{3}{2} \sqrt{R} (T - \bar{T}_0) =$$

$$\frac{3}{2} \sqrt{R} (T - \bar{T}_0)$$

$$= \frac{3}{2} \sqrt{R} \left(\frac{(T - \bar{T}_0)(T + \bar{T}_0)}{T_0} - (T - \bar{T}_0) \right) = \frac{3}{2} \sqrt{R} (T - \bar{T}_0) \left(\frac{T + \bar{T}_0}{T_0} - 1 \right) =$$

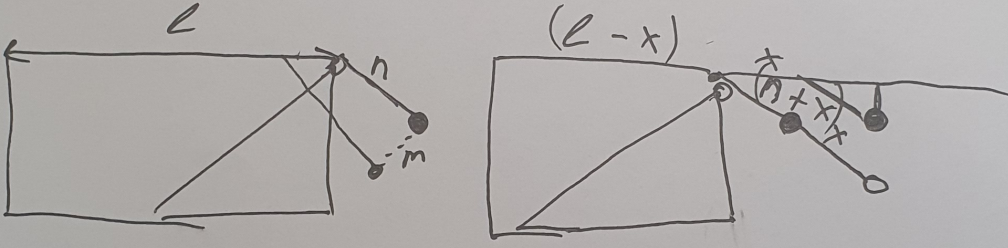
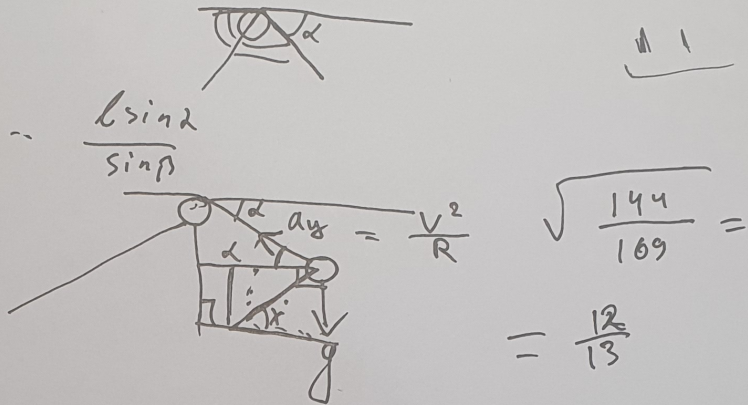
$$= \frac{3}{2} \sqrt{R} (T - \bar{T}_0) \left(\frac{T + \bar{T}_0 - T_0}{T_0} \right) = \frac{3}{2} \sqrt{R} \left(\frac{T - \bar{T}_0}{T_0} \right) T = A_{\text{раб}} = \frac{3}{2} \frac{\sqrt{R}}{T_0} (T - \bar{T}_0) T$$

Вариант 3 Черновик

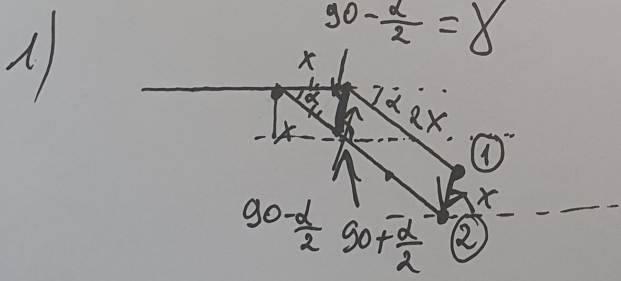


- 1) $\gamma = 90 - \frac{\alpha}{2} : \cos \gamma = 0,55$
 - 2) $a = 0,09 = \frac{g}{1,1}$
 - 3) $\frac{m}{m} = 0,3$
 - 4) $t = 0,49 \sqrt{H}$
-
- $\cos \alpha = \frac{5}{13} \approx 0,38$

$$\frac{a}{\sin \alpha} = \frac{b}{\sin \beta} \Rightarrow \frac{b \sin \alpha}{\sin \beta}$$



