Часть 1

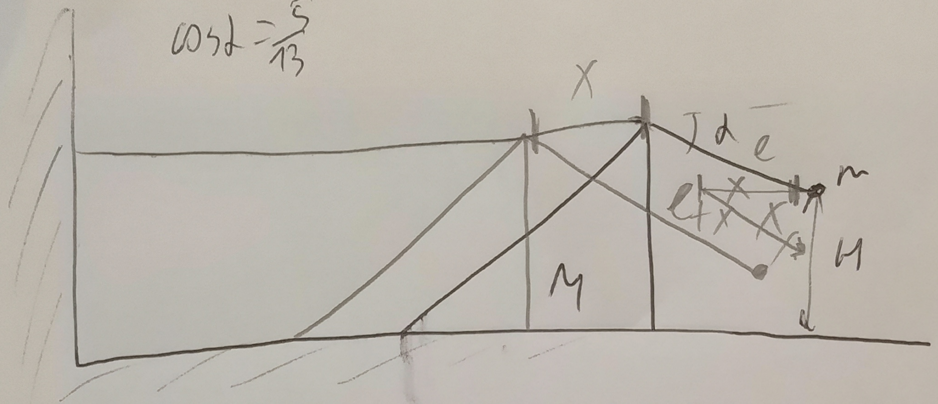
Олимпиада: **Физика, 11 класс (1 часть)**

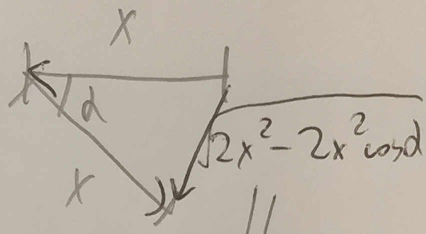
Шифр: **21202436**

ID профиля: **846020**

Вариант 3

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



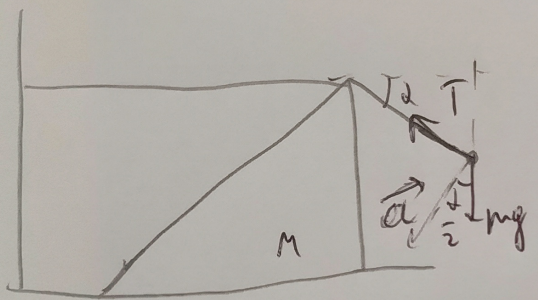


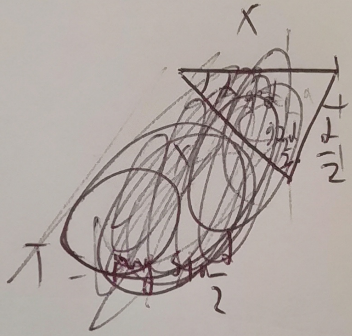
$$\sqrt{2x^2 - 2x^2\cos\alpha}$$

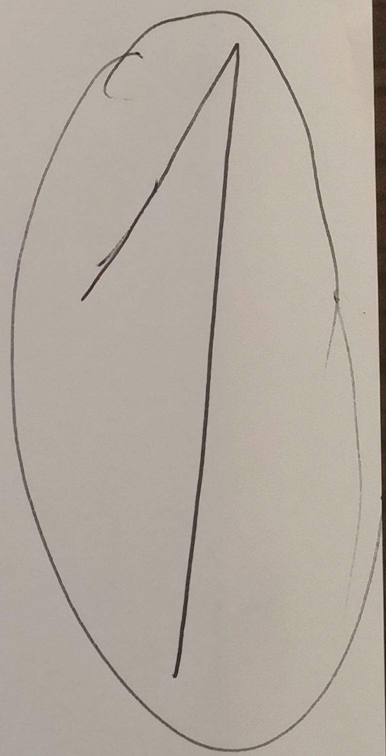
$$\| $$

$$x\sqrt{2\left(1-\frac{5}{13}\right)} =$$

$$= x\sqrt{2\cdot\frac{8}{13}} = \frac{4x}{\sqrt{13}}$$

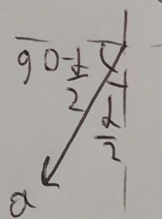






$90 - \frac{\alpha}{2}$

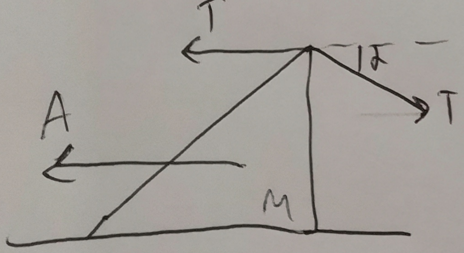
1)



