Часть 1

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

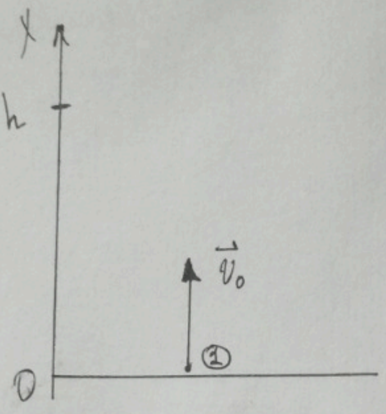
Шифр: **21205947**

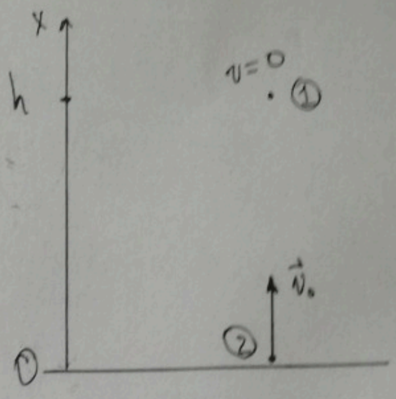
ID профиля: **281734**

Вариант 1

Чистовик

№1





$$x(t) = x_0 + v_{0x} t - g\frac{t^2}{2}$$

$$x_0 = 0$$

$$v_{0x} = v_0$$

$$x(t) = v_0 t - g\frac{t^2}{2}$$

Пусть максимальная высота равна h, тогда

$v_0 = \sqrt{2gh}$ (из закона сохранения энергии $m\frac{v_0^2}{2} = mgh$)

Перейдём в С.О. первого шара (①):

$$v_2 = v_0, \quad a_1 = a_2 = 0$$

$v_0 t_1 = h \Rightarrow t_1 = \frac{h}{v_0}$, t_1 - время от броска 2-го шара до столкновения

$$x_2(t) = v_0 t - g\frac{t^2}{2}$$

$$x_2(t_1) = H$$

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

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

$$v_0^2 = 2gh$$

$$H = h - g\frac{h^2}{2 \cdot 2gh} = h - \frac{h}{4} = \frac{3h}{4}$$

21205947 (U281734 M1281409)

Чистовик

$$h = \frac{4H}{3}$$

$$\cancel{v_0 = \sqrt{2gh} = 2\sqrt{\frac{2H}{3}g}}$$

$$v_0 = \sqrt{2gh} = 2\sqrt{\frac{2gH}{3}}$$

$$t_1 = \frac{h}{v_0} = \frac{4H}{3v_0} = \frac{4H}{3\cdot 2\cdot\sqrt{\frac{2gH}{3}}} = \frac{2H}{\sqrt{6gH}} = \cancel{\sqrt{\frac{2H}{3g}}}$$

$$t_1 = \sqrt{\frac{2H}{3g}}$$

$$L_1 = h + g\frac{t_1^2}{2} = \frac{4H}{3} + g\cdot\frac{h^2}{2v_0^2} = \frac{4H}{3} + g\cdot\frac{\frac{16}{9}H^2}{2\cdot 4\cdot\frac{2gH}{3}}$$

