Часть 1

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

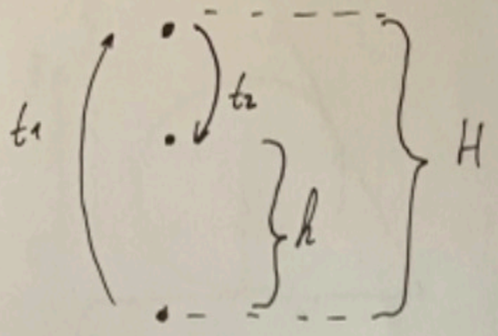
Шифр: **21204649**

ID профиля: **193374**

Вариант 2

Чистовик

№1



Из нач. усл. $H=\frac{v_0^2}{2g}$

$\cancel{\frac{gt_1^2}{2}=H} \Rightarrow \quad t_1=\frac{v_0}{g}$

Перейдем в СО, движущуюся вниз с $\vec{g}$. В ней мячи летят равномерно $\Rightarrow t_2=\frac{H}{v_0}=\frac{v_0}{2g}=\frac{1}{2}t_1$

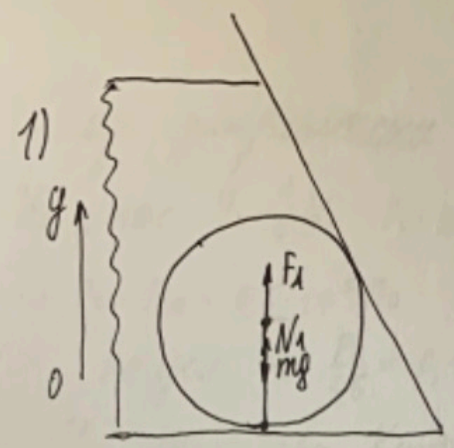
Общее время $\left.\begin{aligned}\tau_1&=t_1+t_2=\frac{3}{2}t_1=\frac{3v_0}{2g}\\ \tau_2&=t_2=\frac{v_0}{2g}\end{aligned}\right\} \Rightarrow \tau_1:\tau_2=3:1.$

Обозначим высоту встречи за h. Тогда $H-h=\frac{gt_2^2}{2}=\frac{g}{2}\cdot\frac{v_0^2}{4g^2}=\frac{v_0^2}{8g}$

$h=H-\frac{v_0^2}{8g}=\frac{v_0^2}{2g}^{(4}-\frac{v_0^2}{8g}=\frac{3v_0^2}{8g}.$

Ответ: $\tau_1=\frac{3v_0}{2g}$; $\tau_1:\tau_2=3:1$; $h=\frac{3v_0^2}{8g}$

№2 Чистовик



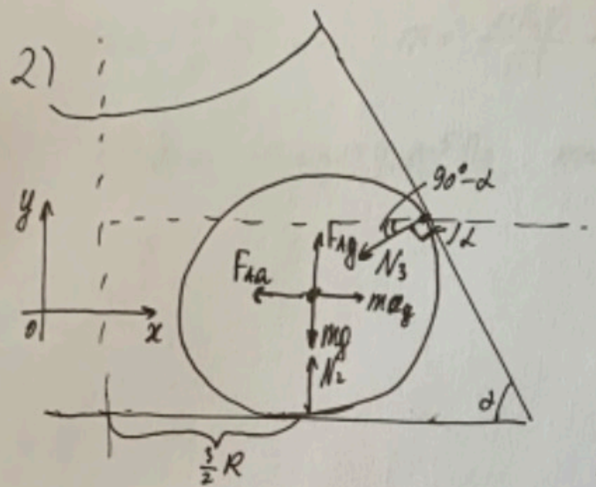
Усл. равновес. на Oy:

$$mg = N_1 + F_A$$

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

$$N_1 = \frac{20}{3}\pi R^3 \rho g$$

Пересядем в НеИСО в центр шара, расставим силы



Усл. равновес. на Ox:

$$ma_ц = F_{Aa} + N_3 \cos(90° - \alpha)$$

Усл. равновес. на Oy:

$$mg + N_3 \cdot \sin(90° - \alpha) = F_{Ag} + N_2$$

Из вращ. движения: $a_ц = \omega^2 \cdot 1{,}5R = \frac{3}{2}\omega^2 R$

Преобразуем:

