Часть 1

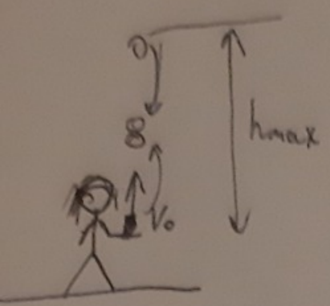
Олимпиада: **Физика, 9 класс (1 часть)**

Шифр: **21204463**

ID профиля: **802979**

Вариант 2

Чистовик. Задача 1. 1



Возьмём, что мячи столкнутся через t время после бросания второго мяча. Тогда:

$$\frac{gt^2}{2} + \left(v_0 t - \frac{gt^2}{2}\right) = h_{max} \qquad v_0 t = h_{max} = \frac{v_0^2}{2g}$$

$$h_{max} = \frac{v_0^2}{2g} = \frac{g(\tau - t)^2}{2}$$

$$v_0 = 2gt \qquad \frac{g\tau^2}{2} + \frac{gt^2}{2} - g\tau t = \frac{(2gt)^2}{2g} = 2gt^2$$

$$\cancel{t^2\left(2g - \frac{g}{2}\right)} \qquad \frac{\tau^2}{2} + \frac{t^2}{2} - \tau t = 2t^2$$

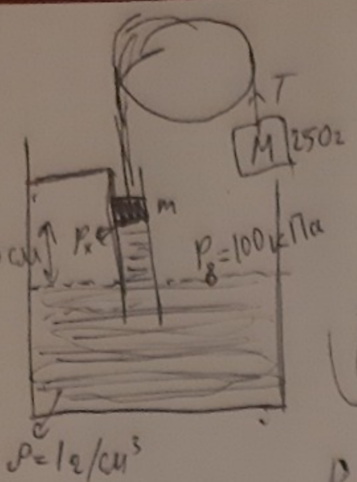
$$\frac{3}{2}t^2 + \tau t - \frac{\tau^2}{2} = 0 \qquad \sqrt{D} = \sqrt{\tau^2 + \frac{4\tau^2}{2}\cdot\frac{3}{2}} = 2\tau,$$

$$t = \frac{-\tau + 2\tau}{2\cdot\frac{3}{2}} = \frac{\tau}{3} \qquad h_{max} = \frac{V_0^2}{2g} = \frac{4g^2\tau^2}{3\cdot 2g} = \frac{2g\tau^2}{9}$$

$$v_0 = 2gt = \frac{2g\tau}{3}$$

Ответ: $\boxed{t = \frac{\tau}{3}; \quad h_{max} = \frac{2g\tau^2}{9}; \quad v_0 = \frac{2g\tau}{3}}$

Чистовик. Задача 2. 1



$$\begin{cases} Mg - T = 0 \Rightarrow Mg = T \\ P_0 S + mg - P_x S - T = 0 \end{cases}$$

$$\boxed{(P_0 - P_x) S = g(M-m)}$$

$$P_x + \rho g H = P_0 \Rightarrow P_0 - P_x = \rho g H$$

$$\Rightarrow \rho g H S = g(M-m)$$

$$\boxed{m = M - \rho H S} = 70г$$

$$P_x = \boxed{P_0 - \rho g H} = 1\cdot 10^5 - 10000\cdot 0{,}2 = 98кПа$$

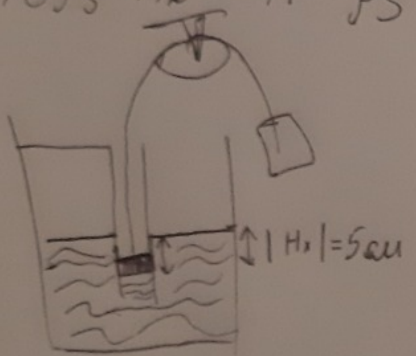
$$T = \frac{Mg}{10}$$

$$g\left(\frac{M}{10} - m\right) = \rho g H_x S$$

$$\frac{M-10m}{10\rho S} = H_x \qquad H = \frac{M-m}{\rho S}$$

$$\frac{H}{H_x} = \frac{(M-m)}{(M-10m)}\cdot 10 = -4$$

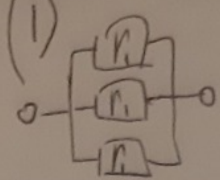
$$H_x = -\frac{H}{4} = -5см$$



Ответ: $\boxed{P_x = 98кПа;\ m = 70г;\ \text{ниже на 5см.}}$

Чистовик. Задача 3. 1

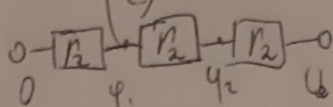
(1)



