Часть 1

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

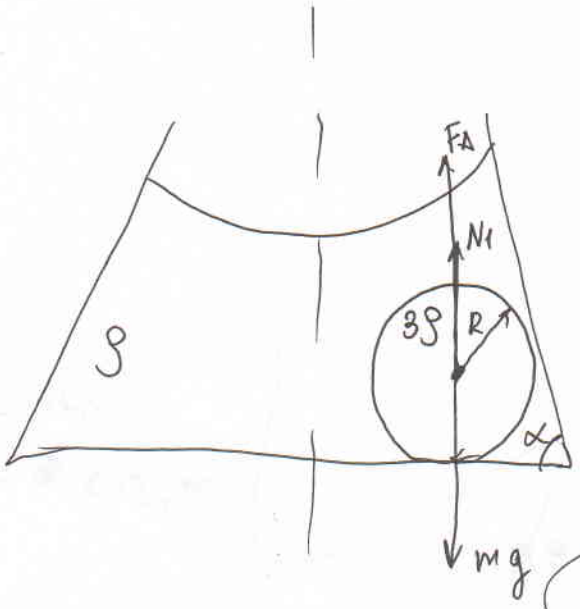
Шифр: **21205912**

ID профиля: **283283**

Вариант 1

Чистовик. Лист 1.

№2.



1) $F_A + N_1 = mg$

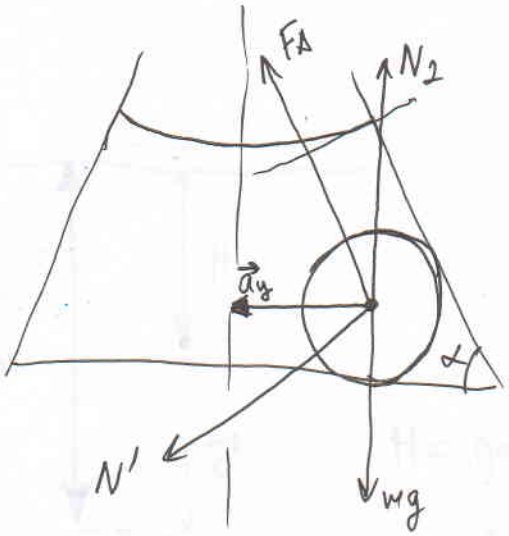
$\rho \frac{4}{3}\pi R^3 g + N_1 = 3\rho \frac{4}{3}\pi R^3 g$

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

$N_1 = \rho\pi R^3 g\left(4 - \frac{4}{3}\right) =$

$= \frac{8}{3}\rho\pi R^3 g$

Ответ: $\frac{8}{3}\rho\pi R^3 g$



Сила Архимеда направлена перпендикулярно границе раздела сред.

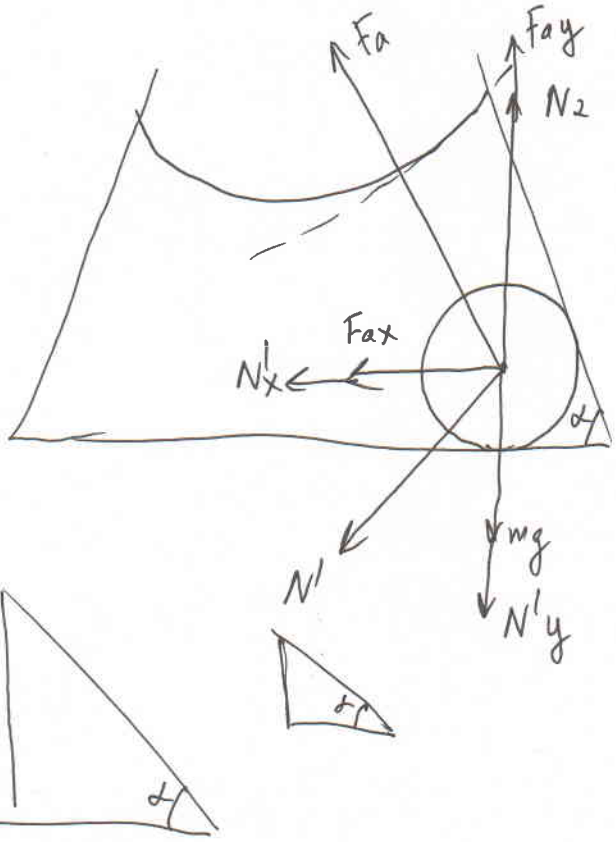
$a = \frac{v^2}{R} = \frac{\omega^2 R^2}{R} = \omega^2 R$

$$\begin{cases} N_2 + F_{ay} - N'_y = mg \\ F_{ax} + N'_x = m\omega^2 \cdot 2R \end{cases}$$

$F_{ax} = \rho a \bar{V}$

$F_{ay} = \rho g \bar{V}$

Чистовик • Лист 2.



