Часть 1

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

Шифр: **21206033**

ID профиля: **320397**

Вариант 2

Чернівик.

ω 3.

$T = const = 81°C = 354\ K$

$V_2 = \frac{V_1}{7} = 1,7\ л$

$P_2 = 3,6 P_1$

$P_{нп} = 0,5 \cdot 10^5\ Па = P_{нп}$

$P_1 \cdot V_1 = \frac{m_1}{\mu} RT = 7\ P_1 V_2 = \frac{m_1}{\mu} RT$

$P_2 \cdot V_2 = \frac{m_2}{\mu} RT = 3,6 P_1 V_2 = \frac{m_2}{\mu} RT$

$P_1 =$

$P_1 V_1 = \frac{m_1}{\mu} RT \quad \frac{7}{3,6} = \frac{m_2}{m_1}$

$P_2 V_2 = \frac{m_2}{\mu} RT \quad +\frac{273}{81}{354} \quad m_2 > m_1.$

$3,6 P_2 V_1 = \frac{m_1}{\mu} RT$

$7 P_2 V_1 = \frac{m_2}{\mu} RT$

$V_1 = 7 V_2 = 11,9\ л$

$1\ м^3 = 1000\ л.$

$x\ м^3 = 11,9\ л$

$x = \frac{11,9}{1000} = 0,0119\ м^3.$

$V_2 = 0,0017\ м^3$

$\frac{7 P_1}{P_{нп}} = \frac{m_1}{m_2'}$

$P_{нп} \cdot V_2 = \frac{m_2'}{\mu} RT \quad \frac{3,6 P_1}{P_{нп}} = \frac{m_2}{m_2'}$

$m_2' = \frac{P_{нп} \cdot V_2 \mu}{RT} =$

$= \frac{0,5 \cdot 10^5 \cdot 0,0017 \cdot 0,018}{8,31 \cdot 354} = 0,0522$

Тут $P_2 = P_{нп}$, $m_2 = m_2'$

$m_2 = \frac{\mu P_2 V_2}{RT} = \frac{0,018 \cdot P_2 \cdot 0,0017}{8,31 \cdot 354}$

$\frac{7}{3,6} = \frac{m_1}{m_2} \quad m_2 = \frac{3,6 m_1}{7} \quad m_1 = \frac{7 m_2'}{3,6} = 0,10$

$P_1 = \frac{m_2' RT}{3,6 V_2 \cdot \mu} = \frac{0,052 \cdot 8,31 \cdot 354}{3,6 \cdot 0,0017 \cdot 0,018} = 139 \cdot 10^5$

X

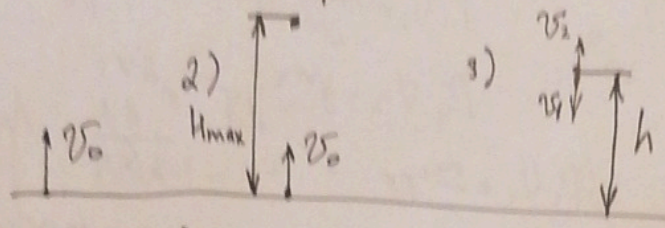
Черновик.

$t_1 + t_2 = ?$

$\frac{t_1+t_2}{t_2} = ?$

$h = ?$

1. 1) 2) 3)



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

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

$H_{max} - h = \frac{g t_2^2}{2}$

$v_0 t_1 - \frac{g t_1^2}{2} - v_0 t_2 + \frac{g t_2^2}{2} = \frac{g t_2^2}{2}$

$v_0(t_1 - t_2) - \frac{g t_1^2}{2} = g t_2^2$ | ·8 | ·4 | :2

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

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

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

$v_0^2 = 2 v_0 t_1 - g t_1^2$

$\underset{a}{g} t_1^2 - \underset{b}{2 v_0} t_1 + \underset{c}{v_0^2} = 0.$

$\frac{\text{м}^2}{\text{с}^2} \cdot \frac{1}{\text{м}} \cdot \text{с}^2$ ✓

$(x+6)(x-3) =$

$= x^2 + 3x - 18 = 0$

$D = 9 + 72 = 9^2$

$x = \frac{-3 \pm 9}{2} =$

$= -6; 3.$

$\frac{\text{м}}{\text{с}} + \frac{\text{м}}{\text{с}} \cdot \frac{\sqrt{\text{м}}}{\text{с}^2}$

