Часть 1

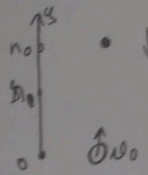
Олимпиада: **Физика, 10 класс (1 часть)**

Шифр: **21204147**

ID профиля: **264224**

Вариант 2

Чистовик 1 №1



Пусть h координата точки столкновения мячей на оси Oy, а h_0 - максимальная высота на которую поднялся мяч

$Oy: h = v_0 t_2 - \frac{g t_2^2}{2}$

$h = h_0 - \frac{g t_2^2}{2}$

$v_0 t_2 - \frac{g t_2^2}{2} = h_0 - \frac{g t_2^2}{2}$

$v_0 t_2 = h_0$

Так-же $h_0 = v_0 \tau - \frac{g\tau^2}{2}$

$0 = v_0 - g\tau$

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

$t_1 = t_2 + \tau$

$h_0 = \frac{v_0^2}{g} - \frac{v_0^2}{2g} = \frac{v_0^2}{2g}$

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

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

$t_1 = \frac{v_0}{2g} + \frac{v_0}{g} = \frac{3}{2}\frac{v_0}{g}$

$\frac{t_1}{t_2} = \frac{\frac{3}{2}\frac{v_0}{g}}{\frac{v_0}{2g}} = 3$

$h = v_0 \cdot \frac{v_0}{2g} - \frac{g v_0^2}{8 g^2} = \cancel{\frac{7 v_0}{16 g}}\ \frac{3}{8}\frac{v_0^2}{g}$

Ответ: $t_1 = \frac{3}{2}\frac{v_0}{g}$

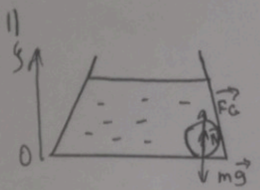
$\frac{t_1}{t_2} = 3$

$h = \frac{3}{8}\frac{v_0^2}{g}$

чистовик 2

w2

1)



$\upsilon = 0 \Rightarrow$ по первому закону Ньютона $\sum\vec{F} = 0$

$Oy: F_a + N - mg = 0$

$N = mg - F_a$

$\rho = \frac{m}{V} \Rightarrow m = \rho V_{ш}$

$V = \frac{4}{3}\pi R^3$

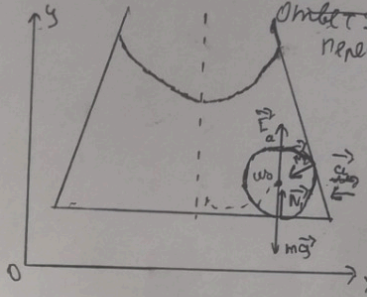
$m = 6\rho \cdot \frac{4}{3}\pi R^3 = 8\pi R^3\rho$

$F_a = \rho_{ср} V_{п.ч.т} g = \rho \cdot \frac{4}{3}\pi R^3 g = \frac{4\pi R^3\rho g}{3}$

$N = 8\pi R^3\rho g - \frac{4\pi R^3 \rho g}{3} = \frac{4}{3}\pi R^3\rho g(6-1) = \frac{20}{3}\pi R^3\rho g$

$N = \frac{20}{3}\pi R^3 \rho g$

2)



~~Ответ: N=~~

перейдём в СО сосуда

по второму закону Ньютона

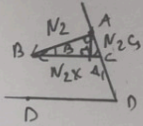
$\sum\vec{F} = m\vec{a}$

Oy: ~~$N_1 + mg$~~ -

$N_1 + F_a - mg - N_{2y} = 0$

$N_1 = mg + N_{2y} - F_a$

$Ox: N_{2x} = ma_y$



$BC \parallel OD \Rightarrow \angle ACB = \alpha \Rightarrow \angle ABA_1 = 90 - \alpha$

$B = 90 - \alpha$

$N_2x = N_2\cos B = N_2\cos(90-\alpha) = N_2\sin\alpha$

$N_2y = N_2\sin B = N_2\sin(90-B) = N_2\cos\alpha$

$Ox: N_2\sin\alpha = ma_y$

$N_2 = \frac{ma_y}{\sin\alpha}$

$Oy: N_1 = mg + N_2\cos\alpha - F_a$

$N_1 = mg + \frac{ma_y}{tg\alpha} - F_a$

$m = 8\pi R^3\rho$

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

$a_y = \omega^2 r = \omega^2 \cdot \frac{3}{2}R$

$N_1 = mg + \frac{\frac{3}{2}m\omega^2 R}{\frac{3}{2}} - F_a$

$N_1 = mg + m\omega^2 R - F_a$

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Чистовик 3 w 2 продол.

