Часть 1

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

Шифр: **21205257**

ID профиля: **284712**

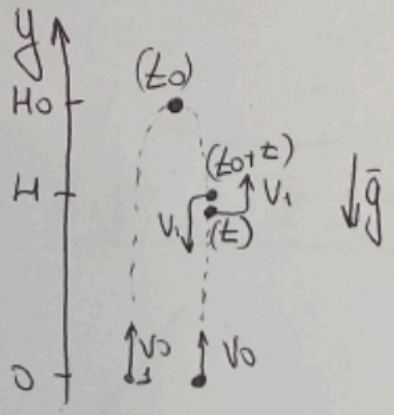
Вариант 1

Чистовик

(1)

№1

H
t, V_0, S



1) пусть V_1 - ск. 2 мяча в мом. столкновения:

$V_1 = V_0 - gt$

2) для 2 мяча:

$H = \frac{V_1^2 - V_0^2}{-2g}$

$-2gH = V_1^2 - V_0^2$

$V_1^2 = V_0^2 - 2gH$

3) пусть H_0 - высота верх. точ. а ~~за время полета 1 мяча~~ тогда:

$H_0 = \frac{V_0^2}{2g}$

4) ~~g~~ с мом. вылета 2 мяча 1ый пролетел $(H_0 - H)$ за исходное время t:

$H_0 - H = \frac{gt^2}{2}$

5) из п.3 и п.4:

$H_0 = H + \frac{gt^2}{2} = \frac{V_0^2}{2g}$

$2gH + g^2t^2 = V_0^2$

$V_0^2 - 2gH = g^2t^2$

6) из п.2 и п.5:

$V_0^2 - 2gH - V_1^2 = g^2t^2$

7) из п.1: $\underline{V_1 = gt}$

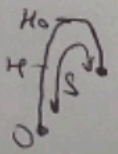
$gt = V_0 - gt$

$\underline{V_0 = 2gt}$

8) из п.2: $4g^2t^2 - 2gH = g^2t^2 \Rightarrow 3g^2t^2 = 2gH \Rightarrow t = \sqrt{\frac{2gH}{3g^2}} = \boxed{\sqrt{\frac{2H}{3g}}}$

9) $V_0 = 2gt = 2g\sqrt{\frac{2H}{3g}} = \sqrt{\frac{8Hg^2}{3g}} = \boxed{\frac{2\sqrt{2Hg}}{\sqrt{3}}}$

10) путь до столкновения 1 мяча:



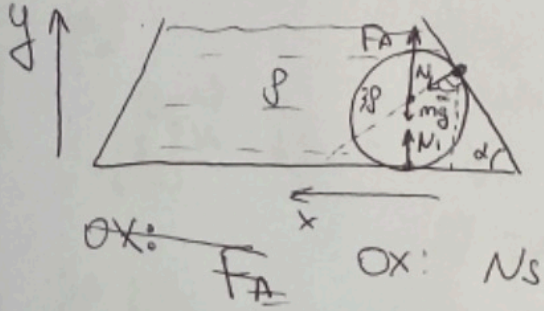
$S = (H_0 - H) + H_0 = 2H_0 - H = \frac{V_0^2}{g} - H = \frac{2H \cdot 4g^2}{3g \cdot g} - H = \boxed{\frac{5H}{3}}$

Ответ: 1) $t = \sqrt{\frac{2H}{3g}}$; 2) $V_0 = 2\sqrt{\frac{2Hg}{3}}$; 3) $S = \frac{5H}{3}$

Условие

№2

ω, R, ρ	1) 1сл:
$tg\alpha = 2$	
N_1, N_2	



OX: F_A

(2)

0) пусть N - сила реакции со стороны стенки

OX: $N\sin\alpha = 0$

$N = 0$

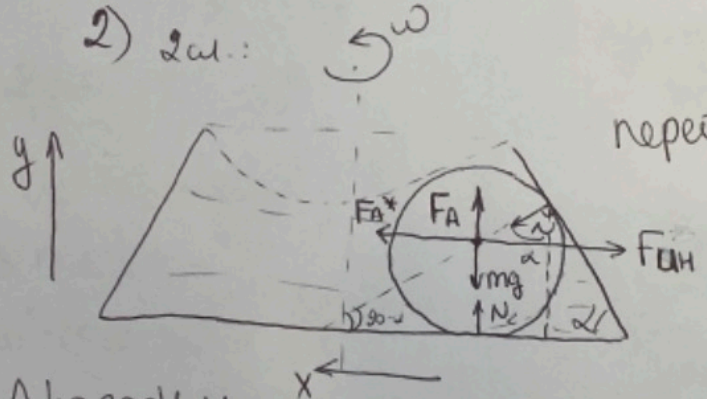
OY:

