Часть 1

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

Шифр: **21204854**

ID профиля: **185928**

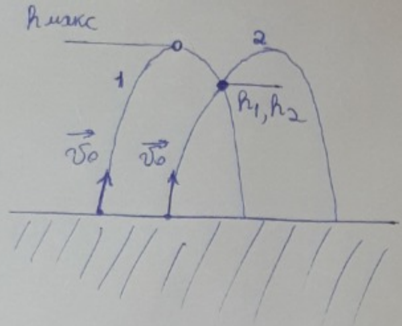
Вариант 1

Чистовик

№1

$h_{макс} = \frac{v_0^2}{2g}$

$t_{макс} = \frac{v_0}{g}$



$h_1 = h_2$

$t_1 = t_2 + t_{макс}$

$t_1 = t_2 + \frac{v_0}{g}$

$h_1 = v_0 t_1 - \frac{g t_1^2}{2}$

$h_2 = v_0 t_2 - \frac{g t_2^2}{2}$

$v_0 t_1 - \frac{g t_1^2}{2} = v_0 t_2 - \frac{g t_2^2}{2}$

$v_0\left(t_2 + \frac{v_0}{g}\right) - \frac{g\left(t_2 + \frac{v_0}{g}\right)^2}{2} = v_0 t_2 - \frac{g t_2^2}{2}$

$v_0 t_2 + \frac{v_0^2}{g} - \frac{g t_2^2}{2} - g t_2 \frac{v_0}{g} - \frac{g v_0^2}{2g^2} = v_0 t_2 - \frac{g t_2^2}{2}$

$\frac{v_0^2}{g} - v_0 t_2 - \frac{v_0^2}{2g} = 0$

$\frac{v_0^2}{2g} = v_0 t_2$

$t_2 = \frac{v_0}{2g}$

$t_2 = \tau$

$\tau = \frac{v_0}{2g}$

$v_0 = 2\tau g$

$\cancel{t_{макс} = \frac{v_0}{g}}$ $h_{макс} = \frac{v_0^2}{2g}$

$\cancel{t_{макс} =}$ $h_{макс} = \frac{4\tau^2 g^2}{2g} = 2\tau^2 g$

$h_{встр} = h_1 = h_2 = v_0 \tau - \frac{g\tau^2}{2}$

$h_{встр} = 2\tau g \tau - \frac{g\tau^2}{2} = 2\tau^2 g - \frac{g\tau^2}{2}$

$h_{встр} = \frac{3g\tau^2}{2}$

~~Ответ: $h_{встр} = \frac{3g\tau^2}{2}$, $h_{макс} = 2g\tau^2$~~

1

21204854 (U185928 M1279687)

Чистовик

$S_1 = 2h_{макс} - h_{встр}$

$S_2 = h_{встр}$

$$\frac{S_1}{S_2} = \frac{2h_{макс} - h_{встр}}{h_{встр}}$$

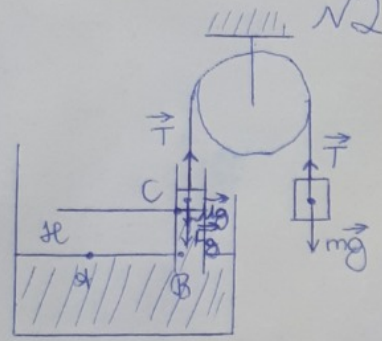
$$\frac{S_1}{S_2} = \frac{2 \cdot 2g\tau^2 - 1{,}5g\tau^2}{1{,}5g\tau^2}$$

$$\frac{S_1}{S_2} = \frac{2{,}5g\tau^2}{1{,}5g\tau^2}$$

$$\frac{S_1}{S_2} = \frac{5}{3}$$

Ответ: $h_{встр} = \frac{3g\tau^2}{2}$; $h_{макс} = 2g\tau^2$; $\frac{S_1}{S_2} = \frac{5}{3}$