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

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

$$A = \frac{T(1-\cos\alpha)}{M}$$

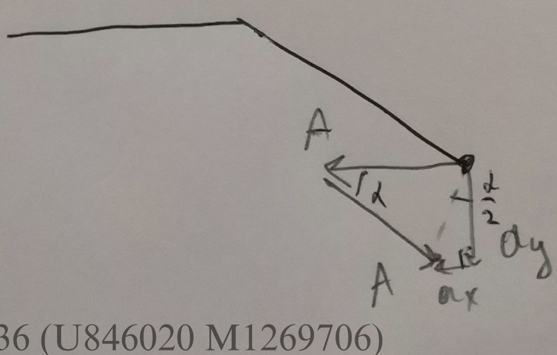


$$\operatorname{tg}\frac{\alpha}{2} = \frac{a_x}{a_y} = \frac{T\cos\alpha}{mg - T\sin\alpha}$$

$$mg\operatorname{tg}\frac{\alpha}{2} - T\sin\alpha\operatorname{tg}\frac{\alpha}{2} = T\cos\alpha$$

$$mg\operatorname{tg}\frac{\alpha}{2} = T\left(\cos\alpha + \sin\alpha\operatorname{tg}\frac{\alpha}{2}\right)$$

$$T = \frac{mg\operatorname{tg}\frac{\alpha}{2}}{\cos\alpha + \sin\alpha\operatorname{tg}\frac{\alpha}{2}}$$



$$a_y = g\left(1 - \frac{\operatorname{tg}\frac{\alpha}{2}\sin\alpha}{\cos\alpha + \sin\alpha \operatorname{tg}\frac{\alpha}{2}}\right) = g\left(1 - \frac{1}{1 + \frac{\operatorname{ctg}\alpha}{\operatorname{tg}\frac{\alpha}{2}}}\right) \qquad \operatorname{tg}\frac{\alpha}{2} = \sqrt{\frac{1-\cos\alpha}{1+\cos\alpha}}$$

$$a_x = g\,\frac{\cos\alpha \operatorname{tg}\frac{\alpha}{2}}{\cos\alpha + \sin\alpha \operatorname{tg}\frac{\alpha}{2}}$$

$$A\sqrt{2(1-\cos\alpha)} = g\sqrt{\left(1 - \frac{1}{1+\frac{\operatorname{ctg}\alpha}{\operatorname{tg}\frac{\alpha}{2}}}\right)^2 + \frac{1}{\left(\operatorname{ctg}\frac{\alpha}{2} + \operatorname{tg}\alpha\right)^2}}$$

$$\boxed{A = g\sqrt{\frac{\left(1 - \frac{1}{1+\frac{\operatorname{ctg}\alpha}{\operatorname{tg}\frac{\alpha}{2}}}\right)^2 + \frac{1}{\left(\operatorname{ctg}\frac{\alpha}{2} + \operatorname{tg}\alpha\right)^2}}{2(1-\cos\alpha)}}}$$ 2

3

$$\frac{A}{a_x} = \frac{\cancel{1}(1-\cos\alpha)}{M}\cdot\frac{m}{\cancel{1}\cos\alpha} = \frac{m}{M}\,\frac{1-\cos\alpha}{\cos\alpha} \quad \Big| \quad \boxed{\frac{m}{M} = \frac{\cos\alpha}{1-\cos\alpha}\cdot \frac{A}{a_x}}$$