$180 - 90 + \frac{\alpha}{2} - \alpha$



$\sin 2x = 2 \sin x \cos x$

$\cos 2x = \sqrt{1 - \sin^2 x} = \sqrt{1 - 4 \sin^2 x \cos^2 x} =$

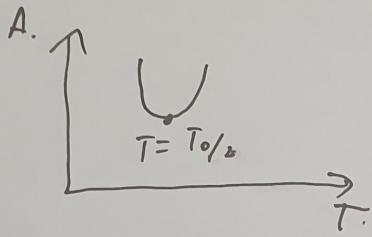
$\cos \gamma = \cos \left(90^\circ + \frac{\alpha \cos(\frac{5}{13})}{2} \right) = \sqrt{(1 - 2 \sin x \cos x)(1 + 2 \sin x \cos x)}$

$\cos \gamma = 0,55$

$\frac{0,8}{1,1} = \frac{0,09}{1,1}$

2) Если вычислить $x \Rightarrow$ шаг мостика: $m = \frac{x \sin \alpha}{\sin \gamma} = \frac{x \sqrt{1 - \frac{25}{169}}}{\sqrt{1 - 0,55^2}} =$

$= x \cdot \frac{0,8}{0,835} = 1,1 \cdot x \Rightarrow \frac{1,1x}{g} = \frac{x}{a} \Rightarrow a = \frac{gx}{1,1x} = \frac{10}{1,1} =$



диск. оптимизация $(T - T_0)T = \bar{T}^2 - T\bar{T}_0 - ?$

$$\therefore 2T - T_0 = 0 \Rightarrow \boxed{T = \frac{T_0}{2}}$$

$$3) A_{\text{max}} = \frac{3}{2} \frac{\nu R}{T_0} \left(\frac{T_0}{2} - T_0 \right) \frac{T_0}{2} = \frac{3}{2} \nu R T_0 \left(-\frac{1}{2} \right) \left(\frac{1}{2} \right) = \boxed{-\frac{3}{8} \nu R T_0}$$

Ответ: 1) $\Delta Q = -\frac{24}{25} \nu R T_0$

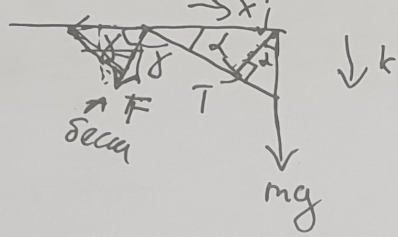
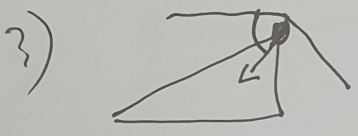
2) $T = \frac{T_0}{2}$

3) $A_{\text{max}} = -\frac{3}{8} \nu R T_0$

$a = 9,09$ Упробук.

$\cos \gamma T = F$

$T = mg \sin \alpha$



$$\frac{M}{m} = \frac{\sin \alpha \cos^2 \gamma mg}{a} =$$

$$\bar{F} = \sin \alpha \cdot \cos \gamma mg$$

$$= \frac{12}{13} \cdot 0,55^2 \cdot 10 =$$

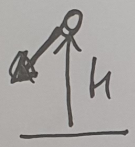
$$m \cdot a = \sin \alpha \cos^2 \gamma mg$$

~~1,1~~ $\frac{\sin \alpha}{\cos \gamma} = \frac{12}{13} \Rightarrow \frac{k}{x} = \sin \alpha = \frac{12}{13}$

$$= \frac{12}{13} \cdot 0,55^2 \cdot 10 = 0,30$$

$k = H$

4)



$$\frac{H}{x} = \frac{12}{13}$$

$$x = \frac{134}{12} t^2$$

$t = c$

$$x = 0 \cdot t + \frac{at^2}{2} = \frac{at^2}{2}$$

~~1,1~~ $\frac{1}{t^2} = \frac{1}{c^2}$

$$t = \sqrt{\frac{2x}{a}} =$$

$$= \sqrt{\frac{2 \cdot 134}{9,09}} = \sqrt{\frac{134}{9,09 \cdot 6}} = 0,49 \sqrt{4}$$

