Часть 1

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

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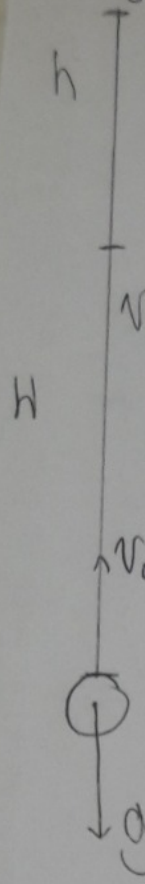
Вариант 1

№1 S

Чистовик



Пусть S - максимальная высота, которой достиг мяч.

$H = S - h'$

$S = v_0 t_{вр} - \frac{g t_{вр}^2}{2}$

$v - g t_{вр} = 0$

$v_0 = g t_{вр} \Rightarrow t_{вр} = \frac{v_0}{g}$

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

$h' = \frac{g t'^2}{2}$, где t' - время полета второго мяча до столкновения

$H = v_0 t' - \frac{g t'^2}{2}$

$v_0 t' - \frac{g t'^2}{2} = \frac{v_0^2}{2g} - \frac{g t'^2}{2}$

$v_0 t' = \frac{v_0^2}{2g} \Rightarrow t' = \frac{v_0}{2g}$

$H = \frac{v_0^2}{2g} - \frac{g v_0^2}{4g^2 2} = \frac{v_0^2}{2g} - \frac{v_0^2}{8g} = \left(\frac{4}{8} - \frac{1}{8}\right)\frac{v_0^2}{g} = \frac{3}{8}\frac{v_0^2}{g}$

$v_0^2 = \frac{Hg}{3} \cdot \frac{8}{3} \Rightarrow v_0 = \sqrt{\frac{8Hg}{3}}$

$S_1 = 2S - H = \frac{v_0^2}{g} - H = \frac{8H}{3} - H = \frac{5H}{3}$

Ответ: 1) $t' = \frac{v_0}{2g}$; 2) $\sqrt{\frac{8}{3}Hg}$; 3) $\frac{5H}{3}$

1

№3

Цилиндр

$P_0V_0 = \frac{m}{M}RT$

$P_1V_1 = T = const$

$T = const \Rightarrow m \neq const \; P_1 = P_{max}$

$P_0V_0 \neq P_1V_1$

$$\begin{cases} P_0V_0 = \frac{m}{M}RT \\ P_{max}V_1 = \frac{m-\Delta m}{M}RT \\ P_{max} = 1{,}8P_0 \\ V_1 = \frac{V_0}{3{,}5} \end{cases}$$

$P_0V_0 - \frac{18}{35}P_0V_0 = \frac{m}{M}RT - \frac{m-\Delta m}{M}RT$

$P_0V_0 - \frac{18}{35}P_0V_0 = \frac{\Delta m}{M}RT$

$\frac{17}{35}\frac{m}{M}RT = \frac{\Delta m}{M}RT$

$\Delta m = \frac{17}{35}m$

$P_0 = \frac{P_{max}}{1{,}8} = \frac{0{,}5 \cdot 10^5 \text{ Па}}{1{,}8} = 2{,}8 \cdot 10^4 \text{ Па}$

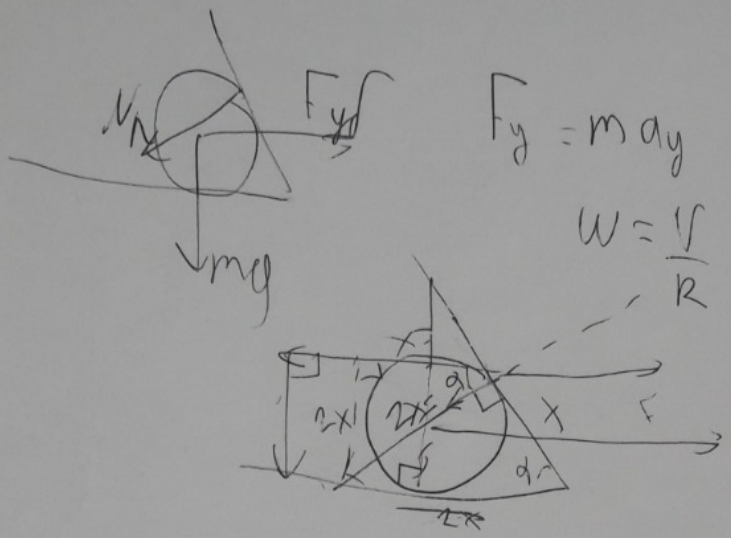
$V_1 = \frac{m-\Delta m}{MP_{max}}RT = \frac{17}{35} \cdot \frac{8{,}31 \frac{\text{Дж}}{\text{моль} \cdot \text{К}} \cdot (27+81)\text{К}}{0{,}5 \cdot 10^5 \text{ Па}}$

