Часть 1

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

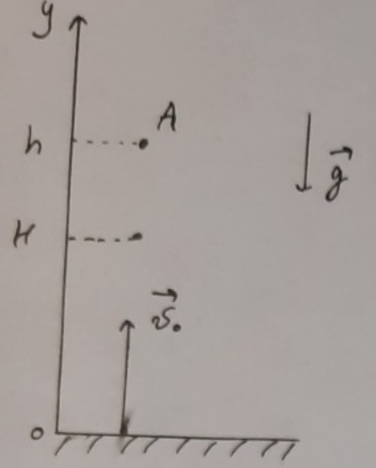
Шифр: **21204880**

ID профиля: **814208**

Вариант 2

Чистовик Физика, 9 кл.

1.



1) Пусть $y_1(t)$ – уравнение движения для I мяча, а $y_2(t)$ – для II.

$y_1 = v_0 t - \frac{gt^2}{2}$

$y_2 = v_0(t-t_A) - \frac{g(t-t_A)^2}{2}$

Тела сталкиваются в момент $\tau \Rightarrow y_1(\tau) = y_2(\tau) = H$

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

$\cancel{v_0\tau} - \cancel{\frac{g\tau^2}{2}} = \cancel{v_0\tau} - v_0 t_A - \cancel{\frac{g\tau^2}{2}} + g\tau t_A - \frac{g t_A^2}{2} \quad |: g t_A$

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

А – макс. точка подъёма $\Rightarrow v_{Ay} = 0$; $v_{Ay} = v_{0y} + g_y t_A$

$t_A = \frac{v_0}{g}$ (1)

$\tau = \frac{v_0}{g} + \frac{v_0}{2g} = \frac{3}{2}\frac{v_0}{g} = \frac{3}{2}t_A \Rightarrow t_A = \frac{2}{3}\tau$

$t_2 = \tau - t_A = \tau - \frac{2}{3}\tau = \underline{\frac{1}{3}\tau}$

2) $h = v_0 t_A - \frac{g t_A^2}{2} = \frac{2}{3}v_0\tau - \frac{g}{2}\cdot\frac{4}{9}\tau^2$

из (1) $v_0 = g t_A = \frac{2}{3}g\tau$

$h = \frac{2}{3}g\tau\cdot\frac{2}{3}\tau - \frac{2}{9}g\tau^2 = \frac{4}{9}g\tau^2 - \frac{2}{9}g\tau^2 = \underline{\frac{2}{9}g\tau^2}$

1

3) $v_0 = \underline{\frac{2}{3}g\tau}$

Ответ: 1) $t_2 = \frac{1}{3}\tau$; 2) $h = \frac{2}{9}g\tau^2$; 3) $v_0 = \frac{2}{3}g\tau$.

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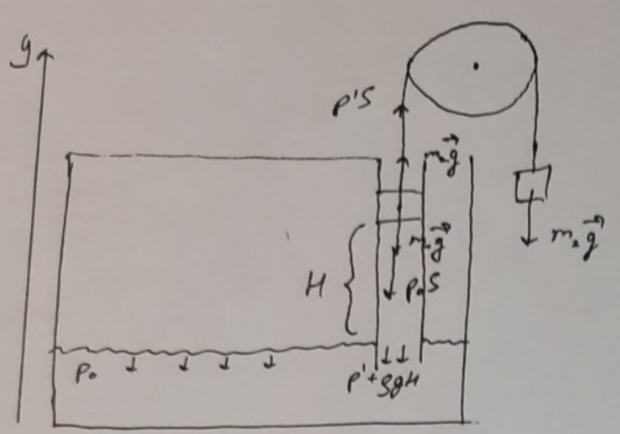
Чистовик Физика, 9 кл.

2.



1) Условие равновесия:

$$p_0 = p' + \rho g H \Rightarrow p' = p_0 - \rho g H$$

$$p' = 100000\,Па - 1000\frac{кг}{м^3}\cdot 10\frac{м}{с^2}\cdot 0{,}2\,м = 100000\,Па - 2000\frac{кг\cdot м}{с^2}\cdot\frac{1}{м^2} = 100000\,Па - 2000\frac{Н}{м^2} =$$
$$= \underline{98\,000\,Па} = 98\,кПа$$

2) II закон Ньютона для поршня:

$$\vec{p'S} + m_2\vec g + m_1\vec g + \vec{p_0S} = 0$$

$$(Oy):\quad p'S + m_2 g - m_1 g - p_0 S = 0 \quad |:g$$

$$m_1 = m_2 - \frac{(p_0 - p')S}{g}$$

$$m_1 = 0{,}25\,кг - \frac{(10^5\,Па - 98\cdot10^3\,Па)\cdot \cancel{0{,}2}\ 0{,}0009\,м^2}{10\frac{м}{с^2}} = -\frac{2000\,Па\cdot 0{,}0009\,м^2}{10\frac{м}{с^2}} + 0{,}25\,кг =$$
$$= 0{,}25\,кг - 0{,}18\,кг = \underline{0{,}07\,кг}$$