Часть 2

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

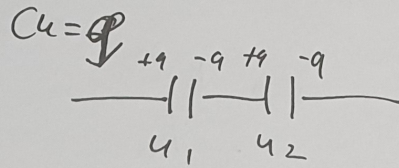
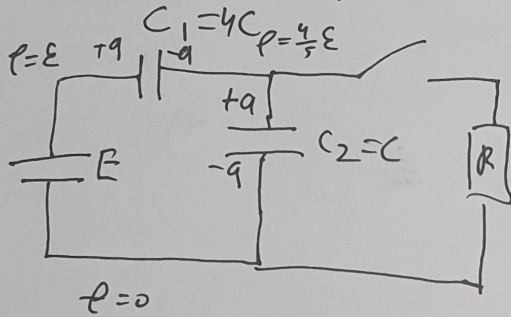
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Вариант 3

3

~~Умова~~, Умова

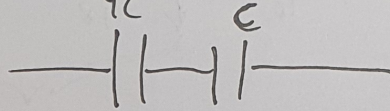


$$u_1 + u_2 = U$$

$$C_1 u_1 = q = C_2 u_2$$

$$C u = q = C(u_1 + u_2) = C\left(\frac{q}{C_1} + \frac{q}{C_2}\right)$$

$$\frac{1}{C} = \frac{1}{4C} + \frac{1}{C_2}$$



$$4C u_1 = q = C u_2$$

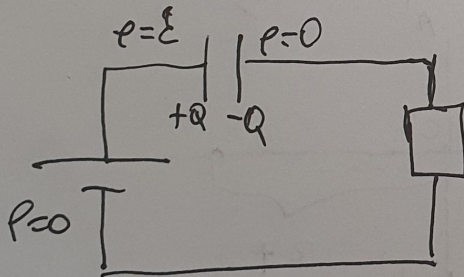
$$4 u_1 = u_2 \Rightarrow$$

$$\Rightarrow \text{Ток } \boxed{I = \frac{\frac{4}{5} \mathcal{E}}{R}}$$

Концы:

Кларно:

2)



$$\text{Заряд: } Q = 4C \cdot \mathcal{E}$$

$$\text{Энергия в источнике}$$

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

$$= 2C \mathcal{E}^2$$

Энергия на конденсаторах в источнике:

$$\frac{4C \left(\mathcal{E} - \frac{4}{5} \mathcal{E}\right)^2}{2} + \frac{C \left(\frac{4}{5} \mathcal{E}\right)^2}{2}$$

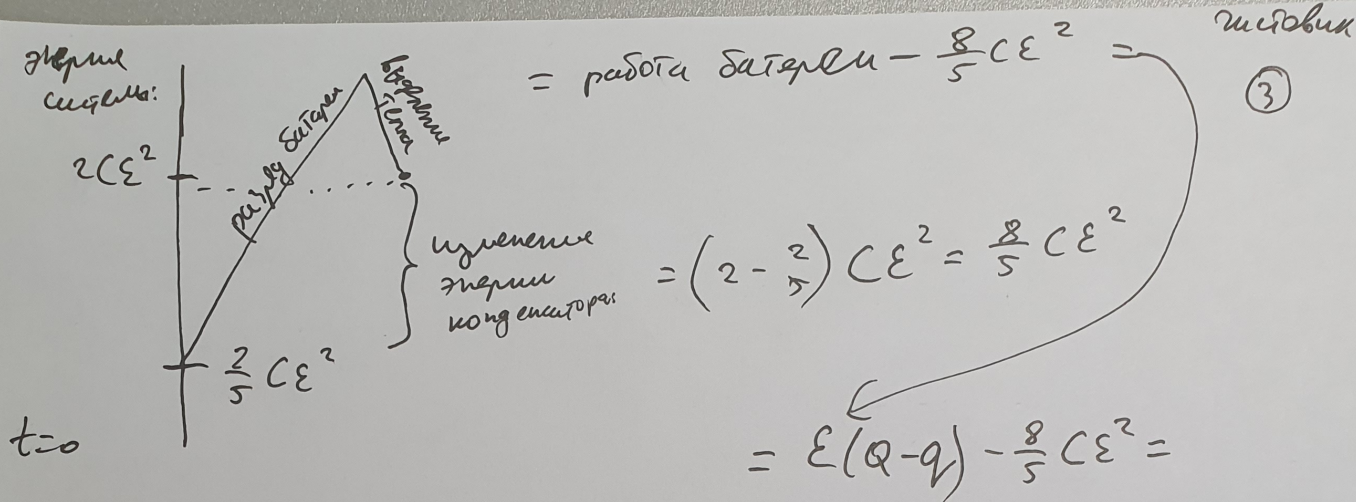
$$= \frac{2C \mathcal{E}^2}{25} = C \mathcal{E}^2 \frac{2}{25}$$

$$= C \mathcal{E}^2 \frac{16}{25 \cdot 2} = C \mathcal{E}^2 \frac{8}{25}$$

$$\Sigma \text{ энергии} = \frac{10}{25} C \mathcal{E}^2 = \frac{2}{5} C \mathcal{E}^2$$

