Часть 1

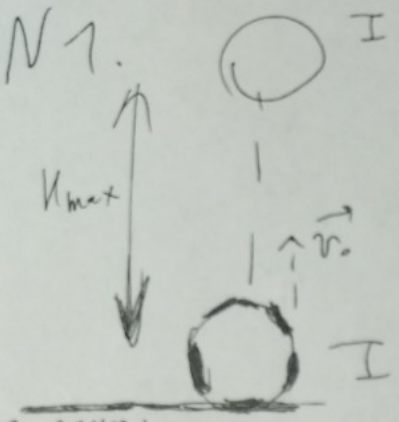
Олимпиада: **Физика, 10 класс (1 часть)**

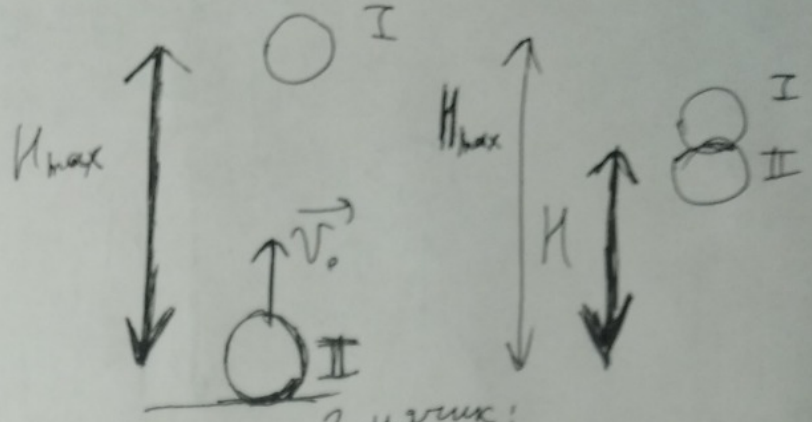
Шифр: **21205665**

ID профиля: **282812**

Вариант 1

№1.





1 мячик:

$0 = v_0 - g\tau_{Hmax}$

$H_{max} = v_0\tau_{Hmax} - \frac{g\tau_{Hmax}^2}{2}$

$\tau_{Hmax} = \frac{v_0}{g}$

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

2 мячик:

$H = v_0\tau_{II} - \frac{g\tau_{II}^2}{2}$

$\begin{cases} H = v_0\tau_{II} - \frac{g\tau_{II}^2}{2} \\ H = H_{max} - \frac{g\tau_{II}^2}{2} \end{cases} \Rightarrow$

$H = H_{max} - \frac{g\tau_{II}^2}{2}$

$\Rightarrow v_0\tau_{II} = H_{max} = \frac{v_0^2}{2g}$

$\tau_{II} = \frac{v_0}{2g}$

$H = \frac{v_0^2}{2g} - \frac{v_0^2}{8g} = \frac{3v_0^2}{8g} \Rightarrow v_0^2 = \frac{8gH}{3} \Rightarrow v_0 = \sqrt{\frac{8gH}{3}} \approx$

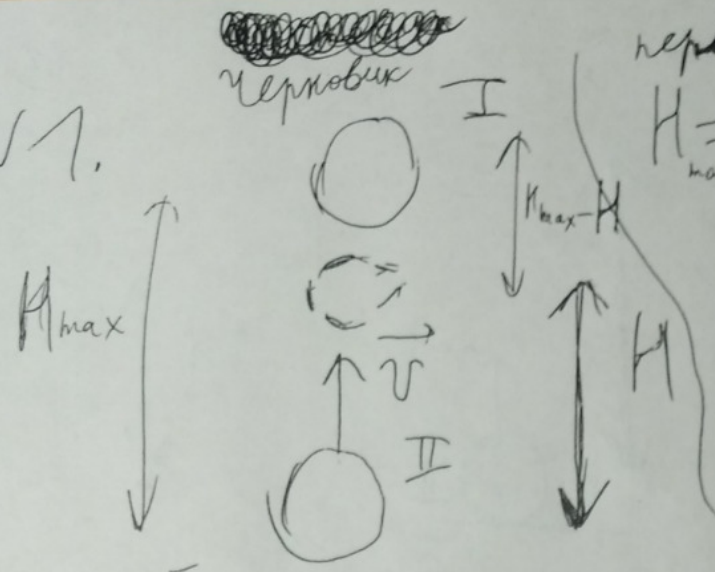
$\approx 1{,}63\sqrt{gH}$

$\tau_{II} = \frac{v_0}{2g} = \frac{\sqrt{\frac{8gH}{3}}}{2g} = \frac{\sqrt{8gH}}{2\sqrt{3}g} = \sqrt{\frac{8H}{12g}} = \sqrt{\frac{2H}{3g}} \approx$

$\approx 0{,}82\sqrt{\frac{H}{g}}$

N 1.