4) $a_y \frac{t^2}{2} = H$ $\quad \boxed{t = \sqrt{\frac{2H}{a_y}}}$

2

К горизонту $90 - \frac{\alpha}{2}$

$$\cos\alpha = 2\cos^2\frac{\alpha}{2} - 1 = \frac{5}{13}$$

$$\cos^2\frac{\alpha}{2} = \frac{18}{13\cdot 2} = \frac{9}{13} \qquad \cos\frac{\alpha}{2} = \pm\sqrt{\frac{9}{13}} \qquad \frac{\alpha}{2} = \arccos\sqrt{\frac{9}{13}}$$

$$\frac{\alpha}{2} = 180^\circ - \arccos\sqrt{\frac{9}{13}}$$

К горизонту $\boxed{\frac{\pi}{2} - \arccos\frac{3}{\sqrt{13}} \text{ или } \arccos\frac{3}{\sqrt{13}} - \frac{\pi}{2}}$ 1

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$$a_x = g \cdot \frac{\cos\alpha \; tg\frac{\alpha}{2}}{\cos\alpha + \sin\alpha \, tg\frac{\alpha}{2}} = g \frac{1}{ctg\frac{\alpha}{2} + tg\alpha} = \frac{g}{\sqrt{\frac{1+\cos\alpha}{1-\cos\alpha}} + \frac{\sqrt{1-\cos^2\alpha}}{\cos\alpha}}$$

$$a_x = \frac{g}{\frac{3}{2}+\frac{12}{5}} = \frac{g}{\frac{15+24}{10}} = \boxed{\frac{10g}{39}}$$

$$a_y = g\left(1 - \frac{1}{1+\frac{\cos\alpha}{\sqrt{1-\cos^2\alpha}}\sqrt{\frac{1+\cos\alpha}{1-\cos\alpha}}}\right) = g\left(1 - \frac{1}{1+\frac{5}{\cancel{12}_4}\cdot\frac{\cancel{3}}{2}}\right) = g\left(1-\frac{1}{\frac{13}{8}}\right)$$

$$\boxed{a_y = g\frac{5}{13}}$$

$$t = \sqrt{\frac{2H}{g\cdot\frac{5}{13}}} \qquad \boxed{t = \sqrt{\frac{26H}{5g}}} \quad 4$$

$$A\sqrt{2(1-\cos\alpha)} = \sqrt{a_x^2 + a_y^2} = g\sqrt{\frac{25}{169} + \frac{100}{169\cdot 9}} = \frac{5g}{13}\sqrt{1+\frac{4}{9}}$$

$$A\sqrt{2\cdot\frac{8}{13}} = \frac{5g}{\frac{13}{\sqrt{13}}}\cdot\frac{\sqrt{13}}{3} \qquad 4A = \frac{5g}{3} \qquad \boxed{A = \frac{5}{12}g} \quad 2$$

$$\frac{m}{M} = \frac{5/13}{1-\frac{5}{13}} \cdot \frac{5g}{12} \cdot \frac{39}{\cancel{12g}_2} = \frac{5}{8}\cdot\frac{\overset{13}{\cancel{39}}}{\cancel{24}_8}$$

3

$$\boxed{\frac{m}{M} = \frac{65}{64}} \quad 3$$

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ν, T_0

$C(T) = 3R\frac{T}{T_0}$ $\qquad \delta Q = \nu C\,dT \qquad Q_1 = \int_{\frac{3}{5}T_0}^{T_0} \frac{3\nu R}{T_0}\cdot T\,dT = \frac{3\nu R}{2T_0}\cdot\left(T_0^2 - \frac{9}{25}T_0^2\right)$

1) $Q_1 = \frac{3\nu R}{\cancel{2}T_0}\cdot T_0^2\cdot\frac{\cancel{16}^{\,8}}{25}$ $\qquad \boxed{Q_1 = \frac{24}{25}\nu R T_0}$