$\cos\alpha = \frac{N'_x}{N'}$

$N'_x = N'\cos\alpha$

$N'_y = N'\sin\alpha$

$$\begin{cases} N_2 + \rho g \bar{V} = mg + N'\sin\alpha \\ \rho a \bar{V} + N'\cos\alpha = m\omega^2 \cdot 2R \end{cases}$$

$$\rho \tfrac{4}{3}\pi R^3 a + N'\cos\alpha = \tfrac{4}{3}\cdot 8\rho\pi R^3 a$$

$$\tfrac{4}{3}\rho\pi R^3 a + N'\cos\alpha = 4\rho\pi R^3 a$$

$$N'\cos\alpha = \rho\pi R^3 a\left(\tfrac{3}{4} - \tfrac{4}{8}\right)$$

$$N' = \frac{\rho\pi R^3 a \cdot \frac{8}{3}}{\cos\alpha}$$

$$N_2 + \rho g \bar{V} = mg + \rho\pi R^3 a \cdot \tfrac{8}{3} tg\alpha$$

$$N_2 + \tfrac{4}{3}\pi R^3 \rho g = \tfrac{4}{3}\cdot 8\rho\pi R^3 g + \rho\pi R^3 \cdot \omega^2 \cdot 2R \cdot \tfrac{8}{3} \cdot tg\alpha$$

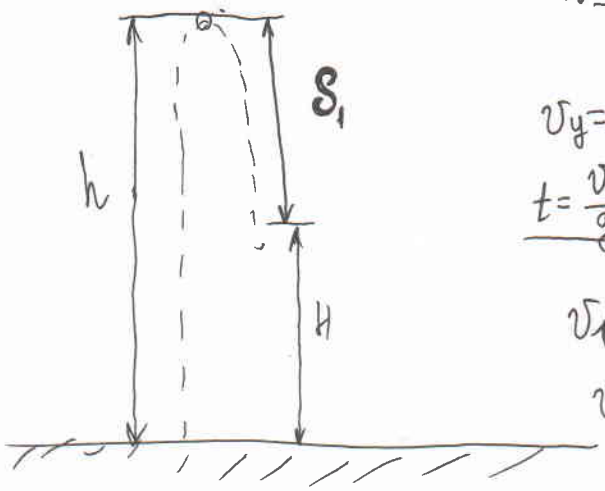
$$N_2 = 4\rho\pi R^3 g + \rho\pi R^4 \cdot \omega^2 \cdot \tfrac{16}{3} tg\alpha - \tfrac{4}{3}\pi R^3 \rho g$$

$$N_2 = \tfrac{8}{3}\rho\pi R^3 g + \rho\pi R^4 \omega^2 \cdot \tfrac{16}{3} tg\alpha = \tfrac{8}{3}\rho\pi R^3 g + \rho\pi R^4 \omega^2 \cdot \tfrac{32}{8} =$$

$$= \left(\tfrac{8}{3}\rho\pi R^3 \cdot \left(g + \tfrac{4}{3}\omega^2 R\right)\right)$$ ← Ответ:

Чистяков. Класс 9а

N1.



$h = S_1 + H$

$\frac{mv_0^2}{2} = mgh$

$v_0 = \sqrt{2gh}$

$v_y = v_{0y} - gt$

$t = \frac{v_0}{g}$ для (h)

$v_1 = g\tau$

$v_1 =$

$y_1 = h - \frac{gt^2}{2}$ – для первого мяча

$y_2 = v_0 t - \frac{gt^2}{2}$ – для 2-го мяча

$y_1 = y_2$

$h - \frac{gt^2}{2} = v_0 t - \frac{gt^2}{2}$

$h = v_0 t$

$t = \frac{h}{v_0} \Rightarrow t = \frac{v_0^2}{2g \cdot v_0} = \frac{v_0}{2g}$

$t_{2\text{го столкновения}} = \frac{v_0}{2g} = \frac{\sqrt{\frac{8}{3}gH}}{2g} = \sqrt{\frac{2}{3}\frac{H}{g}}$

$y_1(t_{2\text{го}}) = H$

$h - \frac{g}{2}\left(\frac{v_0}{2g}\right)^2 = H$

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

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

$\frac{3gv_0^2}{8g} = H$

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

Чистовик. Лист 4.

✱ $h = H + S_1$: I сп.

$S_1 = \frac{gt^2}{2}$

$h = \frac{v_0^2}{2g} = g \cdot \frac{(2t)^2}{2} = 2gt^2 = 4S_1$

~~$H = h - S_1 = 3S_1$~~; $S_1 = \frac{H}{3}$

$S_{1g} = h + S_1 = 5S_1 = \frac{5H}{3}$

$S_{1go} = 2h - H = 2 \cdot \frac{8}{3} H \cancel{g} \cdot \frac{1}{2\cancel{g}} - H = \frac{5}{3} H$

Ответ: $t_{2go} = \sqrt{\frac{2}{3}\frac{H}{g}}$; $v_0 = \sqrt{\frac{8}{3} gH}$; $S_{1go} = \frac{5}{3} H$

Чистовик. Лист 5.

№3.

$m = 3 \cdot 10^{-3}$ кг

$T = 81°C = 354$ К

φ ↓ в 3,5

P ↑ в 1,8

$P_н = 0{,}5 \cdot 10^5$

$\mu = 18$

$R = 8{,}31$

Решение:

Так как φ ↓ в 3,5, а P ↑ в 1,8, то часть пара сконденсировалась.

$\varphi = \frac{P_п}{P_{н.п}}$

$PV = \nu RT$

$P_1V_1 = P_2V_2$ т.к. $T = const$

$\varphi = 100\%$, т.к. пар сконденсировался $\Rightarrow P_п' = P_{н.п.}$

$P_1 = \frac{P_н}{1,8} \approx 0{,}278 \cdot 10^5$ Па ← нач. давление.

