# Часть 1

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

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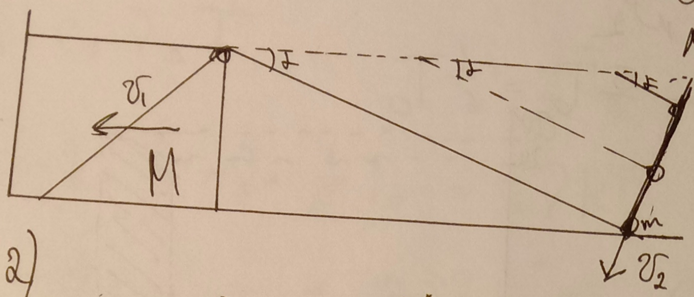
ID профиля: **853389**

Вариант 1

Чистовик

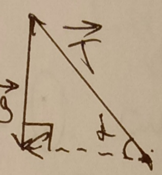
№1.




1) Ускорение направлено под углом $\beta = 90^\circ - \alpha$

$\sin\beta = \frac{3}{5}.$

2)




$\cos^2\alpha + \sin^2\alpha = 1$

$$\vec{T} + m\vec{g} = \frac{5}{4}m\vec{g} + m\vec{g} = \frac{9}{4}m\vec{g} \quad ; \quad \sin\alpha = \frac{4}{5}.$$

$$\frac{9}{4}m\vec{g} = \sum \vec{F} = m\vec{a} \quad ; \quad a = \frac{9}{4}g.$$

$$4)\ S = \frac{H}{\cos\alpha} = \frac{5}{3}H \quad ; \quad S = \cancel{v_0}^{\,0} t + \frac{at^2}{2}.$$

$$\frac{\cancel{5}}{3}H = \frac{9 \cdot \cancel{10} \cdot t^2}{\cancel{8}_4} \quad ; \quad t^2 = \frac{4}{27}H \quad ; \quad t = \frac{2\sqrt{3}}{9}H.$$

$$3)\ v_2 = \cancel{v_0}^{\,0} + at = \frac{\cancel{2}\sqrt{3}}{\cancel{9}}H \cdot \frac{\cancel{9}}{\cancel{4}_2}g = \frac{\sqrt{3}}{2}gH.$$

$$\frac{v_2}{v_1} = \sin\alpha \Rightarrow v_1 = \frac{5}{4}v_2 = \frac{5\sqrt{3}}{8}gH.$$

$$mgH = \frac{m v_2^2}{2} + \frac{M v_1^2}{2}.$$

$$m\cancel{gH} = \frac{m\,3\,\cancel{gH}}{8} + \frac{M\,125}{64 \cdot 2}\cancel{gH}$$

$$\frac{5}{8}m = \frac{125}{64 \cdot 2}M \quad \Big| : \frac{5}{8}M$$

$$\frac{m}{M} = \frac{15}{16}.$$

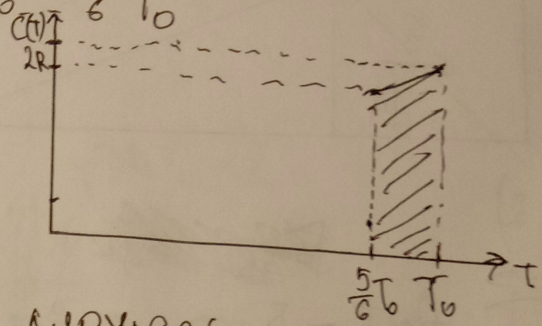
Ответ: 1) $\arcsin\left(\frac{3}{5}\right)$ ; 2) $\frac{9}{4}g$ ; 3) $\frac{15}{16}$ ; 4) $\frac{2\sqrt{3}}{9}H$   1.

Чистовик.

№2.

1) $Q = C_\nu \cdot \nu \cdot \Delta T$ ; $\Delta T = T_0 - \frac{5}{6} T_0 = \frac{1}{6} T_0$

$C_{\nu_2} = 2R \frac{5}{6} \frac{T_0}{T_0} = 2R \cdot \frac{5}{6}$.




