Часть 1

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

Шифр: **21204020**

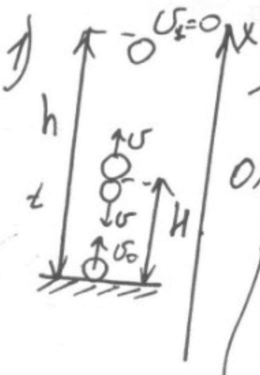
ID профиля: **812709**

Вариант 1

Чистовик.

Задача 1

1)



1 Мяч пролетает расстояние h-H за то же время, что и второй мяч расстояние H.

Ox:
$$\begin{cases} H=v_0t-\frac{gt^2}{2} \quad (1) \\ H-h=-\frac{gt^2}{2};\ h-H=\frac{gt^2}{2} \quad (2) \\ h=\frac{-v_0^2}{-2g}=\frac{v_0^2}{2g} \quad (3) \end{cases}$$

$$\begin{cases} H=v_0t-\frac{gt^2}{2} \\ \frac{v_0^2}{2g}-H=\frac{gt^2}{2} \end{cases}$$

$H+\frac{gt^2}{2}=v_0t;\ \frac{H}{t}+\frac{gt}{2}=v_0$

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

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

$-\frac{3}{4}g^2t^2-gH+\frac{H^2}{t^2}=0 \quad |\cdot(-4t^2)$

$3g^2t^4+4gHt^2-4H^2=0 \qquad t^2=z>0$

$D_1=4g^2H^2+4\cdot 3g^2H^2=16g^2H^2$

$z_{1,2}=\frac{-2gH\pm 4gH}{3g^2}=\frac{2H}{3g}$

$$\boxed{t=\sqrt{\frac{2H}{3g}}}$$

(1)

2) $H=v_0\sqrt{\frac{2H}{3g}}-\frac{g}{2}\cdot\frac{2H}{3g};\ \frac{4H}{3}=v_0\sqrt{\frac{2H}{3g}};\ \boxed{v_0=2\sqrt{\frac{2Hg}{3}}}$

3) Этот путь равен $S=h+h-H=2h-H$

$h=\frac{v_0^2}{2g}=\frac{4\cdot\frac{2Hg}{3}}{2g}=\frac{4}{3}H$

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

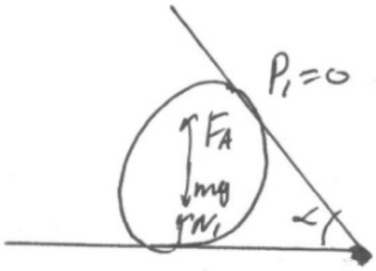
Ответ: 1) $t=\sqrt{\frac{2H}{3g}}$; 2) $v_0=2\sqrt{\frac{2Hg}{3}}$; 3) $S=\frac{5}{3}H$

Задача 2.

Чистовик:

(2)

1)



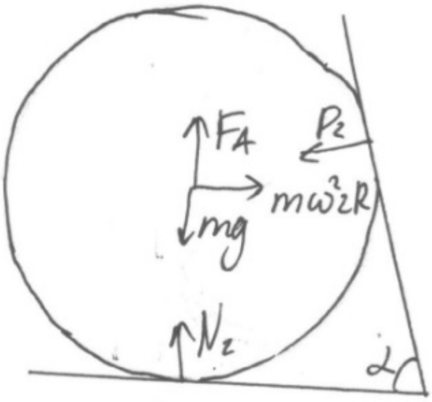
$P_1 = 0$ т.к. нет вращения

Условие равновесия.

$$N_1 + F_A = mg$$

$$N_1 = \frac{8}{3}\pi\rho R^3 g$$

2)



перейдем в НИСО сосуда:

Уравнение моментов относительно точки A:

$$-N_2 \sin\alpha R - F_A \sin\alpha R + mg\sin\alpha R - 2m\omega^2 R\cos\alpha R = 0 \quad \Big|\div \cos\alpha$$

$$N_2 \operatorname{tg}\alpha + F_A \operatorname{tg}\alpha - mg\operatorname{tg}\alpha + 2m\omega^2 R \, \cancel{\cos\alpha} = 0$$

$$2 \quad N_2 + F_A - mg + m\omega^2 R = 0$$

$$N_2 = mg - F_A - m\omega^2 R = \frac{4\pi}{3} 3\rho R^3 (g - \omega^2 R) - \frac{4\pi}{3}\rho R^3 g$$

$$N_2 = 4\pi\rho R^3\left((g - \omega^2 R) - \frac{g}{3}\right) = 4\pi\rho R^3\left(\frac{2g}{3} - \omega^2 R\right) = 0$$

$$\frac{2}{3} g > \omega^2 R$$

Ответ: $N_2 = 4\pi\rho R^3\left(\frac{2g}{3} - \omega^2 R\right)$

Чистовик

Задача 3

p_0 - начальное давление, V - конечный объем.