№2



$T = mg$

$P_A = P_B = P_{атм}$

$P_C = P_B - \rho g H$

$P_C = P_{атм} - \rho g H$

$P_C = 10^5 Па - 1000 \frac{кг}{м^3} \cdot 10 \frac{Н}{кг} \cdot 0{,}1м = 9{,}9 \cdot 10^4 Па$

$$P_C = \frac{F_g + Mg - mg}{S}$$

$$P_C = P_{атм} + \frac{(M-m)g}{S}$$

$$P_{атм} - \rho g H = P_{атм} + \frac{(M-m)g}{S}$$

$$\frac{(M-m)g}{S} = -\rho g H$$

$m = M + \cancel{gg}\, \rho S H$

$m = 0{,}05кг + 1000 \frac{кг}{м^3} \cdot 0{,}0008 м^2 \cdot 0{,}1м = 0{,}13кг$

$M_г$ – масса гири

Чистовик

$$|\rho g h_1| = \left|\frac{mg - Mg - M_г g}{S}\right|$$

$$|h_1| = \left|\frac{mg - Mg - M_г g}{\rho g S}\right|$$

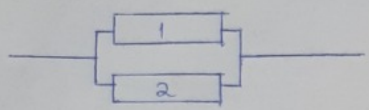
$$|h_1| = \left|\frac{0{,}13кг\cdot 10\frac{Н}{кг} - 0{,}05кг\cdot 10\frac{Н}{кг} - 0{,}12кг\cdot 10\frac{Н}{кг}}{1000\frac{кг}{м^3}\cdot 10\frac{Н}{кг}\cdot 0{,}0008м^2}\right| = |-0{,}05м| = 0{,}05м,$$

значит нижний край поршня окажется ниже уровня воды в сосуде на расстоянии 0,05м

Ответ: $P_c = 9{,}9\cdot 10^4$ Па; $m = 0{,}13$кг; $h_1 = 0{,}05$м

№3

1)



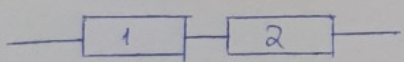
$U_1 = U_2 = U_0$

$P_1 = I_1^2 U_0$

$I_1 = \sqrt{\frac{P_1}{U_0}}$

$I_1 = \sqrt{\frac{20Вт}{12В}} = 1{,}3А$

2)



$U_0 = U_1 + U_2$

$U_1 = U_2 = \frac{U_0}{2}$

$P_2 = I_2^2 \frac{U_0}{2}$

$2P_2 = I_2^2 U_0$

$I_2 = \sqrt{\frac{2P_2}{U_0}}$

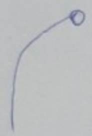
$I_2 = \sqrt{\frac{2\cdot 6{,}6Вт}{12В}} = 1{,}05А$

$P_3 = I_2^2 \frac{2U_0}{2} = I_2^2 \cdot U_0 = 2P_2$

$P_3 = 2\cdot 6{,}6Вт = 13{,}2Вт$

Ответ: $I_1 = 1{,}3А$; $I_2 = 1{,}05А$; $P_3 = 13{,}2Вт$

$v_0t+\frac{gt^2}{2}$ Черновик



$v_0t=\frac{gt^2}{2}$

$v_0=\frac{gt}{2}$

$\frac{v_0}{g}=\frac{t}{2}$ $\qquad t=\frac{2v_0}{g}$

$t_м=\frac{v_0}{g}$

$h=v_0t_м-\frac{gt_м^2}{2}=$

$=\frac{v_0^2}{g}-\frac{gv_0^2}{2g^2}=\frac{v_0^2}{g}-\frac{v_0^2}{2g}=\frac{v_0^2}{2g}$

$h_1=h_2$ $\qquad t_1=t_2+\frac{v_0}{g}$

$v_0t_1-\frac{gt_1^2}{2}=v_0t_2-\frac{gt_2^2}{2}$

$v_0\left(t_2+\frac{v_0}{g}\right)-\frac{g\left(t_2+\frac{v_0}{g}\right)^2}{2}=v_0t_2-\frac{gt_2^2}{2}$