а)



Первый мячик:

$$H_{max} = v_0 \tau_{H max} - \frac{g\tau_{H max}^2}{2}$$

$$0 = v_0 - g\tau_{H max}$$

$$v_0 = g\tau_{H max}$$

$$\tau_{H max} = \frac{v}{g}$$

$$H_{max} = \frac{v^2}{g} - \frac{v^2}{2g} = \frac{v^2}{2g}$$

$$v_0 = \sqrt{2gH_{max}}$$

Второй мячик:

$$H = v_0 \tau_{пол} - \frac{g\tau_{пол}^2}{2}$$

$$H = \sqrt{2gH}\,\tau_{пол} - \frac{g\tau_{пол}^2}{2} \quad | \cdot 2$$

$$2H = 2\sqrt{2gH}\,\tau_{пол} - g\tau_{пол}^2$$

$$g\tau_{пол}^2 - 2\sqrt{2gH}\,\tau_{пол} + 2H = 0$$

$$D = 4 \cdot 2gH - 4 \cdot g \cdot 2H = 8gH - 8gH = 0$$

$$\tau_{пол} = \frac{8\sqrt{2gH}}{8g} = \frac{\sqrt{2gH}}{g}$$

б) $v_0 = \sqrt{2gH}$

в) $L = H_{max} + (H_{max} - H) = 2H_{max} - H$

Чистовик

(2)

$$L = H_{max} + (H_{max} - H) = 2H_{max} - H =$$

$$= 2 \cdot \frac{v_0^2}{2g} - H = \frac{v_0^2}{g} - H = \frac{\frac{8gH}{3}}{g} - H =$$

$$= \frac{8H}{3} - H = \frac{8H - 3H}{3} = \frac{5H}{3} = \frac{5}{3}H \approx 1{,}67H$$

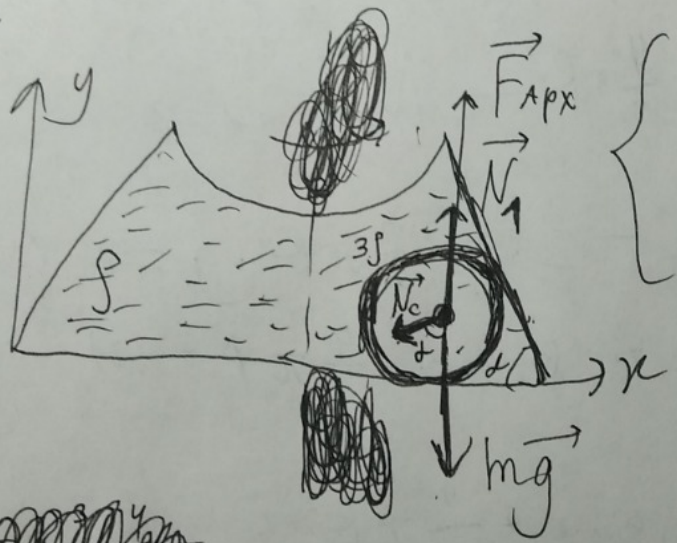
Ответ: 1) $\tau_{II} \approx 0{,}82\sqrt{\frac{H}{g}}$;

2) $v_0 \approx 1{,}63\sqrt{gH}$;

3) $L \approx 1{,}67H$.

N2.

