



МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ  
имени М.В.ЛОМОНОСОВА

Вариант \_\_\_\_\_

Место проведения Москва  
город

ПИСЬМЕННАЯ РАБОТА

Олимпиада школьников «Ломоносов»  
наименование олимпиады

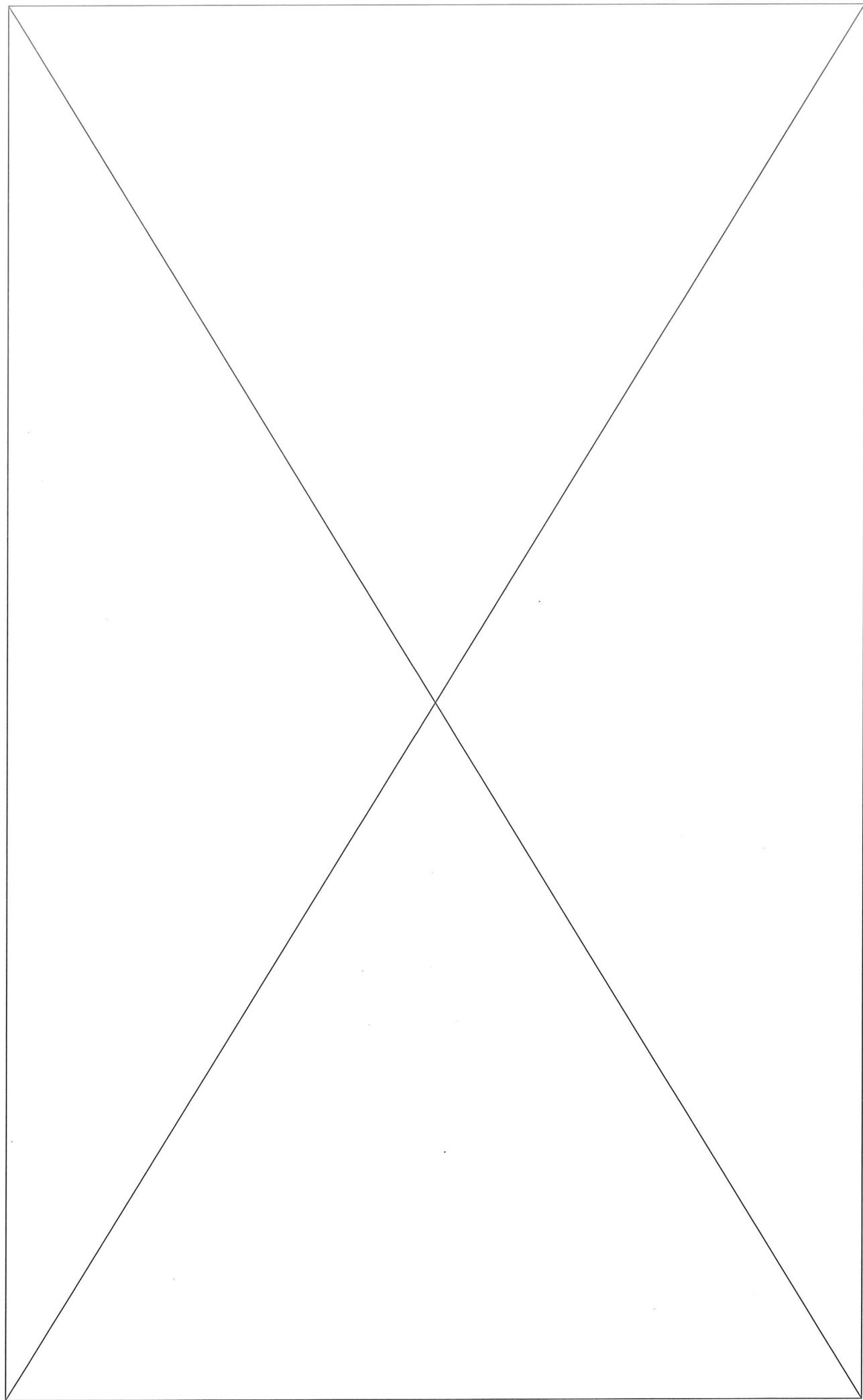
по физике  
профиль олимпиады

Кузнецовой Валерии Ильиничны  
фамилия, имя, отчество участника (в родительном падеже)