$\frac{\text{м}}{\text{с}^2}$

$D = b^2 - 4ac = 4 v_0^2 - 4 g v_0^2 = 4 v_0^2 (1-g)$

$t_1 = \frac{2 v_0 + \sqrt{4 v_0^2 (1-g)}}{2g} = \frac{2 v_0 + 2 v_0 \sqrt{1-g}}{2g} = \frac{v_0 + v_0 \sqrt{1-g}}{g}$

$g t_1^2 - 2 v_0 t_1 + v_0^2 = 0.$

$\sqrt{\frac{\text{м}^2}{\text{с}^2} \cdot \frac{\text{м}}{\text{с}^2}} = \sqrt{\frac{\text{м}^3}{\text{с}^4}} = \frac{\text{м}}{\text{с}^2}\sqrt{\text{м}}$

$D = 4 v_0^2 - 4 \cdot g \cdot v_0^2$

$\frac{v_0^2 + v_0^2\sqrt{1-g}}{g} - \frac{g}{2} \cdot \frac{(v_0 + v_0\sqrt{1-g})^2}{g^2} = \frac{v_0^2 + v_0^2\sqrt{1-g} - v_0^2 - 2 v_0^2 \sqrt{1-g}}{2g}$

$- \frac{v_0^2(1-g)}{g} = \frac{- v_0^2 \sqrt{1-g} - v_0^2(1-g)}{g}$

Черновик.

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

$h = v_0 t_2 - \frac{g t_2^2}{2} = v_0 t_2 - H_{max} + h = h.$

$H_{max} - h = \frac{g t_2^2}{2}$ $\quad H_{max} = v_0 t_2 = g t_1 t_2 = \frac{v_0^2}{2g}.$

$v_0 = g t_1$ $\quad H_{max} = \frac{v_0^2}{g} - \frac{g v_0^2}{2g^2} = \frac{v_0^2}{2g}$

$2 t_2 = v_0 = t_1$ $\quad 2 t_2 = t_1.$

$\frac{3 t_2}{t_2} = 3.$

$\frac{v_0^2}{2g} - h = \frac{g t_2^2}{2}$ $\quad h = \frac{v_0^2}{2g} - \frac{g t_2^2}{2}$

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

$\frac{u^2}{c^2} = \frac{u}{c} \cdot \frac{u}{c^2} \cdot c - \frac{u^2}{c^2} \cdot c$

$v_0^2 = 2 v_0 g t_1 - g^2 t_1^2$ $\quad (g t_1 - v_0)^2 = g^2 t_1^2 - 2 g v_0 t_1 + v_0^2$

$g^2 t_1^2 - 2 v_0 g t_1 + v_0^2 = 0. =$

$= (g t_1 - v_0)^2 = 0.$ $\quad g t_1 - v_0 = 0.$

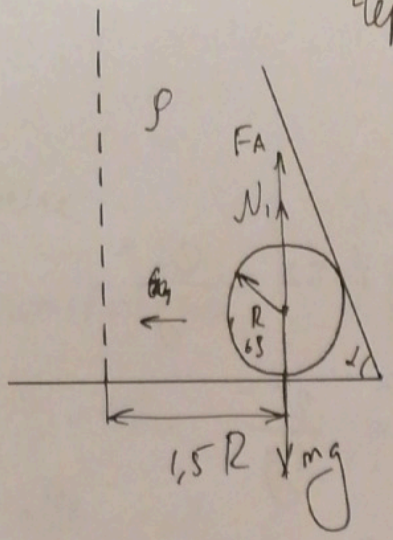
$t_1 = \frac{v_0}{g}.$

$0 =$

$\frac{u}{c} \cdot \frac{c^2}{u}$ ✓ $\quad \frac{u^2}{c^2} \cdot \frac{c^2}{u}$ ✓

Черновик.

1)



2.

