

Fachmathematik für Chemielaboranten

Lösungen

Sabine Meißner

Henning Schnitger

Matthias Weber

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geben jeweils die Buchseite der „Fachmathematik für Chemielaboranten“ an, auf der die betreffenden Aufgaben stehen.

1 Stöchiometrie

1.1 Molare Masse und Stoffmenge

Seite 8

Ü 1 a) $M(\text{MgCl}_2) = M(\text{Mg}) + 2 \cdot M(\text{Cl}) = 24,305 \text{ g/mol} + 2 \cdot 35,453 \text{ g/mol} = \underline{95,211 \text{ g/mol}}$

b) $M(\text{CaCO}_3) = M(\text{Ca}) + M(\text{C}) + 3 \cdot M(\text{O}) = 40,08 \text{ g/mol} + 12,011 \text{ g/mol} + 3 \cdot 15,999 \text{ g/mol} = \underline{100,1 \text{ g/mol}}$

c) $M(\text{K}_2\text{SO}_4) = 2 \cdot M(\text{K}) + M(\text{S}) + 4 \cdot M(\text{O}) = 2 \cdot 39,098 \text{ g/mol} + 32,06 \text{ g/mol} + 4 \cdot 15,999 \text{ g/mol} = \underline{174,3 \text{ g/mol}}$

d) $M(\text{Na}_3\text{PO}_4) = 3 \cdot M(\text{Na}) + M(\text{P}) + 4 \cdot M(\text{O}) = 3 \cdot 22,990 \text{ g/mol} + 30,974 \text{ g/mol} + 4 \cdot 15,999 \text{ g/mol} = \underline{163,94 \text{ g/mol}}$

e) $M(\text{AlCl}_3) = M(\text{Al}) + 3 \cdot M(\text{Cl}) = 26,982 \text{ g/mol} + 3 \cdot 35,453 \text{ g/mol} = \underline{133,34 \text{ g/mol}}$

f) $M(\text{BaCrO}_4) = M(\text{Ba}) + M(\text{Cr}) + 4 \cdot M(\text{O}) = 137,33 \text{ g/mol} + 51,996 \text{ g/mol} + 4 \cdot 15,999 \text{ g/mol} = \underline{253,32 \text{ g/mol}}$

g) $M(\text{KClO}_4) = M(\text{K}) + M(\text{Cl}) + 4 \cdot M(\text{O}) = 39,098 \text{ g/mol} + 35,453 \text{ g/mol} + 4 \cdot 15,999 \text{ g/mol} = \underline{138,55 \text{ g/mol}}$

h) $M(\text{Zn}_2\text{P}_2\text{O}_7) = 2 \cdot M(\text{Zn}) + 2 \cdot M(\text{P}) + 7 \cdot M(\text{O}) = 2 \cdot 65,38 \text{ g/mol} + 2 \cdot 30,974 \text{ g/mol} + 7 \cdot 15,999 \text{ g/mol} = \underline{304,7 \text{ g/mol}}$

i) $M(\text{Co}(\text{NO}_3)_2 \cdot 6 \text{H}_2\text{O}) = M(\text{Co}) + 2 \cdot M(\text{N}) + 12 \cdot M(\text{O}) + 12 \cdot M(\text{H}) + 2 \cdot 14,007 \text{ g/mol} + 12 \cdot 15,999 \text{ g/mol} + 12 \cdot 1,0079 \text{ g/mol} = \underline{291,03 \text{ g/mol}}$

j) $M(\text{H}_2\text{C}_2\text{O}_4 \cdot 2 \text{H}_2\text{O}) = 2 \cdot M(\text{C}) + 6 \cdot M(\text{O}) + 6 \cdot M(\text{H}) = 2 \cdot 12,011 \text{ g/mol} + 6 \cdot 15,999 \text{ g/mol} + 6 \cdot 1,0079 \text{ g/mol} = \underline{126,06 \text{ g/mol}}$

k) $M(\text{C}_2\text{H}_5\text{OH}) = 2 \cdot M(\text{C}) + M(\text{O}) + 6 \cdot M(\text{H}) = 2 \cdot 12,011 \text{ g/mol} + 15,999 \text{ g/mol} + 6 \cdot 1,0079 \text{ g/mol} = \underline{46,068 \text{ g/mol}}$

l) $M(\text{C}_6\text{H}_5\text{COOH}) = 7 \cdot M(\text{C}) + 2 \cdot M(\text{O}) + 6 \cdot M(\text{H}) = 7 \cdot 12,011 \text{ g/mol} + 2 \cdot 15,999 \text{ g/mol} + 6 \cdot 1,0079 \text{ g/mol} = \underline{122,12 \text{ g/mol}}$

Ü 2 $M(\text{Ag}) = w(^{107}\text{Ag}) \cdot M(^{107}\text{Ag}) + w(^{109}\text{Ag}) \cdot M(^{109}\text{Ag}) = 0,518390 \cdot 106,905093 \text{ g/mol} + 0,481610 \cdot 108,904756 \text{ g/mol} = \underline{107,868 \text{ g/mol}}$

Ü 3 $M(\text{Mg}) = w(^{24}\text{Mg}) \cdot M(^{24}\text{Mg}) + w(^{25}\text{Mg}) \cdot M(^{25}\text{Mg}) + w(^{26}\text{Mg}) \cdot M(^{26}\text{Mg}) = 0,789900 \cdot 23,9850419 \text{ g/mol} + 0,100000 \cdot 24,9858370 \text{ g/mol} + 0,110100 \cdot 25,9825930 \text{ g/mol} = \underline{24,3051 \text{ g/mol}}$

Ü 4 $M(\text{Si}) = w(^{28}\text{Si}) \cdot M(^{28}\text{Si}) + w(^{29}\text{Si}) \cdot M(^{29}\text{Si}) + w(^{30}\text{Si}) \cdot M(^{30}\text{Si}) = 0,922300 \cdot 27,97692653 \text{ g/mol} + 0,0467000 \cdot 28,97649472 \text{ g/mol} + 0,0310000 \cdot 29,97377022 \text{ g/mol} = \underline{28,0855 \text{ g/mol}}$

Ü 5 a) $n(\text{NaCN}) = \frac{m(\text{NaCN})}{M(\text{NaCN})} = \frac{6,250 \text{ mg}}{1000 \text{ mg/g} \cdot 49,01 \text{ g/mol}} = \underline{1,275 \cdot 10^{-4} \text{ mol}}$

b) $n(\text{Mg}(\text{OH})_2) = \frac{m(\text{Mg}(\text{OH})_2)}{M(\text{Mg}(\text{OH})_2)} = \frac{45,69 \text{ mg}}{1000 \text{ mg/g} \cdot 58,32 \text{ g/mol}} = \underline{7,834 \cdot 10^{-4} \text{ mol}}$

c) $n((\text{NH}_4)_2\text{CO}_3) = \frac{m((\text{NH}_4)_2\text{CO}_3)}{M((\text{NH}_4)_2\text{CO}_3)} = \frac{248,2 \text{ mg}}{1000 \text{ mg/g} \cdot 96,09 \text{ g/mol}} = \underline{2,583 \cdot 10^{-3} \text{ mol}}$

$$d) n(\text{NiSO}_4) = \frac{m(\text{NiSO}_4)}{M(\text{NiSO}_4)} = \frac{7145 \text{ mg}}{1000 \text{ mg/g} \cdot 154,8 \text{ g/mol}} = \underline{4,616 \cdot 10^{-2} \text{ mol}}$$

$$e) n(\text{CaF}_2) = \frac{m(\text{CaF}_2)}{M(\text{CaF}_2)} = \frac{0,1710 \text{ g}}{78,08 \text{ g/mol}} = \underline{2,190 \cdot 10^{-3} \text{ mol}}$$

$$f) n(\text{PbCl}_2) = \frac{m(\text{PbCl}_2)}{M(\text{PbCl}_2)} = \frac{2,482 \text{ g}}{278,1 \text{ g/mol}} = \underline{8,925 \cdot 10^{-3} \text{ mol}}$$

$$g) n(\text{CuS}) = \frac{m(\text{CuS})}{M(\text{CuS})} = \frac{57,35 \text{ g}}{95,61 \text{ g/mol}} = \underline{0,5998 \text{ mol}}$$