Дата  
«13» 02 2026 года

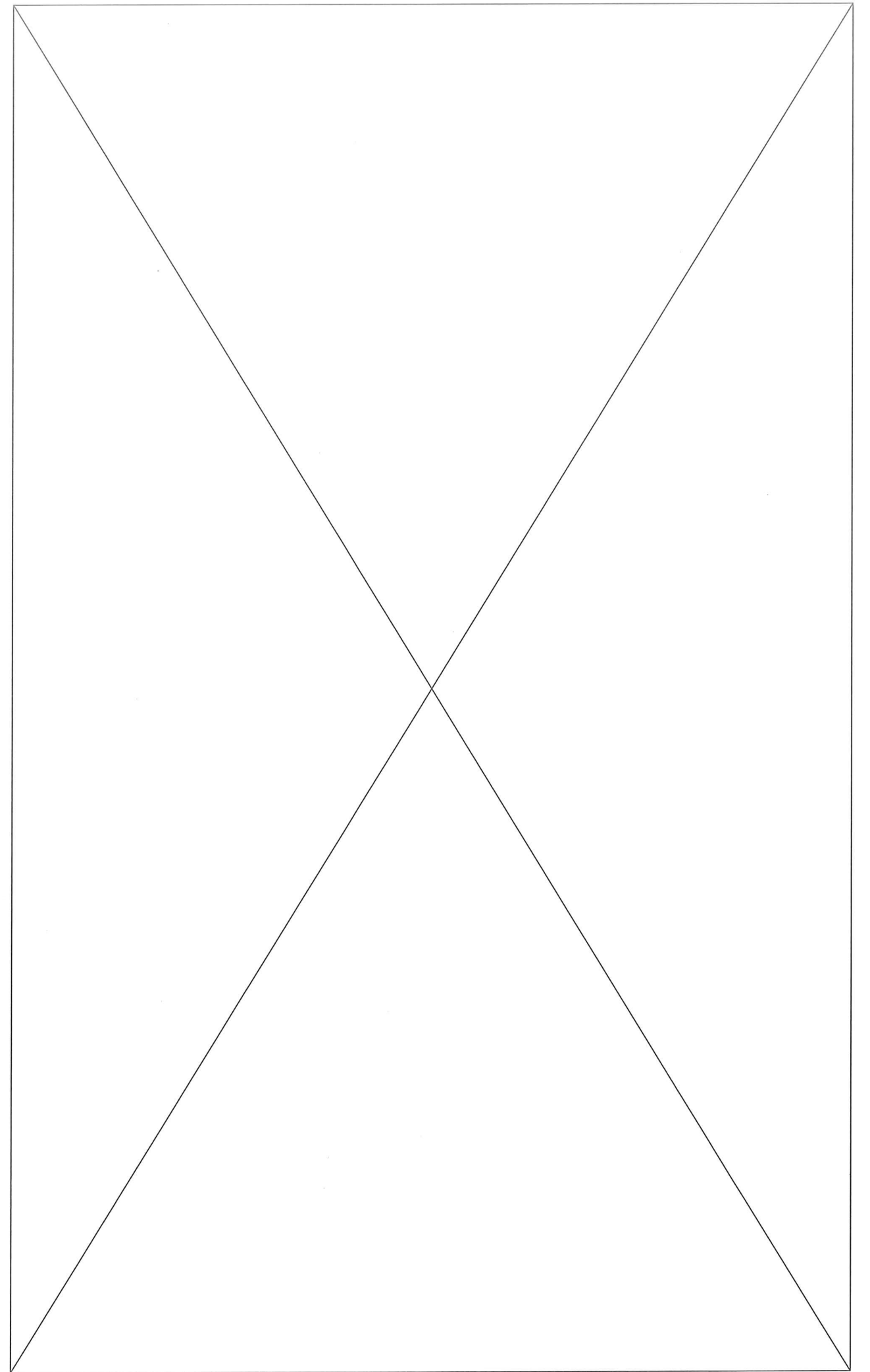
Подпись участника

[Signature]



Выполнять задания на титульном листе запрещается!

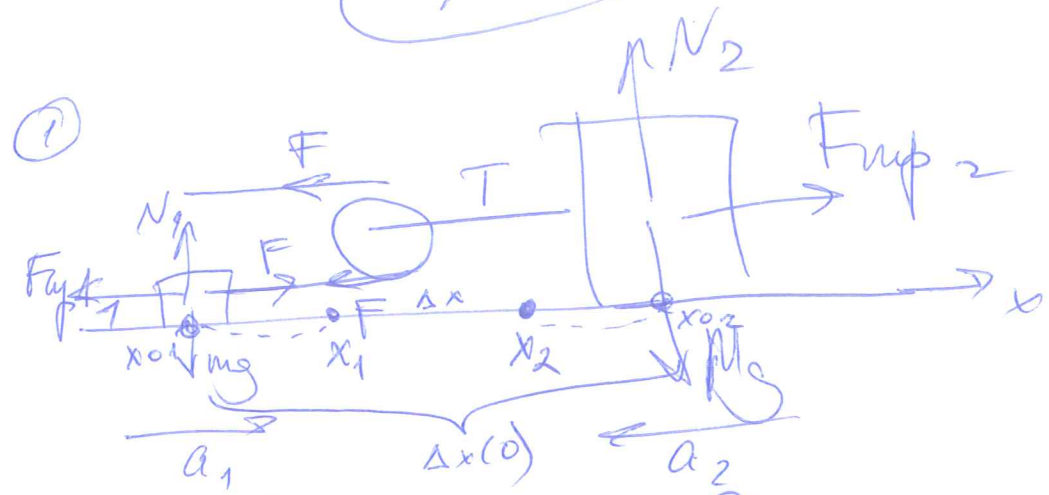
20



Выполнять задания на титульном листе запрещается!

Черновик

①



$$\begin{cases} F - F_{mp1} = ma_1 \\ T - F_{mp2} = Ma_2 \end{cases}$$

$$\begin{cases} N_1 = mg \\ N_2 = Mg \end{cases}$$

$$F_{m2} - T = Ma_2$$

$$\Delta x(t) = x_2(t) - x_1(t)$$

$$x_2(t) = x_{02} + \frac{a_2 t^2}{2}$$

$$x_1(t) = x_{01} + \frac{a_1 t^2}{2}$$

$$\Delta x(0) = x_{02} - x_{01}$$

$$\Delta x = \Delta x(0) - \Delta x(t) = \frac{2F}{m} - 2\mu g$$

$$= x_{02} - x_{01} - x_{02} - \frac{a_2 t^2}{2} + x_{01} + \frac{a_1 t^2}{2}$$

$$= \frac{t^2}{2} (a_1 - a_2)$$

$$\Delta x = t^2 \left( \frac{F}{m} - \mu g \right)$$

$$\frac{F}{m} = m \left( \frac{\Delta x}{t^2} + \mu g \right) = m \left( \frac{\Delta x}{t^2} + \mu g \right)$$