$P_1V_1 = \nu RT$

$V_1 = \frac{\nu RT}{P_1} = \frac{\frac{m}{\mu} RT}{P_1} = \frac{\frac{m}{\mu} RT}{P_1}$

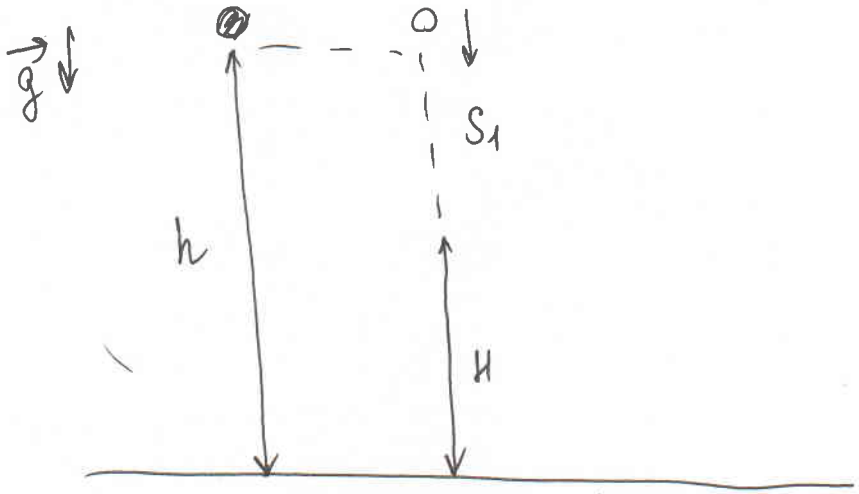
$\frac{3 \cdot 10^{-3}}{18 \cdot 10^{-3}} \cdot 8{,}31 \cdot 354$

$V_2 = \frac{V_1}{3,5} = \frac{\frac{m}{\mu} RT}{\frac{P_1}{3,5}} =$

~~Чернявин. Шкл 9.~~

Чернявин.

N1.



$h_1 = H + S_1$; $S_1 = \frac{gt^2}{2}$; $gt^2 = 2S_1$

$H = \frac{v_0^2 - v_1^2}{2g}$; $h = \frac{v_0^2}{2g} = \frac{g \cdot (2t)^2}{2} = 2gt^2 = 4S_1$

$H = h - S_1 = 3S_1$; $S_1 = \frac{H}{3}$

$S_{10} = h + S_1 = 5S_1 = 5\frac{H}{3}$ ← полный путь первого шарика до ~~столкновения~~ точки столкновения

$x_1 = x_2$

$\frac{mv_0^2}{2} = mgH$

$v_0 = \sqrt{2gH}$ – начальная скорость шарика.

$H = v_0 t - \frac{gt^2}{2}$

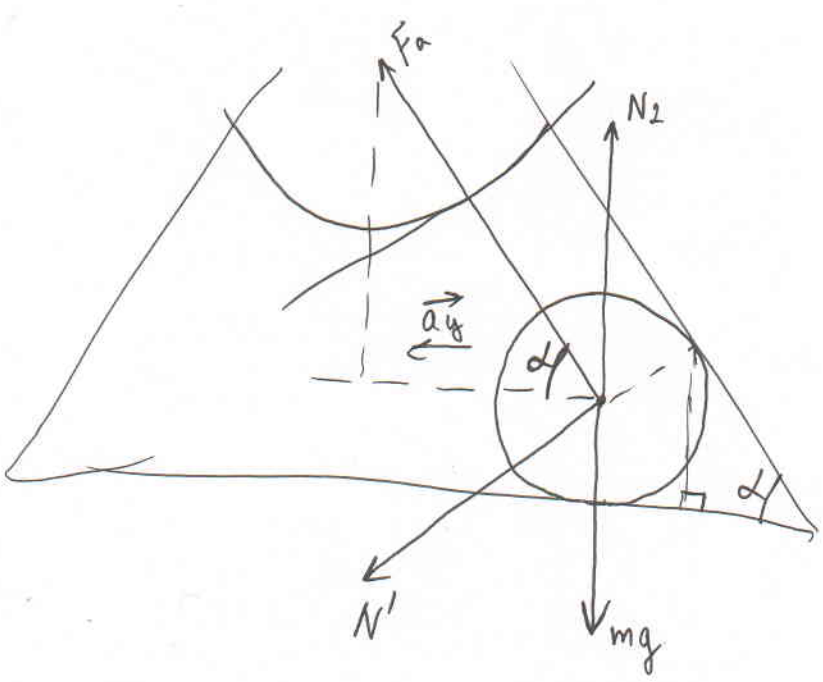
$H = \sqrt{2gH} \cdot t - \frac{1}{2}gt^2$

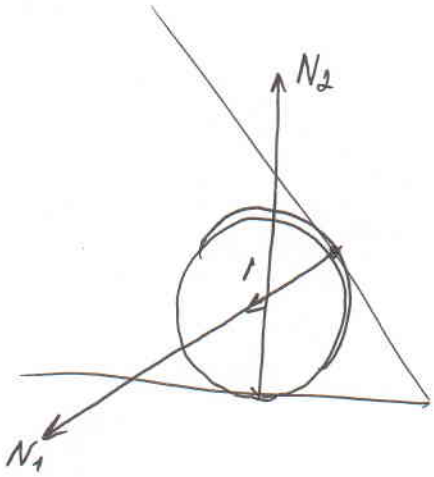
$\frac{gt^2}{2} - \sqrt{2gH}\, t + H = 0$

$D = 2gH - 4 \cdot \frac{g}{2} H = 0$

$t = \frac{\sqrt{2gH}}{g}$ – время полета второго шара

Челябинск

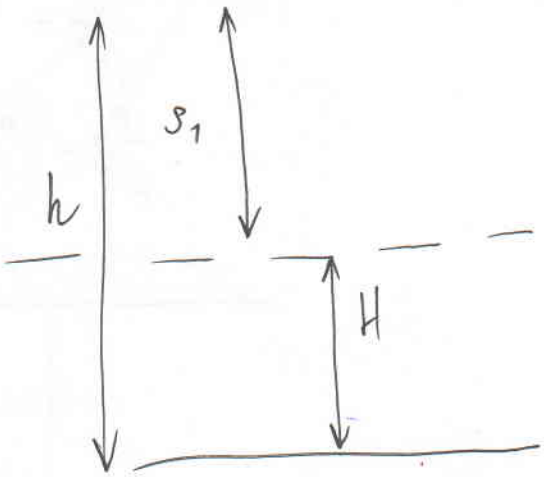




~~$\frac{4}{3}\pi R^3$~~ $F_{ax} = \rho a V$

$F_{ay} = \rho g V$

N1.