3) $H = ?$ если $m_1' = 0{,}007\,кг = 0{,}1 m_1$ (2)

$$p_0 = p' + \rho g H' \qquad H' = \frac{p_0 - p'}{\rho g}$$

$$p'S + m_2 g - m_1' g - p_0 S = 0$$

$$p_0 - p' = \frac{m_2 g - m_1' g}{S} \Rightarrow H' = \frac{(m_2 - m_1')g}{S\cdot\rho g} = \frac{m_2 - m_1'}{\rho S}$$

$$H' = \frac{0{,}25\,кг - 0{,}007\,кг}{1000\frac{кг}{м^3}\cdot 0{,}0009\,м^2} = \frac{0{,}2493\cdot м}{0{,}9} = \frac{2{,}493}{9}\,м = 0{,}277\,м$$

Ответ: 1) $p' = 98\,кПа$; 2) $m_1 = 0{,}07\,кг$; 3) $H' = 0{,}277\,м$.

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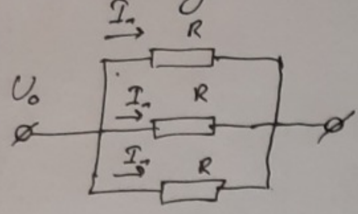
3. Лампочки одинаковые => $R_1 = R_2 = R_3 = R$

1)

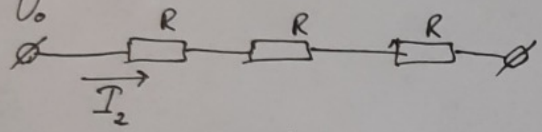


$U = U_0$, т.к. соединение параллельное

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

$$I_1 = \frac{2{,}4\ Вт}{6\ В} = \underline{0{,}4\ А}$$

2)

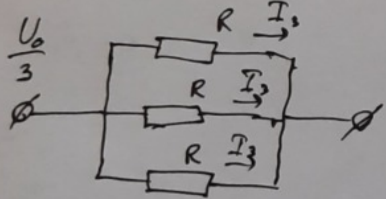


соединение последовательное => $U_0 = I_2 \cdot 3R \Rightarrow R = \dfrac{U_0}{3I_2}$ (1)

$$P_2 = I_2^2 R = \frac{U_0 I_2}{3} \Rightarrow I_2 = \frac{3P_2}{U_0}$$

$$P_2 = \frac{3 \cdot 0{,}5\ Вт}{6\ В} = \underline{0{,}25\ А}$$

3)



$U = \dfrac{U_0}{3}$, т.к. соединение параллельное.

$$P_3 = \left(\frac{U_0}{3}\right)^2 \cdot \frac{1}{R}$$

из (1) → $$P_3 = \frac{U_0^2 \cdot 3I_2}{9 \cdot U_0} = \frac{U_0 I_2}{3}$$

3

$$P_3 = \frac{6\ В \cdot 0{,}25\ А}{3} = \underline{0{,}5\ Вт}$$

Ответ: 1) $I_1 = 0{,}4\ А$; 2) $I_2 = 0{,}25\ А$; 3) $P_3 = 0{,}5\ Вт$.

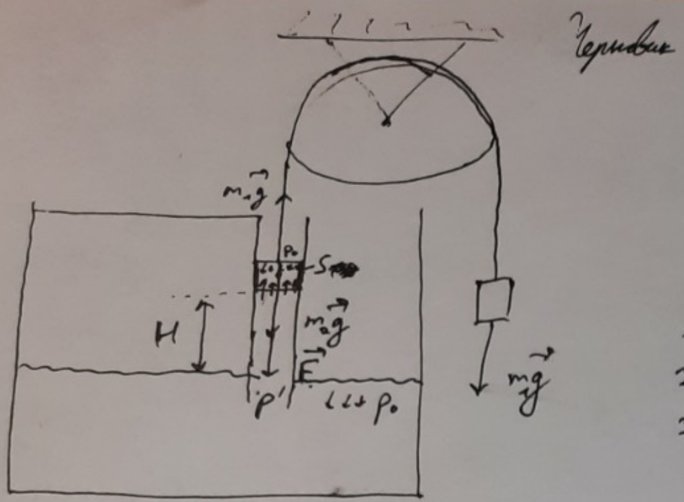
Черновик

$I=\frac{U}{R}$ $\quad R=\frac{U}{I}$

$P=I^2R=\frac{U^2}{R}$

$P=UI$

2.



$m_1 = 250\text{ г} = 0{,}25\text{ кг}$

$H = 20\text{ см} = 0{,}2\text{ м}$

$S = 9\text{ см}^2 = 0{,}0009\text{ м}^2$

$p_0 = 100000\text{ Па}$; $\rho = 1000\frac{\text{кг}}{\text{м}^3}$; $g = 10\frac{\text{м}}{\text{с}^2}$

1) p' - ?