$$\frac{4}{3}\pi R^3 \cdot 6\rho \cancel{g} \cdot \frac{3}{2}\omega^2 R = \frac{4}{3}\pi R^3 \rho \cancel{g} \cdot \frac{3}{2}\omega^2 R + N_3 \cdot \sin\alpha$$

$$N_3 = \frac{10\pi R^4 \rho \omega^2}{\sin\alpha}$$

Подставим:

$$N_2 = mg - F_{Ag} + N_3\cos\alpha = \frac{4}{3}\pi R^3 \cdot 6\rho g - \frac{4}{3}\pi R^3 \cdot \rho g + 10\pi R^4 \rho \omega^2 \cdot \overbrace{ctg\alpha}^{\frac{1}{tg\alpha} = \frac{2}{3}} = \frac{20}{3}\pi R^3 \rho g + \frac{20}{3}\pi R^4 \rho \omega^2 =$$

$$= \frac{20}{3}\pi R^3 \rho \cancel{g} (g + R\omega^2)$$

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

Чистовик.

№3

Пар изотермически сжимают => если бы не было конденсации, то $P_1V_1 = P_2V_2$.

Но у нас $V_2 = \frac{1}{7}V_1$, $P_2 = 3{,}6P_1$ => $PV \neq const$ => в конце пар насыщенный =>

=> $P_2 = P_{нп} = 0{,}5 \cdot 10^5$ Па

по усл. $P_1 = \frac{P_2}{3{,}6} = 0{,}139 \cdot 10^5$ Па

Ур. Менделеева-Клапейрона в начале:

$P_1V_1 = \frac{m}{M}RT$ => $m = \frac{\mu P_1 V_1}{RT} = \frac{0{,}018 \cdot 0{,}139 \cdot 10^5 \cdot 7 \cdot 1{,}7 \cdot 10^{-3}}{8{,}31 \cdot 354} = \frac{2{,}97}{2941{,}74} = 0{,}001$ кг $= 1$ г.

Ответ: $P_1 = 0{,}139 \cdot 10^5$ Па, $m = 0{,}001$ кг $= 1$ г.

Черновик

№3

очев была конденсация => пар насыщенный вконце

$P_1 V_1 = \nu R T$

$P_1 = \frac{P_{нп}}{3,6} = 0,139 \cdot 10^5$ Па

$V_1 = 7V_2 = 10,9$ л. $= 0,0109$

$P_1 V_1 = \frac{m}{\mu} RT \Rightarrow m = \frac{\mu P_1 V_1}{RT} \approx 2,73$ г.

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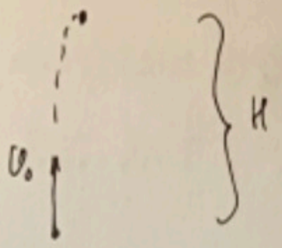
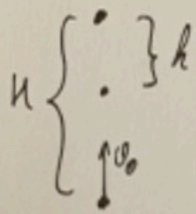
Черновик

N1



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

$$\frac{gt_1^2}{2}=H \Rightarrow t_1=\sqrt{\frac{2H}{g}}=\cancel{\sqrt{\frac{2v_0^2}{2g}}} \quad t_1=\frac{v_0}{g}$$



в СО $\downarrow \vec g$: $\quad t_2=\frac{H}{v_0}=\frac{v_0}{2g}=\frac{1}{2}t_1$

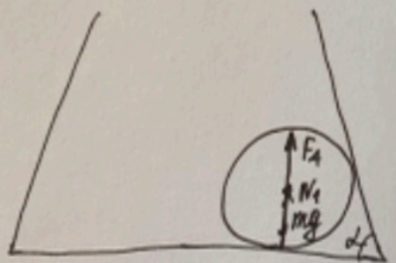
$$\left.\begin{aligned}&\underline{\tau_1=t_1+t_2=\tfrac{3}{2}t_1=\tfrac{3v_0}{2g}}\\&\underline{\tau_2=t_2=\tfrac{1}{2}t_1}\end{aligned}\right\}\Rightarrow \underline{\tau_1:\tau_2=3:1}$$

$$h=\frac{gt_2^2}{2}=\frac{g}{2}\cdot\frac{v_0^2}{4g^2}=\frac{v_0^2}{8g}$$

$$\underline{x=H-h=\frac{v_0^2}{2g}-\frac{v_0^2}{8g}=\frac{3v_0^2}{8g}}$$

N2

1)

