

## 5. KONCENTRACIJA OTOPINA

Fizičke veličine koncentracije

Fizička veličina	Simbol	Definicija	Jedinica*
množinska koncentracija otopljene tvari B;	$c_B$ , [B]	$c_B = n_B/V$	$\text{mol m}^{-3}$
masena koncentracija otopljene tvari B;	$\gamma_B$	$\gamma_B = m_B/V$	$\text{kg m}^{-3}$
molalitet otopljene tvari B u otapalu A;	$b_B$	$b_B = n_B/m_A$	$\text{mol kg}^{-1}$
množinski udio tvari B;	$x_B$ ,	$x_B = n_B/\sum n_i$	1
maseni udio tvari B;	$w_B$	$w_B = m_B/\sum m_i$	1
volumni udio tvari B;	$\varphi_B$	$\varphi_B = V_B/\sum V_i$	1

\* Osim osnovnih, dopuštena je upotreba i svih decimalnih SI-jedinica, kao, na primjer,  $\text{mol dm}^{-3}$ ,  $\text{mmol dm}^{-3}$ ,  $\text{mmol cm}^{-3}$  itd.

### 5.1. Vidi STEHIOMETRIJA

Masena koncentracija otopljene tvari B,  $\gamma_B$ , jest omjer mase otopljene tvari volumena otopine,  $\gamma_B = m_B/V$

Masa natrijeva sulfata koju treba odvagati za pripremu  $250 \text{ cm}^3$  otopine je:

$$\begin{aligned} m_1(\text{Na}_2\text{SO}_4) &= \gamma_B \times V = 20 \text{ g dm}^{-3} \times 0,250 \text{ dm}^3 = \mathbf{5 \text{ g}} \\ m_2(\text{Na}_2\text{SO}_4) &= \gamma_B \times V = 40 \text{ g dm}^{-3} \times 0,250 \text{ dm}^3 = \mathbf{10 \text{ g}} \\ m_3(\text{Na}_2\text{SO}_4) &= \gamma_B \times V = 60 \text{ g dm}^{-3} \times 0,250 \text{ dm}^3 = \mathbf{15 \text{ g}} \\ m_4(\text{Na}_2\text{SO}_4) &= \gamma_B \times V = 100 \text{ g dm}^{-3} \times 0,250 \text{ dm}^3 = \mathbf{25 \text{ g}} \\ m_5(\text{Na}_2\text{SO}_4) &= \gamma_B \times V = 150 \text{ g dm}^{-3} \times 0,250 \text{ dm}^3 = \mathbf{37,5 \text{ g}} \end{aligned}$$

Odvagani natrijev sulfat treba otopiti u odmjernoj tikvici u oko  $200 \text{ cm}^3$  vode i nadopuniti do  $250 \text{ cm}^3$ .

### 5.2. Vidi STEHIOMETRIJA

Maseni udio otopljene tvari u otopini,  $w_B$ , jest omjer mase otopljene tvari i mase otopine,  $w_B = m_B/\sum m_i$

$$\begin{aligned} m_1(\text{Na}_2\text{S}_2\text{O}_3) &= w(\text{Na}_2\text{S}_2\text{O}_3) \times m(\text{otopine}) = 0,05 \times 400 \text{ g} = \mathbf{20 \text{ g}} \\ m_2(\text{Na}_2\text{S}_2\text{O}_3) &= w(\text{Na}_2\text{S}_2\text{O}_3) \times m(\text{otopine}) = 0,15 \times 400 \text{ g} = \mathbf{60 \text{ g}} \\ m_3(\text{Na}_2\text{S}_2\text{O}_3) &= w(\text{Na}_2\text{S}_2\text{O}_3) \times m(\text{otopine}) = 0,25 \times 400 \text{ g} = \mathbf{100 \text{ g}} \end{aligned}$$

### 5.3. Vidi STEHIOMETRIJA

Gustoća neke tvari (ili otopine) je omjer njezine mase i volumena,  $\rho = m/V$ .

Maseni udio neke tvari u otopini je omjer mase tvari i mase otopine,  $w_B = m_B / m_{\text{otop}}$

Mase natrijeva hidroksida koje treba odvagati za pripremu zadanih količina otopina jesu:

$$\begin{aligned} \text{a)} \quad m(\text{NaOH}) &= w \times \rho \times V = 0,05 \times 1,0452 \text{ g cm}^{-3} \times 500 \text{ cm}^3 = \mathbf{26,13 \text{ g}} \\ \text{b)} \quad m(\text{NaOH}) &= w \times \rho \times V = 0,10 \times 1,0918 \text{ g cm}^{-3} \times 800 \text{ cm}^3 = \mathbf{87,34 \text{ g}} \\ \text{c)} \quad m(\text{NaOH}) &= w \times \rho \times V = 0,20 \times 1,1884 \text{ g cm}^{-3} \times 150 \text{ cm}^3 = \mathbf{35,65 \text{ g}} \\ \text{d)} \quad m(\text{NaOH}) &= w \times \rho \times V = 0,40 \times 1,3991 \text{ g cm}^{-3} \times 300 \text{ cm}^3 = \mathbf{167,9 \text{ g}} \end{aligned}$$

#### 5.4. Vidi STEHIOMETRIJA

Množinska koncentracija otopljene tvari,  $c_B$ , je omjer množine tvari i volumena otopine,  $c_B = n_B/V$

Množina tvari iskazuje se jedinicom mol.

Mol (simbol  $n$ ) je ona množina (engl. *amount* — količina) tvari definirane kemijske formule, koja sadržava isto toliko jedinki, koliko ima atoma u točno 0,012 kg izotopa ugljika  $^{12}\text{C}$ .

Kada odvagamo onoliko grama neke tvari definirane kemijske formule, kolika je njezina relativna molekulska masa, odvagali smo upravo 1 mol te tvari, odnosno  $6,022 \times 10^{23}$  jedinki navedene formule. Dakle molarna masa,  $M$ , definirana je izrazom

$$M = M_r \text{ g mol}^{-1}, \text{ odnosno } M = \frac{m}{n}$$

gdje je:  $m$  = masa tvari,  $n$  = množina tvari.

Relativna molekulska masa izračuna se tako da se zbroje realativne atomske mase svih atoma u molekuli ili formulskoj jedinki spoja.

Za pripremu 1 dm<sup>3</sup> zadanih otopina koncentracije 1 mol dm<sup>-3</sup> potrebno je odvagati 1 mol nabrojanih soli, otopiti u odmjernoj tikvici u manjem volumenu vode i nadopuniti do 1 dm<sup>3</sup>.

$m(\text{K}_2\text{CO}_3) = 138,21 \text{ g}$   
 $m(\text{CuSO}_4 \cdot 5 \text{ H}_2\text{O}) = 249,68 \text{ g},$   
 $m(\text{Bi}(\text{NO}_3)_3 \cdot 5 \text{ H}_2\text{O}) = 485,07 \text{ g},$   
 $m(\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}) = 474,39 \text{ g}.$

#### 5.5. Vidi STEHIOMETRIJA

Kao u primjeru 5.4.

$m(\text{CaCl}_2 \cdot 6 \text{ H}_2\text{O}) = 219,08 \text{ g},$   
 $m(\text{K}_2\text{Cr}_2\text{O}_7) = 294,19 \text{ g},$   
 $m(\text{KCr}(\text{SO}_4)_2 \cdot 12 \text{ H}_2\text{O}) = 499,42 \text{ g},$   
 $m(\text{NaClO}_3) = 106,44 \text{ g}.$

## 5.6. Vidi STEHIOMETRIJA

Molalitet otopljene tvari,  $b_B$ , izražava se omjerom množine otopljene tvari,  $n_B$ , i mase otapala,  $m_A$ .

$$b_B = n_B / m_A$$

Kako je  $n_B = m_B / M_B$ , proizlazi

$$m_B = b_B \times M_B \times m_A$$

$$m(\text{otopina}) = m_B + m_A$$

Otopina čiji je molalitet  $b = \text{mol kg}^{-1}$  priprema se tako da se 1 mol zadane tvari otopi u 1 kg otapala. Primjerice, za otopinu natrijeva karbonata, molaliteta  $b = 1 \text{ mol kg}^{-1}$ , potrebno je otopiti 106 g natrijeva karbonata u 1000 g vode. Masa dobivene otopine jednaka je 1106 g. Masa soli potrebna za pripremu 100 g otopine natrijeva karbonata zadanog molaliteta je:

$$m(\text{Na}_2\text{CO}_3) = 100 \text{ g} \times \frac{m_B}{m(\text{otopina})} = 100 \text{ g} \times \frac{m_B}{m_B + m_A} = 100 \text{ g} \times \frac{106 \text{ g}}{106 \text{ g} + 1000 \text{ g}} = 9,58 \text{ g}$$

Sastav jednomolalne otopine

Mase krute tvari (soli) i vode potrebne za pripremu 100 g jednomolalnih otopina

otopljena tvar B	$m_B / \text{g}$	$m_A / \text{g}$	$m_{\text{otopina}} / \text{g}$	$m_{\text{sol}} / \text{g}$	$m_{\text{voda}} / \text{g}$
$\text{Na}_2\text{CO}_3$	106	1000	1106	<b>9,58</b>	<b>90,42</b>
$\text{Na}_2\text{S}$	78	1000	1078	<b>7,23</b>	<b>92,77</b>
$\text{CaCl}_2 \cdot 6 \text{H}_2\text{O}$	219	1000	1219	<b>17,97</b>	<b>82,03</b>
$\text{KH}_2\text{PO}_4$	136	1000	1136	<b>11,97</b>	<b>88,03</b>

## 5.7. Vidi STEHIOMETRIJA

Množinski udio neke tvari u smjesi ili otopini jednak je omjeru množine te tvari prema ukupnoj množini svih tvari.

$$x_A = \frac{n_A}{n_A + n_B}$$

Mase zadanih tvari (prema uvjetima zadatka)	Mase bezvodne soli i vode potrebne za pripremu 100 g otopina, $x(\text{H}_2\text{O}) = 0,99$
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sol	$\frac{0,01 \text{ mol} \times M(\text{sol})}{\text{g}}$	$\frac{0,99 \text{ mol} \times M(\text{H}_2\text{O})}{\text{g}}$	$\frac{m(\text{otopina})}{\text{g}}$	$m_{\text{tvar}} / \text{g}$	$m_{\text{voda}} / \text{g}$
$\text{NH}_4\text{JO}_3$	1,929	17,826	19,755	<b>9,765</b>	<b>90,235</b>
$\text{KNaCO}_3$	1,222	17,826	19,048	<b>6,415</b>	<b>93,585</b>
$\text{NaNH}_4\text{HPO}_4$	1,371	17,826	19,197	<b>7,142</b>	<b>92,858</b>
$\text{CdSO}_4$	2,085	17,826	19,911	<b>10,472</b>	<b>89,528</b>

### 5.8. Vidi STEHIOMETRIJA

Množinska koncentracija otopine je omjer množine otopljene tvari i volumena otopine:  $c_B = n_B / V$

Masena koncentracija otopljene tvari je omjer mase otopljene tvari i volumena otopine:  $\gamma_B = m_B / V$

Ako znamo masu otopljene soli, možemo izračunati i njezinu množinu jer je  $n_B = m_B / M_B$

Za množine soli otopljenih u  $\text{dm}^3$  otopine dobivamo

$$n_B = \frac{m_B}{M_B}, \text{ pa je množinska koncentracija otopine } c_B = \frac{n_B}{V_{\text{otopina}}} = \frac{m_B}{M_B \times V_{\text{otopina}}}$$

Oдавде proizlazi:

tvar B	$m_B / \text{g}$	$M_B / \text{g mol}^{-1}$	$n_B / \text{mol}$	$V_{\text{otopina}} / \text{dm}^3$	$c_B / \text{mol dm}^{-3}$
$\text{Al}_2(\text{SO}_4)_3 \cdot 18 \text{H}_2\text{O}$	100	666,4	0,1501	1	<b>0,1501</b>
$\text{C}_2\text{H}_5\text{OH}$	100	46,07	2,171	1	<b>2,171</b>
$\text{AgNO}_3$	100	169,87	0,5917	1	<b>0,5886</b>
$\text{FeCl}_3$	100	162,2	0,6165	1	<b>0,6165</b>

### 5.9. Vidi STEHIOMETRIJA

Problem rješavamo jednakim postupkom kao u zadatku 5.8.

tvar B	$m_B / \text{g}$	$M_B / \text{g mol}^{-1}$	$n_B / \text{mol}$	$V_{\text{otopina}} / \text{dm}^3$	$c_B / \text{mol dm}^{-3}$
$\text{KH}_2\text{PO}_4$	10	136,09	0,0735	1	<b>0,0735</b>
$\text{H}_3\text{PO}_4$	10	98,00	0,1020	1	<b>0,1020</b>
$\text{H}_2(\text{HPO}_3)$	10	82,00	0,1220	1	<b>0,1220</b>
$\text{H}(\text{H}_2\text{PO}_2)$	10	66,0	0,1515	1	<b>0,1515</b>

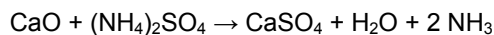
### 5.10. Vidi STEHIOMETRIJA

$$c_B = n_B / V \quad n_B = m_B / M_B \quad n_B = c_B \times V \quad m_B = n_B \times M_B \quad m_B = c_B \times V \times M_B$$

tvar B	$V_{\text{otopina}} / \text{dm}^3$	$c_B / \text{mol dm}^{-3}$	$M_B / \text{g mol}^{-1}$	$m_B / \text{g}$
KMnO <sub>4</sub>	1	0,1	158,04	<b>15,804</b>
K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>	1	0,1	294,19	<b>29,419</b>
KIO <sub>3</sub>	1	0,1	214,00	<b>21,400</b>
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub>	1	0,1	158,18	<b>15,818</b>
Na <sub>2</sub> C <sub>2</sub> O <sub>4</sub>	1	0,1	134,00	<b>13,400</b>
FeSO <sub>4</sub> · 7 H <sub>2</sub> O	1	0,1	278,05	<b>27,805</b>

### 5.11. Vidi STEHIOMETRIJA

Napišimo najprije jedndžbu reakcije



Masu amonijaka koja se može pripremiti iz 5 kmol amonijeva sulfata izračunamo iz omjera:

$$n(\text{NH}_3) : n((\text{NH}_4)_2\text{SO}_4) = 2 : 1$$

Odavde proizlazi

$$n(\text{NH}_3) = 2 n((\text{NH}_4)_2\text{SO}_4)$$

Masa amonijaka koja se može pripremiti iz navedene množine amonijeva sulfata je

$$m(\text{NH}_3) = n(\text{NH}_3) \times M(\text{NH}_3) = 2 n((\text{NH}_4)_2\text{SO}_4) \times M(\text{NH}_3)$$