Уравнение М-К для 1 случая (когда еще ничего не сжато):

$$p_0 \cdot 3{,}5V = \frac{m}{\mu}RT \quad (1)$$

Уравнение М-К для 2 случая (когда сжали пар):

$$1{,}8 p_0 V = \frac{m_{new}}{\mu}RT \quad (2)$$

m_{new} - новая масса пара.

$$\frac{(2)}{(1)}: \quad \frac{1{,}8}{3{,}5} = \frac{m_{new}}{m} \Rightarrow \frac{18}{35}m = m_{new}$$, т.к $m_{new} < m$, значит пар сконденсировался, а значит

$p_{н.п}$ - давление насыщенного пара.

$$1{,}8 p_0 = p_{н.п}$$

$$\boxed{p_0 = \frac{p_{н.п.}}{1{,}8}} = \frac{0{,}5 \cdot 10^5}{1{,}8} = \frac{5}{18} \cdot 10^5 \text{ Па}.$$

(3)

(1) $$\frac{p_{н.п}}{1{,}8} \cdot 3{,}5V = \frac{m}{\mu}RT; \quad \boxed{V = \frac{1{,}8mRT}{\mu p_{н.п} \cdot 3{,}5}} = \frac{18 \cdot 0{,}003 \cdot 8{,}31 \cdot 354}{35 \cdot 0{,}5 \cdot 10^5 \cdot 0{,}018} \approx 0{,}005 \text{ м}^3 = 5 \text{ л}.$$

Ответ: 1) $p_0 = \frac{5}{18} \cdot 10^5$ Па; 2) $V \approx 5$ л.

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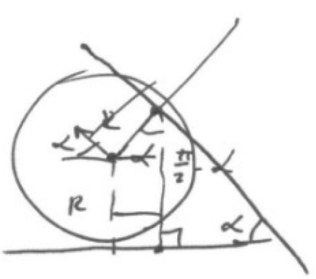
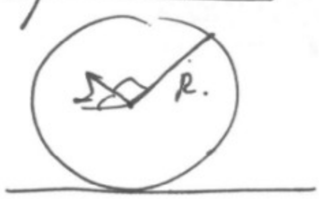
Черновик





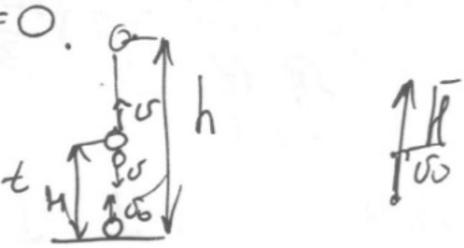
$ctg\alpha = \frac{1}{2}$.

$R\sin\alpha \cdot N_2 - mg\sin\alpha \cdot R - m\omega^2 2R\cos\alpha + F_A R = 0$.

$N_2\sin\alpha - mg\sin\alpha - m\omega^2\cos\alpha + F_A = 0$.

$\sin\alpha N_2 = m(g\sin\alpha + \omega^2 2R\cos\alpha) - F_A = 0$.

$N_2 = m(g + 2\omega^2 R\,ctg\alpha) - \frac{F_A}{\sin\alpha} = 0$.



$H = \upsilon_0 t - \frac{gt^2}{2}$

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

$mgh = \frac{m\upsilon_0^2}{2}$; $h = \frac{\upsilon_0^2}{2g}$

$$\begin{cases} H = \upsilon_0 t - \frac{gt^2}{2} \\ \frac{\upsilon_0^2}{2g} - H = \frac{gt^2}{2}. \end{cases}$$

$H + \frac{gt^2}{2} = \upsilon_0 t$; $\frac{H}{t} + \frac{gt}{2} = \upsilon_0$

$\frac{\left(\frac{H}{t} + \frac{gt}{2}\right)^2}{2g} - H = \frac{gt^2}{2}$; $\left(\frac{H}{t} + \frac{gt}{2}\right)^2 - 2gH = g^2t^2 = 0$