$F_A + N_1 = mg$

$N_1 = 3\rho gV - \rho gV = 2\rho gV =$

$= 2\rho g \cdot \frac{4}{3}\pi R^3 = \frac{8\rho g\pi R^3}{3}$

2) 2сл.:



перейдем в НеИСО с учетом $F_{ин}$ и F_A^*:

$F_{ин} = ma = 3\rho aV$

$F_A^* = \rho aV$

$$\begin{cases} N_2 = 2\rho gV + N\cos\alpha \\ N\sin\alpha = 2\rho aV \end{cases} \Leftarrow \begin{matrix} OY: & F_A + N_2 = mg + N\cos\alpha \\ OX: & N\sin\alpha + F_A^* = F_{ин} \end{matrix}$$

$N_2 = 2\rho gV + \frac{2\rho aV\cos\alpha}{\sin\alpha} = 2\rho gV + \frac{2\rho aV}{tg\alpha}$

$a = \omega^2 \cdot r = 2R\omega^2 \Rightarrow N_2 = 2\rho V\left(g + \frac{2R\omega^2}{tg\alpha}\right) = 2\rho \cdot \frac{4}{3}\pi R^3\left(g + \frac{2R\omega^2}{tg\alpha}\right)$

$N_2 = \frac{8\pi R^3\rho}{3}\left(g + \frac{2R\omega^2}{2}\right) = \frac{8\pi R^3\rho(g + R\omega^2)}{3}$

Ответ. 1) $N_1 = \frac{8\rho g\pi R^3}{3}$

2) $N_2 = \frac{8\pi R^3\rho}{3}\left(g + \frac{2R\omega^2}{tg\alpha}\right) = \frac{8\pi R^3\rho(g + R\omega^2)}{3}$

№3

$m = 3$ г

$T = 81°C = 354$ K

$V_2 = \frac{V_1}{3,5}$

$p_2 = 1,8 p_1$

$p_н(T) = 0,5 \cdot 10^5$ Па

$M = 18 \frac{г}{моль}$

1) p_1
2) V_2

Условие

(3)

1) Неизвестно, насыщ. или нет пар во 2 состоянии, проверим это:

~~ОТА~~ • пусть ненас., тогда $\nu = const \Rightarrow$

$$\nu RT = p_1 V_1 = p_2 V_2$$

$$p_2 = \frac{p_1 \cdot V_1}{V_2} = 3,5 p_1, \text{ но}$$

$p_2 = 1,8 p_1$, противоречие

2) p_{A3} во 2 сост. пар насыщ., пар насыщ., а $T = const$, то

$$p_2 = p_н(T) = 0,5 \cdot 10^5 \text{ Па} \Rightarrow p_1 = \frac{p_2}{1,8} = \frac{5}{18} \cdot 10^5 \text{ Па}$$

$$p_1 = 0,278 \cdot 10^5 \text{ Па}$$

3) Найдем V_1:

~~T.R.~~ по ур-ю ~~Менделеева-Клайпер~~ сост. ид. газа в 1 сл:

$$\nu RT = p_1 \cdot V_1$$

$$\nu = \frac{m}{M} \Rightarrow V_1 = \frac{mRT}{Mp_1}$$

4) $V_2 = \frac{2V_1}{7} = \frac{2mRT}{7Mp_1} = \frac{2 \cdot 0,003 \cdot 8,31 \cdot 354}{7 \cdot 0,018 \cdot \frac{5}{18} \cdot 10^5} =$

$$= \frac{17,65044}{0,035 \cdot 10^5} = 504,3 \cdot 10^{-5} \text{ м}^3 =$$

$$= 0,005 \text{ м}^3 = 5 \text{ л}$$

Ответ: 1) $p_1 = 0,278 \cdot 10^5$ Па

2) $V_2 = 0,005$ м^3

Терновик

$m_1 = 3г$

$t_1 = 354 K$

$V_2 = \frac{V_1}{3,5}$

$p_2 = 1,8 p_1$

$p_н(t_1) = 0,5 \cdot 10^5$ Па

$M = 18 \frac{г}{моль}$

V_2, p_1

1) пусть пар во 2 случае ненас.:

$\nu RT = p_1 V_1 = p_2 V_2$

$p_1 V_1 = 1,8 p_1 \cdot \frac{V_1}{3,5} \neq 0,5 p_1 V_1$

нет равенства

пар стал насыщ.

