

Olimpiada Interdisciplinară Științele Pământului  
Etapa națională – Ediția a XXVI-a, Arad 2024  
Barem proba teoretică  
Chimie

Pagina 1 din 2

Barem de corectare și evaluare:

NOTĂ: Orice rezolvare corectă va fi luată în considerare și punctată ca atare.

Subiectul A: 7 puncte distribuite astfel:

<p>a)</p> $2\text{NO} + \text{O}_2 \xrightleftharpoons[v_2]{v_1} 2\text{NO}_2$ $p_1 = P \quad v_1 = k_1 \cdot [\text{NO}]_1^2 \cdot [\text{O}_2]_1$ $V_1 = V \quad v_2 = k_2 \cdot [\text{NO}_2]_1^2$ $\Rightarrow \frac{v_1}{v_2} = \frac{k_1}{k_2} \frac{[\text{NO}]_1^2 \cdot [\text{O}_2]_1}{[\text{NO}_2]_1^2}$	1 punct
$p_2 = 5P \quad [\text{NO}]_2 = 5[\text{NO}]_1$ $V_2 = \frac{V}{5} \quad [\text{O}_2]_2 = 5[\text{O}_2]_1$ $[\text{NO}_2]_2 = 5[\text{NO}_2]_1$ $\Rightarrow$ $v'_1 = k_1 \cdot (5[\text{NO}]_1)^2 \cdot (5[\text{O}_2]_1) = k_1 \cdot 5^2 \cdot [\text{NO}]_1^2 \cdot 5 \cdot [\text{O}_2]_1$ $v'_2 = k_2 \cdot (5[\text{NO}_2]_1)^2 = k_2 \cdot 5^2 \cdot [\text{NO}_2]_1^2$	1 punct
$\frac{v'_1}{v'_2} = \frac{k_1}{k_2} \frac{5^2 \cdot [\text{NO}]_1^2 \cdot 5 \cdot [\text{O}_2]_1}{5^2 \cdot [\text{NO}_2]_1^2} = 5 \cdot \frac{v_1}{v_2} \Rightarrow \frac{v'_1}{v'_2} = 5 \cdot \frac{v_1}{v_2}$	1 punct
<p>b) <math>2\text{NO} + \text{O}_2 \rightleftharpoons 2\text{NO}_2</math>  <math>[\text{NO}] = 0,7 \text{ (mol/L)}, [\text{O}_2] = 0,7 \text{ (mol/L)}</math> și <math>[\text{NO}_2] = 2,1 \text{ (mol/L)}</math>.  <math>K_c = \frac{k_1}{k_2} = \frac{[\text{NO}_2]^2}{[\text{NO}]^2 \cdot [\text{O}_2]} = 12,85 \text{ L/mol}</math></p>	2 punct
<p>c) prin scăderea presiunii echilibrul se deplasează spre stânga și <math>[\text{NO}_2]</math> scade</p>	2 puncte

Subiectul B: 10 puncte distribuite astfel

<p>a) <math>pV = \nu RT</math>; <math>p \bar{M} = \rho RT \Rightarrow \bar{M} = \frac{\rho \cdot R \cdot T}{p} = 30,5 \text{ g/mol}</math></p>	1 puncte
$\nu_{\text{H}_2} : \nu_{\text{N}_2} : \nu_{\text{N}_2\text{O}_x} = a : a : 2a$	
$\bar{M} = \frac{a}{4a} \cdot M_{\text{H}_2} + \frac{a}{4a} \cdot M_{\text{N}_2} + \frac{2a}{4a} \cdot M_{\text{N}_2\text{O}_x} \Rightarrow$	0,5 puncte
$M_{\text{N}_2\text{O}_x} = 46 \text{ g/mol} \Rightarrow$ oxidul azotului este: $\text{NO}_2$	1 puncte
<p>b)</p> $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ $x \text{ mol} \quad 0,2 \text{ mol}$ $\text{N}_2 \rightarrow \text{N}_2$ $\text{NO}_2 \rightarrow \text{NO}_2$	
$V_{\text{aer}} = 22,4 \text{ L} \Rightarrow V_{\text{O}_2} = \frac{20}{100} \cdot 22,4 = 4,48 \text{ L} \Rightarrow \nu_{\text{O}_2} = 0,2 \text{ moli consumați la arderea hidrogenului}$	0,5 puncte
$\nu_{\text{N}_2} = 0,8 \text{ moli (din aer)}$	0,5 puncte
După răcire amestecul gazos este format din:	0,5 puncte
$a \text{ moli N}_2 \text{ (amestec inițial)} + 0,8 \text{ moli N}_2 \text{ (din aer)} + 2a \text{ moli NO}_2$	
$0,4 \text{ moli H}_2 \text{ (din reacția de ardere)} \Rightarrow 0,4 \text{ moli N}_2$ $0,8 \text{ moli NO}_2$	0,5 puncte
$\vartheta_{\text{total}} = \vartheta_{\text{N}_2 \text{ (amestec inițial)}} + \vartheta_{\text{N}_2 \text{ (din aer)}} + \vartheta_{\text{NO}_2} = 0,4 + 0,8 + 0,8 = 2 \text{ moli}$	0,5 puncte



Olimpiada Interdisciplinară Științele Pământului  
Etapa națională – Ediția a XXVI-a, Arad 2024  
Barem proba teoretică