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

$-\frac{3}{4}g^2t^2 - gH + \frac{H^2}{t^2} = 0 \quad | \times(-1)$

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

$3g^2t^4 - 4gHt^2 + 4H^2 = 0$

$D_1 = 4g^2H^2 + 12H^2g^2 = 16H^2g^2$

$t^2_{1,2} = \frac{2gH \pm 4gH}{3g^2} = \frac{6gH}{3g^2} = \frac{2gH}{g}$; $t = \dots$

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$$\frac{4H\cdot\sqrt{3g}}{\sqrt{2H}\cdot 3\sqrt{3}} = \frac{2\sqrt{2}\,\sqrt{H}\cdot\sqrt{g}}{\sqrt{3}} = 2\sqrt{\frac{2Hg}{3}}$$

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

$$\frac{4H\cdot\sqrt{3}\cdot\sqrt{g}}{3\cdot\sqrt{H}\cdot\sqrt{2}} = \left(2\sqrt{\frac{2Hg}{3}}\right)^2 = 4\cdot\frac{2Hg}{3}$$

$$3\frac{3}{5} = \frac{18}{5}$$

h | $h-H$

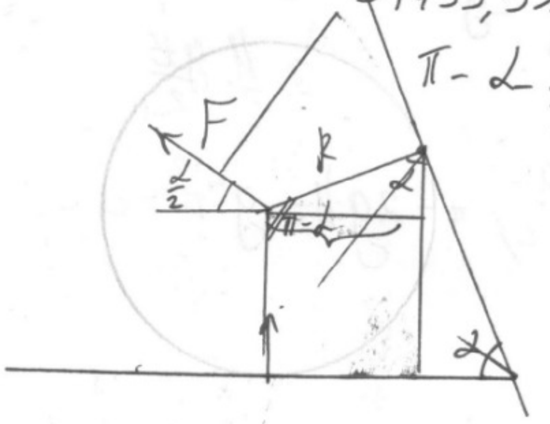
$$\frac{1}{2}\cdot\frac{1}{1{,}8} = \frac{1}{3{,}6}$$

$$\frac{158{,}85396}{31499{,}959}$$

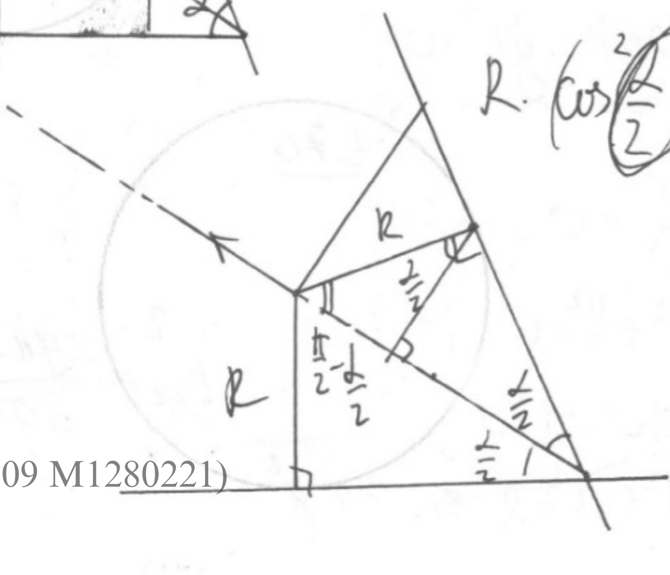
$$\pi - \alpha\ \frac{\pi}{2} = \frac{\pi}{2} - \alpha.$$

$R\sin\alpha.$

$tg\,\alpha.$



$$R\cdot\left(\cos^2\frac{\alpha}{2}\right)$$



p_0 -? $V_к$. Черновик

$3{,}5\, p_0 \frac{V_0}{3{,}5} = \frac{m}{\mu} RT$

(P.)

$1{,}8\, p_0 V = \frac{M}{\mu} RT$.