2) $p_2 = p_н(t_1)$, т.к. $t_1 = const$

$p_2 = 0,5 \cdot 10^5$ Па

$p_1 = \frac{0,5 \cdot 10^5}{1,8} = \underline{0,28 \cdot 10^5 \text{ Па}}$

$\frac{\frac{1}{2}}{\frac{18}{10}} = \frac{10}{36} = \frac{5}{18}$

3) $\nu = \frac{m_1}{M} = \frac{3г}{18 \frac{г}{моль}} = \frac{1}{6}$ моль

$\nu R t_1 = p_1 \cdot V_1$

$V_2 = \frac{V_1}{3,5}$ $\quad V_1 = \frac{\frac{1}{6} \cdot 8,31 \cdot 354}{0,28 \cdot 10^5} =$

$\nu R t_1 = 3,5 p_1 V_2$ $\quad = \frac{8,31 \cdot 354}{6 \cdot \frac{5}{18} \cdot 10^5} =$

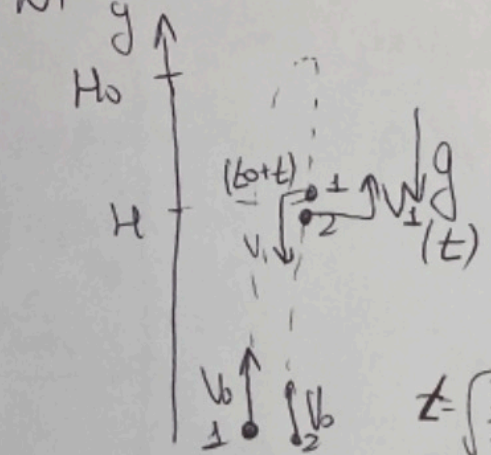
$= 1765 \cdot 10^{-5} =$

$V_2 = 0,005 м^3 < S_л$ $\quad = 1,765 \cdot 10^3 \cdot 10^{-3} =$

$0,01765 м^3$

Черновик

№1



$H_0 = \frac{V_0^2}{2g}$ $\quad V = 0 = V_0 - gt_0$

$H = V_0$ $\quad t_0 = \frac{V_0}{g}$

$H = 2gt^2 - \frac{gt^2}{2} = 1{,}5gt^2$

$t = \sqrt{\frac{2H}{3g}}$ $\quad V_1 = V_0 - gt$ $\quad gt = V_0 - gt$

$V_0 = 2gt$

$V_0 = 2g\sqrt{\frac{4H}{3g}} = 2\sqrt{\frac{2gH}{3}}$

$\begin{cases} H = V_0 t - \frac{gt^2}{2} \\ H_0 - H = \frac{gt^2}{2} \\ H_0 = \frac{V_0^2}{2g} \\ V_1 = V_0 - gt \end{cases}$

$H_0 = H + \frac{gH}{3} = \frac{4H}{3}$

$V_0 = \sqrt{2g \cdot \frac{4H}{3}} = 2\sqrt{\frac{2gH}{3}}$

$-V_1 = V_0 -$

$\frac{mV_1^2}{2} + mgH = \frac{mV_0^2}{2}$

$H_0 + H_0 - H =$

$2H_0 - H =$

$\frac{8H}{3} - H = \frac{5H}{3}$

$H_0 - H = \frac{gt^2}{2}$

$V_1^2 = V_0^2 - 2gH =$

$-gt$

$H = V_0 t - \frac{gt^2}{2}$

$\frac{V_0^2}{2g} = H_0$

$\frac{V_0^2}{2g} = \frac{gt^2}{2} + H$ $\quad H = \frac{V_0^2 - V_1^2}{2g}$

$V_0^2 = g^2t^2 + 2gH$

$V_1 = V_0 - gt$

$V_0 t - H = H_0 - H$

$H_0 = \frac{V_0^2}{2g} = H + \frac{gt^2}{2}$ $\quad V_0 t - H = H_0 = \frac{V_0^2}{2g}$

$V_0 = \sqrt{2gH +}$

$V_0^2 = 2gH + g^2t^2$ $\quad t = \frac{V_0}{2g}$

$\left(\frac{H}{t} + \frac{gt}{2}\right)^2 = 2gH + g^2t^2$ $\quad H = H_0 - \frac{gt^2}{2}$

