МКТ. Газовые законы. Изопроцессы

① Дано:

$V_1 = 10^{-2} \text{ м}^3$

$p_1 = 10^6 \text{ Па}$

$V_2 = 4 \cdot 10^{-3} \text{ м}^3$

$T = const$

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$p_2 - ?$

$T = const$; $p \cdot V = const$; $\boxed{p_1 \cdot V_1 = p_2 \cdot V_2}$

объём увеличился на V_2

$p_1 \cdot V_1 = p_2 \cdot (V_1 + V_2) \Rightarrow p_2 = \dfrac{p_1 \cdot V_1}{V_1 + V_2} = \dfrac{10^6 \cdot 10^{-2}}{14 \cdot 10^{-3}} = 0,07 \cdot 10^7 =$

$= 7 \cdot 10^5 \text{ Па}$

Ответ: $p_2 = 7 \cdot 10^5 \text{ Па}$

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② Дано:

$t_1 = 27 °c$ | СИ | $T_1 = 300 k$

$V_1 = 10 л$

$p = const$

$V_2 = V_1 - 0,25 V_1 =$
$= 0,75 V_1$

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$T_2 - ?$

Решение

$p = const$; $\dfrac{V}{T} = const$; $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2} \Rightarrow T_2 = \dfrac{T_1 \cdot V_2}{V_1}$

$T_2 = \dfrac{300 \cdot 0,75 V_1}{V_1} = 225 k$

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③ Дано:

$V = const$

$T_1 = 280 k$

$p_1 = 10^5 \text{ Па}$

$F = 10 \text{ H}$

$S = 4 \text{ см}^2 =$
$= 4 \cdot 10^{-4} \text{ м}^2$

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$\Delta T - ?$

Решение.

$V = const$ $T_2 = T_1 + \Delta T \Rightarrow \Delta T = T_2 - T_1$

$\dfrac{p_1}{T_1} = \dfrac{p_2}{T_2}$ $T_2 = \dfrac{T_1 \cdot p_2}{p_1}$

$p_2 - p_1 = \dfrac{F}{S} \Rightarrow p_2 = p_1 + \dfrac{F}{S}$

$\Delta T = T_2 - T_1 = \dfrac{T_1 \cdot p_2}{p_1} - T_1 = T_1 \cdot \left(\dfrac{p_1 + \frac{F}{S}}{p_1} - 1 \right) = T_1 \cdot \left(\dfrac{p_1 + \frac{F}{S} - p_1}{p_1} \right) =$

$= T_1 \cdot \dfrac{F}{S \cdot p_1}$; $\Delta T = 280 \cdot \dfrac{10}{10^5 \cdot 4 \cdot 10^{-4}} = 0,25 \cdot 280 = 70 k$

Ответ: $\Delta T = 70 k$

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④ $\dfrac{T_4}{T_1} - ?$

1-2: $p = const$; $V \uparrow$, $T \uparrow$ $(2 p_0, V_0)$

2-3: $V = const$; $p \downarrow$, $T \downarrow$

3-4: $p = const$; $V \uparrow$, $T \uparrow$ $(p_0, 5 V_0)$

$\dfrac{p_1 \cdot V_1}{T_1} = \dfrac{p_4 \cdot V_4}{T_4} \Rightarrow \dfrac{T_4}{T_1} = \dfrac{p_4 \cdot V_4}{p_1 \cdot V_1} = \dfrac{p_0 \cdot 5 V_0}{2 p_0 \cdot V_0} = 2,5$

Ответ: $\dfrac{T_4}{T_1} = 2,5$

⑤ $p(T)-?$ 1-2: $V\uparrow$, $T\uparrow$; $p=const$
   $p(V)-?$ $2V_0 \nearrow 3V_0$; T_0

   2-3: $V=const$; $T\nearrow$; $p\nearrow$
            $3V_0$
   3-4: $V\downarrow$, $T\downarrow$, $p=const$
            $3V_0 \downarrow V_0$; $T\downarrow T_0$

   4-1: $T=const$; $pV=const$
            $V\nearrow$; $p\downarrow$; $V_0 \nearrow 2V_0$

$\dfrac{3V_0}{V_0} = 3$

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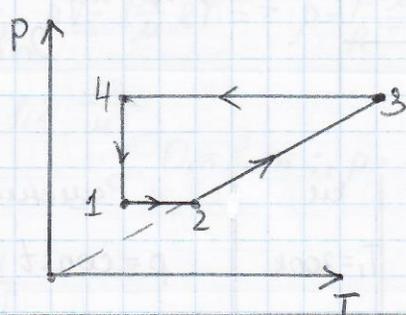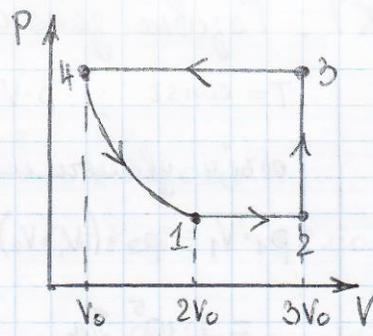
⑥ Дано: Решение
$T=300\,k$ $T=const$