φ

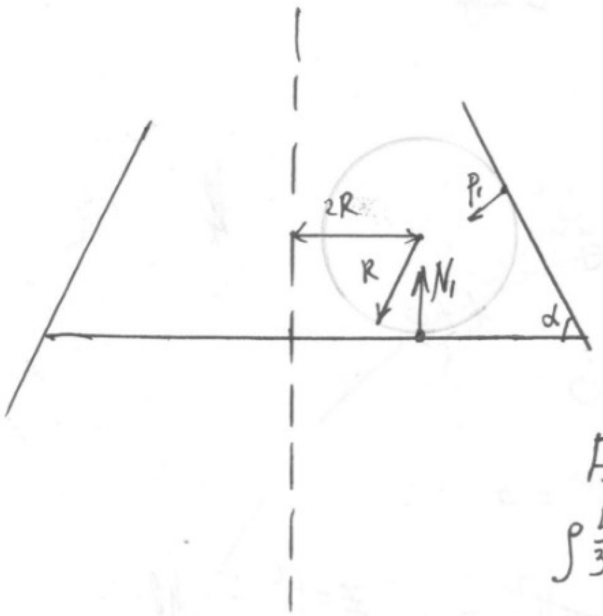
$3{,}5\, p_0 V = \frac{m}{\mu} RT$

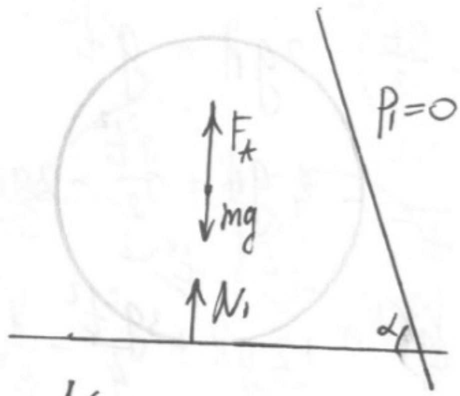
φ $p_{н.п.} = p_0$

φ=1. $1{,}8\, p_0 V = \frac{m_ч}{\mu} RT$

$1{,}8\, p_0 = p_{н.п.}$

$\frac{35}{18} = \frac{m}{m_ч}$ $m_ч = \frac{18m}{35}$ $p_0 = \frac{1}{2}\, 0{,}9 \cdot 10^5 = 9 \cdot 10^4$ Па



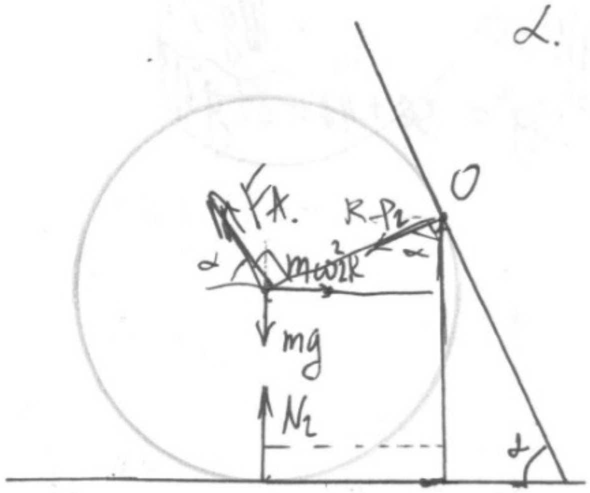


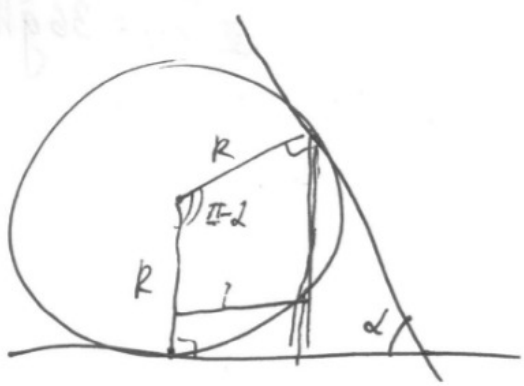
$F_A + N_1 = mg$

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

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

α.





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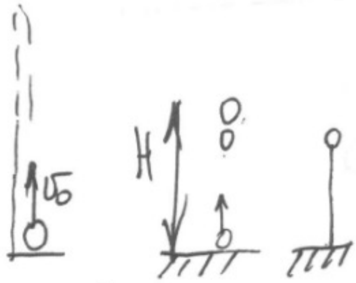
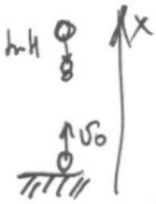
Черновик.



H_g

$H = \upsilon_0 t - \frac{gt^2}{2}$.