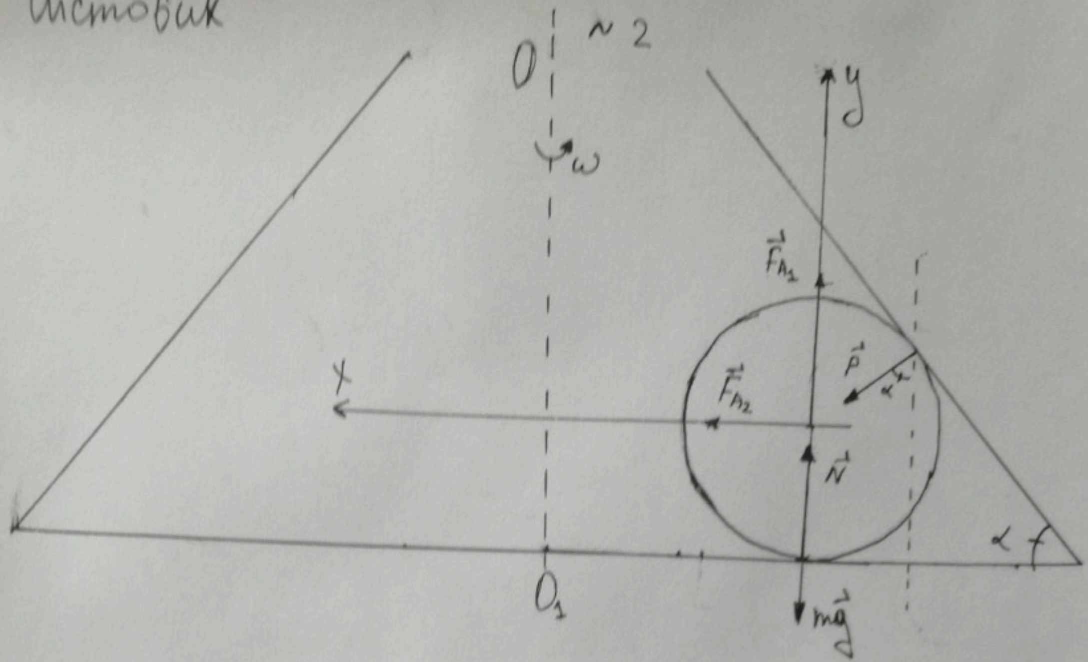
$$L_1 = \frac{5H}{3}$$

Ответ: $\sqrt{\frac{3H}{2g}}$; $2\sqrt{\frac{2gH}{3}}$; $\frac{5H}{3}$.

21205947 (U281734 M1281409)

Чистовик

№ 2



$$m\vec{a} = \vec{F}_{A_1} + \vec{F}_{A_2} + m\vec{g} + \vec{N} + \vec{P}, \quad m = 3\rho \cdot \frac{4\pi R^3}{3} = 4\pi R^3 \rho$$

~~Oy:~~ OX: $a_x = \omega^2 r = \omega^2 \cdot 2R$

$$ma_x = F_{A_2} + P\sin\alpha$$

$$2\omega^2 R \cdot 4\pi R^3 \rho = \rho V \cdot \omega^2 \cdot 2R + P\sin\alpha, \quad V = \frac{4\pi R^3}{3}$$

$\cancel{4\pi R^3 \rho =}$

$$8\pi R^4 \omega^2 \rho = \rho \cdot \frac{4\pi R^3}{3} \cdot \omega^2 \cdot 2R + P\sin\alpha$$

$$\frac{16\pi R^4 \cdot \omega^2 \rho}{3\sin\alpha} = P$$

Oy: $a_y = 0$

$$ma_y = 0$$

$$0 = F_{A_1} - mg + N - P\cdot\cos\alpha$$

$$N = mg + P\cos\alpha - F_{A_1}$$

$$N = 3\rho \cdot \frac{4\pi R^3}{3} g + \frac{16\pi R^4 \cdot \omega^2 \rho}{3\sin\alpha}\cos\alpha - \rho \cdot \frac{4\pi R^3}{3} g$$

$$N = \frac{8\pi R^3 \rho g}{3} + \frac{16\pi R^4 \omega^2 \rho}{3\,tg\alpha}$$

Чистовик

1) $\omega = 0$

$$N_1 = \frac{8\pi R^3 \cdot \rho g}{3} + \frac{16\pi R^4 \cdot 0 \cdot \rho}{3\,\mathrm{tg}\alpha} = \frac{8\pi R^3 \cdot \rho g}{3}$$

2) $\omega \neq 0$

$$N_2 = \frac{8\pi R^3 \cdot \rho g}{3} + \frac{16\pi R^4 \cdot \omega^2 \rho}{3\,\mathrm{tg}\alpha}$$

$$\mathrm{tg}\alpha = 2$$

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

Ответ: $\dfrac{8\pi R^3 \rho g}{3}$; $\dfrac{8\pi R^3 \rho (g + \omega^2 R)}{3}$.