$$\frac{F}{m} - \mu g = a_1$$

$$\mu g - \frac{F}{m} = a_2$$

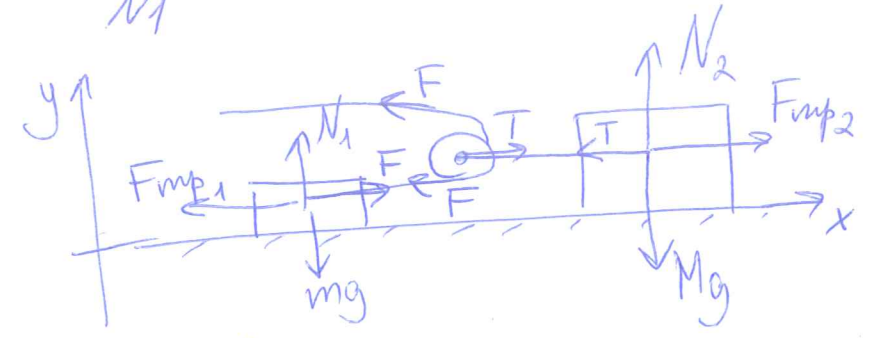
$$\frac{F}{m} - \mu g - \mu g + \frac{F}{m} =$$

**Z**

11-31-14-42  
(4.1)

Черновик

N1



Дано:

$$m = 500 \text{ г} = 0,5 \text{ кг}$$

$$M = 2 \text{ кг}$$

$$t = 1 \text{ с}$$

$$\Delta x = 1 \text{ м}$$

$$\mu = 0,3$$

$$g = 10 \text{ м/с}^2$$

F = ?

① II закон Ньютона:

$$Ox: F - F_{mp1} = ma_1$$

$$Oy: N_1 = mg \quad F_{mp2} - T = Ma_2$$

$$N_2 = Mg \quad T = 2F$$

$$② x_1(t) = x_{01} + \frac{a_1 t^2}{2}$$

$$x_2(t) = x_{02} + \frac{a_2 t^2}{2}$$

$$\Delta x(t) = x_2(t) - x_1(t)$$

$$\Delta x(0) = x_{02} - x_{01}$$

$$\Delta x = \Delta x(0) - \Delta x(t) = x_{02} - x_{01} - x_{02} - \frac{a_2 t^2}{2} + x_{01} + \frac{a_1 t^2}{2} = \frac{t^2}{2} (a_1 - a_2)$$

$$③ F_{mp1} = \mu N_1 = \mu mg$$

$$F_{mp2} = \mu N_2 = \mu Mg$$

$$\Rightarrow F_{mp2} = 2 F_{mp1} \Rightarrow T = 2F$$

$$a_1 = \frac{F - F_{mp1}}{m} = \frac{F - \mu mg}{m}$$

$$a_2 = \frac{F_{mp2} - T}{M} = \frac{2\mu mg - 2F}{2m} = \frac{\mu mg - F}{m}$$

$$\Delta x = \frac{t^2}{2} \cdot \frac{F - \mu mg - \mu mg + F}{m} = \frac{t^2}{2} \cdot \frac{2(F - \mu mg)}{m}$$

$$F = \frac{\Delta x m}{t^2} + \mu mg = m \left( \frac{\Delta x}{t^2} + \mu g \right)$$

$$F = 0,5 \cdot \left( \frac{1}{1^2} + 0,3 \cdot 10 \right) = 2 \text{ Н}$$

Ответ: 2 Н

1	20	20	100
2	20	20	100
3	20	20	100
4	20	20	100
5	20	20	100

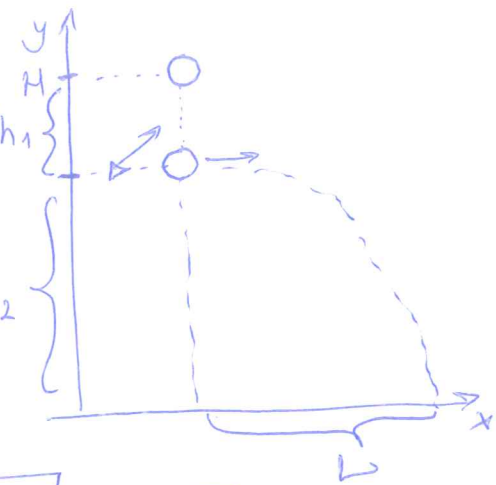
Справка

Чистовик

N2

Дано:  
 $\alpha = 45^\circ$   
 $t = 2c$   
 $L = 20m$   
 $g = 10m/c^2$

① Джематковешия:  
 $h_1 = \frac{gt^2}{2} \Rightarrow \text{ⓐ}$   
 $V_1 = V_0 + gt$   
 $V_0 = 0$   
 $\text{ⓐ} \Rightarrow t = \sqrt{\frac{2h_1}{g}}$

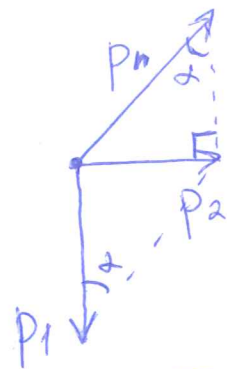


H - ?