$t^2 = \frac{8H}{1{,}5g^2} = \frac{2H}{3g} \Rightarrow \boxed{t = \sqrt{\frac{2H}{3g}}}$

$\frac{H^2}{t^2} + \frac{g^2t^2}{4} + \frac{H}{t} \cdot \frac{gt}{2} \cdot 2 = 2gH + g^2t^2$

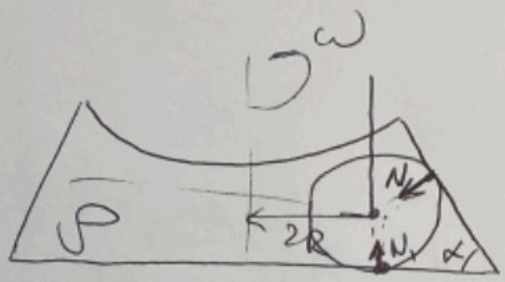
$\frac{3g^2t^4}{4} + gHt^2 - H^2 = 0$ $\quad \frac{H^2}{t^2} = gH + \frac{3g^2t^2}{4}$

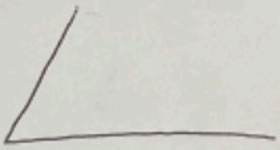
$t^2 = \frac{-gH + \sqrt{g^2H^2 + 3g^2H^2}}{1{,}5g^2} = \frac{-gH + 2gH}{1{,}5g^2}$ $\quad H^2 = \frac{3g^2t^4}{4} + gHt^2$

N2

Черновик

ρ
3ρ
$\operatorname{tg}\alpha = 2$
R
2R

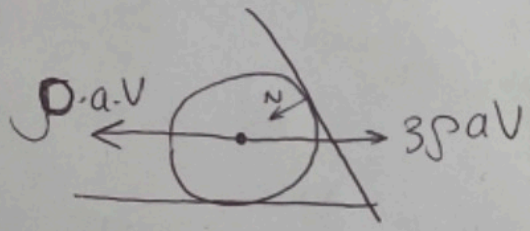




N=0

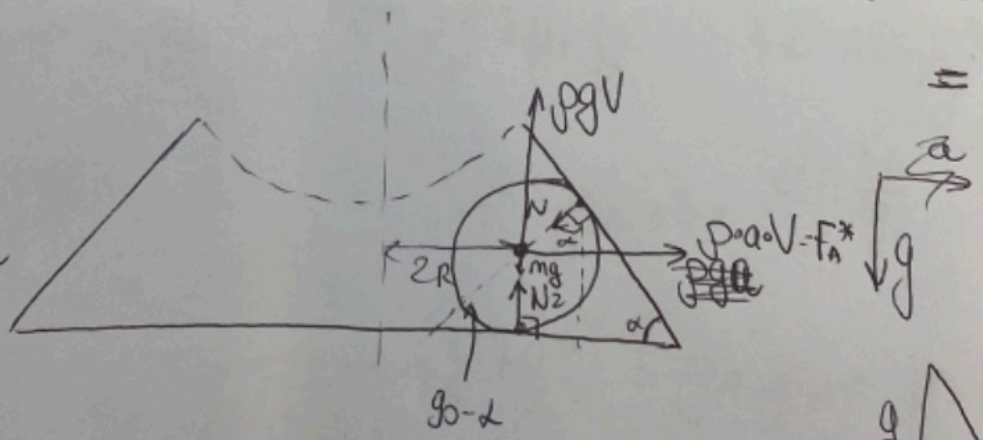
$N_1 + F_A = mg$

$N_1 + \rho g V = 3\rho \cdot V \cdot g$

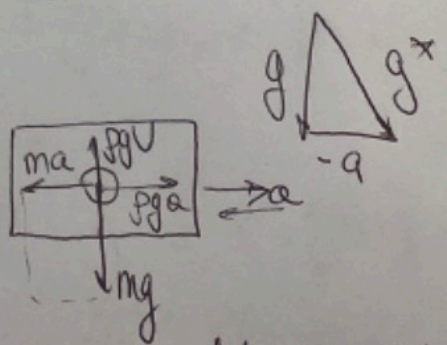


$N_1 = 2\rho V g = 2\rho g \cdot \frac{4}{3}\pi R^3 =$

$= \frac{8\rho g \pi R^3}{3}$



$a = \omega^2 \cdot 2R$



$$\begin{cases} \rho g V + N_2 = mg + N\cos\alpha \\ \rho a V = N \sin\alpha \end{cases}$$