2) m_2 - ?

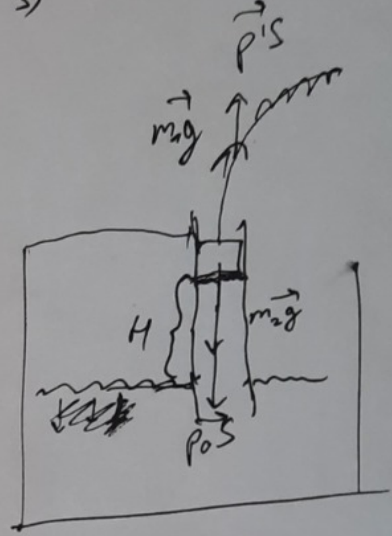
3)

$\vec F + m_0\vec g + m_1\vec g = 0$

$F = m_1 g - m_2 g$

$(p_0 - p')S = F$

$F = \rho g H \cdot S - p_0 = m_1 g - m_2 g$



$\vec{m_1 g} + \vec{p'S} + \vec{m_2 g} + \vec{p_0 S} = 0$

$\Delta p = \rho g H$

$\Delta p S = \rho g H S = (p_0 - p')S$

$\rho g H = p_0 - p'$

1) $p_0 = \rho g H + p' \Rightarrow p' = p_0 - \rho g H =$

$= 10^5\text{ Па} - 10^3\frac{\text{кг}}{\text{м}^3}\cdot 10\frac{\text{м}}{\text{с}^2}\cdot 0{,}2\text{ м} =$

$= 10^5\frac{\text{Н}}{\text{м}^2} - 2\cdot 10^3\frac{\text{кг}}{\text{м}\cdot\text{с}^2} =$

$= 100000\text{ Па} - 2000\frac{\text{Н}}{\text{м}^2} = 98000\text{ Па} = 98\text{ кПа}$

$m_1 g - m_2 g - \Delta p S = 0$

$m_1 g - m_2 g - \rho g H S = 0 \;|:g$

$m_2 = m_1 - \rho H S$

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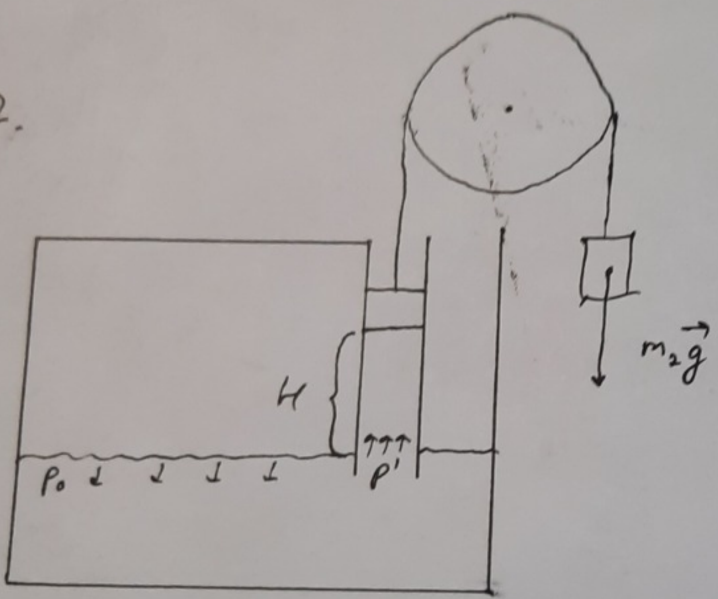
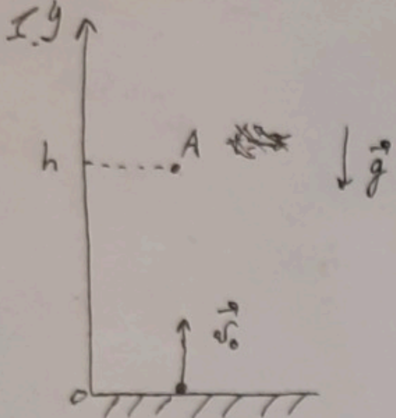
~~[illegible]~~ Черновик Физика, очно

2.

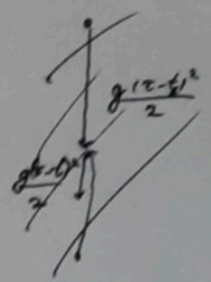


Черновик

Дано: τ



$h = y_0 + v_0 t_A - \frac{g t_A^2}{2} = v_0 t_A - \frac{g t_A^2}{2}$



$\vec{v} = \vec{v}_0 + \vec{g} t_A \Rightarrow v_y = v_{0y} + g_y t_A$

$v_y = 0 \rightarrow \quad v_0 = g t_A \Rightarrow t_A = \frac{v_0}{g}$

$y_1 = 0 + v_0 t - \frac{g t^2}{2} = v_0 t - \frac{g t^2}{2}$

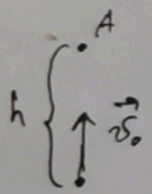
$y_2 = 0 + v_0(t - t_A) - \frac{g(t - t_A)^2}{2} = v_0 t - \frac{v_0^2}{g} - \frac{g\left(t^2 - 2t\frac{v_0}{g} + \frac{v_0^2}{g^2}\right)}{2} =$

