

# Часть 1

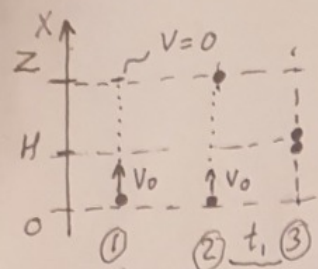
Олимпиада: **Физика, 10 класс (1 часть)**

Шифр: **21206134**

ID профиля: **340335**

Вариант 1

Чистовик



Найти T

- 1) t - время полёта второго мяча
- 2) v<sub>0</sub> - начальная скорость мячей
- 3) S - путь первого мяча до столкновения

$$\begin{aligned} & \text{№1} \\ & \text{1) } Z - \frac{at^2}{2} = H \\ & H = v_0 t - \frac{at^2}{2} \\ & \Downarrow \\ & Z - \frac{at^2}{2} = v_0 t - \frac{at^2}{2} \\ & Z = v_0 t \end{aligned}$$

$$a = g$$

$$\begin{aligned} & \delta) Z = v_0 T - \frac{aT^2}{2} \\ & T \cdot a = v_0 \\ & T = \frac{v_0}{a} \end{aligned}$$

T - время полёта первого мяча до остановки.

$$Z = \frac{v_0^2}{a} - \frac{a v_0^2}{2a^2} = \frac{v_0^2}{2a}$$

$$\text{из (a) } (\delta) \Rightarrow \frac{v_0^2}{2a} = v_0 t \Rightarrow t = \frac{v_0}{2a}$$

$$2) H = v_0 t - \frac{at^2}{2} = \frac{v_0^2}{2a} - \frac{a v_0^2}{2 \cdot 4a^2} = \frac{3 v_0^2}{8a}$$

$$v_0 = \sqrt{\frac{8}{3} H a} \Rightarrow v_0 = 2\sqrt{\frac{2}{3} H g}$$

$$t = \frac{\sqrt{\frac{8}{3} H a}}{2a} = \frac{\sqrt{\frac{2}{3} H a}}{a} \Rightarrow t = \frac{\sqrt{\frac{2}{3} H g}}{g}$$

$$3) S = 2Z - H$$

$$S = 2v_0 t - H = 2 \frac{v_0 \cdot v_0}{2a} - H = \frac{8}{3} \frac{H a}{a} - H = \frac{5}{3} H$$

$$S = \frac{5}{3} H$$

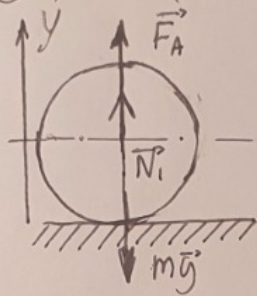
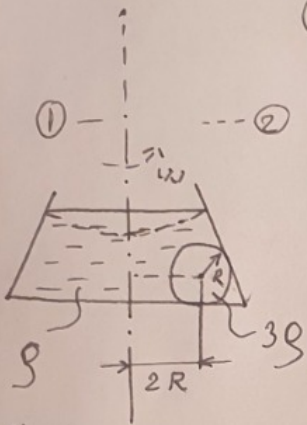
Ответ: 1)  $t = \frac{\sqrt{\frac{2}{3} H g}}{g}$  2)  $v_0 = 2\sqrt{\frac{2}{3} H g}$  3)  $S = \frac{5}{3} H$

1

Чистовик

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

1) а) II 3. Ньютона для шара



$$0 = \vec{F}_A + m\vec{g} + \vec{N}_1$$

$$y: 0 = F_A + N_1 - mg \Rightarrow N = mg - F_A$$

$$\delta) F_A = \rho g V$$

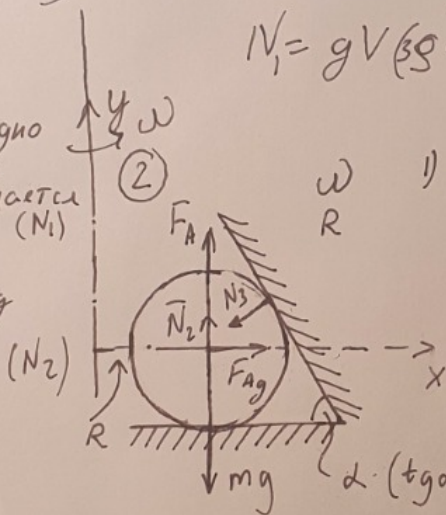
$$mg = 3\rho g V$$

$$N_1 = gV(3\rho - \rho) = gV \cdot 2\rho$$

Найти

1) давление на дно сосуда если он не вращается ( $N_1$ )