№3 Чистовик

$pV = \nu RT$

$T = 81°C$, $T = const$

$p_0 V_0 = \nu_0 RT$

$p_1 = 1,8\, p_0$

$V_1 = \frac{1}{3,5} V_0$

$p_1 V_1 = \nu_1 RT$

$p_1 V_1 = \frac{18}{35} p_0 V_0$

$\nu_1 = \frac{18}{35} \nu_0$

$\Downarrow$

$\nu_0 \left(1 - \frac{18}{35}\right) = \frac{17}{35} \nu_0$ – часть пара, сконденсировавшая в жидкость

$\Downarrow$

оставшайся ~~газ (пар~~ пар (газ) - насыщеный

$p_1 = 0,5 \cdot 10^5$ Па

$p_1 V_1 = \frac{\frac{18}{35} m}{\mu} RT$

$V_1 = \frac{18 mRT}{35 p_1 \cdot \mu} = 0,005$ м^3

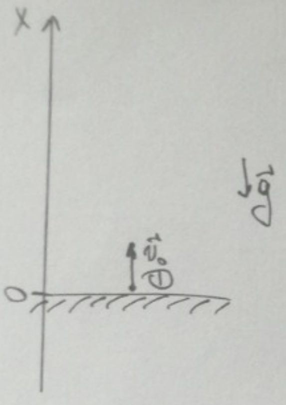
$p_0 = \frac{p_1}{1,8} \approx 2.7778$ Па

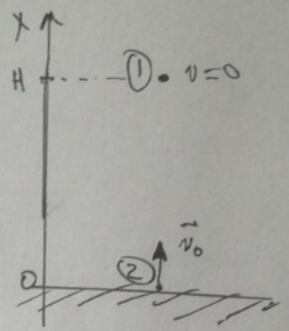
Ответ: ~~2,78~~ $2,78 \cdot 10^4$ Па ; $5 \cdot 10^{-3}$ м^3.

21205947 (U281734 M1281409)

Черновик

№1





$$x(t) = v_0 t - g\frac{t^2}{2}$$

$$x(\tau) = H$$

g

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

$$\frac{4H}{3} + g\cdot\frac{\cancel{x}9H^2}{3g\cdot 2\cancel{4}\cdot\frac{2gH}{3}} =$$

$$\dot{x} = 0$$

$$v_x = 0$$

$$v_x(t) = v_0 - gt$$

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

$$v_x(\tau) = 0$$

$$v_0 = g\tau$$

$$H = \frac{v_0^2}{2g} \Rightarrow v_0 = \sqrt{2gH}$$

В с.о. 1: скорость второго шарика v_0, ускорение шариков равны 0.

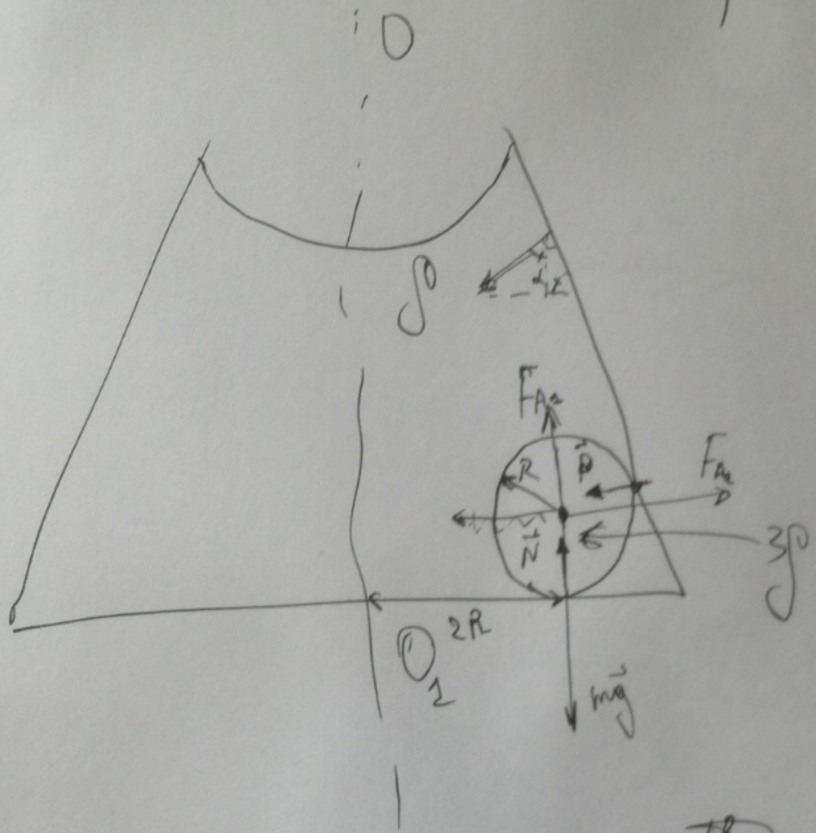
$v_0 t_1 = H$, t_1 – время от ~~начала~~ броска 2-го шара до столкновения