$h = H + s_1$

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

$v_0^2 - v^2 = 2gH$

$s_1 = \frac{gt^2}{2}$; $gt^2 = 2s_1$

$h = \frac{g \cdot (2t)^2}{2} = \frac{g \cdot 4t^2}{2} = 2gt^2 = 4s_1 = 4\frac{H}{3}$

~~h~~ $H = h - s_1 = 4s_1 - s_1 = 3s_1$

$s_1 = \frac{H}{3}$; $s_{10} = h + \frac{H}{3} = \frac{4}{3}H + \frac{1}{3}H = \frac{5}{3}H$

№3.

Дано:

$m_п = 3 \cdot 10^{-3}$ кг

$T = 81°C = 354$ К

$P_{н.п} = 0{,}5 \cdot 10^5$ Па

$\mu = 18$ г/моль

$R = 8{,}31 \frac{Дж}{моль \cdot К}$

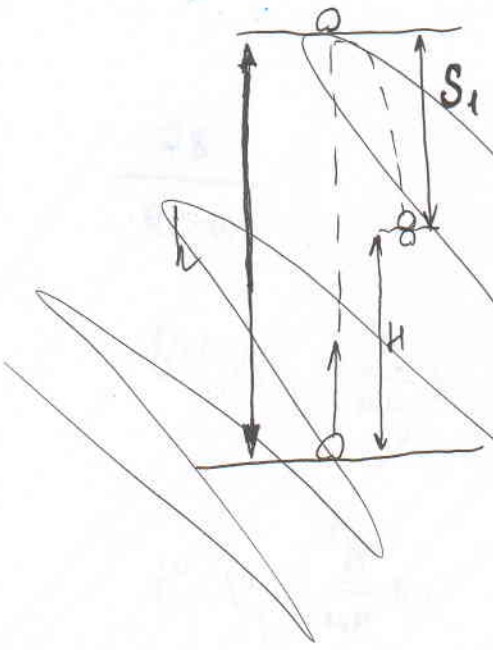
$V \downarrow$ в 3,5

$P \uparrow$ в 1,8

Так как $V \downarrow$ в 3,5 раз, а $P \uparrow$ в 1,8, можно сделать вывод, что наш пар у нас сконденсировался.

$T = 354$ К

$T = const \Rightarrow P_1V_1 = P_2V_2$



$\frac{m\upsilon_0^2}{2} = mgh$

$\frac{m\upsilon_0^2}{2} = mgH + \frac{m\upsilon_1^2}{2}$

$mgS_1 = \frac{m\upsilon_1^2}{2}$

$mgh = mgH + mgS_1$

$h = H + S_1$

Черняев

№3.

$m_п = 3 \cdot 10^{-3}$ кг

$T = 81°C$

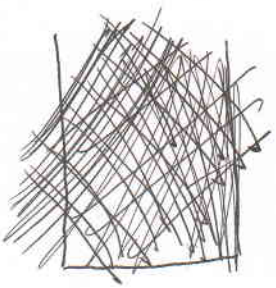
$P_н = 0{,}5 \cdot 10^5$ Па

$\mu = 18$ г/моль

$R = 8{,}31 \frac{Дж}{моль \cdot К}$

Так как у нас $V \downarrow$ в 3,5, а $P \uparrow$ в 1,8 можно сделать вывод, что часть пара у нас сконденсировалась.

$T = 354$ К



V_0 – начальный объём пара.

$PV = \nu RT$

$PV = \frac{m}{\mu} RT$

$T = const \Rightarrow P_1 V_1 = P_2 V_2$

Так как в конце процесса у нас сконденсировался пар, то

$\varphi = 100\%$

$\varphi = \frac{P'_п}{P_{н.п}}$

$P'_п = P_{н.п}$

$P_н =$

Часть 2

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

Шифр: **21205912**

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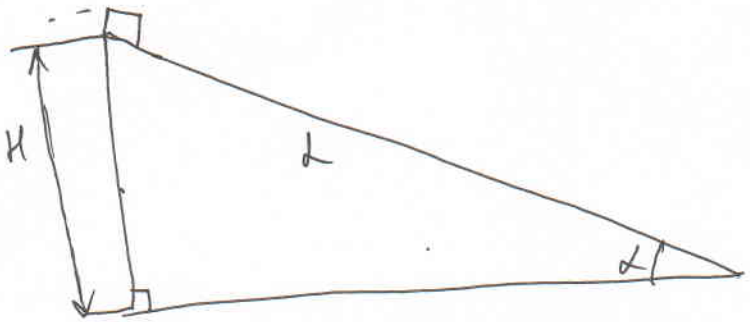
Вариант 1

Чистовик. Лист. 1.

№4.

