

Часть 1

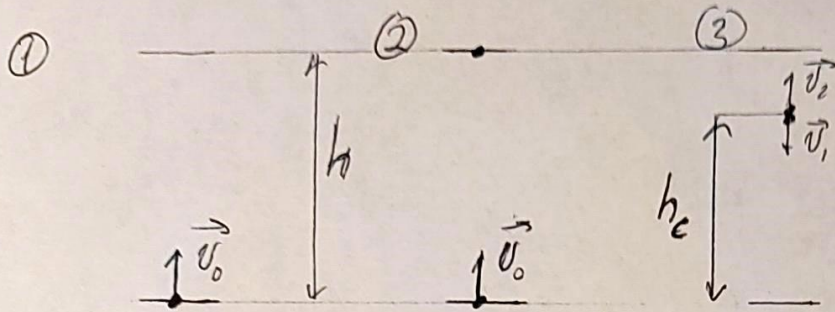
Олимпиада: **Физика, 10 класс (1 часть)**

Шифр: **21205575**

ID профиля: **816236**

Вариант 2

Задача 1



t_1 - время между моментами 1 и 2

t_2 - время между моментами 2 и 3

$$t_1 = \frac{v_0}{g} \quad v_0 - g t_1 = 0 \Rightarrow t_1 = \frac{v_0}{g}$$

$$h = v_0 t_1 - \frac{g t_1^2}{2} = \frac{v_0^2}{g} - \frac{v_0^2}{2g} = \frac{2v_0^2 - v_0^2}{2g} = \frac{v_0^2}{2g}$$

$$S_1 = \frac{g t_2^2}{2} \quad S_1 + S_2 = h \Rightarrow \frac{g t_2^2}{2} + v_0 t_2 - \frac{g t_2^2}{2} = \frac{v_0^2}{2g} \quad | : v_0$$

$$h_c = S_2 = v_0 t_2 - \frac{g t_2^2}{2}$$

$$t_2 = \frac{v_0}{2g}$$

$$t_0 = t_1 + t_2 = \frac{v_0}{g} + \frac{v_0}{2g} = \frac{2v_0 + v_0}{2g} = \frac{3v_0}{2g}$$

$$\frac{t_0}{t_2} = \frac{\frac{3v_0}{2g}}{\frac{v_0}{2g}} = \frac{3v_0 \cdot 2g}{v_0 \cdot 2g} = 3$$

$$h_c = S_2 = v_0 t_2 - \frac{g t_2^2}{2} = \frac{v_0^2}{2g} - \frac{v_0^2}{8g} = \frac{4v_0^2 - v_0^2}{8g} = \frac{3v_0^2}{8g}$$

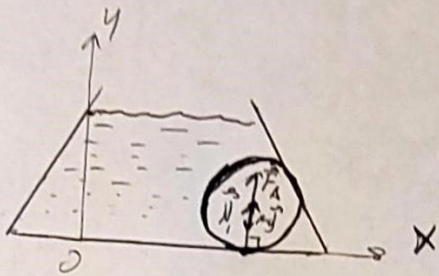
Ответ: 1) $t_0 = \frac{3v_0}{2g}$

2) $\frac{t_0}{t_2} = 3$

3) $h_c = \frac{3v_0^2}{8g}$

Задача 2

1)



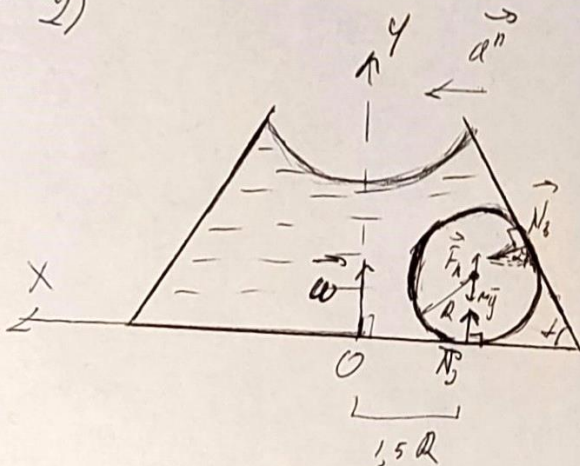
$$\text{Oy: } F_A + N_1 - mg = 0$$

$$N_1 = F_A - mg - F_A$$

$$F_A = \rho g V_{\text{ш}}$$

$$N_1 = mg - \rho g V_{\text{ш}} = 6\rho g V_{\text{ш}} - \rho g V_{\text{ш}} = 5\rho g V_{\text{ш}} = \frac{5\rho g \cdot 4\pi R^3}{3} = \frac{20\pi\rho g R^3}{3}$$