$$t_1 = \frac{H}{v_0} = \frac{H}{\sqrt{2gH}} = \sqrt{\frac{H}{2g}}$$

$$x_1(t_1) = H - g\frac{t_1^2}{2} = H - g\frac{H^2}{2v_0^2}$$

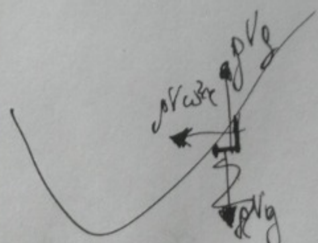
$$L_1 = H + \cancel{x}\,(H - x_1(t_1)) = H + g\frac{H^2}{2v_0^2}$$

Черновик



$\cancel{\frac{4\pi R^3\cdot\rho g}{3g}}$

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



$\cancel{\frac{4R}{3}\cdot 3\rho}\cdot$

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

$$= \frac{4\pi R^3}{3}\cdot\rho\cdot\omega^2 R + P\sin\alpha$$

$$\frac{4\pi R^3}{3}\cdot 2\rho\,\omega^2 R = P\cdot\sin\alpha$$

$$\frac{8\pi R^4\cdot\rho\omega^2}{3\sin\alpha} = \cancel{2}\cdot P$$

$$N = mg - \rho\cdot\frac{4\pi R^3}{3}g + P\cos\alpha$$

$$N = 2\rho\cdot\frac{4\pi R^3}{3}g + \frac{8\pi R^4\cdot\rho\omega^2}{3\,tg\alpha}$$

21205947 (U281734 M1281409)

Часть 2

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

Шифр: **21205947**

ID профиля: **281734**

Вариант 1

№5 Чистовик

$pV = \nu RT$

$p_0V_0 = \nu RT_0$

$p_1 = 1{,}02 p_0$

$V_1 = 0{,}99 V_0$

$p_1V_1 = \nu RT_1$

$$\frac{T_1}{T_0} = \frac{p_1V_1}{p_0V_0} = 1{,}02 \cdot 0{,}99 \approx 1{,}0098$$

$T_1 = 100{,}98\% \, T_0$

$T_1 \approx 101\% \, T_0$

б.

$$Q = \Delta U + A$$

$$\frac{Q}{A} = \frac{\Delta U + A}{A} = \frac{\Delta U}{A} + 1$$

$U = \frac{3}{2}\nu RT$

$\Delta U = \frac{3}{2}\nu R\Delta T$

$A = p\Delta V$

$\frac{\Delta p}{p} \ll 1 \quad \frac{\Delta V}{V} \ll 1 \quad \frac{\Delta T}{T} \ll 1$

$$\Delta U = \frac{3}{2}\nu R\Delta T = \frac{3}{2}\left(p\Delta V + V\Delta p + \Delta p \cdot \Delta V\right) \approx \frac{3}{2}\left(p\Delta V + V\Delta p\right)$$

$$\frac{Q}{A} = \frac{\Delta U}{A} + 1 = \frac{\frac{3}{2}(p\Delta V + V\Delta p)}{p\Delta V} + 1 = \frac{3}{2} + 1 + \frac{3V\Delta p}{2p\Delta V}$$