$\frac{H}{t} - \frac{gt^2}{2} = \upsilon_0$



$H = \upsilon_0 t - \frac{gt^2}{2}$.

$h - H = \frac{gt^2}{2}$.

$$\begin{cases} H = \upsilon_0 t - \frac{gt^2}{2} \\ \frac{\upsilon_0^2}{2g} - H = \frac{gt^2}{2}. \end{cases}$$

$$\frac{\left(\frac{H}{t} - \frac{gt^2}{2}\right)^2}{2g} - H = \frac{gt^2}{2}.$$

$\sqrt{2gh} = \upsilon_0$

$4 + h = \frac{\upsilon_0^2}{2g}$

$gmH + \frac{m\upsilon^2}{2}$

$H = \frac{\upsilon^2 - \upsilon_0^2}{-2g}$

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

$$\frac{H^2}{t^2} - gH + \frac{g^2t^2}{4} - 2gH = g^2t^2 \qquad t^2 \neq 0$$

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

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

$$3g^2t^4 - 12gHt^2 - 4H^2 = 0 \qquad z = t^2$$

$$3g^2z^2 - 12gHz - 4H^2 = 0$$

$$D_1 = 36g^2H^2 + 4H^2 \cdot 3g^2 = 36 + 48 = 84g^2H^2$$

48

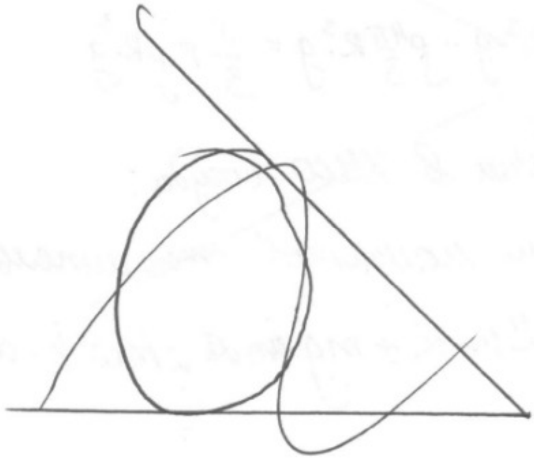
$48g^2H^2$

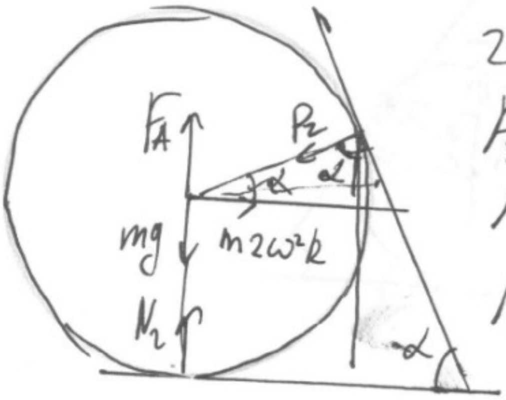
~~Чистовик~~:

Задача 2

Черновик

1)





$2m\omega^2 R\cos\alpha R = d_1,$

$F_A \sin\alpha R = d_2$

$mg \sin\alpha R = d_3$

$N_2 \sin\alpha R = d_4.$

~~Чистовик~~

Черновик

Задача 2

1)

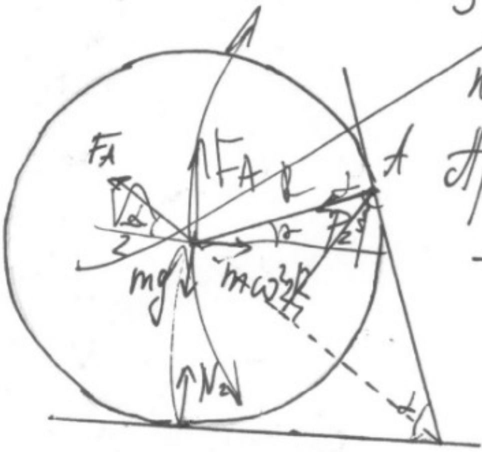
$P_1 = 0$, т.к вращения нет.