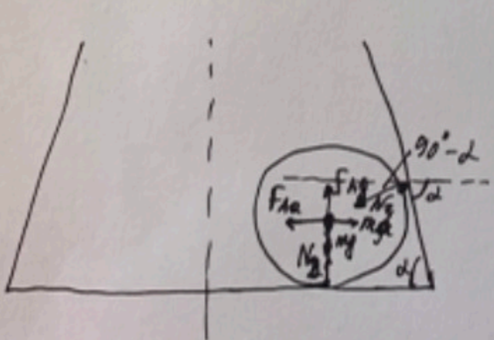


$$mg=F_{A1}+N_1$$

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

$$N_1=\frac{20}{3}\pi R^3\rho g.$$

2)



$$Ox:\ ma_y=F_{Aa_x}+N_3\cos(90°-\alpha)$$

$$Oy:\ mg+N_3\sin(90°-\alpha)=F_{Ag}+N_2$$

$$a_y=\omega^2\cdot 1{,}5R-\frac{3}{2}\omega^2R$$

$$\frac{4}{3}\pi R^3 6\rho\cdot\frac{3}{2}\omega^2R=\frac{4}{3}\pi R^3\cdot\rho\cdot\frac{3}{2}\omega^2R+N_3\sin\alpha$$

$$N_3=\frac{10\pi R^4\rho\omega^2R}{\sin\alpha}$$

$$N_2=\frac{4}{3}\pi R^3\cdot 6\rho g-\frac{4}{3}\pi R^3\cdot\rho g+N_3\cos\alpha$$

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

Часть 2

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

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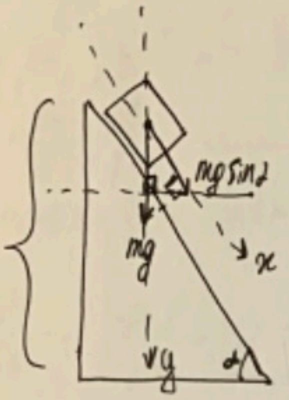
Вариант 2

N4 $\boxed{\text{Чистовик}}$

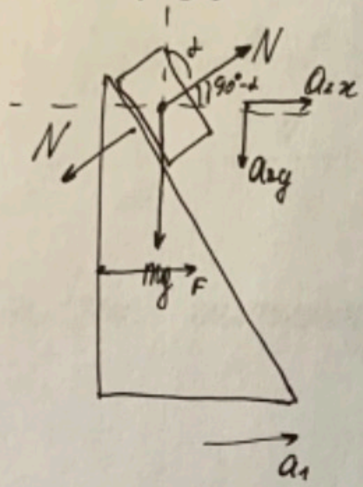
1)



Ускорение на $Ox = g\sin\alpha$ => ускорение на $Oy = g\sin\alpha\cos(90^\circ-\alpha) =$
$= g\sin^2\alpha = \frac{16}{25}g.$

$H = \frac{a_y t_1^2}{2} \Rightarrow t_1 = \sqrt{\frac{2H}{a_y}} = \sqrt{\frac{2H}{\frac{16}{25}g}} = \sqrt{\frac{50H}{16g}} = \sqrt{\frac{25H}{8g}}$

2,3) ИСО:



II з.Н. для клина:

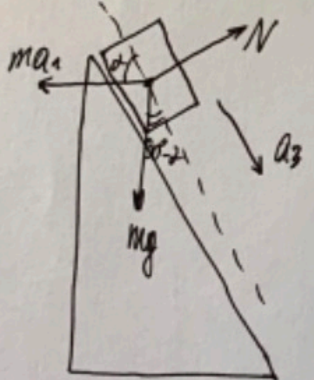
$F - N\sin\alpha = 2ma_1$

II з.Н. для бруска (на гор. и верт. оси)

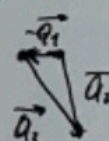
$N\sin\alpha = ma_{2x}$

$\cancel{m}mg - N\cos\alpha = ma_{2y}$

НеИСО:



по пр. сложения ускорений, $\vec{a_3} = \vec{a_2} - \vec{a_1} \Rightarrow$
$\Rightarrow a_{3x} = a_{2x} - a_1, \quad a_{3y} = a_{2y}$



II з.Н. для бруска:

$mg\sin\alpha - ma_1\cos\alpha = ma_3 \Rightarrow a_3 = g\sin\alpha - a_1\cos\alpha$

$a_{3x} = a_{2x} - a_1 = g\sin\alpha\cos\alpha - a_1\cos^2\alpha$

$a_{2x} = g\sin\alpha\cos\alpha + a_1\sin^2\alpha$

Подставим:

$F - N\sin\alpha = 2ma_1$

$mg - mg\sin\alpha\cos\alpha - ma_1\sin^2\alpha = 2ma_1$

$a_1 = g\frac{1-\sin\alpha\cos\alpha}{2+\sin^2\alpha} = g\frac{1-\frac{12}{25}}{2+\frac{16}{25}} = \frac{13}{66}g.$ − ускорение клина

$a_{2y} = a_{3y} = a_3\cdot\sin\alpha = g\sin^2\alpha - a_1\sin\alpha\cos\alpha = \frac{16}{25}g - \frac{13}{66}\cdot\frac{12}{25}g = g\frac{900}{66\cdot25} = g\frac{36}{66} = \frac{6}{11}g$

$H = \frac{a_{2y}t_2^2}{2} \Rightarrow t_2 = \sqrt{\frac{2H}{a_{2y}}} = \sqrt{\frac{2H}{\frac{6}{11}g}} = \sqrt{\frac{22H}{6g}}$

Ответ: $t_1 = \sqrt{\frac{25H}{8g}}$; $a_1 = \frac{13}{66}g$; $t_2 = \sqrt{\frac{22H}{6g}}$

№5 Чистовик

$PV = \nu RT \Rightarrow (P+dP)(V+dV) = \nu R(T+dT)$

$PV + dPV + PdV + \cancel{dPdV}^{\to 0} = \nu RT + \nu R dT \quad | : PV \text{ и } \nu RT$

$\frac{dP}{P} + \frac{dV}{V} = \frac{dT}{T}$

$-0{,}01 + 0{,}02 = \frac{dT}{T} = 0{,}01 \Rightarrow$ температура выросла на 1%.

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

$A' \approx 0{,}02\, PV$, т.к. можно считать, что $P = const$.

$\Delta U = \frac{3}{2}\nu R dT = \frac{3}{2}\nu R \cdot 0{,}01 T = 0{,}015\, \nu RT = 0{,}015\, PV$

$\frac{Q}{\Delta U} = \frac{A'}{\Delta U} + 1 = \frac{4}{3} + 1 = \frac{7}{3}$

Ответ: температура выросла на 1%; $Q : \Delta U = 7:3$

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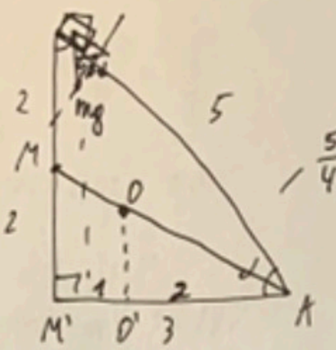
Черновик



$AM = \sqrt{3^2+2^2} = \sqrt{9+4} = \sqrt{13}$

$OA = \frac{2}{3} AM = \frac{2\sqrt{13}}{3}$

$AO' = OA \cdot \cos\angle AO' = \frac{2\sqrt{13}}{3} \cdot \frac{3}{\sqrt{13}} = 2$

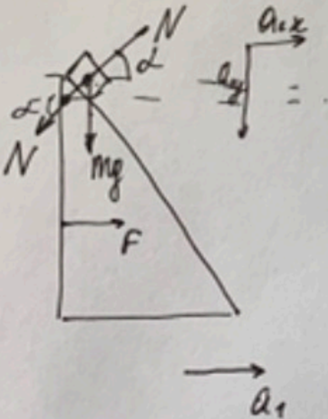
1) $a_1 = g\sin\alpha = \frac{4}{5} g$

$a_{1y} = a_1 \cdot \overset{90-\alpha}{\cos\alpha} \Rightarrow a_{1y} = g\sin^2\alpha\cos\alpha = \frac{16}{25} g = 0{,}64g$

$H = \frac{a_{1y}t^2}{2} \Rightarrow t = \sqrt{\frac{2H}{a_{1y}}} = \sqrt{\frac{2H}{\frac{12}{25}g}} = \sqrt{\frac{50H}{16g}} = \sqrt{\frac{25H}{8g}}$

$\frac{a_1 t^2}{2} = \frac{5}{4}H \Rightarrow t = \sqrt{\frac{10H}{4a_1}} = \sqrt{\frac{50H}{16g}}$

2).