$\underline{v_0t_2}+\frac{v_0^2}{g}-\underline{\frac{gt_2^2}{2}}-\frac{gt_2v_0}{g}-\frac{gv_0^2}{2g^2}=\underline{v_0t_2}-\underline{\frac{gt_2^2}{2}}$

$\frac{v_0^2}{g}-v_0t_2-\frac{v_0^2}{2g}=0$

$\frac{v_0^2}{2g}=v_0t_2$

$h_2=v_0\cdot\tau-\frac{g\tau^2}{2}=$

$t_2=\frac{v_0}{2g}$ $\qquad \tau=\frac{v_0}{2g}$

$=2\tau g\cdot\tau-\frac{g\tau^2}{2}=$

$v_0=2\tau g$

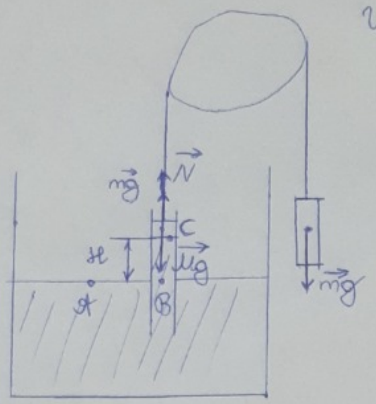
$=2\tau^2g-\frac{\tau^2g}{2}=$

$=\frac{3\tau^2g}{2}$

$t_м=\frac{v_0}{g}$ $\qquad \cancel{t_м=2\tau}$

$h_м=\frac{v_0^2}{2g}=\frac{4\tau^2g^2}{2g}=2\tau^2g$

Черновик



$$|\Delta h_1| = \left|\frac{mg - Mg - M_г g}{\rho g S}\right|$$

$$\rho g h_1 = \left|\frac{mg - Mg - M_г g}{S}\right|$$

$$\cancel{\rho g H}, \quad \cancel{\rho g h_1 = \frac{Mg - mg + M_г g}{S}}$$

$$\cancel{h_1 = \frac{Mg - mg + M_г g}{S}}$$

$P_A = P_B = P_{атм}$

$P_C = P_B - \rho g H$

$\cancel{P_C = 100 \cdot 10}$

$P_C = 10^5 Па - 1000 \frac{кг}{м^3} \cdot 10 \frac{Н}{кг} \cdot 0{,}1 м = 9{,}9 \cdot 10^4 Па$

$N = I^2 U$

$N = I^2 U t$

$P = \frac{F}{S}$

625 1625

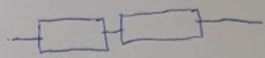
$P = \frac{Mg - mg}{S}$

$\frac{Mg}{S} = \frac{0{,}05 кг \cdot 10 \frac{Н}{кг}}{0{,}0008 м^2} = 625 Па$

$I_1 = I_2 = I$

$\frac{F_g + Mg - mg}{S} =$

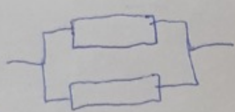
$Q = I^2 U t$



$= 9{,}9 \cdot 10^4 Па$

$P'_A = 0$

$P'_A = P'_B$



$P'_B = \rho g H - (m - M) g$

$|\Delta h_1| = \frac{0{,}13 кг \cdot 10 \frac{Н}{кг} - 0{,}05 кг \cdot 10 \frac{Н}{кг} - 0{,}2 кг \cdot 10 \frac{Н}{кг}}{1000 \frac{кг}{м^3} \cdot 10 \frac{Н}{кг} \cdot 0{,}0008 м^2} =$

$\rho g H = \frac{(m - M) g}{S}$

$\frac{m - M}{S} = \rho H$

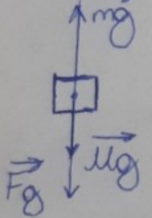
$\cancel{m = \rho H + M}$

$\cancel{m = 1000 \frac{кг}{м^3} \cdot 0{,}1 м + 0{,}05 кг} =$

$= |-0{,}05 м|$, значит нижний край поршня окажется ниже уровня воды в сосуде, на расстоянии 0,05 м