1)



$$\begin{cases} y: F_{Apx} + N_1 - mg - \\ - N_C \cos\alpha = 0 \\ x: -N_C \sin\alpha = 0 \end{cases}$$

$$\Downarrow$$

$$N_C = 0$$

$$F_{Apx} + N_1 - mg = 0$$

$$\rho \cdot g \cdot \frac{4}{3}\pi R^3 + N_1 - 3\rho \cdot \frac{4}{3}\pi R^3 g = 0$$

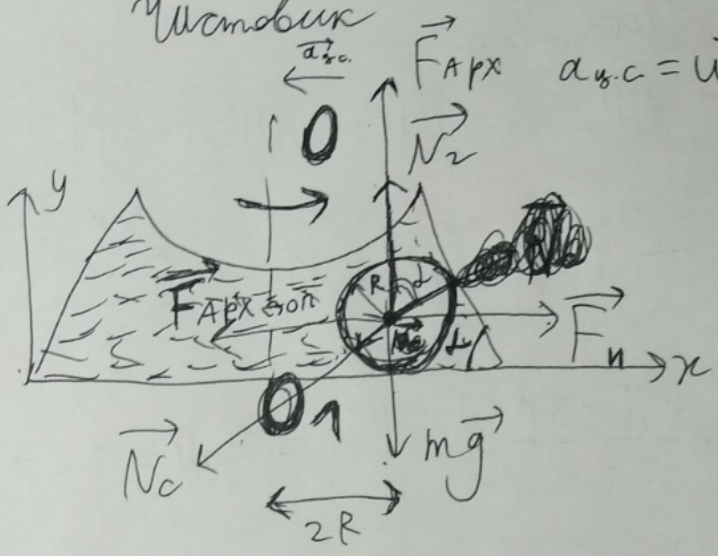
$$N_1 = 4\rho\pi R^3 g - \frac{4}{3}\rho\pi R^3 g =$$

$$= \rho\pi R^3 g\left(4 - \frac{4}{3}\right) = \rho\pi R^3 g \cdot 2\frac{2}{3} = 2\frac{2}{3}\rho\pi R^3 g \approx$$

$$\approx 2{,}67\rho\pi R^3 g$$

③

2)



$a_{ц.с} = \omega^2 \cdot 2R$

$$\begin{cases} y: F_{Apx} + N_2 - N_c\cos\alpha - mg = 0 \\ x: F_н - F_{Apx\,вод} - N_c\sin\alpha = 0 \end{cases}$$

$$\begin{cases} y: \rho g \cdot \frac{4}{3}\pi R^3 + N_2 - N_c\cos\alpha - 3\rho \cdot \frac{4}{3}\pi R^3 \cdot g = 0 \\ x: m a_{ц.с} - \rho \cdot \frac{4}{3}\pi R^3 - N_c\sin\alpha = 0 \end{cases}$$

$$\begin{cases} N_c\cos\alpha = N_2 - 2\cdot\rho\cdot\frac{4}{3}\pi R^3 \cdot g = 0 \quad (1) \\ N_c\sin\alpha = m a_{ц.с.} - \rho a_{ц.с.} \cdot \frac{4}{3}\pi R^3 \quad (2) \end{cases}$$

(2) ÷ (1)

$$tg\alpha = \frac{m a_{ц.с.} - \rho a_{ц.с.} \cdot \frac{4}{3}\pi R^3}{N_2 - \frac{8}{3}\rho\pi R^3 g} = 2$$

$$m a_{ц.с.} - \rho a_{ц.с.} \cdot \frac{4}{3}\pi R^3 = 2N_2 - \frac{16}{3}\rho\pi R^3 g$$

$$m\omega^2 \cdot 2R - \rho \cdot \omega^2 \cdot 2R \cdot \frac{4}{3}\pi R^3 = 2N_2 - \frac{16}{3}\rho\pi R^3 g \quad /\cdot 3$$

$$6 m\omega^2 R - 8\rho\omega^2\pi R^4 = 6N_2 - 16\rho\pi R^3 g$$

Участник (4)

$6N_2 = 6m\omega^2 R - 8\rho\omega^2\pi R^4 + 16\rho\pi R^3 g \;|:6$

$N_2 = m\omega^2 R - \frac{4}{3}\rho\omega^2\pi R^4 + \frac{8}{3}\rho\pi R^3 g$

$N_2 = \frac{1}{3}\rho\cdot\frac{4}{3}\pi R^3\omega^2 R - \frac{4}{3}\rho\omega^2\pi R^4 + \frac{8}{3}\rho\pi R^3 g$

$N_2 = 4\rho\pi\omega^2 R^4 - \frac{4}{3}\rho\omega^2\pi R^4 + \frac{8}{3}\rho\pi R^3 g =$

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

$= \frac{8}{3}\rho\pi R^3(\omega^2 R + g) \approx 2{,}67\rho\pi R^3(\omega^2 R + g)$

Ответ: $N_1 \approx 2{,}67\rho\pi R^3 g$;

$N_2 \approx 2{,}67\rho\pi R^3(\omega^2 R + g)$.