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

$y_1 = y_2 \rightarrow \quad v_0 t - \frac{g t^2}{2} = v_0 t - \frac{g t^2}{2} - \frac{v_0^2}{g} + v_0 t + \frac{v_0^2}{2g} \Rightarrow t = \frac{v_0}{2g} = \frac{v_0}{2g} = \tau$

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

$K \rightarrow K'$ – св. пад. С.О., $\vec{a}' = \vec{g}$



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

$-v_0 \cdot \frac{v_0}{g} + v_0 \tau = \frac{v_0^2}{2g} \quad | : v_0$

$t_A = \frac{v_0}{g} + \frac{v_0}{2g} = \frac{3v_0}{2g} \qquad \tau - t_A = \frac{v_0}{2g}$

1) $t_2 = \tau - t_A = \tau - \frac{3v_0}{2g}$

$y_1 = v_0\tau - \frac{g\tau^2}{2}$; $y_2 = v_0(\tau - t_A) - \frac{g(\tau - t_A)^2}{2}$; $y_1 = y_2 \rightarrow$

$\cancel{v_0\tau} - \cancel{\frac{g\tau^2}{2}} = \cancel{v_0\tau} - v_0 t_A - \cancel{\frac{g\tau^2}{2}} + g\tau t_A - \frac{g t_A^2}{2}$

t_A: $v_A = 0$; $v_A = v_0 - g t_A = 0 \Rightarrow t_A = \frac{v_0}{g}$

$-\frac{v_0^2}{g} + \frac{g\tau v_0}{g} - \frac{g v_0^2}{2g^2} = 0$; $\tau = \frac{v_0}{g} + \frac{v_0}{2g} = \frac{3}{2}\frac{v_0}{g}$; $t_A = \frac{v_0}{g} = \frac{2}{3}\tau$

2) $h = v_0 t_A - \frac{g t_A^2}{2} = \frac{v_0^2}{g} - \frac{v_0^2}{2g} = \frac{v_0^2}{2g}$; $\frac{v_0}{g} = \frac{2}{3}\tau$

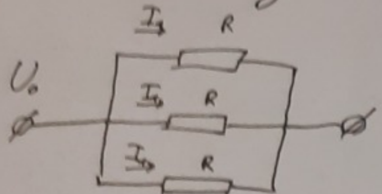
$= \frac{4g^2\tau^2}{9 \cdot 2g} = \frac{2}{9} g\tau^2$

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

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

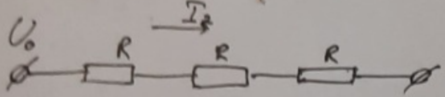
Черновик

3. Лампочки одинаковые $\Rightarrow R_1 = R_2 = R_3 = R$



1) $P_1 = U_0 I_1 \Rightarrow I_1 = \frac{P_1}{U_0}$

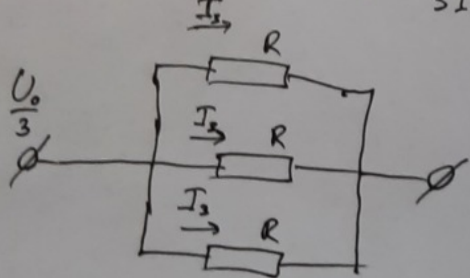
$I_1 = \frac{2,4\ Вт}{6\ В} = \underline{0,4\ А}$

2) 

$P_2 = I_2^2 R \Rightarrow I_2^2 = \frac{P_2}{R} \Rightarrow I_2 = \sqrt{\frac{P_2}{R}}$

$U_0 = 3 I_2 R$ (соединение последовательное) $\Rightarrow R = \frac{U_0}{3I_2}$ (1)

$P_2 = I_2^2 R = I_2^2 \cdot \frac{U_0}{3I_2} = \frac{I_2 U_0}{3} \Rightarrow I_2 = \frac{3P_2}{U_0} = \frac{3 \cdot 0,5\ Вт}{6\ В} = \underline{0,25\ А}$

3) 

$\cancel{P_3 = \frac{U_0^2}{3R}}$ $\cancel{P_3 = \left(\frac{U_0}{3}\right)^2 \cdot \frac{1}{R}}$ $\cancel{P_3 = \frac{U_0}{3} I_3}$ $P_3 = \left(\frac{U_0}{3}\right)^2 \cdot \frac{1}{R}$ $\leftarrow (1)$

$\cancel{I_3 R = \frac{U_0}{3} \Rightarrow I_3}$

$P_3 = \left(\frac{U_0}{3}\right)^2 \cdot \frac{3I_2}{U_0} = \frac{U_0 \cdot I_2}{3} = \frac{6\ В \cdot 0,25\ А}{3} = \underline{0,5\ Вт}$