$$h) n(\text{KBr}) = \frac{m(\text{KBr})}{M(\text{KBr})} = \frac{872,5 \text{ g}}{119,0 \text{ g/mol}} = \underline{7,332 \text{ mol}}$$

$$i) n(\text{AgNO}_3) = \frac{m(\text{AgNO}_3)}{M(\text{AgNO}_3)} = \frac{1674 \text{ g}}{169,9 \text{ g/mol}} = \underline{9,853 \text{ mol}}$$

$$j) n(\text{BaSO}_4) = \frac{m(\text{BaSO}_4)}{M(\text{BaSO}_4)} = \frac{0,6255 \text{ kg} \cdot 1000 \text{ g/kg}}{233,4 \text{ g/mol}} = \underline{2,680 \text{ mol}}$$

$$k) n(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O}) = \frac{m(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O})}{M(\text{FeSO}_4 \cdot 7 \text{ H}_2\text{O})} = \frac{3,755 \text{ kg} \cdot 1000 \text{ g/kg}}{278,0 \text{ g/mol}} = \underline{13,51 \text{ mol}}$$

$$l) n(\text{V}_2\text{O}_5) = \frac{m(\text{V}_2\text{O}_5)}{M(\text{V}_2\text{O}_5)} = \frac{12,55 \text{ kg} \cdot 1000 \text{ g/kg}}{181,9 \text{ g/mol}} = \underline{68,99 \text{ mol}}$$

$$\text{Ü 6 } n(\text{NaNO}_3) = \frac{m(\text{NaNO}_3)}{M(\text{NaNO}_3)} = \frac{132,6 \text{ g}}{85,00 \text{ g/mol}} = \underline{1,560 \text{ mol}}$$

$$n(\text{Na}) = n(\text{NaNO}_3) = \underline{1,560 \text{ mol}}$$

$$n(\text{N}) = n(\text{NaNO}_3) = \underline{1,560 \text{ mol}}$$

$$n(\text{O}) = 3 \cdot n(\text{NaNO}_3) = 3 \cdot 1,560 \text{ mol} = \underline{4,680 \text{ mol}}$$

$$\text{Ü 7 } n(\text{K}_2\text{CrO}_4) = \frac{m(\text{K}_2\text{CrO}_4)}{M(\text{K}_2\text{CrO}_4)} = \frac{250,00 \text{ g}}{194,19 \text{ g/mol}} = \underline{1,2874 \text{ mol}}$$

$$n(\text{K}) = 2 \cdot n(\text{K}_2\text{CrO}_4) = 2 \cdot 1,2874 \text{ mol} = \underline{2,5748 \text{ mol}}$$

$$n(\text{Cr}) = n(\text{K}_2\text{CrO}_4) = \underline{1,2874 \text{ mol}}$$

$$n(\text{O}) = 4 \cdot n(\text{K}_2\text{CrO}_4) = 4 \cdot 1,2874 \text{ mol} = \underline{5,1496 \text{ mol}}$$

$$\text{Ü 8 } a) m(\text{KOH}) = n(\text{KOH}) \cdot M(\text{KOH}) = 0,262 \text{ mol} \cdot 56,1 \text{ g/mol} = \underline{14,7 \text{ g}}$$

$$b) m(\text{CaCl}_2) = n(\text{CaCl}_2) \cdot M(\text{CaCl}_2) = 2,18 \text{ mol} \cdot 111 \text{ g/mol} = \underline{242 \text{ g}}$$

$$c) m(\text{KMnO}_4) = n(\text{KMnO}_4) \cdot M(\text{KMnO}_4) = 0,107 \text{ mol} \cdot 158 \text{ g/mol} = \underline{16,9 \text{ g}}$$

$$d) m(\text{H}_2\text{SO}_4) = n(\text{H}_2\text{SO}_4) \cdot M(\text{H}_2\text{SO}_4) = 0,162 \text{ mol} \cdot 98,1 \text{ g/mol} = \underline{15,9 \text{ g}}$$

$$e) m(\text{KNO}_3) = n(\text{KNO}_3) \cdot M(\text{KNO}_3) = 1,04 \text{ mol} \cdot 101 \text{ g/mol} = \underline{105 \text{ g}}$$

$$f) m(\text{H}_2\text{C}_2\text{O}_4) = n(\text{H}_2\text{C}_2\text{O}_4) \cdot M(\text{H}_2\text{C}_2\text{O}_4) = 0,500 \text{ mol} \cdot 90,0 \text{ g/mol} = \underline{45,0 \text{ g}}$$

$$g) m(\text{NH}_4\text{Cl}) = n(\text{NH}_4\text{Cl}) \cdot M(\text{NH}_4\text{Cl}) = 1,72 \text{ mol} \cdot 53,5 \text{ g/mol} = \underline{92,0 \text{ g}}$$

$$h) m(\text{Na}_2\text{S}_2\text{O}_3) = n(\text{Na}_2\text{S}_2\text{O}_3) \cdot M(\text{Na}_2\text{S}_2\text{O}_3) = 0,624 \text{ mol} \cdot 158 \text{ g/mol} = \underline{98,6 \text{ g}}$$

$$\text{i) } m(\text{KCl}) = n(\text{KCl}) \cdot M(\text{KCl}) = 0,4122 \text{ mol} \cdot 74,5 \text{ g/mol} = \underline{30,7 \text{ g}}$$

$$\text{j) } m(\text{Na}_2\text{CO}_3) = n(\text{Na}_2\text{CO}_3) \cdot M(\text{Na}_2\text{CO}_3) = 1,67 \text{ mol} \cdot 106 \text{ g/mol} = \underline{177 \text{ g}}$$

$$\text{k) } m(\text{KBrO}_3) = n(\text{KBrO}_3) \cdot M(\text{KBrO}_3) = 0,0321 \text{ mol} \cdot 167 \text{ g/mol} = \underline{5,36 \text{ g}}$$

$$\text{l) } m(\text{H}_3\text{PO}_4) = n(\text{H}_3\text{PO}_4) \cdot M(\text{H}_3\text{PO}_4) = 1,50 \text{ mol} \cdot 98,0 \text{ g/mol} = \underline{147 \text{ g}}$$

$$\text{Ü 9 } m(\text{NH}_4\text{HSO}_4) = n(\text{NH}_4\text{HSO}_4) \cdot M(\text{NH}_4\text{HSO}_4) = 1,2500 \text{ mol} \cdot 115,16 \text{ g/mol} = \underline{143,95 \text{ g}}$$

$$m(\text{N}) = n(\text{NH}_4\text{HSO}_4) \cdot M(\text{N}) = 1,2500 \text{ mol} \cdot 14,007 \text{ g/mol} = \underline{17,509 \text{ g}}$$

$$m(\text{H}) = 5 \cdot n(\text{NH}_4\text{HSO}_4) \cdot M(\text{H}) = 5 \cdot 1,2500 \text{ mol} \cdot 1,0079 \text{ g/mol} = \underline{6,2994 \text{ g}}$$

$$m(\text{S}) = n(\text{NH}_4\text{HSO}_4) \cdot M(\text{S}) = 1,2500 \text{ mol} \cdot 32,065 \text{ g/mol} = \underline{40,081 \text{ g}}$$

$$m(\text{O}) = 4 \cdot n(\text{NH}_4\text{HSO}_4) \cdot M(\text{O}) = 4 \cdot 1,2500 \text{ mol} \cdot 15,999 \text{ g/mol} = \underline{79,995 \text{ g}}$$

$$\text{Ü 10 } m(\text{Na}_3[\text{AlF}_6]) = \frac{1}{3} \cdot n(\text{Na}) \cdot M(\text{Na}_3[\text{AlF}_6]) = \frac{1}{3} \cdot 0,475 \text{ mol} \cdot 209,94 \text{ g/mol} = \underline{33,2 \text{ g}}$$

$$m(\text{Na}) = n(\text{Na}) \cdot M(\text{Na}) = 0,475 \text{ mol} \cdot 22,990 \text{ g/mol} = \underline{10,9 \text{ g}}$$

$$m(\text{Al}) = \frac{1}{3} \cdot n(\text{Na}) \cdot M(\text{Al}) = \frac{1}{3} \cdot 0,475 \text{ mol} \cdot 26,982 \text{ g/mol} = \underline{4,27 \text{ g}}$$

$$m(\text{F}) = \frac{6}{3} \cdot n(\text{Na}) \cdot M(\text{F}) = \frac{6}{3} \cdot 0,475 \text{ mol} \cdot 18,998 \text{ g/mol} = \underline{18,0 \text{ g}}$$