$m - M = \rho H S$

$m = \rho H S + M$



$m = 1000 \frac{кг}{м^3} \cdot 0{,}1 м \cdot 0{,}0008 м^2 + 0{,}05 кг = 0{,}13 кг$

$\frac{5}{3}$ $\quad \frac{Дж}{с} = \frac{Н \cdot м}{с}$

$S_1 = 2h_{max} - h_{ветр}$

$S_2 = h_{ветр}$

$S_1 = 2h_{max} - h_2$

$S_2 = h_2$

$\cancel{S_1 = 2 \cdot \frac{3g\tau^2}{2}} -$ $\quad S_1 = 2 \cdot 2g\tau^2 - 1{,}5 g\tau^2 = 2{,}5 g\tau^2$

$S_2 = 1{,}5 g \tau^2$

Часть 2

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

Шифр: **21204854**

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Вариант 1

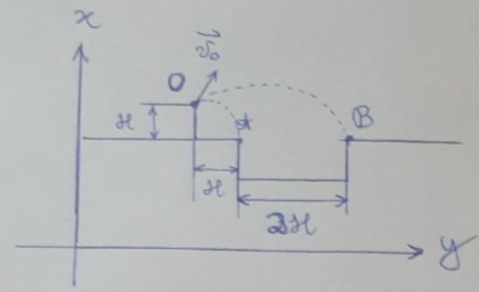
Чистовик

№1

Дано:

$S, H, v_0 = \sqrt{\frac{gH}{2}}$

Найти: t_1, $tg\,\alpha$



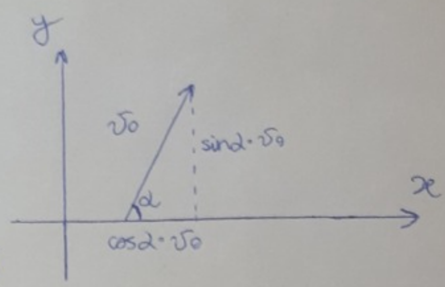
Решение:

$S v_0 t_1 = V$

$S v_0 t_1 = \pi H^2 \cdot H$

$S v_0 t_1 = \pi H^3$

$t_1 = \frac{\pi H^3}{S v_0}$



$t_1 = \frac{\pi H^3}{S\sqrt{\frac{gH}{2}}} = \frac{\pi H^3 \sqrt{\frac{gH}{2}}}{S\,\frac{gH}{2}} = \frac{2\pi H^2 \sqrt{\frac{gH}{2}}}{SgH}$

Пусть струя попала в точку A за время t, тогда

$$\begin{cases} v_0 \cdot \cos\alpha \cdot t = H \\ v_0 \cdot \sin\alpha \cdot t - \frac{gt^2}{2} = -H \end{cases}$$

$t = \frac{H}{v_0 \cdot \cos\alpha}$

$v_0 \cdot \sin\alpha \cdot \frac{H}{v_0 \cdot \cos\alpha} - \frac{gH^2}{2v_0^2 \cdot \cos^2\alpha} = -H$

$tg\,\alpha \cdot H - \frac{gH^2}{2v_0^2 \cdot \cos^2\alpha} = -H$

$tg\,\alpha - \frac{gH}{2v_0^2 \cdot \cos^2\alpha} = -1$

$v_0 = \sqrt{\frac{gH}{2}}$

$2v_0^2 = gH$

$tg\,\alpha - \frac{gH}{gH \cdot \cos^2\alpha} = -1$

$tg\,\alpha - \frac{1}{\cos^2\alpha} = -1$

$tg\,\alpha + 1 = \frac{1}{\cos^2\alpha}$

Чистовик

$\mathrm{tg}\,\alpha + 1 = \mathrm{tg}^2\alpha + 1$

$\mathrm{tg}^2\alpha - \mathrm{tg}\,\alpha = 0$

$\mathrm{tg}\,\alpha(\mathrm{tg}\,\alpha - 1) = 0$

$$\left[\begin{array}{l}\mathrm{tg}\,\alpha = 0\\ \mathrm{tg}\,\alpha = 1\end{array}\right.$$