2) 2)



$$\text{OX: } N_3 \sin \alpha = ma''$$

$$\text{OY: } N_2 + F_A - mg - N_3 \cos \alpha = 0 \Rightarrow$$

$$\text{O } N_3 \sin \alpha = 1,5m\omega^2 R$$

$$\text{O } N_2 + F_A - mg = N_3 \cos \alpha$$

0.0

$$(N_2 + F_A - mg) N_3 \sin \alpha = 1,5m\omega^2 R N_3 \cos \alpha$$

$$N_2 = \frac{1,5m\omega^2 R}{6g\alpha} \cdot \frac{F_A + mg}{F_A + mg} = \frac{1,5m\omega^2 R}{6g\alpha} + N_1 = \frac{1,5 \cdot \frac{4\pi R^3}{3} \cdot 6\rho\omega^2 R}{6g\alpha} + N_1 =$$

$$= \frac{12\pi\rho\omega^2 R^4}{6g\alpha} \cdot N_1 = 8\pi\rho\omega^2 R^4 + \frac{20\pi\rho g R^3}{3} = \frac{4\pi R^3}{3} (6\omega^2 R + 5g)$$

Ответ: 1) $N_1 = \frac{20\pi\rho g R^3}{3}$

2) $N_2 = \rho \frac{4\pi R^3}{3} (6\omega^2 R + 5g)$

Задача 3

Дано: $T = 31^{\circ}\text{C} = 354\text{K}$

$V_2 = \frac{V_1}{7} = 1,7\text{л} = 1,7 \cdot 10^{-3}\text{м}^3$

$p_2 = 3,6 p_1; p_4 = 0,5 \cdot 10^5 \text{Па}$

$\mu = 18\text{г/моль}; R = 8,31\text{ Дж/моль}\cdot\text{К}$

Искать: 1) p_1

2) m_1

Решение

1) $p_1 V_1 = m_1 \frac{RT}{\mu}$

2) $\frac{3,6}{7} p_1 V_1 = m_2 \frac{RT}{\mu}$

3) $\frac{m_2}{m_1} = \frac{3,6}{7} \Rightarrow m_2 \neq m_1 \Rightarrow$ вода конденсировалась

$\Rightarrow p_2 = p_4$ т.к. после открытия порки выравнивание

1) $p_4 = p_2 = 3,6 p_1$

$p_1 = \frac{p_4}{3,6} = \frac{0,5 \cdot 10^5}{3,6} = \frac{5 \cdot 10^4}{3,6} \approx 1,4 \cdot 10^4 \text{Па} = 14 \text{кПа}$

2) $p_1 V_1 = p_2 V_2$

$7 p_1 V_2 = m_1 \frac{RT}{\mu}$

$m_1 = \frac{7 p_1 V_2 \mu}{RT} = \frac{7 \cdot 1,4 \cdot 10^4 \cdot 1,7 \cdot 10^{-3} \cdot 18}{8,31 \cdot 354} \approx 1 \text{г}$

Ответ: 1) $p_1 = 14 \text{кПа}$

2) $m_1 = 1 \text{г}$

Чертовик

$$v = v_0 - gt$$

$$x = v_0 t - \frac{gt^2}{2} + v_0$$

$$t_1 = \frac{v_0}{g}$$

$$h = \frac{gt^2}{2} = \frac{v_0^2}{2g}$$

$$h = v_0 t - \frac{gt^2}{2}$$

$$= \frac{v_0^2}{g} - \frac{v_0^2}{2g} = \frac{v_0^2}{2g}$$

$$\frac{gt_2^2}{2} + v_0 t_2 - \frac{gt_2^2}{2} = \frac{v_0^2}{2g}$$

$$t_2 = \frac{v_0}{2g}$$

$$\frac{t_2}{t_1} = \frac{\frac{v_0}{2g}}{\frac{v_0}{g}} = 3$$

$$v_0 t_2 - \frac{gt_2^2}{2} = \frac{v_0^2}{2g} - \frac{v_0^2}{8g} = \frac{3v_0^2}{8g}$$