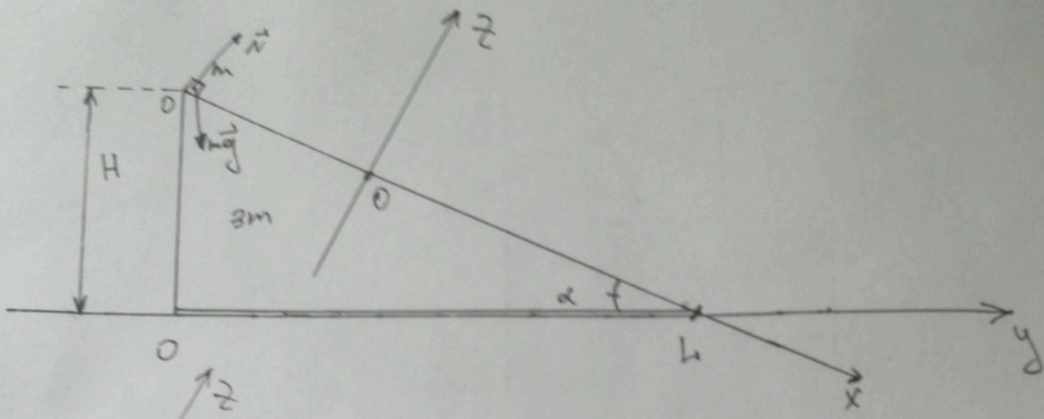
$$\frac{Q}{A} = \frac{5}{2} + \frac{3V \cdot 0{,}02p}{2p \cdot (-0{,}01V)} = -\frac{1}{2}$$

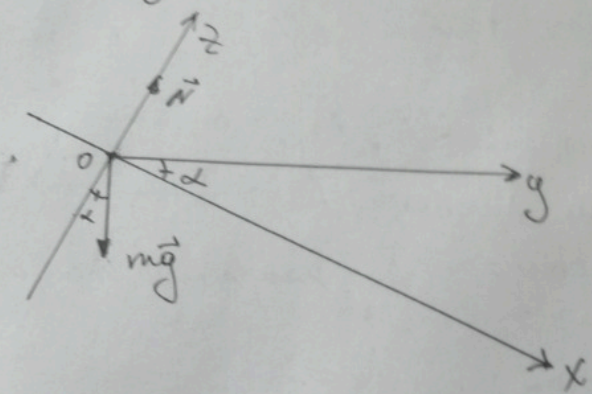
Ответ: увеличилась на 1 % ; −0,5.

Чистовик

N 4

1)





$$ma_x = mg\sin\alpha$$

$$a_x = g\sin\alpha\ ,\ a_x = const$$

$$a_x\frac{T^2}{2} = L$$

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

$$g\sin\alpha\frac{T^2}{2} = \frac{H}{\sin\alpha}$$

$$T = \frac{\sqrt{\frac{2H}{g}}}{\sin\alpha}$$

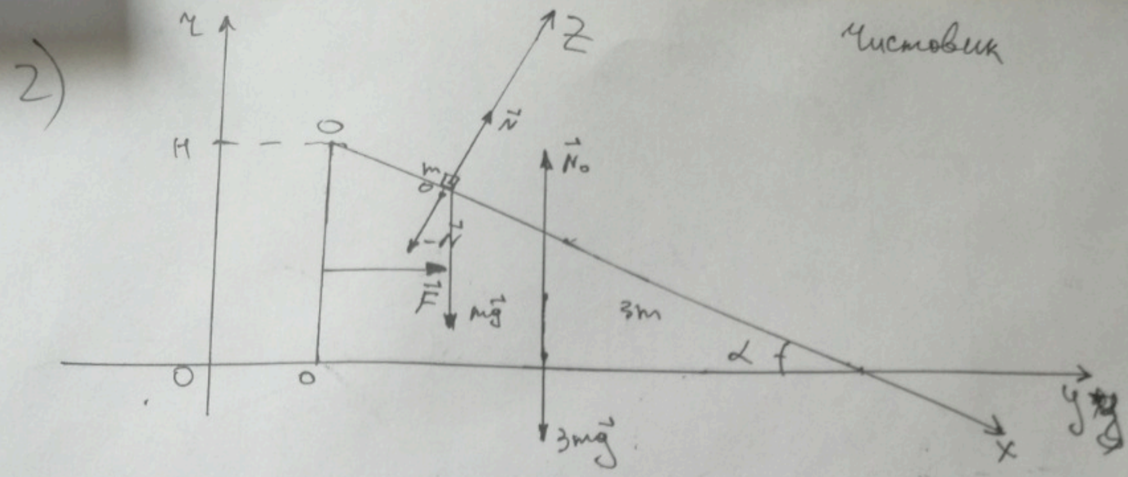
$$\sin\alpha = \sqrt{1-\cos^2\alpha} = \frac{3}{5}$$