$N_2 = 2\rho g V + \frac{8\pi R^3 \rho g}{3} + \frac{8\pi R^4 \rho \omega^2}{3 \operatorname{tg}\alpha}$

$\rho g V + N_2 = mg + \frac{\rho a V \cdot \cos\alpha}{\sin\alpha}$

$N_2 = mg - \rho g V + \frac{\rho a V}{\operatorname{tg}\alpha}$

$N_2 = 3\rho g V - \rho g V + \frac{2\rho V R \omega^2}{\operatorname{tg}\alpha}$

Часть 2

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

Шифр: **21205257**

ID профиля: **284712**

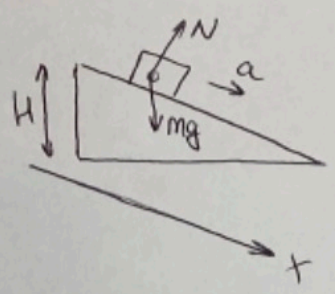
Вариант 1

Условие

№4

$H, m, \cos\alpha = \frac{4}{5}$, $F = 2mg$

$t_1; a_к; t_2$



0) $\sin\alpha = \sqrt{1 - \frac{16}{25}} = \frac{3}{5}$

1) в случае, когда клин покоится: $\Pi_{3Н}$

$m\bar{a} = \bar{N} + m\bar{g}$

OX: $ma = mg\sin\alpha$

$a = g\cdot\sin\alpha = \frac{V}{t_1}$

(1)

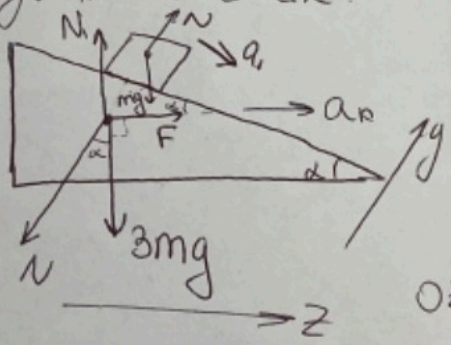
3) $t_1 = \frac{V}{g\sin\alpha} = \frac{\sqrt{2gH}}{g\sin\alpha} =$ 2) ЗСЭ:

$= \frac{5\sqrt{2gH}}{3g} = \sqrt{\frac{2H}{g}}\cdot\frac{5}{3}$

$mgH + 0 = \frac{mV^2}{2}$

$V = \sqrt{2gH}$

4) пусть клин движется с $a_к$:



~~для бруска~~:

- для шайбы: $\Pi_{3Н}$

OY: $N = mg\cos\alpha$

- для клина: $\Pi_{3Н}$

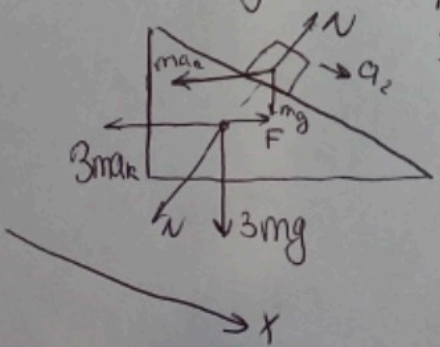
OZ: $3m\cdot a_к = F - N\sin\alpha$

$3ma_к = 2mg - mg\sin\alpha\cos\alpha$

$a_к = \frac{g(2 - \frac{12}{25})}{3} = \frac{38g}{75}$

5) Перейдем в НеИСО клина: для подсчета t_2:

$\Pi_{3Н}$ для шайбы:



OX: $ma_2 = mg\sin\alpha - ma_к\cos\alpha$

$a_2 = g\left(\frac{3}{5} - \frac{38}{75}\cdot\frac{4}{5}\right)$

$a_2 = g\left(\sin\alpha - \frac{\cos\alpha\cdot(2 - \sin\alpha\cos\alpha)}{3}\right)$

6) $a_2 = \frac{V}{t_2} = \frac{\sqrt{2gH}}{t_2} \Rightarrow t_2 = \frac{\sqrt{2gH}}{a_2} = \sqrt{\frac{2H}{g}}\cdot\left(\frac{3\sin\alpha - 2\cos\alpha + \sin\alpha\cos^2\alpha}{3}\right)^{-1}$