$$F_1 = \rho g V = \rho g \frac{4\pi R^3}{3}$$

$$N_0 = mg - F_1 = 6\rho g V - \rho g V = 5\rho g V$$

$$= \frac{20\rho g \pi R^3}{3}$$

$$N_3 \sin \alpha = m \omega^2 1,5 R$$

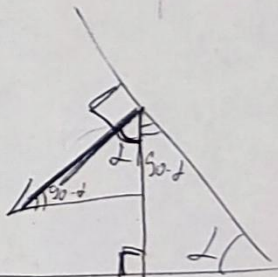
$$N_2 = N_0 + N_3 \cos \alpha$$

$$(N_2 - N_0) N_3 \sin \alpha = m \omega^2 1,5 R \cdot N_3 \cos \alpha$$

$$N_2 - N_0 = \frac{1,5 m \omega^2 R}{\sin \alpha}$$

$$N_2 = N_0 + \frac{1,5 \cdot \frac{4\pi R^3 \rho g}{3} \cdot \omega^2 R}{\sin \alpha} = \frac{12 \pi R^3 \omega^2 R^4}{6g \sin \alpha} + N_0$$

12



$$= 18 \rho g \omega^2 R^4 + \frac{20 \pi \rho g R^3}{3} N_2$$

$$= 4 \pi g R^3 \left(2 \omega^2 R + \frac{5g}{3} \right)$$

ЧЕРНОБУК

13

$$P_1 V_1 = \nu_1 R T$$

$$\frac{1}{3.6} P_1 V_1 = \nu_2 R T$$

$$\frac{P_1 V_1}{3.6} = \nu_1 \cdot \frac{RT}{M}$$

$$\frac{P_1 V_1}{7} = \nu_2 \cdot \frac{RT}{M}$$

$$\frac{\nu_1}{\nu_2} = \frac{7}{3.6} \Rightarrow \nu$$

$$P_1 = \frac{P_1}{3.6}$$

$$P_1 = 3.6 P_1 \quad P_1 = \frac{P_1}{3.6} =$$

$$= \frac{5 \cdot 10^4}{3.6} \approx 1.4 \cdot 10^4 \text{ Pa}$$

$$P_1 V_1 = \nu_1 R T$$

$$\frac{P_1 V_1}{7}$$

$$\frac{P_1 V_1}{3.6} = \nu_1 \frac{RT}{M}$$

$$\frac{P_1 V_1}{7} = \nu_2 \frac{RT}{M}$$

$$\frac{0.5 \cdot 10^5 \cdot 7 \cdot 1.7 \cdot 10^{-3}}{3.6} = \nu_1$$

$$M_1 = \frac{7 P_1 V_2 M}{3.6 RT} = \frac{7 \cdot 0.5 \cdot 10^5 \cdot 1.7 \cdot 10^{-3} \cdot 18}{3.6 \cdot 8.31 \cdot 354} = \frac{7 \cdot 5 \cdot 17 \cdot 18}{36 \cdot 8.31 \cdot 354} \approx 15$$

$$\frac{7 \cdot 1.7 \cdot 0.5 \cdot 10^5 \cdot 10^{-3}}{3.6} \cdot \frac{1}{18} \cdot \frac{6.31 \cdot 354}{1}$$

165 \approx 163

$$M \cdot M^3 = \frac{M}{M^2} \cdot M^1 = M \cdot M = M^2$$

$$7 \cdot 1.7 \cdot 1.4 \cdot 10^4 \cdot 10^{-3}$$

166 \approx 163

$$\frac{6.31 \cdot 354}{18} \frac{\text{K} \cdot \text{m}}{\text{m}^2} \cdot \text{m} = \frac{\text{K} \cdot \text{m}^2}{\text{m}^2}$$