N3

$V \downarrow 3{,}5\,л$

$p \uparrow 1{,}8\,л$

$p_{нас.пар} = 0{,}5\cdot 10^5\,Па$

1)

$T = 87^\circ C$

$m = 3г$

$\mu = 18\,г/моль$

$$\begin{cases} p_{нач}\cdot V_{нач} = \frac{m}{\mu}RT \quad (1) \\ (p_{парциальное} + p_{нас.пара})\cdot V_{кон} = \frac{m}{\mu}RT \quad (2) \end{cases}$$

Чистовик (5)

(2) ÷ (1)

$$\frac{(p_{\text{пар конечн}} + p_{\text{нас. пара}}) \cdot V_{\text{кон}}}{p_{\text{нач}} \cdot V_{\text{нач}}} = 1$$

$$\frac{p_{\text{пар конечн}} + p_{\text{нас. пара}}}{3{,}5\, p_{\text{нач}}} = 1$$

$$\frac{p_{\text{пар конечн}}}{3{,}5\, p_{\text{нач}}} = 1{,}8$$

$$1{,}8 + \frac{p_{\text{нас. пара}}}{3{,}5\, p_{\text{нач}}} = 1$$

$$\frac{1{,}8}{3{,}5} + \frac{p_{\text{нас. пара}}}{3{,}5\, p_{\text{нач}}} = 1 \quad | \cdot 3{,}5\, p_{\text{нач}}$$

$$1{,}8\, p_{\text{нач}} + p_{\text{нас. пара}} = 3{,}5\, p_{\text{нач}}$$

$$p_{\text{нас. пара}} = 1{,}7\, p_{\text{нач}}$$

$$p_{\text{нач}} = \frac{p_{\text{нас. пара}}}{1{,}7} = \frac{0{,}5 \cdot 10^5 \text{ Па}}{1{,}7} =$$

$$= 2{,}94 \cdot 1{,}1{,}76 \text{ Па} \approx 2{,}9 \cdot 10^4 \text{ Па} \approx 29 \text{ кПа}$$

2) $$V_{\text{кон}} = \frac{\frac{m}{\mu} RT}{p_{\text{пар конечн}} + p_{\text{нас. пара}}} = \frac{mRT}{\mu(p_{\text{пар конечн}} + p_{\text{нас. пара}})} = \frac{mRT}{\mu(1{,}8\, p_{\text{нач}} + p_{\text{нас. пара}})} =$$

$$= \frac{0{,}003 \text{ кг} \cdot 8{,}31 \frac{\text{Дж}}{\text{моль} \cdot \text{К}} \cdot 354 \text{ К}}{0{,}018 \frac{\text{кг}}{\text{моль}} \cdot (1{,}8 \cdot 29 \cdot 10^3 \text{ Па} + 0{,}5 \cdot 10^5 \text{ Па})} \approx$$

Чистовик

6

≈ [redacted] 4,8 л

Ответ: $p_{нач} \approx 29$ кПа;

$V_{кон} \approx 4,8$ л.

Часть 2

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

Шифр: **21205665**

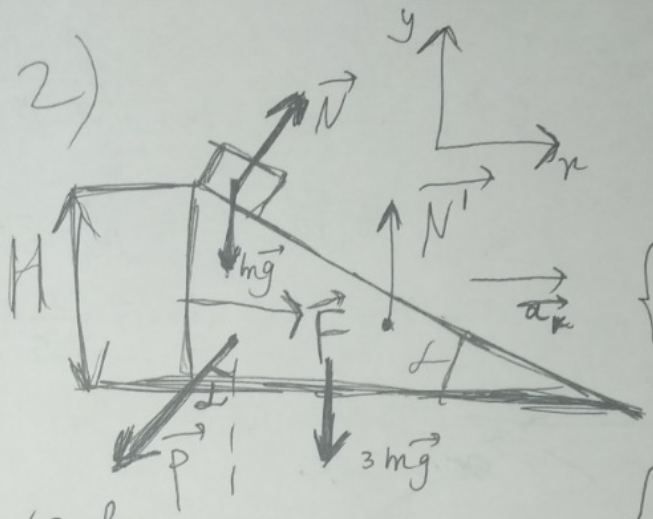
ID профиля: **282812**

Вариант 1

Черновик

1

2)



