Часть 1

Олимпиада: **Физика, 9 класс (1 часть)**

Шифр: **21206402**

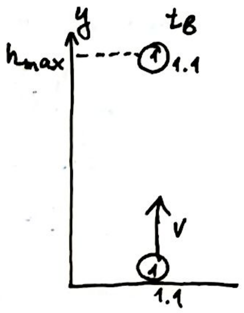
ID профиля: **173118**

Вариант 2

Чистовик

№1

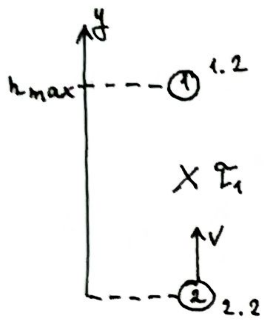
1) Сначала рассмотрим только 1ый мяч



$y_{11}(t) = Vt - \frac{gt^2}{2}$ $\quad t_в:$ $y_{11}(t_в) = h_{max}$ $\Rightarrow$ $h_{max} = \frac{V^2}{g} - \frac{V^2}{2g} = \frac{V^2}{2g}$

$V_{11}(t) = V - gt$ $\quad\quad$ $V_{11}(t_в) = 0$ $\quad\quad$ $t_в = \frac{V}{g}$

2) Теперь рассмотрим оба мяча с момента $t_в$



$y_{12}(t) = h_{max} - \frac{gt^2}{2}$

$y_{22}(t) = Vt - \frac{gt^2}{2}$

$\tau_1:$ $y_{12}(\tau_1) = y_{22}(\tau_1) \Rightarrow$

$\Rightarrow \frac{V^2}{2g} = V\tau_1 \Rightarrow \tau_1 = \frac{V}{2g} \Rightarrow V = 2g\tau_1 \Rightarrow$

$\Rightarrow t_в = 2\tau_1$

(τ_1 —) время после броска 2ого мяча до столкновения

$\tau = \tau_1 + t_в = 3\tau_1 \Rightarrow \boxed{\tau_1 = \frac{\tau}{3}}$

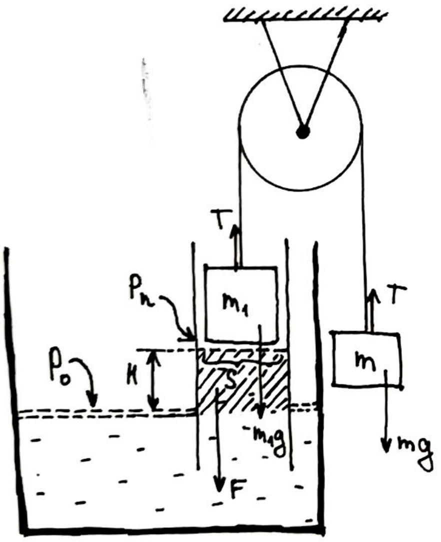
$h_{max} = \frac{V^2}{2g} = 2g\tau_1^2 = 2g \cdot \frac{\tau^2}{9} = \frac{2}{9}g\tau^2$

(↑ „9")

$V = 2g\tau_1 = \frac{2}{3}g\tau$

Ответ: 1) $\tau_1 = \frac{\tau}{3}$ 2) $h_{max} = \frac{2}{9}g\tau^2$ 3) $V = \frac{2}{3}g \cdot \tau$

№2



$S = 9\,см^2$
$H = 20\,см$
$m = 250\,г$

1) $T - mg = 0$

$T - m_1g - x = 0$

$F = H \cdot S \cdot \rho_в \cdot g \Rightarrow x = F$

$mg - m_1g - HS \cdot \rho_в g = 0$

$\Rightarrow m_1 = m - HS \cdot \rho_в = 250\,г - 20\,см \cdot 9\,см^2 \cdot 1\frac{г}{см^3} =$