Maseni udio amonijaka u koncentriranoj otopini je 15 %. Maseni udio sastojaka smjese definiran je izrazom:

$$w(\text{NH}_3) = m(\text{NH}_3) / m(\text{otopina})$$

Odavde proizlazi da je masa 15 postotne otopine manijaka koja se može pripremiti izračunanom masom amonijaka je:

$$m(\text{otopina}) = m(\text{NH}_3) / w(\text{NH}_3)$$

Gustoća otopine definirana je omjerom:

$$\rho = m / V$$

pa je volumen otopine

$$V(15 \% \text{ otop. NH}_3) = m(\text{otopina}) / \rho(\text{otopina})$$

$$= m(\text{NH}_3) / w(\text{NH}_3) \times \rho(\text{otopina})$$

$$= 2 n((\text{NH}_4)_2\text{SO}_4) \times M(\text{NH}_3) / w(\text{NH}_3) \times \rho(\text{otopina})$$

$$= 2 \times 5 \text{ kmol} \times 17 \text{ kg kmol}^{-1} / 0,15 \times 0,942 \text{ kg dm}^{-3}$$

$$= \mathbf{1203 \text{ dm}^3}.$$

### 5.12. Vidi STEHIOMETRIJA

$$\gamma(\text{NaCl}) = 50 \text{ mg dm}^{-3}$$

$$c = n / V$$

$$n = m/M$$

$$c(\text{NaCl}) = \frac{m(\text{NaCl})}{M(\text{NaCl}) \times V} = \frac{50 \times 10^{-3} \text{ g}}{58,44 \text{ g mol}^{-1} \times 1 \text{ dm}^3} = 8,555 \times 10^{-4} \text{ mol dm}^{-3}$$

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$$N_A = \text{Avogadrova konstanta} = \text{broj jedinki} / \text{množina tih jedinki} = N/n = 6,022 \times 10^{23} \text{ mol}^{-1}$$

Odavde proizlazi da je broj jedinki,  $N$ , (atoma, iona, ili bilo kojih definiranih jedinki) jednak umnošku množine jedinki i Avogadrve konstante.

$$N = n \times N_A$$

odnosno

$$\begin{aligned} N(\text{Na}^+) &= N(\text{Cl}^-) = n(\text{NaCl}) \times N_A \\ &= \frac{50 \times 10^{-3} \text{ g}}{58,44 \text{ g mol}^{-1}} \times 6,022 \times 10^{23} \text{ mol}^{-1} \\ &= 5,15 \times 10^{20}. \end{aligned}$$

### 5.13. Vidi STEHIOMETRIJA

$$\rho = m/V$$

$$m = \rho \times V$$

$$m(\text{H}_3\text{PO}_4) = w(\text{H}_3\text{PO}_4) \times \rho \times V$$

$$n(\text{H}_3\text{PO}_4) = m(\text{H}_3\text{PO}_4) / M(\text{H}_3\text{PO}_4)$$

$$\begin{aligned} c(\text{H}_3\text{PO}_4) &= \frac{n(\text{H}_3\text{PO}_4)}{V} = \frac{m(\text{H}_3\text{PO}_4)}{M(\text{H}_3\text{PO}_4) \times V} = \frac{w(\text{H}_3\text{PO}_4) \times \rho \times V}{M(\text{H}_3\text{PO}_4) \times V} \\ &= \frac{0,20 \times 1114,3 \text{ g dm}^{-3} \times 1 \text{ dm}^3}{98,00 \text{ g mol}^{-1} \times 1 \text{ dm}^3} = 2,274 \text{ mol dm}^{-3} \end{aligned}$$

#### 5.14. Vidi STEHIOMETRIJA

$$n = c \times V$$

$$m = n \times M$$

$$V = m / \rho$$

Moramo odrediti volumen 96 postotne  $\text{H}_2\text{SO}_4$  koji sadrži jednaku množinu (ili masu) sumporne kiseline kao i  $1 \text{ dm}^3$  otopine sumporne kiseline  $c(\text{H}_2\text{SO}_4) = 0,5 \text{ mol dm}^{-3}$ . Polazimo od naprijed definiranih odnosa:

$$\begin{aligned} V(96 \% \text{H}_2\text{SO}_4) &= \frac{m(\text{H}_2\text{SO}_4)}{w(\text{H}_2\text{SO}_4) \times \rho(\text{konc. H}_2\text{SO}_4)} = \frac{n(\text{H}_2\text{SO}_4) \times M(\text{H}_2\text{SO}_4)}{w(\text{H}_2\text{SO}_4) \times \rho(\text{konc. H}_2\text{SO}_4)} \\ &= \frac{c(\text{H}_2\text{SO}_4) \times V(\text{otop. H}_2\text{SO}_4) \times M(\text{H}_2\text{SO}_4)}{w(\text{H}_2\text{SO}_4) \times \rho(\text{konc. H}_2\text{SO}_4)} \\ &= \frac{0,5 \text{ mol dm}^{-3} \times 1 \text{ dm}^3 \times 98,08 \text{ g mol}^{-1}}{0,96 \times 1,84 \text{ g cm}^{-3}} \\ &= \mathbf{27,76 \text{ cm}^{-3}}. \end{aligned}$$

#### 5.15. Vidi STEHIOMETRIJA

Problem rješavamo jednakim postupkom kao u zadatku. 5.14.

$$\begin{aligned} V(36 \% \text{HCl}) &= \frac{m(\text{HCl})}{w(\text{HCl}) \times \rho(\text{konc. HCl})} = \frac{n(\text{HCl}) \times M(\text{HCl})}{w(\text{HCl}) \times \rho(\text{konc. HCl})} \\ &= \frac{c(\text{HCl}) \times V(\text{otop. HCl}) \times M(\text{HCl})}{w(\text{HCl}) \times \rho(\text{konc. HCl})} \\ &= \frac{2 \text{ mol dm}^{-3} \times 1 \text{ dm}^3 \times 36,5 \text{ g mol}^{-1}}{0,36 \times 1,18 \text{ g cm}^{-3}} \\ &\approx \mathbf{172 \text{ cm}^{-3}}. \end{aligned}$$

#### 5.16. Vidi STEHIOMETRIJA

Problem rješavamo jednakim postupkom kao u zadatku. 5.14.

$$\begin{aligned} V(67 \% \text{HNO}_3) &= \frac{m(\text{HNO}_3)}{w(\text{HNO}_3) \times \rho(\text{konc. HNO}_3)} = \frac{n(\text{HNO}_3) \times M(\text{HNO}_3)}{w(\text{HNO}_3) \times \rho(\text{konc. HNO}_3)} \\ &= \frac{c(\text{HNO}_3) \times V(\text{otop. HNO}_3) \times M(\text{HNO}_3)}{w(\text{HNO}_3) \times \rho(\text{konc. HNO}_3)} \\ &= \frac{4 \text{ mol dm}^{-3} \times 1 \text{ dm}^3 \times 63,01 \text{ g mol}^{-1}}{0,67 \times 1,4 \text{ g cm}^{-3}} \\ &\approx \mathbf{268,7 \text{ cm}^{-3}}. \end{aligned}$$

### 5.17. Vidi STEHIOMETRIJA

Da bismo riješili problem moramo izračunati množinu sumporne kiseline u 1 dm<sup>3</sup> kiseline.

$$n = m / M$$

$$m = \rho \times V$$

$$n(\text{H}_2\text{SO}_4) = \frac{m(\text{H}_2\text{SO}_4)}{M(\text{H}_2\text{SO}_4)} = \frac{w(\text{H}_2\text{SO}_4) \times \rho(\text{H}_2\text{SO}_4) \times V(\text{otop. H}_2\text{SO}_4)}{M(\text{H}_2\text{SO}_4)}$$

$$= \frac{0,96 \times 1,84 \text{ g cm}^{-3} \times 1000 \text{ cm}^3}{98,08 \text{ g mol}^{-1}}$$

$$= 18,0 \text{ mol}$$

$$c(\text{H}_2\text{SO}_4) = \frac{n(\text{H}_2\text{SO}_4)}{V} = \frac{18,0 \text{ mol}}{1 \text{ dm}^3} = \mathbf{18 \text{ mol dm}^{-3}}$$

### 5.18. Vidi STEHIOMETRIJA

Problem rješavamo istim postupkom kao u primjeru 5.17.

$$n(\text{H}_2\text{O}) = \frac{m(\text{H}_2\text{O})}{M(\text{H}_2\text{O})} = \frac{\rho(\text{H}_2\text{O}) \times V(\text{H}_2\text{O})}{M(\text{H}_2\text{O})} = \frac{1 \text{ g cm}^{-3} \times 1000 \text{ cm}^3}{18 \text{ g mol}^{-1}} = \mathbf{55,55 \text{ mol}}$$

### 5.19. Vidi STEHIOMETRIJA

Problem rješavamo istim postupkom kao u primjeru 5.17

$$n(\text{C}_2\text{H}_5\text{OH}) = \frac{m(\text{C}_2\text{H}_5\text{OH})}{M(\text{C}_2\text{H}_5\text{OH})} = \frac{w(\text{C}_2\text{H}_5\text{OH}) \times \rho(\text{C}_2\text{H}_5\text{OH}) \times V(\text{otop. C}_2\text{H}_5\text{OH})}{M(\text{C}_2\text{H}_5\text{OH})}$$

$$= \frac{0,342 \times 0,95 \text{ g cm}^{-3} \times 1000 \text{ cm}^3}{46,07 \text{ g mol}^{-1}} = 7,05 \text{ mol}$$

$$c(\text{C}_2\text{H}_5\text{OH}) = \frac{n(\text{C}_2\text{H}_5\text{OH})}{V} = \frac{7,05 \text{ mol}}{1 \text{ dm}^3} = \mathbf{7,05 \text{ mol dm}^{-3}}$$

### 5.20. Vidi STEHIOMETRIJA

Kiselina i lužina reagiraju u molarnom omjeru 1 : 1, pa vrijedi:

$$V(\text{kiselina}) \times c(\text{kiselina}) = V(\text{NaOH}) \times c(\text{NaOH})$$

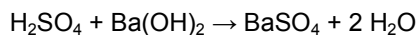
Oдавде proizlazi:

$$c(\text{kiselina}) = \frac{V(\text{NaOH}) \times c(\text{NaOH})}{V(\text{kiselina})} = \frac{32,4 \text{ cm}^3 \times 0,1 \text{ mol dm}^{-3}}{20,0 \text{ cm}^3} = \mathbf{0,162 \text{ mol dm}^{-3}}$$



### 5.21. Vidi STEHIOMETRIJA

Napišimo jednađbu reakcije



Iz jednađbe reakcije vidimo da sumporna kiselina i barijev hidroksid reagiraju u molarnom omjeru 1 : 1, odnosno 1 mol sumporne kiseline neutralizira 1 mol barijeva hidroksida. Treba izračunati množinu barijeva hidroksida koja je ujedno jednaka množini sumporne kiseline. Kako je:

$$n(\text{Ba}(\text{OH})_2) = \frac{m(\text{Ba}(\text{OH})_2)}{M(\text{Ba}(\text{OH})_2)}$$

$$n(\text{H}_2\text{SO}_4) = V(\text{H}_2\text{SO}_4) \times c(\text{H}_2\text{SO}_4)$$

$$n(\text{H}_2\text{SO}_4) = n(\text{Ba}(\text{OH})_2)$$

proizlazi

$$V(\text{otop. H}_2\text{SO}_4) \times c(\text{otop. H}_2\text{SO}_4) = \frac{m(\text{Ba}(\text{OH})_2)}{M(\text{Ba}(\text{OH})_2)}$$

Odavde se dobiva

$$V(\text{otop. H}_2\text{SO}_4) = \frac{m(\text{Ba}(\text{OH})_2)}{M(\text{Ba}(\text{OH})_2) \times c(\text{otop. H}_2\text{SO}_4)} = \frac{0,2 \text{ g}}{171,3 \text{ g mol}^{-1} \times 0,25 \text{ mol dm}^{-3}} = \mathbf{4,67 \text{ cm}^3}$$

### 5.22. Vidi STEHIOMETRIJA

Treba izračunati množinu tvari i podijeliti s volumenom otopine pa ćemo dobiti koncentraciju otopine.

$$n(\text{tvar}) = m(\text{tvar}) / M(\text{tvar}) = 10 \text{ g} / 46 \text{ g mol}^{-1} = 0,217 \text{ mol}$$

$$V(\text{otopina}) = m(\text{otopina}) / \rho(\text{otopina}) = 110 \text{ g} / 0,985 \text{ g cm}^{-3} = 111,7 \text{ cm}^3$$

Odavde proizlazi:

$$c(\text{tvar, otopina}) = \frac{n(\text{tvar})}{V(\text{otopina})} = \frac{0,217 \text{ mol}}{0,1117 \text{ dm}^3} = \mathbf{1,94 \text{ mol dm}^{-3}}$$

### 5.23. Vidi STEHIOMETRIJA

Najprije treba izračunati množine kiselina u zadanim volumenima.

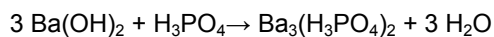
$$n = V \times c$$

$$n(\text{H}_3\text{PO}_4) = 0,1 \text{ dm}^3 \times \frac{1}{3} \text{ mol dm}^{-3} = \frac{1}{30} \text{ mol}$$

$$n(\text{H}_2\text{SO}_4) = 0,2 \text{ dm}^3 \times 0,5 \text{ mol dm}^{-3} = 0,1 \text{ mol}$$

$$n(\text{HNO}_3) = 0,3 \text{ dm}^3 \times 1 \text{ mol dm}^{-3} = 0,3 \text{ mol}$$

Napišimo jednadžbe reakcija

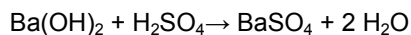


$$n(\text{Ba(OH)}_2) : n(\text{H}_3\text{PO}_4) = 3 : 1$$

$$n(\text{Ba(OH)}_2) = 3 \times n(\text{H}_3\text{PO}_4)$$

$$\begin{aligned} m(\text{Ba(OH)}_2) &= n(\text{Ba(OH)}_2) \times M(\text{Ba(OH)}_2) = 3 \times n(\text{H}_3\text{PO}_4) \times M(\text{Ba(OH)}_2) \\ &= 3 \times \frac{1}{30} \text{ mol} \times 171,3 \text{ g mol}^{-1} = \mathbf{8,565 \text{ g}} \end{aligned}$$

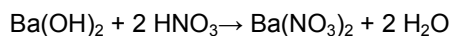
\*\*\*\*\*



$$n(\text{Ba(OH)}_2) : n(\text{H}_2\text{SO}_4) = 1 : 1$$

$$\begin{aligned} m(\text{Ba(OH)}_2) &= n(\text{Ba(OH)}_2) \times M(\text{Ba(OH)}_2) = n(\text{H}_2\text{SO}_4) \times M(\text{Ba(OH)}_2) \\ &= 0,1 \text{ mol} \times 171,3 \text{ g mol}^{-1} = \mathbf{17,13 \text{ g}} \end{aligned}$$

\*\*\*\*\*



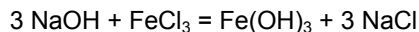
$$n(\text{Ba(OH)}_2) : n(\text{HNO}_3) = 1 : 2$$

$$= n(\text{HNO}_3) / 2$$

$$\begin{aligned} m(\text{Ba(OH)}_2) &= n(\text{Ba(OH)}_2) \times M(\text{Ba(OH)}_2) = \frac{1}{2} n(\text{HNO}_3) \times M(\text{Ba(OH)}_2) \\ &= 0,15 \text{ mol} \times 171,3 \text{ g mol}^{-1} = \mathbf{25,7 \text{ g}} \end{aligned}$$