$p_1=10^5\,\Pi a$ $p_1 \cdot V_1 = p_2 \cdot V_2 \Rightarrow V_2 = \dfrac{p_1 \cdot V_1}{p_2} = \dfrac{10^5 \cdot 16}{1,6 \cdot 10^6} = 1\,u^3$
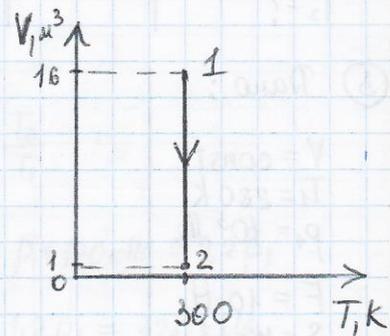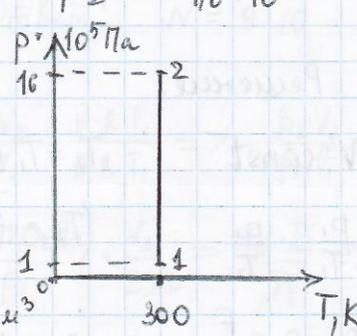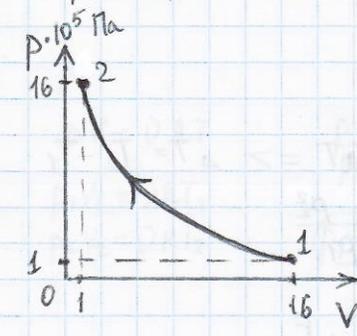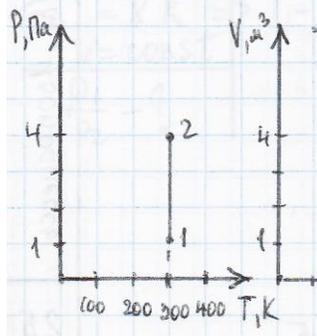
$V_1 = 16\,u^3$

$p_2 = 1,6 \cdot 10^6\,\Pi a$

$p(V)-?$ $p(T)-?$
$V(T)-?$

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⑦ a) $T=const=300k$ б) $p=const=300\,\Pi a$ в) $V=const$; $T_1=200k$
                                        $T_1 = 100\,k$ $p_1=10^5\,\Pi a$; $p_2=3 \cdot 10^5\,\Pi a$
   $p_1 = 4\,\Pi a$ $V=0,1\,u^3$
   $p_2 = 1\,\Pi a$ $V_1 = 10\,u^3$ $\dfrac{p_1}{T_1} = \dfrac{p_2}{T_2} \Rightarrow T_2 = \dfrac{T_1 p_2}{p_1} = 600\,k$
                                        $V_2 = 40\,u^3$
   $V_1 = 1\,u^3$
   $V_2 = 4\,u^3$ $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2} \Rightarrow T_2 = \dfrac{T_1 \cdot V_2}{V_1} = 400\,k$

МКТ. Изопроцессы
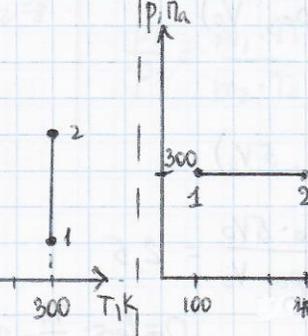
2k

⑧ 1-2: $V\nearrow$, $T\nearrow$, $p=const$
2-3: $V=const$, $T\nearrow$, $p\nearrow$
3-4: $T\downarrow$, $V\downarrow$, $p=const$
4-1: $V=const$, $T\downarrow$, $p\downarrow$
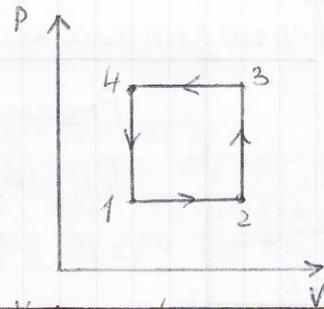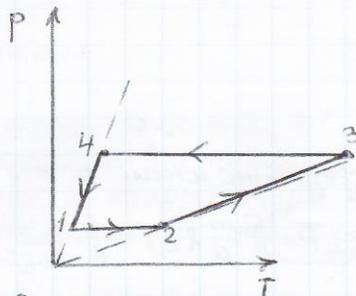
⑨ A-B: $V=const$; $p\nearrow$, $T\nearrow$
B-C: $p=const$; $V\nearrow$, $T\nearrow$
C-D: $T=const$; $p\downarrow$, $V\nearrow$
D-A: $p=const$; $V\downarrow$, $T\downarrow$