т. к. $Q = \nu \cdot C_\nu \cdot \Delta T$, то $Q$ - площадь под графиком

$Q = \nu \cdot \frac{1}{6} T_0 \cdot \frac{1}{\cancel{2}} \cdot (\cancel{2}R + \cancel{2}R \cdot \frac{5}{6}) = \nu R T_0 \cdot \frac{11}{36}$.

2) $Q = -\frac{\nu \cdot 2R}{2 \cdot T_0} (T_0 - T)(T_0 + T)$.

$\Delta U = \frac{3}{2} \nu R (T_0 - T)$.

$Q = \Delta U + A'$, где $A'$ - работа газа;

Газ совершает работу при $-Q < -\Delta U$

$\frac{\nu \cdot \cancel{2}R}{\cancel{2} \cdot T_0} (T_0^2 - T^2) < +\frac{3}{2} \nu R (T_0 - T)$; $2 \cdot (T_0 + T) < +3T_0$

$T < \frac{1}{2} T_0$.

3) Минимальная работа при $T < \frac{1}{2} T_0$.

$A' = Q - \Delta U$ ; $A' = -\nu R (T_0 - T)(1 + \frac{T}{T_0} - \frac{3}{2}) = \nu R (T_0 - T)(\frac{1}{2} - \frac{T}{T_0})$.

$A' = \frac{\nu R}{2T_0} (2T^2 - 3T_0 T + T_0^2)$ ; $2T^2 - 3T_0 T + T_0^2$ - парабола

вершина: $T = \frac{3}{4} T_0$. ; $A' = \frac{\nu R}{2 \cancel{T_0}} (\frac{9}{8} T_0^{\cancel{2}} - \frac{9}{4} T_0^{\cancel{2}} + T_0^{\cancel{2}}) =$

$= \frac{\nu R}{2} T_0 \cdot \frac{13}{4} = \frac{13 \nu R T_0}{8}$.

2

Ответ: 1) $\frac{11}{36} \nu R T_0$; 2) $T < \frac{1}{2} T_0$ ; 3) $\frac{13 \nu R T_0}{8}$.

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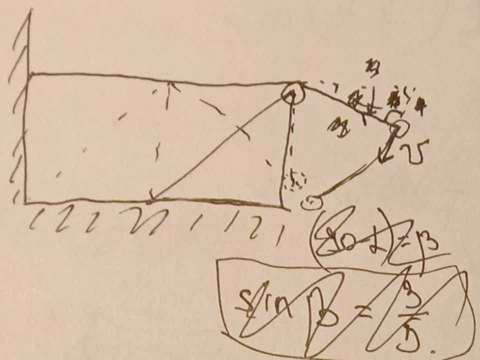
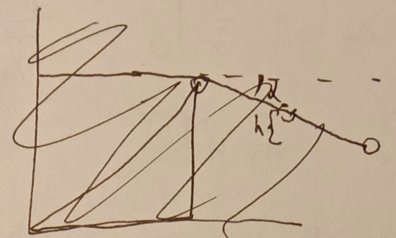
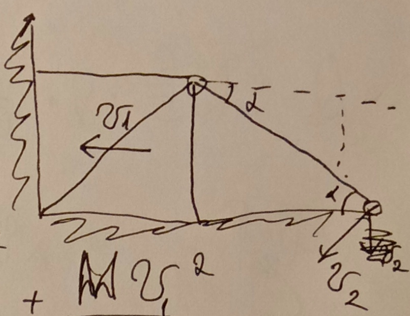
Черновик №1