### 5.24. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



$$n(\text{NaOH}) : n(\text{FeCl}_3) = 3 : 1$$

$$n(\text{NaOH}) = 3 \times n(\text{FeCl}_3)$$

$$V(\text{otop. NaOH}) \times c(\text{otop. NaOH}) = 3 \times V(\text{otop. FeCl}_3) \times c(\text{otop. FeCl}_3)$$

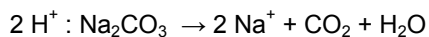
Oдавде proizlazi:

$$V(\text{otop. NaOH}) = \frac{3 \times V(\text{otop. FeCl}_3) \times c(\text{otop. FeCl}_3)}{c(\text{otop. NaOH})} = \frac{3 \times 10 \text{ cm}^3 \times 0,5 \text{ mol dm}^{-3}}{0,1 \text{ mol dm}^{-3}} = \mathbf{150 \text{ cm}^3}$$

### 5.25. Vidi STEHIOMETRIJA

$$c = n / V$$

Napišimo jednadžbu reakcije



Iz jednadžbe reakcija proizlazi da natrijev karbonat i kiselina reagiraju u molarnom omjeru 2 : 1.

$$n(\text{H}^+) : n(\text{Na}_2\text{CO}_3) = 2 : 1$$

$$n(\text{H}^+) = 2 n(\text{Na}_2\text{CO}_3) = 2 \times \frac{m(\text{Na}_2\text{CO}_3)}{M(\text{Na}_2\text{CO}_3)}$$

$$c(\text{H}^+) = \frac{n(\text{H}^+)}{V(\text{otop. H}^+)} = \frac{2 \times m(\text{Na}_2\text{CO}_3)}{V(\text{otop. H}^+) \times M(\text{Na}_2\text{CO}_3)}$$

$$= \frac{2 \times 0,184 \text{ g}}{33,12 \text{ cm}^3 \times 106 \text{ g mol}^{-1}} = 1,048 \times 10^{-4} \text{ mol cm}^{-3} = \mathbf{0,1048 \text{ mol dm}^{-3}}$$

$$\text{Faktor (f)} = \frac{c}{c_{\text{nazivno}}} = \frac{0,1048 \text{ mol dm}^{-3}}{0,1 \text{ mol dm}^{-3}} = \mathbf{1,048}$$

### 5.26. Vidi STEHIOMETRIJA

$$f = \frac{c}{c_{\text{nazivno}}}$$

$$c = f \times c_{\text{nazivno}}$$

Pri razrjeđivanju množina tvari se ne mijenja pa vrijedi.

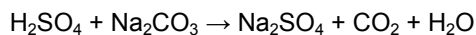
$$V \times c = V_1 \times c_1$$

$$V \times f \times c_{\text{nazivno}} = V_1 \times c_1$$

$$V_1 = \frac{V \times f \times c_{\text{nazivno}}}{c_1} = \frac{1 \text{ dm}^3 \times 1,062 \times 0,1 \text{ mol dm}^{-3}}{0,1 \text{ mol dm}^{-3}} = \mathbf{1,062 \text{ dm}^3}$$

### 5.27. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



Sumporna kiselina i natrijev karbonat međusobno reagiraju u molarnom omjeru 1 : 1, pa vrijedi:

$$n(\text{H}_2\text{SO}_4) = n(\text{Na}_2\text{CO}_3)$$

$$\begin{aligned} c(\text{H}_2\text{SO}_4) &= \frac{n(\text{H}_2\text{SO}_4)}{V(\text{H}_2\text{SO}_4)} = \frac{n(\text{Na}_2\text{CO}_3)}{V(\text{H}_2\text{SO}_4)} = \frac{m(\text{Na}_2\text{CO}_3)}{M(\text{Na}_2\text{CO}_3) \times V(\text{H}_2\text{SO}_4)} \\ &= \frac{0,810 \text{ g}}{106 \text{ g mol}^{-1} \times 50 \text{ cm}^3} = 1,5283 \times 10^{-4} \text{ mol cm}^{-3} = 0,15283 \text{ mol dm}^{-3} \end{aligned}$$

$$V \times c = V_1 \times c_1$$

$$V_1 = \frac{V \times c}{c_1} = \frac{10 \text{ dm}^3 \times 0,15283 \text{ mol dm}^{-3}}{0,1 \text{ mol dm}^{-3}} = \mathbf{15,28 \text{ dm}^3}$$

### 5.28. Vidi STEHIOMETRIJA

Moramo uzeti u obzir gustoće klorovodične kiseline koje nisu zadane. Odredit ćemo ih na temelju empirijskog pravila, pa je gustoća 36 postotne kiseline,  $\rho = 1,18 \text{ g cm}^{-3}$ , a 10 postotne otopine klorovodične kiseline,  $\rho_1 = 1,05 \text{ g cm}^{-3}$ .

Masa klorovodične kiseline u  $5 \text{ dm}^3$  36 postotne kiseline je:

$$m(\text{HCl}) = w(\text{HCl}) \times V(\text{HCl}) \times \rho(\text{HCl})$$

Masa klorovodične kiseline ne mijenja se pri razrjeđivanju, pa za razrijeđenu otopinu vrijedi:

$$m(\text{HCl}) = w_1(\text{HCl}) \times V_1(\text{HCl}) \times \rho_1(\text{HCl})$$

Možemo pisati:

$$w(\text{HCl}) \times V(\text{HCl}) \times \rho(\text{HCl}) = w_1(\text{HCl}) \times V_1(\text{HCl}) \times \rho_1(\text{HCl})$$

Oдавде proizlazi

$$V_1(\text{HCl}) = \frac{w(\text{HCl}) \times V(\text{HCl}) \times \rho(\text{HCl})}{w_1(\text{HCl}) \times \rho_1(\text{HCl})} = \frac{0,36 \times 5 \text{ dm}^3 \times 1,18 \text{ g cm}^{-3}}{0,10 \times 1,05 \text{ g cm}^{-3}} = \mathbf{20,2 \text{ dm}^3}$$

### 5.29. Vidi STEHIOMETRIJA

Izračunajmo najprije množinu sumporne kiseline koju mora sadržavati otopina nakon mješanja.

$$n_3 = V_3 \times c_3$$

Znamo da tu množinu sumporne kiseline moramo dobiti mješanjem otopina koncentracije  $c_1 = 1 \text{ mol dm}^{-3}$  i otopine koncentracije  $c_2 = 0,05 \text{ mol dm}^{-3}$ . Prema tome vrijedi:

$$V_1 c_1 + V_2 c_2 = V_3 c_3$$

Nadalje prema uvjetima zadatka mora biti:

$$V_1 + V_2 = V_3$$

Za  $V_1$  iz prve jednadžbe dobivmo:

$$V_1 = \frac{V_3 c_3 - V_2 c_2}{c_1}$$

Supstitucijom  $V_1$  u drugu jednadžbu dobivamo:

$$\frac{V_3 c_3 - V_2 c_2}{c_1} + V_2 = V_3$$

$$V_3 c_3 - V_2 c_2 + V_2 c_1 = V_3 c_1$$

$$V_2 c_1 - V_2 c_2 = V_3 c_1 - V_3 c_3$$

$$V_2(c_1 - c_2) = V_3(c_1 - c_3)$$

Odavde proizlazi:

$$V_2 = \frac{V_3(c_1 - c_3)}{(c_1 - c_2)} = \frac{0,5 \text{ dm}^3 (1 \text{ mol dm}^{-3} - 0,25 \text{ mol dm}^{-3})}{(1 \text{ mol dm}^{-3} - 0,05 \text{ mol dm}^{-3})} = \mathbf{0,395 \text{ dm}^3}$$

$$V_1 = V_3 - V_2 = 0,500 \text{ dm}^3 - 0,395 \text{ dm}^3 = \mathbf{0,105 \text{ dm}^3}$$

Za dobivanje  $500 \text{ cm}^3$  otopine sumporne kiseline,  $c_3 = 0,25 \text{ mol dm}^{-3}$ , treba pomiješati  $105 \text{ cm}^3$  otopine sumporne kiseline  $c_1 = 1 \text{ mol dm}^{-3}$  i  $395 \text{ cm}^3$  otopine  $c_2 = 0,05 \text{ mol dm}^{-3}$ . Pretpostavljena je aditivnost volumena.

### 5.30. Vidi STEHIOMETRIJA

Treba izračunati volumen otopine srebrova nitrata,  $c(\text{Ag}^+) = 1 \text{ mol dm}^{-3}$ , koji sadržava 1 g iona  $\text{Ag}^+$ .

$$n = V \times c$$

$$n = m / M$$

$$\begin{aligned} V(\text{otop. AgNO}_3) &= \frac{n(\text{Ag}^+)}{c(\text{otop. AgNO}_3)} = \frac{m(\text{Ag}^+)}{M(\text{Ag}^+) \times c(\text{otop. AgNO}_3)} \\ &= \frac{1 \text{ g}}{107,9 \text{ g mol}^{-1} \times 1 \text{ mol dm}^{-3}} = 0,00927 \text{ dm}^3 = \mathbf{9,27 \text{ cm}^3} \end{aligned}$$

### 5.31. Vidi STEHIOMETRIJA

Potrebno je najprije izračunati masu bakrovih iona u  $25 \text{ cm}^3$  otopine bakrova(II) sulfata, koncentracije  $c(\text{CuSO}_4) = 1 \text{ mol dm}^{-3}$ , a potom izračunati volumen,  $V_1$ , otopine u kojoj je  $\gamma(\text{Cu}^{2+}) = 10 \text{ mg cm}^{-3}$ , a sadržava istu masu bakrovih iona.

$$n = V c$$

$$n = m / M$$

$$m(\text{Cu}^{2+}) = n \times M = V \times c \times M$$

$$\gamma = m / V_1$$

$$V_1 = \frac{m(\text{Cu}^{2+})}{\gamma(\text{Cu}^{2+})} = \frac{V \times c \times M}{\gamma(\text{Cu}^{2+})} = \frac{25 \text{ cm}^3 \times 1 \text{ mmol cm}^{-3} \times 63,55 \text{ mg mmol}^{-1}}{10 \text{ mg cm}^{-3}} = \mathbf{158,87 \text{ cm}^3}$$

### 5.32. Vidi STEHIOMETRIJA

Vidi zadatak 5.29. gdje je rješavan sličan problem.

$$n_3 = V_3 \times c_3$$

Znamo da tu množinu klorovodične kiseline moramo dobiti mješanjem otopina koncentracije  $c_1 = 2 \text{ mol dm}^{-3}$  i otopine koncentracije  $c_2 = 9 \text{ mol dm}^{-3}$ . Prema tome vrijedi:

$$V_1 c_1 + V_2 c_2 = V_3 c_3$$

Nadalje prema uvjetima zadatka mora biti:

$$V_1 + V_2 = V_3$$

Za  $V_1$  iz prve jednadžbe dobivmo:

$$V_1 = \frac{V_3 c_3 - V_2 c_2}{c_1}$$

Supstitucijom  $V_1$  u drugu jednadžbu dobivamo:

$$\frac{V_3 c_3 - V_2 c_2}{c_1} + V_2 = V_3$$

$$V_3 c_3 - V_2 c_2 + V_2 c_1 = V_3 c_1$$

$$V_2 c_1 - V_2 c_2 = V_3 c_1 - V_3 c_3$$

$$V_2(c_1 - c_2) = V_3(c_1 - c_3)$$

Oдавde proizlazi:

$$V_2 = \frac{V_3(c_1 - c_3)}{(c_1 - c_2)} = \frac{2 \text{ dm}^3 (2 \text{ mol dm}^{-3} - 6 \text{ mol dm}^{-3})}{(2 \text{ mol dm}^{-3} - 9 \text{ mol dm}^{-3})} = \mathbf{1,143 \text{ dm}^3}$$

$$V_1 = V_3 - V_2 = 2 \text{ dm}^3 - 1,143 \text{ dm}^3 = \mathbf{0,857 \text{ dm}^3}$$

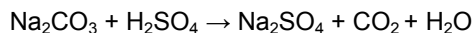
Za dobivanje  $2 \text{ dm}^3$  otopine klorovodične kiseline,  $c_3 = 6 \text{ mol dm}^{-3}$ , treba pomiješati  $0,857 \text{ dm}^3$  otopine klorovodične kiseline  $c_1 = 2 \text{ mol dm}^{-3}$  i  $1,143 \text{ dm}^3$  otopine  $c_2 = 9 \text{ mol dm}^{-3}$ . Pretpostavlja se aditivnost volumena.

### 5.33. Vidi STEHIOMETRIJA

Čvrsta točka je 28,4 cm<sup>3</sup> otopine sumporne kiseline  $c(\text{H}_2\text{SO}_4) = 0,05 \text{ mol dm}^{-3}$ . Množina sumporne kiseline sadržana u tom volumenu kiseline je:

$$n(\text{H}_2\text{SO}_4) = V(\text{H}_2\text{SO}_4) \times c(\text{H}_2\text{SO}_4) = 28,4 \text{ cm}^3 \times 0,05 \text{ mmol cm}^{-3} = 1,42 \text{ mmol}$$

Prema jednadžbi reakcije:



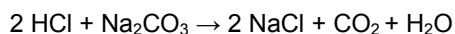
proizlazi da je

$$n(\text{H}_2\text{SO}_4) = n(\text{Na}_2\text{CO}_3)$$

odnosno 50 cm<sup>3</sup> otopine natrijeva karbonata sadržava 1,42 mmol Na<sub>2</sub>CO<sub>3</sub>.

25 cm<sup>3</sup> otopine natrijeva karbonata sadržava 0,71 mmol Na<sub>2</sub>CO<sub>3</sub>.