$= 70\,г$

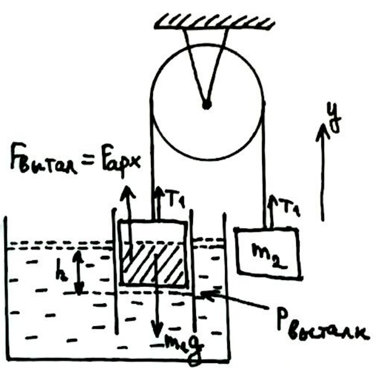
2) Пусть давление прямо под поршнем $= P_п$

$P_{на\ уровне\ воды} = P_0 = P_п + \rho_в g H \Rightarrow P_п = P_0 - \rho_в g H =$

$= 100 \cdot 10^3\,Па - 1000\,\frac{кг}{м^3} \cdot 10\,\frac{м}{с^2} \cdot 20 \cdot \frac{1}{100}\,м =$

$= 100 \cdot 10^3\,Па - 2 \cdot 10^3\,Па = 98 \cdot 10^3\,Па$

3) $m \to m_2 = \frac{m}{10} = 25\,г$



$P_{выталк} = \rho_в g h$

$\Rightarrow F_{выталк} (= F_{арх}) = P_{выталк} \cdot S = \rho_в g \cdot V_{погр.части} = \rho_в \cdot g \cdot h \cdot S$

$\left.\begin{array}{l} T_1 - m_2g = 0 \\ F_{арх} + T_1 - m_1g = 0 \end{array}\right\} \Rightarrow F_{арх} = (m_1 - m_2)g \Rightarrow h = \frac{m_1 - m_2}{S \cdot \rho_в} = \frac{45\,г}{-\shortparallel-} =$

$= \frac{45\,г}{1\frac{г}{см^3} \cdot 9\,см^2} = 5\,см^1$

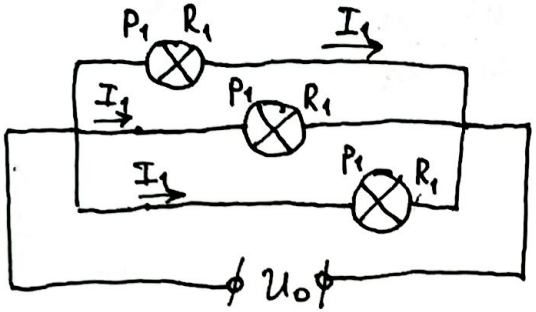
Ответы: 1) $98 \cdot 10^3\,Па$; 2) $70\,г$; 3) $5\,см$ (если по оси Oy, то, если 0 - уровень воды и было $H = 20\,см$, то $h = -5\,см$)

Чистовик

№3

Лампочки накаливания

1)



$P_1 = U_0 \cdot I_1 \Rightarrow I_1 = \frac{P_1}{U_0} = 0{,}4\,А$

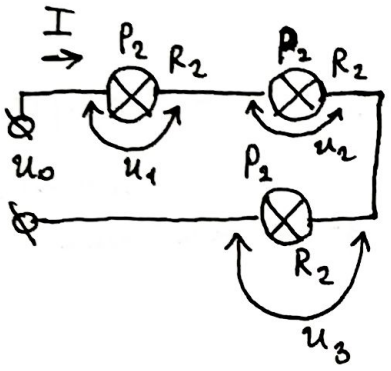
$I = \frac{\Delta q}{\Delta t}$

$U = \frac{A_{1\to 2}}{\Delta q}$

$A_{1\to 2} = I \cdot U \cdot \Delta t$

$P = \frac{A_{1\to 2}}{\Delta t} = I \cdot U = \frac{U^2}{R} = I^2 R$

2)