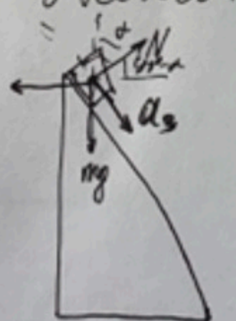
$F - N\cos\alpha = 2ma_1$

$\cancel{N\sin\alpha = mg}$

$mg - N\sin\alpha = ma_{2y}$

$N\cos\alpha = ma_{2x}$

в НеИСО:



$mg\cos(90^\circ-\alpha) - ma_1\cos\alpha = ma_3$

$N\sin\alpha - ma_1 = ma_3$

$mg\sin\alpha - ma_1\cos\alpha = N\sin\alpha - ma_1$

$a_3\cos\alpha + a_1 = a_{2x}$

$a_3 = mg\sin\alpha\cos\alpha - ma_1\cos^2\alpha$

$a_{2x} = g\sin\alpha\cos\alpha + a_1(1-\cos^2\alpha) = g\sin\alpha\cos\alpha + a_1\sin^2\alpha$

$mg - N\cos\alpha - ma_3\sin\alpha$

$mg\sin\alpha - N\cos\alpha = ma_3$

$mg\sin^2\alpha - ma_1\sin\alpha\cos\alpha = mg - N\cos\alpha$

$F - mg\sin\alpha\cos\alpha - ma_1\sin^2\alpha = 2ma_1$

$a_1 = \frac{F - mg\sin\alpha\cos\alpha}{2m + m\sin^2\alpha} = \frac{g - g\sin\alpha\cos\alpha}{2+\sin^2\alpha} = g\frac{1-\sin\alpha\cos\alpha}{2+\sin^2\alpha}$

$N = \frac{ma_{2x}}{\cos\alpha}$

$N\sin\alpha = ma_{2x}\frac{\sin\alpha}{\cos\alpha} = mg\sin^2\alpha + ma_1\frac{\sin^3\alpha}{\cos\alpha}$

$\cancel{N\sin\alpha = ma_1 + ma_1}$

$ma_{2y} = mg - N\sin\alpha = mg(1-\sin^2\alpha) - m\frac{F - mg\sin\alpha\cos\alpha}{2m + m\sin^2\alpha} \cdot \frac{\sin^3\alpha}{\cos\alpha}$

Черновик

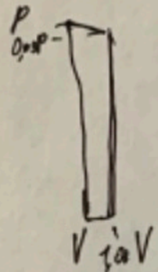
№5

$$\frac{dP}{P}+\frac{dV}{V}=\frac{dT}{T}$$
$$-0{,}01+0{,}02=0{,}01$$
$$\Rightarrow \frac{dT}{T}=0{,}01$$

$$\frac{Q}{\Delta U}=\frac{\Delta U+A'}{\Delta U}=1+\frac{A'}{\Delta U}=1+\frac{4}{3}=2\frac{1}{3}$$