Часть 2

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

Шифр: **21204880**

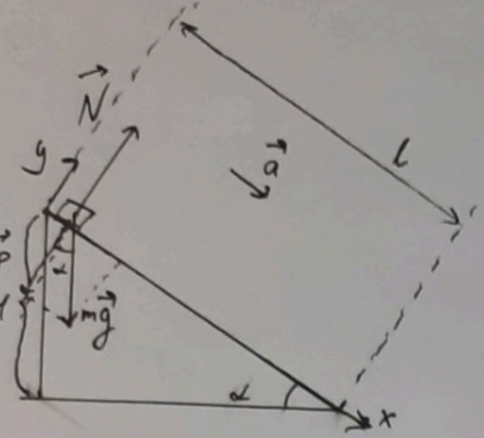
ID профиля: **814208**

Вариант 2

Чистовик

Физика, 9 кл.

4. 1)



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

$$\sin\alpha = \sqrt{1-\cos^2\alpha} = \sqrt{1-\frac{9}{25}} = \sqrt{\frac{16}{25}} = \frac{4}{5}$$

$$l = \frac{5H}{4}$$

II закон Ньютона для шайбы:

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

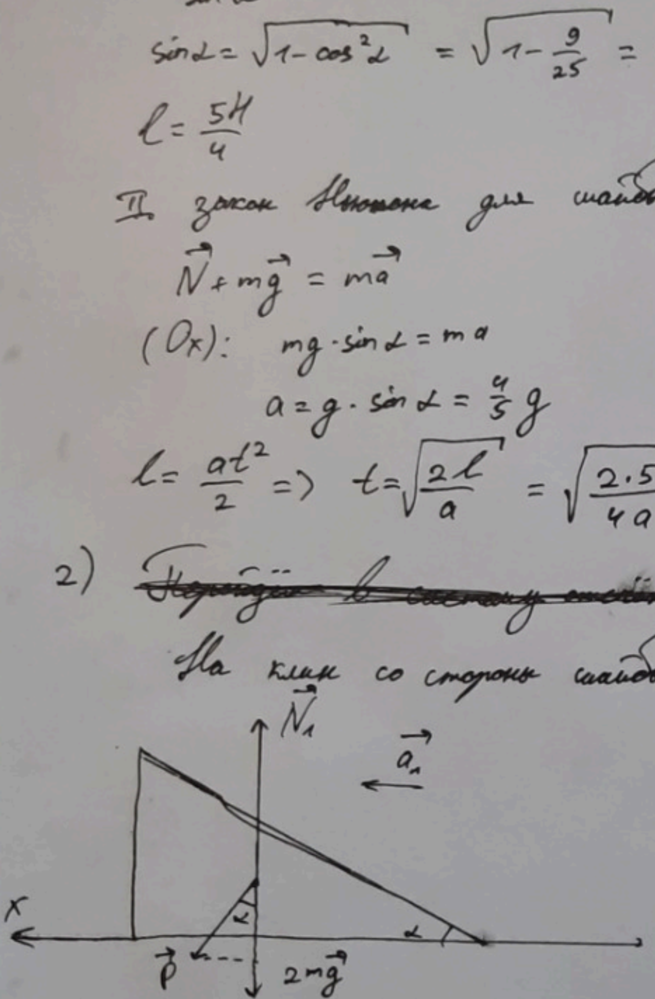
$$(Ox):\quad mg\cdot\sin\alpha = ma$$

$$a = g\cdot\sin\alpha = \frac{4}{5}g$$

$$l = \frac{at^2}{2} \Rightarrow t = \sqrt{\frac{2l}{a}} = \sqrt{\frac{2\cdot 5H}{4a}} = \sqrt{\frac{5}{4}H\cdot\frac{2\cdot 5}{4g}} = \frac{5}{4}\sqrt{\frac{2H}{g}}$$

2) ~~Перейдём в систему отсчёта, связанную с клином~~

На клин со стороны шайбы действует сила $\vec{P}$, $|\vec{P}| = |\vec{N}| = mg\cdot\cos\alpha$



II закон Ньютона для клина:

$$\vec{N}_1 + \vec{P} + 2m\vec{g} = 2m\vec{a}_1$$

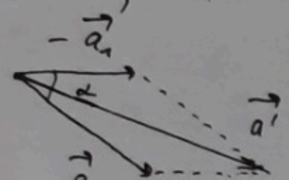
$$(Ox):\quad P\cdot\sin\alpha = 2ma_1$$

$$mg\cdot\cos\alpha\cdot\sin\alpha = 2ma_1 \qquad (1)$$

$$a_1 = \frac{g\cdot\cos\alpha\cdot\sin\alpha}{2} = \frac{\frac{3}{5}\cdot\frac{4}{5}}{2}g = \frac{12}{50}g = 0{,}24g$$

