Часть 1

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

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ID профиля: **858536**

Вариант 2

$t = 31°C$

$V_1 = 7V_2$

$V_2 = 7,7 л$

$P_2 = 3,6 P_1$

$\mu = 18 г/моль$

$R = 8,31$

$P_{нп} = 0,5 \cdot 10^5$

P_1

m

2956°

$PV = \nu RT$

$\frac{P_1V_1}{T_1} = \frac{P_{2н}V_2}{T_2}$ т.к. T-const

$P_1V_1 = P_{2н}V_2$

$\frac{P_2}{P_{1н}} = \frac{V_1}{V_2}$ (если газ идеален)

$\frac{P_{12}}{P_{1н}} = \frac{7V_2}{V_2} \Rightarrow P_1 = 7P_{2н}$; значит при $P_2 = 3,6 P_1$ пар стал насыщенным $\Rightarrow$

$\frac{P_1}{P_2} = \frac{V_1}{V_{2нп}}$ $V_1 = 3,6 V_2$

$P_2 = P_{нп} = 0,5 \cdot 10^5 Па$ $P_1 = \frac{3,6 P_2}{3,6} = \cancel{7 \cdot 10^5} = 13 \cdot 10^3 Па = 13 кПа$

$\nu = \frac{m}{\mu}$

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

$m = \frac{P_2V_2\mu}{RT} = \frac{0,5 \cdot 10^5 \cdot 7,7 \cdot 10^{-3} \cdot 18}{8,31 \cdot 31} = 22,73 г$

№1

$\frac{2\pi}{T} = \omega$ $V = \frac{2\pi R}{T}$

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

$2,25 + 2,25^2 =$

$\vec{F}_1 = -\vec{F}_2$ $F_1 = \vec{F}_T + \vec{F}_a$

$F_1 = F_T - F_a$

$\rho \frac{4}{3} V_{ш} g - \rho_0 V_ш g$ $(\rho - \rho_0) R^3 \frac{4}{3} \pi g = 5\rho \cdot \frac{4}{3} \pi R g$

№1

$S - S_2 = S - \frac{at^2}{2}$

$x\ S = V_0 t + \frac{at^2}{2}$ в наивысшей точке $V = 0$

$V = V_0 + at$ $t_2 = \frac{2v_0 + v - v_0}{2av_0} = \frac{v_0 + v}{} = \frac{1}{2g}$

$t = \frac{V - V_0}{a}$ в верхней точке 1) $t_1 + t_2$

$S = v_0 \frac{v - v_0}{a} + a\left(\frac{v - v_0}{a}\right)^2 : 2$ 2) $\frac{t_2}{t_1 + t_2}$

$S = \frac{2v_0(V - v_0)}{2a} + \frac{(v - v_0)^2}{2a}$

$V_{сближ} = \frac{at^2}{2} + V_0 t - \frac{at^2}{2} = V_0 t$

$t_2 = \frac{2v_0(v - v_0) + (v - v_0)^2}{2a\cancel{(v - v_0)} \cdot v_0}$

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Чистовик

3 Дано:

Дано	СИ
$t_1 = t_2 = const = 81^\circ C$	354 K
$V_1 = 7V_2$	
$V_2 = 1{,}7$ л	$1{,}7 \cdot 10^{-3}$ м^3
$P_1 \cdot 3{,}6 = P_2$	
$P_{НП} = 0{,}5 \cdot 10^5$ Па	
$M = 18$ г/моль	
$P_1 = ?$ Па	
$m = ?$ г	

$PV = \nu RT$

$\frac{PV}{T} = \nu R$

$\frac{P_1 V_1}{T_1} = \frac{P_{2ид} V_2}{T_2}$ $T_1 = T_2 \Rightarrow P_1 V_1 = P_{2ид} V_2 \Rightarrow \frac{P_{2ид}}{P_1} = \frac{V_1}{V_2}$

$\frac{P_{2ид}}{P_1} = \frac{7V_2}{V_2} = 7$, но $\frac{P_2}{P_1} = 3{,}6 \Rightarrow$ когда $V_3 = \frac{V_1}{3{,}6}$ ст пар стал насыщенным, а у насыщенного пара $P_{нп} = const = 0{,}5 \cdot 10^5$ Па (при $T = 354$ K)

