Часть 1

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

Шифр: **21204226**

ID профиля: **872899**

Вариант 2

(1) Листовик

№1

Дано: Си: Р-е:

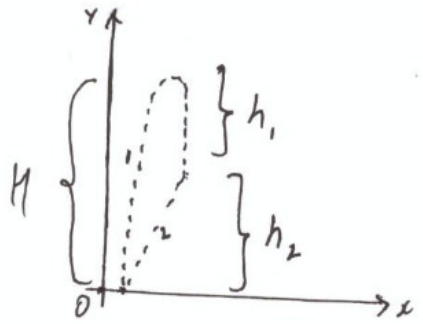
V_0

Найти:

$t+t_1$

$\frac{t+t_1}{t_1}$

h_2



Пусть время на $h_1 = t_1$; на $h_2 = t_2$; на $H = t$

Путь первого мячика $= S$

$S = H + h_1$

Путь второго мячика $= h_2$

$$\begin{cases} H = V_{0y} t - \frac{g t^2}{2} = V_0 t - \frac{g t^2}{2} \\ H = \frac{0 - V_0^2}{-2g} = \frac{V_0^2}{2g} \end{cases}$$

$$\Rightarrow V_0 t - \frac{g t^2}{2} = \frac{V_0^2}{2g}$$

$$+\frac{g t^2}{2} + V_0 t - \frac{V_0^2}{2g} = 0 \quad | \cdot 2g$$

$$g^2 t^2 - 2 V_0 g + V_0^2 = 0$$

$$D = b^2 - 4ac = 4V_0^2 g^2 - 4V_0^2 g^2 = 0$$

$$t = \frac{-b}{2a} = \frac{2V_0 g}{2g^2} = \frac{V_0}{g}$$

1) $t + t_1 = 3t_1 = \frac{3V_0}{g}$ ($t = 2t_1$; т.к. $t_1 = t_2$ исходя из усл. задачи)

2) $\frac{t+t_1}{t_1} = \frac{\frac{3V_0}{g}}{\frac{2V_0}{g}} = 1{,}5 \cdot 2 = 3$

3) $h_2 = V_{0y} t_2 - \frac{g t_2^2}{2} = V_0 \cdot \frac{t}{2} - g \cdot \frac{t^2}{4} = V_0 \cdot \frac{0{,}5 V_0^2}{g} - \frac{0{,}25 V_0^2}{2g} = \frac{V_0^2 - 0{,}25 V_0^2}{2g} = \frac{0{,}75 V_0^2}{2g} = 0{,}375 \frac{V_0^2}{g}$

Ответ: 1) $1{,}5 V_0/g$; 2) 3; 3) $0{,}375 V_0^2/g$

(2) Чистовик

№2

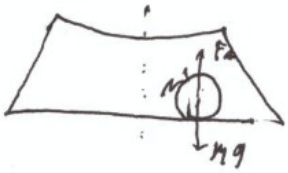
Дано: см. рис.

ω

$\rho_б = \rho$

$\rho_ш = 6\rho$

$R' = 1{,}5R$



1) $F_A = \rho g V_ш = \rho_б g \cdot \frac{4}{3}\pi R^3$

$mg = \rho_ш V_ш g = \rho_ш \frac{4}{3}\pi R^3 g$

$N = \rho_ш \frac{4}{3}\pi R^3 g - \rho_б \frac{4}{3}\pi R^3 g = 6\rho \cdot \frac{4}{3}\pi R^3 g - \rho \frac{4}{3}\pi R^3 g =$

$= \frac{4}{3}\pi R^3 \rho g (6-1) = \frac{20}{3}\rho g \pi R^3$

2) $N' = mg + ma - F_A = (mg - F_A) + ma = N + ma$

$a = \frac{v^2}{R'} = \frac{\omega^2 R'^2}{R'} = \omega^2 R'$

$N' = \frac{20}{3}\rho g \pi R^3 + \frac{4}{3}\pi R^3 \cdot 6\rho \cdot \omega^2 1{,}5R = \frac{20}{3}\rho g \pi R^3 +$