1.2 Empirische Formeln

Seite 15 **Ü 11** Bei $m(\text{Verbindung}) = 100 \text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{Mn}) = \frac{m(\text{Mn})}{M(\text{Mn})} = \frac{36,38 \text{ g}}{54,94 \text{ g/mol}} = 0,6622 \text{ mol}$$

$$n(\text{S}) = \frac{m(\text{S})}{M(\text{S})} = \frac{21,24 \text{ g}}{32,07 \text{ g/mol}} = 0,6623 \text{ mol}$$

$$n(\text{O}) = \frac{m(\text{O})}{M(\text{O})} = \frac{42,38 \text{ g}}{16,00 \text{ g/mol}} = 2,649 \text{ mol}$$

Stoffmengenverhältnisse:

$$0,6622 \text{ mol} / 0,6622 \text{ mol} = 1,000 \text{ Mn}$$

$$0,6623 \text{ mol} / 0,6622 \text{ mol} = 1,000 \text{ S}$$

$$2,649 \text{ mol} / 0,6622 \text{ mol} = 4,000 \text{ O}$$

$$n(\text{Mn}) : n(\text{S}) : n(\text{O}) \approx 1 : 1 : 4$$

Empirische Formel der Verbindung = $(\text{MnSO}_4)_n$

$$\begin{aligned} M(\text{Verbindung}) &= M(\text{Mn}) + M(\text{S}) + 4 \cdot M(\text{O}) \\ &= 54,94 \text{ g/mol} + 32,07 \text{ g/mol} + 4 \cdot 16,00 \text{ g/mol} = 151,0 \text{ g/mol} \end{aligned}$$

Molekülformel der Verbindung = MnSO_4

Ü 12 Wie Aufgabe Ü 13, ohne die 1. Zeile, $n = 1$ ergibt sich aus der Aufgabenstellung.

Molekülformel der Verbindung = KClO_4

Ü 13 $w(\text{O}) = 100,0\% - (w(\text{Ca}) + w(\text{C})) = 100,0\% - (40,04\% + 12,00\%) = 47,96\%$

Bei $m(\text{Verbindung}) = 100\text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{Ca}) = \frac{m(\text{Ca})}{M(\text{Ca})} = \frac{40,04\text{ g}}{40,08\text{ g/mol}} = 0,9990\text{ mol}$$

$$n(\text{C}) = \frac{m(\text{C})}{M(\text{C})} = \frac{12,00\text{ g}}{12,01\text{ g/mol}} = 0,9992\text{ mol}$$

$$n(\text{O}) = \frac{m(\text{O})}{M(\text{O})} = \frac{47,96\text{ g}}{16,00\text{ g/mol}} = 2,998\text{ mol}$$

Stoffmengenverhältnisse:

$$0,9990\text{ mol}/0,9990\text{ mol} = 1,000\text{ Ca}$$

$$0,9992\text{ mol}/0,9990\text{ mol} = 1,000\text{ C}$$

$$2,998\text{ mol}/0,9990\text{ mol} = 3,001\text{ O}$$

$$n(\text{Ca}) : n(\text{C}) : n(\text{O}) \approx 1 : 1 : 3$$

Empirische Formel der Verbindung = $(\text{CaCO}_3)_n$

Ü 14 $w(\text{O}) = 100,0\% - w(\text{N}) = 100,0\% - 25,93\% = 74,07\%$

Bei $m(\text{Verbindung}) = 100\text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{N}) = \frac{m(\text{N})}{M(\text{N})} = \frac{25,93\text{ g}}{14,01\text{ g/mol}} = 1,851\text{ mol}$$

$$n(\text{O}) = \frac{m(\text{O})}{M(\text{O})} = \frac{74,07\text{ g}}{16,00\text{ g/mol}} = 4,629\text{ mol}$$

Stoffmengenverhältnisse:

$$1,851\text{ mol}/1,851\text{ mol} = 1,000\text{ N}$$

$$4,629\text{ mol}/1,851\text{ mol} = 2,501\text{ O}$$

Ganzzahlige Stoffmengenverhältnisse:

$$1,000\text{ N} \cdot 2 = 2,000$$

$$2,501\text{ O} \cdot 2 = 5,002$$

$$n(\text{N}) : n(\text{O}) \approx 2 : 5$$

Empirische Formel der Verbindung = $(\text{N}_2\text{O}_5)_n$

$$M(\text{Verbindung}) = 2 \cdot M(\text{N}) + 5 \cdot M(\text{O}) = 2 \cdot 14,01\text{ g/mol} + 5 \cdot 16,00\text{ g/mol} \\ = 108,0\text{ g/mol}$$

Molekülformel der Verbindung = N_2O_5

Ü 15 Wie Aufgabe Ü 14, ohne die 1. Zeile.

Molekülformel der Verbindung = $\text{Mn}_2\text{P}_2\text{O}_7$

Ü 16 Wie Aufgabe Ü 11.

Molekülformel der Verbindung = $\text{Na}_3\text{PO}_4 \cdot 12\text{ H}_2\text{O}$

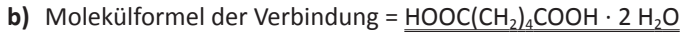
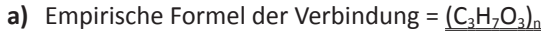
Ü 17 Wie Aufgabe Ü 14, ohne die 1. Zeile.

Molekülformel der Verbindung = $\text{Fe}_2(\text{SO}_4)_3$

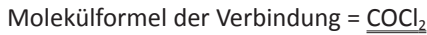
Ü 18 Wie Aufgabe Ü 14, ohne die 1. Zeile, $n = 1$ ergibt sich aus der Aufgabenstellung.

Molekülformel der Verbindung = $\text{C}_4\text{H}_9\text{COOH}$

Seite 16 **Ü 19** Wie Aufgabe Ü 14, ohne die 1. Zeile.



Ü 20 Wie Aufgabe Ü 11.



Ü 21 Wie Aufgabe Ü 11.



Ü 22 Bei $m(\text{Verbindung}) = 100 \text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{C}) = \frac{m(\text{C})}{M(\text{C})} = \frac{92,26 \text{ g}}{12,01 \text{ g/mol}} = 7,682 \text{ mol}$$

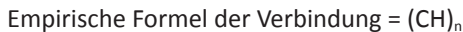
$$n(\text{H}) = \frac{m(\text{H})}{M(\text{H})} = \frac{7,740 \text{ g}}{1,008 \text{ g/mol}} = 7,679 \text{ mol}$$

Stoffmengenverhältnisse:

$$7,682 \text{ mol}/7,679 \text{ mol} = 1,000 \text{ C}$$

$$7,679 \text{ mol}/7,679 \text{ mol} = 1,000 \text{ H}$$

$$n(\text{C}) : n(\text{H}) \approx 1 : 1$$



$$M(\text{Verbindung}) = V_{\text{m}} \cdot \rho = 22,4 \text{ L/mol} \cdot 1,162 \text{ g/L} = 26,0 \text{ g/mol}$$

$$M(\text{Verbindung}) = 2 \cdot M(\text{C}) + 2 \cdot M(\text{H}) = 2 \cdot 12,01 \text{ g/mol} + 2 \cdot 1,008 \text{ g/mol} = 26,0 \text{ g/mol}$$



Ü 23 Wie Aufgabe Ü 22.