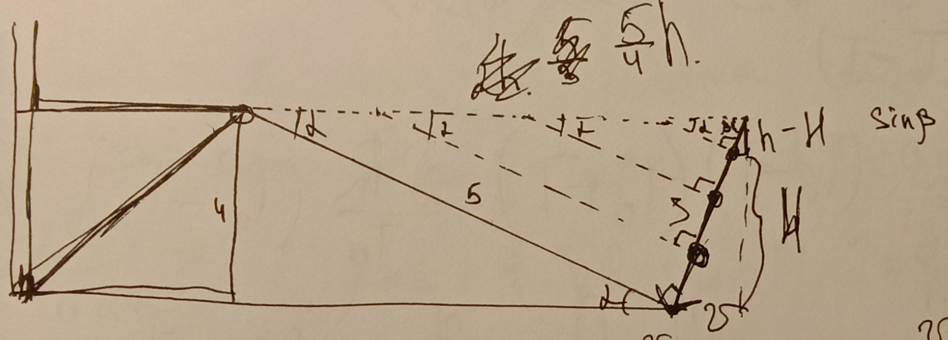
$$mgH = \frac{mv_2^2}{2} + \frac{Mv_1^2}{2}$$

$$\cos^2\alpha + \sin^2\alpha = 1 \; : \cos^2\alpha$$

$$tg^2\alpha = \frac{1}{\cos^2\alpha} - 1$$

$$tg^2\alpha = \frac{25}{9} - 1 = \frac{16}{9} = \frac{4}{3}$$

$\frac{5}{4}h$



$h - H \quad \sin\beta$

$$\frac{H}{S} = \cos\alpha$$

$$\sin\alpha = \frac{4}{5} = \frac{v_2}{v_1}$$

$$v_2 = \frac{4}{5}v_1$$

$N$

$mg$

$$mgH = \frac{m\cdot 16 v_1^2}{50} + \frac{Mv_1^2}{2} + \frac{5}{4}h\cdot T$$

$$m\cdot\frac{4}{5}v_1 = M\cdot v_1$$

$$mg\cancel{H} = T\cdot\frac{5}{4}\cancel{H}$$

$$T = \frac{4}{5}mg$$

$\frac{4}{5}mg$

$$4mg = 5T$$

$\frac{4}{5}a$

$a$

1

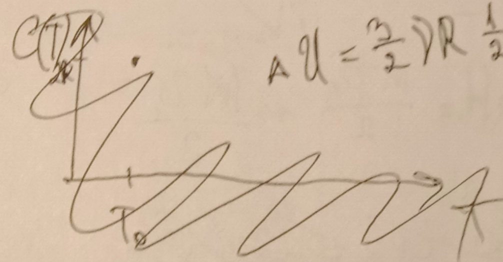
$mgH =$

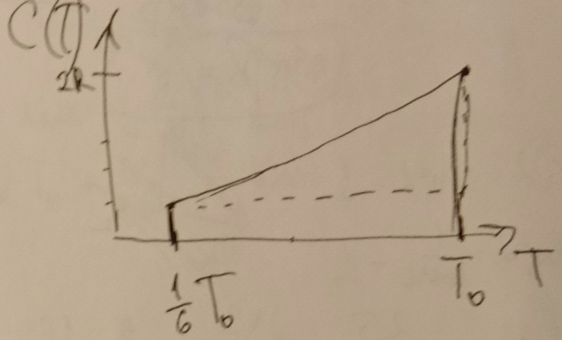
Черновик.

$Q = C_v \cdot \nu \Delta T$ $\quad \Delta T = \frac{1}{6} T_0 \quad \frac{\nu R}{T_0}\left(\frac{3}{4} T_0\right)$

$Q = 2R\frac{6}{5} \cdot \nu \cdot \frac{1}{6} T_0 = \frac{2}{5}\nu R T_0$ $\quad \frac{3}{4}\nu R T_0 = Q.$

$\Delta U = \frac{3}{2}\nu R \frac{1}{2} T_0$




2.