$$V_1 = g \cdot \sqrt{\frac{2h_1}{g}} = \sqrt{\frac{2h_1 g^2}{g}} = \sqrt{2gh_1}$$

$$V_1 = \sqrt{2gh_1} \text{ ⓐ}$$

② Стоикковешие:



$$\vec{P}_n + \vec{P}_1 = \vec{P}_2$$

$$tg \alpha = \frac{P_2}{P_1} \Rightarrow P_2 = P_1 tg \alpha$$

$$\left. \begin{aligned} (m_n + m)V_2 &= mV_1 tg \alpha \\ m_n \ll m \text{ (но yes.)} \end{aligned} \right\} \Rightarrow$$

$$\Rightarrow mV_2 = mV_1 tg \alpha$$

$$V_2 = V_1 tg \alpha \text{ ⓐ}$$

③ Тосие стоикковешия:

$$\begin{cases} L = V_2 t \\ h_2 = \frac{gt^2}{2} \\ V_1 = \sqrt{2gh_1} \end{cases} \begin{cases} L = V_1 tg \alpha t \Rightarrow V_1 = \frac{L}{t tg \alpha} \\ h_2 = \frac{gt^2}{2} \\ 2gh_1 = V_1^2 = \frac{L^2}{t^2} \cdot \frac{1}{tg^2 \alpha} \Rightarrow \end{cases}$$

$$\Rightarrow h_1 = \frac{L^2}{2gt^2} \cdot ctg^2 \alpha$$

$$\text{ⓐ} H = h_1 + h_2 = \frac{L^2}{2gt^2} \cdot ctg^2 \alpha + \frac{gt^2}{2} \text{ ⓐ}$$

$$= \frac{400}{2 \cdot 10 \cdot 4} \cdot 1^2 + \frac{10 \cdot 4^2}{2} = 5 + 20 = 25 \text{ м}$$

ⓐ Ответ: 25 м ⓐ

Чистовик

②

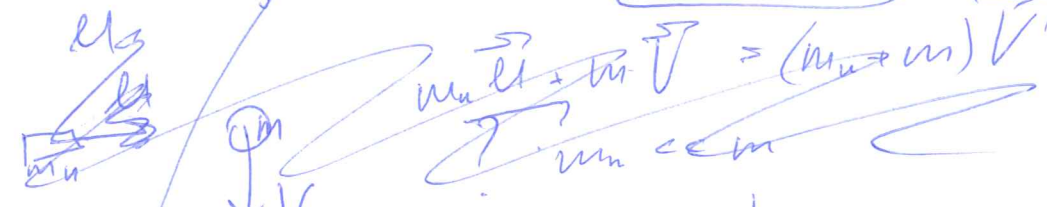
$$h_1 = \frac{gt^2}{2}$$

$$t^2 = \frac{2h_1}{g}$$

$$V_1 = g \sqrt{\frac{2h_1}{g}}$$

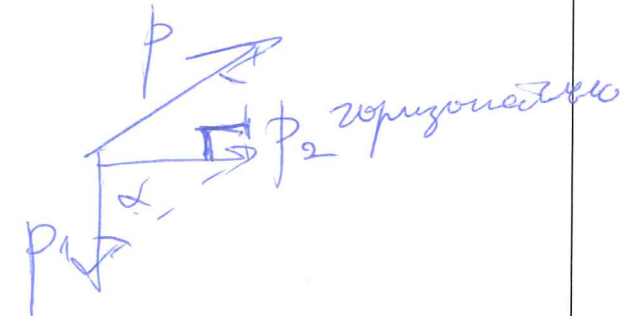
$$= \sqrt{\frac{2h_1 g^2}{g}} = \sqrt{2gh_1}$$

$$V_1 = \sqrt{2gh_1}$$



$$P_2 = tg \alpha P_1$$

$$mV_2 = tg \alpha mV_1$$

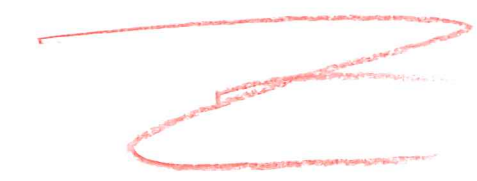


$$h_2 = \frac{gt^2}{2}$$

$$L = V_2 t = V_1 tg \alpha t \Rightarrow V_1 = \frac{L}{tg \alpha t}$$

$$2gh_1 = V_1^2 = \frac{L^2}{2g tg^2 \alpha t^2}$$

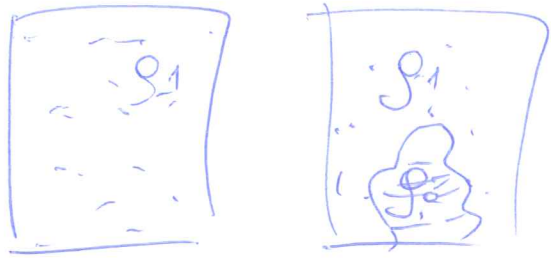
$$H = h_1 + h_2 = \frac{L^2}{2g tg^2 \alpha t^2} + \frac{gt^2}{2}$$



Термодинамика

3

абс. влаж. =  $\rho_{\text{влаг.}}$



$$\rho = \rho_1 + \rho_{\text{доп}}$$

$$p_1 = \frac{\rho_1 R T}{M}$$

$$y = \frac{\rho_1}{\rho_{\text{влаг}}} = \frac{p_1}{p_{\text{влаг}}}$$

$$p_{\text{влаг}} = \frac{p_{\text{влаг}} R T}{M}$$

$$\rho_1 = y \cdot \frac{M p_{\text{влаг}}}{R T} \quad \& \quad U = IR$$

$$Q_{\text{от}} = I^2 R t = \frac{U^2 t}{R}$$

$$Q_{\text{н}} = \eta \cdot \frac{U^2 t}{R} = 2 \text{ м}$$

$$m = \rho V \rightarrow \rho_{\text{доп}}$$

$$\rho = \frac{\eta U^2 t}{2 R V}$$

$$\rho = \frac{M p_{\text{влаг}}}{R T} = \frac{M U^2 t}{2 R V}$$

2

11-31-14-42  
(4.1)