$N_1 = 8\pi R^3 \rho g + 8\pi R^3 \rho g \omega^2 R - \frac{4}{3}\pi R^3 \rho g =$

$= \frac{4\pi R^3}{3}\rho(6g + 6\omega^2 R - g) = \frac{4}{3}\pi R^3 \rho(5g + 6\omega^2 R)$

$N_1 = \frac{4}{3}\pi R^3 \rho(5g + 6\omega^2 R)$

Ответ: $N = \frac{20}{3}\pi R^3 \rho g$

$N_1 = \frac{4}{3}\pi R^3 \rho(5g + 6\omega^2 R)$

Чистовик 4 №3

$p_0 - ?,\ m_0 - ?$

$t = 81^\circ C = 354\,К$

$\frac{V}{V_0} = 7$

$V = 1.7\,л = 1.7 \cdot 10^{-3}\,м^3$

$\frac{p}{p_0} = 3{,}6$

$p_{н.п} = 0.5 \cdot 10^5\,Па$

$R = 8.31\,\frac{Дж}{моль \cdot К}$

$M = 18\,\frac{г}{моль} = 18 \cdot 10^{-3}\,\frac{кг}{моль}$

Докажем, что после сжатия водяной пар стал насыщенным, и его часть сконденсировалась если это не так, то $m_п$ и $V_п = const$

$V_0 p_0 = V_п RT$

$3{,}6 p_0 \cdot \frac{V_0}{7} = V_п RT$

$\frac{3{,}6}{7} p_0 V_0 = V_0 p_0$

$3{,}6 = 7$ противоречие => пар стал насыщенным =>

$p = p_{н.п} \Rightarrow p_0 = \frac{p_{н.п}}{3{,}6}$

$p_0 = \frac{0{,}5 \cdot 10^5\,Па}{3{,}6} \approx 13.9\,кПа$

$V_п = \frac{m_п}{M_п}$

$V_0 p_0 = \frac{m_п}{M_п} RT$

$m_п = \frac{M_н V_0 p_0}{RT}$

$V_0 = 7V \qquad p_0 = \frac{p_{н.п}}{3.6}$

$m_п = \frac{7 M_н V p_{н.п}}{3.6 RT}$

$m_п = \frac{35 M_н V p_{н.п}}{18 RT}$

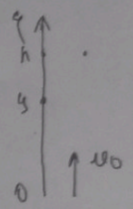
$m_п = \frac{35 \cdot 18 \cdot 10^{-3}\,\frac{кг}{моль} \cdot 0.5 \cdot 10^5\,Па \cdot 1.7 \cdot 10^{-3}\,м^3}{18 \cdot 8.31\,\frac{Дж}{моль\,К} \cdot 354\,К} \approx 0.001\,кг = 1\,г$

Ответ: $p_0 = \frac{p_{н.п}}{3.6} = 13.9\,кПа$

$m_п = \frac{7 M_н V p_{н.п}}{3.6 RT} = 1\,г$

4

Черновик



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

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

$$h = v_0 t$$

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

$$0 = v_0 - g\tau$$

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

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

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

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

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

$$t_1 = t + \tau = \frac{v_0}{2g} + \frac{v_0}{g} = \frac{3}{2}\frac{v_0}{g}$$

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

$$\frac{t_1}{t_2} = \frac{\frac{3}{2}\frac{v_0}{g}}{\frac{v_0}{2g}} = 3$$

$$y = \frac{v_0^2}{2g} - \frac{\cancel{g} v_0^2}{16g^2} = \frac{v_0^2}{g}\left(\frac{8-1}{16}\right) = \frac{7}{16}\frac{v_0^2}{g}$$