Предположим, что струя достигла точки B, тогда

$$\begin{cases} v_0 \cdot \sin\alpha \cdot t - g\frac{t^2}{2} = -H \\ v_0 \cdot \cos\alpha \cdot t = 3H \end{cases}$$

$t = \frac{3H}{v_0 \cdot \cos\alpha}$

$v_0 \cdot \sin\alpha \cdot \frac{3H}{v_0 \cdot \cos\alpha} - \frac{9gH^2}{2v_0^2 \cdot \cos^2\alpha} = -H$

$3\,\mathrm{tg}\,\alpha - \frac{9gH}{gH \cdot \cos^2\alpha} = -1$

$3\,\mathrm{tg}\,\alpha - \frac{9}{\cos^2\alpha} = -1$

$3\,\mathrm{tg}\,\alpha + 1 = \frac{9}{\cos^2\alpha}$

$3\,\mathrm{tg}\,\alpha + 1 = 9 + 9\,\mathrm{tg}^2\alpha$

$9\,\mathrm{tg}^2\alpha - 3\,\mathrm{tg}\,\alpha + 8 = 0$

Пусть $\mathrm{tg}\,\alpha = x$

$9x^2 - 3x + 8 = 0$

$D = 3^2 - 4 \cdot 9 \cdot 8 = 9 - 288 = -279$

$D < 0$, значит $9\,\mathrm{tg}^2\alpha - 3\,\mathrm{tg}\,\alpha + 8$ не может равняться 0, значит струя не достигнет точки B при любом α, значит чтобы струя попала в бак достаточно условия, что когда координата тела по оси Ox совпадало с ~~точк~~ координатой точки A, то координата по оси Oy была бы больше, чем у точки A

Чистовик

$$\begin{cases} v_0 \cdot \cos\alpha \cdot t = H \\ v_0 \cdot \sin\alpha \cdot t - \frac{gt^2}{2} > -H \end{cases}$$

$$t = \frac{H}{v_0 \cdot \cos\alpha}$$

$$v_0 \cdot \sin\alpha \cdot \frac{H}{v_0 \cdot \cos\alpha} - \frac{gH^2}{2v_0^2 \cdot \cos^2\alpha} > -H$$

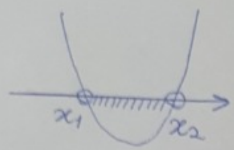
$$\operatorname{tg}\alpha - \frac{1}{\cos^2\alpha} > -1$$

$$\operatorname{tg}\alpha + 1 > \operatorname{tg}^2\alpha + 1$$

$$\operatorname{tg}^2\alpha - \operatorname{tg}\alpha < 0$$

Пусть $\operatorname{tg}\alpha = x$

(1) $x^2 - x < 0$



(1) $x^2 - x = 0$

$D = 1$

$$\begin{cases} x_1 + x_2 = 1 \\ x_1 \cdot x_2 = 0 \end{cases} \quad \begin{cases} x_1 = 0 \\ x_2 = 1 \end{cases}$$

Чтобы $x^2 - x < 0$

$x_1 < x < x_2$

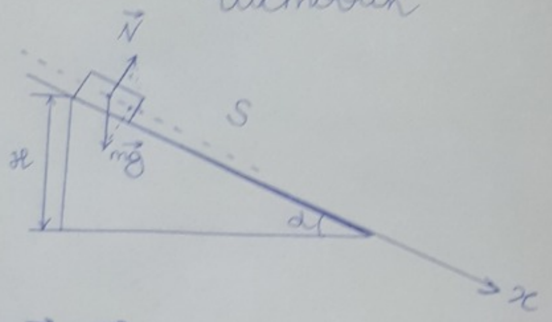
$0 < x < 1$

$0 < \operatorname{tg}\alpha < 1$

Ответ: $t_1 = \frac{2\pi r H^2 \sqrt{\frac{gH}{2}}}{5gH}$; чтобы струя попала в т. А нужно чтобы $\operatorname{tg}\alpha = 0$ либо $\operatorname{tg}\alpha = 1$; чтобы струя попала в бак нужно, чтобы $\operatorname{tg}\alpha \in (0; 1)$