Часть 2

Олимпиада: **Физика, 10 класс (2 часть)**

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Вариант 2

Чистовар

Вариант 10-02

лист 1

курс II

Задача 5

$$① p_1 V_1 = \nu R T_1$$

$$② p_2 V_2 = \nu R T_2$$

$$② : ① \quad \frac{T_2}{T_1} = \frac{p_2 V_2}{p_1 V_1}$$

$$1) \quad T_2 = T_1 \cdot \frac{0,99 p_1 \cdot 1,02 V_1}{p_1 V_1} = 1,0098 T_1$$

$$\frac{T_2 - T_1}{T_1} \cdot 100\% = 0,98\%$$

$$2) \quad \frac{\Delta p}{p} \ll 1 \Rightarrow A \approx p_1 (V_2 - V_1) = 0,02 p_1 V_1$$

$$\Delta U = \frac{3}{2} \nu R (T_2 - T_1) = \frac{3}{2} (p_2 V_2 - p_1 V_1)$$

$$Q = A + \Delta U$$

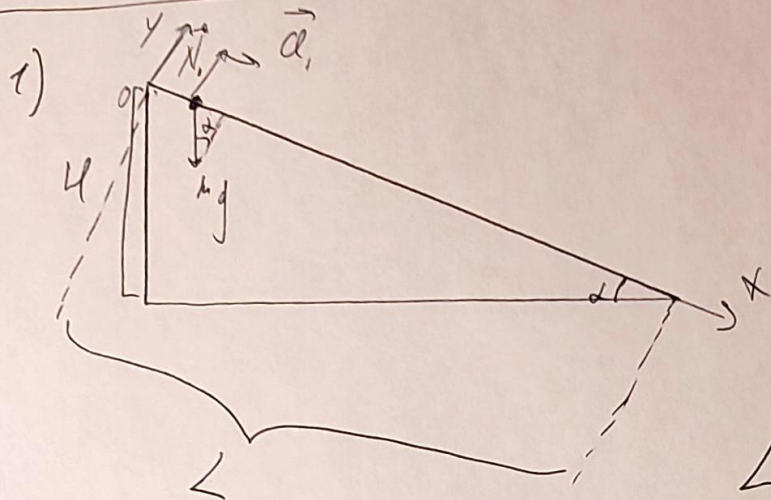
$$\eta = \frac{Q}{\Delta U} = \frac{A + \Delta U}{\Delta U} = \frac{A}{\Delta U} + 1 = \frac{0,02 p_1 V_1}{1,5 (p_2 V_2 - p_1 V_1)} + 1 = \frac{0,02 p_1 V_1}{1,5 p_1 V_1 (0,02 - 0,99 - 1)} + 1 = 0,0147$$

$$= 1,4 + 1 = 2,4$$

Ответ: 1) увеличилась на 0,98%

2) 2,4

Задача 4



$$Ox: mg \sin \alpha = ma,$$

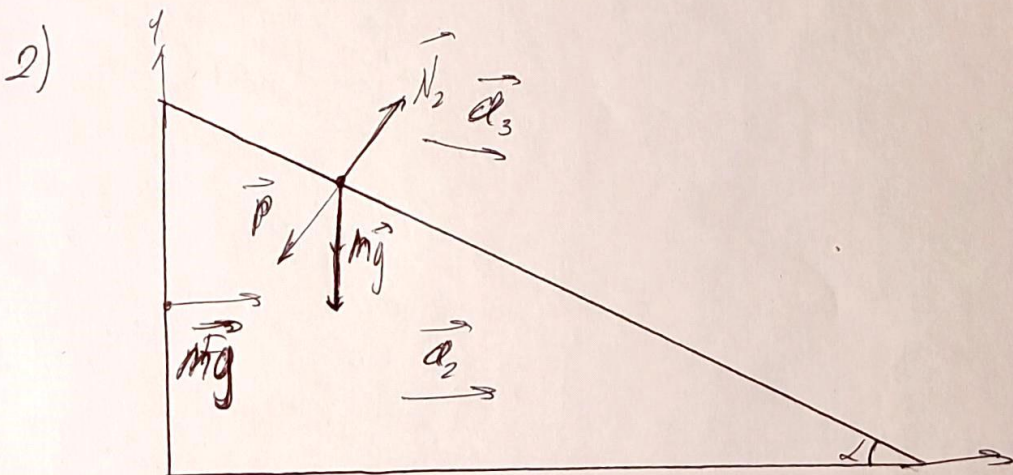
$$\sin \alpha = \sqrt{1 - \cos^2 \alpha} = \sqrt{1 - 0,36} = \sqrt{0,64} = 0,8 = \frac{4}{5} \Rightarrow \alpha = 0,8g$$

$$L = \frac{H}{\sin \alpha} = \frac{5H}{4}$$

$$L = \frac{a_1 t_1^2}{2}$$

$$5H = \frac{5H}{4} = \frac{0,8g t_1^2}{2}$$

$$t_1 = \sqrt{\frac{10H}{3,2g}} = \sqrt{\frac{50H}{16g}} = \frac{5}{4} \sqrt{\frac{2H}{g}}$$



$$p = N_2$$

$$\begin{cases} \text{① } mg - N_2 \cos \alpha = ma_{3y} \\ \text{② } N_2 \sin \alpha = ma_{3x} \\ \text{③ } mg - N_2 \sin \alpha = 2ma_2 \end{cases}$$

