1 тур

1\. 1.1 $V_0 + a\cos\alpha\, t = 0;\ \ t = -\frac{V_0}{a\cdot\cos\alpha} = -\frac{2}{1\cdot\cos(135^0)} \approx 2{,}8$ с

1.2 $|V| = a\sin\alpha\cdot t = a\cdot\sin\alpha\cdot\left(-\frac{V_0}{a\cdot\cos\alpha}\right);\ |V| = -V_0\mathrm{tg}\alpha = -2\cdot tg(135^0) = 2$ м/с

1.3 $S_x = V_0 t + \frac{a\cos\alpha t^2}{2} = -\frac{{V_0}^2}{2a\cos\alpha};\qquad S_y = \frac{a\cdot\sin\alpha}{2}\cdot t^2 = \frac{a\sin\alpha}{2}\cdot\frac{{V_0}^2}{a^2\cos^2\alpha} = \frac{{V_0}^2\mathrm{tg}\alpha}{2a\cos\alpha};$

$S = \sqrt{{S_x}^2 + {S_y}^2} = \sqrt{\frac{\frac{1}{4}{V_0}^4}{a^2\cos^2\alpha} + \frac{{V_0}^4\mathrm{tg}^2\alpha}{4a^2\cos^2\alpha}} = \left|\frac{{V_0}^2}{2a\cos\alpha}\right|\sqrt{1+\mathrm{tg}^2\alpha} = 4$ м.

2\. 2.1 $\left(\frac{V_1+2V_1}{V_1}\right) = 3;$

2.2 После столкновения начальные скорости брусков

$V_1{}' = \frac{V_1(m_1-m_2)-2m_2V_2}{m_1+m_2} = \frac{V_1(m_1-3m_1)-2\cdot 3m_1\cdot 2V_1}{m_1+3m_1} = -3{,}5V_1;$

$V_2{}' = \frac{2V_1m_1-V_2(m_2-m_1)}{m_1+m_2} = \frac{2V_1m_1-2V_1(3m_1-m_1)}{m_1+3m_1} = -0{,}5V_1;$

$\frac{L_1}{L_2} = \left(\frac{V_2{}'}{V_1{}'}\right)^{-2} = \left(\frac{3{,}5}{0{,}5}\right)^2 = 49;$

2.3 $L_1 = \left(\frac{V_1'^2}{2\mu g}\right);\ L_2 = \frac{V_2'^2}{2\mu g};\qquad L_1 - L_2 = \frac{V_1'^2 - V_2'^2}{2\mu g};$

$L_1 - L_2 = \frac{3{,}5^2-0{,}25}{2\cdot 0{,}1\cdot 10} = 6$ м.

3\. 3.1 $Q = mgH = 20\cdot 10\cdot 2 = 400$ Дж;

3.2 $V = \sqrt{2gH(1-\mu\cdot\mathrm{ctg}\alpha)} = \sqrt{2\cdot 10\cdot 2(1-0{,}4\cdot\mathrm{ctg}80^0)} \approx 6{,}1$ м/с;

3.3 т.к. $\cos\alpha - \mu\sin\alpha < 0$, то $L = 0$.

4\. 4.1 $\frac{P}{V} = const \Rightarrow \frac{P^2}{T} = const';\qquad \frac{P_2^2T_1}{P_1^2T_2} = 1;\qquad \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^2 = 9.$

4.2 $\frac{P}{V} = PV^{-1} = const;\ \frac{C-C_P}{C-C_V} = -1 \Rightarrow -C + C_V = C - C_P.$

$2C = C_P + C_V \Rightarrow C = 2R = 2\cdot 8{,}31 \approx 16{,}62$ Дж/моль·К

4.3 $P = \alpha V\qquad A = \frac{\alpha}{2}\left({V_2}^2 - {V_1}^2\right);\quad \frac{A_2}{A_1} = \frac{25-1}{4-1} = \frac{24}{3} = 8.$

5\. 5.1 $I = \frac{\varepsilon}{R_1+R_2+r} = \frac{12}{20+30+10} = 0{,}2$ А;

5.2 $Q = \frac{C\varepsilon^2}{2}\frac{R_1}{r+R_1+R_2} = \frac{150\cdot 10^{-6}\cdot 12^2}{2}\cdot\frac{20}{10+20+30} = 3{,}6$ мДж;

5.3 $\frac{q}{C} + I(R_1+R_2+r) = \varepsilon \Rightarrow \frac{1}{C}\frac{da}{dt} + \frac{dI}{dt}(R_1+R_2+r) = 0;$

$\left|\frac{dI}{dt}\right| = \frac{I}{C(R_1+R_2+r)} = \frac{0{,}1}{150\cdot 10^{-6}\cdot(10+20+30)} \approx 11{,}1$ А/с

2 тур

1. 1.1 $|V| = \sqrt{2}V_0 \approx 2{,}8$ м/с

   1.2 $V_0 = \frac{\alpha t^2}{2}$; $t = \sqrt{\frac{2V_0}{\alpha}} = \sqrt{\frac{2\cdot 2}{1}}$; $t = 2$ с.

