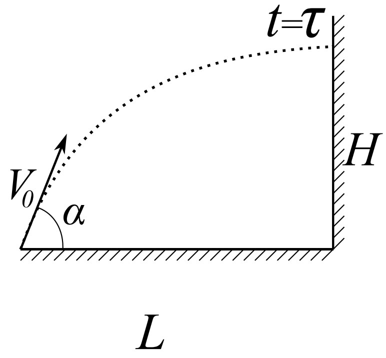
Олимпиада «Phystech International» - 2016. Физика. Решения. 10-01.

1. $V_0 \sin\alpha - g\tau = 0 \Rightarrow V_0 = \dfrac{g\tau}{\sin\alpha}$



$$L = V_0 \cos\alpha \cdot \tau = \frac{g\tau}{\sin\alpha} \cdot \cos\alpha \cdot \tau = \frac{g\tau^2}{tg\alpha} \Rightarrow \tau = \sqrt{\frac{Ltg\alpha}{g}}$$

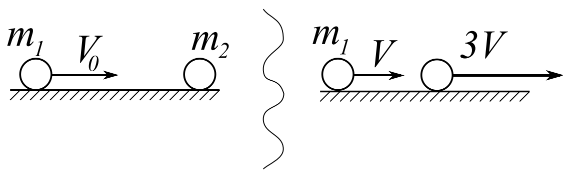
$$T = 2\tau = 2\sqrt{\frac{Ltg\alpha}{g}} = 2\sqrt{\frac{10\cdot\sqrt{3}}{10}} = 2\sqrt[4]{3} \approx 2{,}6\,\text{с}$$

$$H = V_0 \sin\alpha \cdot \tau - \frac{g\tau^2}{2} = g\tau^2 - \frac{g\tau^2}{2} = \frac{g\tau^2}{2} = \frac{g}{2} \cdot \frac{Ltg\alpha}{g} = \frac{L}{2} tg\alpha = \frac{10}{2}\sqrt{3} = 5\sqrt{3} = 8{,}7\,\text{м}$$

2. ЗСЭ: $\dfrac{m_1 V_0^2}{2} = \dfrac{m_1 V^2}{2} + \dfrac{m_2 (3V)^2}{2}$; $\left(\dfrac{V_0}{V}\right)^2 = 1 + 9\dfrac{m_2}{m_1}$ (1)

ЗСИ: $m_1 V_0 = m_1 V + m_2 \cdot 3V$; $\dfrac{V_0}{V} = 1 + 3\dfrac{m_2}{m_1}$ (2)

(2)→(1): $1 + 6\dfrac{m_2}{m_1} + 9\left(\dfrac{m_2}{m_1}\right)^2 = 1 + 9\dfrac{m_2}{m_1}$;



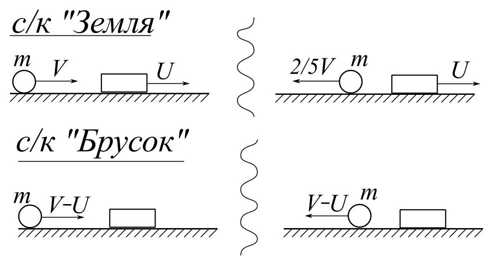
$9\dfrac{m_2}{m_1} = 3$; $\dfrac{m_2}{m_1} = \dfrac{1}{3}$ (3)

(3)→(2): $\dfrac{V_0}{V} = 1 + 3\cdot\dfrac{1}{3} = 2$

3. Закон сложения скоростей:

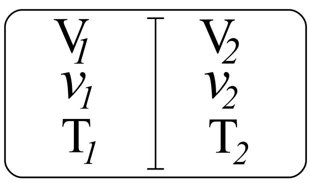
$(V - U) - U = \dfrac{2}{5}V$; $V\left(1 - \dfrac{2}{5}\right) = 2U$;