$\frac{U_0^2}{R_1} = P_1$ $\quad$ $\frac{U_0^2}{P_1} = R_1 = \frac{36}{2,4} = 15$ Ом

$I_1 = \frac{U_1}{R_1} = \frac{6}{15} = \frac{2}{5} = 0,4$ Ам

(2)

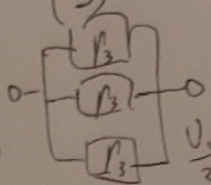


Так как лампочки одинаковые, $\varphi_1 - 0 = \varphi_2 - \varphi_1 = U_0 - \varphi_2 = \frac{U_0}{3} = 2$ В

$\frac{\left(\frac{U_0}{3}\right)^2}{R_2} = P_2 \Rightarrow R_2 = \frac{2^2}{0,5} = 8$ Ом

$I_2 = \frac{\left(\frac{U_0}{3}\right)}{R_2} = \frac{2}{8} = 0,25$ Ам

(3)



Из (2) имеем, что если $U = \frac{U_0}{3} = 2$ В, то

$r = R_3 = R_2 = 8$ Ом; $I = I_3 = I_2 = 0,25$ Ам; $\boxed{P = P_3 = P_2 = 0,5 \text{ Вт}}$

Ответ: $\boxed{I_1 = 0,4 \text{ Ам}, \; I_2 = 0,25 \text{ Ам}; \; P_3 = 0,5 \text{ Вт.}}$

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Черновик

$\frac{v_0^2}{2g}$ $\frac{v_0}{g}=t$ $v_0\tau-\frac{g\tau^2}{2}=v_0(\tau-t)-\frac{g(\tau-t)^2}{2}$

$S_1=\frac{gt^2}{2}+v_0t=\frac{gt^2}{2}$

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

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

$v_0t=h=\frac{v_0^2}{2g}$ $v_0=2gt$

$h=\frac{v_0^2}{2g}=\frac{g(\tau-t)^2}{2}$

$\frac{g\tau^2}{2}+\frac{gt^2}{2}-g\tau t=2gt^2$

250

10

$\frac{4g^2\tau^2}{g\,2g}$

$\frac{2g\tau^2}{2}=\frac{gt^2}{2}$ $\frac{2g\tau^2}{g}=\frac{g(\tau-t)^2}{2}$

$4\tau^2$

$t=\boxed{\frac{3\tau}{2}}$

$\frac{3\tau}{2}=\tau-t$

$t=\tau-\frac{3\tau}{2}$

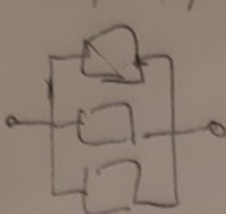
2 700

250

$\frac{180}{-450}$ 10 2

$=-\frac{20}{5}$

Черновик.