Числовик

N3(a)

Дано:

$$V = 50 \text{ м}^3$$

$$T_0 = 300 \text{ К}$$

$$y = 41,5\% =$$

$$= 0,415$$

$$t = 100^\circ \text{C}$$

$$r = 80 \text{ Дж}$$

$$U = 100 \text{ В}$$

$$\eta = 80\% = 0,8$$

$$t = 2300 \text{ с}$$

$$p_{\text{влаг}}(T_0) = 2 \text{ кПа}$$

$$\lambda = 2,3 \text{ МДж/кг} \cdot \text{К}$$

$$M = 0,018 \text{ кг/моль}$$

$$R = 8,3 \text{ Дж/моль} \cdot \text{К}$$

$$\textcircled{1} \rho_2 = \rho_1 + \rho_{\text{доп}} \oplus$$

$$\textcircled{2} y = \frac{\rho_1}{\rho_{\text{влаг}}}$$

$$p_{\text{влаг}} = \frac{p_{\text{влаг}} R T}{M} \Rightarrow p_{\text{влаг}} = \frac{M p_{\text{влаг}}}{R T}$$

$$\rho_1 = y \cdot \frac{M p_{\text{влаг}}}{R T} \oplus$$

$$\textcircled{3} Q_{\text{от}} = \frac{U^2 t}{R}$$

$$Q_{\text{получ}} = \frac{\eta U^2 t}{R} = 2 \text{ м} = 2 \rho_{\text{доп}} V \Rightarrow$$

$$\Rightarrow \rho_{\text{доп}} = \frac{\eta U^2 t}{R 2 V} \oplus$$

$$\textcircled{4} \rho_2 = y \cdot \frac{M p_{\text{влаг}}}{R T} + \frac{\eta U^2 t}{R 2 V} \oplus$$

$\rho_2 = ?$

$$1) \rho_1 = 0,415 \cdot \frac{18 \cdot 10^{-3} \cdot 2 \cdot 10^3}{8,3 \cdot 300} = \frac{415 \cdot 10^{-3} \cdot 18 \cdot 2}{8,3 \cdot 10^{-1} \cdot 8 \cdot 10^1} = 60 \cdot 10^{-4}$$

$$2) \rho_{\text{доп}} = \frac{0,8 \cdot 100^2 \cdot 23 \cdot 10^2}{80 \cdot 2,3 \cdot 10^6 \cdot 50} = \frac{8 \cdot 23 \cdot 10^{-1}}{8 \cdot 10 \cdot 23 \cdot 10^1 \cdot 50}$$

$$= \frac{1}{500} = 2 \cdot 10^{-3}$$

$$3) \rho_2 = (6 + 2) \cdot 10^{-3} = 8 \cdot 10^{-3} \text{ кг/м}^3 = 8 \text{ г/м}^3$$

Ответ: 8 г/м<sup>3</sup>  $\oplus$

Числовик

N3(8) 4

Дано:

$m_1 = 660 \text{ мг}$

$m_3 = 744 \text{ мг}$

$S = 110 \text{ см}^2$

$k_1 = 3,3 \cdot 10^{-7} \text{ к}2/\text{к}1$

$k_2 = 1,1 \cdot 10^{-6} \text{ к}2/\text{к}1$

$k_3 = 9,3 \cdot 10^{-8} \text{ к}2/\text{к}1$

$\rho = 1,05 \cdot 10^4 \text{ к}2/\text{м}^3$

$h = ?$

$\frac{m_2}{k_2} = \frac{m_3}{k_3} - \frac{m_1}{k_1}$

$m_2 = \rho V = \rho S h = k_2 \left( \frac{m_3}{k_3} - \frac{m_1}{k_1} \right)$

$h = \frac{k_2}{\rho S} \left( \frac{m_3}{k_3} - \frac{m_1}{k_1} \right)$

1)  $\frac{m_3}{k_3} = \frac{744 \cdot 10^{-6}}{9,3 \cdot 10^{-8}} = 8 \cdot 10^3$

2)  $\frac{m_1}{k_1} = \frac{660 \cdot 10^{-6}}{3,3 \cdot 10^{-7}} = 2 \cdot 10^3$

3)  $(8 - 2) \cdot 10^3 = 6 \cdot 10^3$

4)  $\frac{1,1 \cdot 10^{-6}}{1,05 \cdot 10^4 \cdot 110 \cdot 10^{-4}} = \frac{11 \cdot 10^{-7}}{105 \cdot 10^4 \cdot 11 \cdot 10^{-4}} =$

①  $\begin{cases} m_1 = k_1 I_1 t \\ m_2 = k_2 I_2 t \\ m_3 = k_3 I_3 t \end{cases}$