2) давление на дно если сосуд вращается



II 3. Ньютона

$$y: F_A + N_2 + N_3 \cdot \sin \alpha + mg = 0$$

$$x: 0 = F_y + F_{Ay} - N_3 \cos \alpha$$

$$N_3 = \frac{ma + F_{Ag}}{\cos \alpha}$$

$$F_{Ag} = \rho a V$$

$$N_2 = mg - F_A + N_3 \sin \alpha$$

$$N_2 = mg - F_A + \frac{ma + F_{Ag}}{\cos \alpha} \sin \alpha$$

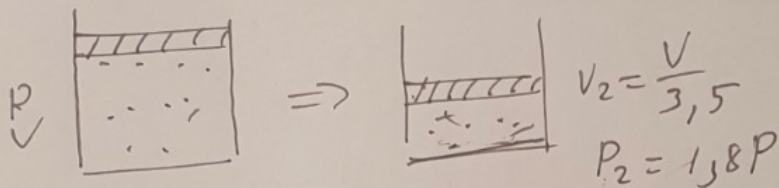
$$N_2 = g(3\rho V - \rho V) + \frac{a(4\rho V)}{\cos \alpha} \sin \alpha$$

$$N_2 = 2\rho V g + 2R\omega \cdot 4\rho \operatorname{tg} \alpha V$$

$$N_2 = \frac{4\pi}{3} R^3 (2\rho g + 16\rho g)$$

(2)

Чистовик



$$T = 81^\circ\text{C} = (81 + 273)\text{K}$$

$P$  - давление в начале

$V_2$  - объем пара в конце

$$P \cdot V = \nu_1 RT$$

$$P_2 V_2 = \nu_2 RT$$

$$\frac{\nu_1}{\nu_2} = \frac{PV}{P_2 V_2} = \frac{3,5}{1,8}$$

$$\nu_1 = \frac{m}{M_r} = \frac{3}{18}$$

$$\nu_2 = \frac{\nu_1 RT}{P_2}$$

$$\nu_2 = \frac{0,0857 \cdot R \cdot (81 + 273)}{0,5 \cdot 10^5}$$

$$\nu_2 = 0,05 \text{ моль}$$

$$\nu_2 = \frac{18 \cdot 3}{35 \cdot 18} = 0,0857 \text{ моль}$$

$\Downarrow$  есть вода  $\Rightarrow$  пар насыщеннй

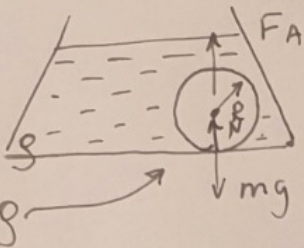
$$P_2 = 0,5 \cdot 10^5 \text{ Па}$$

$$P = P_2 / 1,8 = 2,77 (7) \cdot 10^4 \text{ Па}$$

ответ:  $P_1 = 2,77 \cdot 10^4 \text{ Па}$  ;  $V = 0,005 \text{ л}$ .

(3)

1) не вращается



$$F_A = \rho \cdot gV$$

$$mg = 3\rho gV$$

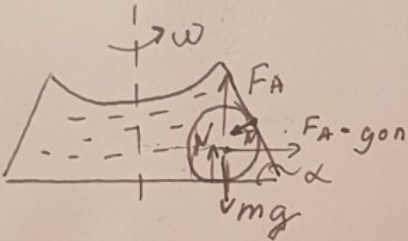
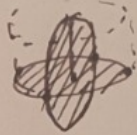
⇒ По II з. Ньютона

$$0 = N + F_A - mg$$

$$N = 2\rho gV$$

$$V_{шара} = \frac{\pi}{4} R^3 \text{ (сферическая)}$$

Задача 2  
Черновик.

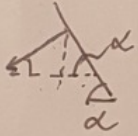


$$\omega_2 R = a$$

$$ma = F_{A \text{ гон}} - N_3 \cdot \cos \alpha$$

$$N_3 = \frac{F_{A \text{ гон}} - ma}{\cos \alpha}$$

$$N_2 = mg - F_A + N_3 \cdot \sin \alpha$$



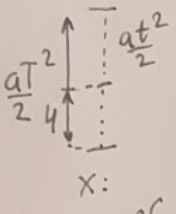
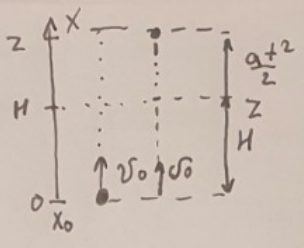
$$N_2 = mg - F_A + (F_{A \text{ гон}} - ma) \cdot \tan \alpha$$