3) $K \to K'$ — перейдём в систему отсчёта, связанную с клином.

$$\vec{a}_1{}' = 0,\quad \vec{a}' = \vec{a} - \vec{a}_1$$



$$a' = \sqrt{a_1^2 + a^2 + 2a_1a\cdot\cos\alpha}$$

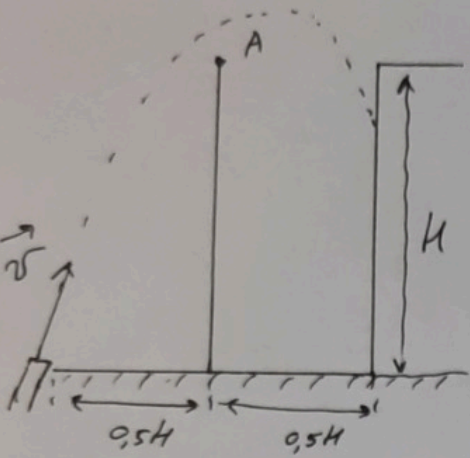
$$a' = g\sqrt{0{,}24^2 + 0{,}8^2 + 2\cdot 0{,}24\cdot 0{,}8\cdot\frac{3}{5}} = g\sqrt{0{,}6976 + 0{,}2304} = g\sqrt{0{,}928} \approx$$
$$\approx 0{,}96g$$

$$\frac{a't'^2}{2} = l = \frac{5}{4}H \Rightarrow t'^2 = \frac{5H}{2a'} \Rightarrow t' = \sqrt{\frac{5H}{2a'}} = \sqrt{\frac{5H}{2\cdot 0{,}96g}} = \sqrt{\frac{5H}{1{,}92g}} \approx \sqrt{2{,}6\frac{H}{g}} \approx$$
$$\approx 1{,}6\sqrt{\frac{H}{g}}$$

Ответ: 1) $t = \frac{5}{4}\sqrt{\frac{2H}{g}}$; 2) $a_1 = 0{,}24g$; 3) $t' = 1{,}6\sqrt{\frac{H}{g}}$.

Чистовик. Физика, 9 кл.

5.



$v=\sqrt{2,5gH}$

$R=0,25H$

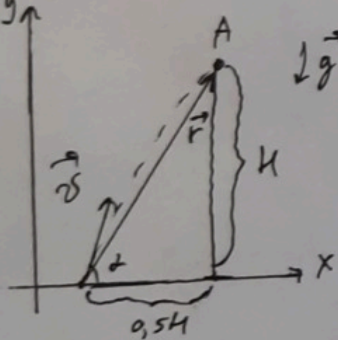
1) Объём цилиндра: $V=\pi R^2 \cdot H=\pi \cdot 0,5^4 H^3$

За время t из шланга выходит струя воды длиной $l=vt$

$V=Sl=Svt=0,5^4\pi H^3$

$t=\frac{0,5^4\pi H^3}{Sv}=\frac{0,5^4\pi H^3}{S\sqrt{2,5gH}}=\frac{0,5^3\pi H^2\sqrt{H}}{S\sqrt{10g}}=\frac{0,125\pi H^2}{S}\cdot\sqrt{\frac{H}{10g}}$

2)



$\downarrow\vec{g}$

$\vec{v}t'+\frac{\vec{g}t'^2}{2}=\vec{r}$

$\div\begin{cases}0,5H=v\cdot\cos\alpha\cdot t', \\ H=v\cdot\sin\alpha\cdot t'-\frac{gt'^2}{2};\end{cases}$ $\longrightarrow$ ~~$t'=\frac{...}{2}$~~ $t'=\frac{H}{2v\cdot\cos\alpha}$

$2=\frac{\sin\alpha}{\cos\alpha}-\frac{gt'^2}{2v\cdot\cos\alpha\cdot t'}$

$tg\alpha-\frac{gt'}{2v\cdot\cos\alpha}-2=0$

$tg\alpha-\frac{gH}{4v^2\cdot\cos^2\alpha}-2=0$, $tg\alpha-\frac{gH\cdot(1+tg^2\alpha)}{4\cdot 2,5gH}-2=0 \quad |\cdot(10)$

$tg^2\alpha-10tg\alpha+21=0$

По т. Виета $\left[\begin{array}{l} tg\alpha=3, \\ tg\alpha=7;\end{array}\right.$

(2)

3)

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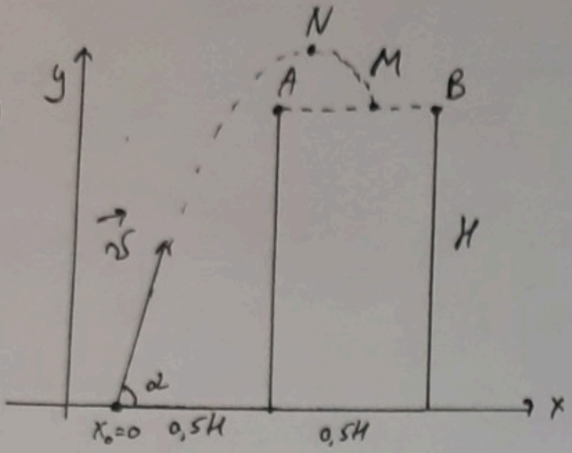
Чистовик. Физика, 9 кл.