$$\text{Ü 24 } m(\text{C}) = \frac{m(\text{CO}_2) \cdot M(\text{C})}{M(\text{CO}_2)} = \frac{0,906 \text{ g} \cdot 12,01 \text{ g/mol}}{44,01 \text{ g/mol}} = 0,247 \text{ g}$$

$$m(\text{H}) = \frac{m(\text{H}_2\text{O}) \cdot 2 \cdot M(\text{H})}{M(\text{H}_2\text{O})} = \frac{0,649 \text{ g} \cdot 2 \cdot 1,008 \text{ g/mol}}{18,02 \text{ g/mol}} = 0,0726 \text{ g}$$

$$m(\text{N}) = m(\text{Verbindung}) - (m(\text{C}) + m(\text{H})) = 0,464 \text{ g} - (0,247 \text{ g} + 0,0726 \text{ g}) = 0,144 \text{ g}$$

$$n(\text{C}) = \frac{m(\text{C})}{M(\text{C})} = \frac{0,247 \text{ g}}{12,01 \text{ g/mol}} = 0,0206 \text{ mol}$$

$$n(\text{H}) = \frac{m(\text{H})}{M(\text{H})} = \frac{0,0726 \text{ g}}{1,008 \text{ g/mol}} = 0,0720 \text{ mol}$$

$$n(\text{N}) = \frac{m(\text{N})}{M(\text{N})} = \frac{0,144 \text{ g}}{14,01 \text{ g/mol}} = 0,0103 \text{ mol}$$

Stoffmengenverhältnisse:

$$0,0206 \text{ mol}/0,0103 \text{ mol} = 2,00 \text{ C}$$

$$0,0720 \text{ mol}/0,0103 \text{ mol} = 6,99 \text{ H}$$

$$0,0103 \text{ mol}/0,0103 \text{ mol} = 1,000 \text{ N}$$

$$n(\text{C}) : n(\text{H}) : n(\text{N}) \approx 2 : 7 : 1$$



Ü 25 Wie Aufgabe Ü 24.
Empirische Formel der Verbindung = $(C_7H_6O)_n$

1.3 Aufstellen von Reaktionsgleichungen

Bei der Aufstellung von Reaktionsgleichungen werden folgende Einzelschritte durchgeführt:

- Reaktionsgleichung mit den Formeln der Edukte und Produkte ohne stöchiometrische Koeffizienten aufstellen
- Ermittlung der Oxidationszahlen, wenn notwendig
- Ausgleich der Elemente
- Ausgleich der Ladungen
- Wasserstoff- und Sauerstoffbilanz durchführen – Ausgleich mit Wasser, wenn notwendig
- Aufstellen der bilanzierten Reaktionsgleichung

Ü 26 $HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$

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Ü 27 $H_2SO_4 + 2 NH_4OH \rightarrow (NH_4)_2SO_4 + 2 H_2O$

Ü 28 $H_3PO_4 + 3 KOH \rightarrow K_3PO_4 + 3 H_2O$

Ü 29 a) $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2 H_2O$

b) $2 SO_2 + O_2 \rightarrow 2 SO_3$

c) $C_5H_{12} + 8 O_2 \rightarrow 5 CO_2 + 6 H_2O$

d) $Bi(NO_3)_3 + 3 NaOH \rightarrow Bi(OH)_3 + 3 NaNO_3$

e) $FeCl_3 + 3 NH_4SCN \rightarrow Fe(SCN)_3 + 3 NH_4Cl$

f) $P_2O_5 + 3 H_2O \rightarrow 2 H_3PO_4$

g) $2 Pb(NO_3)_2 \rightarrow 2 PbO + 4 NO_2 + O_2$

h) $NiCl_2 + 2 NH_4OH + 2 C_4H_8O_2N_2 \rightarrow Ni(C_4H_7O_2N_2)_2 + 2 NH_4Cl + 2 H_2O$

Ü 30 a) $NaOH + NH_4Cl \rightarrow NaCl + NH_3 + H_2O$

b) $2 Al + 6 HCl \rightarrow 2 AlCl_3 + 3 H_2$

c) $Na_2CO_3 + 2 HNO_3 \rightarrow 2 NaNO_3 + H_2O + CO_2$

d) $H_2CO_3 + Ca(OH)_2 \rightarrow CaCO_3 + 2 H_2O$

e) $2 Fe_2O_3 + 3 C \rightarrow 3 CO_2 + 4 Fe$

f) $4 NH_3 + 7 O_2 \rightarrow 4 NO_2 + 6 H_2O$

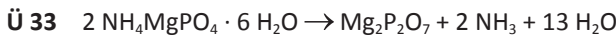
Ü 31 a) $Zn + Cl_2 \rightarrow ZnCl_2$

b) $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

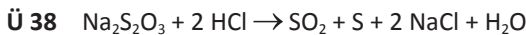
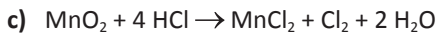
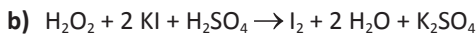
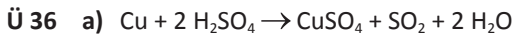
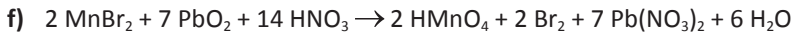
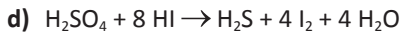
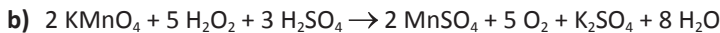
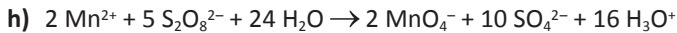
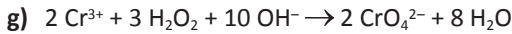
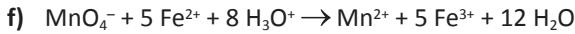
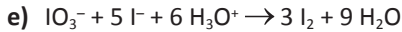
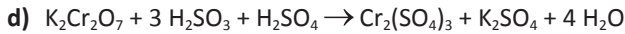
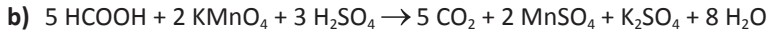
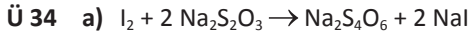
c) $Cl_2 + 2 NaOH \rightarrow NaClO + NaCl + H_2O$

d) $N_2 + 3 H_2 \rightarrow 2 NH_3$

Ü 32 $2 NaCl + 2 H_2O \rightarrow 2 NaOH + Cl_2 + H_2$



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2 Charakterisieren von Stoffen

2.1 Dichte

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Ü 1 $\rho = \frac{m}{V} = \frac{75,0 \text{ g}}{61,8 \text{ mL}} = \underline{1,21 \text{ g/mL}}$

Ü 2 $\rho = \frac{m}{V} = \frac{90,9 \text{ g}}{115 \text{ cm}^3} = \underline{0,790 \text{ g/cm}^3}$

Ü 3 $1,395 \text{ g/cm}^3 \triangleq 1,395 \text{ kg/L}$
 $m = V \cdot \rho = 125,0 \text{ L} \cdot 1,395 \text{ kg/L} = \underline{174,4 \text{ kg}}$

Ü 4 $m = V \cdot \rho = 250 \text{ mL} \cdot 0,860 \text{ g/mL} = \underline{215 \text{ g}}$

$$\text{Ü 5} \quad V = \frac{m}{\rho} = \frac{2,75 \text{ kg}}{0,877 \text{ kg/dm}^3} = 3,14 \text{ dm}^3 = \underline{3,14 \text{ L}}$$

$$\text{Ü 6} \quad V = \frac{m}{\rho} = \frac{750 \text{ g}}{0,785 \text{ g/cm}^3} = 955 \text{ cm}^3 = \frac{955 \text{ cm}^3}{1000 \text{ cm}^3/\text{L}} = \underline{0,955 \text{ L}}$$

$$\text{Ü 7} \quad m(\text{Öl}) = m_2 - m_1 = 835 \text{ kg} - 225 \text{ kg} = \underline{610 \text{ kg}}$$

$$V = \frac{m(\text{Öl})}{\rho} = \frac{610 \text{ kg}}{0,870 \text{ kg/dm}^3} = 701 \text{ dm}^3 = \underline{701 \text{ L}}$$

$$\text{Ü 8} \quad V = \frac{m}{\rho} = \frac{68,0 \text{ g}}{3,14 \text{ g/mL}} = \underline{21,7 \text{ mL}}$$