$+ 12\pi R^4 \rho \omega^2$

Ответ: 1) $\frac{20}{3}\rho g \pi R^3$

2) $\frac{20}{3}\rho g \pi R^3 + 12\pi R^4 \rho \omega^2$

(3) Zacтобан

№3

Дано: СИ Р-ие

$V_2 = 1,7\ л$

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

$T = const = 354\ K$

$P_2 = 3,6\ P_1$

$P_{нп} = 0,5 \cdot 10^5\ Па$

$V_1 = 7 \cdot V_2 = 11,9\ л$

1) $\begin{cases} P_1 V_1 = \nu_1 R T \\ P_2 V_2 = \nu_2 R T \end{cases}$

$\Rightarrow \frac{P_1 V_1}{P_2 V_2} = \frac{m_1}{m_2} = \frac{1 \cdot 7}{3,6} = 1,94$

$\varphi = 1$ (при $V' = V_1 : 3,6 = 3,31\ л$)

$P_{нп} = P_{п_2} = 0,5 \cdot 10^5\ Па$

$P_{п_2} = P_{п_1} \cdot 3,6$

$P_{п_1} = \frac{P_{п_2}}{3,6} \approx 0,14 \cdot 10^5\ Па$

2) $m_2 = \frac{P_2 V_2 M}{R T} = \frac{0,5 \cdot 10^5\ Па \cdot 1,7 \cdot 10^{-3}\ м^3 \cdot 18 \cdot 10^{-3}\ \frac{кг}{моль}}{8,31\ Дж/(К \cdot моль) \cdot 354\ К} \approx$

$\approx 0,52\ г$

$m_1 = 1,94 \cdot m_2 = 1\ г$

Ответ: 1) $0,14 \cdot 10^5\ Па$

2) $1\ г$

~~Задача~~ Задача

$T = const = 354\ K$

$V_1 = 11{,}9\ л$

$V_2 = 1{,}7\ л$

$P_2 = 3{,}6 P_1$

$P_{нп} = 0{,}5 \cdot 10^5\ Па$

$$\begin{cases} P_1 V_1 = \nu_1 R T \\ P_2 V_2 = \nu_2 R T \end{cases}$$

$$\vdots \begin{cases} P_1 V_1 = \frac{m_1}{M} R T \\ P_2 V_2 = \frac{m_2}{M} R T \end{cases}$$

$$\frac{P_1 V_1}{P_2 V_2} = \frac{m_1}{m_2}$$

$$\frac{1 \cdot 7}{3{,}6} = \frac{m_1}{m_2} = 1{,}94$$

$$P_2 V_2 = \frac{m_2}{M} R T$$

$$m_2 = \frac{P_2 V_2 M}{R T} \to 5{,}2\ г$$

$m_1 = 1\ г.$

$0{,}52\ г$

$$\frac{0{,}5 \cdot 10^5\ Па \cdot 1{,}7 \cdot 10^{-3} \cdot 18 \cdot 10^{-3}}{35{,}4 \cdot 10 \cdot 0{,}31} = \frac{0{,}5 \cdot 1{,}7 \cdot 18}{35{,}4 \cdot 8{,}31} =$$

$$= \frac{0{,}5 \cdot 10^5 \cdot 1{,}7 \cdot 10^{-3} \cdot 18}{354 \cdot 0{,}31} \cdot 10$$