5. 3)



Струя попадает внутрь бочки, если после достижения высоты максимального подъёма (после N) на высоте H струя попадает в точку N на отрезке AB, то есть $x_M \in [x_A; x_B]$, $x_M \in [0{,}5H; H]$

$$\div\begin{cases} x_M = v\cdot\cos\alpha\cdot t \Rightarrow t = \frac{x_M}{v\cdot\cos\alpha} \\ H = v\cdot\sin\alpha\cdot t - \frac{gt^2}{2} \end{cases}$$

$$\frac{H}{x_M} = \frac{\sin\alpha}{\cos\alpha} - \frac{gt^2}{2\cdot v\cdot\cos\alpha\cdot t} = tg\alpha - \frac{gt}{2v\cdot\cos\alpha} = tg\alpha - \frac{g x_M}{2v^2\cdot\cos^2\alpha} = tg\alpha - \frac{g x_M(1+tg^2\alpha)}{2\cdot 2{,}5gH} =$$

$$= tg\alpha - \frac{x_M}{5H} - \frac{x_M\cdot tg^2\alpha}{5H}$$

$$\frac{H}{x_M} = -\frac{x_M\cdot tg^2\alpha}{5H} - \frac{x_M}{5H} + tg\alpha \Big| \cdot \left(\frac{5H}{x_M}\right)$$

$$tg^2\alpha - \frac{5H}{x_M}tg\alpha + 1 + \frac{5H^2}{x_M^2} = 0$$

3

$$D = \frac{25H^2}{x_M^2} - 4 - \frac{20H^2}{x_M^2} = \frac{5H^2}{x_M^2} - 4$$

$$tg\alpha = \frac{\frac{5H}{x_M} \pm \sqrt{\frac{5H^2}{x_M^2} - 4}}{2}$$

$tg\alpha$ — больший при $x_M = 0{,}5H$

$$tg\alpha = \frac{10 \pm \sqrt{20-4}}{2}; \quad \left[\begin{array}{l} tg\alpha = 7, \\ tg\alpha = 3; \end{array}\right.$$

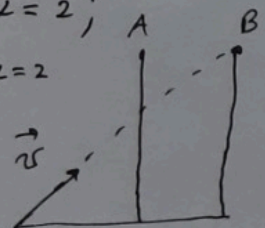
при $tg\alpha = 3$:

$tg\alpha$ — меньший при $x_M = H$

$$tg\alpha = \frac{5 \pm \sqrt{5-4}}{2}$$

$$\left[\begin{array}{l} tg\alpha = 3, \\ tg\alpha = 2; \end{array}\right.$$

при $tg\alpha = 2$



— не подходит

Значит, $tg\alpha \in [3; 7]$

Ответ: 1) $t = \frac{0{,}125\pi H^2}{S}\cdot\sqrt{\frac{H}{10g}}$; 2) $tg\alpha = 3$ или $tg\alpha = 7$; 3) $tg\alpha \in [3; 7]$.

Черновик.

$$1 \cdot \left(-\frac{5H}{x_м}\right)$$

$$\operatorname{tg}^2\alpha - \frac{5H}{x_м}\operatorname{tg}\alpha + 1 + \frac{5H^2}{x_м^2} = 0$$

$$D = \frac{25H^2}{x_м^2} - 4 - \frac{20H^2}{x_м^2} = \frac{5H^2}{x_м^2} - 4$$

$$\operatorname{tg}\alpha = \frac{\frac{5H}{x_м} \pm \sqrt{\frac{5H^2}{x_м^2} - 4}}{2}$$

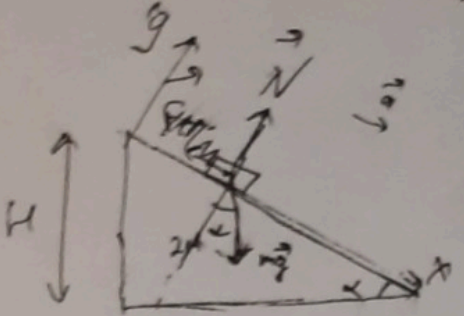
$\operatorname{tg}\alpha$ – max при $x_м = 0{,}5H$

$\operatorname{tg} \uparrow \alpha$

Черновик.

$2 = tg\alpha - g\frac{t'}{2v\cdot\cos\alpha} = tg\alpha - gt'$

4.