$\cancel{Q = \nu \cdot 2R \cdot T_0 \left(1 + \frac{T}{T_0}\right) = \nu R (T_0 + T)}$

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

$Q = -\frac{\nu \cdot 2R}{T_0}(T_0 - T)(T_0 + T) = -\frac{2\nu R}{T_0}(T_0^2 - T^2).$

$Q = \Delta U + A'$ $\quad A' = Q - \Delta U > 0$

$-Q < \Delta U$

$\frac{\nu 2R}{2T_0}(T_0^2 - T^2) < \frac{3}{2}\nu R (T_0 - T)$

$4T_0 + 4T < 3T_0$

$4T < T_0.$

$2T_0 + 2T = \frac{3}{2} T_0$

$-4T_0 - 4T > -3T_0$

$2T_0 + 2T < 3T_0 \quad T < \frac{1}{2} T_0.$ (2)

$-\nu R (T_0 - T)\cdot\left(1 - \frac{T}{T_0} - \frac{3}{2}\right) = \nu R (T_0 - T)\left(\frac{1}{2} + \frac{T}{T_0}\right).$

$\frac{\nu R}{T_0}\left(\frac{T_0}{2} - T\right)(T_0 - T)$

$\frac{\nu R}{T_0}\left(\frac{T_0^2}{2} - T_0 T - \frac{T_0 T}{2} + T^2\right)$

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# Часть 2

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

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Вариант 1

Чистовик

№3.

1). $\frac{1}{C_{общ}} = \frac{3}{2C}$ ; $C_{общ} = \frac{2C}{3}$.

$Q = \mathcal{E} \cdot C_{общ} = \frac{2}{3}\mathcal{E}C$.

$U_2 = \frac{Q}{C_2} = \frac{2}{3}\mathcal{E}$. ; $U_R = U_2 \Rightarrow I_R = \frac{U_2}{R} = \frac{2\mathcal{E}}{3R}$.

2). $\Delta U = U_2 - U_1 = \frac{1}{3}\mathcal{E}$ ; $\Delta Q_1 = 2C \cdot \frac{1}{3}\mathcal{E} = I_R \Delta t$

$W = \frac{Q^2}{2C} = \frac{4C^2 \cdot \mathcal{E}^2}{9\,C} = \frac{4\mathcal{E}^2 C}{9}$.

Ответ: 1) $\frac{2\mathcal{E}}{3R}$ ; 2) $\frac{4\mathcal{E}^2 C}{9}$.



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Чистовик.

№4.

1) $\Delta\Phi = B\Delta S$ ; $\Delta S = L\cdot x$ ; $x = v_0 t$ ;

$R_{общ} = 3R$

$$\frac{\Delta\Phi}{\Delta t} = \mathcal{E} = \frac{BLv_0\cancel{t}}{\cancel{t}} = BLv_0 \; ; \; \mathcal{E} = I\cdot R_{общ}$$

$$I = \frac{BLv_0}{3R}$$

$$F_{АМПЕРА} = BIL = \frac{B^2L^2v_0}{3R} \; ; \; F = 2ma_2 \Rightarrow a_2 = \frac{B^2L^2v_0}{6mR}$$

2) Спустя время $t$, перемычки двигаются с одинаковой скоростью.

$$v_0 - \frac{B^2L^2v_0}{3mR}\cdot t = \frac{B^2L^2v_0}{6mR}\cdot t \; ; \; t\left(\frac{1}{3}+\frac{1}{6}\right)\cdot\frac{B^2L^2}{mR} = 1$$

$$t = \frac{2mR}{B^2L^2} \; ; \quad v_2 = v_1 = \frac{\cancel{B^2L^2}v_0}{\cancel{6mR}}\cdot\frac{\cancel{2mR}}{\cancel{B^2L^2}} = \frac{1}{3}v_0$$