2)

$$\delta Q = \nu C\,dT = \frac{3}{2}\nu R\,dT + \delta A \qquad \delta A = \nu C\,dT - \frac{3}{2}\nu R\,dT$$

$$\delta A = \frac{3\nu R}{T_0}T\,dT - \frac{3}{2}\nu R\,dT = 3\nu R\left(\frac{T\,dT}{T_0} - \frac{dT}{2}\right) = \frac{3\nu R}{2}\left(\frac{dT^2}{T_0} - dT\right)$$

$$A = \frac{3\nu R}{2}\left(\int_{T_0}^{T'}\frac{dT^2}{T_0} - \int_{T_0}^{T'} dT\right) = \frac{3}{2}\nu R\left(\frac{T'^2 - T_0^2}{T_0} - T' + T_0\right)$$

$$A = \frac{3}{2}\nu R\left(\frac{T'^2}{T_0} - T'\right) \to \min$$

$$\left.\frac{\delta A}{dT}\right|_{T'} = 0 \Rightarrow \frac{2T'}{T_0} = 1 \qquad \boxed{T' = \frac{T_0}{2}}$$

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

$$\boxed{A_{min} = -\frac{3}{8}\nu R T_0}$$

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Часть 2

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

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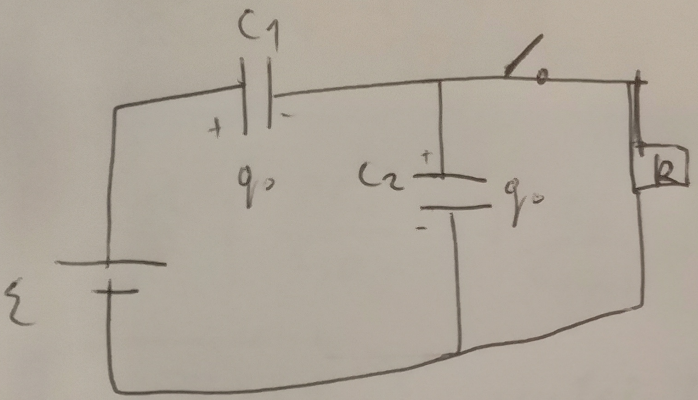
Вариант 3



$$\begin{cases} \frac{q_{10}}{C_1} + \frac{q_{20}}{C_2} = \varepsilon \\ q_{10} = q_{20} = q_0 \end{cases}$$

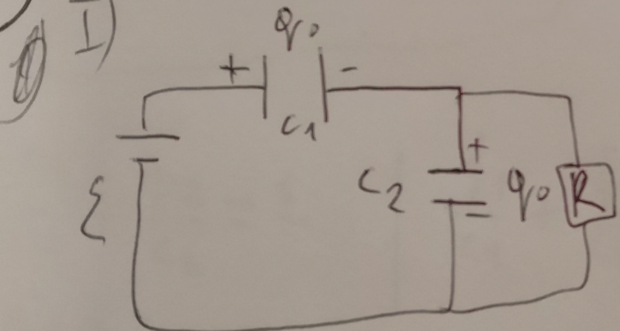
$$q_0 \frac{(C_1+C_2)}{C_1 C_2} = \varepsilon$$

$$q_0 = \frac{\varepsilon C_1 C_2}{C_1+C_2}$$

1) $I_0 R = \frac{q_0}{C_2}$ $\qquad I_0 = \frac{\varepsilon C_1 \cancel{C_2}}{(C_1+C_2)\cancel{C_2} \cdot R} = \boxed{\frac{\varepsilon C_1}{R(C_1+C_2)}} = \frac{\varepsilon \cdot 4\cancel{C}}{R \cdot 5\cancel{C}}$

$$\boxed{I = \frac{4\varepsilon}{5R}}$$

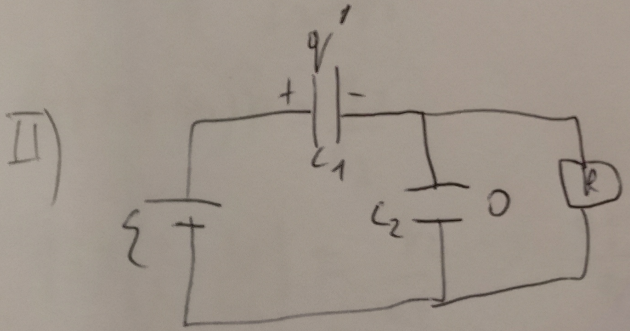
2) I)