$V \cdot \dfrac{3}{5} = 2U$; $\dfrac{V}{U} = \dfrac{10}{3}$



4. Т.к. P-const, то $\dfrac{\nu_1 T_1}{V_1} = \dfrac{\nu_2 T_2}{V_2}$; $\dfrac{V_2}{V_1} = \dfrac{\nu_2 T_2}{\nu_1 T_1}$

$$ЗСЭ: \nu_1 C_V T_1 + \nu_2 C_V T_2 = (\nu_1 + \nu_2) C_V T \Rightarrow$$



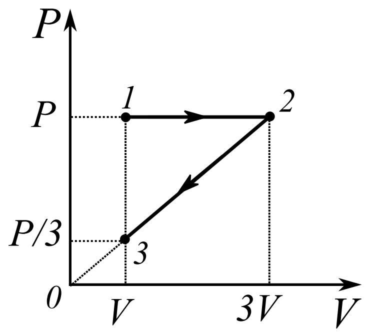
$$\Rightarrow T = \frac{\nu_1 T_1 + \nu_2 T_2}{\nu_1 + \nu_2} = \frac{0{,}5\cdot 200 + \frac{1}{3}\cdot 300}{0{,}5 + \frac{1}{3}} = 240K$$

$$P' = \frac{(\nu_1 + \nu_2)RT}{V_1 + V_2};\quad P = \frac{\nu_1 R T_1}{V_1}$$

$$\frac{P'}{P}=\frac{(\nu_1+\nu_2)}{\nu_1}\cdot\frac{V_1}{V_1+V_2}\cdot\frac{T}{T_1}=\frac{\nu_1+\nu_2}{\nu_1}\frac{1}{1+V_2/V_1}\cdot\frac{T}{T_1}=\frac{(\nu_1+\nu_2)}{\nu_1}\cdot\frac{1}{1+\frac{\nu_2T_2}{\nu_1T_1}}\cdot\frac{\nu_1T_1+\nu_2T_2}{(\nu_1+\nu_2)T_1}=1$$

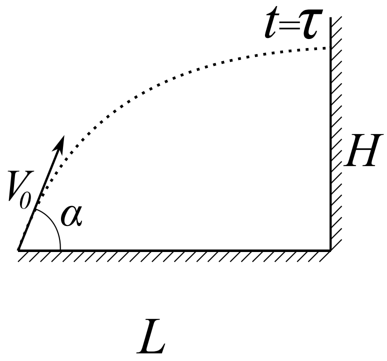
5.
$$\left.\begin{aligned}&P\cdot 3V=\nu RT_2\\&\frac{P}{3}\cdot V=\nu RT_3\end{aligned}\right\}\Rightarrow\frac{T_2}{T_3}=9$$

$$\left.\begin{aligned}&A_{12}=P(3V-V)\\&A'_{23}=\frac{1}{2}(P+\frac{P}{3})(3V-V)\end{aligned}\right\}\Rightarrow\frac{A_{12}}{A'_{23}}=\frac{1}{\frac{1}{2}(1+\frac{1}{3})}=\frac{3}{2}$$



Олимпиада «Phystech International» - 2016. Физика. Решения. 10-02.

1. $V_0 \sin\alpha - g\tau = 0 \Rightarrow V_0 = \dfrac{g\tau}{\sin\alpha}$



$$L = V_0\cos\alpha\cdot\tau = \frac{g\tau}{\sin\alpha}\cdot\cos\alpha\cdot\tau = \frac{g\tau^2}{tg\alpha} \Rightarrow \tau = \sqrt{\frac{Ltg\alpha}{g}}$$

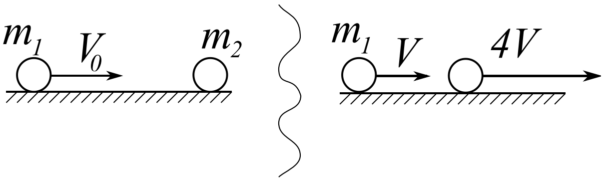
$$T = 2\tau = 2\sqrt{\frac{Ltg\alpha}{g}} = 2\sqrt{\frac{5\cdot 1}{10}} = \sqrt{2} \approx 1{,}4\,\text{с}$$

$$H = V_0\sin\alpha\cdot\tau - \frac{g\tau^2}{2} = g\tau^2 - \frac{g\tau^2}{2} = \frac{g\tau^2}{2} = \frac{g}{2}\cdot\frac{Ltg\alpha}{g} = \frac{L}{2}tg\alpha = \frac{5}{2}\cdot 1 = 2{,}5\,\text{м}$$