$F_A = \rho g V_m = \rho g \cdot \frac{4}{3}\pi R^3$ $\quad mg = 6\rho \cdot V_m \cdot g = 6\rho \cdot \frac{4}{3}\pi R^3 \cdot g$

$\rho g V_m + N_1 = mg$

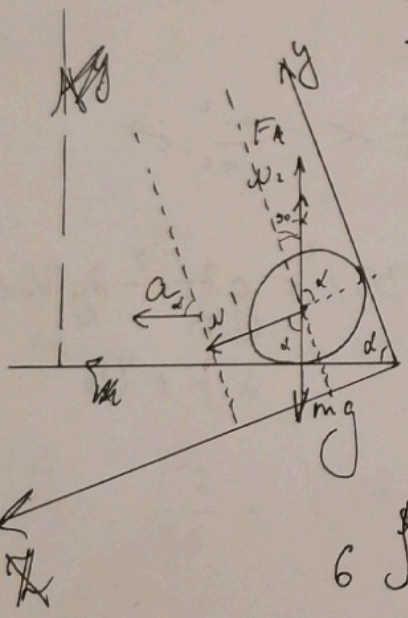
$\rho g \cdot \frac{4}{3}\pi R^3 + N_1 = 6\rho \cdot \frac{4}{3}\pi R^3 \cdot g$

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

$\frac{k2}{\cancel{м^3}} \cdot \frac{м}{с^2} \cdot \cancel{м^3} = Н$ $\quad \frac{k2}{\cancel{м^3}} \cdot \cancel{м^3} \cdot \frac{м}{с^2} = Н$ $\quad \frac{k2}{\cancel{м^3}} \cdot \frac{м}{с^2} \cdot \cancel{м^3}$ $\quad \omega = [\frac{1}{с^2}]$

II з-н Ньютона $\quad a = R\omega^2$

~~Ox: ma =~~



Oy: $ma \cdot \cos\alpha = N_2 \cdot \sin\alpha + F_A \cdot \sin\alpha - mg \cdot \sin\alpha \;/ : \sin\alpha$

$\frac{ma}{tg\alpha} = N_2 + F_A - mg$

$\frac{6\rho \cdot \frac{4}{3}\pi R^3 \cdot \omega^2 R}{tg\alpha} = N_2 + \rho g \cdot \frac{4}{3}\pi R^3 - 6\rho \cdot \frac{4}{3}\pi R^3 \cdot g$

$\frac{8\rho\pi R^4\omega^2}{tg\alpha} = N_2 + 5\rho g \cdot \frac{4}{3}\pi R^3 = N_2 - \frac{20}{3}\rho g \pi R^3 = \frac{16\rho\pi R^4\omega^2}{3}$

$N_2 = \frac{20\rho g \pi R^3 + 16\rho\pi R^4\omega^2}{3} = \frac{4\rho\pi R^3(5g + 4R\omega^2)}{3}$

Чистовик

№1.

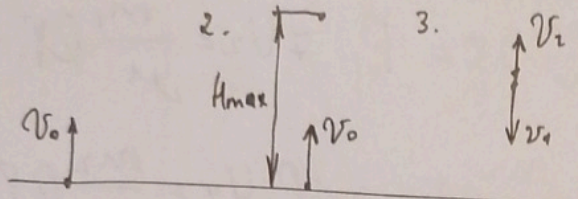
* t_1 – время полета первого мяча до H_{max}, t_2 – время полета того же мяча от H_{max} до h

Дано: v_0, g

Найти:
1) $t_1 + t_2 = ?$
2) $\frac{t_1 + t_2}{t_2} = ?$
3) $h = ?$

Решение:

1. 2. 3.



$v_к = v_0 - gt_1 = 0$

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

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

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

$H_{max} - h = \frac{g t_2^2}{2}$

$h = v_0 t_2 - H_{max} + K \rightarrow H_{max} = v_0 t_2 = g t_1 t_2 = \frac{v_0^2}{2g}$

$v_0 t_2 = \frac{v_0^2}{2g}$ $\quad 2t_2 = t_1$. $\quad \frac{t_1 + t_2}{t_2} = \frac{2t_2 + t_2}{t_2} = 3$.