Задача 4 (продолжение)

$$\alpha - \text{б)}: N_2 (\sin \alpha - \cos \alpha) = m(a_{3y} - 2a_2)$$

$$N_2 = 5m(a_{3y} - 2a_2)$$

$$mg - 5m(a_{3y} - 2a_2) \sin \alpha = 2ma_2$$

$$g - 4a_{3y} + 8a_2 = 2a_2$$

$$6a_2 + g = 4a_{3y}$$

$$a_{3y} = \frac{6a_2 + g}{4}$$

$$N_2 = 5m \left(\frac{6a_2 + g}{4} - 2a_2 \right) = 5m \left(\frac{g + 6a_2 - 8a_2}{4} \right) = m \frac{5}{4} (g - 2a_2)$$

$$\text{Ответ: 1) } \frac{5}{4} \sqrt{\frac{2H}{g}}$$

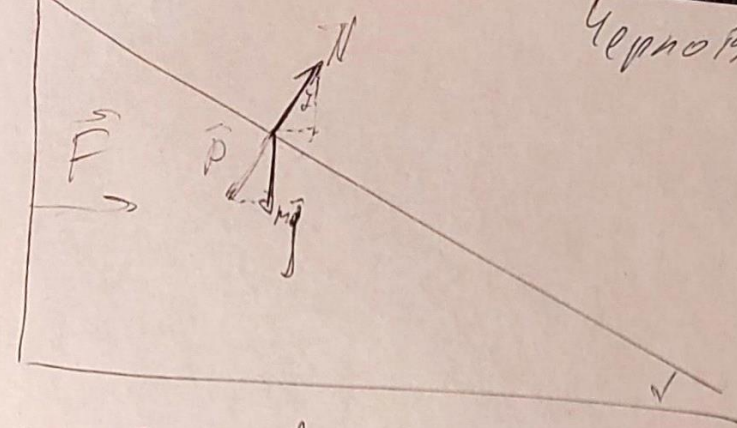
Черновики

$mg \sin \alpha = ma$
 $v = g \cos \alpha = \frac{3g}{5}$
 $L = 4$
 $L = \frac{4}{\sin \alpha}$
 $v^2 = 2u$
 $v = \sqrt{\frac{2u}{g}}$
 $P = mg \sin \alpha$
 $P = N - mg \cos \alpha$

$a = mg \sin \alpha$
 $L = \frac{4}{\sin \alpha}$
 $v^2 = 2u$
 $v = \sqrt{\frac{2u}{g}}$

$-mg \cos \alpha \sin \alpha + F = 2mu$
 $mg \left(1 - \frac{3 \cdot 4}{25}\right) = 2 \cdot 75 \cdot a$
 $a = \frac{(25 - 12)g}{2 \cdot 75} = \frac{13g}{150}$

Упробу



$$N \sin \alpha = m a_2$$

$$F - N \sin \alpha = 2 m a_1$$

$$N = \frac{m a_1}{\sin \alpha} = \frac{m g}{3 \sin \alpha}$$

$$F = 3 m a_2$$

$$m g = 3 m a_2$$

$$a_2 = \frac{g}{3}$$

$$m g - N \cos \alpha = m a_3$$

$$m g \left(1 - \frac{\cos \alpha}{3 \sin \alpha} \right) = m a_3$$

$$a_3 = g \left(1 - \frac{\cos \alpha}{3 \sin \alpha} \right) = g \left(1 - \frac{\frac{3}{4}}{3 \cdot \frac{4}{5}} \right) = g \left(1 - \frac{5 \cdot 3}{3 \cdot 4 \cdot 5} \right) = \frac{3g}{4}$$

$$h = \frac{a_3 t^2}{2} \quad t = \sqrt{\frac{2h}{a_3}} = \sqrt{\frac{8h}{3g}} = 4 \sqrt{\frac{h}{3g}}$$