$$\text{Ü 9} \quad V(\text{HCl}) = \frac{m}{\rho} = \frac{696 \text{ kg} \cdot 1000 \text{ g/kg}}{1,16 \text{ g/mL}} = \frac{600000}{1000 \text{ mL/L}} = 600 \text{ L}$$

$$n(\text{Flaschen}) = \frac{V(\text{HCl})}{V(\text{Flasche})} = \frac{600 \text{ L}}{2,5 \text{ L}} = \underline{240}$$

$$\text{Ü 10} \quad V(\text{Behälter}) = a \cdot b \cdot c = 2000 \text{ mm} \cdot 750,0 \text{ mm} \cdot 500,0 \text{ mm} = \frac{750000000 \text{ mm}^3}{1000000 \text{ dm}^3} = 750,0 \text{ dm}^3$$

$$m = V(\text{Behälter}) \cdot \rho = 750,0 \text{ dm}^3 \cdot 0,8580 \text{ kg/dm}^3 = \underline{643,5 \text{ kg}}$$

$$\text{Ü 11} \quad V(\text{Behälter}) = A \cdot h = 625 \text{ cm}^2 \cdot 40,0 \text{ cm} = 25000 \text{ cm}^3$$

$$V(\text{Methanol}) = V(\text{Behälter}) \cdot w = 25000 \text{ cm}^3 \cdot 0,75 = 18750 \text{ cm}^3$$

$$m = V(\text{Methanol}) \cdot \rho = 18750 \text{ cm}^3 \cdot 0,870 \text{ g/cm}^3 = 16312,5 \text{ g} = \frac{16312,5 \text{ g}}{1000 \text{ g/kg}} = \underline{16,3 \text{ kg}}$$

$$\text{Ü 12} \quad V(\text{Milch}) = \left(\frac{d}{2}\right)^2 \cdot \pi \cdot h \cdot w = \left(\frac{1,650 \text{ m}}{2}\right)^2 \cdot \pi \cdot 4,250 \text{ m} \cdot 0,6800 = 6,180 \text{ m}^3$$

$$m = V(\text{Milch}) \cdot \rho = 6,180 \text{ m}^3 \cdot 1000 \text{ dm}^3/\text{m}^3 \cdot 1,030 \text{ kg/dm}^3 = \underline{6365 \text{ kg}}$$

$$\text{Ü 13} \quad V(\text{Faden}) = \left(\frac{d}{2}\right)^2 \cdot \pi \cdot l = \left(\frac{0,850 \text{ mm}}{2}\right)^2 \cdot \pi \cdot 650 \text{ m} \cdot 1000 \text{ mm/m} = 368843 \text{ mm}^3 = 368,843 \text{ cm}^3$$

$$\rho = \frac{m}{V} = \frac{4,13 \text{ g}}{369 \text{ cm}^3} = \underline{0,0112 \text{ g/cm}^3}$$

$$\text{Ü 14} \quad \rho_1(\text{vor der Ausdehnung}) = 2,70 \text{ g/cm}^3 \Rightarrow m_0 = 2,70 \text{ g nehmen } V_0 = 1 \text{ cm}^3 \text{ ein}$$

$$V(\text{nach der Ausdehnung}) = V_0 \cdot (1 + \text{Ausdehnung}) = 1 \text{ cm}^3 \cdot 1,00750 = 1,00750 \text{ cm}^3$$

$$\rho_2(\text{nach der Ausdehnung}) = \frac{m_0}{V_{\text{NA}}} = \frac{2,70 \text{ g}}{1,00750 \text{ cm}^3} = \underline{2,68 \text{ g/cm}^3}$$

Ü 15 Wie Aufgabe Ü 14.

$$\rho_2(\text{nach der Ausdehnung}) = \underline{0,858 \text{ kg/dm}^3}$$

$$\text{Ü 16} \quad m(\text{Toluol}) = m_{\text{gefüllt}} - m_{\text{leer}} = 49,51 \text{ g} - 27,97 \text{ g} = 21,54 \text{ g}$$

$$\rho(\text{Toluol}) = \frac{m(\text{Toluol})}{V(\text{Pyknometer})} = \frac{21,54 \text{ g}}{24,99 \text{ mL}} = 0,8619 \text{ g/mL} = \underline{0,8619 \text{ g/cm}^3}$$

Ü 17 Wie Aufgabe Ü 16.

$$\rho_{20}(\text{Alkohol}) = \underline{0,784 \text{ g/cm}^3}$$

Ü 18 $m(\text{Wasser}) = m_2 - m_1 = 51,006 \text{ g} - 26,124 \text{ g} = 24,882 \text{ g}$

$$V(\text{Pyknometer}) = \frac{m(\text{Wasser})}{\rho(\text{Wasser})} = \frac{24,882 \text{ g}}{0,99823 \text{ g/mL}} = 24,926 \text{ mL}$$

$$m(\text{Flüssigkeit}) = m_3 - m_1 = 52,937 \text{ g} - 26,124 \text{ g} = 26,813 \text{ g}$$

$$\rho(\text{Flüssigkeit}) = \frac{m(\text{Flüssigkeit})}{V(\text{Pyknometer})} = \frac{26,813 \text{ g}}{24,926 \text{ mL}} = 1,0757 \text{ g/mL} = \underline{1,0757 \text{ g/cm}^3}$$

Ü 19 Wie Aufgabe Ü 18.

$$\rho(\text{Flüssigkeit}) = \underline{1,1520 \text{ g/cm}^3}$$

Ü 20 Wie Aufgabe Ü 18.

$$\rho(\text{Flüssigkeit}) = \underline{1,1441 \text{ g/cm}^3}$$

Ü 21 $m(\text{Salz}) = m_2 - m_1 = 65,34 \text{ g} - 33,85 \text{ g} = 31,49 \text{ g}$

$$m(\text{Aceton}) = m_3 - m_2 = 75,94 \text{ g} - 65,34 \text{ g} = 10,60 \text{ g}$$

$$V(\text{Aceton}) = \frac{m(\text{Aceton})}{\rho(\text{Aceton})} = \frac{10,60 \text{ g}}{0,7910 \text{ g/mL}} = 13,40 \text{ mL}$$

$$V(\text{Salz}) = V(\text{Pyknometer}) - V(\text{Aceton}) = 25,09 \text{ mL} - 13,40 \text{ mL} = 11,69 \text{ mL}$$

$$\rho(\text{Salz}) = \frac{m(\text{Salz})}{V(\text{Salz})} = \frac{31,49 \text{ g}}{11,69 \text{ mL}} = 2,694 \text{ g/mL} = \underline{2,694 \text{ g/cm}^3}$$

Ü 22 Wie Aufgabe Ü 21.

$$\rho(\text{Salz}) = \underline{3,129 \text{ g/cm}^3}$$

Ü 23 Wie Aufgabe Ü 21.

$$\rho(\text{Legierung}) = \underline{8,404 \text{ g/cm}^3}$$

Ü 24 $m(\text{Wasser}) = m_1 - m_2 = 84,62 \text{ g} - 61,74 \text{ g} = 22,88 \text{ g}$

$$V(\text{Wasser}) = V(\text{Mineral}) = \frac{m(\text{Wasser})}{\rho(\text{Wasser})} = \frac{22,88 \text{ g}}{0,9982 \text{ g/mL}} = 22,92 \text{ mL}$$

$$\rho(\text{Mineral}) = \frac{m(\text{Mineral})}{V(\text{Mineral})} = \frac{84,62 \text{ g}}{22,92 \text{ mL}} = 3,692 \text{ g/mL} = \underline{3,692 \text{ g/cm}^3}$$

Ü 25 $m(\text{Flüssigkeit}) = m_1 - m_2 = 15,27 \text{ g} - 10,28 \text{ g} = 4,99 \text{ g}$

$$V(\text{Körper}) = V(\text{Flüssigkeit}) = \frac{m(\text{Körper})}{\rho(\text{Körper})} = \frac{15,27 \text{ g}}{2,420 \text{ g/cm}^3} = 6,310 \text{ cm}^3$$

$$\rho(\text{Flüssigkeit}) = \frac{m(\text{Flüssigkeit})}{V(\text{Flüssigkeit})} = \frac{4,990 \text{ g}}{6,310 \text{ cm}^3} = \underline{0,7908 \text{ g/cm}^3}$$