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

$h = \frac{v_0 \cdot v_0}{2g} - \frac{g \cdot v_0^2}{8g^2} = \frac{4v_0^2 - v_0^2}{8g} = \frac{3v_0^2}{8g}$

Ответ: 1) $t_1 + t_2 = \frac{3v_0}{2g}$ 2) $\frac{t_1 + t_2}{t_2} = 3$ 3) $h = \frac{3v_0^2}{8g}$

(1)

Чистовик

ω^2.

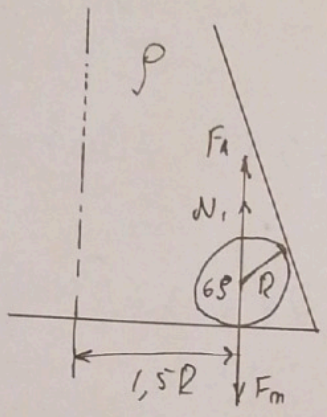
Дано: ω, R, ρ, α

Найти: 1) N_1 2) N_2

Решение:

$\omega=0 \to a=0$.

1)



$F_A + N_1 = F_m$.

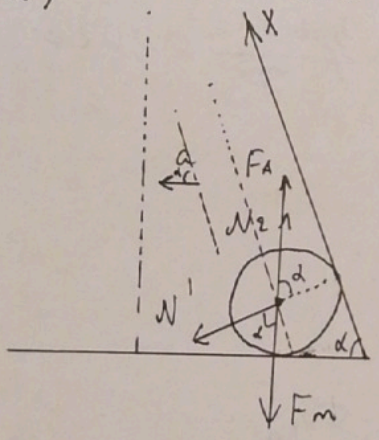
$F_A = \rho \cdot V \cdot g = \rho \cdot \frac{4}{3}\pi R^3 \cdot g$

$F_m = mg = 6\rho V g = 6 \cdot \rho \cdot \frac{4}{3}\pi R^3 \cdot g$

$N_1 = F_m - F_A = 5\rho V g =$

$= 5\rho \cdot \frac{4}{3} \cdot \pi R^3 \cdot g = \frac{20}{3}\rho g \pi R^3$

2) $\omega > 0 \to a > 0$



II з-н Ньютона:

Ox: $ma \cdot \cos\alpha = F_A \cdot \sin\alpha + N_2 \cdot \sin\alpha - mg \cdot \sin\alpha \;|:\sin\alpha$.

$\frac{ma}{tg\alpha} = F_A + N_2 - mg$

$a = \omega^2 R$

$\frac{m\omega^2 R}{tg\alpha} = \rho \cdot \frac{4}{3}\pi R^3 g + N_2 - 6 \cdot \rho \cdot \frac{4}{3}\pi R^3 g =$

$= \frac{6\rho \cdot \frac{4}{3}\pi R^3 \cdot \omega^2 R}{tg\alpha}$

$\frac{8\rho\pi R^3 \cdot \omega^2 R}{tg\alpha} = N_2 - 5\rho \cdot \frac{4}{3}\pi R^3 g$

$N_2 = \frac{16\rho\pi R^4 \omega^2}{3} + \frac{20}{3}\rho\pi R^3 g = \frac{4\rho\pi R^3(5g + 4R\omega^2)}{3}$

Ответ: 1) $N_1 = \frac{20}{3}\rho g \pi R^3$; 2) $N_2 = \frac{4}{3}\rho\pi R^3(5g + 4R\omega^2)$

Чистовик

№3.

Дано:

$T = const = 354\,K$

$V_2 = \frac{V_1}{7} = 1{,}7 V_1$

$P_2 = 3{,}6 P_1 = 3{,}6 P_1$

$P_{нп} = 0{,}5 \cdot 10^5$

$P_1 = ?$

$m_1 = ?$

Решение:

$P_1 V_1 = \frac{m_1}{\mu} RT = P_1 \cdot 7 V_2 = \frac{m_1}{\mu} RT$

$P_2 V_2 = \frac{m_2}{\mu} RT = 3{,}6 P_1 V_2 = \frac{m_2}{\mu} RT$

$\frac{7}{3{,}6} = \frac{m_1}{m_2}$ $m_1 > m_2$ → часть пара сконденсировалась → $P_2 = P_{нп}$