$$\frac{q'}{C_1} = \varepsilon$$

$$q' = \varepsilon C_1$$

II)



$$\Delta q = q' - q_0 = \varepsilon C_1 \left(1 - \frac{C_2}{C_1+C_2}\right) =$$

$$= \frac{\varepsilon C_1^2}{C_1+C_2}$$

$$A = \varepsilon \Delta q$$

$$A + \frac{q_0^2}{2C_1} + \frac{q_0^2}{2C_2} = \frac{q'^2}{2C_1} + Q$$

$$\varepsilon \Delta q + \left(\frac{\varepsilon C_1 C_2}{C_1+C_2}\right)^2 \cdot \frac{C_1+C_2}{2C_1C_2} = \frac{C_1 \varepsilon^2}{2} + Q$$

1

$$Q=\frac{\varepsilon^2C_1^2}{C_1+C_2}+\frac{\varepsilon^2C_1C_2}{2(C_1+C_2)}-\frac{C_1\varepsilon^2}{2}=C_1\varepsilon^2\left(\frac{C_1}{C_1+C_2}+\frac{C_2}{2(C_1+C_2)}-\frac{1}{2}\right)=$$

$$=\frac{C_1\varepsilon^2}{2}\left(\frac{2C_1}{C_1+C_2}+\frac{C_2}{C_1+C_2}-\frac{C_1+C_2}{C_1+C_2}\right)=\frac{C_1\varepsilon^2}{2}\cdot\frac{C_1}{C_1+C_2}$$

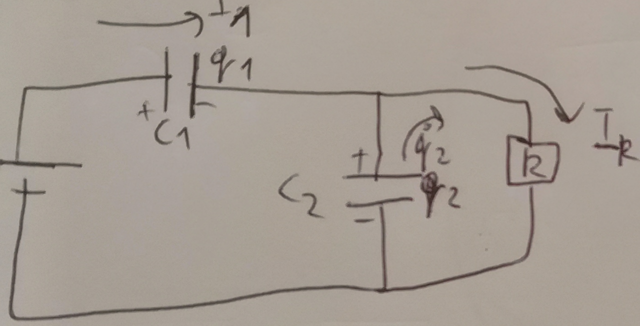
$$\boxed{Q=\frac{C_1^2\varepsilon^2}{2(C_1+C_2)}}=\frac{16C^2\varepsilon^2}{2\cdot 5C}=\boxed{1{,}6C\varepsilon^2}$$

$$\frac{q_1}{C_1}+\frac{q_2}{C_2}=\varepsilon$$

$$\dot q_1=I_0$$

$$\frac{q_2}{C_2}=I_R=I_0+\dot q_2$$

3)



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$$\frac{q_1}{C_1}+\frac{q_2}{C_2}=\varepsilon \quad\Big|\quad \frac{\dot q_1}{C_1}+\frac{\dot q_2}{C_2}=0 \quad\Big|\quad \dot q_1=-\dot q_2\frac{C_1}{C_2}$$

$$\dot q_1=I_1 \qquad I_2=\dot q_2$$

$$(\dot q_1+\dot q_2)R=\frac{q_2}{C_2}$$

$$\dot q_2R\left(1-\frac{C_1}{C_2}\right)=\frac{q_2}{C_2} \qquad \frac{dq_2}{q_2}=\frac{dt}{R(C_2-C_1)} \qquad q_2=q_0e^{-\frac{t}{R(C_1-C_2)}}$$

$$-\dot q_2\frac{C_1}{C_2}=-\frac{C_1}{C_2}\cdot q_0\cdot\left(-\frac{1}{R(C_1-C_2)}\right)e^{-\frac{t}{R(C_1-C_2)}}=\dot q_1$$