Pagina 2 din 2

Chimie

$X_{\text{NO}_2} = \frac{0,4 + 0,8}{2} = 0,6$	0,5 puncte
c) $\begin{array}{cccccc} 2\text{mol} & 2\text{mol} & 1\text{mol} & 1\text{mol} & 1\text{mol} & \\ 2\text{NO}_2 + 2\text{KOH} & \rightarrow & \text{KNO}_3 + & \text{KNO}_2 + & \text{H}_2\text{O} & \\ 0,8\text{mol} & 0,8\text{mol} & 0,4\text{mol} & 0,4\text{mol} & 0,4\text{mol} & \end{array}$	0,5 puncte
$m(\text{KOH}) = 0,8 \cdot 56 = 44,8\text{ g}$ $m(\text{KNO}_3) = 0,4 \cdot 101 = 40,4\text{ g}$ $m(\text{H}_2\text{O}) = 0,4 \cdot 18 = 7,2\text{ g}$ $m(\text{KNO}_2) = 0,4 \cdot 85 = 34\text{ g}$	0,5 x 4 = 2 puncte
$C_{\text{KNO}_3} = 20,2\%$ $m_{\text{d KNO}_3} = 40,4\text{ g} \Rightarrow m_{\text{s}} = 200\text{g sol}$	0,5 puncte
$m_{\text{apă sol KOH}} = m_{\text{sfinală}} - m_{\text{KNO}_3} - m_{\text{KNO}_2} - m_{\text{H}_2\text{O}} = 118,4\text{ g}$	0,5 puncte
$m_{\text{d}} = 44,8\text{ g KOH}$ $m_{\text{s KOH}} = m_{\text{d}} + m_{\text{apă}} = 44,8 + 118,4 = 163,2\text{g sol}$	0,5 puncte
$C_{\text{KNO}_3} = 27,45\%$	0,5 puncte

Subiectul C: 8 puncte distribuite astfel:

$\begin{array}{l} (1) 4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g}) \\ (2) 2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) \\ (3) 3\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{HNO}_3(\text{l}) + \text{NO}(\text{g}) \end{array}$	$\begin{array}{l} \times 1 \\ \times 2 \\ \times 4/3 \end{array}$	2 puncte
$\begin{array}{l} \Delta_f H^0_{(\text{NH}_3(\text{g}))} = -46,0\text{ kJ/mol} \\ \Delta_f H^0_{(\text{H}_2\text{O}(\text{g}))} = -241,6\text{ kJ/mol} \\ \Delta_f H^0_{(\text{NO}_2(\text{g}))} = +33,9\text{ kJ/mol} \end{array}$	$\begin{array}{l} \Delta_f H^0_{(\text{NO}(\text{g}))} = +90,3\text{ kJ/mol} \\ \Delta_f H^0_{(\text{H}_2\text{O}(\text{l}))} = -285,5\text{ kJ/mol} \\ \Delta_f H^0_{(\text{HNO}_3(\text{l}))} = -173,0\text{ kJ/mol} \end{array}$	
<p>După înmulțire ecuațiile devin:</p> $\begin{array}{l} (1) 4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g}) \\ (2) 4\text{NO}(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) \\ (3) 4\text{NO}_2(\text{g}) + 4/3\text{H}_2\text{O}(\text{l}) \rightarrow 8/3\text{HNO}_3(\text{l}) + 4/3\text{NO}(\text{g}) \end{array}$ $4\text{NH}_3(\text{g}) + 7\text{O}_2(\text{g}) + 4/3\text{H}_2\text{O}(\text{l}) \rightarrow 8/3\text{HNO}_3(\text{l}) + 6\text{H}_2\text{O}(\text{g}) + 4/3\text{NO}(\text{g})$	<p>se adună</p>	2 puncte
<p>Sau</p> $12\text{NH}_3(\text{g}) + 21\text{O}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l}) \rightarrow 8\text{HNO}_3(\text{l}) + 18\text{H}_2\text{O}(\text{g}) + 4\text{NO}(\text{g})$		
$\Delta_f H_r^0 = 8 \cdot \Delta_f H^0_{(\text{HNO}_3(\text{l}))} + 18 \cdot \Delta_f H^0_{(\text{H}_2\text{O}(\text{g}))} + 4 \cdot \Delta_f H^0_{(\text{NO}(\text{g}))} -$ $\left\{ 12 \cdot \Delta_f H^0_{(\text{NH}_3(\text{g}))} + 21 \cdot \Delta_f H^0_{(\text{O}_2(\text{g}))} + 4 \cdot \Delta_f H^0_{(\text{H}_2\text{O}(\text{l}))} \right\} =$ $= 8 \cdot (-173,0) + 18 \cdot (-241,6) + 4 \cdot (+90,3) - [12 \cdot (-46,0) + 21 \cdot 0 + 4 \cdot (-285,5)]$ $= -3677,6\text{ kJ}$		2 puncte
$\begin{array}{l} 12 \cdot 17\text{ g NH}_3 \dots\dots\dots (-3677,6\text{ kJ}) \\ 100\text{ g NH}_3 \dots\dots\dots \mathbf{X\text{ (kJ)}} \\ \mathbf{X = -1802,745\text{ kJ}} \end{array}$		2 puncte