$V_1 = 4{,}76 \cdot 10^{-5} \text{ м}^3$

Ответ: $P_0 = 2{,}8 \cdot 10^4$ Па, $V_1 = 4{,}76 \cdot 10^{-3}$ м^3.

3

1) $N_1 = mg - F_{apx} = mg - \rho V g = 3\rho V g - \rho V g = 2\rho V g = \frac{4}{3}R^3 \pi \cdot 2\rho g$



$F_y = m a_y \quad a_y = \omega^2 2R$

$\omega = \frac{V}{R}$

$N_x = F_{уд}$

$N_y = 2F_{уд}$

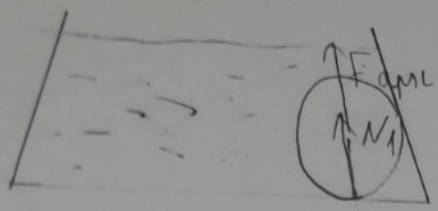
$N_{ody} = mg + (g + \omega^2 4R) - \rho V g$

$N_{ody} = \frac{4}{3}R^3 \pi 2\rho g + 4R^3 \pi \rho \omega^2 4R$

№2

Условие

1)

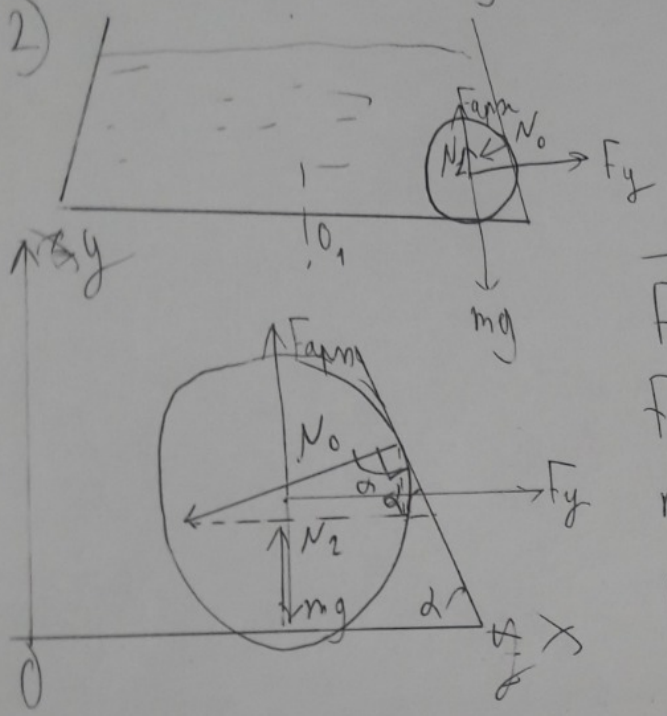


$\vec{F} = m\vec{a}$

$mg - F_{арх} - N = 0$

$N_1 = mg - F_{арх}$

$N_1 = 3\rho Vg - \rho Vg = 2\rho Vg = 2\rho \frac{4}{3}\pi R^3 g$



$\vec{F} = m\vec{a}$

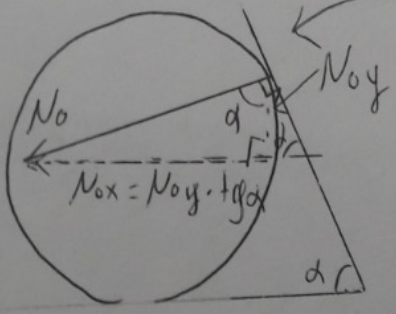
$F_{арх} + mg \quad mg - F_{арх}$

$m\vec{g} + \vec{F}_{арх} + \vec{N}_0 + \vec{N}_2 + \vec{F}_y = 0$

ox: $N_{0x} - F_y = 0$

$N_{0x} = F_y$

$N_{oy} \operatorname{tg}\alpha = F_y$



$N_{oy} = \frac{F_y}{\operatorname{tg}\alpha} = \frac{ma_y}{\operatorname{tg}\alpha} = \frac{m\omega^2 \cdot 2R}{2} = m\omega^2 R$