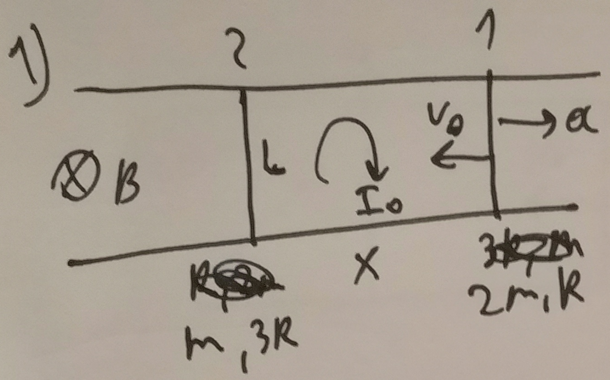
$$I_0=\frac{q_0C_1}{RC_2(C_1-C_2)}e^{-\frac{t_1}{R(C_1-C_2)}} \quad\Big|\quad e^{-\frac{t_1}{R(C_1-C_2)}}=I_0\cdot\frac{RC_2(C_1-C_2)}{q_0\cdot C_1}$$

$$q_2(t_1) = \cancel{q_0} \cdot I_0 \cdot \frac{R C_2 (C_1 - C_2)}{\cancel{q_0} C_1}$$

$$\frac{q_2(t_1)}{C_2} = U_R(t_1) = I_0 R\left(1 - \frac{C_2}{C_1}\right) = \boxed{\frac{3}{4} I_0 R}$$

3

1)



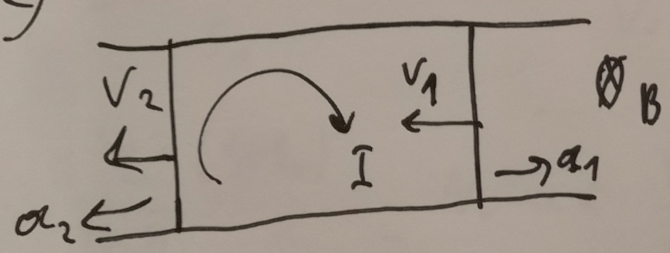
$\dot{x} = -v_0$

$\varepsilon = -BL \cdot \dot{x} = BLv_0$

$\varepsilon = I_0 \cdot 4R \qquad I_0 = \frac{BLv_0}{4R}$

$2ma = LI_0B = \frac{B^2L^2v_0}{4R} \qquad \boxed{a = \frac{B^2L^2v_0}{8mR}}$

2)



$\varepsilon = (v_1 - v_2)BL = I \cdot 4R$

$I = \frac{BL(v_1 - v_2)}{4R}$

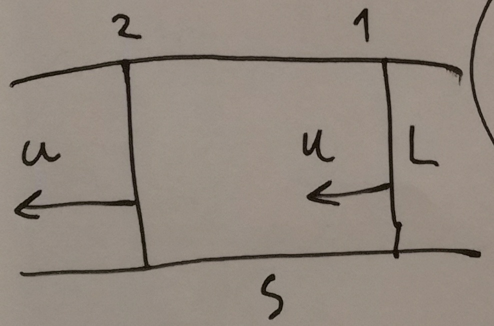
$a_1 = \frac{B^2L^2(v_1 - v_2)}{8mR} = -\dot{v}_1$

$(:) \qquad -\frac{\dot{v}_1}{\dot{v}_2} = \frac{1}{2} \qquad 2\dot{v}_1 = -\dot{v}_2$

$a_2 = \frac{B^2L^2(v_1 - v_2)}{4mR} = \dot{v}_2$

$2\int_{v_0}^{u} dv_1 = -\int_{0}^{u} dv_2$

1

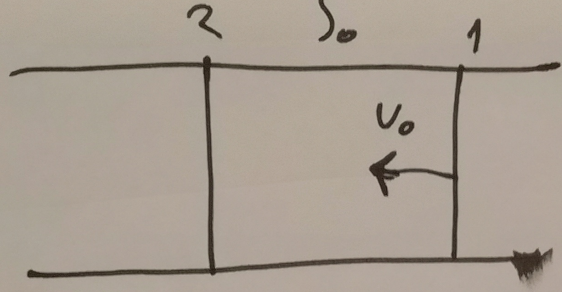


$2(u - v_0) = -u$

$3u = 2v_0$

$\boxed{u = \frac{2}{3}v_0}$

3)