$$\frac{P_1}{t_1} = \frac{P_2}{t_2} \quad \frac{100}{100}$$

$P_1 = 0{,}81$

$P_n = 0{,}905 \cdot 10^5\ Па$

$$3{,}6 P_1 \cdot \frac{V_1}{3{,}6} = \frac{m}{M} R T$$

$$P_1 V_1 = \frac{m R T}{M}$$

$3{,}6 P_1 \cdot 3{,}31 = P_1 \cdot 11{,}9$

$$\varphi = \frac{P_n}{P_{нп.}}$$

$$\varphi = \frac{P_n}{P_{н.п.}}$$

$\varphi = 1 \ (V_2 = 3{,}31)$

$P_{нп} = P_{n_2} = 0{,}5 \cdot 10^5\ Па$

$P_{n_2} = P_{n_1} \cdot 3{,}6 = 0{,}14 \cdot 10^5\ Па$

$\varphi = 28\%$

Черновик

$\omega = w$

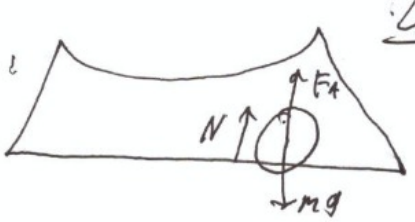
$\rho_б = \rho$

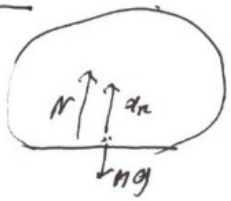
$\rho_м = 6\rho$

R

$R' = 1{,}5R$

$\operatorname{tg}\alpha = \frac{3}{2}$





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

$mg = \rho_м \cdot V_м \cdot g$

$\rho_б g \cdot \frac{4}{3}\pi R^3 = \rho_м g \cdot \frac{4}{3}\pi R^3$

$N + F_A = mg$

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

$= \frac{4}{3}\pi R^3 \rho g (6-1) = \frac{20}{3}\rho g \pi R^3$

$N =$

~~$ma = N$~~

$N = mg + mg - F_A = 2 \cdot N' + mg$

$a = \frac{v^2}{R} = w^2 R$

$= w^2 \cdot 2{,}5R \qquad m = \frac{4}{3}\pi R^3 \cdot 6\rho$

$\frac{20}{3}\rho g \pi R^3 + \frac{24}{3}\pi R^3 \rho \qquad N = \frac{20}{3}\rho g \pi R^3 + 2{,}5 \cdot w^2 R$

$R\left(\frac{20}{3}\rho g \pi R^2 + 2{,}5 w^2\right)$

Черновик

$H = \frac{V_0^2}{2g}$

$\frac{V_0^2}{2g} = V_0 t + \frac{g t^2}{2}$

$V_0 t + \frac{g t^2}{2} - \frac{V_0^2}{2g} = 0$

$2 V_0 g t + g^2 t^2 - V_0^2 = 0$

$g^2 t^2 + 2 V_0 g t - V_0^2 = 0$

$D = b^2 - 4ac = 4 V_0^2 g^2 + V_0^2 4g^2 = 8 V_0^2 g^2$

$t = \frac{-2V_0 g + 2V_0 g\sqrt{2}}{4V_0 g} =$

$= \frac{2V_0 g(\sqrt{2}-1)}{4V_0 g}$

$\frac{\sqrt{2}-1}{2} =$

$\frac{\sqrt{2}}{2} - \frac{1}{2} = 0{,}71 - 0.$

$h = y = y_0 + v_{0y} t - \frac{g t^2}{2}$

$h = V_{0y} t_1 - \frac{g t_1^2}{2}$

$\frac{g t_2^2}{2} = V_{0y} t_2 - \frac{g t_2^2}{2}$

$t_2 = \sqrt{\frac{2h_1}{g}}$

$h_2 = V_{0y} t_2 - \frac{g t_2^2}{2}$

$h_2 = V_{0y}\sqrt{\frac{2h_1}{g}} - \frac{g\frac{2h_1}{g}}{2}$

$h_2 = V_{0y}\frac{\sqrt{2h_1}}{\sqrt{g}} - h_1$

$H = h_2 + h_1 = V_{0y}\frac{\sqrt{2h_1}}{\sqrt{g}}$

$H = V_{0y} t - \frac{g t^2}{2}$

$H = 2V_{0y}\sqrt{\frac{2h_1}{g}} - g\frac{4 \cdot 2h_1}{2g}$

$H = 2V_{0y}\frac{\sqrt{2h_1}}{\sqrt{g}} - 4h_1$

$H^2 = 4V_{0y}^2 \frac{2h_1}{g} - 16 V_{0y}$

$h = \frac{V_0^2}{2g}$

$h = \frac{g t_1^2}{2}$

$g t_1^2 = \frac{V_0^2}{g}$

$t_1^2 = \frac{V_0^2}{g^2}$

$t_1 = \frac{V_0}{g}$

1) $T = 3t_1 = \frac{3V_0}{g}$

2) $= 3$

$h_2 = \frac{V_0^2}{2g} =$

$h = g\frac{\frac{V_0^2}{g^2}}{2} = \frac{V_0^2}{2g}$

$$H = V_0 t - \frac{g t^2}{2}$$

$$H = \frac{V_0^2}{2g}$$

$$V_0 t - \frac{g t^2}{2} - \frac{V_0^2}{2g} = 0$$

$$2 V_0 g t - g^2 t^2 - V_0^2 = 0$$

$$g^2 t^2 - 2 V_0 g t + V_0^2 = 0$$

$$D = b^2 - 4ac = 4 V_0^2 g^2 - 4 V_0^2 g^2 = 0$$

$$t = \frac{2 V_0 g}{2 g^2} = \frac{V_0}{g}$$

$$V_0 t_1 - \frac{g t_1^2}{2} \qquad \frac{V_0 \cdot 0{,}5 V_0}{g} - g \cdot \frac{0{,}25 V_0^2}{2 g^2}$$