②  $I_3 = I_1 + I_2$

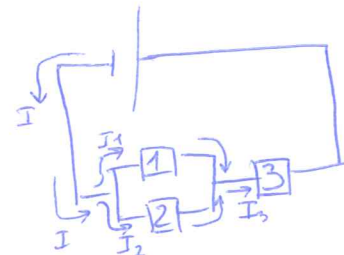
③  $m_3 = k_3 (I_1 + I_2) t$

$I_1 = \frac{m_1}{k_1 t}$

$\frac{m_1}{k_1 t} + I_2 t = \frac{m_3}{k_3 t}$

$I_2 = \frac{m_2}{k_2 t} = \frac{m_3}{k_3 t} - \frac{m_1}{k_1 t}$

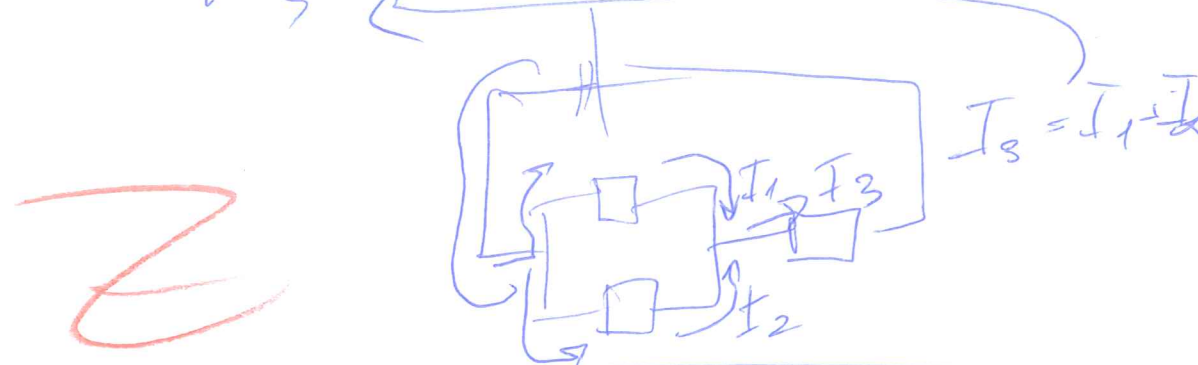
элементы уз.



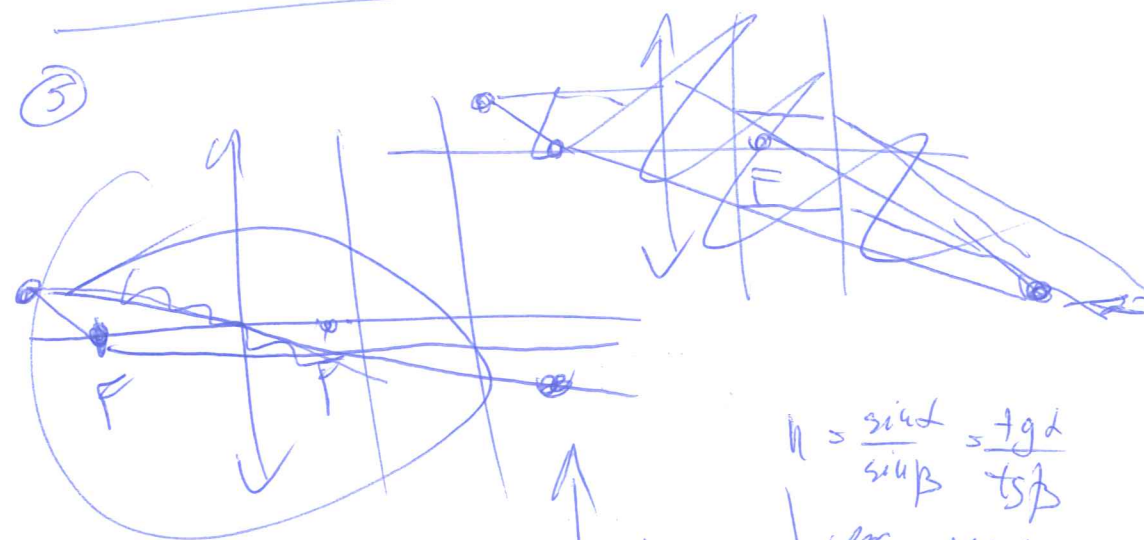
Суровен.