$$a_1 = \frac{B^2L^2(v_1 - v_2)}{8mR} = -\dot{v}_1 = -\frac{dv_1}{dt}$$

$$\frac{B^2L^2}{8mR}\int_{S_0}^{S}(v_1 - v_2)\,dt = -\int_{v_0}^{u} dv_1$$

$$\frac{B^2L^2(S - S_0)}{8mR} = v_0 - u = \frac{v_0}{3} \quad \Big| \quad S - S_0 = \frac{8mv_0R}{3B^2L^2}$$

$$\boxed{S = S_0 + \frac{8mv_0R}{3B^2L^2}}$$

2

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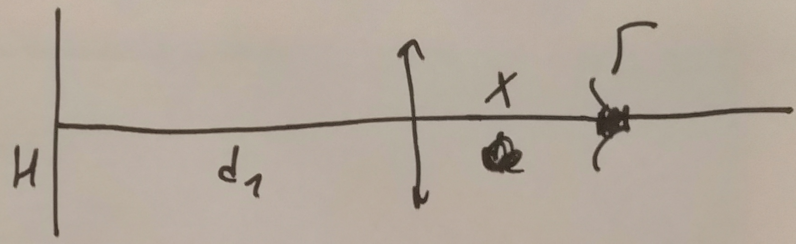
$F = 18$ см

$H = 9$ см

$d_1 = 72$ см

$d_2 = 24$ см



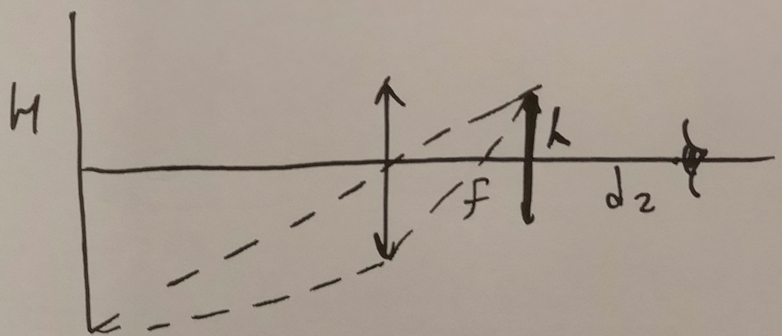
$$\frac{1}{d_1} + \frac{1}{f} = \frac{1}{F} \qquad f = \frac{d_1 F}{d_1 - F} = \frac{72 \cdot 18}{72 - 18} = 24 \text{ см}$$

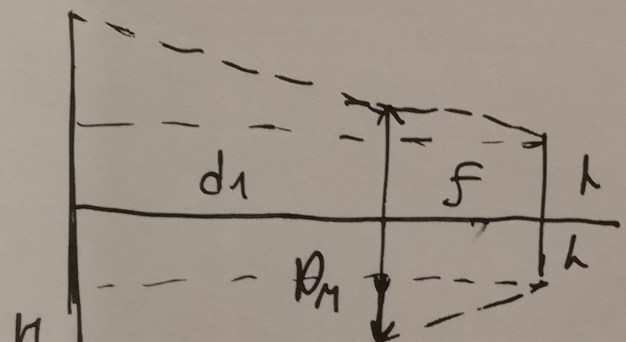
1)

$$X = d_2 + f = \boxed{48 \text{ см}}$$

2)

$$\frac{h}{H} = \frac{f}{d_1} \qquad h = H \cdot \frac{24}{72} = \frac{9}{3} = 3 \text{ см}$$





$$\frac{D_м - h}{f} = \frac{H - h}{d_1 + f}$$

$$D_м - h = 24 \cdot \frac{9-3}{72+24} = \frac{24}{96} \cdot 6$$

$$D_м = 3 + 1{,}5 = \boxed{4{,}5 \text{ см}}$$

3) небольшой экран надо поставить очень близко к глазу чтобы закрывать всё, так-как размеры экрана очень маленькие по сравнению с линзой. Тоесть надо поставить $x = 48$ см от линзы