$$F_{A \text{ гон}} = \rho aV$$

$$N_2 = mg - F_A + \frac{\rho aV - mg \tan \alpha}{\cos \alpha}$$

$$N_2 = g(2\rho V) + a(2\rho V) \tan \alpha$$

$$N_2 = 2\rho V(g + a \tan \alpha)$$



Задача 1  
Кепробук

$$a = g$$

$$H + \frac{at^2}{2} = Z$$

$$Z = v_0 T - \frac{aT^2}{2}$$

$$T = \frac{v_0}{a}$$

$$Z = \frac{v_0^2}{a} - \frac{v_0^2}{2a} = \frac{v_0^2}{2a}$$

$$H + \frac{at^2}{2} = \frac{v_0^2}{2a}$$

$$H = \frac{v_0^2 - at^2}{2a}$$

$$v_0 t - \frac{at^2}{2} = Z - \frac{at^2}{2}$$

$$v_0 t = Z$$

$$Z = v_0 T - \frac{aT^2}{2} = \frac{aT^2}{2}$$

$$v_0 = aT$$

$$v_0 t = \frac{aT^2}{2} = \frac{v_0^2}{2a}$$

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

$$H = v_0 t - \frac{at^2}{2} = \frac{v_0^2}{2a} - \frac{a \cdot \frac{v_0^2}{4a^2}}{2} = \frac{v_0^2}{2a} - \frac{v_0^2}{8a} = \frac{3v_0^2}{8a}$$

$$H = \frac{v_0^2}{2a} - \frac{a \cdot \frac{v_0^2}{2(2a)^2}}{2} = \frac{v_0^2}{2a} - \frac{a \cdot \frac{v_0^2}{8a^2}}{2} = \frac{v_0^2}{2a} - \frac{v_0^2}{16a} = \frac{7v_0^2}{16a}$$

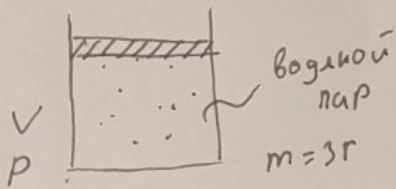
$$v_0 = \sqrt{\frac{8H \cdot g}{3}} = \frac{M}{c}$$

$$t = \frac{v_0}{2a} = \frac{\sqrt{\frac{8Hg}{3}}}{2g} = \frac{\sqrt{\frac{8Hg}{3}}}{2g}$$

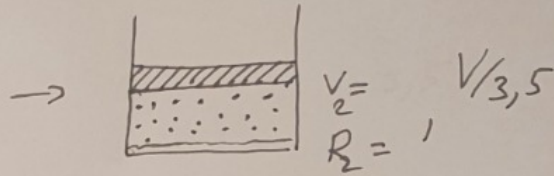
$$\frac{\sqrt{\frac{2Hg}{3}}}{\frac{M}{c^2}} = \frac{M/c}{M/c^2} = c$$

$$S = 2Z - H = 2v_0 t - H$$

$$2 \cdot \frac{v_0 \cdot v_0}{2g} - H = \frac{8Hg}{3g} - H = \frac{5}{3}H$$



$$T = 81^\circ\text{C}$$



$$P_{\text{вог пара}} = 0,5 \cdot 10^5 \text{ Па}$$

$$V \rightarrow \frac{V}{3,5}$$

$$P \rightarrow$$

$$PV = \nu RT \rightarrow \text{const} \quad \downarrow \text{ - не const}$$

$$PV = P_2 V_2 \quad (\text{не выполняется})$$

$$PV = \nu RT \Rightarrow \frac{PV}{P_2 V_2} = \frac{\nu_1}{\nu_2}$$

$$P_2 V_2 = \nu_2 RT \quad \frac{3,5 PV}{1,8 P_2 V} \approx 1,9$$

$$\nu_1 = \frac{m}{M_r} = \frac{3}{18}$$

$$\frac{\nu_1}{\nu_2} = \frac{3,5}{1,8} = \frac{35}{18}$$

$$\frac{3}{18 \nu_2} = \frac{3,5}{1,8}$$

$$\nu_2 = \frac{18 \cdot 3}{35 \cdot 1,8} = 0,0857 \text{ моль}$$

$$\downarrow \approx 1,542.$$

вода  $\Rightarrow$  пар. насыщенный в конце.