Значит $P_2 = P_{нп} = 3{,}6 \cdot P_1 \Rightarrow P_1 = \frac{P_{нп}}{3{,}6} = 13{,}9 \cdot 10^3$ Па $= 13{,}9$ кПа

$V_1 = 7V_2 = 11{,}9 \cdot 10^{-3}$ м^3

$P_1 V_1 = \nu RT$

$\nu = \frac{m}{M}$

$P_1 V_1 = \frac{m}{M} RT$

$m = \frac{P_1 V_1 M}{RT} = \frac{13{,}9 \cdot 10^3 \cdot 11{,}9 \cdot 10^{-3} \cdot 18}{8{,}31 \cdot 354} = \frac{2977}{2942} \approx 1$ г

ОТВЕТ: $P_1 = 13{,}9$ кПа ; $m = 1$ г

3

чистовик

2 Дано:

ω

$6 \cdot \rho_в = \rho_ш$

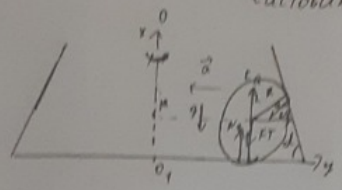
R

$tg\alpha = 3/2$

$M L = 1,5 R$

N_1 - ?

N_2 - ?



1) $\omega = 0$ $a_{цс} = 0$

по 3-му з-ну Ньютона

$\vec{N_1} = -\vec{F}_ш$

$\vec{F}_{ш_1} = \vec{F_T} + \vec{F_a}$

$\vec{F_T} = m\vec{g}$ $\quad F_a = \rho_в V_ш g$

$m = \rho_ш V$

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

$F = F_{Tx} + F_{ax} = -F_T + F_a = (\rho_ш - \rho_в)\frac{4}{3}\pi R^3 \cdot g = -5 \cdot \frac{4}{3}\pi R^3 \cdot g$

$N_1 = \frac{20}{3}\pi R^3 \cdot g$

2) $\omega \neq 0$ $a_{цс} \neq 0$

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

$\sum \vec{F} = \vec{F}_ш + \vec{N_2} + \vec{N_3}$

$\vec{F_T} + \vec{F_a} + \vec{N_2} + \vec{N_3} = m\vec{a}$

$a = \omega^2 R$

$F_{Tx} + F_{ax} + N_{2x} + N_{3x} = ma_x$ $\qquad F_{Ty} + F_a + N_{2y} + N_{3y} = ma_y$

$-F_T + F_a + N_2 - N_3 \sin\alpha = 0$ $\qquad N_3 \cos\alpha = ma$

$-5 \cdot \frac{4}{3}\pi R^3 \cdot g + N_2 - \frac{m\omega^2 R \sin\alpha}{\cos\alpha} = 0$ $\qquad N_3 = \frac{m\omega^2 R}{\cos\alpha}$

$N_2 = 5 \cdot \frac{4}{3}\pi R^3 \cdot g + m\omega^2 R\, tg\alpha = 5 \cdot \frac{4}{3}\pi R^3 + \rho_ш \frac{4}{3}\pi R^4\, tg\alpha\, \omega^2 =$

$= \frac{4}{3}\pi R^3 (5 + \rho_ш R\omega^2 1,5)$

Ответ: $N_1 = 6 \frac{2}{3} \pi R^3 g$ $N_2 = \frac{4}{3}\pi R^3 (5 + \rho_ш R\omega^2 \cdot 1,5)$

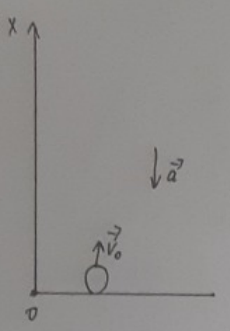
2

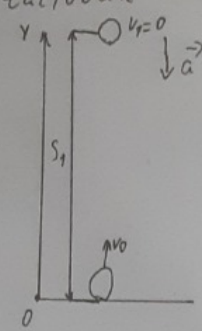
значит при $R_2 = 36 R_1$ пар стал насыщенным