черновик

W3

$pV = \nu RT$

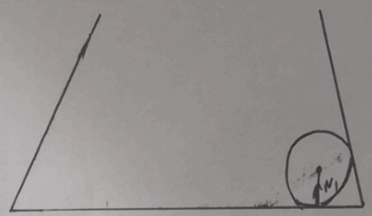
$p_0 = \frac{p_1}{3,6}$

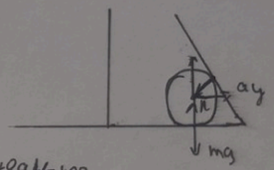
$V_0 = 7V$

$\frac{7Vp_1}{3,6} = \frac{m}{\mu} RT$

$m = \frac{7Vp_1\mu}{3,6RT}$

W2





Oy: $N + \rho g V = mg$

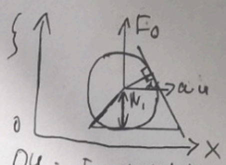
$N = mg - \rho g V$

$\cancel{m=} 8\rho V$ $V = \frac{4}{3}\pi R^3$

$m = 8\pi R^3 \rho$

$N = 8\pi R^3 \rho - \frac{4}{3}\pi R^3$

$N = \frac{20}{3}\pi R^3 \rho$



Oy: $F_a + N_1 + N_{2y} = mg$

$\frac{\sin\alpha}{\cancel{tg\alpha}} = \frac{N_{2x}}{N_{2y}}$

$N_{2x} = ma_y$

$\frac{N_2}{\cancel{tg\alpha}} = ma_y$

$N_2 = \frac{ma_y}{\sin\alpha}$

$N_{2y} = N_2 \cos\alpha$

$F_a + N_1 = mg + N_2 \cos\alpha$

$N_1 = mg + \frac{ma_y}{tg\alpha} - F_a$

$N_2 = mg + \omega^2 R \cdot m - F_a$

$N_2 = 8\pi R^3 \rho g + 8\pi R^3 \omega^2 R - \frac{4}{3}\pi R^3 \rho g =$

$= \frac{4\pi R^3 \rho}{3}(6g + 6\omega^2 R - g) = \frac{4}{3}\pi R^3 \rho (5g + 6\omega^2 R)$

CO.

$a_y = \omega^2 R =$

$\omega^2 \cdot \frac{3}{2} R$

Часть 2

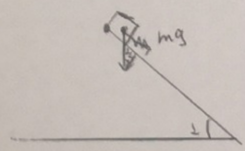
Олимпиада: **Физика, 10 класс (2 часть)**

Шифр: **21204147**

ID профиля: **264224**

Вариант 2

w1



1) $a = g\sin\alpha$

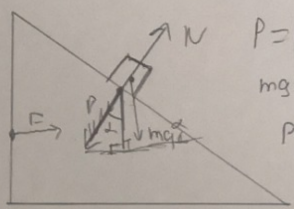
$l = \frac{H}{\sin\alpha}$

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

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

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

2)



$P = N$

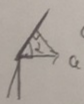
$mg\cos\alpha = N$

$P = mg\cos\alpha$

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

$\sin\alpha = \frac{4}{5}$

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



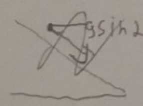
$a_y = a\cos\alpha$

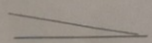
$mg - mg\cos\alpha\sin\alpha = 2ma$

$a = g(1 - \cos\alpha \cdot \sin\alpha) = g\left(1 - \frac{4}{5}\cdot\frac{3}{5}\right) = \frac{13}{25}g$

$\cancel{mg}\ N - mg\cos\alpha = ma\cos\alpha$

3)





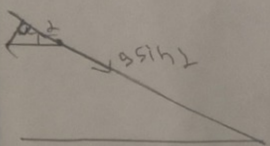
$N = m\cos\alpha(a+g)$

$F - m\cos\alpha\sin\alpha(a+g) = 2ma$

$g - \cos\alpha\sin\alpha\, g = 2a - \cos\alpha\sin\alpha\, a$

$a = \frac{g(1-\cos\alpha\sin\alpha)}{2-\cos\alpha\sin\alpha}$

$a = g\left(\frac{\frac{13}{25}}{\frac{38}{25}}\right) = \frac{13}{38}g$



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

$a_r = g\sin\alpha - \frac{13g}{38\cos\alpha} = g\left(\sin\alpha - \frac{13}{38\cos\alpha}\right) = g\left(\frac{4}{5} - \frac{13\cdot 5}{38\cdot 3}\right)$