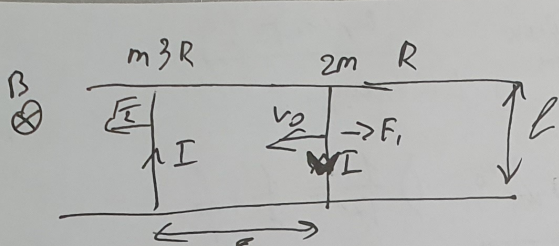
$$\text{Заряд батареи: } q = C \frac{4}{5} \mathcal{E}$$

$$\text{Батарея на протяжении через себя заряд: } Q - q = 4C \mathcal{E} - C \frac{4}{5} \mathcal{E} = 3 \frac{1}{5} C \mathcal{E} = \frac{16}{5} C \mathcal{E}$$



$$= \frac{16}{5}CE^2 - \frac{8}{5}CE^2 = \boxed{\frac{8}{5}CE^2 = Q_T}$$

- Ответ: 1) $I = \frac{4\mathcal{E}}{R}$
 2) $Q_T = \frac{8}{5}CE^2$



Учет обук.

(4)

$$\Rightarrow DC = BLv_0$$

$$I = \frac{BLv_0}{4R}$$

$$\left. \begin{aligned} \vec{F}_2 = BIL \\ a_2 = \frac{F_2}{m} = \frac{BIL}{m} ; a_1 = \frac{F_1}{2m} = \frac{BIL}{2m} \end{aligned} \right\} \Rightarrow F_0 = B I_0 l =$$

$$= B \cdot \frac{BLv_0}{4R} l = 2m a_1$$

$$a_0 = \frac{B^2 L^2 v_0}{4R 2m} = \frac{B^2 L^2 v_0}{8Rm}$$

$$v_2(t) = a_2 t = \frac{BIL}{m} t ; v_1(t) = v_0 - a_1 t = v_0 - \frac{BIL}{2m} t$$

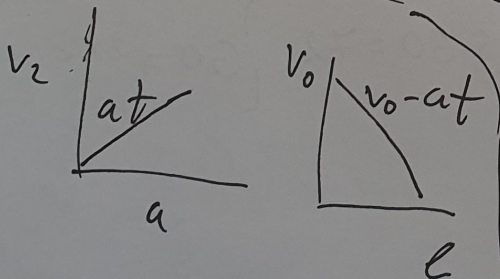
$$v_1(t) = v_0 - a_1 t = v_0 - \frac{BIL}{2m} t$$

$$Q = \oint \vec{E} \cdot d\vec{l} = [v_2 \cdot t - (v_0 - a_1 t)] \cdot l =$$

$$\text{Ток от брешни} = \frac{\partial DC}{4R} = \frac{I'}{4R} = \frac{2l}{4R} = \frac{l}{4R} (v_2 - v_1)$$

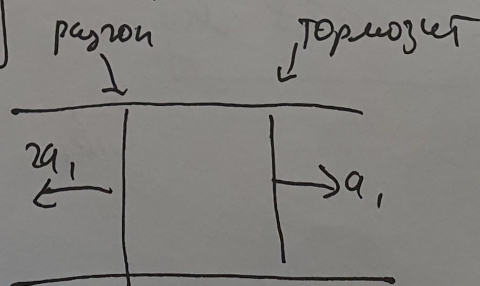
$$\text{Сила от брешни} = BIL = BL \cdot \frac{l}{4R} (v_2 - v_1)$$

$$\text{Ускорение от брешни} = a_2 = \frac{BIL}{m} = \frac{BL^2}{4Rm} (v_2 - v_1)$$



$$a_1 = \frac{BIL}{2m} = \frac{BL^2}{8Rm} (v_2 - v_1)$$

$$2a_1 = a_2$$



$$\begin{aligned} v_2 - v_1 &= a_2 t - (v_0 - a_1 t) = \\ &= (a_2 + a_1) t - v_0 \end{aligned}$$

microbun.