Prema jednadžbi reakcije



proizlazi

$$n(\text{HCl}) = 2 n(\text{Na}_2\text{CO}_3)$$

odnosno

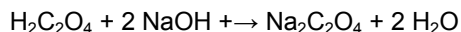
$$n(\text{HCl}) = 2 \times 0,71 \text{ mmol} = 1,42 \text{ mmol}$$

Koncentracija otopine klorovodične kiseline je:

$$c(\text{HCl}) = \frac{n(\text{HCl})}{V(\text{HCl})} = \frac{1,42 \text{ mmol}}{38,6 \text{ cm}^3} = \mathbf{0,0368 \text{ mol dm}^{-3}}$$

### 5.34. Vidi STEHIOMETRIJA

Oksalna kiselina neutralizira se natrijevim hidroksidom prema jednadžbi:



Oksalna kiselina i natrijev hidroksid reagiraju u molarnom omjeru 1 : 2. Odavde proizlazi:

$$\begin{aligned} n(\text{H}_2\text{C}_2\text{O}_4) &= \frac{1}{2} \times n(\text{NaOH}) = \frac{1}{2} \times V(\text{otop. NaOH}) \times c(\text{otop. NaOH}) \\ &= \frac{1}{2} \times 26,8 \text{ cm}^3 \times 0,0934 \text{ mmol cm}^{-3} \\ &= 1,25156 \text{ mmol} \end{aligned}$$

Oksalna kiselina i kalijev permanganat reagiraju prema jednadžbi:



Iz jednadžbe reakcije proizlazi da oksalna kiselina i kalijev permanganat reagiraju u molarnom omjeru 5 : 2. Odavde proizlazi:

$$5 \times n(\text{KMnO}_4) = 2 \times n(\text{H}_2\text{C}_2\text{O}_4)$$

$$\begin{aligned} n(\text{KMnO}_4) &= \frac{2 \times n(\text{H}_2\text{C}_2\text{O}_4)}{5} = \frac{2 \times 1,25156 \text{ mmol}}{5} = 0,5006 \text{ mmol} \\ c(\text{KMnO}_4) &= \frac{n(\text{KMnO}_4)}{V(\text{otop. KMnO}_4)} = \frac{0,5006 \text{ mmol}}{23,8 \text{ cm}^3} = \mathbf{0,0210 \text{ mol dm}^{-3}} \end{aligned}$$

ili **"0,02 M",  $f = 1,0517$**

### 5.35. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



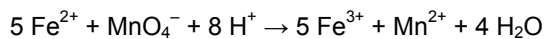
Željezov(II) sulfat i kalijev permanganat reagiraju u molarnom omjeru 5 : 1. Odavde proizlazi:

$$\begin{aligned} n(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) &= 5 \times n(\text{KMnO}_4) \\ &= 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ m(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) &= M(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) \times n(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) \\ &= M(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) \times 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ &= 278,05 \text{ g mol}^{-1} \times 5 \times 0,02 \text{ mol dm}^{-3} \times 0,028 \text{ dm}^3 \\ &= \mathbf{0,7785 \text{ g}} \end{aligned}$$

### 5.36. Vidi STEHIOMETRIJA

Problem rješavamo jednakim postupkom kao u zadatku 5.35

Napišimo jednadžbu reakcije u ionskom obliku



Željezovi ioni i permanganatni ioni reagiraju u molarnom omjeru 5 : 1. Odavde proizlazi:

$$\begin{aligned} n(\text{Fe}^{2+}) &= 5 \times n(\text{MnO}_4^-) \\ &= 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ m(\text{Fe}^{2+}) &= M(\text{Fe}^{2+}) \times n(\text{Fe}^{2+}) \\ &= M(\text{Fe}^{2+}) \times 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ &= 55,85 \text{ g mol}^{-1} \times 5 \times 0,004 \text{ mol dm}^{-3} \times 0,00221 \text{ dm}^3 \\ &= 0,00247 \text{ g} \end{aligned}$$

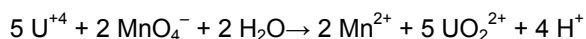
Maseni udio željeza u uzorku sumporne kiseline je:

$$w(\text{Fe}^{2+}) = \frac{m(\text{Fe}^{2+})}{m(\text{H}_2\text{SO}_4)} = \frac{m(\text{Fe}^{2+})}{V(\text{H}_2\text{SO}_4) \times \rho(\text{H}_2\text{SO}_4)} = \frac{0,00247 \text{ g}}{100 \text{ cm}^3 \times 1,84 \text{ g cm}^{-3}} = \mathbf{1,34 \times 10^{-5}}$$



### 5.37. Vidi STEHIOMETRIJA

Napišimo najprije jednadžbu reakcije



Uranijevi ioni i permanganatni ioni reagiraju u molarnom omjeru 5 : 2. Odavde proizlazi:

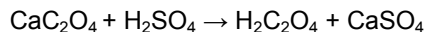
$$\begin{aligned} n(\text{U}^{4+}) &= \frac{5}{2} \times n(\text{MnO}_4^-) \\ &= \frac{5}{2} \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ m(\text{U}^{4+}) &= M(\text{U}^{4+}) \times n(\text{U}^{4+}) \\ &= M(\text{U}^{4+}) \times \frac{5}{2} \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ &= 238,0 \text{ g mol}^{-1} \times \frac{5}{2} \times 0,02 \text{ mol dm}^{-3} \times 0,0248 \text{ dm}^3 \\ &= 0,29512 \text{ g} \end{aligned}$$

Maseni udio uranija u uzorku je:

$$w(\text{U}^{4+}) = \frac{m(\text{U}^{4+})}{m(\text{uzorak})} = \frac{0,29512 \text{ g}}{0,335 \text{ g}} = \mathbf{0,881}$$

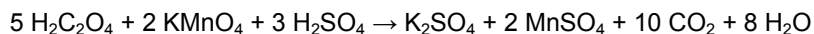
### 5.38. Vidi STEHIOMETRIJA

Napišimo najprije jednadžbe reakcija.



Odavde proizlazi da je  $n(\text{Ca}^{2+}) = n(\text{C}_2\text{O}_4^{2-})$

Oksalna kiselina i kalijev permanganat reagiraju prema jednadžbi:



Iz jednadžbe reakcije proizlazi da oksalna kiselina i kalijev permanganat reagiraju u molarnom omjeru 5 : 2. Odavde proizlazi:

$$\begin{aligned} 5 \times n(\text{KMnO}_4) &= 2 \times n(\text{Ca}^{2+}) \\ n(\text{Ca}^{2+}) &= \frac{5}{2} \times n(\text{KMnO}_4) \\ &= \frac{5}{2} \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ m(\text{Ca}^{2+}) &= M(\text{Ca}^{2+}) \times n(\text{Ca}^{2+}) \\ w(\text{Ca}^{2+}) &= \frac{m(\text{Ca}^{2+})}{m(\text{uzorak})} = \frac{M(\text{Ca}^{2+}) \times n(\text{Ca}^{2+})}{m(\text{uzorak})} = \frac{M(\text{Ca}^{2+}) \times \frac{5}{2} \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4)}{m(\text{uzorak})} \\ &= \frac{40,08 \text{ g mol}^{-1} \times \frac{5}{2} \times 0,02 \text{ mol dm}^{-3} \times 0,0287 \text{ dm}^3}{0,450 \text{ g}} = \mathbf{0,1278} \end{aligned}$$

### 5.39. Vidi STEHIOMETRIJA

Moramo doznati množinu oksalne kiseline utrošene u reakciji s olovovim dioksidom.

Iz jednadžbe reakcije



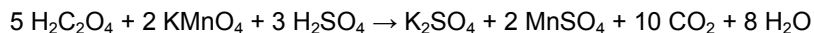
vidi se da olovov dioksid i oksalna kiselina reagiraju u molarnom omjeru 1 : 1. Zato vrijedi:

$$n(\text{H}_2\text{C}_2\text{O}_4) = n(\text{PbO}_2)$$

Na talog olovova dioksida dodano je  $V_1 = 50 \text{ cm}^3$  otopine oksalne kiseline,  $c_1(\text{H}_2\text{C}_2\text{O}_4) = 0,1 \text{ mmol cm}^{-3}$ . Množina upotrijebljene oksalne kiseline je:

$$n_1(\text{H}_2\text{C}_2\text{O}_4) = V_1(\text{H}_2\text{C}_2\text{O}_4) \times c_1(\text{H}_2\text{C}_2\text{O}_4)$$

Višak oksalne kiseline titriran je otopinom kalijeva permanganata prema jednadžbi:



Iz jednadžbe reakcije proizlazi da oksalna kiselina i kalijev permanganat reagiraju u molarnom omjeru 5 : 2., pa vrijedi:

$$5 \times n(\text{KMnO}_4) = 2 \times n(\text{H}_2\text{C}_2\text{O}_4)$$

Oдавде proizlazi da višak oksalne kiseline iznosi:

$$n_2(\text{H}_2\text{C}_2\text{O}_4) = \frac{5}{2} \times n(\text{KMnO}_4) = \frac{5}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4)$$

Kako je

$$n_1(\text{H}_2\text{C}_2\text{O}_4) - n_2(\text{H}_2\text{C}_2\text{O}_4) = n(\text{H}_2\text{C}_2\text{O}_4) = n(\text{PbO}_2)$$

konačno dobivamo:

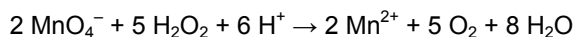
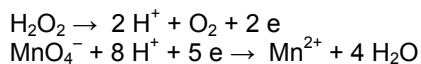
$$\begin{aligned} n(\text{PbO}_2) &= V_1(\text{H}_2\text{C}_2\text{O}_4) \times c_1(\text{H}_2\text{C}_2\text{O}_4) - \frac{5}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4) \\ &= 50 \text{ cm}^3 \times 0,1 \text{ mmol cm}^{-3} - \frac{5}{2} \times 37,5 \text{ cm}^3 \times 0,04 \text{ mmol cm}^{-3} \\ &= 1,25 \text{ mmol} \end{aligned}$$

$$m(\text{PbO}_2) = n(\text{PbO}_2) \times M(\text{PbO}_2)$$

$$w(\text{PbO}_2) = \frac{m(\text{PbO}_2)}{m(\text{minij})} = \frac{n(\text{PbO}_2) \times M(\text{PbO}_2)}{m(\text{minij})} = \frac{1,25 \text{ mmol} \times 239,2 \text{ g mol}^{-1}}{1 \text{ g}} = \mathbf{0,299}$$

#### 5.40. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije kalijeva permanganata s vodikovim peroksidom u kiselj otolini.



Prema uvjetima zadatka pri titraciji 1 g vodikova peroksida,  $w(\text{H}_2\text{O}_2) = 100 \%$ , utrošak otopine kalijeva permanganata treba biti  $100 \text{ cm}^3$ . Prema tome treba odrediti množinu vodikova peroksida u 1 g čistog vodikova peroksida.

$$n(\text{H}_2\text{O}_2) = \frac{m(\text{H}_2\text{O}_2)}{M(\text{H}_2\text{O}_2)}$$

Iz jednadžbe reakcije vidimo da kalijev permanganat i vodikov peroksid međusobno reagiraju u molarnom omjer 2 : 5, pa možemo pisati:

$$n(\text{KMnO}_4) = \frac{2}{5} \times n(\text{H}_2\text{O}_2)$$

Odavde proizlazi

$$n(\text{KMnO}_4) = \frac{2 \times m(\text{H}_2\text{O}_2)}{5 \times M(\text{H}_2\text{O}_2)} = \frac{2 \times 1 \text{ g}}{5 \times 34,01 \text{ g mol}^{-1}} = 0,01176 \text{ mol}$$

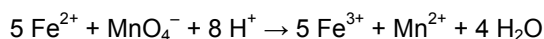
$100 \text{ cm}^3$  otopine mora sadržavati izračunanu množinu kalijeva permanganata, pa proizlazi da je koncentracija kalijeva permanganata u otopini:

$$c(\text{KMnO}_4) = \frac{n(\text{KMnO}_4)}{V(\text{otop. KMnO}_4)} = \frac{0,01176 \text{ mol}}{100 \text{ cm}^3} = \mathbf{0,1176 \text{ mol dm}^{-3}}$$

#### 5.41. Vidi STEHIOMETRIJA

Osnovni problem je u tome što ne znamo koncentraciju otopine željezova(II) sulfata. Moramo je odrediti na temelju rezultata titracije otopinom kalijeva permanganata poznate koncentracije.

Ioni  $\text{Fe}^{2+}$  s permanganatnim ionima reagiraju prema jednadžbi:



odnosno u molarnom omjeru 5 : 1. Odavde proizlazi da 75 cm<sup>3</sup> otopine željezova sulfata sadržava sljedeću množinu iona  $\text{Fe}^{2+}$ :

$$\begin{aligned} n(\text{Fe}^{2+}) &= 5 \times n(\text{MnO}_4^-) \\ &= 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \\ &= 5 \times 0,1 \text{ mmol cm}^{-3} \times 73 \text{ cm}^3 = 36,5 \text{ mmol.} \end{aligned}$$

Nakon dodatka 75 cm<sup>3</sup> zakiseljene otopine željezova sulfata, odnosno 36,5 mmol, na manganov dioksid, za titraciju viška iona  $\text{Fe}^{2+}$  utrošeno je  $V_1 = 30 \text{ cm}^3$  otopine kalijeva permanganata,  $c(\text{KMnO}_4) = 0,1 \text{ mol dm}^{-3}$ . Odavde proizlazi da množina iona,  $n_1(\text{Fe}^{2+})$ , preostalih u otopini nakon oksidacije manganovim dioksidom iznosi:

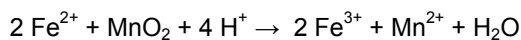
$$\begin{aligned} n_1(\text{Fe}^{2+}) &= 5 \times n(\text{MnO}_4^-) \\ &= 5 \times c(\text{otop.KMnO}_4) \times V_1(\text{otop.KMnO}_4) \\ &= 5 \times 0,1 \text{ mmol cm}^{-3} \times 30 \text{ cm}^3 = 15 \text{ mmol.} \end{aligned}$$

Prema tome, množina iona,  $n_2(\text{Fe}^{2+})$ , koja je oksidirana uzorkom piroluzita iznosi:

$$n_2(\text{Fe}^{2+}) = n(\text{Fe}^{2+}) - n_1(\text{Fe}^{2+}) = 36,5 \text{ mmol} - 15 \text{ mmol} = 21,5 \text{ mmol.}$$

Sada možemo odrediti množinu, masu i maseni udio manganova dioksida u uzorku piroluzita.

Napišimo najprije jedndžbu reakcije oksidacije iona  $\text{Fe}^{2+}$  manganovim dioksidom u kiseloj otopini.



Ioni  $\text{Fe}^{2+}$  i  $\text{MnO}_2$  međusobno reagiraju u molarnom omjeru 2 : 1, pa možemo pisati:

$$\begin{aligned} n(\text{MnO}_2) &= \frac{1}{2} \times n_2(\text{Fe}^{2+}) \\ m(\text{MnO}_2) &= n(\text{MnO}_2) \times M(\text{MnO}_2) = \frac{1}{2} \times n_2(\text{Fe}^{2+}) \times M(\text{MnO}_2) \\ &= \frac{1}{2} \times 21,5 \text{ mmol} \times 86,94 \text{ g mol}^{-1} \\ &= 0,934 \text{ g} \end{aligned}$$

Maseni udio  $\text{MnO}_2$  u piroluzitu je:

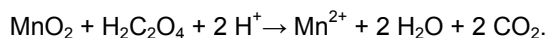
$$\begin{aligned} w(\text{MnO}_2) &= \frac{m(\text{MnO}_2)}{m(\text{piroluzit})} = \frac{\frac{1}{2} \times n_2(\text{Fe}^{2+}) \times M(\text{MnO}_2)}{m(\text{piroluzit})} \\ &= \frac{\frac{1}{2} \times 21,5 \text{ mmol} \times 86,94 \text{ g mol}^{-1}}{1,0866 \text{ g}} = \mathbf{0,860} \end{aligned}$$

#### 5.42. Vidi STEHIOMETRIJA

Problem je identičan onom u zadatku 5.39. i rješavamo ga jednakim postupkom.

Moramo doznati množinu oksalne kiseline utrošene u reakciji s manganovim dioksidom.