$P_2 = I^2 R_2 = U_1 \cdot I \Rightarrow U_1 = I R_2$

$= I^2 R_2 = U_2 \cdot I \Rightarrow U_2 = I R_2$

$= U_3 \cdot I \Rightarrow U_3 = I R_2$

$\Rightarrow U_1 + U_2 + U_3 = 3U_1 = U_0$

$\Rightarrow U_1 = \frac{U_0}{3} \Rightarrow$

$\Rightarrow P_2 = U_1 \cdot I = \frac{U_0}{3} \cdot I \Rightarrow I = \frac{3P_2}{U_0} = \frac{1{,}5\,Вт}{6\,В} = 0{,}25\,А$

3) $U_0 \to \frac{U_0}{3}$ (R₁) $\Rightarrow I_1 \to \frac{I_1}{3}$

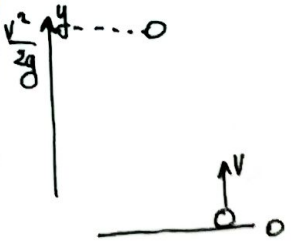
$P_2 = 0{,}5\,Вт \quad — \quad R_2 = \frac{P_2}{I^2} = 8\,\Omega$

$P_1 = 2{,}4\,Вт \quad — \quad R_1 = \frac{P_1}{I_1^2} = 15\,\Omega$

$\frac{1}{9} \cdot P_1 = \frac{8}{30}\,Вт$

Ответ: 1) 0,4 А 2) 0,25 А 3) $\frac{8}{30}$ Вт

№1



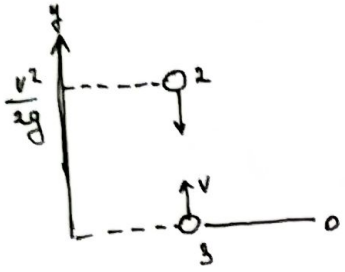
$y_1(t) = Vt - \frac{gt^2}{2}$

$V_1(t) = V - gt$

$t_к$: $V_1(t_к) = 0 \Rightarrow V = g t_к \Rightarrow t_к = \frac{V}{g}$

$y_1(t_к) = \frac{V^2}{g} - \frac{V^2}{2g} = \frac{V^2}{2g}$

Черновик



$y_2(t) = \frac{V^2}{2g} - \frac{gt^2}{2}$

$y_3(t) = Vt - \frac{gt^2}{2}$

$y_2(\tau) = y_3(\tau) \Rightarrow$

$\Rightarrow \frac{V^2}{2g} - \frac{g\tau^2}{2} = V\tau - \frac{g\tau^2}{2}$

$\Rightarrow \tau = \frac{V}{2g}$ $\quad V = \tau \cdot 2g$

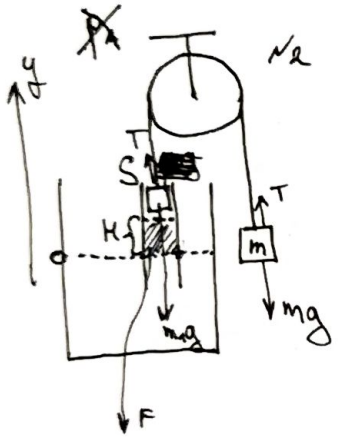
$\Rightarrow$ чтобы y_2 ого $= \tau = \frac{V}{2g}$

$h_{max} = \tau^2 \cdot 2g$

$V = 2g\tau$

$\frac{T - mg - F -}{S} =$

$= m - m_1 - 180г$



Равновесие $\Rightarrow T - mg = 0$

$T - m_1 g - X = 0$

$F = H \cdot S \cdot \rho_в \cdot g \quad \Rightarrow X = F \quad \Rightarrow T - m_1 g - F = 0$

$mg - m_1 g - HS\rho_в g = 0$

1) $m_1 = m - HS\rho_в = 70г$

3)