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

21205947 (U281734 M1281410)

2)

Чистовик



На клин действуют силы $\vec{F}$, $\vec{N_0}$, $-\vec{N}$, $3m\vec{g}$

ускорение клина ~~$\vec{A}$ пол~~ $\vec{A}$, ~~$|\vec{A_\eta}| = 0$~~ $A_\eta = 0$, т.к. клин не отрывается от плоскости $\Rightarrow$ $\vec{A}$ направлен по оси Oy.

$$3m A_y = F - N \cdot \sin\alpha \quad , \quad A_y = A$$

Шайба не отрывается от клина $\Rightarrow$ $A_z = a_z$, a - ускорение шайбы

$$m a_z = N - mg\cos\alpha$$

$$\cancel{A_y = a} \qquad A_z = A \cdot \sin\alpha = A_y \cdot \sin\alpha$$

$$a_z = \frac{N}{m} - g\cos\alpha$$

$$A_y = \frac{F}{3m} - \frac{N\sin\alpha}{3m}$$

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

$$N - mg\cos\alpha = \sin\alpha\left(\frac{F}{3} - \frac{N\sin\alpha}{3}\right)$$

$$3N - 3mg\cos\alpha = F\sin\alpha - N\sin^2\alpha$$

$$N = \frac{F\sin\alpha + 3mg\cos\alpha}{3 + \sin^2\alpha}$$

Чистовик

$$3mA_y = F - N\sin\alpha$$

II. $$3mA_y = F - \frac{F\sin\alpha + 3mg\cos\alpha}{3+\sin^2\alpha}\cdot\sin\alpha$$

$$A_y = \frac{F}{3m} - \frac{F\cdot\sin\alpha + 3mg\cos\alpha}{3m(3+\sin^2\alpha)}\sin\alpha$$

$$A = A_y$$

$$A = \frac{F}{3m} - \frac{F\cdot\frac{3}{5} + 3mg\cdot\frac{4}{5}}{3m\cdot\left(3+\frac{9}{25}\right)}\cdot\frac{3}{5}$$

$$A = \frac{F}{3m} - \frac{3F + 12mg}{3m\left(\frac{24}{25}\right)}\cdot\frac{3}{25} = \frac{F}{3m} - \frac{3F + 12mg}{24m}$$

$$A = \frac{F}{3m} - \left(\frac{F}{8m} + \frac{mg}{2}\right) = \frac{5F}{24m} + \frac{mg}{2}$$

~~На шайбу по оси Ox по прежн~~

3) На шайбу по прежнему действуют силы $\vec{N}$ и $m\vec{g}$

$N_x = 0$, $(mg)_x = mg\sin\alpha$ $\Rightarrow a_x = g\sin\alpha$

$\Downarrow$

время не изменится

Ответ: $\dfrac{5\sqrt{\frac{2H}{g}}}{3}$; $\dfrac{5F}{24} + \dfrac{mg}{2}$; $\dfrac{5\sqrt{\frac{2H}{g}}}{3}$

Чистовик

$$A = \frac{F}{3m} - \frac{F\cdot\frac{3}{5} + 3mg\cdot\frac{4}{5}}{3m\cdot\left(3+\frac{9}{25}\right)}\cdot\frac{3}{5}$$

$$\cancel{A = \frac{F}{3\cdot m} - 3F + 12mg}$$

$$A = \frac{F}{3m} - \frac{F\cdot\frac{3}{5} + 3mg\cdot\frac{4}{5}}{m\cdot\frac{75+9}{25}}\cdot\frac{1}{5}$$

$$A = \frac{F}{3m} - \frac{3F + 12mg}{m\cdot 84}$$

$$\cancel{A = \frac{F}{3m} - \frac{F+4mg}{m\cdot 28} = \frac{28F - 3(F+4mg)}{84m} = \frac{25F - 12mg}{84m}}$$