а)

$$v_1(t) = v_0 - a_1 t = v_0 - \frac{BL^2}{8mR} (v_2 - v_1) t = v_0 - A(v_2 - v_1) t$$

$$= v_1$$

$$v_2(t) = a_2 t = \frac{BL^2}{4mR} (v_2 - v_1) \cdot t = 2A(v_2 - v_1) t = v_2$$

$$v_1 = v_0 - A(v_2 - v_1) t$$

$$v_2 = 2A(v_2 - v_1) t$$

$$\Delta v = v_2 - v_1 = 2A(v_2 - v_1) t - v_0 + A(v_2 - v_1) t = 3A \Delta v t - v_0$$

$$\Delta v = 3A \Delta v t - v_0$$

$$v_0 = \Delta v (3At - 1)$$

$$\Delta v = \frac{v_0}{3At - 1} = \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1}$$

$$v_1 = v_0 - A \Delta v \cdot t = v_0 - \frac{A v_0}{3At - 1} \cdot t = v_0 \left(1 - \frac{\frac{BL^2}{8mR}}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t \right)$$

$$v_2 = 2 \frac{BL^2}{8mR} \cdot \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t$$

$$= 2 \frac{BL^2}{8mR} \cdot \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t$$

Работа силы перемещения =

$$= \int_0^t \Delta v \cdot t = \int_0^t \frac{v_0}{3At - 1} \cdot t = \int_0^t \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t$$

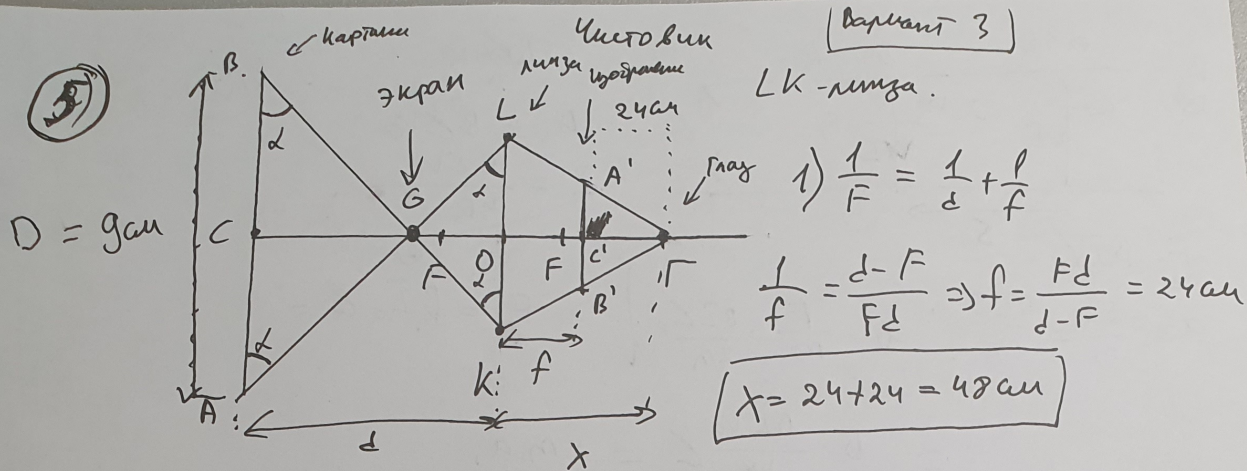
Отсюда: 1) $a_0 = \frac{B^2 L^2 v_0}{8mR}$

2) $v_1 = v_0 \left(1 - \frac{\frac{BL^2}{8mR}}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t \right)$

$$v_2 = 2 \frac{BL^2}{8mR} \cdot \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t$$

3) $S = \int_0^t \frac{v_0}{\frac{3BL^2}{8mR} \cdot t - 1} \cdot t$

5)



1) $\frac{1}{f} = \frac{1}{d} + \frac{1}{f}$
 $\frac{1}{f} = \frac{d-f}{fd} \Rightarrow f = \frac{fd}{d-f} = 24 \text{ cm}$