$= \left(\frac{375}{73}\sqrt{\frac{2H}{g}}\right)$

Ответ. $t_1 = \frac{\sqrt{2gH}}{g\sin\alpha} = \sqrt{\frac{2H}{g}}\cdot\frac{5}{3}$; $a_к = \frac{g(2 - \sin\alpha\cos\alpha)}{3} = \frac{38g}{75}$; $t_2 = \frac{3\sqrt{\frac{2H}{g}}}{3\sin\alpha - 2\cos\alpha + \sin\alpha\cdot\cos^2\alpha} = \frac{375}{73}\sqrt{\frac{2H}{g}} \approx \sqrt{\frac{2H}{g}}\cdot 5{,}14$

Чистовик

№5

$\Delta P = 0{,}02P$

$\Delta V = -0{,}01V$

1) $\frac{\Delta T}{T}$ - ?

2) $\frac{\Delta Q}{\Delta A}$ - ?

(2)

1) Из ур-е сост. ид. газа:

$$\begin{cases} PV = \nu RT \\ (P+\Delta P)(V+\Delta V) = \nu R(T+\Delta T) \end{cases}$$

$$\begin{cases} PV + \Delta PV + \Delta VP + \Delta P\Delta V = \nu RT + \nu R\Delta T \\ PV = \nu RT \end{cases}$$

$$\Delta PV + \Delta VP + \Delta P\Delta V = \nu R\Delta T \quad | : PV$$

$$\frac{\Delta P}{P} + \frac{\Delta V}{V} + \frac{\Delta P\Delta V}{PV} = \frac{\nu R\Delta T}{PV} = \frac{\Delta T}{T}$$

$\frac{\Delta P}{P} \cdot \frac{\Delta V}{V} \to 0$ - малы по сравнению с $\frac{\Delta P}{P}; \frac{\Delta V}{V}$ ⇒

$$\frac{\Delta P}{P} + \frac{\Delta V}{V} = \frac{\Delta T}{T}$$

$\frac{\Delta T}{T} = 0{,}02 - 0{,}01 = 0{,}01 \Rightarrow T \nearrow$ на 1%

2) I начало термодинамики:

$$\Delta Q = \frac{3}{2}\nu R\Delta T + \Delta A \quad | : \Delta A$$

$$\frac{\Delta Q}{\Delta A} = 1 + \frac{3\nu R\Delta T}{2\Delta A} = 1 + \frac{3\frac{\Delta T}{T}PV}{2\Delta A}$$

$$\Delta A = \Delta(P \cdot V) = \Delta P \cdot V + \Delta V \cdot P = 0{,}01\, P \cdot V$$

$$\frac{\Delta Q}{\Delta A} = 1 + \frac{3 \cdot 0{,}01PV}{2 \cdot 0{,}01PV} = \frac{5}{2} = 2{,}5$$

Ответ. 1) $\frac{\Delta T}{T} \nearrow 1\%$

2) $\frac{\Delta Q}{\Delta A} = 2{,}5$

N5 Горковик

P ↗ 2%
V ↘ 1%

$\frac{\Delta P}{P} + \frac{\Delta V}{V} = \frac{\Delta T}{T}$ ||

$PV = \nu RT$

$(P+\Delta P)(V-\Delta V) = \nu R(T+\Delta T)$

$\Delta P = P$
$\Delta V = V$

$\Delta PV - P\Delta V - \Delta V\Delta P = \nu R\Delta T$

νR

$Q = \frac{3}{2}\nu R\Delta T + 2pV$

$\Delta PV + P\Delta V = \nu R\Delta T \quad | : PV$

$\nu R\Delta T = P_2V_2 - P_1V_1 = 3pV$

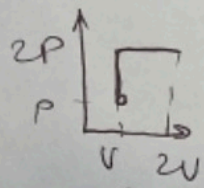
$\frac{\Delta P}{P} - \frac{\Delta V}{V} = \frac{\nu R\Delta T}{PV} = \frac{\Delta T}{T}$

$\frac{3}{2} \cdot \frac{\Delta A + \Delta P\Delta V}{\Delta A} \frac{Q}{\Delta A} - ?$

$\frac{\nu R\Delta T}{\Delta A} = 1$

$\frac{0,02P}{P} - \frac{0,01V}{V} = k$

$\Delta P\Delta V = PV \frac{\Delta}{\Delta A}$
$0,0002V \frac{\Delta}{\Delta A}$