$P_{нп} V_2 = \frac{m_2}{\mu} RT$

$m_2 = \frac{P_{нп} \cdot V_2 \cdot \mu}{RT} = \frac{0{,}5 \cdot 10^5 \cdot 0{,}0017 \cdot 0{,}018}{8{,}31 \cdot 354} = 0{,}052 г =$

$= 0{,}052 г$

$m_1 = \frac{m_2 \cdot 7}{3{,}6} = 0{,}1 г$

$P_1 = \frac{P_2}{3{,}6} = 0{,}14 \cdot 10^5$ Па

Ответ: $P_1 = 0{,}14 \cdot 10^5$ Па $= P_1$; $m_1 = 0{,}1 г$ (3)

Часть 2

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

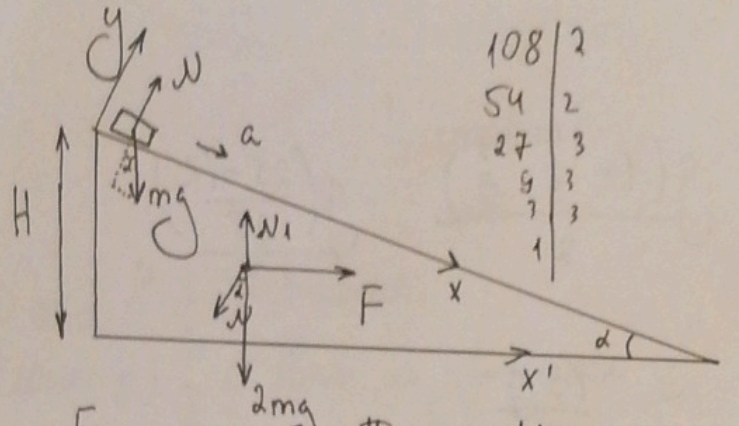
Шифр: **21206033**

ID профиля: **320397**

Вариант 2

Черновик

№ 4.



108	2
54	2
27	3
9	3
3	3
1	

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

1) Клин не двигается.

$L = \frac{L \cdot H}{H} = H \cdot \frac{1}{\sin\alpha} = \frac{H}{\sin\alpha} = \frac{5H}{4}$

$\sin\alpha = \sqrt{1 - \frac{9}{25}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$

$F_{тр} = 0$. II з-н Ньютона:

$Ox: ma = mg\sin\alpha \quad a = g\sin\alpha \frac{g(1 - \frac{4}{5}\cdot\frac{3}{5})}{2} = \frac{g \cdot 13}{50}$

$L = \overset{0}{\cancel{v_0 t}} + \frac{at^2}{2} = \frac{at^2}{2}$ $\quad t = \sqrt{\frac{2L}{a}} = \sqrt{\frac{10H}{4g\sin\alpha}} = \sqrt{\frac{2H}{\sin^2\alpha \, g}} = \sqrt{\frac{2H}{g}} \cdot \frac{1}{\sin\alpha} =$

$= \sqrt{\frac{2H}{g}} \cdot \frac{5}{4} = \sqrt{\frac{10H \cdot 5}{4 \cdot g \cdot 4}} = \frac{5}{4} \cdot \sqrt{\frac{2H}{g}}$ ✓

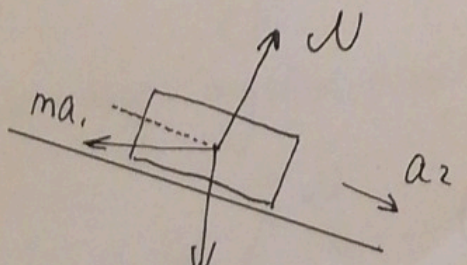
2) $F > 0$ $\quad Oy: N = mg \cdot \cos\alpha$

Ox': для клина: $2ma_1 = F - N \cdot \sin\alpha = F - mg \cdot \sin\alpha \cdot \cos\alpha = mg - mg \cdot \sin\alpha \cdot \cos\alpha$

$2ma_1 = mg - mg \cdot \sin\alpha \cdot \cos\alpha \quad a_1 = \frac{g(1 - \sin\alpha \cdot \cos\alpha)}{2}$ ✓ $= \frac{13g}{50}$