oy: $mg - F_{арх} + N_{oy} - N_2 = 0$

$mg + N_{oy} - F_{арх} = N_2$

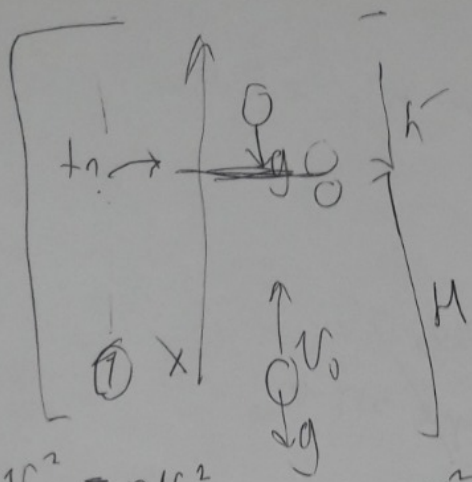
$2\rho \frac{4}{3}\pi R^3 g + 3\rho \frac{4}{3}\pi R^3 \omega^2 R = N_2$

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

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

N_1'' N_2

Черновик



$H = S - h'$

$S = v_0 t_n - \frac{g t_n^2}{2}$

$v(t_n) = 0$

$v_0 - g t_n$

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

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

$S = v_0 t_n - \frac{g t_n^2}{2} = \frac{v_0^2}{g} - \frac{v_0^2}{2g}$

$h' = \frac{g t_n^2}{2}$

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

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

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

1) $t_1 = \frac{v_0}{2g}$

2) $H = \frac{v_0^2}{2g} - \frac{g v_0^2}{4g^2 \cdot 2} = \frac{v_0^2}{2g} - \frac{v_0^2}{8g}$

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

$\frac{Hg8}{3} = v_0^2$

$v_0 = \sqrt{\frac{Hg8}{3}}$

3) $S_1 = 2S \quad H = \frac{v_0^2}{g} - H = \frac{H8}{3} - H = \frac{5}{3}H$

2 Сценарии

№35

$PV = \nu RT$

$P_0 V_0 = \frac{m}{\mu} RT$

$1{,}8 P_0 \frac{V_0}{3{,}5} = \frac{m - \Delta m}{\mu} RT$

$P_0 = ?$

$\frac{V_0}{3{,}5} = 1$

$m = const$

$T = const \Rightarrow P_0 V_0 = P_1 V_1$

$P_0 V_0 / P_1 V_1$ по усл. $\Rightarrow P_1 = P_{max}$

$P_0 = \frac{P_{max}}{1{,}8}$

$\frac{P_{max}}{1{,}8} V_0 = \frac{m}{\mu} RT$

$V_0 = 1{,}8 \frac{m}{\mu} RT / P_{max}$???

$V_{01} = \frac{1{,}8}{3{,}5} \frac{m}{\mu P_{max}} RT$???

$P_{max} V_1 = m_1 RT$

$P_0 V_0 - 1{,}8 P_0 \frac{V_0}{3{,}5} = \frac{\Delta m}{\mu} RT$

$P_{max} V_1 = P_0 V_0 - P_0 V_0 + \frac{P_{max} V_0}{3{,}5}$

$\frac{18}{35} \frac{m}{\mu} RT = \frac{m - \Delta m}{\mu} RT$

$\frac{18}{35} m = m - \Delta m$

$\Delta m = \frac{17}{35} m$

$P_{max} V_1 = \frac{17}{35} \frac{m}{\mu} RT$

$V_1 = \frac{17}{35} \frac{m}{\mu} RT : P_{max}$

$P_0 = \frac{P_{max}}{1{,}8}$

Часть 2

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

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Вариант 1

Числовик

№5

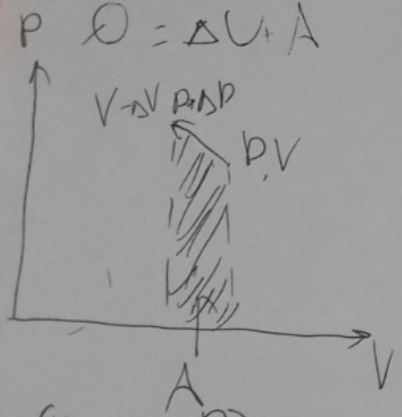
$$\begin{cases} PV = \nu RT \\ (P + 0{,}02P)(V - 0{,}01V) = \nu R(T + \Delta T) \end{cases}$$