$\frac{U^2}{R} = N$

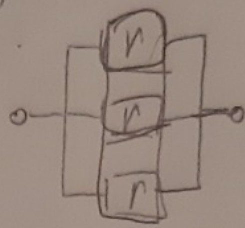
$\frac{6}{5}$

$\frac{36}{2,4} = R = 15\,Ом$

$\frac{4}{15}$ $I^2 R = N = 2,4$

$\frac{4}{25} \cdot 15$

$\frac{12}{5}$



$\frac{R}{3}$

$P_x + \rho g H = P_0$

$$\begin{cases} P_0 S - P_x S + mg - T = 0 \\ Mg - T = 0 \end{cases}$$

$S(P_0 - P_x) = g(M - m)$

$I^2 \cdot 15 = 0,5$

$I^2 \cdot 3 = 0,1$

$7,2 = \frac{36}{\frac{R}{3}}$

$I \cdot 3R =$

$\frac{4}{15}$

$I^2 = \boxed{\frac{1}{30}}$

$\frac{4}{15} = \frac{R}{3}$

$\frac{40}{0,5} = \frac{2}{R}$

$\frac{6}{R}$

$U = 6$

8

$\boxed{15}$

$\frac{6 \cdot 3}{R} = \frac{18}{R}$

$\frac{6}{15} = \frac{2}{5} = 0,4\,Ом$

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Часть 2

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

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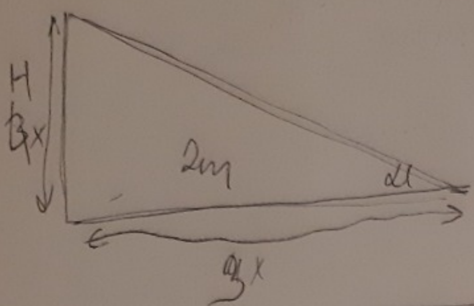
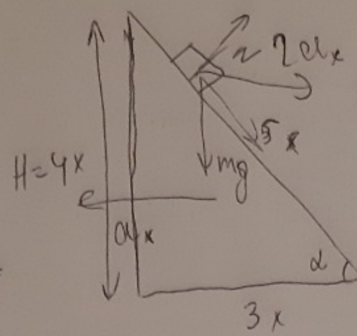
Вариант 2

Чистовик. Задача 4 1





Если клин будут удерживать ускорение шайбы будет $g\sin\alpha = g\cdot\frac{4}{5}$, тогда $\frac{H}{\cos\alpha} = \frac{t_x^2}{2}\left(g\cdot\frac{4}{5}\right)$

$$\frac{5H}{3} = \frac{t_x^2\cdot 2g}{5}$$

$$t_x = \sqrt{\frac{25H}{6g}}$$

$N\sin\alpha = 2m a_x = \cancel{m\cdot 2a_x}$

$\cancel{mg - N\cos\alpha} = m a_y$

$\cancel{\frac{\sqrt{a_x^2+a_y^2}\,t^2}{2}}$

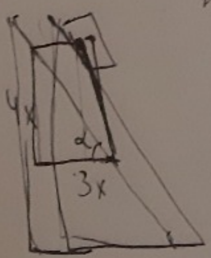
$\cancel{mgH = \frac{mv^2}{2} + \frac{m\left(\frac{v\cos\alpha}{2}\right)^2}{2}}$

$\cancel{p_1 = p_2 = mv\cos\alpha = 2m\left(\frac{v\cos\alpha}{2}\right)}$

$\cancel{gH = \frac{v^2}{2} + \frac{v^2}{2}\cdot\frac{\cos^2\alpha}{4} = v^2\left(\frac{1}{2}+\frac{9}{200}\right)}$

$\cancel{v^2 = \frac{200gH}{109}}$ $\cancel{v_y = \frac{200gH}{109}\cdot\frac{4}{5} = \frac{160gH}{109}}$

$\cancel{v_x = \frac{120gH}{109}}$



$$\frac{3a_x}{a_y} = \frac{3}{4} \Rightarrow a_y = 4a_x$$

$$\begin{cases} N\sin\alpha = 2a_x\cdot m \\ mg - N\cos\alpha = m\cdot a_y = 4ma_x \end{cases} \Rightarrow \begin{matrix} N\frac{4}{5} = 2a_x m \\ N\frac{3}{5} = mg - 4ma_x \end{matrix}$$

$$\frac{2\cancel{4ma_x}}{\cancel{2ma_x}} = \frac{mg - N\cdot\frac{3}{5}}{N\cdot\frac{4}{5}} \qquad 8N = 5mg - 3N \Rightarrow N = \frac{5mg}{11}$$

$$a_x = \frac{\cancel{5}mg}{11}\cdot\frac{2\cdot 2}{\cancel{5}}\cdot\frac{1}{2m} = \frac{2g}{11} \qquad \frac{a_y t^2}{2} = H \Leftrightarrow \frac{4g}{11}t^2 = H \Rightarrow t = \sqrt{\frac{11H}{4g}}$$