$T - m_1 g$ 2) $P_0 -$

$g = \frac{кг \cdot м}{с^2}$

$\frac{g}{100} \cdot 1000 =$

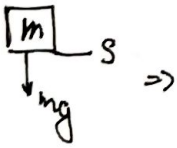
$g = \frac{1000г \cdot 100см}{с^2}$

$180 \cdot \frac{1}{100} = 0,18$

$m_1 = 0,25 - g \cdot (\frac{1}{1000})^2 \cdot 20 \cdot (\frac{1}{100}) \cdot$

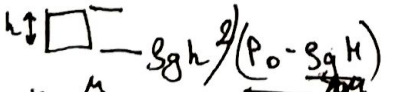
$\cdot 1000 \cdot 10$

$m_1 = 70г$



$\Rightarrow \frac{mg}{S}$

$g\,см^2 \cdot 20см \cdot 1г/см^3 = 180г$

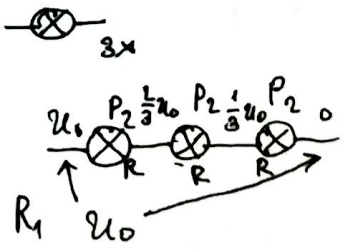


$P = \frac{F}{S} = \left[\frac{Н}{м^2} = \frac{кг \cdot м}{с^2 \cdot м^2} = \frac{кг}{с^2 \cdot м} = Па\right]$

2000 Па

$100 \cdot 10^3 \frac{кг}{с^2 \cdot м} - 1000 \frac{кг}{м^3} \cdot 10 \frac{м}{с^2} \cdot 2 \cdot \frac{1}{100} м$

$100\,000 - 2000 = 98\,000$ Па



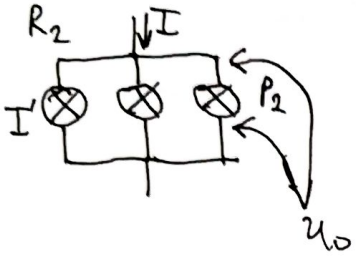
$I = \frac{\Delta q}{\Delta t}$

$U = \frac{A_{1\to 2}}{\Delta q} \Rightarrow A_{1\to 2} = U \cdot I \cdot \Delta t$ (работа)

$P = \frac{A_{1\to 2}}{\Delta t} = U \cdot I = I^2 R = \frac{U^2}{R}$

$\frac{U_0}{3R} = I \Rightarrow P_2 = I^2 \cdot R = \frac{U_0^2}{9R}$

Черновик



$\frac{1}{R_{общ}} = \frac{3}{R} \Rightarrow R_{общ} = \frac{R}{3} \Rightarrow I = \frac{U_0}{R_{общ}} = 3\frac{U_0}{R}$

$I' = \frac{U_0}{R} \Rightarrow P_1 = \frac{U_0^2}{R}$

$I = \frac{U_0}{3R} \Rightarrow U_0 - IR =$

1) $P_1 = U_0 I' \Rightarrow I' = \frac{P_1}{U_0}$

2) $P_2 = \frac{1}{3}U_0 \cdot I'' \Rightarrow I'' =$

3) $\frac{U_0^2}{9R_1} = 0{,}5$

$\frac{U_0^2}{R_2} = 2{,}4 = 0{,}5 \cdot 5 - 0{,}1$

$P = \frac{A}{\Delta t}$

$A = P \cdot \Delta t = c \cdot \Delta T$

$\frac{U_0}{3}$ R_3 $\Rightarrow$ I ↓ в 3 р.

$\frac{0{,}5}{2} = 0{,}25$

$\frac{1}{3}$.