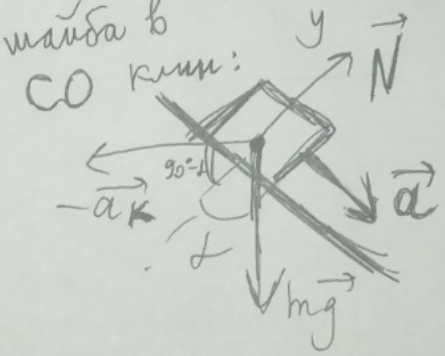
клин:

$$\vec{N'} + 3m\vec{g} + \vec{P} + \vec{F} = 3m\vec{a}_к$$

$$\begin{cases} y: N' - 3mg - P\cos\alpha = 0 \\ x: -P\sin\alpha + F = 3ma_к \end{cases}$$

$$\begin{cases} N' - 3mg - N\cos\alpha = 0 \\ -N\sin\alpha + 2mg = 3ma_к \end{cases}$$

шайба в СО клин:



$$y: N - mg\cos\alpha = -a_к\cos(90° - \alpha) = -a_к\sin\alpha$$

$$\begin{cases} -N\sin\alpha + 2mg = 3ma_к \\ N - mg\cos\alpha = -ma_к\sin\alpha \end{cases}$$

$$N = mg\cos\alpha - ma_к\sin\alpha$$

$$-(mg\cos\alpha - ma_к\sin\alpha)\sin\alpha + 2mg = 3ma_к$$

$$(-(g\cos\alpha - a_к\sin\alpha)\cdot\sin\alpha + 2g = 3a_к$$

$$-g\cos\alpha\sin\alpha + a_к\sin^2\alpha + 2g = 3a_к$$

$$a_к(3 - \sin^2\alpha) = g(2 - \cos\alpha\sin\alpha)$$

$$a_к = \frac{g\left(2 - \frac{4}{5}\cdot\frac{3}{5}\right)}{3 - \frac{9}{25}} = \frac{g\left(2 - \frac{12}{25}\right)}{\frac{75-9}{25}} = \frac{g\cdot\left(\frac{50-12}{25}\right)}{\frac{66}{25}} =$$

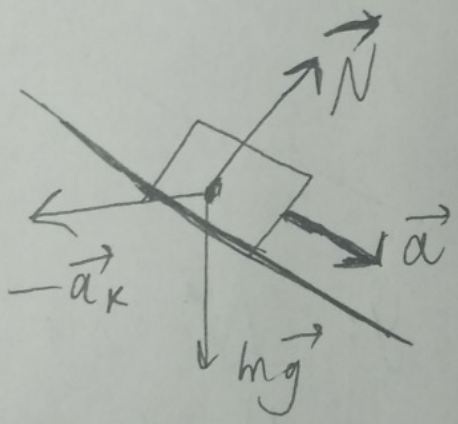
[redacted] Черных

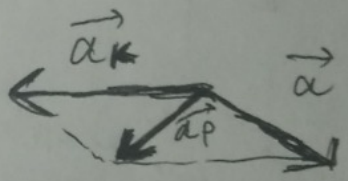
2

$$= \frac{g \cdot \frac{38}{25}}{\frac{66}{25}} = \frac{38g}{66} \approx 0{,}58g$$

3)

шайба в СО клин:





Чистовик (1)

N4

1)

$\cos\alpha = \frac{4}{5} \Rightarrow \sin\alpha = \sqrt{1-\left(\frac{4}{5}\right)^2} = \sqrt{1-\frac{16}{25}} = \sqrt{\frac{9}{25}} = \frac{3}{5}$

$\sin^2\alpha = \frac{9}{25}$

$\sin\alpha = \frac{H}{L} \Rightarrow L = \frac{H}{\sin\alpha} = \frac{H}{\frac{3}{5}} = \frac{5H}{3}$