Ü 26 $m(\text{Butanol}) = m_1 - m = 63,2 \text{ g} - 56,7 \text{ g} = 6,50 \text{ g}$

$$V(\text{Körper}) = V(\text{Butanol}) = \frac{m(\text{Butanol})}{\rho(\text{Butanol})} = \frac{6,50 \text{ g}}{0,810 \text{ g/cm}^3} = 8,02 \text{ cm}^3$$

$$\rho(\text{Körper}) = \frac{m(\text{Körper})}{V(\text{Körper})} = \frac{63,2 \text{ g}}{8,02 \text{ cm}^3} = \underline{7,88 \text{ g/cm}^3}$$

Ü 27 $V(\text{Körper}) = V(\text{Flüssigkeit}) = A \cdot h = 25,0 \text{ cm}^2 \cdot 12,0 \text{ cm} = 300 \text{ cm}^3$

$$\rho(\text{Flüssigkeit}) = \frac{m(\text{Flüssigkeit})}{V(\text{Flüssigkeit})} = \frac{324 \text{ g}}{300 \text{ cm}^3} = \underline{1,08 \text{ g/cm}^3}$$

Ü 28 a) $m(\text{Wasser}) = m_1 - m_2 = 54,725 \text{ g} - 25,838 \text{ g} = 28,887 \text{ g}$

$$V(\text{Wasser}) = V(\text{Stein}) = \frac{m(\text{Wasser})}{\rho(\text{Wasser})} = \frac{28,887 \text{ g}}{0,99823 \text{ g/cm}^3} = 28,938 \text{ cm}^3$$

$$\rho(\text{Stein}) = \frac{m(\text{Stein})}{V(\text{Stein})} = \frac{54,725 \text{ g}}{28,938 \text{ cm}^3} = \underline{1,8911 \text{ g/cm}^3}$$

b) $m(\text{Meerwasser}) = m_1 - m_3 = 54,725 \text{ g} - 24,919 \text{ g} = 29,806 \text{ g}$

$$\rho(\text{Meerwasser}) = \frac{m(\text{Meerwasser})}{V(\text{Meerwasser, Stein})} = \frac{29,806 \text{ g}}{28,938 \text{ cm}^3} = \underline{1,0300 \text{ g/cm}^3}$$

2.2 Viskosität

Ü 29 $1 \text{ Pa} = 1 \frac{\text{N}}{\text{m}^2} = 1 \frac{\text{kg}}{\text{m} \cdot \text{s}^2}$

Seite 34

$$\rho = \frac{1,126 \text{ g/cm}^3 \cdot 1000000 \text{ cm}^3/\text{m}^3}{1000 \text{ g/kg}} = 1126 \text{ kg/m}^3$$

$$\nu = \frac{\eta}{\rho} = \frac{6,050 \cdot 10^{-3} \text{ kg}/(\text{m} \cdot \text{s}^2) \cdot \text{s}}{1126 \text{ kg/m}^3} = \underline{5,373 \cdot 10^{-6} \text{ m}^2/\text{s}}$$

Ü 30 $2,003 \text{ mPa} = 2,003 \cdot 10^{-3} \frac{\text{N}}{\text{m}^2} = 2,003 \cdot 10^{-3} \frac{\text{kg}}{\text{m} \cdot \text{s}^2}$

$$\rho = \frac{1,203 \text{ g/cm}^3 \cdot 1000000 \text{ cm}^3/\text{m}^3}{1000 \text{ g/kg}} = 1203 \text{ kg/m}^3$$

$$\nu = \frac{\eta}{\rho} = \frac{2,003 \cdot 10^{-3} \text{ kg}/(\text{m} \cdot \text{s}^2) \cdot \text{s}}{1203 \text{ kg/m}^3} = \underline{1,665 \cdot 10^{-6} \text{ m}^2/\text{s}}$$

Ü 31 $\eta = K_H \cdot (\rho_K - \rho_{Fl}) \cdot t = 0,01310 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 1,274 \text{ g/cm}^3) \cdot 190,3 \text{ s}$
 $= \underline{2,782 \text{ mPa} \cdot \text{s}}$

Ü 32 $\eta = K_H \cdot (\rho_K - \rho_{Fl}) \cdot t = 0,1300 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 0,7976 \text{ g/cm}^3) \cdot 142,6 \text{ s}$
 $= \underline{29,52 \text{ mPa} \cdot \text{s}}$

Ü 33 $t(\text{Kugel 1}) = \frac{\eta(\text{Wasser})}{K_H \cdot (\rho_K - \rho_{Fl})} = \frac{1,0087 \text{ mPa} \cdot \text{s}}{0,0131 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)}$
 $= \underline{55,3 \text{ s}}$

Seite 35

$$t(\text{Kugel 2}) = \frac{1,0087 \text{ mPa} \cdot \text{s}}{0,130 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)} = \underline{5,57 \text{ s}}$$

$$t(\text{Kugel 3}) = \frac{1,0087 \text{ mPa} \cdot \text{s}}{0,152 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (8,155 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)} = \underline{0,927 \text{ s}}$$

$$t(\text{Kugel 4}) = \frac{1,0087 \text{ mPa} \cdot \text{s}}{1,02 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (8,155 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)} = \underline{0,138 \text{ s}}$$

$$t(\text{Kugel 5}) = \frac{1,0087 \text{ mPa} \cdot \text{s}}{9,20 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (7,717 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)} = \underline{0,0163 \text{ s}}$$

$$t(\text{Kugel 6}) = \frac{1,0087 \text{ mPa} \cdot \text{s}}{82,3 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (7,717 \text{ g/cm}^3 - 0,9982 \text{ g/cm}^3)} = \underline{0,00182 \text{ s}}$$

$$\text{Ü 34 } t(\text{Kugel 1}) = \frac{\eta(\text{Rizinusöl})}{K_H \cdot (\rho_K - \rho_{Fl})} = \frac{9,76 \text{ mPa} \cdot \text{s}}{0,0131 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)}$$

$$= \underline{511 \text{ s}}$$

$$t(\text{Kugel 2}) = \frac{9,76 \text{ mPa} \cdot \text{s}}{0,130 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (2,390 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)} = \underline{51,5 \text{ s}}$$

$$t(\text{Kugel 3}) = \frac{9,76 \text{ mPa} \cdot \text{s}}{0,152 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (8,155 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)} = \underline{8,89 \text{ s}}$$

$$t(\text{Kugel 4}) = \frac{9,76 \text{ mPa} \cdot \text{s}}{1,02 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (8,155 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)} = \underline{1,32 \text{ s}}$$

$$t(\text{Kugel 5}) = \frac{9,76 \text{ mPa} \cdot \text{s}}{9,20 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (7,717 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)} = \underline{0,156 \text{ s}}$$

$$t(\text{Kugel 6}) = \frac{9,76 \text{ mPa} \cdot \text{s}}{82,3 \text{ mPa} \cdot \text{cm}^3 \cdot \text{g}^{-1} \cdot (7,717 \text{ g/cm}^3 - 0,932 \text{ g/cm}^3)} = \underline{0,0175 \text{ s}}$$

$$\text{Kugel 2, } t = \underline{51,5 \text{ s}}$$

$$\text{Ü 35 } v = K \cdot t = 0,500 \text{ mm}^2/\text{s}^2 \cdot 154,2 \text{ s} = \underline{77,1 \text{ mm}^2/\text{s}}$$

$$\text{Ü 36 } v = K \cdot t = 0,100 \text{ mm}^2/\text{s}^2 \cdot 187 \text{ s} = \underline{18,7 \text{ mm}^2/\text{s}}$$

$$\text{Ü 37 } \eta = K_R \cdot M = 6,274 \text{ Pa} \cdot \text{s/Nm} \cdot 1000 \text{ mPa/Pa} \cdot 0,06376 \text{ Nm} = \underline{400,0 \text{ mPa} \cdot \text{s}}$$

$$\text{Ü 38 } \eta = K_R \cdot M = 3,092 \text{ Pa} \cdot \text{s/Nm} \cdot 1000 \text{ mPa/Pa} \cdot 0,03477 \text{ Nm} = \underline{107,5 \text{ mPa} \cdot \text{s}}$$

$$\text{Seite 36 } \text{Ü 39 } M = \frac{\eta}{K_R} = \frac{1,500 \text{ Pa} \cdot \text{s}}{6,274 \text{ Pa} \cdot \text{s/Nm}} = \underline{0,2391 \text{ Nm}}$$