P ⇒ R

$R = \frac{P}{I^2} = \frac{(U_0/3)^2}{P_x}$

45 г · g ↓

P_x $I = \frac{U_0}{R}$

$\frac{(U_0/3)^2}{R}$

$\rho_в g h \cdot S$ $\rho g V_n$

$\frac{24}{10} = \frac{240}{10} = \frac{120}{8} = \frac{60}{4} = 15$

P_2 $\frac{16}{100}$ $\frac{1/2}{(1/4)^2} = \frac{1/2}{1/16} = 8$

$\frac{2{,}4}{(\frac{4}{10})^2} =$

Часть 2

Олимпиада: **Физика, 9 класс (2 часть)**

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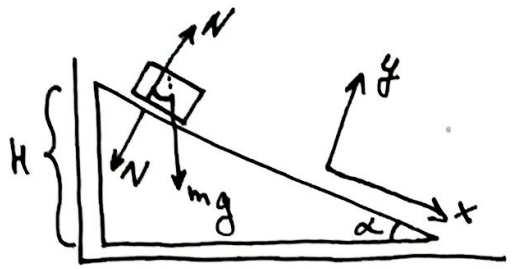
Вариант 2

Чистовик

№4

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

1)

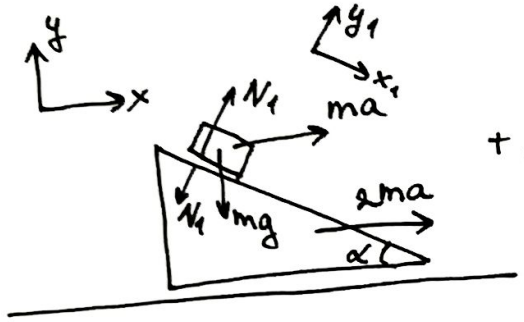


$$\left.\begin{aligned} -mg\cdot\cos\alpha + N = 0 \\ mg\cdot\sin\alpha = m\cdot a \end{aligned}\right\} \Rightarrow a = g\sin\alpha$$

$$S = H/\sin\alpha \quad \Rightarrow \quad \frac{at^2}{2} = S \quad \Rightarrow \quad t = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2H}{g\sin^2\alpha}} =$$

$$= \sqrt{\frac{2H}{\frac{16}{25}g}} = \frac{5}{2}\sqrt{\frac{H}{2g}}$$

2)



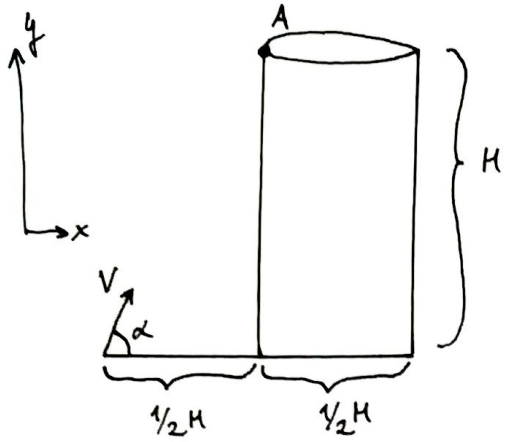
$+_{\parallel}$ $\xrightarrow{a_1}$ $\parallel$ a_1 | клин остановится

$$\begin{cases} 2ma_1 - N_1\cdot\sin\alpha = 0 \\ N_1 + ma_1\cdot\sin\alpha - mg\cdot\cos\alpha = 0 \end{cases} \Leftrightarrow \begin{cases} N_1 = \frac{2ma_1}{\sin\alpha} \\ a_1 = g\cdot\frac{\cos\alpha}{\frac{2}{\sin\alpha} + \sin\alpha} \end{cases} = g\frac{\frac{3}{5}}{\frac{5}{2}+\frac{4}{5}} = g\frac{3}{\frac{25}{2}+4} = \frac{6}{33}g = \frac{2}{11}g$$

Ox_1: $ma_1\cos\alpha + mg\sin\alpha = ma_{x_1} \Rightarrow a_{x_1} = \frac{3}{5}\cdot\frac{2}{11}g + \frac{4}{5}g = \frac{6+44}{55}g = \frac{10}{11}g$

$$\frac{a_{x_1}t_1^2}{2} = S \Rightarrow t_1 = \sqrt{\frac{2S}{a_{x_1}}} = \sqrt{\frac{2H}{\sin\alpha\cdot\frac{10}{11}g}} = \sqrt{\frac{11H}{4g}}$$