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$\Delta T, \frac{Q}{\Delta U}$

$p = 0{,}99p_0$

$V = 1{,}02V$

$P_0V_0 = \nu RT_0$

$PV = \nu RT$

$\nu RT - \nu RT_0 = PV - P_0V_0$

$\nu R(T - T_0) = PV - P_0V_0$

$$\frac{T-T_0}{T_0} = \frac{\frac{PV - P_0V_0}{\nu R}}{\frac{P_0V_0}{\nu R}}$$

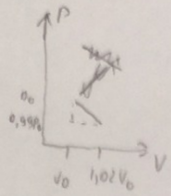
$$\frac{\Delta T}{T}(\%) = \frac{PV - P_0V_0}{P_0V_0}$$

$$\frac{\Delta T}{T} = \frac{0.99P_0 \cdot 1{,}02V_0 - P_0V_0}{P_0V_0}$$

$\Delta T = 0.99 \cdot 1{,}02 - 1 = 0.0098 = 0.98\%$

увеличилась на 0.98%

$\frac{Q}{\Delta U}$ $\quad \Delta=$ $Q = A + \Delta U$



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

$$\Delta U = \frac{3}{2}\nu R\Delta T = \frac{3}{2}(PV - P_0V_0) = \frac{3}{2} \cdot 0.0098P_0V_0$$

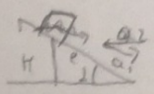
$$A = 0.99P_0 \cdot 0{,}02V_0 + \frac{0.01P_0 \cdot 0.02V_0}{2} = 1.99P_0 \cdot 0.01V_0 =$$

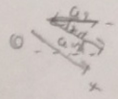
$$= 0.0199P_0V_0$$

$$\frac{Q}{\Delta U} = 1 + \frac{3}{2}\frac{0.0098P_0V_0}{0.0199P_0V_0} \approx 1.74$$

Чистовик 3 №4 продол.

перейдём в СО клина





$a_1 = g\sin\alpha$

$a_2 = \frac{13}{50}g$

$$Ox: a = a_{1x} + a_{2x} = a_1 + a_2\cos\alpha$$

$$a = g\sin\alpha + \frac{13}{50}\cos\alpha g$$

$$a = g\left(\frac{50\sin\alpha + 13\cos\alpha}{50}\right)$$

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

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

$$\frac{H}{\sin\alpha} = \frac{gt^2(50\sin\alpha + 13\cos\alpha)}{100}$$

$$t = 10\sqrt{\frac{H}{g(50\sin\alpha + 13\cos\alpha)}} =$$

$$= 10\sqrt{\frac{H}{g(40 + \frac{39}{5})}} = 10\sqrt{\frac{5H}{g(239)}}$$

Ответ: $t_1 = \sqrt{\frac{2H}{g\sin^2\alpha}}$

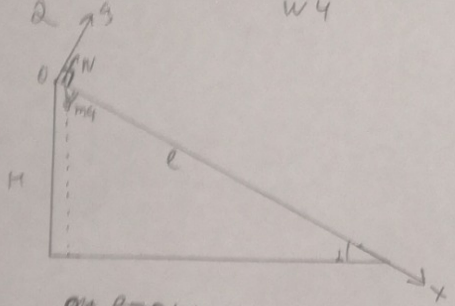
$a = \frac{13}{50}g \quad \frac{g(1-\sin\alpha\cos\alpha)}{2} = \frac{13}{50}g$