$$a_y = 4a_x = \frac{8g}{11}$$

Ответ: $\sqrt{\frac{25H}{6g}}$; $\frac{2g}{11}$; $\sqrt{\frac{11H}{4g}}$

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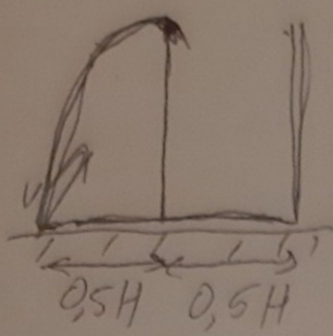
Чистовик. Задача 5. 1



$$V\cdot S\cdot t = H\cdot \pi(0{,}25H)^2 = \frac{\pi H^3}{16}$$

$$\boxed{t = \frac{\pi H^3}{16VS}}$$

$$t = \frac{0{,}5H}{v\cos\alpha}$$

$$\begin{cases} v\sin\alpha t - \frac{gt^2}{2} = H \\ v\cos\alpha t = 0{,}5H \end{cases}$$

$$\cancel{v}\sin\alpha\frac{0{,}5H}{\cancel{v}\cos\alpha} - \frac{g}{2}\cdot\frac{H^2}{4v^2\cos^2\alpha} = H$$

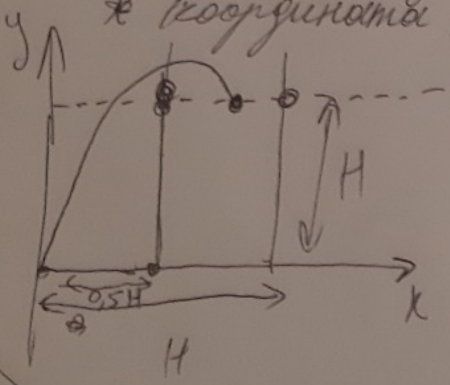
$$\frac{\operatorname{tg}\alpha H}{2} - \frac{g}{8}\cdot\frac{H^2}{\cos^2\alpha\cdot 2{,}5gH} = H$$

$$\frac{\operatorname{tg}\alpha}{2} - \frac{1}{20\cos^2\alpha} = 1 \Rightarrow 10\operatorname{tg}\alpha - \frac{1}{\cos^2\alpha} = 20$$

$$10\operatorname{tg}\alpha - 1 - \operatorname{tg}^2\alpha = 20 \Rightarrow \operatorname{tg}^2\alpha - 10\operatorname{tg}\alpha + 21 = 0 \quad \sqrt{D} = \sqrt{100-84} = 4$$

$$\operatorname{tg}\alpha = \frac{10\pm4}{2} = 7;\ 3$$

Чтобы струя воды попало внутрь бочки, на высоте H его координата x должен быть больше 0,5H и меньше H



$$\left[\begin{array}{l} \begin{cases} v\sin\alpha t - \frac{gt^2}{2} = H \\ v\cos\alpha t > 0{,}5H \end{cases} \quad (1) \\ \begin{cases} v\sin\alpha t - \frac{gt^2}{2} = H \\ v\cos\alpha t < H \end{cases} \quad (2) \end{array}\right.$$

(1) $t > \frac{0{,}5H}{v\cos\alpha} \Rightarrow H > v\sin\alpha\frac{0{,}5H}{v\cos\alpha} - \frac{g}{2}\frac{H^2}{4v^2\cos^2\alpha} \Leftrightarrow \operatorname{tg}^2\alpha - 10\operatorname{tg}\alpha + 21 > 0$

$\boxed{\operatorname{tg}\alpha \in (-\infty; 3) \cup (7; +\infty)}$

(2) $t < \frac{H}{v\cos\alpha} \Rightarrow H < v\sin\alpha t - \frac{gt^2}{2} \Leftrightarrow H < \operatorname{tg}\alpha H - \frac{g}{2}\cdot\frac{H^2}{\cos^2\alpha \cdot 2{,}5gH}$

$1 < \operatorname{tg}\alpha - \frac{1}{5\cos^2\alpha} \Leftrightarrow 5 < 5\operatorname{tg}\alpha - 1 - \operatorname{tg}^2\alpha \Leftrightarrow \operatorname{tg}^2\alpha - 5\operatorname{tg}\alpha + 6 < 0$