3) $$S_1 = v_0\cdot\frac{2mR}{B^2L^2} - \frac{B^2L^2v_0}{\cancel{6mR}}\cdot\frac{\cancel{4}m^{\cancel{2}}R^{\cancel{2}}}{B^4L^4} = \frac{2v_0mR}{B^2L^2}\left(1-\frac{1}{3}\right) = \frac{2}{3}\cdot\frac{2v_0mR}{B^2L^2}$$

$$S_2 = \frac{B^2L^2v_0}{3\cancel{6mR}}\cdot\frac{\cancel{4}m\cancel{R^2}}{B^4L^4\cdot\cancel{2}} = \frac{v_0mR}{B^2L^2}\cdot\frac{1}{3}$$

$$\Delta S = S_1 - S_2 = \frac{v_0mR}{B^2L^2}\left(\frac{4}{3}-\frac{1}{3}\right) = 1\cdot\frac{v_0mR}{B^2L^2}$$

$$S = S_0 + \Delta S = S_0 + \frac{v_0mR}{B^2L^2}$$

Ответ: 1) $\frac{B^2L^2v_0}{6MR}$ ; 2) $\frac{1}{3}v_0$ ; 3) $S_0 + \frac{v_0mR}{B^2L^2}$

2

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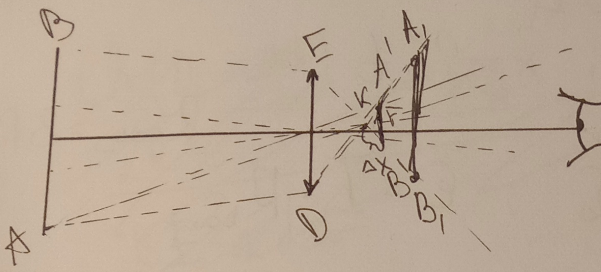
Чистовик

№5.




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

$\frac{1}{d} = \frac{1}{9} - \frac{1}{36} = \frac{1}{12}; \; d = 12.$

$S = 24 + d = 36$ см.

2) $\frac{h}{H} = \frac{f}{d} = \frac{36}{12} = 3; \quad H = 3.$

$\frac{A_1B_1^{=3}}{ED} = \frac{3+\Delta x}{9-\Delta x}; \qquad \frac{9-\Delta x}{\Delta x} = \frac{ED}{y}$, где $y$ - min.

$ED = 9 - 3\Delta x; \qquad 9\Delta x - 3\Delta x^2 + 18 + 3\Delta x = y; \; y \to \min$

$ED = 9 - 3\cdot 2 = 3. \qquad (\Delta x - 2)^2 + 2 = y; \; y \to \min \Rightarrow$

$\Rightarrow \Delta x = 2$

3). Между линзой и изображением на расстоянии $F - \Delta x = 7$ см.

Ответ: 1) ~~12 см~~ 36 см; 2) 3 см; 3) 7 см.

3.

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черновик

1) $\Delta\Phi = B\Delta S$; $\Delta S = L\cdot x$; $x = v_0 t$ $\cancel{\frac{at^2}{2}}$

$\frac{\Delta\Phi}{\Delta t} = \mathcal{E}$

$a_2 = \frac{B^2L^2v_0}{6mR}$

$a_1 = \frac{B^2L^2v_0}{3mR}$

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{BL\cdot v_0 \cancel{t}}{\cancel{\Delta t}} = BLv_0 = I\cdot 2R$

$BIL = \frac{B^2L^2v_0}{2R} = 2m\,a_2$; $\boxed{a_2 = \frac{B^2L^2v_0}{4mR}}$

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

$1 = \frac{B^2L^2}{mR}\left(\frac{1}{6} + \frac{1}{3}\right)\cdot t$

$\cancel{v_0} - \frac{4B^2L^2\cancel{v_0}}{4mR}\cdot t = \frac{B^2L^2\cancel{v_0}}{4mR}t$

$1 = \frac{5B^2L^2}{4mR}\cdot t$

$t = \frac{4mR}{5B^2L^2}$

$v_0 = \frac{1}{5}v_0 + a\cdot\frac{4mR}{5B^2L^2}$

$\frac{1}{5}v_0 = \frac{mR}{B^2L^2}\cdot a_1$

$\frac{B^2L^2v_0\cdot 4\cdot mR}{5B^2L^2\cdot 4mR} = \boxed{\frac{1}{5}v_0}$

$v_0\left(1 - \frac{4B^2L^2\cdot 4mR}{4mR\cdot 5B^2L^2}\right)$

$S_1 = v_0\cdot\frac{4mR}{5B^2L^2} - \frac{\cancel{B^2}\cancel{L^2}v_0}{\cancel{2}\cdot m\cancel{R}}\cdot\frac{\overset{8}{\cancel{16}}\,m^{\cancel{2}}R^{\cancel{2}}}{25\cdot B^{\cancel{2}}L^2} = \frac{v_0 mR4}{5B^2L^2}\left(1 - \frac{2}{5}\right) = \frac{2v_0 mR}{B^2L^2}\cdot\frac{6}{5}$