Ответ: $t = \frac{5}{2}\sqrt{\frac{H}{2g}}$; $a_1 = \frac{2}{11}g$; $t_1 = \sqrt{\frac{11H}{2g}}$



$V_y(t) = V\cdot\sin\alpha - gt$

$V_x(t) = V\cdot\cos\alpha$

$y(t) = V\cdot\sin\alpha\cdot t - \frac{gt^2}{2}$

$x(t) = V\cos\alpha\, t$

2) t_A: $\begin{cases} y(t_A) = H \\ x(t_A) = \frac{1}{2}H \end{cases} \Leftrightarrow$

$\Leftrightarrow \begin{cases} V\sin\alpha\cdot t_A - \frac{gt_A^2}{2} = H \\ V\cos\alpha\, t_A = \frac{1}{2}H \end{cases} \Leftrightarrow \begin{cases} \frac{H\cdot\sin\alpha}{2\cos\alpha} - \frac{gH^2}{8V^2\cos^2\alpha} = H \\ t_A = \frac{H}{2V\cos\alpha} \end{cases}$

Решим (1): $tg\alpha\cdot\frac{H}{2} - \frac{gH^2}{8V^2}\cdot(1+tg^2\alpha) = H \Leftrightarrow$

$\Leftrightarrow tg\alpha\cdot\frac{H}{2} - \frac{H}{20} - tg^2\alpha\cdot\frac{H}{20} = H \Leftrightarrow$

$\Leftrightarrow H tg^2\alpha - 10H tg\alpha + 21H = 0$

$tg^2\alpha - 10\,tg\alpha + 21 = 0$

$(tg\alpha - 7)(tg\alpha - 3) = 0$

$tg\alpha = 7 \vee 3$

(при 3 струя не попадает в бочку)

$\frac{gH^2}{8\cdot 2{,}5gH} = \frac{H}{20}$

3) min $\angle\alpha$ – тот угол, при котором вершина параболы полёта струи ≡ с т. A

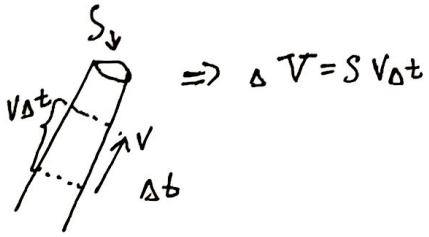
(если $\angle\alpha$ ещё меньше, то V_y при $t_{начальн}$ будет ↓ ⇒ $t_{полёта\ до\ верш}$ будет меньше : $V_y(t_в) = 0 \Rightarrow t_в = \frac{V\sin\alpha}{g} \Rightarrow y(t_в) = \frac{V^2\sin^2\alpha}{2g}$ будет $< H$ при $V < V_{крит\ при\ \angle\alpha}$)

⇒ ищем min $\angle\alpha$: $\frac{V^2\sin^2\alpha}{2g} = H \Rightarrow \sin^2\alpha = \frac{2gH}{V^2} = \frac{2gH}{2{,}5gH} = \frac{2}{2{,}5} = \frac{4}{5}$

$\Rightarrow \cos^2\alpha = \frac{1}{5} \Rightarrow 1 + tg^2\alpha = 5 \Rightarrow tg^2\alpha = 4$

(больше тангенс – больше угол) ⇒ диапазон тангенсов: $[4;7]$

1) $x(t_з) = V\cdot\cos\alpha\cdot t_з = H \Rightarrow t_з = \frac{H}{V\cdot\cos\alpha}$