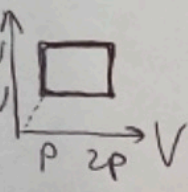


$k = 0,01$
↗ 1%

$dQ = \nu R d$

$\Delta Q = \frac{3}{2}\nu R\Delta T + \Delta(PV)\frac{3}{2} \quad 2P \cdot 2V - PV) + P$

$2pV = Q$



$3\sin\alpha\cos\beta + 3\sin\alpha - 2\sin\beta\cos\beta - 2\cos\beta = \frac{\Delta Q}{\Delta A} = 1 + \frac{3\nu R\Delta T}{2(\Delta PV + \Delta VP)} = \frac{5}{2}$

$= 3\sin\alpha(\cos\beta + 1) - 2\cos\beta(\sin\alpha + 1)$

$\nu R\Delta T$

$\frac{152}{375} = \frac{75 \cdot 3}{375} = \frac{225}{375}$

$\frac{9pV}{2} + 2pV = Q$

$5,5$

$\frac{73}{375}g = \frac{\sqrt{2gH}}{t_2}$ $\Delta P = 4V$ $\Delta PV + \Delta VP = 0,02PV + 0,01PV = 0,01PV$

$\Delta V = -0,5V$

$t_2 = \frac{375}{73}\sqrt{\frac{2H}{g}}$ $4P \cdot \frac{V}{2} = PV + \nu R\frac{\Delta T}{T}PV$ $\nu R\Delta T = \frac{PV}{T}\Delta T = 0,01PV$

$\Delta T = T$ $\frac{1}{4} + \frac{48}{125} = \frac{73}{125}$

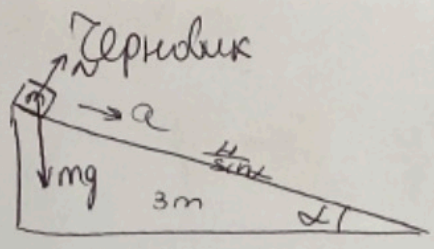
$P\frac{\Delta T}{T} = 1$ $1,02P \cdot 0,99V = \nu RT(1+k)$

$\frac{3\nu RT}{2(2PV - PV)}$ $1,02 \cdot 0,99 - 1 = k$

№4

$\cos\alpha = \frac{4}{5}$

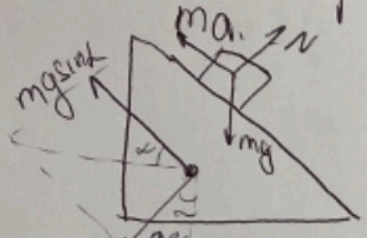
H, m



$a_1 = g\sin\alpha - \cos\alpha \cdot \frac{3}{5} g$

$a_1 = g\left(\frac{3}{5} - 1 \cdot \frac{4}{5} \cdot \frac{3}{5}\right)$

$a_1 = 0{,}195g$



$ma_1 = mg\sin\alpha$

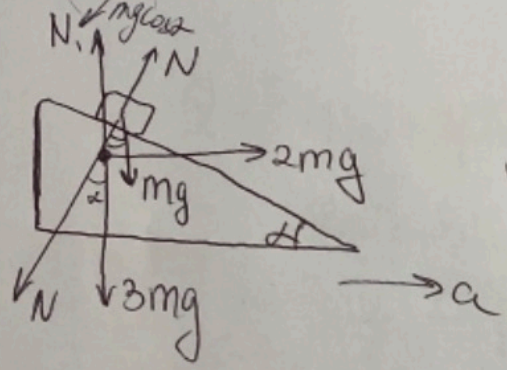
$a = V \quad \frac{H}{\sin\alpha} = \frac{V^2}{2a} = \frac{V^2}{2g\sin\alpha}$