④  $m_1 = k_1 I_1 t$   
 $m_2 = \dots$   
 $m_3 = \dots$

$m_1 = k_1 I_1 t$

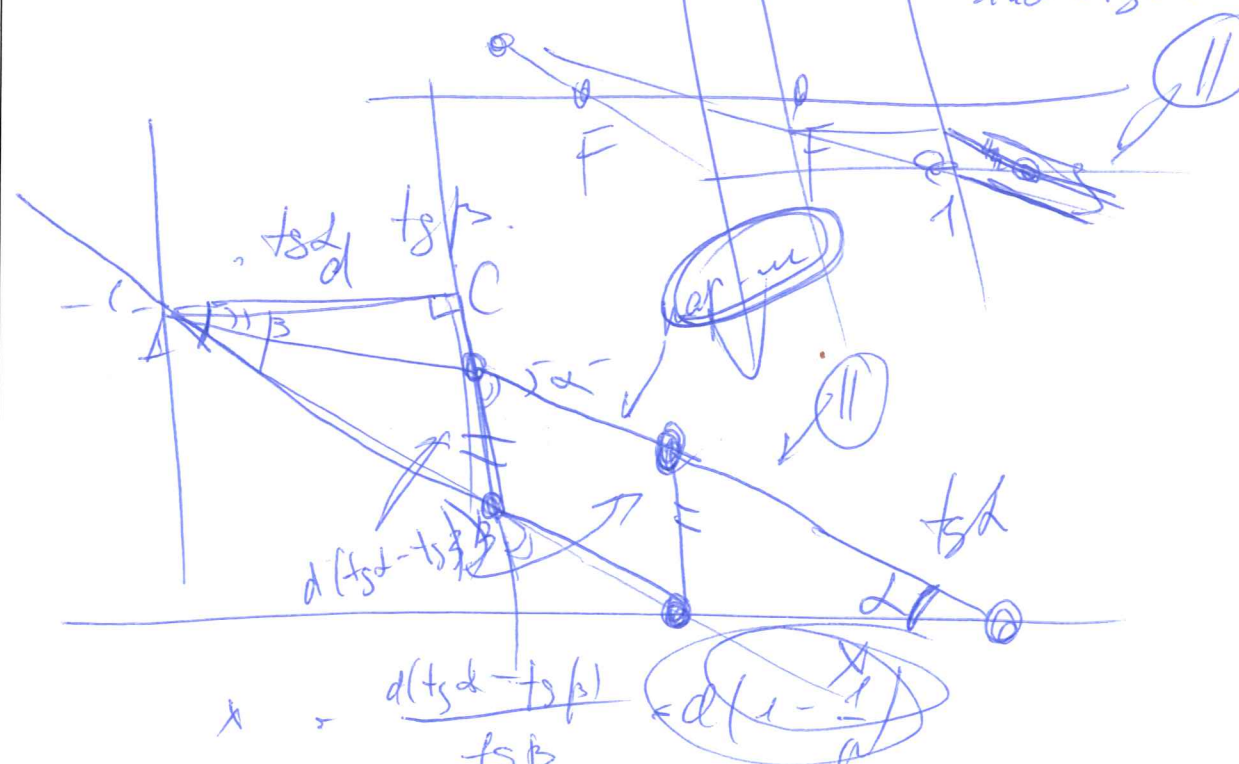


③

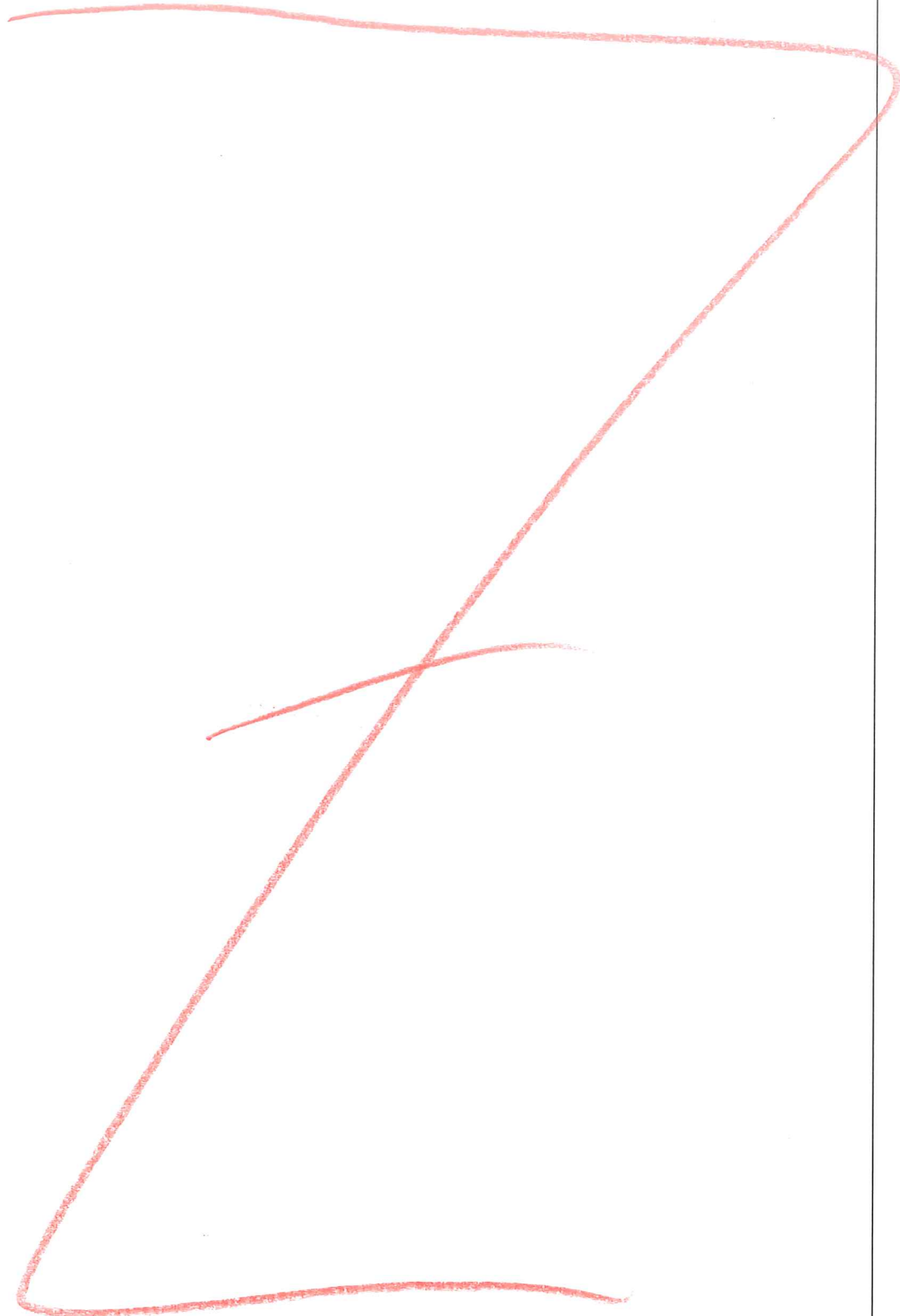


$h = \frac{\sin \alpha}{\sin \beta} = \frac{\text{tg} \alpha}{\text{tg} \beta}$

$\sin \alpha = \text{tg} \alpha$



$x = \frac{d(\text{tg} \alpha - \text{tg} \beta)}{\text{tg} \beta} = d \left( 1 - \frac{1}{\dots} \right)$