$x = 24 + 24 = 48 \text{ cm}$

2) $\frac{A'C'}{AC} = \frac{C'O}{CO} = \frac{f}{d} = \frac{24}{72} = \frac{1}{3} \Rightarrow A'C' = \frac{1}{3} \cdot \frac{D}{2} = 1,5 \text{ cm}$

$\frac{LO}{A'C'} = \frac{O\Gamma}{A'C'} = \frac{48}{24} = \frac{2}{1} \Rightarrow LO = 2A'C' = 3 \text{ cm} = R_m$

$\Rightarrow D_m = 2R_m = 6 \text{ cm}$

3) $\triangle BGA \sim \triangle KGL \Rightarrow$ (но 3 унаал)

$\Rightarrow \begin{cases} \frac{CG}{GO} = \frac{BA}{LK} = \frac{9}{6} = \frac{3}{2} \\ CG + GO = d = 72 \end{cases} \Rightarrow \begin{cases} CG = \frac{3GO}{2} \\ 2,5GO = 72 \end{cases} \Rightarrow \begin{cases} CG = 43,2 \\ GO = 28,8 \end{cases}$

$GO = 28,8 \text{ cm}$

- Откер: 1) $x = 48 \text{ cm}$
 2) $D_m = 6 \text{ cm}$
 3) $GO = 28,8 \text{ cm}$

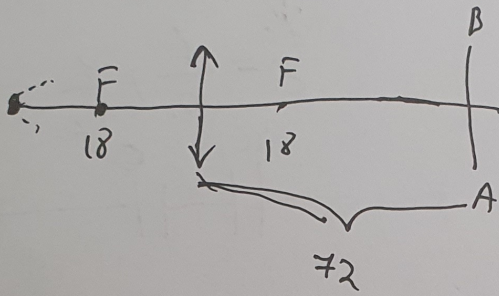
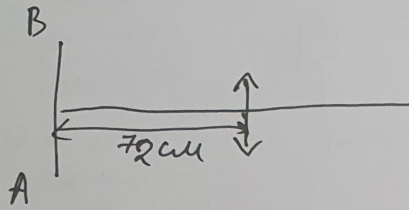
Упробук:

$AB = 9 \text{ cm}$

1) $x = 48 \text{ cm}$

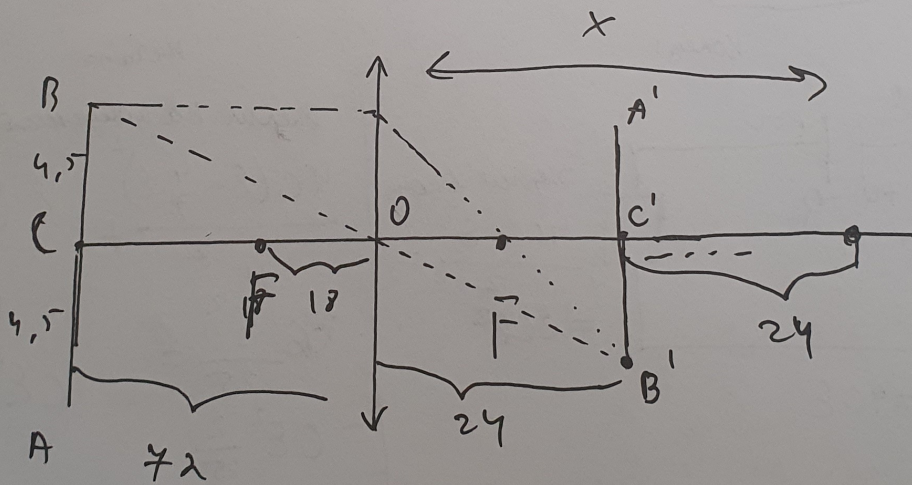
2) $D = 6 \text{ cm}$

3)



m
m
m
m

1)



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

$\Rightarrow x = 24 + 24 = 48 \text{ cm}$

$$\frac{1}{f} = \frac{1}{F} - \frac{1}{c} \Rightarrow \frac{1}{f} = \frac{c - F}{Fd} \Rightarrow f = \frac{Fd}{c - F} = \frac{18 \cdot 72}{54} = 24$$