$$V_0 \cdot \frac{0{,}5 V_0}{g} - \frac{g \cdot 0{,}25 V_0}{2 g}$$

$$\frac{3 V_0}{2 g} - \frac{1{,}25 V_0}{2 g} = 0{,}75 V_0 / 2 g$$

Часть 2

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

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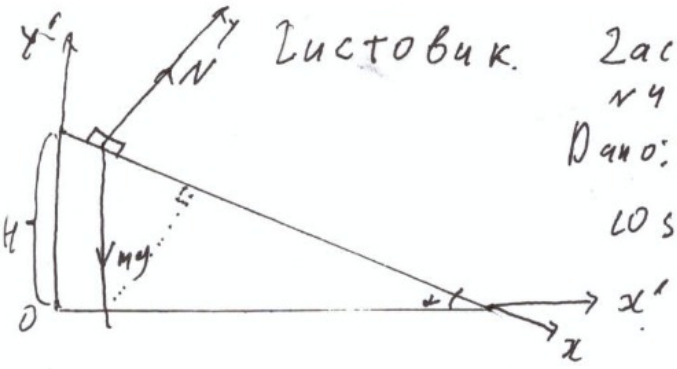
Вариант 2

Листовик. Задача 11

№ 4



Дано:

$\cos\alpha = \frac{3}{5}$; $M_{клина} = 2m$; $m_{шарика} = m$.

1) $ma_1 = mg\sin\alpha$

$a_1 = g\sin\alpha$

$H = \frac{V_0^2 - V_1^2}{-2g} = \frac{V_1^2}{2g}$; $\rightarrow V = \sqrt{2gH}$

$V_2 = at_1$

$V_1 = V_2$ (Т.к. трение и иные силы сопротивления отсутствует)

$a_1 t_1 = \sqrt{2gH}$

$t_1 = \frac{\sqrt{2gH}}{a_1} = \frac{\sqrt{2gH}}{g\sin\alpha} = \sqrt{\frac{2gH}{g^2\sin^2\alpha}} = \sqrt{\frac{2H}{g\sin^2\alpha}}$; $\sin^2\alpha = 1 - \cos^2\alpha = \frac{16}{25}$

$t_1 = \sqrt{\frac{2 \cdot H}{10g \cdot \frac{16}{25}}} = \sqrt{\frac{25H}{8g}} = \sqrt{\frac{25H}{8 \cdot 10\frac{м}{с^2}}} = \sqrt{\frac{5H}{16}}$ $c = \frac{\sqrt{5H}}{4}$ $c \approx 0{,}56\sqrt{H}$

2) $\vec{F} = M\vec{a}_к$

OX' ; $F = Ma_к$

$mg = Ma_к$

$mg = 2ma_к \rightarrow a_к = g/2 = 5\frac{м}{с^2}$

3) $t_2 = \frac{V}{a_2} = \frac{\sqrt{2gH}}{a_2}$; $a_2 = a_1 - a_к = 8\frac{м}{с^2} - 5\frac{м}{с^2} = 3\frac{м}{с^2}$

$t_2 = \frac{\sqrt{2gH}}{3\frac{м}{с^2}} = \sqrt{\frac{20}{9}H}$ $c = 1{,}49\sqrt{H}$ c.

Ответ: 1) $0{,}56\sqrt{H}$ c; 2) $5\frac{м}{с^2}$; 3) $1{,}49\sqrt{H}$ c.