11-31-14-42  
(4.1)

$$= \frac{10^{-6}}{105}$$

Числовик

$$\begin{array}{r} 6,000 \quad | \quad 105 \\ 600 \quad | \quad 10,0572 \\ \hline 525 \\ \hline 750 \\ \hline 735 \\ \hline 250 \\ \hline 210 \\ \hline 40 \dots \end{array}$$

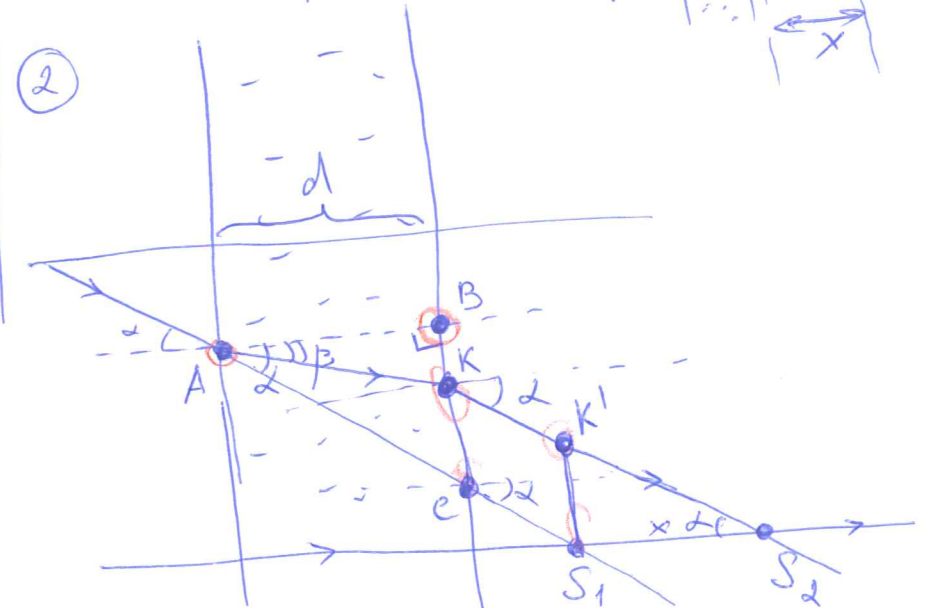
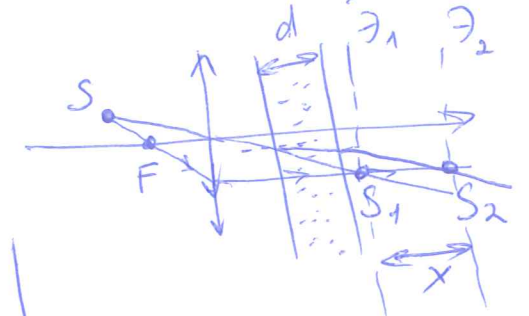
$$5) \frac{10^{-6} \cdot 6 \cdot 10^3}{105} = \frac{6}{105} \cdot 10^{-3} \approx$$

$$\approx \cancel{0,0572} \cdot 10^{-3}$$

$$= 57,2 \cdot 10^{-6} \text{ м} \approx 60 \text{ мкм}$$

Ответ: 60 мкм

Дано:  $n = \frac{\sin \alpha}{\sin \beta}$   
 $d = 3 \text{ см}$   
 $n = 1,5$   
 $x = ?$



$$1) \text{ П. пр. } \Delta ABC: \operatorname{tg} \alpha = \frac{BC}{d} \Rightarrow BC = d \operatorname{tg} \alpha$$

$$\text{П. пр. } \Delta ABK: \operatorname{tg} \beta = \frac{BK}{d} \Rightarrow BK = d \operatorname{tg} \beta$$

$$KC = BC - BK = d(\operatorname{tg} \alpha - \operatorname{tg} \beta)$$

$$2) \text{ П. пр. } \Delta S_1 K' S_2, S_1 S_2 = x$$

$$KK' \parallel CS_1 \text{ (соотв. пр.)} \Rightarrow KC = K'S_1$$

$$\operatorname{tg} \alpha = \frac{K'S_1}{S_1 S_2} = \frac{KC}{x} = \frac{d(\operatorname{tg} \alpha - \operatorname{tg} \beta)}{x} \Rightarrow$$

$$x = \frac{d(\operatorname{tg} \alpha - \operatorname{tg} \beta)}{\operatorname{tg} \alpha}$$

Z

③  $\sin \alpha \approx \text{tg} \alpha$  Установки  
 $\sin \beta \approx \text{tg} \beta$  (маленькие углы)  $\Rightarrow$

$$\Rightarrow n = \frac{\text{tg} \alpha}{\text{tg} \beta}$$

④  $x = \frac{d(\text{tg} \alpha - \text{tg} \beta)}{\text{tg} \alpha} = \cancel{d} \cdot \left( \frac{\text{tg} \alpha}{\text{tg} \alpha} - \frac{\text{tg} \beta}{\text{tg} \alpha} \right) =$

$$= d \left( 1 - \frac{1}{n} \right)$$

$$x = \frac{3}{100} \cdot \left( 1 - \frac{10}{15} \right) = \frac{3}{100} \cdot \frac{1}{3} = 0,01 \text{ м} =$$

$$= 1 \text{ см}$$

Ответ: 1 см.

20