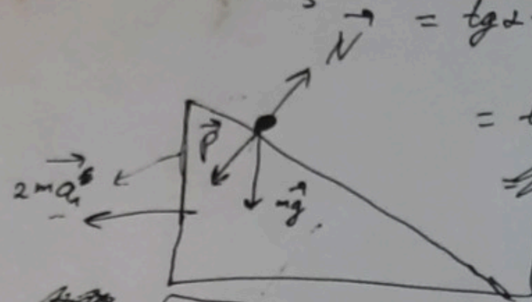


$t' = \frac{H}{2v\cdot\cos\alpha} \to 2 = tg\alpha - \frac{gH}{4v^2\cdot\cos^2\alpha} =$

$\cos\alpha = \frac{3}{5}$

$= tg\alpha - \frac{gH(1+tg^2\alpha)}{4\cdot 2{,}5gH} =$

$= tg\alpha - \frac{1+tg^2\alpha}{10}$ $|\cdot(-10)$



$tg^2\alpha - 10tg\alpha + 21 = 0$

$tg\alpha = 7$; $tg\alpha = 3$;

шайба: $\vec N + m\vec g + \vec F_{тр} = m\vec a$

(O_y): $N = mg\cdot\cos\alpha$

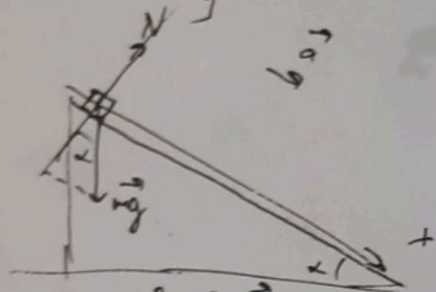
$g\sqrt{0{,}24^2 + 0{,}64 + 2\cdot0{,}8\cdot0{,}24\cdot\frac{3}{5}} = g\sqrt{0{,}6976 + 0{,}2304} =$

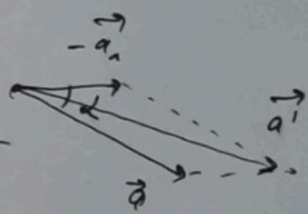
$0{,}0576$

$= g\sqrt{0{,}928} \approx 0{,}96g$

$mg\sin\alpha - F_{тр} = ma$

1)





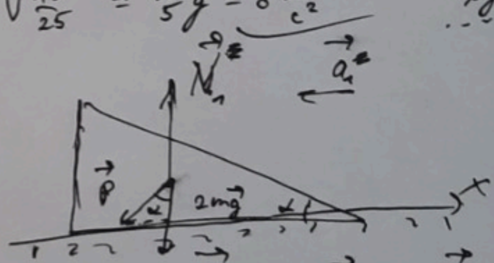
$a' = g\sqrt{0{,}24^2}$

$\vec N + m\vec g = m\vec a$;

II з.Н. (O_x): $mg\cdot\sin\alpha = ma \Rightarrow a = g\cdot\sin\alpha = g\sqrt{1-\cos^2\alpha}$

$a = g\sqrt{1-\frac{9}{25}} = g\sqrt{\frac{16}{25}} = \frac{4}{5}g = 8\ \frac{м}{с^2}$ $0{,}8g$.

2)



шайба действует на брусок с силой P, $|\vec P| = |\vec N| = mg\cdot\cos\alpha$

$\vec N_1 + \vec P + 2m\vec g = 2m\vec a_1$

$0{,}5^2 = 0{,}25$

$2{,}5 = 0{,}25\cdot10$

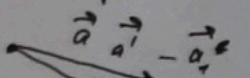
(O_x): $-P\cdot\sin\alpha = -2ma_1$

$a_1 = \frac{P\cdot\sin\alpha}{2m} = \frac{mg\cdot\cos\alpha\cdot\sin\alpha}{2m} = \frac{\sin\alpha\cdot\cos\alpha}{2}g = \frac{\frac{3}{5}\cdot\frac{4}{5}\cdot10\frac{м}{с^2}}{2} = \frac{12}{5}\frac{м}{с^2} = 2{,}4\frac{м}{с^2}$

$= 0{,}24g$

3) $l = \frac{H}{\sin\alpha}$

$K \to K'$ — С.О., связанная с клином; $\vec a_1' = 0$; $\vec a' = \vec a - \vec a_1$



$l = \frac{a't^2}{2}$; $t = \sqrt{\frac{2l}{a'}} = \sqrt{\frac{2H}{a'\cdot\sin\alpha}}$

$a' = \sqrt{a^2 + a_1^2 - 2aa_1\cdot\cos(180-\alpha)} = \sqrt{a^2 + a_1^2 + 2aa_1\cdot\cos\alpha} = \sqrt{64 + 5{,}76 + 2\cdot8\cdot2{,}4\cdot\frac{3}{5}} = \sqrt{93{,}8}\ \frac{м}{с^2} \approx 9{,}63\ \frac{м}{с^2}$

$69{,}76$ $23{,}04$

$t = \sqrt{\frac{2\cdot H}{9{,}63\cdot\frac{4}{5}}} = \sqrt{\frac{2}{7{,}704}H}$