(2) Чистовик Часть II

№ 5

Дано: СИ Р-я

$P_2 = \frac{P_1}{1,01}$

$V_2 = 1,02 V_1$

1) $\begin{cases} P_1 V_1 = \nu R T_1 \\ P_2 V_2 = \nu R T_2 \end{cases} \rightarrow \frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2}$

$$\frac{P_1 V_1}{\frac{P_1}{1,01} \cdot 1,02 V_1} = \frac{T_1}{T_2}$$

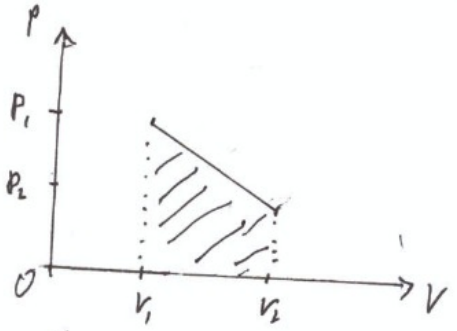
$$\frac{1,01}{1,02} = \frac{T_1}{T_2}; \quad \frac{T_2}{T_1} = \frac{1,02}{1,01} \approx 1,0099$$

$T_2 - T_1 = 1,0099 T_1 - T_1 = 0,0099 T_1$, или 0,99%

2) $Q = \Delta U + A'$

$\Delta U = \frac{3}{2} \nu R \Delta T = \frac{3}{2}(P_2 V_2 - P_1 V_1) = \frac{3}{2}\left(\frac{P_1}{1,01} \cdot 1,02 V_1 - P_1 V_1\right) \approx 0,01485 P_1 V_1$

A' = $S_{\text{под графиком в коорд. } P(V)}$



$$\Rightarrow A' = \frac{(P_1 + P_2)}{2} \cdot (V_2 - V_1)$$

$$A' = \frac{P_1 + \frac{P_1}{1,01}}{2} \cdot 0,02 V_1 \approx 0,0199 P_1 V_1$$

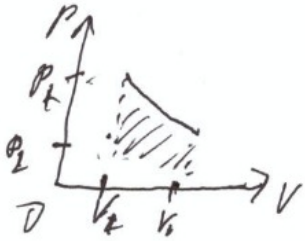
$$\frac{Q}{\Delta U} = \frac{\Delta U + A'}{\Delta U} = \frac{(0,01485 + 0,0199) P_1 V_1}{0,01485 P_1 V_1} \approx 2,34$$

Ответ: 1) 0,99%; 2) 2,34

$$\begin{cases} P_1 V_1 = \nu R T_1 \\ P_2 V_2 = \nu R T_2 \end{cases}$$

$$P_2 = \frac{P_1}{1{,}01}$$

$$V_2 = 1{,}02 V_1$$



$$\frac{T_2}{T_1} = \frac{P_1 \cdot 1{,}02 V_1}{1{,}01 \cdot V_1} = 1{,}01$$

$$Q = \Delta U + A'$$

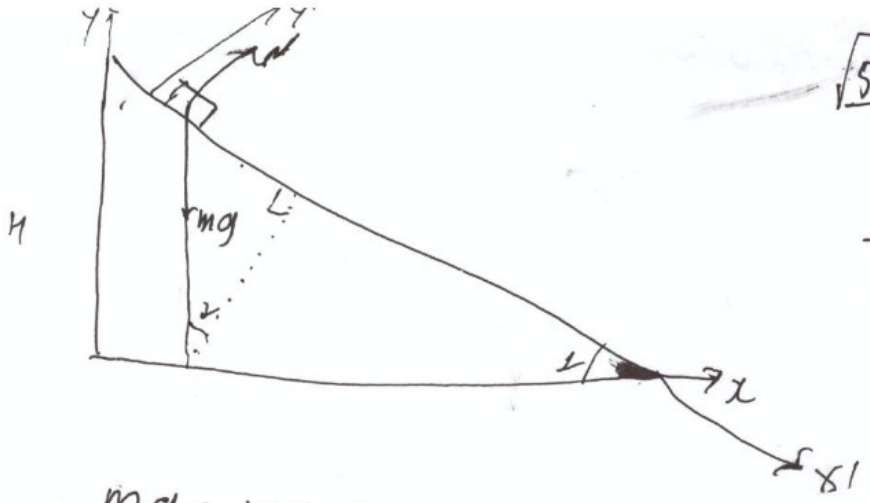
$$\Delta U = \frac{3}{2} \nu R \Delta T = \frac{3}{2} \nu R (T_2 - T_1) = \frac{3}{2} \nu R (P_2 V_2 - P_1 V_1) = 101 - 100 = 0{,}01$$