$x: mg\cos(90^\circ - \alpha) = ma$

$g\sin\alpha = a$

$g \cdot \frac{3}{5} = a \Rightarrow a = \frac{3}{5}g = 0{,}6g$

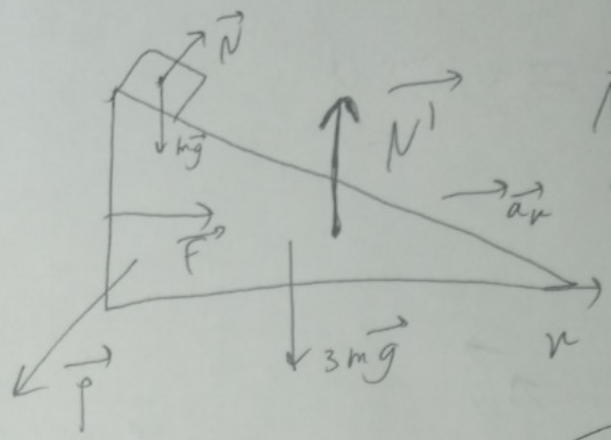
$L = 0 + \frac{a\tau^2}{2} = \frac{a\tau^2}{2} \Rightarrow \tau^2 = \frac{2L}{a} \Rightarrow$

$\Rightarrow \tau = \sqrt{\frac{2L}{a}} = \sqrt{\frac{2 \cdot \frac{5H}{3}}{a}} = \sqrt{\frac{10H}{3a}} \approx 1{,}8\sqrt{\frac{H}{a}} \approx$

$\approx 1{,}8\sqrt{\frac{H}{0{,}6g}} \approx 2{,}3\sqrt{\frac{H}{g}}$

Чистовик

(2)

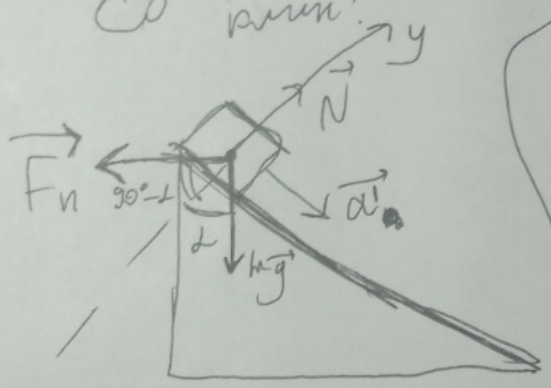


кли:

$\vec{N'} + 3m\vec{g} + \vec{P} + \vec{F} = 3m\vec{a}_к$

x: $-N\sin\alpha + 2mg = 3ma_к$

со кли:



y: $N - mg\cos\alpha - F_п\cos(90° - \alpha) = 0$

$N - mg\cos\alpha - ma_к\sin\alpha = 0$

$N = mg\cos\alpha + ma_к\sin\alpha =$

$= mg \cdot \frac{4}{5} + ma_к \cdot \frac{3}{5} =$

$= \frac{1}{5}m(4g + 3a_к)$

$-\frac{1}{5}m(4g + 3a_к)\sin\alpha + 2mg = 3ma_к$

$-\frac{4}{5}g\sin\alpha - \frac{3}{5}a_к\sin\alpha + 2g = 3a_к$

$\left(-\frac{4}{5}g\right) \cdot \frac{3}{5} - \frac{3}{5}a_к \cdot \frac{3}{5} + 2g = 3a_к$

Чистовик (3)

$$-\frac{12}{25}g - \frac{9}{25}a_к + 2g = 3a_к$$

$$a_к\left(3 + \frac{9}{25}\right) = g\left(2 - \frac{12}{25}\right)$$

$$a_к\left(\frac{75+9}{25}\right) = g\left(\frac{50-12}{25}\right)$$

$$a_к \cdot \frac{84}{25} = g \cdot \frac{38}{25}$$

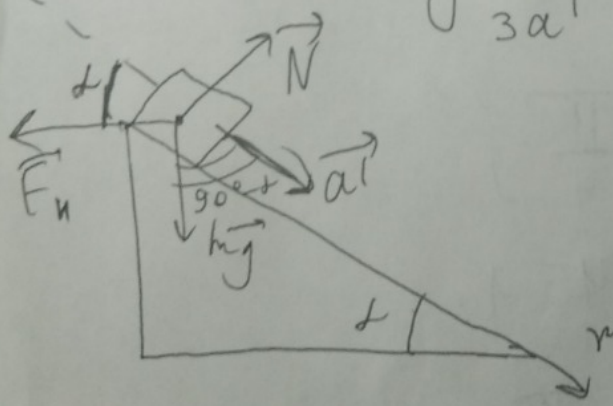
$$84a_к = 38g$$

$$a_к = \frac{38g}{84} \approx 0{,}45g$$

3) $L = \frac{a'(\tau')^2}{2} = \frac{5H}{3}$

$3a'(\tau')^2 = 10H$

$\tau' = \sqrt{\frac{10H}{3a'}}$



$x: -F_н \cdot \cos\alpha + mg\cos(90° - \alpha) = ma'$

$-ma_к\cos\alpha + mg\sin\alpha = ma'$

$\left(-\frac{19g}{42}\right)\cdot\cos\alpha + g\sin\alpha = a' \quad | \cdot 42$