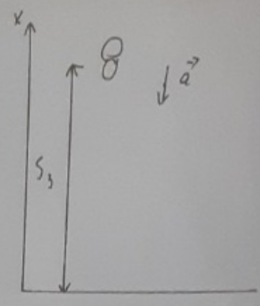
$a = \omega^2 R$

$R_1 = 36 R_2$

Чистовик







Дано:

V_0

$\vec{a} = \vec{g}$

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t

$\frac{t}{t_2}$

S_3

t_1 - до макс. высоты

t_2 - от макс высоты - до столкн.

$$S_1 = \vec{V}_0 t_1 + \frac{\vec{a} t_1^2}{2}$$

$$S_1 = V_{0x} t + \frac{a_x t_1^2}{2}$$

$$S_1 = V_0 t - \frac{g t_1^2}{2}$$

$$\vec{V}_1 = \vec{V}_0 + \vec{a} t_1$$

$$t_1 = \frac{\vec{V}_1 - \vec{V}_0}{\vec{a}} \quad \text{но } V_1 = 0 \Rightarrow$$

$$t_1 = \frac{-V_{0x}}{a_x} = \frac{-V_0}{-a} = \frac{V_0}{a}$$

$$S_1 = V_0 \cdot \frac{V_0}{a} - a\left(\frac{V_0}{a}\right)^2 : 2 = \frac{V_0^2}{a} - \frac{V_0^2}{2a} = \frac{V_0^2}{2a}$$

$$t_2 = \frac{S_1}{V_{сбл}}$$

$$\vec{V}_{сбл} = \vec{V}_{2шара} - \vec{V}_{1шара}$$

$$V_{2шара} = \vec{V}_0 + \vec{a} t = V_{0x} + a_x t = V_0 - a t$$

$$V_{1шара} = \vec{a} t = +a_x t = -a t$$

$$V_{сбл} = V_0 - a t - (-a t) = V_0$$

$$t_2 = \frac{S_1}{V_{сбл}} = \frac{V_0^2}{2a} : V_0 = \frac{V_0}{2a}$$

$$t = t_1 + t_2 = \frac{V_0}{2a} + \frac{V_0}{a} = \frac{3V_0}{2a}$$

$$\frac{t}{t_2} = \frac{3V_0}{2a} : \frac{V_0}{2a} = 3$$

Ответ: $t = \frac{3V_0}{2a}$; $\frac{t}{t_2} = 3$; $S_3 = \frac{3V_0^2}{8a}$

$$S_3 = S_1 + S_2$$

$$S_2 = \frac{\vec{a} t_2^2}{2} = \frac{a_x t_2^2}{2} = \frac{-a t_2^2}{2}$$

$$S_3 = \frac{V_0^2}{2a} - \left(\frac{V_0}{2a}\right)^2 \cdot \frac{a}{2} = \frac{3V_0^2}{8a}$$

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Часть 2

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

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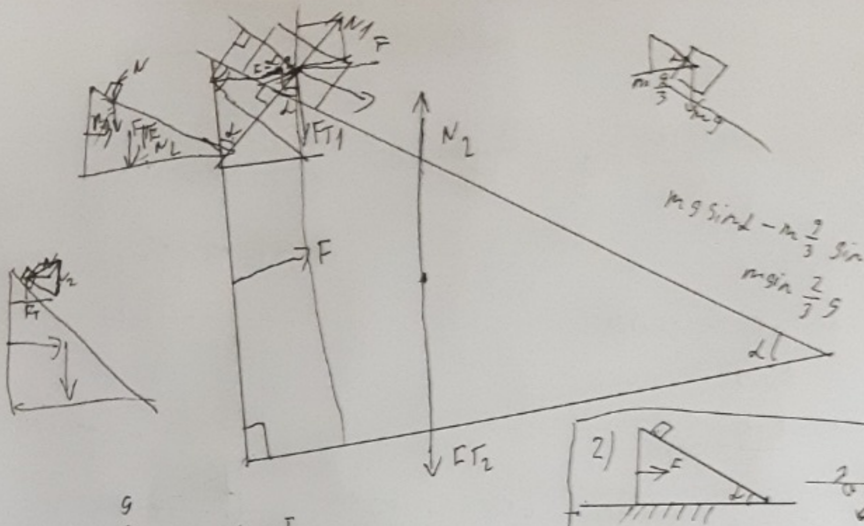
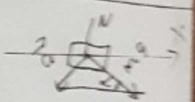
Вариант 2