$S_2 = \frac{\cancel{B^2}\cancel{L^2}v_0}{\cancel{8}m\cancel{R}}\cdot\frac{\overset{2}{\cancel{16}}m^{\cancel{2}}R^{\cancel{2}}}{5B^2L^2} = \frac{v_0 mR\cdot 2}{5B^2L^2}$

$\frac{1}{5}$

1

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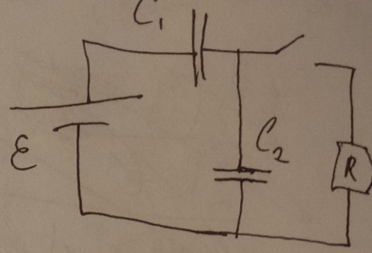
Черновик.

$C = \frac{Q}{U_2}$



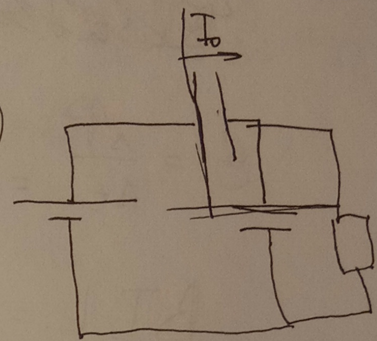

$\frac{1}{C_{общ}} = \frac{1}{C} + \frac{1}{2C}$ ; $C_{общ} = \frac{2C}{3}$

$Q = \mathcal{E} \cdot C_{общ} = \mathcal{E} \cdot \frac{2C}{3} = \frac{2}{3}\mathcal{E}C$

$U_2 = \frac{Q}{C_2} = \frac{2\mathcal{E}C}{3 \cdot C} = \frac{2}{3}\mathcal{E}$

$U_1 = \frac{1}{3}\mathcal{E}$

$\boxed{I = \frac{U_2}{R} = \frac{2\mathcal{E}}{3R}}$




$\cancel{IU = I\frac{U^2}{R} = \frac{\frac{4}{9}\mathcal{E}}{R} = 0}$

$I = \frac{\Delta Q}{\Delta t}$

$\frac{CU^2}{2}$ $\frac{Q^2}{2C}$

$\frac{QU}{2}$

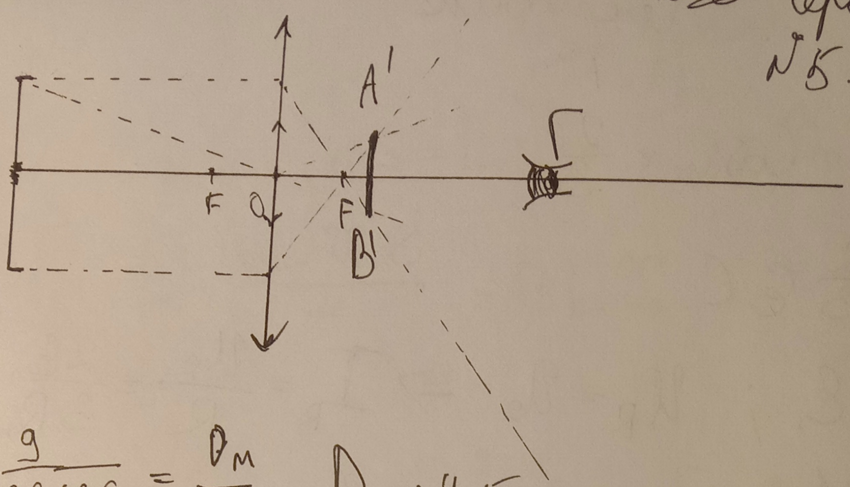
$U_2 - U_1 = \frac{1}{3}\mathcal{E}$ ; $\Delta Q = 2C \cdot \frac{1}{3}\mathcal{E} = I\Delta t$