   1.3 $R = \frac{V^2}{\alpha t \cos\varphi} = \frac{\left(\sqrt{2}V_0\right)^2}{\alpha t \cos\varphi} = \frac{2\cdot 4\cdot 2}{1\cdot 2\cdot\sqrt{2}} = \frac{8}{\sqrt{2}}$; $R = 5{,}7$ м.

2. 2.1 $a = g \cdot \sin(\omega t) \approx g \cdot \omega t \approx 10 \cdot \text{рад}(1^0) \cdot 1 \approx 0{,}17$ м/с^2

   2.2 $V \approx \frac{g\omega t^2}{2}$; $\frac{V_2}{V_1} = \left(\frac{t_2}{t_1}\right)^2 = \left(\frac{3}{1}\right)^2 = 9$;

   2.3 $V \approx \frac{g\alpha^2}{2\omega}$; $\alpha \approx \sqrt{\frac{2\omega V}{g}}$; $\alpha \approx \sqrt{\frac{2\cdot \text{рад}(1^0)\cdot 3}{10}} = 5{,}9^0$.

3. 3.1 $n\varphi = 1 \Rightarrow n = \frac{1}{\varphi} = \frac{1}{0{,}4} = 2{,}5$;

   3.2 В начале (V) $P_\Pi V = \frac{m}{\mu}RT; P_\Pi = \frac{\rho_\Pi}{\mu}RT$; $\rho_\Pi = \frac{\mu P_\Pi}{RT} = \frac{\mu\cdot\varphi P_\Pi}{RT}$

   В конце $\left(\frac{V}{5}\right)$ $\rho_\Pi{}' = \frac{\mu P_\Pi}{RT}$; $\left(\frac{\rho_\Pi{}'}{\rho_\Pi}\right)^{-1} = 0{,}4$;

   3.3 Давление вначале $P = P_{\text{св}} + P_{\text{н}}$; $P_{\text{св}} = (P - \varphi P_{\text{н}})$

   в конце

   $P_{\text{к}} = 5P_{\text{св}} + P_{\text{н}} = 5(P - \varphi P_{\text{н}}) + P_{\text{н}} = 5P - 5\varphi P_{\text{н}} + P_{\text{н}} = 5P - P_{\text{н}}(5\varphi - 1)$; $\frac{P_{\text{к}}}{P} = 5 - \frac{P_{\text{н}}}{P}(5\varphi - 1)$

   $P_{\text{к}}/P = 5 - \frac{100}{50}(5 \cdot 0{,}4 - 1) = 3$.

4. 4.1 $\Delta U_{12} = \frac{3}{2}\nu R(T_2 - T_1)$; $A_{12} = \frac{1}{2}(P_2 + P_1)(V_2 - V_1) = \frac{1}{2}\nu R(T_2 - T_1)$; $\frac{\Delta U_{12}}{A_{12}} = 3$.

   4.2 $Q_{12} = \Delta U_{12} + A_{12} = 2\nu R(T_2 - T_1)$; $Q'_{23} = \frac{3}{2}\nu R(T_2 - T_1) \Rightarrow \frac{Q_{12}}{Q'_{23}} = \frac{4}{3} \approx 1{,}3$

   4.3 $C = 2R = 2 \cdot 8{,}31 \approx 16{,}6$ Дж/моль·К.

5. 5.1 $I = \frac{\varepsilon}{R_1} = \frac{40}{10} = 4$ А;

   5.2 $I_2 \cdot R_2 = U_2 \Rightarrow I_2 = \frac{U_2}{R_2} = \frac{10}{20} = 0{,}5$ А;

   Напряжение на R_1 $U_1 = E - U_2 = 30$ В

   Ток через R_1 $I_1 = \frac{U_1}{R_1} = \frac{30}{10} = 3$ А

   $I_1 = I_2 + I_{\text{c}} \Rightarrow I_{\text{c}} = I_1 - I_2 = 3 - 0{,}5 = 2{,}5$ А

   5.3 $I_2 R_2 = \frac{q}{c}$; $\frac{\Delta I_2}{\Delta t} = \frac{I_C}{CR_2} = \frac{2{,}5}{100\cdot 10^{-6}\cdot 20} = 1250$ А/с.