~~3) П~~ 3) Проекция ~~равн~~ суммы всех сил, действующих на шайбу, на ось x равна ~~на~~ $mg\sin\alpha$

$$a_x = g\sin\alpha$$

a_x не изменилось $\Rightarrow$ время не изменится

$$\cancel{2)\ A = \frac{25F - 3mg}{84m} = \frac{50mg - 3mg}{84m} = \frac{47mg}{84m} = \frac{1}{2}g}$$

2) $$A = \frac{F}{3m} - \frac{3F + 12mg}{84m} = \frac{2mg}{3m} - \frac{3\cdot 2mg + 12mg}{84m}$$

$$A = \frac{19}{42}g$$

21205947 (U281734 M1281410)

Чистовик

Ответ: $\frac{5\sqrt{\frac{2H}{g}}}{3}$; $\frac{19}{42}g$; $\frac{5\sqrt{\frac{2H}{g}}}{3}$.

$$\frac{2mg\cdot\frac{3}{5}+3mg\cdot\frac{4}{5}}{3+\frac{9}{25}} = \frac{1}{5}(6mg+12h) \qquad \cancel{\frac{57}{24}}$$

$$\frac{\frac{18}{5}mg}{\frac{84}{85}mg}$$

$$ma_x = mg - N\cos\alpha$$

$$= \frac{5\cdot 18}{84}mg$$

$$a_x = g - \frac{4}{5}\cdot\frac{F\cdot\frac{3}{5}+3mg\cdot\frac{4}{5}}{3+\frac{9}{25}}\cdot\frac{4}{5}$$

$$\frac{3}{5}N = \frac{f}{10}$$

$$N =$$

$$\frac{3}{5}\cdot\frac{4}{5}mg = \frac{f}{10}$$

$$a_x = g - \frac{16}{25}\cdot\frac{3F+12mg}{\frac{84}{25}}\cdot\frac{1}{5}$$

$$\frac{5\cdot 2\cdot 3\cdot 3}{34\cdot 7} = \frac{15}{14}mg = N$$

$$75+9 = 84 = 28\cdot 3 = 3\cdot 4\cdot 7$$

$$a_x = g - \frac{16}{5}\cdot\frac{3F+12mg}{84} = g - \frac{4}{35}\cdot(F+4mg)$$

$$3mA_y = F - N\sin\alpha$$

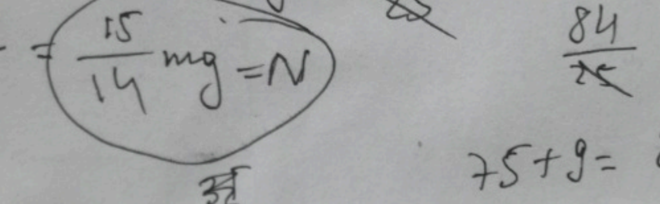
$$3mA_y = 2mg - \frac{15mg}{14}\cdot\frac{3}{5}$$

$$N = mg\cos\alpha$$

$$= A_y\cdot 7 \qquad \frac{2mg}{3m} - \frac{6mg+12mg}{84m}$$

$$3mA_y = 2mg - \frac{9}{14}mg = \frac{19mg}{14}$$

$$\frac{1}{m}(mg - mg\cos^2\alpha) = g\sin^2\alpha$$



$$A_y = \frac{19mg}{42m} = \frac{19g}{42}$$

$$\sqrt{\frac{2H}{g\sin^2\alpha}}$$

$$\frac{2}{3}g - \frac{18}{84}g = \left(\frac{56}{84}-\frac{18}{84}\right)g$$

$$\frac{38}{84} = \frac{19}{42}$$

Черновик

21205947 (U281734 M1281410)