$$\frac{25^3}{8} \quad \frac{8}{3}$$

$$\frac{70}{20} \quad \frac{69}{20}$$

5 $pV = \nu R T$

~~$0,99 \cdot 10^2 pV = \nu R (1+x) T$~~

~~$1+x = 0,99 \cdot 10^2$~~

~~$x = 1,0098 - 1 = 0,0098 \quad 100\% \cdot 4 = 0,98\%$~~



~~$p_2 V_2 = \nu R T = p_1 V_1 = \nu R T$~~

$$A = \frac{p_1 p_2}{2} \cdot \frac{1}{\rho} = \frac{p_1 p_2}{2} \cdot \Delta V$$

$$U = \frac{1}{2} \nu R \Delta T = \frac{1}{2} \nu p \Delta V$$

$$q = \frac{AU}{\kappa U + \Delta U} = \frac{\frac{1}{2} \nu p \Delta V}{\left(\frac{\nu p_1 p_2}{2} \right) \Delta V}$$

$$= \frac{\frac{3}{2} \Delta p}{\left(\frac{3}{2} \Delta p + \frac{p_1 p_2}{2} \right)}$$

Черновик

5

$$P_1 V_1 = \nu R T_1$$

$$P_2 V_2 = \nu R T_2$$

$$\frac{T_2}{T_1} = \frac{P_2 V_2}{P_1 V_1}$$

$$T_2 = T_1 \cdot \frac{0,99 P_1 \cdot 1,01 V_2}{P_1 V_1} = 1,0098 T_1$$

$$\frac{T_2 - T_1}{T_1} = \frac{0,0098 T_1}{T_1} = 0,98\%$$

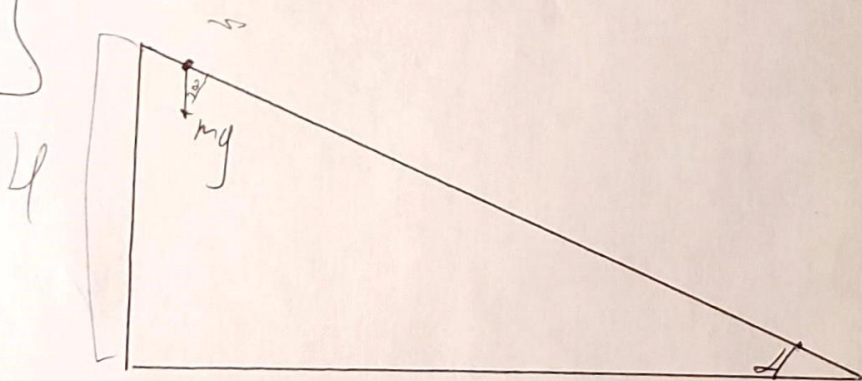
$$A \approx \frac{P_1 P_2}{2} (V_2 - V_1) \nu = \frac{1,99 P_1}{2} \cdot 0,02 V_1 = 0,0199 P_1 V_1$$

$$\Delta U = \frac{3}{2} \nu R (T_2 - T_1) = \frac{3}{2} \nu R (0,0098 T_1) = \frac{3}{2} \nu R (0,0098 \frac{P_1 V_1}{P_1}) =$$

$$\frac{1,5 P_1 V_1 - 1,5 P_1 V_1}{1,5 P_1 V_1 + 1,5 P_1 V_1 + 0,0199 P_1 V_1} = \frac{1,5 P_1 V_2 - 1,5 P_1 V_1}{1,5 P_1 V_2 - 1,4801 P_1 V_1}$$

$$= \frac{1,5 \cdot 1,0098 - 1,5}{1,5 + 1,5 + 0,0199} \frac{P_1 V_1}{P_1 V_1 (1,5 \cdot 0,0098 - 1,4801)} = \frac{0,0147}{0,0346} \approx 0,42$$