$V^2 = 2gH$

$V^2 = 2gH$

$V = 0 + at \Rightarrow a^2t^2 = 2gH$

$t = \frac{\sqrt{2gH}}{a} = \sqrt{\frac{2H}{g\sin\alpha}}$



$g^2\sin\gamma t^2 = 2gH$

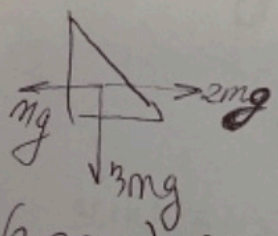
$g\sqrt{\quad}$

$g(1-\cos\gamma)t^2 = 2H$

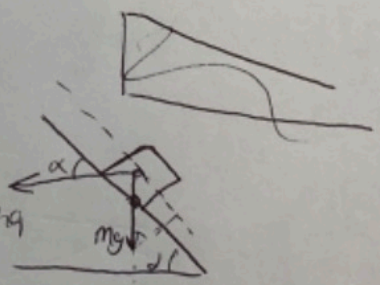
$t = \sqrt{\frac{2H}{g(1-\cos\gamma)}}$

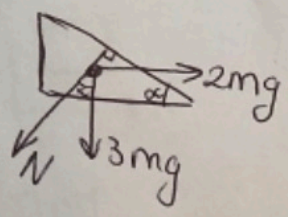
~~N cos α = 2mg~~

~~N sin α = 2mg~~



$N = mg\cos\alpha$





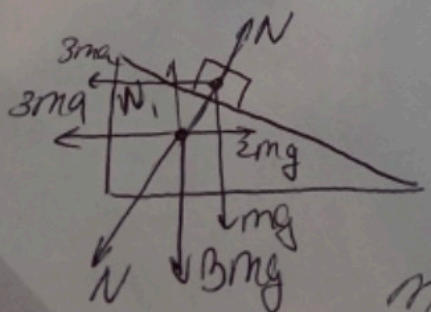
~~(3m + m)a = 2mg - N sin α~~

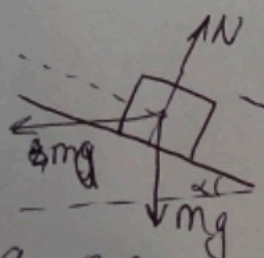
~~2mg = 4ma~~ или $3ma = 2mg - mg\sin\alpha\cos\alpha$

$a = \frac{g}{2}$

$a = \frac{g\left(2 - \frac{4}{5}\cdot\frac{3}{5}\right)}{3} = \frac{g\left(2 - \frac{12}{25}\right)}{3} =$

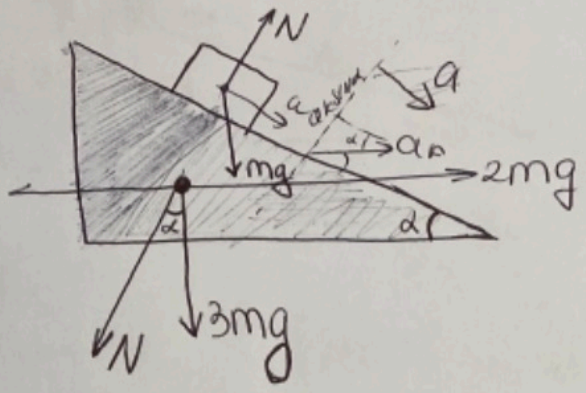
$= \frac{50 - 12}{75} g = \frac{38}{75} g$

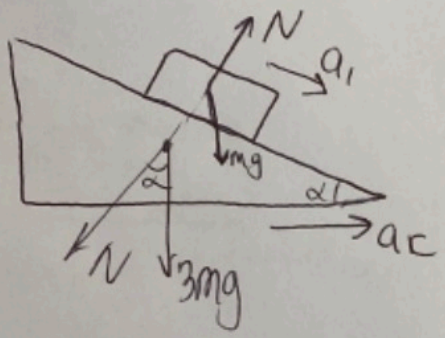


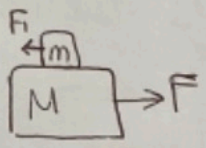


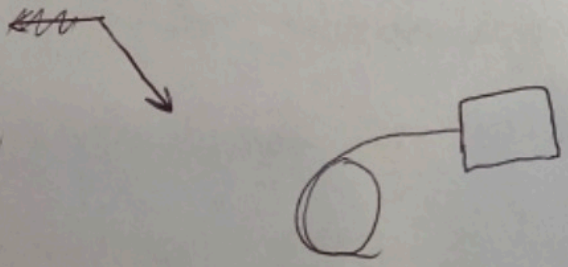
$ma_1 = mg\sin\alpha - 3mg\cos\alpha$

Черновик







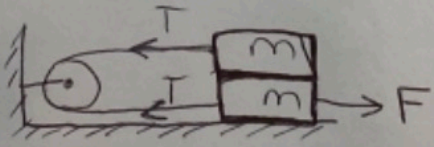


$F = Ma$

$F_1 = ma_1$

~~$F - F_1 = M_1 m$~~

$(F - F_1) = (M+m)a_1$



$ma = T$

$ma = F - T$

$2ma = F - T$

$2T = F$

$2T = F - T$

$a = \frac{F}{2m}$

$F = 3T$

$a = \frac{2F}{3m}$

$a =$