③

Чистовик



$m\vec{a} = \vec{N} + m\vec{g}$

$Ox)\ ma = mg \cdot \sin\alpha$

$a = g \cdot \sin\alpha$

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

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

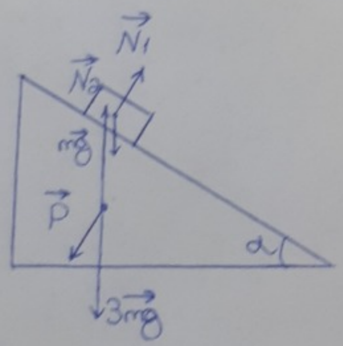
$\frac{\mathcal{H}}{\sin\alpha} = \frac{at^2}{2}$

$t^2 = \frac{2\mathcal{H}}{a \cdot \sin\alpha}$

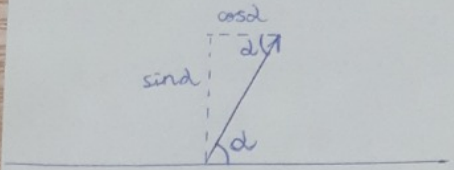
$t^2 = \frac{2\mathcal{H}}{g \cdot \sin^2\alpha}$

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

$t = \sqrt{\frac{2\mathcal{H}}{g(1 - \frac{16}{25})}} = \sqrt{\frac{2\mathcal{H}}{\frac{9}{25}g}} = \sqrt{\frac{25 \cdot 2\mathcal{H}}{9g}} = \frac{5}{3}\sqrt{\frac{2\mathcal{H}}{g}}$



черновик



$v_0 \cdot \cos\alpha \cdot t = H$

$t = \frac{H}{v_0 \cdot \cos\alpha}$

$v_0 \cdot \sin\alpha \cdot t - \frac{gt^2}{2} = \cancel{H} - H$

$v_0 = \sqrt{\frac{gH}{2}}$

$v_0^2 = \frac{gH}{2}$

$2v_0^2 = gH$

$\cancel{v_0} \cdot \sin\alpha \cdot \frac{H}{\cancel{v_0} \cdot \cos\alpha} - \frac{gH^{\cancel{2}}}{2v_0^2 \cdot \cos^2\alpha} = -\cancel{H}$

$tg\,\alpha - \frac{gH}{2v_0^2 \cdot \cos^2\alpha} = \cancel{1} - 1$

$tg\,\alpha - \frac{gH}{gH \cdot \cos^2\alpha} = \cancel{1} - 1$

$tg\,\alpha - \frac{1}{\cos^2\alpha} = \cancel{1} - 1$

$\cancel{tg\,\alpha - 1 = \frac{1}{\cos^2\alpha} = 1 + tg^2\alpha}$

$\cancel{tg\,\alpha - 1 = 1 + tg^2\alpha}$

$tg\,\alpha + 1 = \frac{1}{\cos^2\alpha}$

$tg\,\alpha + 1 = tg^2\alpha + 1$

$tg^2\alpha - tg\,\alpha = 0$

$tg\,\alpha(tg\,\alpha - 1) = 0$

$\left[\begin{array}{l} tg\,\alpha = 1 \\ tg\,\alpha = 0 \end{array}\right.$

Черновик

$\frac{м}{c}\cdot м^2 = \frac{м^3}{c}$

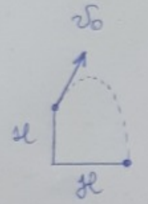
м

vS

$\pi H^2 \cdot H$

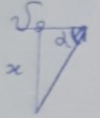
$$\frac{\pi H^3}{vS}$$

$$t = \frac{\pi H^3}{S\sqrt{\frac{gH}{2}}}$$



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

$$\underline{v_0}\cdot \sin\alpha \cdot t - \frac{gt^2}{2} = H$$



$$\underline{v_0}\cdot \cos\alpha \cdot t = H \qquad t = \frac{H}{v_0\cdot\cos\alpha}$$