Iz jednadžbe reakcije



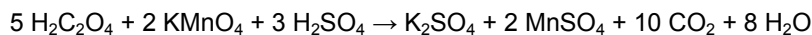
vidi se da manganov dioksid i oksalna kiselina reagiraju u molarnom omjeru 1 : 1. Zato vrijedi:

$$n(\text{H}_2\text{C}_2\text{O}_4) = n(\text{MnO}_2)$$

Na piroluzit je dodano  $V_1 = 75 \text{ cm}^3$  otopine oksalne kiseline,  $c_1(\text{H}_2\text{C}_2\text{O}_4) = 0,25 \text{ mmol cm}^{-3}$ . Množina upotrijebljene oksalne kiseline je:

$$n_1(\text{H}_2\text{C}_2\text{O}_4) = V_1(\text{H}_2\text{C}_2\text{O}_4) \times c_1(\text{H}_2\text{C}_2\text{O}_4)$$

Višak oksalne kiseline titriran je otopinom kalijeva permanganata prema jednadžbi:



Iz jednadžbe reakcije proizlazi da oksalna kiselina i kalijev permanganat reagiraju u molarnom omjeru 5 : 2., pa vrijedi:

$$5 \times n(\text{KMnO}_4) = 2 \times n(\text{H}_2\text{C}_2\text{O}_4)$$

Odavde proizlazi da višak oksalne kiseline iznosi:

$$n_2(\text{H}_2\text{C}_2\text{O}_4) = \frac{5}{2} \times n(\text{KMnO}_4) = \frac{5}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4)$$

Kako je

$$n_1(\text{H}_2\text{C}_2\text{O}_4) - n_2(\text{H}_2\text{C}_2\text{O}_4) = n(\text{H}_2\text{C}_2\text{O}_4) = n(\text{MnO}_2)$$

konačno dobivamo:

$$\begin{aligned} n(\text{MnO}_2) &= V_1(\text{H}_2\text{C}_2\text{O}_4) \times c_1(\text{H}_2\text{C}_2\text{O}_4) - \frac{5}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4) \\ &= 75 \text{ cm}^3 \times 0,25 \text{ mmol cm}^{-3} - \frac{5}{2} \times 32 \text{ cm}^3 \times 0,1 \text{ mmol cm}^{-3} \\ &= 10,75 \text{ mmol} \end{aligned}$$

$$m(\text{MnO}_2) = n(\text{MnO}_2) \times M(\text{MnO}_2)$$

$$w(\text{MnO}_2) = \frac{m(\text{MnO}_2)}{m(\text{piroluzit})} = \frac{n(\text{MnO}_2) \times M(\text{MnO}_2)}{m(\text{piroluzit})} = \frac{10,75 \text{ mmol} \times 86,94 \text{ g mol}^{-1}}{1 \text{ g}} = \mathbf{0,935}$$

#### 5.43. Vidi STEHIOMETRIJA

Npišimo najprije jednadžbu reakcije.



Kalijev permanganat i kalijev oksalat reagiraju u molarnom omjeru 2 : 3, pa vrijedi:

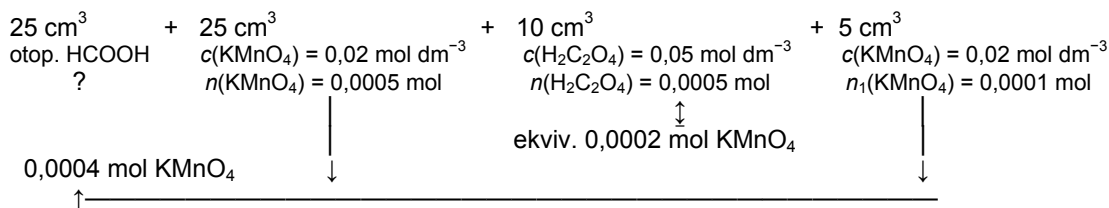
$$n(\text{HCOOH}) = \frac{3}{2} \times n(\text{MnO}_4^-) = \frac{3}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4)$$

$$\begin{aligned} m(\text{HCOOH}) &= n(\text{HCOOH}) \times M(\text{HCOOH}) \\ &= \frac{3}{2} \times V(\text{KMnO}_4) \times c(\text{KMnO}_4) \times M(\text{HCOOH}) \\ &= \frac{3}{2} \times 0,040 \text{ dm}^3 \times 0,2 \text{ mol dm}^{-3} \times 46 \text{ g mol}^{-1} \\ &= 0,552 \text{ g} \end{aligned}$$

$$w(\text{HCOOH}) = \frac{m(\text{HCOOH})}{m(\text{uzorak})} = \frac{0,552 \text{ g}}{25 \text{ g}} = \mathbf{0,0221}$$

#### 5.44. Vidi STEHIOMETRIJA

Potrebno je doznati množinu kalijeva permanganata koja u kiseloj otopini reagira s mravljom kiselinom. Prikažimo tijek analize shemom:



Poznate su nam množine dodana kalijeva permanganata i oksalne kiseline. Odbijmo množinu kalijeva permanganata koja reagira s oksalnom kiselinom, pa ćemo dobiti ostatak, odnosno množinu kalijeva permanganata koja je reagirala s mravljom kiselinom.

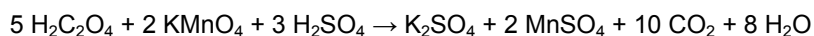
Ukupna množina upotrijebljena kalijeva permanganata,  $n_1(\text{KMnO}_4)$

$$n_1(\text{KMnO}_4) = (25 + 5) \text{ cm}^3 \times 0,02 \text{ mol dm}^{-3} = 0,0006 \text{ mol.}$$

Množina dodane oksalne kiseline,  $n(\text{H}_2\text{C}_2\text{O}_4)$

$$n(\text{H}_2\text{C}_2\text{O}_4) = 10 \text{ cm}^3 \times 0,05 \text{ mol dm}^{-3} = 0,0005 \text{ mol.}$$

Prema jednadžbi reakcije



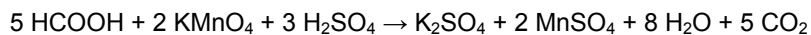
proizlazi da oksalna kiselina i kalijev permanganat reagiraju u molarnom omjeru 5 : 2, pa vrijedi:

$$n_2(\text{KMnO}_4) = \frac{2}{5} \times n(\text{H}_2\text{C}_2\text{O}_4) = \frac{2}{5} \times 0,0005 \text{ mol} = 0,0002 \text{ mol.}$$

Množina kalijeva permanganata utrošena za oksidaciju mravlje kiseline,  $n_3(\text{KMnO}_4)$  je:

$$n_3(\text{KMnO}_4) = n_1(\text{KMnO}_4) - n_2(\text{KMnO}_4) = 0,0006 \text{ mol} - 0,0002 \text{ mol} = 0,0004 \text{ mol}$$

Mravlja kiselina i kalijev permanganat u kiseloj otopini reagiraju prema jednadžbi



pa se dobiva

$$n(\text{HCOOH}) = \frac{5}{2} \times n_3(\text{MnO}_4^-)$$

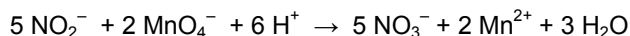
$$m(\text{HCOOH}) = \frac{5}{2} \times n_3(\text{MnO}_4^-) \times M(\text{HCOOH})$$

$$\gamma(\text{HCOOH}) = \frac{m(\text{HCOOH})}{V(\text{otop. HCOOH})} = \frac{\frac{5}{2} \times n_3(\text{MnO}_4^-) \times M(\text{HCOOH})}{V(\text{otop. HCOOH})}$$

$$= \frac{\frac{5}{2} \times 4,00 \times 10^{-4} \text{ mol} \times 46 \text{ g mol}^{-1}}{0,025 \text{ dm}^3} = 1,84 \text{ g dm}^{-3}$$

#### 5.45. Vidi STEHIOMETRIJA

Napšimo jednadžbu reakcije



Nitritni i permanganatni ioni reagiraju u molarnom omjeru 5 : 2, pa vrijedi:

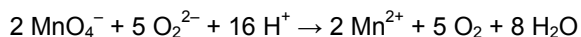
$$\begin{aligned} n(\text{NO}_2^-) &= \frac{5}{2} \times n(\text{MnO}_4^-) \\ &= \frac{5}{2} \times 0,004 \text{ mol} = 0,01 \text{ mol} \end{aligned}$$

$$m(\text{NaNO}_2) = n(\text{NaNO}_2) \times M(\text{NaNO}_2)$$

$$\begin{aligned} c(\text{NaNO}_2) &= \frac{m(\text{NaNO}_2)}{V(\text{otop. NaNO}_2)} = \frac{n(\text{NaNO}_2) \times M(\text{NaNO}_2)}{V(\text{otop. NaNO}_2)} \\ &= \frac{0,01 \text{ mol} \times 69 \text{ g mol}^{-1}}{0,038 \text{ dm}^3} = \mathbf{18,16 \text{ g dm}^{-3}} \end{aligned}$$

#### 5.46. Vidi STEHIOMETRIJA

Napšimo jednadžbu reakcije kalijeva permanganata i barijeva peroksida u kiseloj otopini



Iz jednadžbe reakcije vidimo da permanganatni i peroksidni ioni međusobno reagiraju u molarnom omjer 2 : 5, pa možemo pisati:

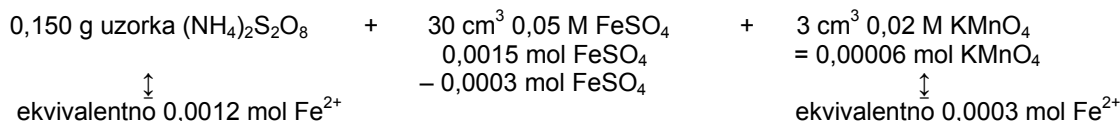
$$n(\text{BaO}_2) = \frac{5}{2} \times n(\text{KMnO}_4)$$

$$\begin{aligned} m(\text{BaO}_2) &= n(\text{BaO}_2) \times M(\text{BaO}_2) = \frac{5}{2} \times n(\text{KMnO}_4) \times M(\text{BaO}_2) \\ &= \frac{5}{2} \times V(\text{otop. KMnO}_4) \times c(\text{otop. KMnO}_4) \times M(\text{BaO}_2) \end{aligned}$$

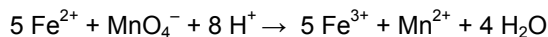
$$\begin{aligned} w(\text{BaO}_2) &= \frac{m(\text{BaO}_2)}{m(\text{uzorak})} = \frac{\frac{5}{2} \times V(\text{otop. KMnO}_4) \times c(\text{otop. KMnO}_4) \times M(\text{BaO}_2)}{m(\text{uzorak})} \\ &= \frac{\frac{5}{2} \times 0,030 \text{ cm}^3 \times 0,02 \text{ mol dm}^{-3} \times 169,34 \text{ g mol}^{-1}}{0,4 \text{ g}} = \mathbf{0,635} \end{aligned}$$

#### 5.47. Vidi STEHIOMETRIJA

Načinimo shemu reakcije:



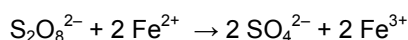
Na osnovi jednadžbe reakcije



vidimo da je

$$n(\text{Fe}^{2+}) = 5 \times n(\text{KMnO}_4) = 5 \times 0,00006 \text{ mol} = \mathbf{0,0003 \text{ mol}},$$

pa je s amonijevim persulfatom reagiralo  $(0,0015 - 0,0003 = 0,0012)$  mol  $\text{FeSO}_4$  prema sljedećoj jednadžbi reakcije:



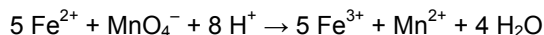
Odavde proizlazi

$$n((\text{NH}_4)_2\text{S}_2\text{O}_8) = \frac{1}{2} \times n(\text{FeSO}_4) = \frac{1}{2} \times 0,0012 \text{ mol} = 0,0006 \text{ mol}.$$

$$\begin{aligned}
 w((\text{NH}_4)_2\text{S}_2\text{O}_8) &= \frac{m((\text{NH}_4)_2\text{S}_2\text{O}_8)}{m(\text{uzorak})} = \frac{n((\text{NH}_4)_2\text{S}_2\text{O}_8) \times M((\text{NH}_4)_2\text{S}_2\text{O}_8)}{m(\text{uzorak})} \\
 &= \frac{0,0006 \text{ mol} \times 228 \text{ g mol}^{-1}}{0,150 \text{ g}} = \mathbf{0,912}
 \end{aligned}$$

#### 5.48. Vidi STEHIOMETRIJA

Izračunajmo najprije množinu iona  $\text{Fe}^{2+}$ .



Ioni  $\text{Fe}^{2+}$  s permanganatnim ionima reagiraju u molarnom omjeru 5 : 1. Odavde proizlazi:

$$\begin{aligned}
 n(\text{Fe}^{2+}) &= 5 \times n(\text{MnO}_4^-) \\
 &= 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4)
 \end{aligned}$$

Iz jednadžbe reakcije



vidimo da je

$$n(\text{NH}_2\text{OH}) = \frac{1}{2} \times n(\text{FeSO}_4)$$

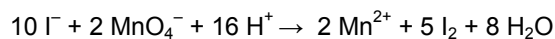
$$m(\text{NH}_2\text{OH}) = \frac{1}{2} \times n(\text{FeSO}_4) \times M(\text{NH}_2\text{OH})$$

$$\begin{aligned}
 w(\text{NH}_2\text{OH}) &= \frac{m(\text{NH}_2\text{OH})}{m(\text{uzorak})} = \frac{\frac{1}{2} \times n(\text{FeSO}_4) \times M(\text{NH}_2\text{OH})}{m(\text{uzorak})} \\
 &= \frac{\frac{1}{2} \times 5 \times c(\text{otop.KMnO}_4) \times V(\text{otop.KMnO}_4) \times M(\text{NH}_2\text{OH})}{m(\text{uzorak})} \\
 &= \frac{\frac{1}{2} \times 5 \times 0,02 \text{ mol dm}^{-3} \times 0,025 \text{ dm}^3 \times 33 \text{ g mol}^{-1}}{0,1 \text{ g}} = \mathbf{0,4125}
 \end{aligned}$$



#### 5.49. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



Jodidni i permanganatni ioni međusobno reagiraju u molarnom omjeru 5 : 1. Odavde proizlazi:

$$n(\text{I}) = 5 \times n(\text{KMnO}_4)$$

$$m(\text{I}) = n(\text{I}) \times M(\text{I}) = 5 \times n(\text{KMnO}_4) \times M(\text{I})$$

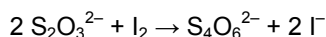
$$= 5 \times V(\text{otop. KMnO}_4) \times c(\text{KMnO}_4) \times M(\text{I})$$

$$= 5 \times 0,001 \text{ dm}^3 \times 0,02 \text{ mol dm}^{-3} \times 126,9 \text{ g mol}^{-1} = 0,01269 \text{ g} = \mathbf{12,69 \text{ mg}}$$



#### 5.50. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



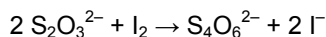
Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{S}_2\text{O}_3^{2-}) = 2 \times n(\text{I}_2)$$

$$\begin{aligned} c(\text{S}_2\text{O}_3^{2-}) &= \frac{n(\text{S}_2\text{O}_3^{2-})}{V(\text{otop. S}_2\text{O}_3^{2-})} = \frac{2 \times n(\text{I}_2)}{V(\text{otop. S}_2\text{O}_3^{2-})} = \frac{2 \times m(\text{I}_2)}{V(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{I}_2)} \\ &= \frac{2 \times 0,25 \text{ g}}{0,020 \text{ dm}^3 \times 253,8 \text{ g mol}^{-1}} = \mathbf{0,0985 \text{ mol dm}^{-3}} \end{aligned}$$

#### 5.51. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

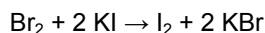
$$n(\text{I}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-})$$

$$m(\text{I}_2) = n(\text{I}_2) \times M(\text{I}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) \times M(\text{I}_2) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{I}_2)$$

$$\begin{aligned} \gamma(\text{I}_2) &= \frac{m(\text{I}_2)}{V(\text{otop. I}_2)} = \frac{\frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{I}_2)}{V(\text{otop. I}_2)} \\ &= \frac{\frac{1}{2} \times 0,025 \text{ dm}^3 \times 0,05 \text{ mol dm}^{-3} \times 253,8 \text{ g mol}^{-1}}{0,020 \text{ dm}^3} = \mathbf{7,93 \text{ g dm}^{-3}} \end{aligned}$$

### 5.52. Vidi STEHIOMETRIJA

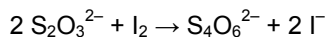
Napišimo jednađbu reakcije



Odavde proizlazi

$$n(\text{Br}_2) = n(\text{I}_2)$$

Natrijev tiosulfat i izlučeni jod reagiraju prema jednađbi



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = n(\text{Br}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-})$$

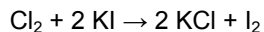
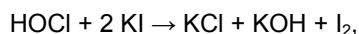
$$m(\text{Br}_2) = n(\text{Br}_2) \times M(\text{Br}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) \times M(\text{Br}_2) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{Br}_2)$$

$$\gamma(\text{Br}_2) = \frac{m(\text{Br}_2)}{V(\text{otop. Br}_2)} = \frac{\frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{Br}_2)}{V(\text{otop. Br}_2)}$$

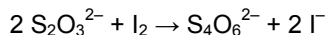
$$= \frac{\frac{1}{2} \times 0,030 \text{ dm}^3 \times 0,10 \text{ mol dm}^{-3} \times 159,8 \text{ g mol}^{-1}}{0,010 \text{ dm}^3} = 23,97 \text{ g dm}^{-3}$$

### 5.53. Vidi STEHIOMETRIJA

Kalijev jodid s otopinom klora i hipokloraste kiseline reagira prema jednađbama:



Odredimo najprije ukupnu množinu joda na temelju utroška otopine  $\text{Na}_2\text{S}_2\text{O}_3$ .