$t_2 = 10\sqrt{\frac{5H}{239g}}$

Чистовик 2

w4

H
$F = mg$
m
$2m$
g
$\cos\alpha = \frac{3}{5}$



по второму закону Ньютона

$\sum \vec{F} = ma$

$Ox: mg\sin\alpha = ma$

$a = g\sin\alpha$

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

~~Ox: l = 0 + 0 · t~~ $x = x_0 + v_0 t + \frac{at^2}{2}$

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

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

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

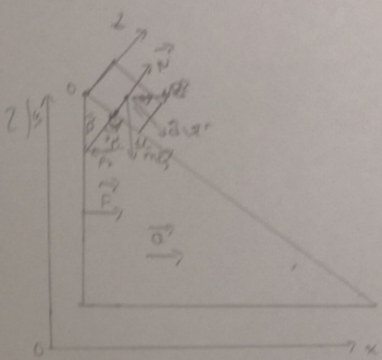
$t = \sqrt{\frac{2H}{g\sin^2\alpha}}$

$\sin^2\alpha + \cos^2\alpha = 1$

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

$\sin\alpha = \frac{4}{5}$

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



по 1 закону Ньютона

$Oz: N - mg\cos\alpha = 0$

$a_z = a$

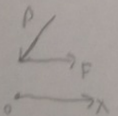
~~$a_z = a\sin\alpha$~~

$N - mg\cos\alpha = \cancel{a\sin\alpha\, m}\,0$

$N = m(g\cos\alpha \cancel{+ a\sin\alpha})$

по 3 закону Ньютона $N = P$

$P = m(g\cos\alpha \cancel{+ a\sin\alpha})$



$Ox: F - P_x = 2ma$

$P_x = P\sin\alpha$

$F - P\sin\alpha = 2ma$

$mg - m\sin\alpha(g\cos\alpha \cancel{+ a\sin\alpha}) = 2ma$

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

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

$a = \frac{g \cdot (1 - \frac{12}{25})}{2 - \frac{16}{25}} = \frac{13}{34}g$

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

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

$a = \frac{g(1 - \sin\alpha\cos\alpha)}{2}$

$a = \frac{g(1 - \frac{12}{25})}{2} = \frac{13}{50}g$

a_F

2

Чистовик 1 №5

$\Delta T(\%)$	$\frac{Q}{\Delta U}-?$
$P = 0.99P_0$	
$V = 1{,}02V$	

1) $P_0V_0 = \nu RT_0$

$PV = \nu RT$

$$T - T_0 = \frac{PV - P_0V_0}{\nu R}$$

$$T_0 = \frac{P_0V_0}{\nu R}$$

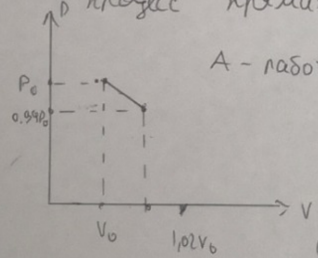
$$\frac{T-T_0}{T_0} = \frac{PV - P_0V_0}{P_0V_0}$$

$$\frac{T-T_0}{T_0} = \frac{1{,}02 \cdot 0{,}99P_0V_0 - P_0V_0}{P_0V_0} = 1{,}02 \cdot 0.99 - 1$$

$$\Delta T(\%) = 1{,}02 \cdot 0.99 - 1 = 0{,}0098 = 0{,}98\%$$

2) $Q = A + \Delta U$

~~изменения~~ $\Delta V \ll V$, $\Delta P \ll P$ => мы можем считать что данный процесс прямая



A – работа, под графиком и $A_Г > 0$ т.к. $V > V_0$

$$A = 0.02V \cdot 0.99P_0 + \frac{0.01P_0 \cdot 0.02V_0}{2} = \frac{1.99P_0 \cdot 0.02V_0}{2} = 0.0199P_0V_0$$

$$\Delta U = \frac{i}{2}\nu R\Delta T = \frac{3}{2}\nu R\Delta T = \frac{3}{2}(PV - P_0V_0) = \frac{3}{2} \cdot 0.0098\, P_0V_0$$

$Q = A_Г + \Delta U$

$$\frac{Q}{\Delta U} = 1 + \frac{A_Г}{\Delta U}$$

$$\frac{Q}{\Delta U} = 1 + \frac{0.0199P_0V_0}{\frac{3}{2} \cdot 0.0098P_0V_0} \approx 2.35$$

Ответ: $\Delta T = \frac{PV - P_0V_0}{PV} = 0.98\%$

$$\frac{Q}{\Delta U} = 1 + \frac{A_Г}{\Delta U} = 2.35$$

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