$PV + 0{,}02PV - 0{,}01PV - 0{,}0002PV = \nu R(T + \Delta T)$

$(0{,}02 - 0{,}01 - 0{,}0002)PV = \nu R\Delta T$

$\frac{PV}{\nu R} = T \quad (0{,}01 - 0{,}0002)T = \Delta T$

$0{,}0098T = \Delta T \quad 0{,}0098 = 0{,}98\%$



$Q = \Delta U + A$

$A = -\frac{(P + P + \Delta P)}{2} \cdot \Delta V$

$\Delta U = (P + 0{,}02P)(V - 0{,}01V) - PV = 1{,}0098PV - PV = 0{,}0098PV$

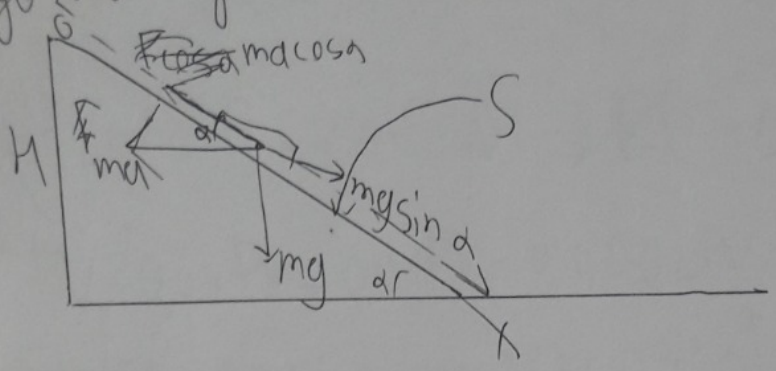
$\frac{Q}{A} = \frac{-\frac{P + P + \Delta P}{2} \cdot \Delta V + 0{,}0098PV}{-\frac{2P + \Delta P}{2}\Delta V} = 1 - \frac{0{,}0098PV}{(2P + \Delta P)\Delta V} =$

$\frac{Q}{A} = 1 - \frac{0{,}0098 \cdot 3PV}{(2 + 0{,}02)P \cdot 0{,}01V} = -0{,}45$ при нагреве, $\Delta T = 0{,}98\%\, T$

Ответ: $\frac{Q}{A} = -0{,}45$ 3

Типовые.

Свяжем систему отсчета с клином. Тогда при его движении появится сила ~~F~~ : ma :



$$\vec{F} = m\vec{a}$$

$$Ox: mg\sin\alpha - ma\cos\alpha = ma_0$$

$$a_0 = g\sin\alpha - a\cos\alpha$$

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

$$S = \frac{a_0 t_0^2}{2}$$

$$\frac{H}{\sin\alpha} = \frac{a_0 t_0^2}{2}$$

$$\frac{2H}{\sin\alpha\, a_0} = t_0^2$$

$$t_0 = \sqrt{\frac{2H}{\sin\alpha(g\sin\alpha - 0{,}38g\cos\alpha)}}$$

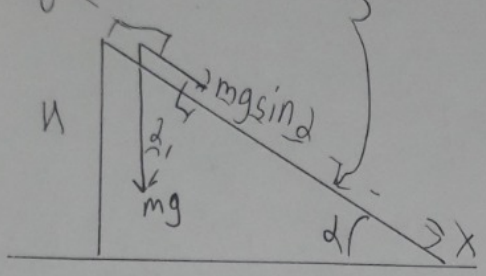
$$t_0 = \frac{2H}{g^{\frac{3}{5}}(\ldots)}$$

$$t_0 = \sqrt{\frac{2H}{0{,}1776g}} = \sqrt{11{,}26\frac{H}{g}}$$

Ответ: 1) $t = \frac{5}{3}\sqrt{\frac{2H}{g}}$; 2) $a = 0{,}38g$; 3) $\sqrt{11{,}26\frac{H}{g}}$