$mgH = \frac{mv_к^2}{2} \quad v_к = \sqrt{2gH} \quad v_к = at$

$t = \frac{\sqrt{2gH}}{g\sin\alpha} = \sqrt{\frac{2H}{g}} \cdot \frac{1}{\sin\alpha}$



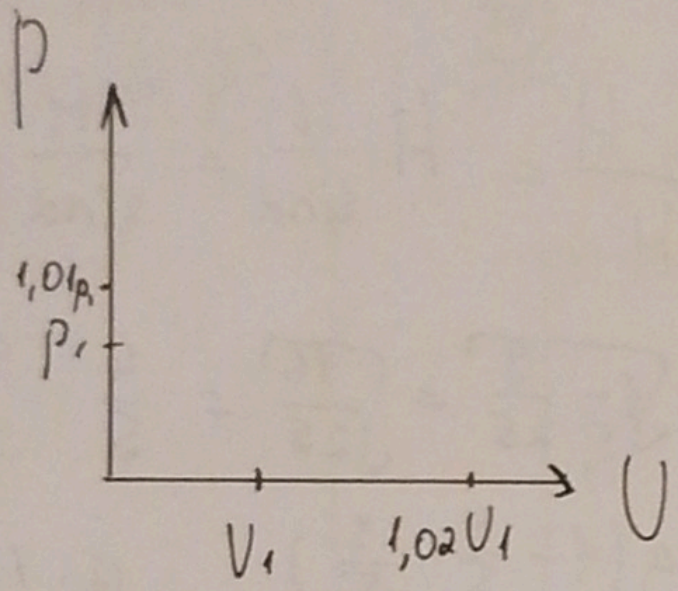
$ma_2 = mg\sin\alpha - ma_1 \cdot \cos\alpha = -\frac{13mg\cos\alpha}{5} + mg\sin\alpha$

$a_2 = -\frac{13g \cdot 3}{25} + g \cdot \frac{4}{5} = \frac{39g + 20g}{25} =$

$t' = \sqrt{\frac{10H}{4} \cdot \frac{25}{59g}} = \sqrt{\frac{75H}{118g}}$ ✓ $= \frac{5g}{25}g$

Иванова, Черновик

№5.



$$\frac{g\left(1-\frac{4}{5}\cdot\frac{3}{5}\right)}{2}=\frac{g\left(\frac{25-12}{25}\right)}{2}=$$

$$=\frac{13g}{50}$$

$$a_2=\frac{4}{5}g-\frac{13g}{50}\cdot\frac{3}{5}=\frac{200-39}{250}g=$$

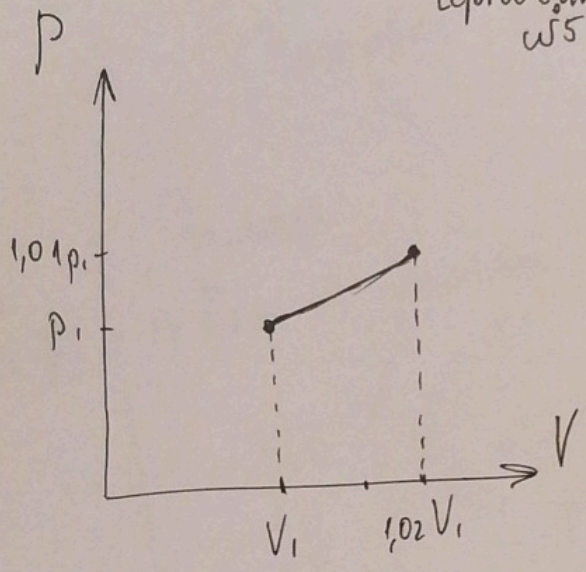
$$=\frac{161}{250}g$$

+23
 7

161

Черновик

№5



$i=3$

$P_2 = 1{,}01 P_1$

$V_2 = 1{,}02 V_1$

$P_1V_1 = \nu R T_1$

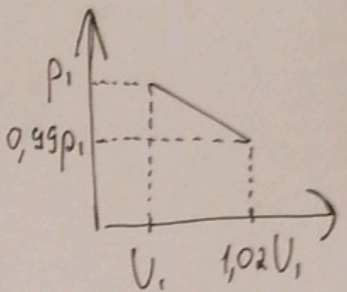
$P_2V_2 = \nu R T_2$

$1{,}01 P_1 \cdot 1{,}02 V_1 = \nu R T_2$.