Условие равновесия:

$N_1 + F_A = mg$;

$N_1 = 3\rho \frac{4\pi}{3} R^3 g - \rho \frac{4\pi}{3} R^3 g = \frac{8}{3}\pi\rho R^3 g$

2)



перейдем в НИСО сосуда:

Правило моментов относительно точки A:

$-N_2 R\sin\alpha + mg\sin\alpha + 2m\omega^2 R\cdot\cos\alpha + F_A\cos\frac{\alpha}{2} = 0$

Часть 2

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

Шифр: **21204020**

ID профиля: **812709**

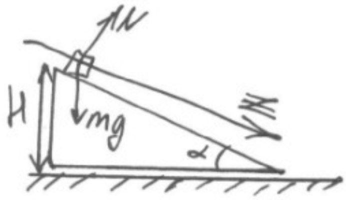
Вариант 1

Чистовик

Задача 4

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

1)



II З.Н. на Oz: для шайбы

$ma = mg\sin\alpha$

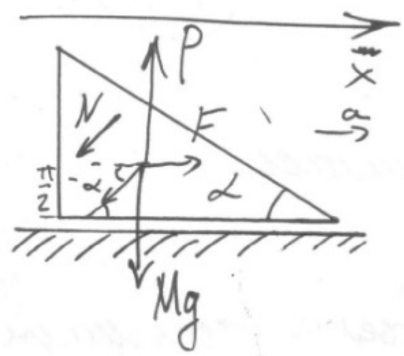
$a = g\sin\alpha = \frac{3g}{5}$

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

$S = \frac{at^2}{2}$

$\frac{5}{3}H = \frac{3gt^2}{5\cdot 2}$; $\frac{25}{9}\cdot 2\frac{H}{g} = t^2$; $\boxed{\frac{5}{3}\sqrt{\frac{2H}{g}} = t}$

2)



II З.Н. на Ox для клина.

$Ma_к = F - N\sin\alpha$; $N = mg\cos\alpha$

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

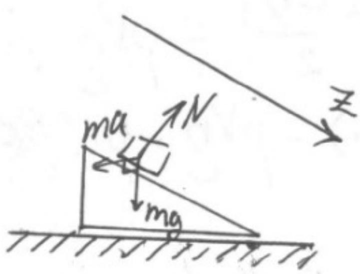
$3a_к = 2g - \frac{12}{25}g$

$a_к = \left(\frac{2}{3} - \frac{4}{25}\right)g = \frac{38}{75}g \approx \frac{g}{2}$

$\boxed{a_к = \frac{g}{2}}$

(1)

3) Перейдем в НИСО клина:



II З.Н. на Oz:

$ma_{new} = mg\sin\alpha - ma\cos\alpha$

$a_{new} = g\cdot\frac{3}{5} - \frac{g}{2}\cdot\frac{4}{5} = \frac{g}{5}$

$S = \frac{a_{new}T^2}{2}$; $\frac{H}{\sin\alpha} = \frac{gT^2}{10}$; $\frac{5}{3}H = \frac{gT^2}{10}$; $\frac{50H}{3g} = T^2$

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

Ответ: 1) $t = \frac{5}{3}\sqrt{\frac{2H}{g}}$; 2) $a_к = \frac{g}{2}$; 3) $T = 5\sqrt{\frac{2H}{3g}}$

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Задача 5

1) $\xi = 2\%$ $\eta = 1\%$

$$\begin{cases} pV = \nu RT \\ p(1+\xi)V(1-\eta) = T(1+\mu)\nu R \end{cases}$$

$(1+\xi)(1-\eta) = 1+\mu$ $\qquad \xi \cdot \eta \ll \xi ; \eta$

$1+\xi-\eta-\xi\cdot\eta = 1+\mu$

$\xi - \eta = \mu$

$\mu = 1\%$ температура увеличилась.

(2)

2) так как изменения давления и объема очень малы, примем, что процесс линейный.

т.к. $V\downarrow$, $A<0$.

$$A = -\frac{(1+\xi)p+p}{2}\eta V = pV\left(\left(1+\frac{\xi}{2}\right)\eta\right) = pV\left(\eta + \frac{\xi\eta}{2}\right) \cong pV\eta$$

$$Q = \frac{3}{2}\Delta(pV) + A = \frac{3}{2}(\Delta p\cdot V + p\cdot\Delta V) + A = \frac{3}{2}pV(\xi-\eta) - pV\eta = pV\left(\frac{3}{2}\xi - \frac{5}{2}\eta\right)$$

$$\frac{Q}{A} = -\frac{pV\left(\frac{3}{2}\xi-\frac{5}{2}\eta\right)}{pV\eta} = -\frac{3}{2}\frac{\xi}{\eta} + \frac{5}{2} = -3 + \frac{5}{2} = -0{,}5$$