2

№4



$S\sin\alpha = H$

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

Ox: $F = ma$

$mg\sin\alpha = ma$

$a = g\sin\alpha$

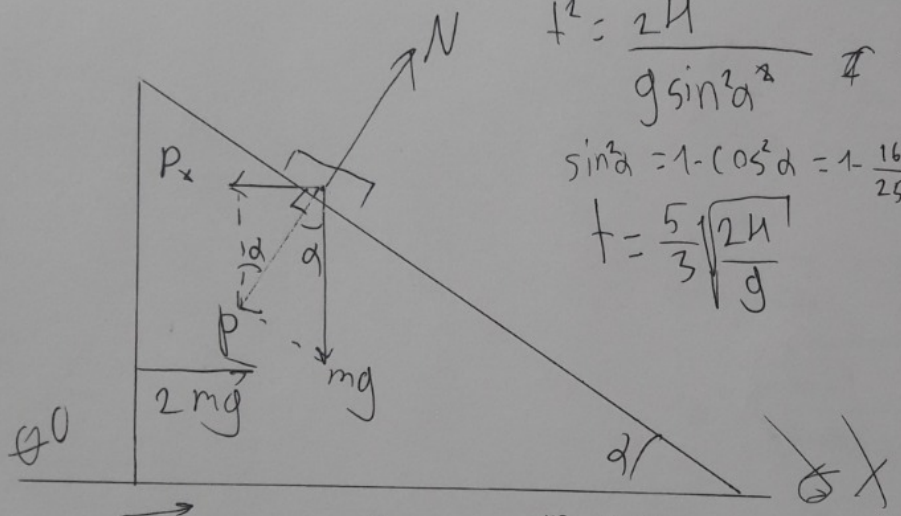
$S = \frac{at^2}{2}$

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

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

$\sin^2\alpha = 1 - \cos^2\alpha = 1 - \frac{16}{25} = \frac{9}{25}$ $\sin\alpha = \frac{3}{5}$

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



$\vec{F} = 3m\vec{a}$ ← $m_м + m_{кл}$

Ox: $2mg - P_x = 3ma$

$P = mg\cos\alpha$ $P_x = mg\cos\alpha\sin\alpha$

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

$a = \frac{g(2 - \cos\alpha\sin\alpha)}{4} = \frac{g\left(2 - \frac{4}{5}\cdot\frac{3}{5}\right)}{4} = \frac{g(2 - 0{,}48)}{4} =$

$a = 0{,}38g$

1

№5 Черновик $T = \frac{PV}{\nu R}$

$PV = \nu RT$

$(P + 0{,}02P)(V - 0{,}01V) = \nu R(T + \Delta T)$

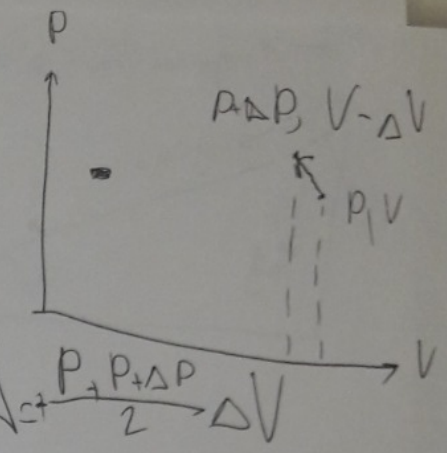
$PV + 0{,}02PV - 0{,}01PV - 0{,}00002PV = \nu RT + \Delta T \nu R$

$PV(0{,}02 - 0{,}01 - 0{,}00002) = \nu R \Delta T$

$\frac{PV}{\nu R}(0{,}02 - 0{,}01 - 0{,}0002) = \Delta T$

$1 \cdot 0{,}00998 = \Delta T$

1) температура увеличилась, $\Delta T = 0{,}998\%$



$Q = \Delta U + A$ $\quad \Delta U = \frac{1{,}00998PV_i}{2} - \frac{PV_i}{2} = \frac{0{,}00998PV_3}{2}$

$\frac{Q}{A} = \frac{\left(\frac{0{,}00998PV_3}{2} + \frac{2P + \Delta P}{2}\Delta V\right) \cdot 2}{(2P + \Delta P)\Delta V} = \frac{0{,}00998PV \cdot 3 + (2P + \Delta P)\Delta V}{(2P + \Delta P)\Delta V}$

$\frac{Q}{A} = 1 + \frac{0{,}00998 \cdot 3PV}{(2 + 0{,}02)P \cdot (-0{,}01)V} = 1 - \frac{0{,}00998}{0{,}0202}$ Б