$$A' = \frac{(P_2 + P_1)}{2} (V_2 - V_1) = \frac{1{,}99 P_1}{2} \cdot 0{,}02 V_1 = 0{,}02 P_1 V_1$$

$$Q = 0{,}015 + 0{,}02 = 0{,}035$$

$$\Delta U = 0{,}015$$

$$= 2{,}33$$



$$\frac{\sqrt{5H}}{4} = \frac{5\sqrt{H}}{8}$$

$$\frac{5H}{16} = \frac{25H}{64}$$

$20H$

$ma = mg \cdot \sin\alpha$

$a = g\sin\alpha$

$t = \frac{V}{a}$

~~$H = \frac{gt^2}{2} \rightarrow t = \sqrt{2gH}$~~

$a \cdot t = V$

$H = \frac{V^2}{2g} \rightarrow V = \sqrt{2gH}$

$$t = \frac{\sqrt{2gH}}{g\sin\alpha} = \frac{\sqrt{2H}}{\sqrt{g}\cdot\frac{4}{5}} = \frac{\sqrt{2H}}{\sqrt{\frac{16g}{25}}} = \sqrt{\frac{25\cdot 2H}{16g}} = \sqrt{\frac{25H}{8g}} =$$

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

~~$t^2 = \frac{2gH}{g^2\sin^2\alpha}$~~ =

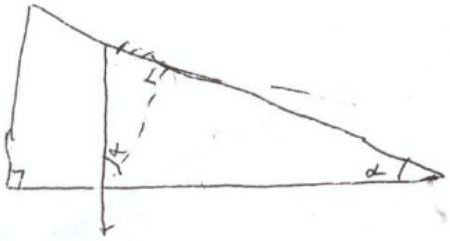
$$t = \frac{V}{a} = \frac{\sqrt{2gH}}{g\sin\alpha} = \frac{\sqrt{2gH}}{\sqrt{g^2\sin^2\alpha}} = \sqrt{\frac{2H}{g\cdot\frac{16}{25}}} =$$

$\frac{5\sqrt{H}}{8\sqrt{2}}$.

$$= \sqrt{\frac{50H}{16g}} = \sqrt{\frac{5H}{16}} = \frac{\sqrt{5H}}{4}$$

$$t_2 = \frac{V}{a} = \frac{\sqrt{2gH}}{g/2} = \frac{\sqrt{2gH}}{\sqrt{\frac{g^2}{4}}} = \sqrt{\frac{2H}{g/4}} = \frac{\sqrt{8H}}{\sqrt{g}} = \frac{8}{10}H = \sqrt{\frac{4}{5}H}$$

$0,89\sqrt{H}$



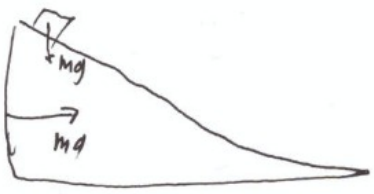
1) Ox: $ma = mg\sin\alpha$

$a = g\sin\alpha = 8\frac{м}{с^2}$

$H = \frac{V_x^2}{2g}$; $V_x = \sqrt{2gH}$

$t = \frac{V}{a} = \frac{2gH}{g^2\sin^2\alpha} : \frac{2H}{g\sin^2\alpha} = \frac{2H}{10\cdot\frac{16}{25}} = \frac{H}{\frac{16}{5}} = \frac{5H}{16} = 0{,}3125H$

2)



$t = \frac{V}{a} = \frac{\sqrt{2gH}}{g\sin\alpha} = \frac{2gH}{g^2\sin^2\alpha} = \frac{2H}{g\sin^2\alpha} =$

$= \frac{2H}{10\cdot\frac{16}{25}} = \frac{H}{5\cdot\frac{16}{25}} = \frac{H}{\frac{16}{5}} = \frac{5H}{16}$

$F = 2ma$

$2ma = mg$

$a = g/2 = 5\,м/с^2$

$a_{sp} = g\sin\alpha = 8\frac{м}{с^2}$

$t = \frac{V}{a} = \frac{\sqrt{20H}}{3} = \sqrt{\frac{20}{9}}H = 1{,}49H$

$\frac{\sqrt{5H}}{4}$