$$V_k = \frac{\nu RT}{P_2}$$

$$V_k = \frac{0,0857 \cdot R \cdot (81+273)}{0,5 \cdot 10^5} \quad \frac{P_2 = 0,5 \cdot 10^5 \text{ Па}}{\downarrow}$$

$$P_1 = 0,027777 \text{ Па.}$$

$$\frac{252 \cdot 10718}{0,5} = 504 \cdot 214236$$

$$100000 = 0,00504214 \text{ л.}$$

# Часть 2

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

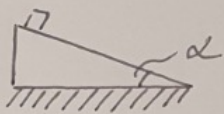
Шифр: **21206134**

ID профиля: **340335**

Вариант 1



Чисто вук



$m; 3m$

Найти

1)  $t_1$  - шайба  
сведет если  
клин закреплен

2) на клин действует

$F = 2mg$

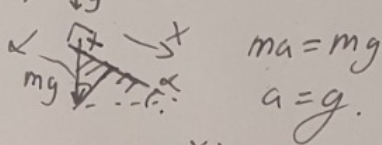
найти  $t_2$  - шайба  
сведет

$\mu$  а - клин



№4

1) ↓  $g$  II Закон Ньютона



$$ma = mg$$

$$a = g$$

$$x: g \cdot \sin \alpha = a_x$$

$$\frac{a_x t^2}{2} = l$$

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

$$l = H / \sin \alpha$$

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

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

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

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

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

2)

$$mg \cdot \sin \alpha - \mu a \cdot \cos \alpha = ma_m$$

$$F - N \cdot \sin \alpha = 3ma$$

$$N \sin \alpha = mg \cdot \cos \alpha + ma$$

$$2mg - \mu g \cos \alpha - \mu a = 3ma$$

$$g(2 - \cos \alpha) = 4a$$

$$4a = 1,2g$$

$$a = 0,3g$$

$$g(\sin \alpha - 0,3 \cos \alpha) = a_m \Rightarrow a_m = g \left( \frac{3}{5} - \frac{4}{5} \cdot \frac{3}{10} \right) = 0,36g$$

$$t = \sqrt{\frac{2H}{a_m \cdot \sin \alpha}} = \sqrt{\frac{2H}{0,36g \sin \alpha}} = \sqrt{\frac{2H}{0,216g}}$$

1

Числовик

№5

$$PV = \nu RT$$

$$P_2 V_2 = \nu R T_2$$

$$P_2 = 1,02 P$$

$$V_2 = 0,99 V$$

$$\Rightarrow \frac{T}{T_2} = \frac{PV}{P_2 V_2}$$

$$\frac{T}{T_2} = \frac{1}{1,02 \cdot 0,99} = \frac{1}{1,0098}$$

⇓  
Температура увеличилась на 0,98%.

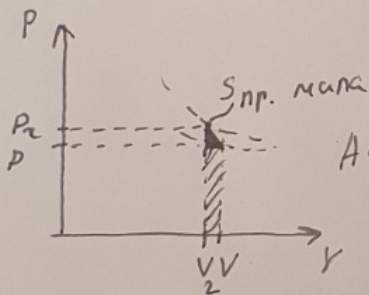
$$\frac{Q}{A_{газ}} = ?$$

$$Q = U + A_{газ}$$

$$U = \frac{i}{2} (\Delta T \nu R) = \frac{3}{2} (P_2 V_2 - PV) = \frac{3}{2} \cdot (P + \Delta P) \cdot (V + \Delta V) - PV$$

$$= \frac{3}{2} (PV + \Delta PV + P \Delta V - PV)$$

$$A_{газ} = S$$



$$A \approx P_2 \cdot \Delta V = P \Delta V + \Delta P \Delta V$$

$$\frac{\frac{3}{2} (\Delta PV + P \Delta V) + P \Delta V + \Delta P \Delta V}{P \Delta V + \Delta P \Delta V} =$$

$$= \frac{\frac{3}{2} \Delta PV + \frac{3}{2} P \Delta V + P \Delta V + \Delta P \Delta V}{P \Delta V + \Delta P \Delta V} =$$

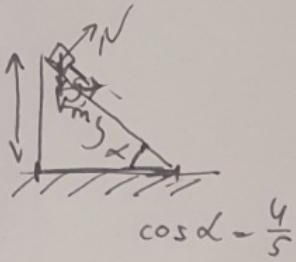
$$= \frac{\frac{5}{2} \Delta PV + \frac{3}{2} P \Delta V}{P \Delta V} = \frac{V (\frac{5}{2} \cdot 0,01 P + \frac{3}{2} \cdot 0,02 P)}{V (0,01 P)} = \frac{\frac{5}{2} \cdot 0,01 + \frac{3}{2} \cdot 0,02}{0,01}$$

$$= \frac{\frac{5}{2} \cdot 1 + 3}{1} = 5,5$$

Ответ: в 5,5 раза

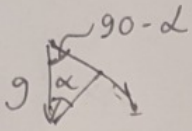
на 0,98%.