Ответ: 1) $\mu = 1\%$; 2) $\frac{Q}{A} = -0{,}5$

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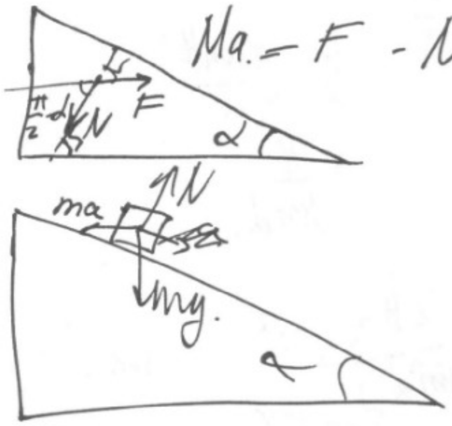
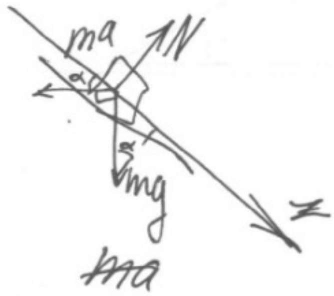
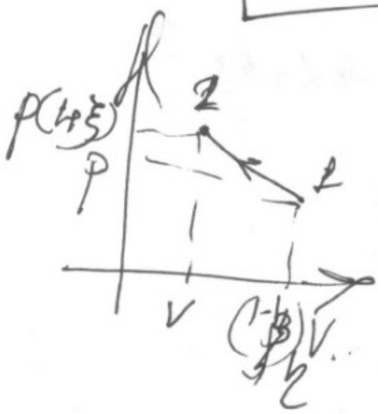
Черновик



$Ma = F - N\sin\alpha$





$ma_{new} = -ma\cos\alpha + mg\sin\alpha$

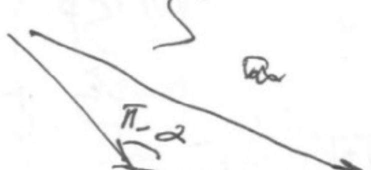
$\frac{30-12}{75} =$

$\eta V \cdot \frac{\xi}{2} p$ $\quad \frac{\xi\eta}{2} pV$

$a_{new} = -\frac{g}{2}\cos\alpha + g\sin\alpha = g\left(\sin\alpha - \frac{\cos\alpha}{2}\right) = \frac{3}{5} - \frac{2}{5} = \frac{g}{5}$

$\frac{H}{\sin\alpha} = \frac{gT}{10}$

$\frac{50H}{3g} = \frac{gT^2}{}$ $\qquad 5\sqrt{\frac{2H}{3g}} = 4T$



$\frac{H}{\sin\alpha}$ $\qquad \frac{aT^2}{2}$

$\frac{3+3\xi-3\eta-3\eta\xi-\xi\eta}{-\xi\eta}$

$-\frac{3}{\xi\eta} + \frac{3}{\eta} + 4 +$

$Q = \frac{3}{2}(1-\eta)(1+\xi)pV - \frac{\xi\eta}{2}pV$

$\overline{\quad -\frac{\xi}{2}\eta pV \quad}$ $- 15000 + 4 = 15296$

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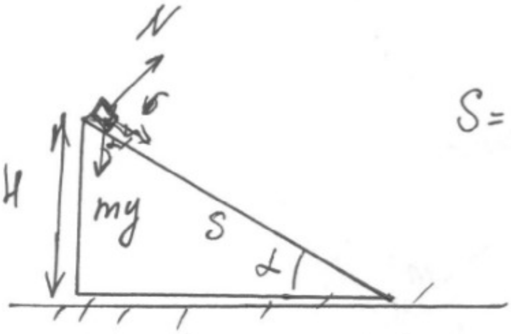
(4)



$a = g\sin\alpha.$

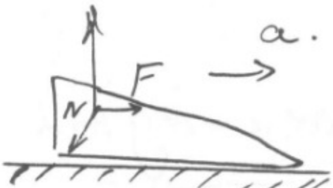
$S = \frac{at^2}{2}$

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

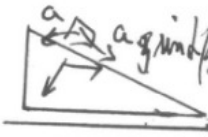
$S = \frac{H}{\sin\alpha}.$

$\frac{2H}{\sin^2\alpha\cdot g} = t^2$ $\sin^2\alpha = 1-\cos^2\alpha.$

$\frac{1}{\sin\alpha}\sqrt{\frac{2H}{g}}$ $\sin\alpha = \frac{3}{5}$



(?)