2. ЗСЭ: $\dfrac{m_1V_0^2}{2} = \dfrac{m_1V^2}{2} + \dfrac{m_2(4V)^2}{2}$; $\qquad \left(\dfrac{V_0}{V}\right)^2 = 1 + 16\dfrac{m_2}{m_1} \qquad (1)$

ЗСИ: $m_1V_0 = m_1V + m_2\cdot 4V$; $\qquad \dfrac{V_0}{V} = 1 + 4\dfrac{m_2}{m_1} \qquad (2)$

(2)→(1):

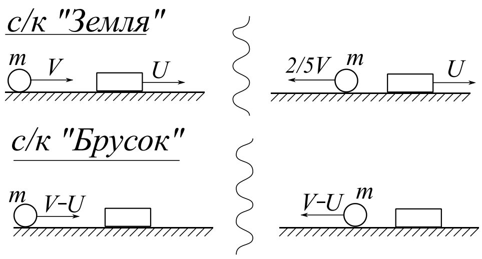


$$1 + 8\frac{m_2}{m_1} + 16\left(\frac{m_2}{m_1}\right)^2 = 1 + 16\frac{m_2}{m_1};$$

$$2\frac{m_2}{m_1} = 1; \qquad \frac{m_2}{m_1} = \frac{1}{2} \qquad (3)$$

(3)→(2): $\dfrac{V_0}{V_1} = 1 + 4\cdot\dfrac{1}{2} = 3$

3. Закон сложения скоростей:



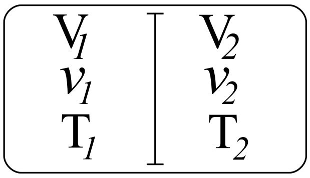
$$(V - U) - U = \frac{1}{2}V; \qquad V\left(1 - \frac{1}{2}\right) = 2U;$$

$$\frac{V}{2} = 2U; \qquad \frac{V}{U} = 4$$

4. Т.к. p-const, то $\dfrac{\nu_1T_1}{V_1} = \dfrac{\nu_2T_2}{V_2}$; $\quad \dfrac{V_2}{V_1} = \dfrac{\nu_2T_2}{\nu_1T_1}$

$$ЗСЭ: \nu_1C_VT_1 + \nu_2C_VT_2 = (\nu_1 + \nu_2)C_VT \Rightarrow$$

$$\Rightarrow T = \frac{\nu_1T_1 + \nu_2T_2}{\nu_1 + \nu_2} = \frac{\frac{1}{3}\cdot 300 + \frac{1}{5}\cdot 500}{\frac{1}{3} + \frac{1}{5}} = 375K$$



$$P' = \frac{(\nu_1+\nu_2)RT}{V_1+V_2}; \quad P = \frac{\nu_1 RT_1}{V_1}$$

$$\frac{P'}{P} = \frac{(\nu_1+\nu_2)}{\nu_1}\cdot\frac{V_1}{V_1+V_2}\cdot\frac{T}{T_1} = \frac{\nu_1+\nu_2}{\nu_1}\cdot\frac{1}{1+V_2/V_1}\cdot\frac{T}{T_1} = \frac{(\nu_1+\nu_2)}{\nu_1}\cdot\frac{1}{1+\frac{\nu_2 T_2}{\nu_1 T_1}}\cdot\frac{\nu_1 T_1+\nu_2 T_2}{(\nu_1+\nu_2)T_1} = 1$$

5.

$$\left.\begin{array}{l} P\cdot 2V = \nu RT_2 \\ \frac{P}{3}\cdot V = \nu RT_3 \end{array}\right\} \Rightarrow \frac{T_2}{T_3} = 4$$

$$\left.\begin{array}{l} A_{12} = P(2V - V) \\ A'_{23} = \frac{1}{2}(P+\frac{P}{3})(2V-V) \end{array}\right\} \Rightarrow \frac{A_{12}}{A'_{23}} = \frac{1}{\frac{1}{2}(1+\frac{1}{2})} = \frac{4}{3}$$