⑩
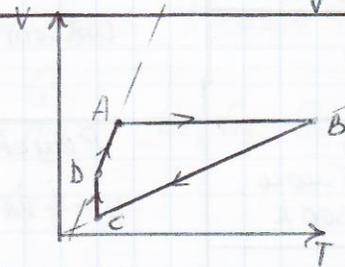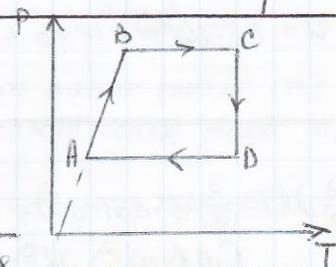
Дано:
$t_1=7°C$ | $T_1=280K$
$t_2=27°C$ | $T_2=300K$
$p=10^5 \text{Па}$
$V=50м^3$
$\mu=29\cdot10^{-3}\frac{кг}{моль}$
$\Delta m-?$

Решение

$$p\cdot V = \frac{m_1}{\mu}RT_1 \quad ; \quad p\cdot V = \frac{m_2}{\mu}RT_2$$

$$m_1 = \frac{pV\mu}{RT_1} = \frac{10^5\cdot50\cdot29\cdot10^{-3}}{8,31\cdot280} = 62 кг$$

$$m_2 = \frac{pV\mu}{RT_2} = \frac{10^5\cdot50\cdot29\cdot10^{-3}}{8,31\cdot300} = 58 кг$$

$$\Delta m = m_1 - m_2 = 62кг - 58кг = 4кг$$

Ответ: $\Delta m = 4кг$

⑪

Дано:
O_2 $V_1=3\cdot10^{-3}м^3$
N_2 $V_2=7\cdot10^{-3}м^3$
CO_2 $V_3=5\cdot10^{-3}м^3$
$p_1=10^5 \text{Па}$
$p_2=3\cdot10^5 \text{Па}$
$p_3=0,6\cdot10^5 \text{Па}$
$T=const$
$p-?$

Решение

кислород | азот | угл. газ

V_1 | V_2 | V_3
p_1 | p_2 | p_3

З-н Дальтона:
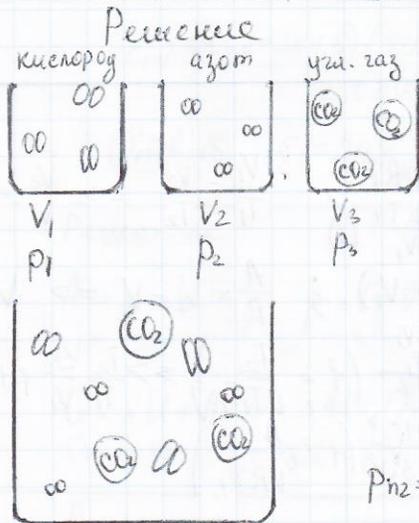
общее давление всех газов вместе взятых равно сумме парциальных давлений каждого газа в отдельности

$$p = p_{n1} + p_{n2} + p_{n3}$$

$$\frac{p_i}{V_i} = \frac{p_{n1}}{V_1+V_2+V_3} => p_{n1} = \frac{p_1}{V_1}\cdot(V_1+V_2+V_3)$$

$$p_{n2} = \frac{p_2}{V_2}\cdot(V_1+V_2+V_3) \quad ; \quad p_{n3} = \frac{p_3}{V_3}\cdot(V_1+V_2+V_3)$$

$$p = \frac{p_1}{V_1}\cdot(V_1+V_2+V_3) + \frac{p_2}{V_2}\cdot(V_1+V_2+V_3) + \frac{p_3}{V_3}\cdot(V_1+V_2+V_3)$$

$$p = (V_1+V_2+V_3)\cdot\left(\frac{p_1}{V_1} + \frac{p_2}{V_2} + \frac{p_3}{V_3}\right)$$

$$p = \left(3\cdot10^{-3}+7\cdot10^{-3}+5\cdot10^{-3}\right)\left(\frac{10^5}{3\cdot10^{-3}} + \frac{3\cdot10^5}{7\cdot10^{-3}} + \frac{0,6\cdot10^5}{5\cdot10^{-3}}\right) = 1,01\cdot10^6 \text{Па}$$

Ответ: $p = 1,01\cdot10^6 \text{Па}$