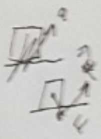
$mg\sin\alpha - m\frac{g}{3}\sin\alpha$

$mg\sin\alpha\ \frac{2}{3}g$



$N_2 > F_{T_2}$ $N_1 < F_{T_1}$

$F_2 > F$



$N_2 \ne F_{T_1} + F_{T_2} + N_2 + N_1\cos\alpha$

$\vec{F}$

$F_{T_1}\sin\alpha - \frac{4}{5} = \frac{4}{5}mg = \frac{3}{5}N_1$ $N_1 = \frac{3}{4}F_{T_1}$

$N = F$

$a = a$

$\frac{N}{m} = \frac{F}{M+m}$ $mg + 2mg = N_2 -$

$F = mg = 3m\vec{a}$ $a = \frac{g}{3}$

$\frac{F}{M} = \frac{N\sin\alpha}{m_1}$

a

$a = \frac{5}{3}$

$M_1 +$

Дано

$M_1 = 2M_2$

$\cos\alpha = 3/5$

H

$F = mg$

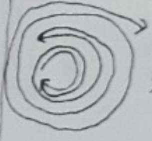
1)

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

$\vec{F_T} + \vec{N_1} = ma$

$F_{T_x} + N_{1x} = ma_x$

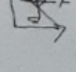
$F_T\sin\alpha = ma$



$a = g\sin\alpha$

$s = \frac{at^2}{2}$ $s = \frac{5}{3}H$

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



[redacted]

5 Дано:

$P_2 = 0{,}99 P_1$

$V_2 = 1{,}02 V_1$

$\left(\frac{T_2}{T_1} - 1\right) \cdot 100\%$

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

$PV = \nu RT$

$\frac{PV}{T}$ [redacted] $= \nu R = const \Rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{T_2}{T_1} = \frac{P_2 V_2}{P_1 V_1} = \frac{0{,}99 \cdot 1{,}02 PV}{PV} \approx 1{,}01$

$\left(\frac{T}{T_1} - 1\right) \cdot 100\% = 1\%$ (увеличилась

$Q = \Delta U + A$

$A = P_{cp} \cdot \Delta V$

$P_{cp} = \frac{P_1 + P_2}{2}$ [redacted]

$\Delta V = V_2 - V_1$ [redacted]

$A = \frac{P_1 + P_2}{2} \cdot (V_2 - V_1)$

$\Delta U = U_2 - U_1$

$U = 1{,}5 PV$

$\Delta U = 1{,}5 (P_2 V_2 - P_1 V_1)$

$$\frac{Q}{\Delta U} = \frac{1{,}5 (P_2 V_2 - P_1 V_1)}{\frac{P_1 + P_2}{2} (V_2 - V_1)} = \frac{1{,}5 \cdot (0{,}99 P_1 \cdot 1{,}02 V_1 - P_1 V_1)}{\frac{0{,}99 P_1 + P_1}{2} \cdot (1{,}02 V_1 - V_1)} = 1{,}5 \cdot$$

$F = mg$ $\quad$ $F = mg \cos\alpha$

$mg \cos\alpha + ma =$

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5 Дано

$P_2 = 0{,}99 P_1$

$V_2 = 1{,}02 V_1$

$\left(\frac{T_2}{T_1} - 1\right) \cdot 100\%$

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

$PV = \nu RT$

$\frac{PV}{T} = \nu R = const \Rightarrow \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{T_2}{T_1} = \frac{P_2 V_2}{P_1 V_1} = \frac{0{,}99 P_1 \cdot 1{,}02 V_1}{P_1 V_1} = 1{,}01$

$\left(\frac{T_2}{T_1} - 1\right) \cdot 100\% = 1\%$ (увеличилась)