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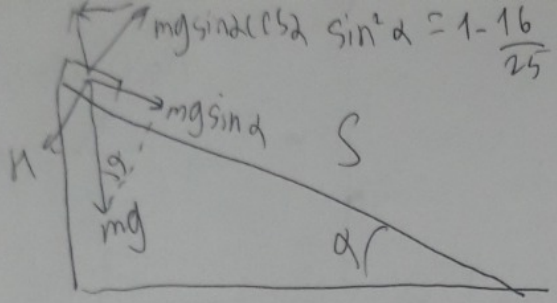


$mg\sin\alpha\cos\alpha \quad \sin^2\alpha = 1 - \frac{16}{25} = \frac{9}{25}$

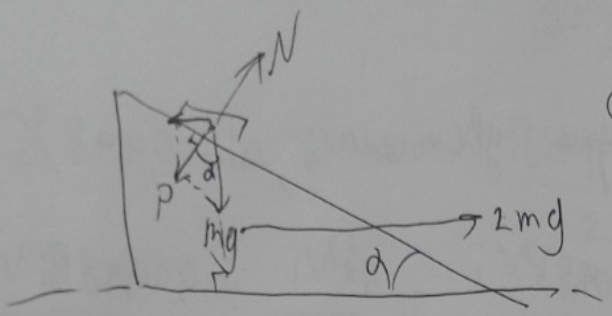
$H = S\sin\alpha$

Ускорение

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

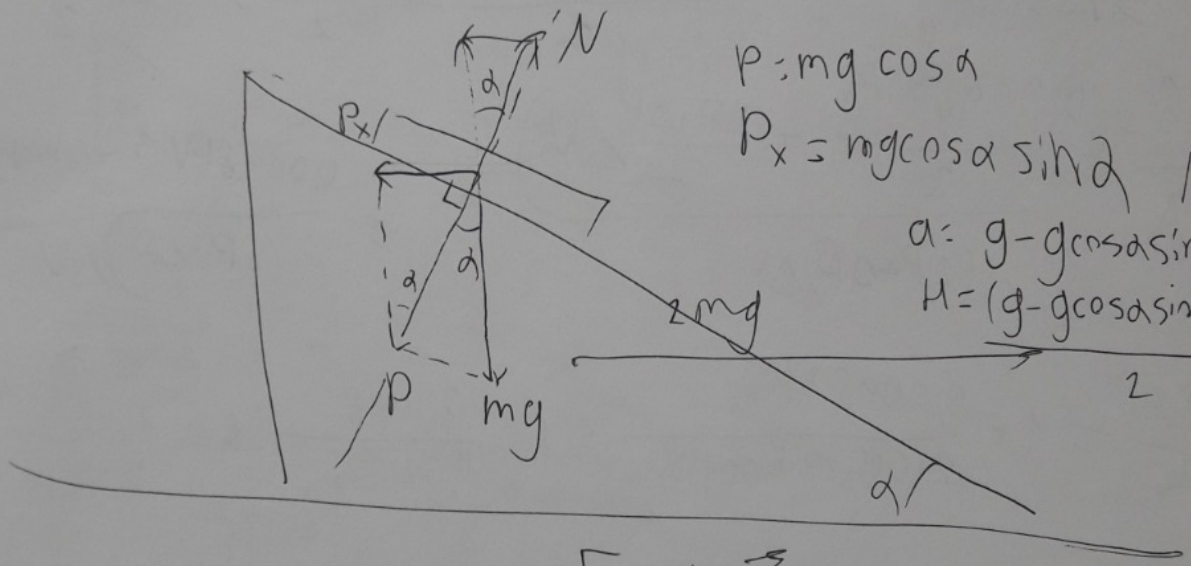
$\frac{H}{\sin\alpha} = \frac{g\sin\alpha\, t^2}{2}$

1) $t^2 = \frac{2H}{g\sin\alpha^2}$ $\quad t = \sqrt{\frac{2H}{g(1-\cos^2\alpha)}}$



Oy: $mg - mg\sin\alpha\cos^2\alpha = mg - mg\sin\alpha(1-\sin^2\alpha)$

$a = g(1 - \sin\alpha\cos^2\alpha)$



$P = mg\cos\alpha$

$P_x = mg\cos\alpha\sin\alpha$ $\quad N = P$

$a = g - g\cos\alpha\sin\alpha$

$H = \frac{(g - g\cos\alpha\sin\alpha)t^2}{2}$

$\vec{F} = 3m\vec{g} + m\vec{a}$

Ox: $4ma = 2mg - mg\cos\alpha\sin\alpha$

$a = \frac{g(2 - \cos\alpha\sin\alpha)}{4}$