$L = \frac{H}{\sin\alpha}$; $\cos\alpha = \frac{4}{5}$; $\sin\alpha = \frac{3}{5}$



$\downarrow \vec{g}$

1) $L = \frac{at_{сп}^2}{2} = \frac{g\sin\alpha t_{сп}^2}{2}$; $mg\sin\alpha = ma \Rightarrow$

$\Rightarrow a = g\sin\alpha$

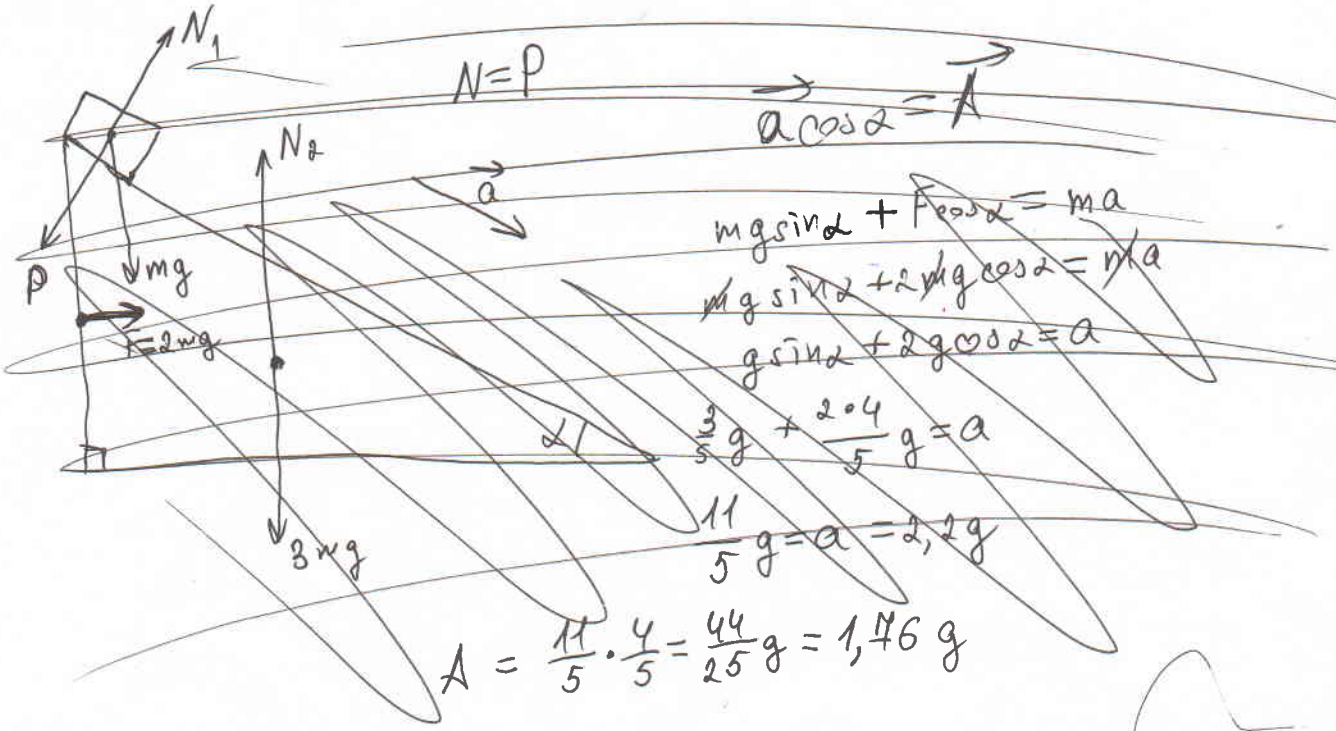
$\frac{H}{\sin\alpha} = \frac{g\sin\alpha t_{сп}^2}{2}$

$2H = g\sin^2\alpha t_{сп}^2$

$t_{сп}^2 = \frac{2H}{g\sin^2\alpha} =$ [illegible]

$t_{сп} = \sqrt{\frac{2H}{g}} \cdot \frac{1}{\sin\alpha} = \frac{5}{3}\sqrt{\frac{2H}{g}}$

2)



$\vec{a}\cos\alpha = \vec{A}$

$mg\sin\alpha + F\cos\alpha = ma$

$mg\sin\alpha + 2mg\cos\alpha = ma$

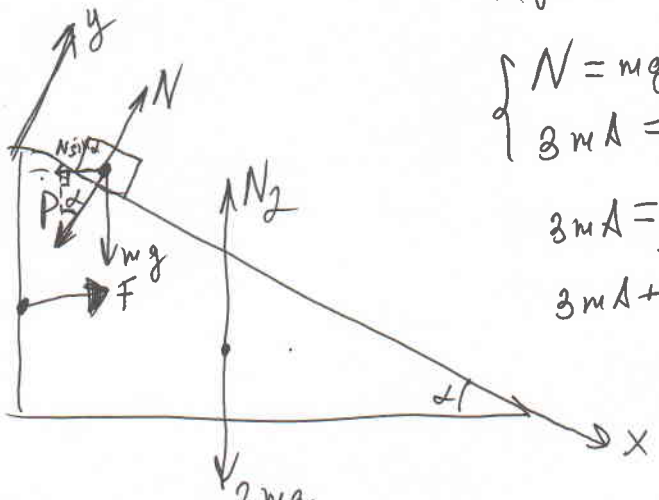
$g\sin\alpha + 2g\cos\alpha = a$

$\frac{3}{5}g + \frac{2\cdot4}{5}g = a$

$\frac{11}{5}g = a = 2{,}2g$

$A = \frac{11}{5}\cdot\frac{4}{5} = \frac{44}{25}g = 1{,}76\,g$

Чистовик. Лист 2.