$-19g\cos\alpha + 42g\sin\alpha = 42a'$

Чистовик

(4)

$(-19g)\cdot\frac{4}{5}+42g\cdot\frac{3}{5}=42a' \quad |\cdot 5$

$-76g+126g=210a' \quad |:2$

$-38g+63g=105a'$

$105a'=25g$

$a'=\frac{25g}{105}=\frac{5g}{21}$

$\tau'=\sqrt{\frac{10H}{3a'}}=\sqrt{\frac{10H}{3\cdot\left(\frac{5g}{21}\right)}}=\sqrt{\frac{10H}{\frac{5g}{7}}}=$

$=\sqrt{\frac{70H}{5g}}=\sqrt{\frac{14H}{g}}\approx 3{,}7\sqrt{\frac{H}{g}}$

Ответ: 1) $\tau\approx 3{,}3\sqrt{\frac{H}{g}}$;

2) $a_к\approx 9{,}45g$;

3) $\tau'\approx 3{,}7\sqrt{\frac{H}{g}}$.

N5 Участник (5)

1) $\begin{cases} p_1V_1 = \nu R T_1 \\ p_2V_2 = \nu R T_2 \end{cases}$ $\quad \frac{p_1V_1}{p_2V_2} = \frac{T_1}{T_2}$

$p_2 = 1{,}02\,p_1 \Rightarrow \frac{p_1}{p_2} = \frac{1}{1{,}02}$

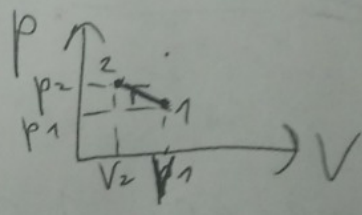
$V_2 = 0{,}99\,V_1 \Rightarrow \frac{V_1}{V_2} = \frac{1}{0{,}99}$

$\frac{1}{1{,}02} \cdot \frac{1}{0{,}99} = \frac{T_1}{T_2}$

$\frac{T_1}{T_2} = \frac{1}{1{,}02 \cdot 0{,}99} \approx 0{,}99 \Rightarrow T_2 \approx \frac{T_1}{0{,}99} \approx$

$\approx 1{,}01\,T_1 \Rightarrow T$ увеличилась на 1%

2) $\frac{Q}{A} = ?$



$Q = \Delta U + A = \frac{3}{2}\nu R T_2 - \frac{3}{2}\nu R T_1 +$

$+ \frac{p_2 + p_1}{2} \cdot (V_1 - V_2) = \frac{3}{2} p_2V_2 - \frac{3}{2} p_1V_1 +$

$+ \frac{p_2 + p_1}{2} \cdot (V_1 - V_2)$

~~Черновик~~ Чистовик (6)

$= \frac{3}{2} \cdot 1{,}02 p_1 \cdot 0{,}99 V_1 - \frac{3}{2} p_1 V_1 +$

$+ \frac{1{,}02 p_1 + p_1}{2} \cdot (V_1 - 0{,}99 V_1) =$

$= 1{,}5147 p_1 V_1 - 1{,}5 p_1 V_1 +$

$+ \frac{2{,}02 p_1}{2} \cdot 0{,}01 V_1 = 0{,}0147 p_1 V_1 +$

$+ 1{,}01 p_1 \cdot 0{,}01 V_1 = 0{,}0147 p_1 V_1 +$

$+ 0{,}0101 p_1 V_1 = 0{,}0248 p_1 V_1$

$A = \frac{p_2 + p_1}{2} \cdot (V_1 - V_2) =$

$= 1{,}01 p_1 \cdot 0{,}01 V_1 = 0{,}0101 p_1 V_1$

$\frac{Q}{A} = \frac{0{,}0248 p_1 V_1}{0{,}0101 p_1 V_1} = \frac{0{,}0248}{0{,}0101} \approx 2{,}46$

Ответ: 1) увеличится на 1%;
2) $\frac{Q}{A} \approx 2{,}46$.