3 тур

1. 1.1 $T = \frac{\tau}{1-\sqrt{1-\frac{1}{7}}} = \frac{0,1}{1-\sqrt{1-\frac{1}{7}}} \approx 1,3$ с;

1.2 $V_x = 10$ м/с; $|V_y| = gT \approx 13$ м/с; $V = \sqrt{{V_x}^2 + {V_y}^2} \approx \sqrt{10^2 + 13^2} \approx 17$ м/с;

1.3 $\text{tg}\alpha \approx \frac{V_y}{V_x} \approx 1,3$; $a_n = g \cdot \cos\alpha = g\frac{1}{\sqrt{1+\text{tg}^2\alpha}} = \sqrt{\frac{10}{\sqrt{1+1,3^2}}} \approx 6$ м/с²; $R = \frac{V^2}{a_n} \approx \frac{16,8^2}{6} \approx 47$ м.

2. 2.1 $ma = F = \mu mg \Rightarrow ma = 1\ \ a = 0,5$ м/с;

2.2 $a = 0; F \cdot \cos\alpha - \mu(mg - F\sin\alpha) = 0$;

$F(\cos\alpha + \mu\sin\alpha) = \mu mg \Rightarrow 0,3\sin\alpha + 3\cos\alpha = 2$;

$\cos(\alpha - \varphi) = \frac{2}{\sqrt{0,3^2+3^2}} \cos\varphi = \frac{3}{\sqrt{0,3^2+3^2}} \Rightarrow \alpha \approx 54,15^0$; $\omega\tau \approx 54,15^0$; $\tau \approx 10,8$ с.

2.3 Ускорение максимально при $\text{tg}\alpha = \mu$; $ma_m = F(\cos\alpha + \mu\sin\alpha) - \mu mg \Rightarrow$

$a_m = \frac{F}{m}\left(\sqrt{\frac{1}{1+tg^2}} + \mu\sqrt{\frac{1}{1+\frac{1}{tg^2\alpha}}}\right) - \mu g = \frac{3}{2}\sqrt{\frac{1}{1+0,1^2} + 0,1\sqrt{\frac{1}{1+0,1^2}}} - 0,1 \cdot 10 \approx 0,507$ м/с²;

$\frac{a_m - a}{a} \approx 1,5$ %.

3. 3.1 $\frac{P_2V_2}{P_1V_1} = 1 \Rightarrow \frac{P_2}{P_1} = \frac{V_1}{V_2} = 4$;

3.2 $A = \frac{1}{2}RT_0\left(\frac{n^2-1}{n}\right)$; $U = \frac{3}{2}RT_0$; $\left(\frac{U}{A}\right) = \left(\frac{3n}{n^2-1}\right) = \left(\frac{3\cdot4}{16-1}\right) = 0,8$;

3.3 $\frac{U_{max}}{U_0} = \frac{(n+1)^2}{4n} = \frac{(4+1)^2}{4\cdot4} \approx 1,6$.

4. 4.1 $P = \alpha V$; $PV = \alpha V^2$; $RT = \alpha V^2$; $\frac{T_{max}}{T_{min}} = \frac{{V_2}^2}{{V_1}^2} = 2,25$;

$T_{max} = 2,25$; $T_{min} = 450$ K;

4.2 $\frac{P_2}{P_3} = 2,3$;

4.3 $\eta = \frac{A_y}{Q_н} = \frac{\frac{1}{2}\nu R(T_{max} - T_{min}) - Q'_{31}}{2\nu R(T_{max} - T_{min})} = \frac{\frac{1}{2}\cdot 8,31(450-200) - 674}{2\cdot 8,31\cdot(450-200)} \approx 8,8$ %.

5. 5.1 $U_0 = \varepsilon = 8$ B;

5.2 $\frac{Q}{W} = 1$;

5.3 $C = \frac{\varepsilon_0 S}{d}$; $d = \frac{\varepsilon_0 S}{C}$; $F = \frac{Cu^2}{2d}$; $U = \varepsilon - IR = \varepsilon - \frac{\varepsilon R}{2R} = \frac{\varepsilon}{2}$;

$F = \frac{C\varepsilon^2}{8d} = \frac{C^2\varepsilon^2}{8\varepsilon_0 S} = \frac{(2\cdot10^{-6})^2\cdot 8^2}{8\cdot 8,85\cdot10^{-12}\cdot 2} \approx 1,8$ Н.