$$a_y = A\sin\alpha$$

$$\begin{cases} N = mg\cos\alpha + mA\sin\alpha \\ 3mA = F - N\sin\alpha \end{cases}$$

$$3mA = F - mg\sin\alpha\cos\alpha - mA\sin^2\alpha$$

$$3mA + mA\sin^2\alpha = F - mg\sin\alpha\cos\alpha$$

$$A = \frac{F - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha} =$$

$$= \frac{2mg - \frac{3}{5}mg\cdot\frac{4}{5}}{3m + m\cdot\frac{9}{25}} = \frac{1{,}52g}{3{,}36}$$

$$= \frac{2mg - mg\sin\alpha\cos\alpha}{3m + m\sin\alpha\cos\alpha} =$$

$$A = \frac{F - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha} = \frac{1{,}52g}{5{,}36}$$

3) $\frac{a_{отн} t^2}{2} = L$;

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

$$t^2 = \frac{2L}{a_{отн}} = \frac{2L}{g\sin\alpha - A_x} = \frac{2L}{g\sin\alpha - \left(\frac{F - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha}\cdot\cos\alpha\right)}$$

$$t^2 = \frac{2\cdot\frac{H}{\sin\alpha}}{g\sin\alpha - \left(\frac{F\cos\alpha - mg\sin\alpha\cos^2\alpha}{3m + m\sin^2\alpha}\right)}$$

$$t = \sqrt{\frac{2\cdot\frac{5}{3}H}{\frac{3}{5}g - \frac{1{,}52g}{3{,}36}\cdot\frac{4}{5}}} \approx 3{,}74\,с$$

Ответ: $\frac{5}{3}\sqrt{\frac{2H}{g}}$; $A = \frac{1{,}52}{3{,}36}g$; $t_{сп2} = 3{,}74\,с$

Чистовик. Лист 3.

N5.

$i = 3$

$P \uparrow$ на 2%

$V \downarrow$ на 1%

1) $PV = \nu RT$; $P_1V_1 = \nu RT_1$; $P_2V_2 = \nu RT_2$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Найти: $\frac{Q}{A} - ?$; $\Delta T - ?$

$P_2 = 1{,}02P_1$

$V_2 = 0{,}99V_1$

$P_2V_2 = \nu RT_2$

$1{,}0098 P_1V_1 = \nu RT_2$

$1{,}0098 \nu RT_1 = \nu RT_2$

$T_2 = 1{,}0098T_1$; темп. увеличилась на 0,98%.

$\Delta T = 0{,}098T_1$

2) $\Delta U = \frac{3}{2}\nu R\Delta T$; $A = P_{ср}\Delta V = \frac{P_1+P_2}{2} \cdot (V_2 - V_1)$

$Q = \Delta U + A$; $A < 0 \Rightarrow$ $\frac{Q}{A} = \frac{\Delta U}{A} + 1 = \frac{\frac{3}{2}\nu R\Delta T}{P_{ср}\Delta V} + 1 =$

$\Delta U = Q - A$

$= \frac{3}{2} \cdot \frac{V}{T} \cdot \frac{\Delta T}{\Delta V} + 1 = -0{,}4$

$Q = \Delta U + A = \frac{3}{2}\nu R(T_2 - T_1) =$

$\frac{Q}{A} = \frac{\Delta U}{A} + 1 = \frac{\frac{3}{2}\nu R\Delta T}{P_{ср}\Delta V} + 1$

Ответ: $T_2 = 1{,}0098T_1$ $\Delta T = 0{,}098T_1$

$\frac{Q}{A} = -0{,}4$.

Чистовик. Лист 4.

Продолжение 4 задачи:

$$A = \frac{F - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha} = \frac{1,52g}{3,36} = \frac{2mg - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha} = \frac{2g - g\sin\alpha\cos\alpha}{3 + \sin^2\alpha} = \frac{1,52}{3,36}g \approx 0,45g$$

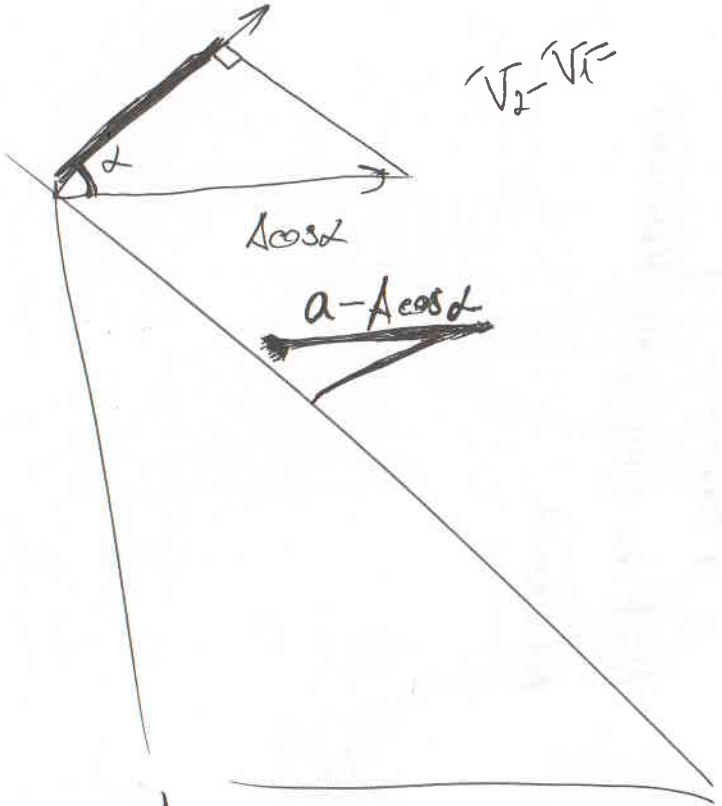
3) $\frac{a_{отн} \cdot t^2}{2} = L = \frac{H}{\sin\alpha}$