$\frac{T_2}{T_1} = 1{,}0302$

$T_2 = 1{,}0302 T_1$ на 3% увеличилась T.

$i=3$.



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

$A = \frac{P_1(1+1{,}01)\cdot V_1(1{,}02-1)}{2} = \frac{P_1V_1 \cdot 2{,}01 \cdot 0{,}02}{2} = 0{,}0201 P_1V_1$

$\Delta U = \frac{i}{2}\nu R(T_2 - T_1) = \frac{i}{2}P_2V_2 - \frac{i}{2}P_1V_1 = \frac{i}{2}(1{,}01 \cdot 1{,}02)P_1V_1 - P_1V_1)$

$= \frac{i}{2} \cdot 1{,}01 \cdot P_1 \cdot 1{,}02 \cdot V_1 - \frac{i}{2}P_1V_1 = \frac{i}{2}P_1V_1(1{,}01 \cdot 1{,}02 - 1) =$

$= \frac{i}{2}P_1V_1 \cdot 0{,}0302 = 0{,}0453 P_1V_1$

$\frac{Q}{\Delta U} = \frac{0{,}0201}{0{,}0453} + 1 = 1{,}444 \approx 1{,}44$

$\frac{A}{Q} = \sim\!\!0{,}425$ ~~0~~ $0{,}575$

~~$\eta \approx 0{,}43\% \approx 42\%$~~

$0{,}0346$

$\eta \approx 0{,}58$

Чистовик

№4

Дано:

α ($\cos\alpha = \frac{3}{5}$),

H,

m,

F

$t = ?$

$a_1 = ?$

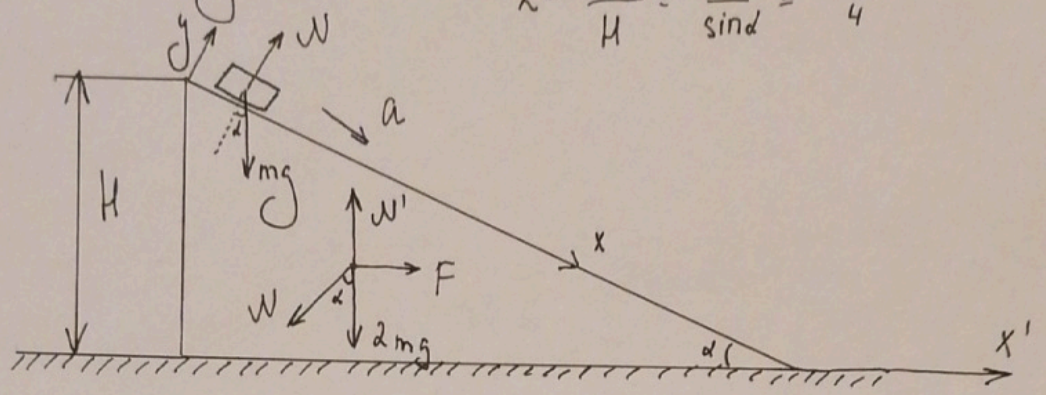
$t' = ?$

Решение:

$\cos\alpha = \frac{3}{5} \to \sin\alpha = \sqrt{1 - \frac{9}{25}} = \frac{4}{5}$

1) Клин не двигается.