$$tg\alpha - \frac{gt}{2v_0\cdot\cos\alpha} = 1$$

$$v_0 = \sqrt{\frac{gH}{2}}$$

$$v_0^2 = \frac{gH}{2}$$

$$2v_0^2 = gH$$

$$\cancel{v_0}\cdot\sin\alpha\cdot\frac{H}{\cancel{v_0}\cdot\cos\alpha} - \frac{gH^2}{2v_0^2\cdot\cos^2\alpha} = H$$

$$tg\alpha\cdot\cancel{H} - \frac{gH}{2v_0^2\cdot\cos^2\alpha} = 1$$

$$tg\alpha - \frac{gH}{gH\cdot\cos^2\alpha} = 1$$

$$tg\alpha - \frac{1}{\cos^2\alpha} = 1$$

$$tg\alpha - 1 = \frac{1}{\cos^2\alpha}$$

$$tg\alpha - 1 = 1 + tg^2\alpha$$

$$tg^2\alpha - tg\alpha + 2 = 0$$

$$D = 1 - 8 = -7$$

Черновик

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

$H < v_0 \cdot \cos\alpha \cdot t < 3H$

$v_0 \cdot \cos\alpha \cdot t = 3H$

$t = \frac{3H}{v_0 \cdot \cos\alpha}$

$v_0 \cdot \sin\alpha \cdot \frac{3H}{v_0 \cdot \cos\alpha} - \frac{9gH^{\cancel{2}}}{2v_0^2 \cdot \cos^2\alpha} = -\cancel{H}$

$3tg\alpha - \frac{9gH}{2gH \cdot \cos^2\alpha} = -1$

$3tg\alpha - \frac{9}{\cos^2\alpha} = -1$

$3tg\alpha + 1 = \frac{9}{\cos^2\alpha}$

$3tg\alpha + 1 = 9 + 9tg^2\alpha$

$9tg^2\alpha - 3tg\alpha + 8 = 0$

$D = 9 - 4 \cdot 9 \cdot 8 = 9 - 288 = -279$

$D < 0$

Пусть

$H < v_0 \cdot \cos\alpha \cdot t$

$H < \sqrt{\frac{gH}{2}} \cdot \cos\alpha \cdot t$

$H^{\cancel{2}} < \frac{g\cancel{H}}{2} \cdot \cos^2\alpha \cdot t^2$

$H < \frac{gt^2}{2} \cdot \cos^2\alpha$

$\frac{H}{\cos^2\alpha} < \frac{gt^2}{2}$

$v_0 \cdot \sin\alpha \cdot t - \frac{gt^2}{2} < v_0 \cdot \sin\alpha \cdot t - \frac{H}{\cos^2\alpha}$

чернетка

$v_0 \cdot \cos\alpha \cdot t = H$ $\qquad$ $t = \frac{H}{v_0 \cdot \cos\alpha}$

$$v_0 \cdot \sin\alpha \cdot t - \frac{gt^2}{2} > -H$$

$$\cancel{v_0} \cdot \sin\alpha \cdot \frac{\cancel{H}}{\cancel{v_0} \cdot \cos\alpha} - \frac{gH^{\cancel{2}}}{2v_0^2 \cdot \cos^2\alpha} > -\cancel{H}$$

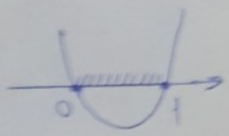
$$tg\,\alpha - \frac{gH}{gH \cdot \cos^2\alpha} > -1$$

$$tg\,\alpha - \frac{1}{\cos^2\alpha} > -1$$

$$tg\,\alpha + 1 > \frac{1}{\cos^2\alpha}$$

$$tg\,\alpha + 1 > 1 + tg^2\alpha$$

$$tg^2\alpha - tg\,\alpha < 0$$



$$tg\,\alpha = x$$

$$x^2 - x < 0$$

$$\begin{cases} x_1 + x_2 = 1 \\ x_1 \cdot x_2 = 0 \end{cases} \qquad \begin{cases} x_1 = 0 \\ x_2 = 1 \end{cases}$$

$$0 < tg\,\alpha < 1$$