$\cancel{UI = \frac{1}{3}\mathcal{E} \cdot 2C \cdot \frac{1}{3}\mathcal{E} = \frac{2}{9}C\mathcal{E}^2}$

$\frac{4\cancel{C}\mathcal{E}^2}{9 \cdot 4\cancel{C}} = \frac{\mathcal{E}^2 C}{9}$

~~№5.~~ Черновик 1см = 9

№5.

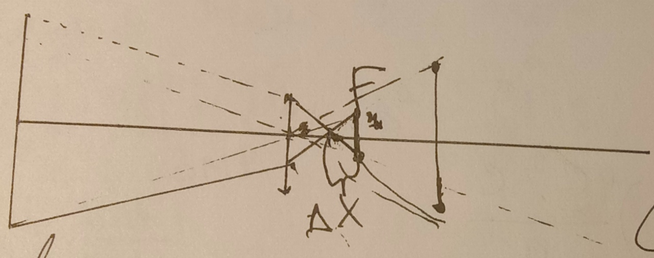



$$\frac{1}{36}+\frac{1}{d}=\frac{1}{9}$$

$$\frac{1}{d}=\frac{4-1}{36}=\frac{3}{36}=\frac{1}{12}$$

$d=12.$

$$\frac{9}{36+36}=\frac{D_м}{36} \quad D_м=4,5.$$




~~$\frac{12}{36}=\frac{1}{3}=\frac{H}{9}$~~ ~~$H=3$~~

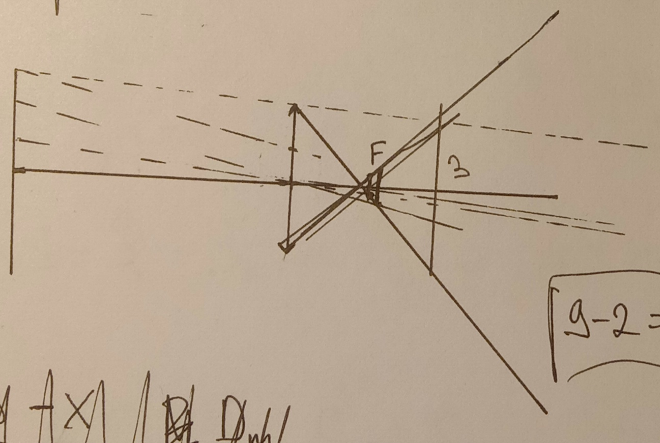
$H=3$

~~$x=9$~~

~~$\frac{3}{12-9}=\frac{9}{x} \Rightarrow x=9$~~

~~в фокальной плоскости.~~

~~$\frac{36}{9}$~~ $=4=\frac{9}{H} \Rightarrow H=\frac{9}{4}$




$$\frac{D_м}{3}=\frac{9-x}{3+x}$$

$(3-x)(3+x)$

$\boxed{9-2=7}$

$D_м=9-3x=9-3\cdot2=3.$

~~$\frac{9-x}{x}=\frac{D_м}{6}$~~

~~$9x=$~~

~~$54+6x=x\cdot D_м$~~

$x\leq$

~~$54-6x=9x-3x^2$~~ $|:3$

~~$3x^2-15x+18=0$~~

~~$D=225-216$~~

3

$9x-3x^2<18-3x$

$3x^2-12x+18>0$ min

$x^2-4x+6>0$ min

$(x-2)^2+2$ min

$\boxed{x=2}$

$$\frac{9-x}{x}=\frac{D_м}{y}$$

$y\leq3;$ $\frac{D_м\cdot x}{9-x}<3$