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$\begin{aligned} n(\text{I}_2) &= \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \\ &= \frac{1}{2} \times 0,038 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} = 0,0019 \text{ mol.} \end{aligned}$$

Na temelju jednađbe reakcije hipokloraste kiseline i kalijeva jodida,  $\text{HOCl} + 2 \text{KI} \rightarrow \text{KCl} + \text{KOH} + \text{I}_2$ , proizlazi  $n(\text{HOCl}) = n(\text{KOH})$ .

Množinu KOH, odnosno HOCl, odredit ćemo kao razliku množine dodane klorovodične kiseline,  $n(\text{HCl})$  i množine natrijeva hidroksida,  $n(\text{NaOH})$ , utrošena za retitraciju viška HCl.

$$\begin{aligned} n(\text{HOCl}) &= n(\text{otop. HCl}) - n(\text{otop. NaOH}) \\ &= V(\text{otop. HCl}) \times c(\text{otop. HCl}) - V(\text{otop. NaOH}) \times c(\text{otop. NaOH}) \\ &= 0,025 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} - 0,010 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} = 0,0015 \text{ mol} \end{aligned}$$

Na temelju prvih dviju jednađbi možemo zaključiti da je množina elementarnog klora sadržana u otopini jednaka razlici ukupne množine izlučena joda i množine hipokloraste kiseline.

$$n(\text{Cl}_2) = n(\text{I}_2) - n(\text{HOCl}) = 0,0019 \text{ mol} - 0,0015 \text{ mol} = 0,0004 \text{ mol}$$

$$\begin{aligned} \gamma(\text{Cl}_2) &= m(\text{Cl}_2) / V(\text{otop}) = n(\text{Cl}_2) \times M(\text{Cl}_2) / V(\text{otop}) \\ &= 0,0004 \text{ mol} \times 70,9 \text{ g mol}^{-1} / 0,025 \text{ dm}^3 = 1,134 \text{ g dm}^{-3} \end{aligned}$$

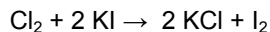
$$\begin{aligned} \gamma(\text{HOCl}) &= m(\text{HOCl}) / V(\text{otop}) = n(\text{HOCl}) \times M(\text{HOCl}) / V(\text{otop}) \\ &= 0,0015 \text{ mol} \times 52,45 \text{ g mol}^{-1} / 0,025 \text{ dm}^3 = 3,147 \text{ g dm}^{-3} \end{aligned}$$

### 5.54. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije manganova dioksida i klorovodične kiseline.



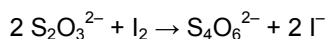
Dobiveni klor istiskuje jod iz otopine kalijeva jodida.



Odavde proizlazi

$$n(\text{I}_2) = n(\text{Cl}_2) = n(\text{MnO}_2)$$

Zadan nam je maksimalni volumen otopine natrijeva tiosulfata,  $V(\text{otop. Na}_2\text{S}_2\text{O}_3) = 50 \text{ cm}^3$ , koncentracije,  $c(\text{Na}_2\text{S}_2\text{O}_3) = 0,1 \text{ mol dm}^{-3}$ , koji smijemo utrošiti za titraciju izlučena joda. Na osnovi jednadžbe reakcije joda i otopine tiosulfata:



zaključujemo da tiosulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

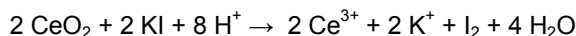
$$n(\text{I}_2) = n(\text{Cl}_2) = n(\text{MnO}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

Za maksimalnu masu piroluzita, odnosno čistog  $\text{MnO}_2$ , dobivamo:

$$\begin{aligned} m(\text{MnO}_2) &= n(\text{MnO}_2) \times M(\text{MnO}_2) \\ &= \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{MnO}_2) \\ &= \frac{1}{2} \times 0,050 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 86,94 \text{ g mol}^{-1} = \mathbf{0,217 \text{ g}} \end{aligned}$$

### 5.55. Vidi STEHIOMETRIJA

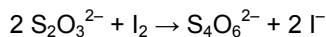
Napišimo jednadžbu reakcije cerijeva(IV) oksida i kalijeva jodida.



Odavde proizlazi

$$n(\text{I}_2) = 2 \times n(\text{CeO}_2)$$

Zadan nam je maksimalni volumen otopine natrijeva tiosulfata,  $V(\text{otop. Na}_2\text{S}_2\text{O}_3) = 50 \text{ cm}^3$ , koncentracije,  $c(\text{Na}_2\text{S}_2\text{O}_3) = 0,1 \text{ mol dm}^{-3}$ , koji smijemo utrošiti za titraciju izlučena joda. Na osnovi jednadžbe reakcije joda i otopine tiosulfata:



zaključujemo da tiosulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

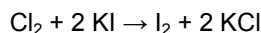
$$n(\text{I}_2) = 2 \times n(\text{CeO}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

Za maksimalnu masu  $\text{CeO}_2$ , dobivamo:

$$\begin{aligned} m(\text{CeO}_2) &= 2 \times n(\text{CeO}_2) \times M(\text{CeO}_2) \\ &= 2 \times \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{CeO}_2) \\ &= 0,050 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 172,1 \text{ g mol}^{-1} = \mathbf{0,860 \text{ g}} \end{aligned}$$

### 5.56. Vidi STEHIOMETRIJA

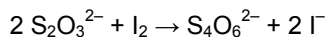
Klor istiskuje jod iz kalijeva jodida prema jednađbi:



Odavde proizlazi:

$$n(\text{Cl}_2) = n(\text{I}_2)$$

Izlučeni se jod titrira natrijevim tiosulfatom.



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = n(\text{Cl}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

Zadanu masu klora, 10 mg, iskažimo množinom pa dobivamo:

$$n(\text{Cl}_2) = \frac{10 \text{ mg}}{M(\text{Cl}_2)}$$

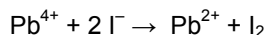
Uvrstimo ovaj rezultat u prethodnu jednađbu:

$$\frac{10 \text{ mg}}{M(\text{Cl}_2)} = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

Odavde se za koncentraciju otopine natrijeva tiosulfata dobiva:

$$c(\text{S}_2\text{O}_3^{2-}) = \frac{10 \text{ mg}}{M(\text{Cl}_2) \times \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-})} = \frac{0,010 \text{ g}}{71 \text{ g mol}^{-1} \times 0,0005 \text{ dm}^3} = \mathbf{0,282 \text{ mol dm}^{-3}}$$

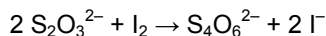
### 5.57. Vidi STEHIOMETRIJA



Odavde proizlazi:

$$n(\text{PbO}_2) = n(\text{I}_2)$$

Izlučeni se jod titrira natrijevim tiosulfatom.

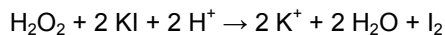


Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = n(\text{PbO}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

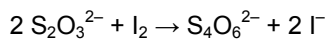
$$\begin{aligned} w(\text{PbO}_2) &= \frac{m(\text{PbO}_2)}{m(\text{uzorak})} = \frac{n(\text{PbO}_2) \times M(\text{PbO}_2)}{m(\text{uzorak})} \\ &= \frac{\frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{PbO}_2)}{m(\text{uzorak})} \\ &= \frac{\frac{1}{2} \times 0,038 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 239,2 \text{ g mol}^{-1}}{0,5 \text{ g}} = \mathbf{0,909} \end{aligned}$$

5.58. Vidi STEHIOMETRIJA



$$n(\text{H}_2\text{O}_2) = n(\text{I}_2)$$

Izlučeni se jod titrira natrijevim tiosulfatom.

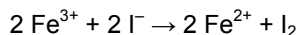


Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = n(\text{H}_2\text{O}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

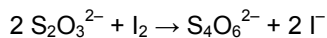
$$\begin{aligned} w(\text{H}_2\text{O}_2) &= \frac{m(\text{H}_2\text{O}_2)}{m(\text{uzorak})} = \frac{n(\text{H}_2\text{O}_2) \times M(\text{H}_2\text{O}_2)}{m(\text{uzorak})} \\ &= \frac{\frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{H}_2\text{O}_2)}{m(\text{uzorak})} \\ &= \frac{\frac{1}{2} \times 0,036 \text{ dm}^3 \times 1 \text{ mol dm}^{-3} \times 34 \text{ g mol}^{-1}}{5 \text{ g}} = \mathbf{0,122} \end{aligned}$$

5.59. Vidi STEHIOMETRIJA



$$n(\text{Fe}^{3+}) = 2 \times n(\text{I}_2)$$

Izlučeni se jod titrira natrijevim tiosulfatom.

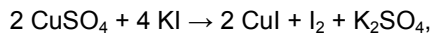


Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = \frac{1}{2} \times n(\text{Fe}^{3+}) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

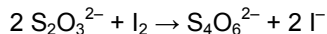
$$\begin{aligned} w(\text{Fe}^{3+}) &= \frac{m(\text{Fe}^{3+})}{m(\text{uzorak})} = \frac{n(\text{Fe}^{3+}) \times M(\text{Fe}^{3+})}{m(\text{uzorak})} \\ &= \frac{V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{Fe}^{3+})}{m(\text{uzorak})} \\ &= \frac{0,025 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 55,85 \text{ g mol}^{-1}}{1 \text{ g}} = \mathbf{0,1396} \end{aligned}$$

5.60. Vidi STEHIOMETRIJA



$$n(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}) = 2 \times n(\text{I}_2)$$

Izlučeni se jod titrira natrijevim tiosulfatom.

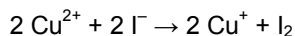


Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{I}_2) = \frac{1}{2} \times n(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

$$\begin{aligned} w(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}) &= \frac{m(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O})}{m(\text{uzorak})} = \frac{n(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}) \times M(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O})}{m(\text{uzorak})} \\ &= \frac{V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{CuSO}_4 \cdot 5 \text{H}_2\text{O})}{m(\text{uzorak})} \\ &= \frac{0,020 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 249,7 \text{ g mol}^{-1}}{0,5 \text{ g}} = \mathbf{0,9988} \end{aligned}$$

5.61. Vidi STEHIOMETRIJA

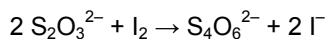


$$n(\text{I}_2) = \frac{1}{2} \times n(\text{Cu}^{2+})$$

Kako nam je zadana masa bakra, proizlazi:

$$n(\text{I}_2) = \frac{m(\text{Cu}^{2+})}{2 \times M(\text{Cu}^{2+})}$$

Izlučeni se jod titrira natrijevim tiosulfatom.

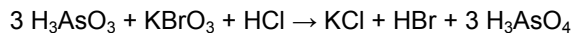


Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n(\text{S}_2\text{O}_3^{2-}) = 2 \times n(\text{I}_2) = 2 \times \frac{m(\text{Cu}^{2+})}{2 \times M(\text{Cu}^{2+})}$$

$$\begin{aligned} c(\text{otop. S}_2\text{O}_3^{2-}) &= \frac{n(\text{S}_2\text{O}_3^{2-})}{V(\text{otop. S}_2\text{O}_3^{2-})} = \frac{m(\text{Cu}^{2+})}{V(\text{otop. S}_2\text{O}_3^{2-}) \times M(\text{Cu}^{2+})} \\ &= \frac{0,2 \text{ g}}{0,025 \text{ dm}^3 \times 63,55 \text{ g mol}^{-1}} = \mathbf{0,126 \text{ mol dm}^{-3}} \end{aligned}$$

### 5.62. Vidi STEHIOMETRIJA



Ioni  $\text{As}^{3+}$  s bromatnim ionima,  $\text{BrO}_3^-$ , reagiraju u molarnom omjeru 3 : 1. Odavde proizlazi:

$$n(\text{As}^{3+}) = 3 \times n(\text{BrO}_3^-)$$

$$m(\text{As}^{3+}) = n(\text{As}^{3+}) \times M(\text{As}^{3+})$$

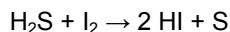
$$= 3 \times n(\text{BrO}_3^-) \times M(\text{As}^{3+})$$

$$= 3 \times V(\text{otop. BrO}_3^-) \times c(\text{BrO}_3^-) \times M(\text{As}^{3+})$$

$$= 3 \times 0,030 \text{ dm}^3 \times \frac{1}{60} \text{ mol dm}^{-3} \times 74,92 \text{ g mol}^{-1} = \mathbf{0,112 \text{ g}}$$

### 5.63. Vidi STEHIOMETRIJA

Otopine sumporovodika i joda međusobno reagiraju u molarnom omjeru 1:1.



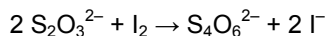
Odavde proizlazi

$$n(\text{I}_2) = n(\text{H}_2\text{S})$$

Množina joda,  $n_1(\text{I}_2)$  dodanog u otopinu sumporovodika je:

$$n_1(\text{I}_2) = \frac{m(\text{I}_2)}{M(\text{I}_2)} = \frac{\gamma(\text{I}_2) \times V(\text{otop. I}_2)}{M(\text{I}_2)} = \frac{12,69 \text{ g dm}^{-3} \times 0,040 \text{ dm}^3}{253,8 \text{ g mol}^{-1}} = \mathbf{0,002 \text{ mol}}$$

Višak joda,  $n_2(\text{I}_2)$ , koji nije reagirao sa sumporovodikom određen je titracijom s natrijevim tiosulfatom.