4



$$\sin \alpha = \frac{4}{5} = 0,8$$

$$\cos \alpha = 0,6$$

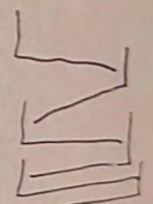
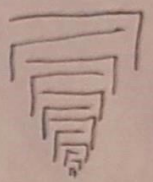
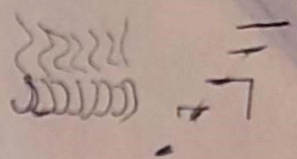
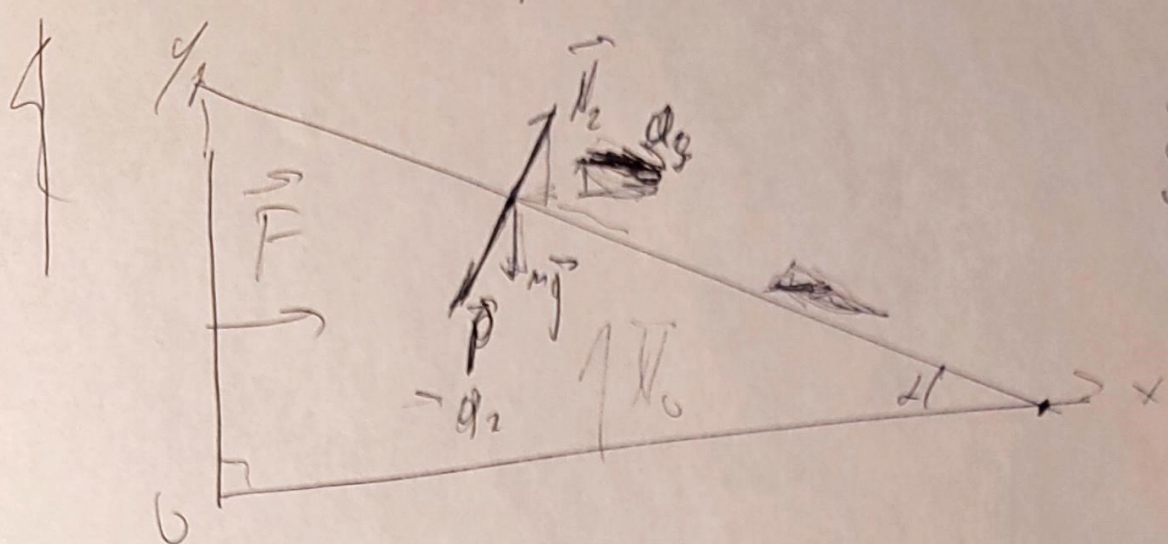
$$m \cdot l = m g \sin \alpha$$

$$d_2 g \sin \alpha$$

$$\frac{l}{\sin \alpha} = \frac{g \sin \alpha t^2}{2}$$

$$t_1 = \sqrt{\frac{2l}{g \sin^2 \alpha}} = \frac{5}{4} \sqrt{\frac{24}{g}}$$

УПРОВАЖКА



$$N_2 \cos \alpha = m a_{3y}$$

$$m g - N_2 \sin \alpha = m a_{3y}$$

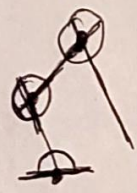
$$N_2 \sin \alpha = m a_{3x}$$

$$m g - N_2 \sin \alpha = 2 m a_2$$

$$\textcircled{1} - \textcircled{2}: N_2 \sin \alpha$$

$$N_2 (\sin \alpha - \cos \alpha) = m (a_{3y} - 2 a_2)$$

$$N_2 = 5 m (a_{3y} - 2 a_2)$$



$$5 m (a_{3y} - 2 a_2) \sin \alpha = m a_{3x}$$

$$4 a_{3y} - 8 a_2 = a_{3x}$$

$$m g - 5 m (a_{3y} - 2 a_2) \sin \alpha = 2 m a_2$$

$$g - a_{3y} + 8 a_2 = 2 a_2$$

$$6 a_2 = a_{3y} - g$$

$$4 a_{3y} = 6 a_2 + g$$

$$a_2 = \frac{a_{3y} - g}{6}$$

$$a_{3y} = \frac{3 a_2 + g}{4}$$

$$4 a_{3y} - 8 a_2 = a_{3x}$$

$$N_2 = 5 m \left(\frac{3 a_2 + g}{4} - 2 a_2 \right)$$

$$= 5 m \left(\frac{g}{4} - \frac{5 a_2}{2} \right) = \frac{5 m}{4} (2g - 5 a_2)$$

$$4 a_{3y} = \frac{8}{6} (a_{3y} - g) = a_{3x}$$

~~$$g - \frac{5}{4} (2g - 5 a_2) = 2 a_2$$~~

~~$$\frac{3g}{4} - \frac{5}{4} (2g - 5 a_2) = 2 a_2 \Rightarrow -\frac{g}{4} = -\frac{5 a_2}{2} \Rightarrow a_2 = \frac{g}{2}$$~~