$\Rightarrow \Delta V = S\,V\,\Delta t$

$V_б = H\cdot\left(\frac{1}{4}H\right)^2\pi = \pi\frac{H^3}{16}$

$\sum\Delta V = V_б \Rightarrow S\,V\,\sum\Delta t = V_б = \pi\frac{H^3}{16}$

$\Rightarrow t_x = \frac{\pi H^3}{16SV}$

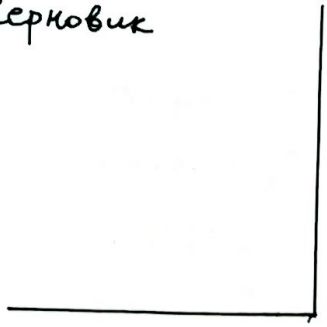
$t_{общ\ заполн} = t_з + t_x = \frac{H}{V\cdot\cos\alpha} + \frac{\pi H^3}{16SV}$

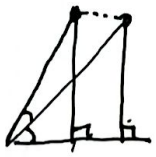
Ответ: 1) если учит время полёта струи до начала заполн. бочки, то $\frac{H}{V\cdot\cos\alpha} + \frac{\pi H^3}{16SV}$;

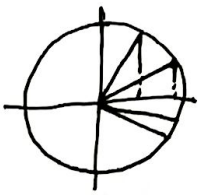
если не учит, то $t_x = \frac{\pi H^3}{16SV}$ ← конечный ответ. ;

2) $tg\alpha = 7 \vee 3$; 3) $[4;7]$

Черновик





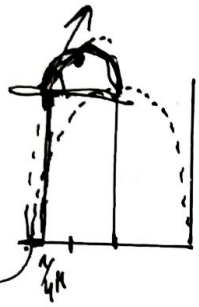


$\sin^2\alpha - \sin^4\alpha = 0^2$

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

$\sin\alpha \cdot \sqrt{} = 0$

$\sin(2k) = \sin k \cos k \cdot 2$



$V_y(t) = V\cdot\sin\alpha - gt$

$t_в = \frac{V}{g}\cdot\sin\alpha$

$x(t_в) = V\cdot\cos\alpha = \frac{V^2}{g}\cdot\sin\alpha\cdot\cos\alpha = \frac{1}{4}H$

$\frac{\sin(2\alpha)}{2}$

$x(t_x)$

$4\cdot 6{,}25 g^2H^2$

$V^2 = 2{,}5gH$

$V - gt \quad t = \frac{V}{g}$

$\frac{g^2H^2}{2V^4}$

$(2\cdot 2{,}5)^2 = 5^2$

$5gH$

$\frac{V^2}{g}$

$\sin\alpha\cdot\sqrt{} = \frac{gH}{4V^2}$

$\sin^2\alpha - \sin^4\alpha = \frac{g^2H^2}{2V^4}$

$\sin^4\alpha - \sin^2\alpha + = 0$

$y(t) = \sin\alpha V t - \frac{gt^2}{2}$

$x(t) = V\cdot\cos\alpha t$

$\Delta = 1 - \frac{g^2H^2}{4V^4} =$

$= \frac{4V^4 - g^2H^2}{4V^4} = \frac{5^2 g^2H^2}{4V^4}$

$y(t_x) = H \Rightarrow t_x$ берём min

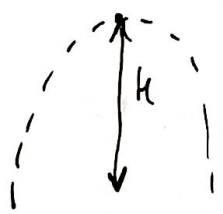
$\Rightarrow x(t_x)$

$\sin^2\alpha = \frac{1 \pm \sqrt{\Delta}}{2} = \frac{1 \pm \frac{5gH}{2V^2}}{2}$

$\frac{2V^2 \pm 5gH}{4V^2}$

$V_y(t_в) = 0$

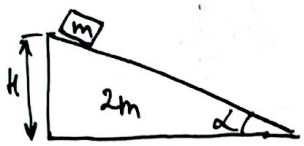
$t_в = \frac{V\cdot\sin\alpha}{g}$

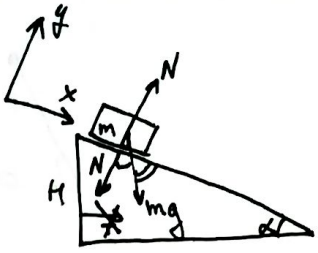


$y(t_в) = \frac{V^2\sin^2\alpha}{g} - \frac{gV^2\sin^2\alpha}{2g^2} = \frac{V^2\sin^2\alpha}{2g}$