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n_2(\text{I}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

$$= \frac{1}{2} \times 0,010 \text{ dm}^3 \times 0,05 \text{ mol dm}^{-3} = \mathbf{0,00025 \text{ mol}}$$

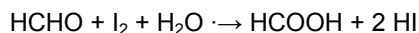
Ako od ukupne množine dodanog joda,  $n_1(\text{I}_2)$ , odbijemo množinu viška joda,  $n_2(\text{I}_2)$ , dobit ćemo množinu joda koja je reagirala sa sumporovodikom, a ta je jednaka množini sumporovodika. Za koncentraciju sumporovodika u otopini konačno dobivamo:

$$c(\text{H}_2\text{S}) = \frac{n(\text{H}_2\text{S})}{V(\text{otop. H}_2\text{S})} = \frac{n(\text{I}_2)}{V(\text{otop. H}_2\text{S})} = \frac{n_1(\text{I}_2) - n_2(\text{I}_2)}{V(\text{otop. H}_2\text{S})}$$

$$= \frac{0,002 \text{ mol} - 0,00025 \text{ mol}}{0,020 \text{ dm}^3} = \mathbf{0,0875 \text{ mol dm}^{-3}}$$

### 5.64. Vidi STEHIOMETRIJA

Formaldehid i jod reagiraju prema sljedećoj jednačbi reakcije:



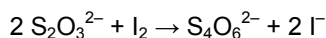
Odavde proizlazi da je

$$n(\text{HCHO}) = n(\text{I}_2)$$

Množina joda,  $n_1(\text{I}_2)$  dodanog u razrijeđenu otopinu formalina je:

$$n_1(\text{I}_2) = V(\text{otop. I}_2) \times c(\text{otop. I}_2)$$

Višak joda,  $n_2(\text{I}_2)$ , koji nije reagirao s formalinom određen je titracijom s natrijevim tiosulfatom.



Tisulfatni ioni i jod reagiraju u molarnom omjeru 2 : 1. Odavde proizlazi:

$$n_2(\text{I}_2) = \frac{1}{2} \times n(\text{S}_2\text{O}_3^{2-}) = \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-})$$

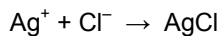
Ako od ukupne dodane množine joda,  $n_1(\text{I}_2)$ , odbijemo množinu viška joda,  $n_2(\text{I}_2)$ , dobit ćemo množinu joda koja je reagirala s 10 cm<sup>3</sup> razrijeđene otopine formalina. Kako je  $n(\text{HCHO}) = n(\text{I}_2)$ , proizlazi:

$$\begin{aligned} n(\text{HCHO}) &= n(\text{I}_2) = n_1(\text{I}_2) - n_2(\text{I}_2) = V(\text{otop. I}_2) \times c(\text{otop. I}_2) - \frac{1}{2} \times V(\text{otop. S}_2\text{O}_3^{2-}) \times c(\text{otop. S}_2\text{O}_3^{2-}) \\ &= 0,040 \text{ dm}^3 \times 0,05 \text{ mol dm}^{-3} - \frac{1}{2} \times 0,010 \text{ dm}^3 \times 0,05 \text{ mol dm}^{-3} \\ &= 0,0020 \text{ mol} - 0,00025 \text{ mol} = \mathbf{0,00175 \text{ mol}} \end{aligned}$$

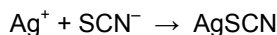
Prema uvjetima zadatka znamo da je 10 g kupovnog "formalina" razrijeđeno na volumen 400 cm<sup>3</sup>, i od te otopine za analizu uzeto 10 cm<sup>3</sup>. To znači da 10 g kupovnog formalina sadržava 400 puta veću množinu formaldehida pa je maseni udio formaldehida u kupovnom formalinu:

$$\begin{aligned} w(\text{HCHO}) &= \frac{40 \times m(\text{HCHO})}{m(\text{formalin})} = \frac{40 \times M(\text{HCHO}) \times n(\text{HCHO})}{m(\text{formalin})} \\ &= \frac{40 \times M(\text{HCHO}) \times [n_1(\text{I}_2) - n_2(\text{I}_2)]}{m(\text{formalin})} \\ &= \frac{40 \times 30 \text{ g mol}^{-1} \times 0,00175 \text{ mol}}{10 \text{ g}} = \mathbf{0,21} \end{aligned}$$

### 5.65. Vidi STEHIOMETRIJA



$$n(\text{Ag}^+) = n(\text{Cl}^-)$$

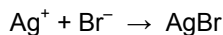


$$n_1(\text{Ag}^+) = n(\text{SCN}^-)$$

$$\begin{aligned} \gamma(\text{Cl}^-) &= \frac{m(\text{Cl}^-)}{V(\text{otop. Cl}^-)} = \frac{n(\text{Cl}^-) \times M(\text{Cl}^-)}{V(\text{otop. Cl}^-)} = \frac{[n(\text{Ag}^+) - n_1(\text{Ag}^+)] \times M(\text{Cl}^-)}{V(\text{otop. Cl}^-)} \\ &= \frac{[V(\text{otop. Ag}^+) \times c(\text{otop. Ag}^+) - V(\text{otop. SCN}^-) \times c(\text{otop. SCN}^-)] \times M(\text{Cl}^-)}{V(\text{otop. Cl}^-)} \\ &= \frac{[0,025 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} - 0,010 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3}] \times 35,45 \text{ g mol}^{-1}}{0,025 \text{ dm}^3} = \mathbf{2,13 \text{ g dm}^{-3}} \end{aligned}$$



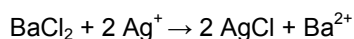
5.66. Vidi STEHIOMETRIJA



$$n(\text{Ag}^+) = n(\text{Br}^-)$$

$$\begin{aligned} \gamma(\text{Br}^-) &= \frac{n(\text{Br}^-) \times M(\text{Br}^-)}{V(\text{otop. Br}^-)} = \frac{V(\text{otop. Ag}^+) \times c(\text{otop. Ag}^+) \times M(\text{Br}^-)}{V(\text{otop. Br}^-)} \\ &= \frac{0,010 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} \times 79,90 \text{ g mol}^{-1}}{0,025 \text{ dm}^3} = \mathbf{3,196 \text{ g dm}^{-3}} \end{aligned}$$

5.67. Vidi STEHIOMETRIJA



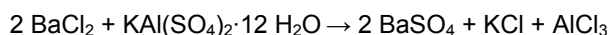
$$n(\text{Ag}^+) = 2 \times n(\text{Ba}^{2+})$$

$$n(\text{Ba}^{2+}) = \frac{m(\text{BaCl}_2 \cdot 2 \text{H}_2\text{O})}{M(\text{BaCl}_2 \cdot 2 \text{H}_2\text{O})}$$

$$n(\text{Ag}^+) = V(\text{otop. Ag}^+) \times c(\text{otop. Ag}^+)$$

$$\begin{aligned} V(\text{otop. Ag}^+) &= \frac{n(\text{Ag}^+)}{c(\text{otop. Ag}^+)} = \frac{2 \times n(\text{Ba}^{2+})}{c(\text{otop. Ag}^+)} = \frac{2 \times m(\text{BaCl}_2 \cdot 2 \text{H}_2\text{O})}{c(\text{otop. Ag}^+) \times M(\text{BaCl}_2 \cdot 2 \text{H}_2\text{O})} \\ &= \frac{2 \times 0,25 \text{ g}}{0,15 \text{ mol dm}^{-3} \times 244,25 \text{ g mol}^{-1}} \cdot 0,01365 \text{ dm}^3 = \mathbf{13,65 \text{ cm}^3}. \end{aligned}$$

5.68. Vidi STEHIOMETRIJA



Barijev klorid i alaun reagiraju u molarnom omjeru 2:1, pa vrijedi

$$n(\text{BaCl}_2) = 2 \times n(\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O})$$

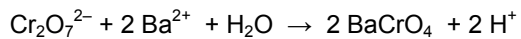
Kako je

$$n = V \times c$$

Za volumen otopine  $\text{BaCl}_2$  dobivamo:

$$\begin{aligned} V(\text{otop. BaCl}_2) &= \frac{n(\text{BaCl}_2)}{c(\text{otop. BaCl}_2)} = \frac{2 \times n(\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O})}{c(\text{otop. BaCl}_2)} \\ &= \frac{2 \times m(\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O})}{c(\text{otop. BaCl}_2) \times M(\text{KAl}(\text{SO}_4)_2 \cdot 12 \text{H}_2\text{O})} \\ &= \frac{2 \times 0,5 \text{ g}}{0,05 \text{ mol dm}^{-3} \times 474,4 \text{ g mol}^{-1}} = 0,04216 \text{ dm}^3 = \mathbf{42,16 \text{ cm}^3} \end{aligned}$$

5.69. Vidi STEHIOMETRIJA



Bikromatni i barijevi ioni reagiraju u molarnom omjeru 1 : 2. Odavde proizlazi:

$$n(\text{Cr}_2\text{O}_7^{2-}) = \frac{1}{2} \times n(\text{Ba}^{2+})$$

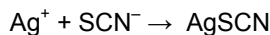
Kako je

$$n = V \times c$$

Za volumen otopine kalijeva bikromata dobivamo.

$$\begin{aligned} V(\text{otop. K}_2\text{Cr}_2\text{O}_7) &= \frac{n(\text{K}_2\text{Cr}_2\text{O}_7)}{c(\text{otop. K}_2\text{Cr}_2\text{O}_7)} = \frac{\frac{1}{2} \times n(\text{BaCl}_2)}{c(\text{otop. K}_2\text{Cr}_2\text{O}_7)} = \frac{\frac{1}{2} \times m(\text{BaCl}_2)}{c(\text{otop. K}_2\text{Cr}_2\text{O}_7) \times M(\text{BaCl}_2)} \\ &= \frac{\frac{1}{2} \times 0,244 \text{ g}}{\frac{1}{60} \text{ mol dm}^{-3} \times 244,28 \text{ g mol}^{-1}} = 0,02996 \text{ dm}^3 = \mathbf{29,96 \text{ cm}^3} \end{aligned}$$

## 5.70. Vidi STEHIOMETRIJA



$$n(\text{Ag}^+) = n(\text{SCN}^-)$$

Izračunajmo najprije množinu iona srebra,  $n(\text{Ag}^+)$ , upotrijebljenih za taloženje klorida i jodida iz smjese  $\text{BaCl}_2$  i  $\text{BaI}_2$  tako da od dodane množine iona,  $n_1(\text{Ag}^+)$  odbijemo višak, odnosno onu množinu iona,  $n_2(\text{Ag}^+)$ , koja je reagirala s otopinom KSCN.

$$\begin{aligned} n(\text{Ag}^+) &= n_1(\text{Ag}^+) - n_2(\text{Ag}^+) = V(\text{otop. AgNO}_3) \times c(\text{otop. AgNO}_3) - V(\text{otop. KSCN}) \times c(\text{otop. KSCN}) \\ &= 0,040 \text{ dm}^3 \times 0,2 \text{ mol dm}^{-3} - 0,0133 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} = \mathbf{0,00667 \text{ mol}} \end{aligned}$$

Možemo napisati dvije jednadžbe:

$$m(\text{BaCl}_2) + m(\text{BaI}_2) = 1 \text{ g}$$

$$n(\text{Cl}^-) + n(\text{I}^-) = 0,00667 \text{ mol}$$

uzmemo li da je

$$m(\text{BaCl}_2) = x$$

$$m(\text{BaI}_2) = y$$

i cijeli izraz podijelimo jedinicom mase dobivamo

$$x + y = 1 \quad (1)$$

Druga jednadžba mora uzeti u obzir množinu kloridnih i jodidnih iona. Ne zaboravimo da je množina kloridnih i jodidnih iona dva puta veća od množine barijeva klorida i jodida, pa vrijedi

$$\frac{2 \times m(\text{BaCl}_2)}{M(\text{BaCl}_2)} + \frac{2 \times m(\text{BaI}_2)}{M(\text{BaI}_2)} = 0,00667 \text{ mol}$$

Ako cjelu jednadžbu podijelimo s 2 i s jedinicom množine, te uvrstimo nepoznanice x i y, dobivamo:

$$\frac{x}{208,25} + \frac{y}{391,15} = 0,003335 \quad (2)$$

Izlučimo iz prve jednadžbe x i uvrstimo u drugu jednadžbu pa dobivamo:

$$\frac{1 - y}{208,25} + \frac{y}{391,15} = 0,003335$$

odnosno

$$0,004802 - 0,004802 y + 0,002556 y = 0,003335$$

Oдавde proizlazi

$$0,001467 = 0,002246 y$$

odnosno

$$y = \frac{0,001467}{0,002246} = 0,6532$$

Kako je  $m(\text{BaI}_2) = y$

slijedi

$$m(\text{BaI}_2) = 0,653 \text{ g}$$

$$m(\text{BaCl}_2) = 0,347 \text{ g}$$

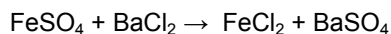
$$w(\text{I}) = \frac{m(\text{BaI}_2) \times M(\text{I}_2)}{m(\text{uzorak}) \times M(\text{BaI}_2)} = \frac{0,653 \text{ g} \times 253,8 \text{ g mol}^{-1}}{1,0 \text{ g} \times 391,15 \text{ g mol}^{-1}} = \mathbf{0,424}$$

### 5.71. Vidi STEHIOMETRIJA

$$w(\text{Fe}, \text{FeSO}_4 \cdot 7\text{H}_2\text{O}) = \frac{M_r(\text{Fe})}{M_r(\text{FeSO}_4 \cdot 7\text{H}_2\text{O})} = \frac{55,85}{278,05} = 0,2008 = 20,08 \%$$

Za taloženje je utrošeno  $20,08 \text{ cm}^3$  otopine barijeva klorida,  $c(\text{BaCl}_2) = 0,1 \text{ mol dm}^{-3}$ .

$$n(\text{BaCl}_2) = V(\text{otop. BaCl}_2) \times c(\text{otop. BaCl}_2) = 20,08 \text{ cm}^3 \times 0,1 \text{ mol dm}^{-3} = 0,002008 \text{ mol.}$$



Željezov(II) sulfat heptahidrat i barijev klorid reagiraju u molarnom omjeru 1 : 1. Odavde proizlazi:

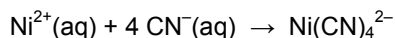
$$n(\text{BaCl}_2) = n(\text{FeSO}_4)$$

Za masu uzorka željezova(II) sulfata heptahidrata dobivamo:

$$\begin{aligned} m(\text{FeSO}_4 \cdot 7\text{H}_2\text{O}) &= n(\text{BaCl}_2) \times M(\text{FeSO}_4 \cdot 7\text{H}_2\text{O}) \\ &= 0,002008 \text{ mol} \times 278,05 \text{ g mol}^{-1} = \mathbf{0,5583 \text{ g}} \end{aligned}$$

### 5.72. Vidi STEHIOMETRIJA

$$m(\text{Ni}) = m(\text{uzorak}) \times w(\text{Ni}) = 0,50 \text{ g} \times 0,10 = 0,050 \text{ g}$$



Ioni  $\text{Ni}^{2+}$  i ioni  $\text{CN}^{-}$  međusobno reagiraju u molarnom omjeru 1 : 4. Odavde proizlazi:

$$n(\text{CN}^{-}) = 4 \times n(\text{Ni}) = 4 \times \frac{m(\text{Ni})}{M(\text{Ni})} = 4 \times \frac{0,050 \text{ g}}{58,69 \text{ g mol}^{-1}} = \mathbf{0,003408 \text{ mol}}$$

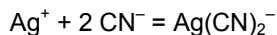
Množina dodanog kalijeva cijanida, iskazana kao  $n_1(\text{CN}^{-})$  je:

$$n_1(\text{CN}^{-}) = V(\text{otop. KCN}) \times c(\text{otop. KCN}) = 0,0500 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} = \mathbf{0,0050 \text{ mol}}$$

Višak cijanidnih iona,  $n_2(\text{CN}^{-})$  je:

$$n_2(\text{CN}^{-}) = n_1(\text{CN}^{-}) - n(\text{CN}^{-}) = \mathbf{0,0050 \text{ mol} - 0,003408 \text{ mol} = 0,001592 \text{ mol}}$$

Srebrovi i cijanidni ioni reagiraju prema jednadžbi:



Dodatak sljedeća kapi otopine srebrova nitrata uzrokuje zamućenje otopin.