$Ma = mg$

$\frac{5}{3}\sqrt{\frac{2H}{g}}.$

$\eta = 1\%.$ $\xi = 2\%.$

$pV = \nu RT$ ξ

$(p+\xi p)(V-\eta V) = \nu R(T+\mu T)$

$\xi,\eta \gg \xi\eta \ll 1$ $pV(1+\xi)(1-\eta) = \nu RT(1+\mu)$

$\frac{Q}{A}$

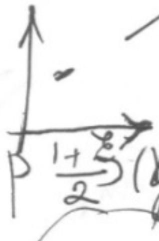
$(1+\xi)(1-\eta) = 1+\mu$

$1+\xi-\eta-\xi\eta = 1+\mu.$

$p\Delta V + \Delta pV = \nu R\Delta T.$

$-\eta pV + \xi p$

$\xi - \eta = \mu = 1\%$



~~$Q = \frac{3}{2}(1+\xi)(1-\eta)pV - \Delta pV\frac{(1+\xi)}{2}(1-\eta)$~~

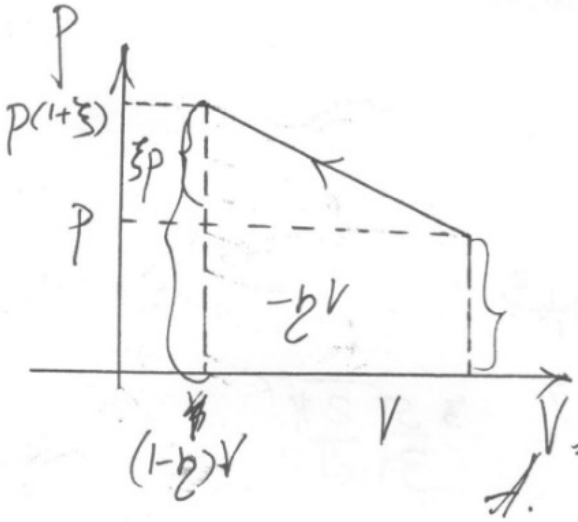
$\frac{p+p\xi}{2}$

$p\,\frac{1+\xi}{2}(1-\eta)$

$-\frac{1}{2}pV(1+\xi)(1-\eta)$ -2

$-3(1+\xi)(1-\eta)+1$ $-3+1=-2.$

черновик.



$$\frac{(1+\xi)p + p}{2}\eta V$$

$$pV\frac{2+\xi}{2}\eta$$

$$A = pV\cdot\eta + \frac{\eta+\xi}{2} = pV\eta$$

$$\frac{Q}{A} = \frac{\frac{3}{2}(1+\xi-\eta)\xi - \eta}{+\eta}$$

$$\frac{(1+\xi)(1-\eta)-\eta}{\eta} \quad \frac{1+\xi-\eta-\eta\xi-\eta}{\eta}$$

$$\frac{1}{\eta}+\frac{\xi}{\eta}-2-\xi$$

$$100+2-2-\xi = 100$$

$$\Delta pV + p\Delta V$$

ξp

$\xi pV = \eta Vp$

$$\frac{3}{2}\xi - \frac{3}{2}\eta - \eta \qquad \frac{3}{2}\xi^2 - \frac{5\eta^2}{2}$$

$$\frac{3}{2} - \frac{5}{2} = -\frac{1}{2}$$

21204020 (U812709 M1280222)

$\frac{\frac{4}{\frac{5}{3}}}{} = \frac{3 \cdot 4}{5}$ Черновик

$\frac{5}{3} \cdot \frac{4}{2} = \frac{3}{5} \cdot \frac{gt^2}{2}$ ~~$25 \cdot 2gt^2$~~

$\sqrt{\frac{25 \cdot 2 \cdot 4}{9 \cdot g}}$ $\frac{5}{3}\sqrt{\frac{2 \cdot 4}{g}}$

$\sin\alpha = \frac{3}{5}$ $\frac{3 \cdot 4}{5 \cdot 5} = \frac{12}{25}$

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

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

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

$3a_k = 2g - \frac{12}{25} g$

$a_k = g\left(\frac{2}{3} - \frac{12}{75}\right)$ $50 - 12$.