2

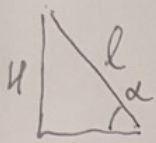


$$mg$$

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



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



$$l \cdot \sin \alpha = H$$

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

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

$$\sin^2 \alpha = 1 - \cos^2 \alpha = 1 - \frac{16}{25} = \frac{9}{25} = \frac{3}{5}$$

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

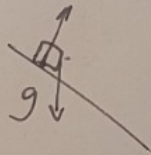


$$am = F$$

$$m = 3m + m$$

$$4m \cdot a = F = 2mg$$

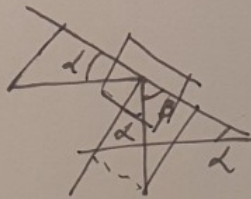
$$a = \frac{1}{2}g$$



N-работы не совершает

⇓

t = const.



→ N

N5

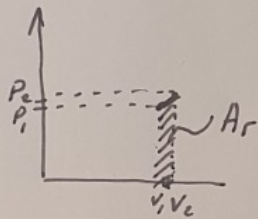
$$\frac{\Delta P}{P_0} \ll 1$$

$$P_1 V_1 = \nu R T_1$$

$$1,02 P_1 \cdot 0,99 V_1 = \nu R T_1$$

$$1,0098 P V = \nu R T_2$$

$$\Delta T_2 \approx 0,98\%$$



$$Q = A_r + U$$

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

$$A_r = P_0 \Delta V + \frac{3}{2} \Delta T \nu R \quad \left. \begin{array}{l} P_2 V_2 - P_1 V_1 \\ \approx 0 P_0 \Delta V \end{array} \right\} \text{manus}$$

$$\frac{Q}{A_r} = \frac{P_0 \Delta V + \frac{3}{2} \Delta T \nu R}{P_0 \Delta V} = \frac{P(\Delta V + \Delta V)}{P(\Delta V)} = \frac{2}{1}$$

Чистовик

№5

$$PV = \nu RT$$

$$P_2 V_2 = \nu R T_2$$

$$P_2 = 1,02 P$$

$$V_2 = 0,99 V$$

$$\Rightarrow \frac{T}{T_2} = \frac{PV}{P_2 V_2}$$

$$\frac{T}{T_2} = \frac{1}{1,02 \cdot 0,99} = \frac{1}{1,0098}$$

⇓  
Температура увеличилась на 0,98%.

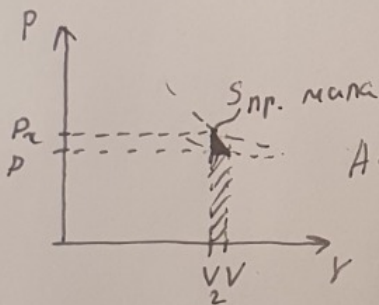
$$\frac{Q}{A_{раз}} = ?$$

$$Q = U + A_{раз}$$

$$U = \frac{1}{2} (\Delta T \nu R) = \frac{3}{2} (P_2 V_2 - PV) = \frac{3}{2} \cdot ((P + \Delta P) \cdot (V + \Delta V) - PV)$$

$$= \frac{3}{2} (PV + \Delta PV + P \Delta V - PV)$$

$$A_{раз} = S$$



$$A \approx P_2 \cdot \Delta V = P \Delta V + \Delta P \Delta V$$

$$\frac{\frac{3}{2} (\Delta PV + P \Delta V) + P \Delta V + \Delta P \Delta V}{P \Delta V + \Delta P \Delta V} =$$

$$= \frac{\frac{3}{2} \Delta PV + \frac{3}{2} P \Delta V + P \Delta V + \Delta P \Delta V}{P \Delta V + \Delta P \Delta V} =$$

$$= \frac{\frac{5}{2} \Delta PV + \frac{3}{2} \Delta P V}{P \Delta V} = \frac{V (\frac{5}{2} \cdot 0,01 P + \frac{3}{2} \cdot 0,02 P)}{V (0,01 P)} = \frac{5 \cdot 0,001 + 3}{0,01}$$

$$= \frac{5 \cdot 1 + 3}{1} = 5,5$$

Ответ: в 5,5 раза

на 0,98%.

2