Odavde proizlazi:

$$n(\text{Ag}^{+}) = 2 n(\text{CN}^{-})$$

Volumen otopine srebrova nitrata potreban za taloženje viška cijanidnih iona je

$$V(\text{otop. Ag}^{+}) = \frac{n(\text{Ag}^{+})}{2 \times c(\text{otop. Ag}^{+})} = \frac{0,001592 \text{ mol}}{0,2 \text{ mol dm}^{-3}} = 0,00796 \text{ dm}^3 = \mathbf{7,96 \text{ cm}^3}$$

### 5.73. Vidi STEHIOMETRIJA

Masa smjese KCl i NaCl = 0,209 g

Množina klorida u smjesi određena je titracijom srebrovim nitratom prema jednažbi:

$\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$ ; Odavde proizlazi:

$$n(\text{Ag}^+) = n(\text{Cl}^-) = n(\text{Na}^+) + n(\text{K}^+) = 0,0314 \text{ dm}^3 \times 0,1 \text{ mol dm}^{-3} = 0,00314 \text{ mol}.$$

Možemo napisati dvije jednažbe:

$$m(\text{NaCl}) + m(\text{KCl}) = 0,209 \text{ g}$$

$$n(\text{Na}^+) + n(\text{K}^+) = 0,00314 \text{ mol}$$

uzmemo li da je:

$$m(\text{NaCl}) = x, \quad m(\text{KCl}) = y,$$

i cijeli izraz podijelimo jedinicom mase dobivamo

$$x + y = 0,209 \quad (1)$$

Druga jednažba mora uzeti u obzir množinu natrijevih i kloridnih iona.

$$\frac{m(\text{NaCl})}{M(\text{NaCl})} + \frac{m(\text{KCl})}{M(\text{KCl})} = 0,00314 \text{ mol}$$

Ako cjelu jednažbu podijelimo jedinicom množine, te uvrstimo nepoznanice x i y, dobivamo:

$$\frac{x}{58,44} + \frac{y}{74,56} = 0,00314 \quad (2)$$

Izlučimo iz prve jednažbe x i uvrstimo u drugu jednažbu pa dobivamo:

$$\frac{0,209 - y}{58,44} + \frac{y}{74,56} = 0,00314$$

odnosno

$$0,003576 - 0,01711 y + 0,013412 y = 0,00314$$

Odavde proizlazi

$$0,003698 y = 0,000436$$

odnosno

$$y = \frac{0,000436}{0,003698} = 0,1179$$

Kako je  $m(\text{KCl}) = y$ , slijedi

$$m(\text{KCl}) = 0,1179 \text{ g}$$

$$m(\text{NaCl}) = 0,209 \text{ g} - 0,1179 \text{ g} = 0,0911 \text{ g}$$

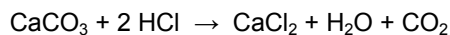
$$c(\text{NaCl}) = \frac{n(\text{NaCl})}{V(\text{otop. NaCl})} = \frac{m(\text{NaCl})}{M(\text{NaCl}) \times V(\text{otop. NaCl})} = \frac{0,0911 \text{ g}}{58,44 \text{ g mol}^{-1} \times 0,025 \text{ dm}^3} = 0,06235 \text{ mol dm}^{-3}$$

$$c(\text{KCl}) = \frac{n(\text{KCl})}{V(\text{otop. KCl})} = \frac{m(\text{KCl})}{M(\text{KCl}) \times V(\text{otop. KCl})} = \frac{0,1179 \text{ g}}{74,56 \text{ g mol}^{-1} \times 0,025 \text{ dm}^3} = 0,06325 \text{ mol dm}^{-3}$$

Zadatak je postavljen tako da su koncentracije NaCl i KCl jednake. Razlika koncentracija u rješenju uzrokovana je zaokruživanjem međurezultata s kojima se ušlo u rješavanje algebarske jednažbe.

#### 5.74. Vidi STEHIOMETRIJA

Napišimo jednadžbu reakcije otapanja kalcijeva karbonata (mineral kalcit) u klorovodičnoj kiselini.



Kalciti i klorovodična kiselina reagiraju u molarnom omjeru 1 : 2. Odavde proizlazi:

$$2 \times n(\text{CaCO}_3) = n(\text{HCl})$$

$$\text{Kako je } n(\text{CaCO}_3) = \frac{m(\text{CaCO}_3)}{M(\text{CaCO}_3)} = \frac{0,5 \text{ g}}{100 \text{ g mol}^{-1}} = 0,005 \text{ mol}$$

proizlazi

$$n(\text{HCl}) = 2 \times n(\text{CaCO}_3) = 2 \times 0,005 \text{ mol} = 0,010 \text{ mol}$$

Za koncentraciju klorovodične kiseline dobivamo:

$$c(\text{HCl}) = \frac{n(\text{HCl})}{V(\text{otop. HCl})} = \frac{0,010 \text{ mol}}{0,050 \text{ dm}^3} = \mathbf{0,20 \text{ mol dm}^{-3}}$$

Za taloženje klorida utrošeno je 40 cm<sup>3</sup> otopine srebrova nitrata kojemu je koncentracija:

$$c(\text{AgNO}_3) = \frac{n(\text{HCl})}{V(\text{otop. AgNO}_3)} = \frac{0,010 \text{ mol}}{0,040 \text{ dm}^3} = \mathbf{0,25 \text{ mol dm}^{-3}}.$$

#### 5.75. Vidi STEHIOMETRIJA

$$m(\text{NaCl}) = w(\text{NaCl}) \times m(\text{uzorak}) = 0,02 \times 0,1 \text{ g} = 0,002 \text{ g}$$

$$n(\text{NaCl}) = \frac{m(\text{NaCl})}{M(\text{NaCl})}$$

$$m(\text{KCl}) = w(\text{KCl}) \times m(\text{uzorak}) = 0,98 \times 0,1 \text{ g} = 0,098 \text{ g}$$

$$n(\text{KCl}) = \frac{m(\text{KCl})}{M(\text{KCl})}$$

Kloridni ioni i srebrovi ioni reagiraju u molarnom omjeru 1 : 1 pa slijedi da je množina srebrova nitrata potrebna za taloženje klorida

$$n(\text{AgNO}_3) = n(\text{KCl}) + n(\text{NaCl}) = n(\text{Cl}^-)$$

Volumen otopine srebrova nitrata potreban za taloženje kloridnih iona je:

$$\begin{aligned} V(\text{otop. AgNO}_3) &= \frac{n(\text{Cl}^-)}{c(\text{otop. AgNO}_3)} = \frac{n(\text{KCl}) + n(\text{NaCl})}{c(\text{otop. AgNO}_3)} \\ &= \frac{m(\text{KCl})}{M(\text{KCl}) \times c(\text{otop. AgNO}_3)} + \frac{m(\text{NaCl})}{M(\text{NaCl}) \times c(\text{otop. AgNO}_3)} \\ &= \frac{0,098 \text{ g}}{74,56 \text{ g mol}^{-1} \times 0,1 \text{ mol dm}^{-3}} + \frac{0,002 \text{ g}}{58,44 \text{ g mol}^{-1} \times 0,1 \text{ mol dm}^{-3}} = \mathbf{0,01349 \text{ dm}^3} \end{aligned}$$

### 5.76. Vidi STEHIOMETRIJA

Množinski udio elementa u spoju jednak je omjeru množine tog elementa prema ukupnoj množini svih elemenata u spoju ili formulskoj jedinki spoja.

$$\text{NaCl} \quad x(\text{Na}) = \frac{1}{2} = \mathbf{0,50} \quad x(\text{Cl}) = \frac{1}{2} = \mathbf{0,50}$$

$$\text{H}_3\text{PO}_4 \quad x(\text{H}) = \frac{3}{8} = \mathbf{0,375} \quad x(\text{P}) = \frac{1}{8} = \mathbf{0,125} \quad x(\text{O}) = \frac{4}{8} = \mathbf{0,50}$$

$$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O} \quad x(\text{H}) = \frac{20}{43} = \mathbf{0,465} \quad x(\text{O}) = \frac{17}{43} = \mathbf{0,395}$$

$$x(\text{B}) = \frac{4}{43} = \mathbf{0,093} \quad x(\text{Na}) = \frac{2}{43} = \mathbf{0,047}$$

Zbroj svih udjela sastojaka smjese ili spoja mora biti 1.

### 5.77. Vidi STEHIOMETRIJA

Treba izračunati množinu vode i množinu alkohola. Djeljenjem množine vode (ili alkohola) s ukupnom množinom tvari u smjesi (vode i alkohola) dobivamo množinski udio vode (ili alkohola) u smjesi.

$$n(\text{H}_2\text{O}) = \frac{m(\text{H}_2\text{O})}{M(\text{H}_2\text{O})} = \frac{30 \text{ g}}{18 \text{ g mol}^{-1}} = 1,667 \text{ mol}$$

$$n(\text{C}_2\text{H}_5\text{OH}) = \frac{m(\text{C}_2\text{H}_5\text{OH})}{M(\text{C}_2\text{H}_5\text{OH})} = \frac{50 \text{ g}}{46 \text{ g mol}^{-1}} = 1,087 \text{ mol}$$

$$\hline 2,754 \text{ mol}$$

$$x(\text{H}_2\text{O}) = \frac{n(\text{H}_2\text{O})}{n(\text{H}_2\text{O}) + n(\text{C}_2\text{H}_5\text{OH})} = \frac{1,667 \text{ mol}}{2,754 \text{ mol}} = \mathbf{0,605}$$

$$x(\text{C}_2\text{H}_5\text{OH}) = \frac{n(\text{C}_2\text{H}_5\text{OH})}{n(\text{H}_2\text{O}) + n(\text{C}_2\text{H}_5\text{OH})} = \frac{1,087 \text{ mol}}{2,754 \text{ mol}} = \mathbf{0,395}$$

### 5.78. Vidi STEHIOMETRIJA

Maseni udio sastojaka u smjesi jednak je omjeru mase pojedinog sastojka prema ukupnoj masi sastojaka smjese.

$$w(\text{Cu}) = \mathbf{0,745}$$

$$w(\text{Zn}) = 1 - w(\text{Cu}) = 1 - 0,745 = 0,255$$

Množinski udio sastojaka u smjesi jednak je omjeru množine pojedinog sastojka prema ukupnoj množini svih sastojaka smjese.

Primjerice, u 100 g zadane slitine (legure) za množinu bakra i cinka dobivamo:

$$n(\text{Cu}) = \frac{m(\text{Cu})}{M(\text{Cu})} = \frac{74,5 \text{ g}}{63,55 \text{ g mol}^{-1}} = 1,172 \text{ mol}$$

$$n(\text{Zn}) = \frac{m(\text{Zn})}{M(\text{Zn})} = \frac{25,5 \text{ g}}{65,41 \text{ g mol}^{-1}} = 0,390 \text{ mol}$$


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$$\mathbf{1,562 \text{ mol}}$$

$$x(\text{Cu}) = \frac{n(\text{Cu})}{n(\text{Cu}) + n(\text{Zn})} = \frac{1,172 \text{ mol}}{1,562 \text{ mol}} = \mathbf{0,750}$$

$$x(\text{Zn}) = \frac{n(\text{Zn})}{n(\text{Cu}) + n(\text{Zn})} = \frac{0,390 \text{ mol}}{1,562 \text{ mol}} = 0,250$$

### 5.79. Vidi STEHIOMETRIJA

Vidi zadatke 5.76., 5.77. i 5.78.

$$x(\text{U}) = \frac{4}{12} = \mathbf{0,333} \quad x(\text{Mo}) = \frac{5}{12} = \mathbf{0,417} \quad x(\text{Si}) = \frac{3}{12} = \mathbf{0,250}$$

$$M_r(\text{U}_4\text{Mo}_5\text{Si}_3) = 4 A_r(\text{U}) + 5 A_r(\text{Mo}) + 3 A_r(\text{Si}) = 4 \times 238 + 5 \times 95,94 + 3 \times 28,09 = 1516$$

Da bismo doznali koliko treba odvagati pojedinih sastojaka za pripremu 100 g slitine (legure) moramo izračunati njihov maseni udio u spoju. Maseni udio pojedinog sastojka (elementa), iskazan u postotcima, brojčano je jednak masi tog sastojka potreban za pripremu 100 g slitine.

$$w(\text{U}) = \frac{4 A_r(\text{U})}{M_r(\text{U}_4\text{Mo}_5\text{Si}_3)} = \frac{4 \times 238}{1516} = 0,628 = 62,8 \% \quad m(\text{U}) = \mathbf{62,8 \text{ g}}$$

$$w(\text{Mo}) = \frac{5 A_r(\text{Mo})}{M_r(\text{U}_4\text{Mo}_5\text{Si}_3)} = \frac{5 \times 95,94}{1516} = 0,316 = 31,6 \% \quad m(\text{Mo}) = \mathbf{31,6 \text{ g}}$$

$$w(\text{Si}) = \frac{3 A_r(\text{Si})}{M_r(\text{U}_4\text{Mo}_5\text{Si}_3)} = \frac{3 \times 28,09}{1516} = 0,056 = 5,6 \% \quad m(\text{Si}) = \mathbf{5,6 \text{ g}}$$

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100 g



5.80. Vidi STEHIOMETRIJA

$$x(\text{Fe}) = \frac{3}{4} = \mathbf{0,75}$$

$$x(\text{C}) = \frac{1}{4} = \mathbf{0,25}$$

$$M_r(\text{Fe}_3\text{C}) = 3 \times A_r(\text{Fe}) + A_r(\text{C}) = 3 \times 55,85 + 12 = 179,55$$

$$w(\text{Fe}) = \frac{3 \times A_r(\text{Fe})}{M_r(\text{Fe}_3\text{C})} = \frac{3 \times 55,85}{179,55} = \mathbf{0,933}$$

$$w(\text{C}) = \frac{3 \times A_r(\text{C})}{M_r(\text{Fe}_3\text{C})} = \frac{12}{179,55} = \mathbf{0,067}$$

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1,000