3

$Q = \Delta U + A$

$A = P_{ср} \Delta V$

$\Delta V = V_2 - V_1$

$P_{ср} = \frac{P_2 + P_1}{2}$

$A = \frac{P_2 + P_1}{2}(V_2 - V_1)$

$\Delta U = 1{,}5 \Delta PV$

$\Delta PV = P_2 V_2 - P_1 V_1$

$\Delta U = 1{,}5(P_2 V_2 - P_1 V_1)$

$Q = \frac{P_2 + P_1}{2}(V_2 - V_1) + 1{,}5(P_2 V_2 - P_1 V_1)$

$\frac{Q}{\Delta U} = \frac{\frac{P_2 + P_1}{2}(V_2 - V_1) + 1{,}5(P_2 V_2 - P_1 V_1)}{1{,}5(P_2 V_2 - P_1 V_1)} = \frac{\frac{0{,}99 P_1 + P_1}{2}(1{,}02 V_1 - V_1) + 1{,}5(0{,}99 \cdot 1{,}02 PV - P_1 V_1)}{1{,}5(0{,}99 \cdot 1{,}02 P_1 V_1 - P_1 V_1)}$

$= \frac{0{,}02 PV + 0{,}015 PV}{0{,}015 PV} = 2{,}33$

Ответ: увеличилась на 1% ; $\frac{Q}{\Delta U} = 2{,}33$

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чистовик

2

$\vec{a}_3 = -\vec{a}_2 + \vec{a}$

$a_3 = g - \frac{g}{3} = \frac{2}{3}g$

$t_2 = \sqrt{\frac{2,5H}{\frac{2}{3}g}} = \sqrt{\frac{3,75H}{g}}$

Ответ: $t_1 = \sqrt{\frac{3,125H}{g}}$, $t_2 = \sqrt{\frac{3,75H}{g}}$, $a = \frac{g}{3}$

4 Дано:

$m_1 = 2m_2$

$\cos\alpha = 3/5$

H

$F = m_1 g$

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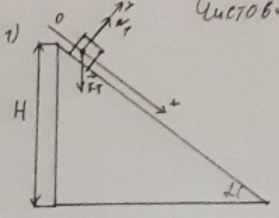
t_1

a_2

t_2

1) 

Чистовик

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

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

$F_T = m\vec{g}$

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

$N_1 \perp OX$

$mg_x + N_x = ma_x$ $\qquad$ $mg_y + N_y = ma_y$

$mg\sin\alpha = ma$ $\qquad$ $mg\cos\alpha + N = 0$

если $\cos\alpha = 3/5$ то $\sin\alpha = \frac{4}{5}$

$\frac{4}{5}mg = mg$

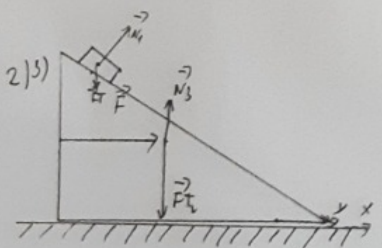
$a = \frac{\frac{4}{5}mg}{m} = \frac{4}{5}g$

$S = H \cdot \sin\alpha = H : \frac{4}{5} = \frac{5}{4}H$

$S = \vec{v_0}t + \frac{\vec{a}t^2}{2}$ $\qquad$ $\vec{v_0} = 0$

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

$\frac{2S}{a} = t^2$ $\qquad$ $t = \sqrt{\frac{2S}{a}} = \sqrt{\frac{2{,}5H}{\frac{4}{5}g}} = \sqrt{\frac{3{,}125H}{g}}$

2) 3) 

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

$\vec{F} + \vec{F_{T_3}} + \vec{N_3} = m\vec{a}$

$F = m_3\vec{a}$

$m_1 g = m_3 a$

$m_3 = m_1 + m_2 = 3m_1$

$\frac{m_1 g}{3m_1} = a$

$a = \frac{g}{3}$

1

3) $S = \frac{a_3 t^2}{2}$ $\qquad$ $t = \sqrt{\frac{2{,}5H}{a_3}}$ $\qquad$ $F_2 = F \cdot \frac{m_1}{m_3} = \frac{F}{3}$

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

$\vec{N_1} + \vec{F_T} + \vec{F_2} = m\vec{a}$ $\qquad$ $N_y + F_{Ty} + F_{2y} = ma_y$ $\qquad$ $mg\sin\alpha + \frac{F}{3}\cos\alpha = ma$ $\qquad$ $a = g\sin\alpha + \frac{g}{3}\cos\alpha$

$a = g$