$\frac{20gH}{4V^2}$

Черновик





$\cos\alpha \cdot mg = N$

$mg \cdot \sin\alpha = ma_x$

$a_x = g \cdot \sin\alpha$

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

$\xrightarrow{a}$

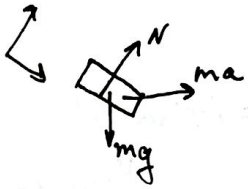
$N \cdot \sin\alpha \Rightarrow \frac{\sin\alpha \cos\alpha mg}{2m} = a_1$

$\frac{a_x t^2}{2} = S \Rightarrow t = \frac{2S}{a_x} = \frac{2H}{g\sin^2\alpha}$

$\sin\alpha \cdot N = 2ma$

$1 - \cos^2 = \sin^2$

$\Rightarrow \sin\alpha = \frac{4}{5}$

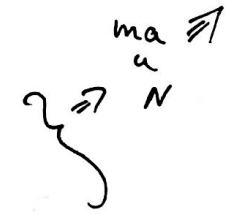


$ma \cdot \sin\alpha + N - mg \cdot \cos\alpha = 0$

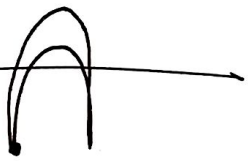
$\begin{cases} \sin\alpha N = 2ma \\ ma\sin\alpha + N - mg\cos\alpha = 0 \end{cases}$

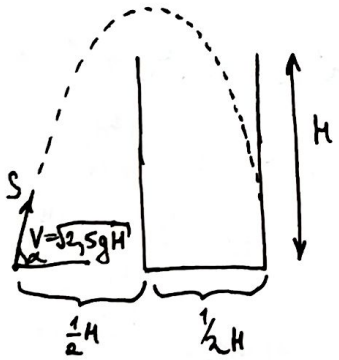
$N = \frac{2ma}{\sin\alpha} =$

$ma = mg \cdot \frac{\cos\alpha}{\sin\alpha + \frac{2}{\sin\alpha}}$



$\frac{3/5}{4/5 + \frac{2}{4/5}} = \frac{3/5}{\frac{4}{5} + \frac{10}{4}} = \frac{3}{4 + \frac{25}{2}} = \frac{6}{33}$





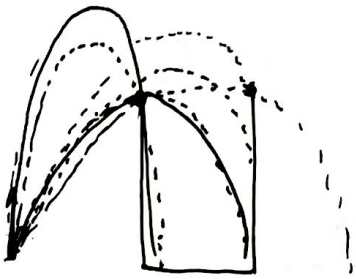
Δt $S \cdot V \cdot \Delta t = \Delta V$

$\frac{1}{\cos\alpha \cdot (-11)} = 10$

$y(t) = V\sin\alpha \cdot t - \frac{gt^2}{2}$

$x(t) = V\cos\alpha \cdot t$

t_n : $x(t_n) = H$ $\quad t_n = \frac{H}{V\cos\alpha}$



τ: $y(t) \in [0; H]$

$x(t) \in$

$V = \frac{1}{2}\sqrt{\frac{gH}{\cos\alpha \cdot (\sin\alpha - 2\cos\alpha)}}$

$y(\tau) = \begin{cases} V\sin\alpha \cdot \tau - \frac{g\tau^2}{2} = H \\ x(\tau) = V\cos\alpha \cdot \tau = \frac{1}{2}H \end{cases}$

$\tau = \sqrt{V \cdot \frac{\sin\alpha - 2\cos\alpha}{g} \cdot 2}$

$\tau^2 \frac{g}{2} + V\tau(2\cos\alpha V - V\sin\alpha) = 0$

$\tau = 0$?