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



II з-н Ньютона:

Ox: $ma = mg\sin\alpha \to a = g\sin\alpha$

$L = v_0 t + \frac{at^2}{2} = \frac{g\sin\alpha\, t^2}{2}$ ($v_0 = 0$)

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

$= \sqrt{\frac{2H}{g}} \cdot \frac{1}{\sin\alpha} = \frac{5}{4}\sqrt{\frac{2H}{g}}$

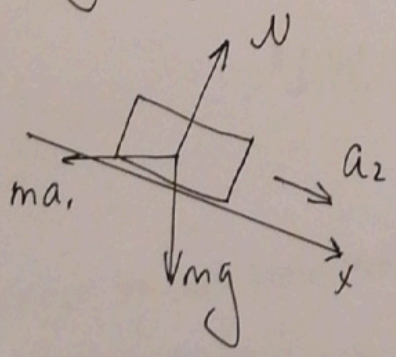
(Ответ:) * $t' = 2{,}79\sqrt{\frac{H}{2g}}$

2) $F > 0$ Ox': $2ma_1 = F - N\cdot\sin\alpha$ (для клина)

Oy: $N = mg\cdot\cos\alpha$ (для бруска)

$2ma_1 = mg - mg\sin\alpha\cdot\cos\alpha$ $\quad a_1 = \frac{g(1 - \sin\alpha\cdot\cos\alpha)}{2} = \frac{13g}{50}$

3)



Ox: $ma_2 = mg\cdot\sin\alpha - ma_1\cdot\cos\alpha$

$a_2 = \frac{4}{5}g - \frac{13g}{50}\cdot\frac{3}{5} = \frac{(200 - 39)g}{250} = \frac{161g}{125} = \frac{80{,}5g}{125}$

$t' = \sqrt{\frac{2L}{a_2}} = \sqrt{\frac{5H\cdot 125}{80{,}5g\cdot 2}} = \sqrt{\frac{25\cdot 5H}{4\cdot 3g}} = \frac{5}{6}\sqrt{\frac{5H}{3g}}$

$t' = 2{,}79\sqrt{\frac{H}{g\cdot 2}}$

Ответ: 1) $t = \frac{5}{4}\sqrt{\frac{2H}{g}}$, 2) $a_1 = \frac{13}{50}g$; 3) $t' = \frac{5}{6}\sqrt{\frac{5H}{3g}}$ $\quad t' = 2{,}79\sqrt{\frac{H}{g\cdot 2}}$

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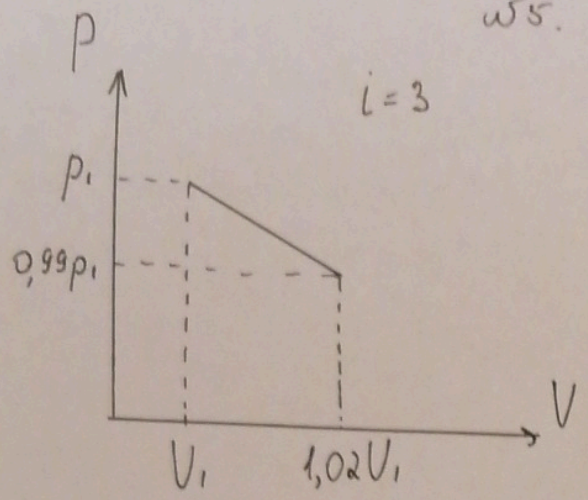
Чистовик.

№5.



Считаем, что график - прямая, т.к. все изменения очень малы.

$p_1V_1 = \nu RT_1$

$0{,}99p_1 \cdot 1{,}02V_1 = \nu RT_2$

$\frac{T_1}{T_2} = \frac{1}{1{,}0098}$ $\frac{T_2}{T_1} = 1{,}0098$

1) температура увеличилась на 1%

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

$A = \frac{p_1(1+0{,}99) \cdot V_1(1{,}02-1)}{2} = p_1V_1 \cdot 0{,}0199 \approx 0{,}02\, p_1V_1$

$\Delta U = \frac{i}{2}\nu R(T_2 - T_1) = \frac{i}{2}p_2V_2 - \frac{i}{2}p_1V_1 = \frac{i}{2} \cdot 0{,}99p_1 \cdot 1{,}02V_1 - \frac{i}{2}p_1V_1 =$

$= \frac{i}{2}p_1V_1(0{,}99 \cdot 1{,}02 - 1) = 0{,}0147\, p_1V_1$

$\frac{Q}{\Delta U} = \frac{0{,}02\, p_1V_1}{0{,}0147\, p_1V_1} + 1 = 2{,}35$

(2)

Ответ: 1) температура увеличилась на 1%

2) $\frac{Q}{\Delta U} = 2{,}35$