$$PV=\nu RT$$
$$0{,}99P\cdot 1{,}02V=1{,}01\nu RT$$

$$Q:\Delta U=\cancel{7}:3$$

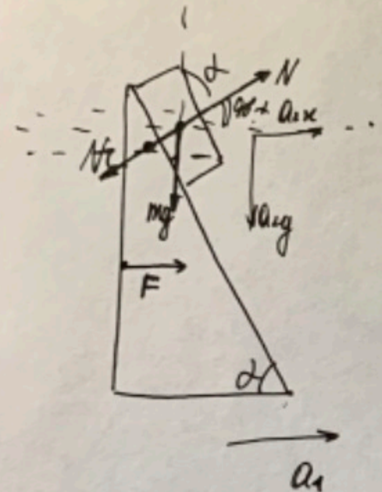


$$A'\approx 0{,}02PV$$
$$\cancel{A'=0{,}995P\cdot 0{,}02V}$$

$$\Delta U=0{,}01T\cdot\frac{3}{2}\nu R=$$
$$=0{,}015\cdot\nu RT=0{,}015PV$$

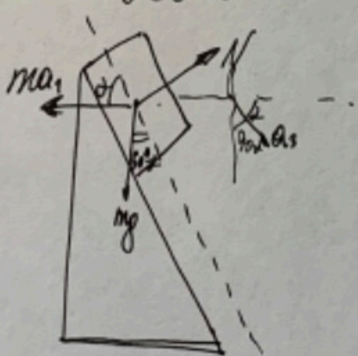
$$(P+dP)(V+dV)=\nu R(T+dT)$$
$$PV+dPV+PdV+\cancel{dPdV}=\nu RT+\nu RdT$$
$$\frac{dP}{P}+\frac{dV}{V}=\cancel{\nu R}\,dT$$

№4



$$2ma_1=F-N\sin\alpha$$
$$mg-N\cos\alpha=ma_{2y}$$
$$N\sin\alpha=ma_{2x}$$

НеИСО:



$$a_3\cos\alpha+a_1=a_{2x}$$
$$ma_3=mg\sin\alpha-ma_1\cos\alpha$$
$$a_3=g\sin\alpha-a_1\cos\alpha$$

$$a_{2x}=a_1+g\sin\alpha\cos\alpha-a_1\cos^2\alpha=$$
$$=a_1\sin^2\alpha+g\sin\alpha\cos\alpha$$

$$a_1=\frac{F-N\sin\alpha}{2m}=\frac{mg-ma_{2x}}{2m}=\frac{g-a_{2x}}{2}=\frac{g-g\sin\alpha\cos\alpha-a_1\sin^2\alpha}{2}$$

$$2a_1+a_1\sin^2\alpha=g(1-\sin\alpha\cos\alpha)$$
$$a_1=g\,\frac{1-\sin\alpha\cos\alpha}{2+\sin^2\alpha}=g\,\frac{1-\frac{12}{25}}{2+\frac{16}{25}}=g\,\frac{13}{66}$$

$$a_{2y}=a_3\sin\alpha=$$
$$=g\left(\frac{16}{25}-\frac{13}{66}\cdot\frac{12}{25}\right)=\frac{1056-156}{66\cdot 25}=\frac{900}{66\cdot 25}=\frac{36}{66}=\frac{6}{11}$$

$$N\cos\alpha=mg-ma_{2y}$$
$$N\sin\alpha=ma_{2x}$$

$$\frac{a_{2x}}{\mathrm{tg}\,\alpha}=\frac{11}{66}g\cdot\cancel{\sin^2\alpha}+g\sin\alpha\cos\alpha=$$
$$=\frac{13}{66}g\sin\alpha\cos\alpha+g\cos^2\alpha=$$
$$=g\left(\frac{13}{66}\cdot\frac{12}{25}+\frac{9}{25}\right)=$$
$$=g\,\frac{156+594}{66\cdot 25}=\frac{750}{66\cdot 25}g=$$
$$=\frac{30}{66}g=\frac{5}{11}g$$

$$\mathrm{tg}\,\alpha=\frac{ma_{2x}}{mg-ma_{2y}}\Rightarrow\ \cancel{\mathrm{tg}\,\alpha=\frac{g}{}}$$
$$-a_{2y}\,\mathrm{tg}\,\alpha+g\,\mathrm{tg}\,\alpha=a_{2x}$$

$$a_{2y}=\frac{g\,\mathrm{tg}\,\alpha-a_{2x}}{\mathrm{tg}\,\alpha}=g-\frac{a_{2x}}{\mathrm{tg}\,\alpha}=g\left(1-\frac{\frac{13}{66}\cdot 5}{11}\right)=\frac{6}{11}g$$

$$H=\frac{a_{2y}t^2}{2}\Rightarrow t=\sqrt{\frac{2H}{a_{2y}}}=\sqrt{\frac{2H}{\frac{6}{11}g}}=\sqrt{\frac{22H}{6g}}$$