черновик

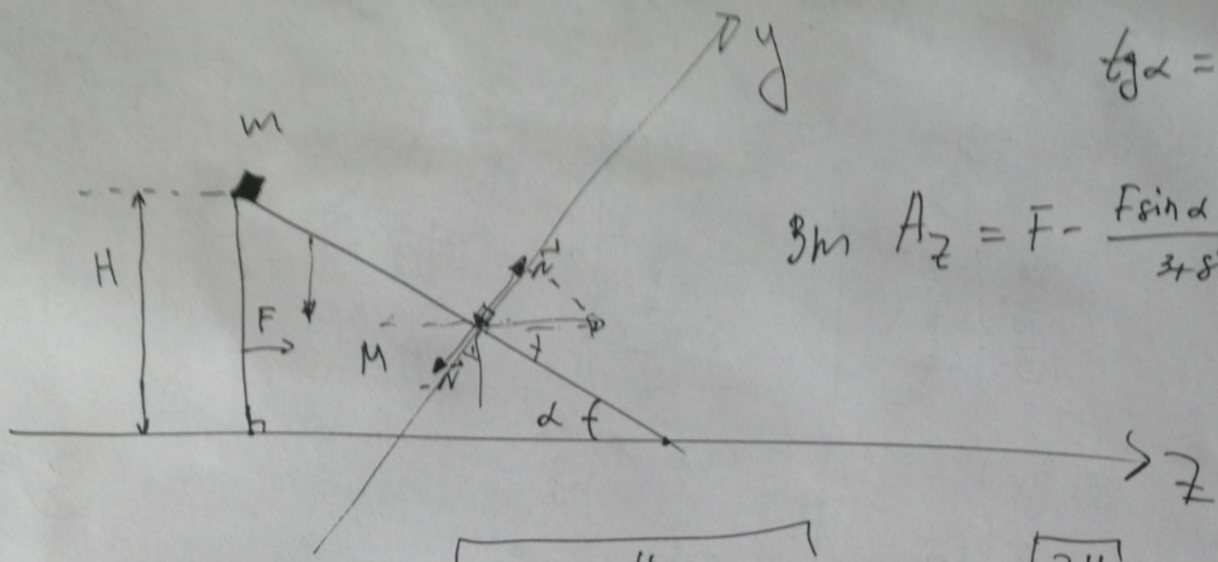
$$\frac{\frac{3}{2}\left(p\Delta V + V\Delta p\right)}{p\Delta V} = \frac{3}{2} + \frac{3}{2}\cdot\frac{V}{p}\cdot\frac{\Delta p}{\Delta V} = \frac{3}{2} + \frac{3}{2}\cdot\frac{V\cdot(0{,}02p)}{p\cdot(-0{,}01V)} =$$

$$= \frac{3}{2} - 3$$

$\frac{3}{2} - 3$

$\cos\alpha = \frac{4}{5}$ $\sin\alpha = \frac{3}{5}$

$tg\alpha = \frac{3}{4}$



$$3m\,A_z = F - \frac{F\sin\alpha + 3mg\cos\alpha}{3+\sin^2\alpha}$$

$\cancel{3ma_z}$

$\cancel{3m A_z =}$

$3m\cdot A_z = F - N\sin\alpha$

$A_z \sin\alpha = \frac{N}{m} - g\cos\alpha$

$$\sqrt{\frac{2\frac{H}{\sin\alpha}}{g\sin\alpha}} = \frac{\sqrt{\frac{2H}{g}}}{\sin\alpha} = \tau$$

$A_z\cdot\sin\alpha = \frac{N}{m} - g\cos\alpha$

$\frac{F}{3m} - \frac{N\sin\alpha}{3m} =$

$\cancel{ma_y = F\sin\alpha - N}$

$ma_y = N - mg\cos\alpha$

$\frac{F}{3m}\sin\alpha - \frac{N\sin^2\alpha}{3m} = \frac{N}{m} - g\cos\alpha$

$\frac{F}{3}\sin\alpha - \frac{N\sin^2\alpha}{3} = N - mg\cos\alpha$

$F\sin\alpha - N\sin^2\alpha = 3N - 3mg\cos\alpha$

$\frac{M}{m}\left(N - mg\cos\alpha\right) = F\sin\alpha - N$

$\boxed{N = \frac{1}{2}F\sin\alpha + \frac{3}{2}mg\cos\alpha}$

$3N - 3mg\cos\alpha = F\sin\alpha - N$

$\cancel{N(3-\sin)}$

$\frac{F\sin\alpha + 3mg\cos\alpha}{3+\sin^2\alpha} = N$