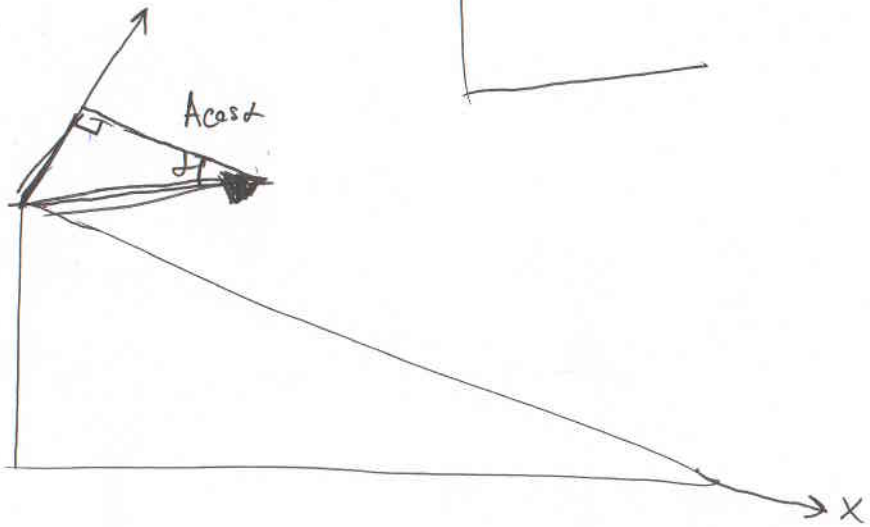
$a_{отн} = a - Ax = a - A\cos\alpha = g\sin\alpha - \left(\frac{F - mg\sin\alpha\cos\alpha}{3m + m\sin^2\alpha}\right)\cos\alpha$

$t^2 = \frac{2L}{a_{отн}} = \frac{\frac{2H}{\sin\alpha}}{g\sin\alpha - \left(\frac{F\cos\alpha - mg\sin\alpha\cos^2\alpha}{3m + m\sin^2\alpha}\right)} \Rightarrow$

$\Rightarrow t_{ср2} = \sqrt{\frac{\frac{2H}{\sin\alpha}}{g\sin\alpha - \left(\frac{F\cos\alpha - mg\sin\alpha\cos^2\alpha}{3m + m\sin^2\alpha}\right)}} \approx 3,74\sqrt{\frac{H}{g}}$