2.3 Molekularrefraktion

$$\text{Seite 37 } \text{Ü 40 } R_D = \frac{M(\text{Heptan})}{\rho(\text{Heptan})} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right) = \frac{100,2 \text{ g/mol}}{0,6836 \text{ g/cm}^3} \cdot \left(\frac{1,3878^2 - 1}{1,3878^2 + 2} \right) = \underline{34,57 \text{ cm}^3/\text{mol}}$$

$$\text{Ü 41 } R_D = \frac{M(\text{Pentan-1-ol})}{\rho(\text{Pentan-1-ol})} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right) = \frac{88,15 \text{ g/mol}}{0,8198 \text{ g/cm}^3} \cdot \left(\frac{1,4089^2 - 1}{1,4089^2 + 2} \right) = \underline{26,58 \text{ cm}^3/\text{mol}}$$

$$\text{Ü 42 } R_D = \frac{M(\text{Ethanol})}{\rho(\text{Ethanol})} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right) = \frac{46,07 \text{ g/mol}}{0,7894 \text{ g/cm}^3} \cdot \left(\frac{1,3623^2 - 1}{1,3623^2 + 2} \right) = \underline{12,95 \text{ cm}^3/\text{mol}}$$

$$\text{Ü 43 } \rho(\text{Phenylmethan}) = \frac{M(\text{C}_7\text{H}_8)}{R_D(\text{C}_7\text{H}_8)} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right) = \frac{92,14 \text{ g/mol}}{31,09 \text{ cm}^3/\text{mol}} \cdot \left(\frac{1,4969^2 - 1}{1,4969^2 + 2} \right)$$

$$= \underline{0,8671 \text{ g/cm}^3}$$

$$\text{Ü 44 } \rho(1,2\text{-Dimethylbenzol}) = \frac{M(1,2\text{-Dimethylbenzol})}{R_D(1,2\text{-Dimethylbenzol})} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right)$$

$$= \frac{106,18 \text{ g/mol}}{35,74 \text{ cm}^3/\text{mol}} \cdot \left(\frac{1,505^2 - 1}{1,505^2 + 2} \right) = \underline{0,8812 \text{ g/cm}^3}$$

$$\text{Ü 45 } \rho(\text{Propan-2-ol}) = \frac{M(\text{Propan-2-ol})}{R_D(\text{Propan-2-ol})} \cdot \left(\frac{n^2 - 1}{n^2 + 2} \right)$$

$$= \frac{60,10 \text{ g/mol}}{17,61 \text{ cm}^3/\text{mol}} \cdot \left(\frac{1,3771^2 - 1}{1,3771^2 + 2} \right) = \underline{0,7852 \text{ g/cm}^3}$$

2.4 Siedepunkterhöhung/Gefrierpunkterniedrigung

$$\text{Ü 46} \quad \Delta T = \frac{K_m \cdot m(\text{C}_6\text{H}_5\text{Cl})}{M(\text{C}_6\text{H}_5\text{Cl}) \cdot m(\text{C}_6\text{H}_6)} = \frac{5,100 \text{ K} \cdot \text{kg/mol} \cdot 1,04 \text{ g}}{0,112557 \text{ kg/mol} \cdot 62,5 \text{ g}} = \underline{0,754 \text{ K}}$$

$$\text{Ü 47} \quad m(\text{H}_2\text{O}) = m(\text{Lösung}) - m(\text{C}_6\text{H}_4(\text{OH})_2) = 8,17 \text{ g} - 0,596 \text{ g} = \underline{7,574 \text{ g}}$$

$$\Delta T = \frac{K_m \cdot m(\text{C}_6\text{H}_4(\text{OH})_2)}{M(\text{C}_6\text{H}_4(\text{OH})_2) \cdot m(\text{H}_2\text{O})} = \frac{1,858 \text{ K} \cdot \text{kg/mol} \cdot 0,596 \text{ g}}{0,110111 \text{ kg/mol} \cdot 7,574 \text{ g}} = \underline{1,33 \text{ K}}$$

$$\text{Ü 48} \quad \Delta T = \frac{K_b \cdot m(\text{C}_6\text{H}_5\text{COOH})}{M(\text{C}_6\text{H}_5\text{COOH}) \cdot m(\text{C}_2\text{H}_5\text{OH})} = \frac{1,20 \text{ K} \cdot \text{kg/mol} \cdot 0,275 \text{ g}}{0,12212 \text{ kg/mol} \cdot 28,2 \text{ g}} = \underline{0,0958 \text{ K}}$$

$$\text{Ü 49} \quad K_m = \frac{M(\text{CH}_2\text{Br}_2) \cdot \Delta T \cdot m(\text{Lösemittel})}{m(\text{CH}_2\text{Br}_2)} = \frac{0,17384 \text{ kg/mol} \cdot 2,60 \text{ K} \cdot 12,8 \text{ g}}{1,78 \text{ g}} \\ = \underline{3,25 \text{ K} \cdot \text{kg/mol}}$$

$$\text{Ü 50} \quad \Delta T = \vartheta_m(\text{CH}_3\text{COOH}) - \vartheta(\text{Lösung}) = 16,65 \text{ }^\circ\text{C} - 15,75 \text{ }^\circ\text{C} = 0,900 \text{ K}$$

$$m(\text{CH}_3\text{COOH}) = \frac{M(\text{CH}_3\text{COOH}) \cdot \Delta T \cdot m(\text{H}_2\text{O})}{K_m(\text{CH}_3\text{COOH})} = \frac{0,060052 \text{ kg/mol} \cdot 0,900 \text{ K} \cdot 19,7 \text{ g}}{3,900 \text{ K} \cdot \text{kg/mol}} \\ = \underline{0,273 \text{ g}}$$

$$\text{Ü 51} \quad m(\text{C}_{10}\text{H}_8) = \frac{M(\text{C}_{10}\text{H}_8) \cdot \Delta T \cdot m(1,4\text{-Dioxan})}{K_b(\text{C}_{10}\text{H}_8)} = \frac{0,12817 \text{ kg/mol} \cdot 1,08 \text{ K} \cdot 38,5 \text{ g}}{3,270 \text{ K} \cdot \text{kg/mol}} \\ = \underline{1,63 \text{ g}}$$

$$\text{Ü 52} \quad M(\text{Verbindung}) = \frac{K_m(\text{Benzol}) \cdot m(\text{Verbindung})}{\Delta T \cdot m(\text{Benzol})} = \frac{5,100 \text{ K} \cdot \text{kg/mol} \cdot 1,67 \text{ g}}{3,56 \text{ K} \cdot 8,75 \text{ g}} \\ = 0,27342 \text{ kg/mol}$$

$$\Delta T = \frac{K_m((\text{CH}_3)_3\text{COH}) \cdot m(\text{Verbindung})}{M(\text{Verbindung}) \cdot m((\text{CH}_3)_3\text{OH})} = \frac{8,250 \text{ K} \cdot \text{kg/mol} \cdot 1,67 \text{ g}}{0,27342 \text{ kg/mol} \cdot 8,75 \text{ g}} = 5,76 \text{ K}$$

$$\Delta T = \Delta\vartheta, 5,76 \text{ K} = 5,76 \text{ }^\circ\text{C}$$

$$\vartheta_m(\text{Lösung}, (\text{CH}_3)_3\text{COH}) = \vartheta_m((\text{CH}_3)_3\text{COH}) - \Delta\vartheta = 25,4 \text{ }^\circ\text{C} - 5,76 \text{ }^\circ\text{C} = \underline{19,6 \text{ }^\circ\text{C}}$$

$$\text{Ü 53} \quad \Delta T = \vartheta_m(\text{Campher}) - \vartheta_m(\text{Mischung}) = 178,8 \text{ }^\circ\text{C} - 172,3 \text{ }^\circ\text{C} = 6,50 \text{ K}$$