$\boxed{\operatorname{tg}\alpha \in (2; 3)}$

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Чистовик. Задача 5. 2

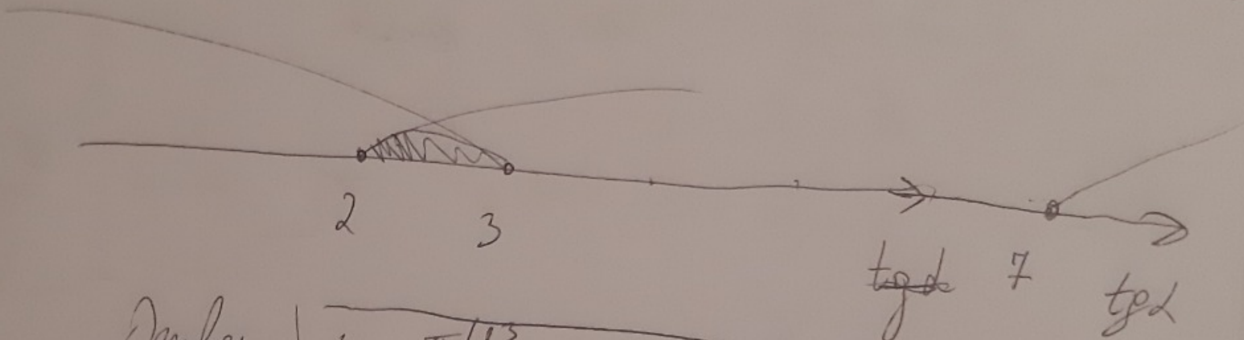
Так же нужно сказать, что струя должна достичь высоты H.

$$\frac{(v\sin\alpha)^2}{2g} \geq H \qquad \frac{2,5gH\sin^2\alpha}{2g} \geq H \Leftrightarrow 1,25\sin^2\alpha \geq 1$$

$$1,25\sin^2\alpha \geq \sin^2\alpha+\cos^2\alpha \Leftrightarrow 0,25\sin^2\alpha \geq \cos^2\alpha \Leftrightarrow$$

$$\Leftrightarrow tg^2\alpha \geq 4 \Rightarrow tg\alpha \geq 2$$

($tg\alpha < 0$ будет тогда, когда $\alpha > 90°$, нет смысла рассматривать).



Ответ: $\boxed{t=\frac{\pi H^3}{16VS};\quad tg\alpha=7;3;\quad tg\alpha\in(2;3)}$

Черновик

$mV_h = 2m$

$N \cdot \frac{4}{5} = 2ma_x$

$mg - N\cos\alpha = ma_1$

$$\begin{cases} mg - N\cos\alpha = ma_1 \\ mg\,N\sin\alpha = ma_2 \\ N\sin\alpha = 2m\frac{a_2}{2} \end{cases}$$

$2a \cdot m = N\sin\alpha$

$mg - \frac{3}{5}N = ma_1$

$N \cdot \frac{3}{5} = m(g - a_x)$

$N\cos\alpha =$

$\boxed{\frac{v\cos\alpha}{2}}$

$N \cdot \frac{4}{5} = m \cdot 2a_x$

$\frac{N\sin\alpha}{2m} = \frac{N\sin\alpha}{2m}$

$mgh = \frac{2m}{2}\left(\frac{v\cos\alpha}{2}\right)^2 + \frac{mv^2}{2}$

$= mv^2\left(\frac{1}{2} + \right.$

$100 - 4 \cdot 21$

$2ma = N \cdot \frac{4}{5}$

$N\cos\alpha = N \cdot \sin\alpha \cdot \frac{\cos\alpha}{\sin\alpha}$

$\frac{(v\sin\alpha)^2}{2g} \geq H$

$N \cdot \frac{3}{5} = 2ma\frac{3}{4} = ma \cdot \frac{3}{2}$

$\frac{2{,}5gH\sin^2\alpha}{2g} \geq H$

$16 + 6$

$mg - ma\frac{3}{2}$

$(tg - 3)(tg - 2)$

$1{,}25\sin^2\alpha \geq 1$

$g - \frac{3}{2}a$

$v\sin\alpha\, t - \frac{gt^2}{2} = H$

$v\cos\alpha\, t = 0{,}5H$

$2{,}25 - 7{,}5 + 6$

$4 - 10 + 6$

$9 + 6 - 15$