Ответ: $\frac{5}{3}\sqrt{\frac{2H}{g}}$; $0,45g$; $3,74\sqrt{\frac{H}{g}}$

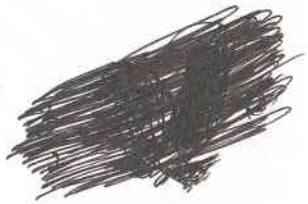




$\Delta U = Q + A$

$-A = Q + \Delta U$

$Q = \Delta U + A$



$A < 0$

~~$Q = \Delta U - A$~~

$\Delta U = Q - A$

$\frac{\Delta U}{A} = \frac{Q}{A} - 1$

~~Условие~~

Черновик

$L = \frac{a_{сти} t^2}{2}$; $a_{сти} = a - A_x = 0{,}44\,g$

$L = \frac{0{,}44\,g\,t^2}{2}$

$L = 0{,}22\,g t^2$

$\frac{H}{\sin\alpha} = 0{,}22 g t^2$

$\frac{5}{3} H = \frac{22}{100} g t^2$

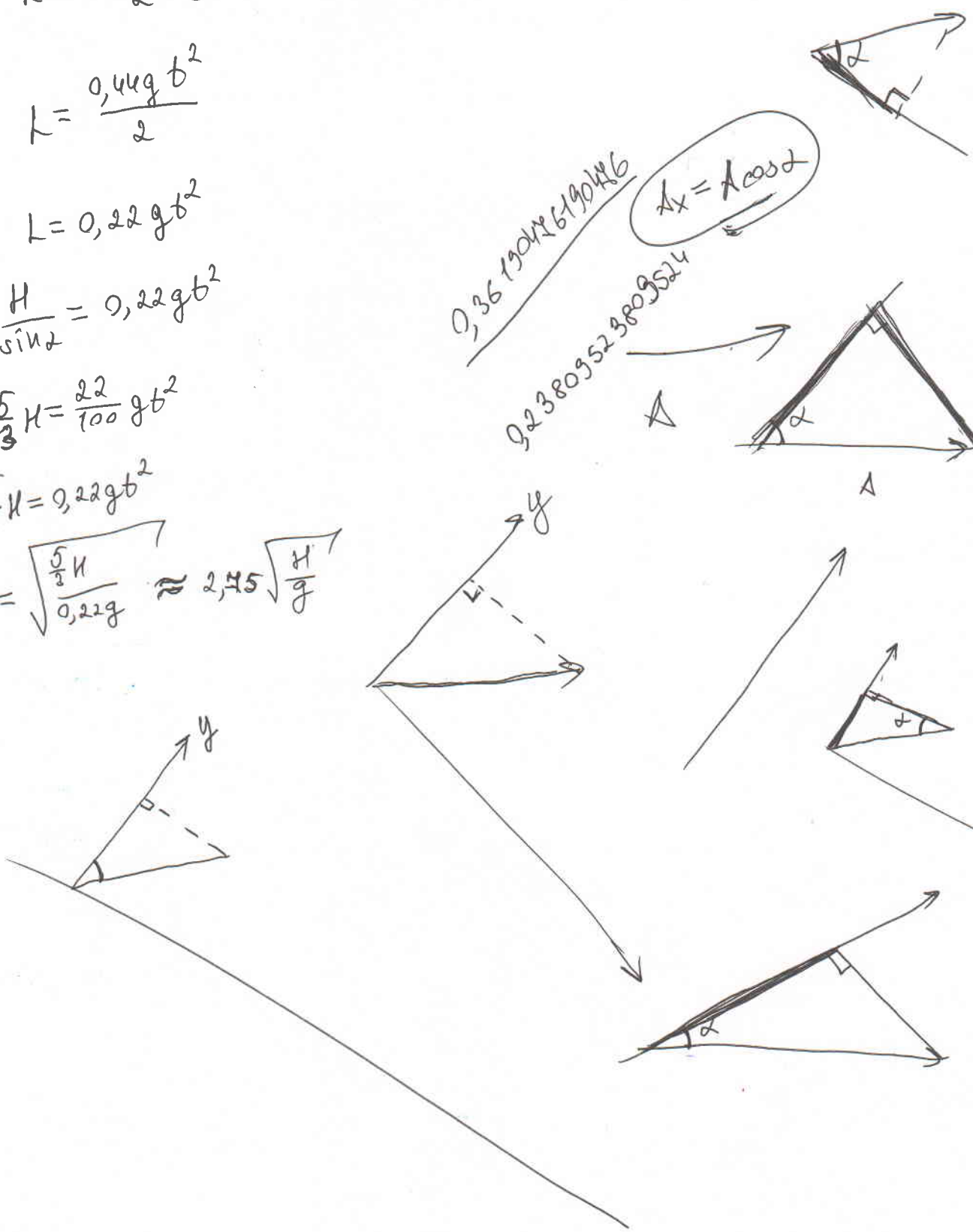
$\frac{5}{3} H = 0{,}22 g t^2$

$t = \sqrt{\frac{\frac{5}{3}H}{0{,}22g}} \approx 2{,}75\sqrt{\frac{H}{g}}$

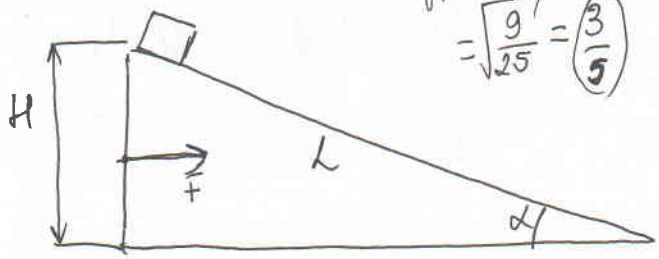
$A_x = A\cos\alpha$

0,36190476190476

0,23809523809524



$g\downarrow$



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

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

$mgH = \frac{mv_0^2}{2}$

$v_0^2 = 2gH$

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

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

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

$2H = g\sin^2\alpha t^2$

$t = \sqrt{\frac{2H}{g\sin^2\alpha}} = \sqrt{\frac{2H}{g}} \cdot \frac{1}{\sin\alpha} = \frac{5}{3}\sqrt{\frac{2H}{g}}$

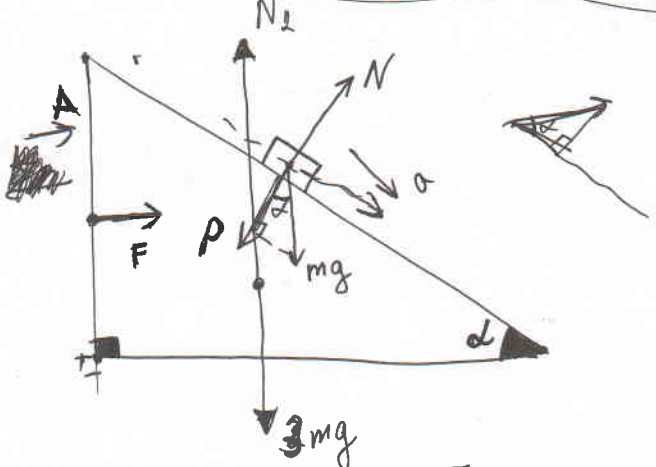
$N = mg\cos\alpha$

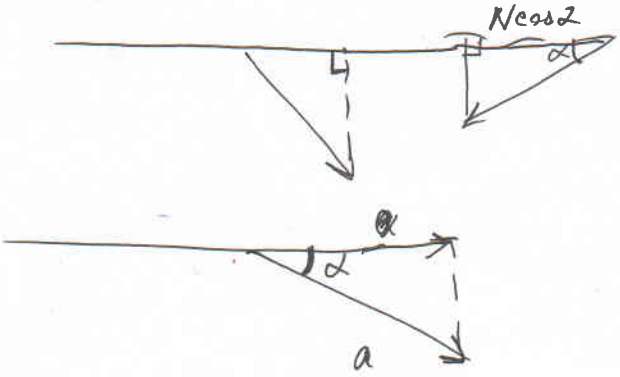
$F + mg\cos^2\alpha = MA$

$\frac{3}{5}mg + \frac{16}{25}mg = MA$

$g + \frac{16}{25}g = A$

$F + N\cos\alpha = MA$





$mg\sin\alpha + F\cos\alpha = ma$

$mg\sin\alpha\cos\alpha + F\cos^2\alpha = MA$

$\cos\alpha = \frac{x}{a}$

$x = a\cos\alpha$

$A = a\cos\alpha$

$a = \frac{A}{\cos\alpha}$