4 тур

1. 1.1 $V_0 = \sqrt{2gH} = \sqrt{20} \approx 4{,}5$ м/с;

   1.2 $T = 2\sqrt{\frac{2H}{g}} = 2 \cdot \sqrt{\frac{2}{10}} \approx 0{,}9$ с;

   1.3 $L = V_0 \cdot \sin\alpha T + \frac{g \sin\alpha T^2}{2} = V_0 \cdot \sin\alpha \cdot 2\sqrt{\frac{2H}{g}} + \frac{g\sin\alpha}{2}\frac{4\cdot 2H}{g} = 2\sin\alpha\left(V_0\sqrt{\frac{2H}{g}} + 2H\right);$

   $\sin\alpha = \frac{L}{2\left(V_0\sqrt{\frac{2H}{g}}+2H\right)} = \frac{L}{2(2H+2H)} = \frac{L}{8H} = \frac{1}{8};$ $\alpha \approx 7{,}2^0.$

2. 2.1 $a = \frac{F}{m_1+m_2+m_3} = \frac{12}{1+2+3} = 2$ м/с^2;

   2.2 $a_3 = \frac{2m_2F}{4m_1m_2+m_3(m_1+m_2)} = \frac{2\cdot 2\cdot 12}{4\cdot 1\cdot 2+3(1+2)} = \frac{48}{17} \approx 2{,}8$ м/с^2;

   $a_{\text{отн}} = \frac{(2m_2+m_3)F}{4m_1m_2+m_3(m_1+m_2)} = \frac{(2\cdot 2+3)\cdot 12}{4\cdot 1\cdot 2+3(1+2)} = \frac{84}{17} = 4{,}9$ м/с^2; $a_1 = a_3 + a_{\text{отн}} \approx 7{,}8$ м/с^2.

   2.3 $2T = m_3a_3;$ $T = \frac{m_3a_3}{2} = \frac{3\cdot 48}{2\cdot 17} \approx 4{,}2$ Н.

3. 3.1 $\frac{P_2}{P_1} = n = 1{,}5$

   3.2 $\Delta T = T_2 - T_1 = (n^2-1)T_1 = 1{,}25 \cdot 300 = 375\ ^0$C.

   3.3 $\frac{Q}{A} = \frac{3\nu R\Delta T}{\frac{1}{2}\nu R\Delta T} = 6.$

4. 4.1 $R = \frac{V_0^2}{\frac{q}{m}E\cdot\sin\alpha} = \frac{\left(1\cdot 10^5\right)^2}{9{,}6\cdot 10^7\cdot 10\sin 60^0} \approx 12$ м;

   4.2 т.к. $d < \frac{(V_0\cos\alpha)^2}{2a} \approx 1{,}3$ м; $ma = qE;$ $a = \frac{q}{m}E;$

   $t = \frac{V_0\cos\alpha - \sqrt{(V_0\cos\alpha)^2 - 2ad}}{a};$ $a = 9{,}6 \cdot 10^8$ м/с^2;

   $t = \frac{1\cdot 10^5\cdot\cos 60^0 - \sqrt{(1\cdot 10^5\cdot\cos 60^0)^2 - 2\cdot 9{,}6\cdot 10^8\cdot 1}}{9{,}6\cdot 10^8};$ $t \approx 2{,}7\cdot 10^{-5} \Rightarrow V_x = V_0 \cdot \sin\alpha;$

   $V_y = V_0 \cdot \cos\alpha - at;$ $|V| = \sqrt{(V_0\sin\alpha)^2 + (V_0\cos\alpha - at)^2} \approx 90$ км/с;

   $|V - V_0| \approx 10$ км/с.

   4.3 $tg\beta = \frac{V_x}{V_y};$ $\beta \approx 74^0;$ $\beta - \alpha \approx 74^0 - 60^0 = 14^0.$

5. 5.1 $I = \frac{\varepsilon}{R+3R} = \frac{12}{1+3} = 3$ А.

   5.2 $L\frac{\Delta I}{\Delta t} + IR = \varepsilon;$ $\left|\frac{\Delta I}{\Delta t}\right| = \frac{\varepsilon - IR}{L} = \frac{12-3\cdot 1}{50\cdot 10^{-3}} \approx 180$ А/с.

   5.3 $-L\frac{\Delta I}{\Delta t} = 3RI;$ $-L\frac{\Delta I}{\Delta t} = 3R\frac{\Delta q}{\Delta t};$ $-L(0 - I_1) = 3R(q - 0);$ $I_1 = \frac{\varepsilon}{R} = 12$ А;

   $LI_1 = 3Rq;$ $q = \frac{LI_1}{3R} = \frac{L\varepsilon}{3R^2};$ $q = \frac{50\cdot 10^{-3}\cdot 12}{3\cdot 1^2} = 0{,}2$ Кл.