$$M(\text{Verbindung}) = \frac{K_m(\text{Campher}) \cdot m(\text{Verbindung})}{\Delta T \cdot m(\text{Campher})} = \frac{40,00 \text{ K} \cdot \text{kg/mol} \cdot 0,459 \text{ g}}{6,50 \text{ K} \cdot 32,8 \text{ g}} \\ = 0,0861 \text{ kg/mol} = \underline{86,1 \text{ g/mol}}$$

$$\text{Ü 54} \quad M(\text{Verbindung}) = \frac{K_m(\text{Benzol}) \cdot m(\text{Verbindung})}{\Delta T \cdot m(\text{Benzol})} = \frac{5,100 \text{ K} \cdot \text{kg/mol} \cdot 1,07 \text{ g}}{1,33 \text{ K} \cdot 70,6 \text{ g}} \\ = 0,0581 \text{ kg/mol} = \underline{58,1 \text{ g/mol}}$$

$$\text{Ü 55} \quad M(\text{Substanz}) = \frac{K_b(\text{Wasser}) \cdot m(\text{Substanz})}{\Delta T \cdot m(\text{Wasser})} = \frac{0,515 \text{ K} \cdot \text{kg/mol} \cdot 0,817 \text{ g}}{0,430 \text{ K} \cdot 10,4 \text{ g}} \\ = 0,0941 \text{ kg/mol} = \underline{94,1 \text{ g/mol}}$$

3 Gehaltsangaben

3.1 Anteile/Verhältnisse

Seite 44

Ü 1 $w(\text{KCl}) = \frac{m(\text{KCl})}{m(\text{Lösung})} \cdot 100\% = \frac{36,5 \text{ g}}{165 \text{ g}} \cdot 100\% = \underline{22,1\%}$

Ü 2 $w(\text{Na}_2\text{SO}_4) = \frac{m(\text{Na}_2\text{SO}_4)}{m(\text{Lösung})} \cdot 100\% = \frac{106 \text{ g}}{950 \text{ g}} \cdot 100\% = \underline{11,2\%}$

Ü 3 $w(\text{K}_2\text{SO}_4) = \frac{m(\text{K}_2\text{SO}_4)}{m(\text{Wasser}) + m(\text{K}_2\text{SO}_4)} \cdot 100\% = \frac{43,0 \text{ g}}{386 \text{ g} + 43,0 \text{ g}} \cdot 100\% = \underline{10,0\%}$

Ü 4 $w(\text{C}_6\text{H}_{12}\text{O}_6) = \frac{m(\text{Glukose})}{m(\text{Glukose}) + m(\text{Wasser})} \cdot 100\% = \frac{42,5 \text{ g}}{42,5 \text{ g} + 275 \text{ g}} \cdot 100\% = \underline{13,4\%}$

Ü 5 $w(\text{NaOH}) = \frac{m(\text{NaOH})}{m(\text{Wasser}) + m(\text{NaOH})} \cdot 100\% = \frac{655 \text{ g}}{5,25 \text{ kg} \cdot 1000 \text{ g/kg} + 655 \text{ g}} \cdot 100\% = \underline{11,1\%}$

Ü 6 $w(\text{Na}_2\text{CO}_3) = \frac{m(\text{Na}_2\text{CO}_3)}{m(\text{Lösung})} \cdot 100\% = \frac{31,2 \text{ g}}{980 \text{ g}} \cdot 100\% = \underline{3,18\%}$

$$w(\text{K}_2\text{CO}_3) = \frac{m(\text{K}_2\text{CO}_3)}{m(\text{Lösung})} \cdot 100\% = \frac{20,5 \text{ g}}{980 \text{ g}} \cdot 100\% = \underline{2,09\%}$$

Ü 7 $m(\text{Lösung}) = m(\text{NaOH}) + m(\text{Wasser})$

$$w(\text{NaOH}) = \frac{m(\text{NaOH})}{m(\text{NaOH}) + m(\text{Wasser})}$$

$$m(\text{NaOH}) = w(\text{NaOH}) \cdot [m(\text{NaOH}) + m(\text{Lösemittel})] = 0,1470 \cdot [m(\text{NaOH}) + 800,0 \text{ g}]$$

$$m(\text{NaOH}) - 0,1470 \cdot m(\text{NaOH}) = 117,6 \text{ g}$$

$$0,8530 m(\text{NaOH}) = 117,6 \text{ g}$$

$$m(\text{NaOH}) = \frac{117,6 \text{ g}}{0,8530} = \underline{137,9 \text{ g}}$$

Ü 8 Wie Aufgabe Ü 7.

$$m(\text{NaNO}_3) = \underline{102,1 \text{ g}}$$

Ü 9 Wie Aufgabe Ü 7.

$$m(\text{KOH}) = \underline{14,66 \text{ kg}}$$

Ü 10 $m(\text{CaCl}_2) = w(\text{CaCl}_2) \cdot m_L = 0,118 \cdot 370 \text{ g} = \underline{43,7 \text{ g}}$

Ü 11 $m(\text{Na}_2\text{CO}_3) = w(\text{Na}_2\text{CO}_3) \cdot m_L = 0,0825 \cdot 720 \text{ g} = \underline{59,4 \text{ g}}$

Ü 12 $m(\text{KNO}_3) = w(\text{KNO}_3) \cdot m_L = 0,0643 \cdot 426 \text{ g} = \underline{27,4 \text{ g}}$

Ü 13 $m(\text{C}_6\text{H}_5\text{COOH}) = w(\text{C}_6\text{H}_5\text{COOH}) \cdot m_L = 0,0175 \cdot 500 \text{ g} = \underline{8,75 \text{ g}}$

Ü 14 $m(\text{Salzlösung}) = \frac{m(\text{Salz})}{w(\text{Salz})} = \frac{1,25 \text{ kg}}{0,232} = \underline{5,39 \text{ kg}}$

Seite 45

Ü 15 $m(\text{NaNO}_3\text{-Lösung}) = \frac{m(\text{NaNO}_3)}{w(\text{NaNO}_3)} = \frac{72,5 \text{ g}}{0,163} = \underline{445 \text{ g}}$

Ü 16 $m(\text{N})$ in 1 mol $\text{NH}_2\text{-CO-NH}_2 = n(\text{N}) \cdot M(\text{N}) = 2 \text{ mol} \cdot 14,0 \text{ g/mol}$
 $= 28,0 \text{ g N}$ in $60,0 \text{ g NH}_2\text{-CO-NH}_2$

$$w(\text{N}) = \frac{m(\text{N})}{m(\text{NH}_2\text{-CO-NH}_2)} \cdot 100 \% = \frac{28,0 \text{ g}}{60,0 \text{ g}} \cdot 100 \% = \underline{46,7 \%}$$

Ü 17 $m(\text{Ca})$ in 1 mol $\text{Ca}(\text{ClO}_3)_2 = 1 \text{ mol} \cdot 40,1 \text{ g/mol} = 40,1 \text{ g Ca}$ in $207 \text{ g Ca}(\text{ClO}_3)_2$

$$w(\text{Ca}) = \frac{m(\text{Ca})}{m(\text{Ca}(\text{ClO}_3)_2)} \cdot 100 \% = \frac{40,1 \text{ g}}{207 \text{ g}} \cdot 100 \% = \underline{19,4 \%}$$

$m(\text{Cl})$ in 1 mol $\text{Ca}(\text{ClO}_3)_2 = 2 \text{ mol} \cdot 35,5 \text{ g/mol} = 71,0 \text{ g Cl}$ in $207 \text{ g Ca}(\text{ClO}_3)_2$

$$w(\text{Cl}) = \frac{m(\text{Cl})}{m(\text{Ca}(\text{ClO}_3)_2)} \cdot 100 \% = \frac{71,0 \text{ g}}{207 \text{ g}} \cdot 100 \% = \underline{34,3 \%}$$

$m(\text{O})$ in 1 mol $\text{Ca}(\text{ClO}_3)_2 = 6 \text{ mol} \cdot 16,0 \text{ g/mol} = 96,0 \text{ g O}$ in $207 \text{ g Ca}(\text{ClO}_3)_2$

$$w(\text{O}) = \frac{m(\text{O})}{m(\text{Ca}(\text{ClO}_3)_2)} \cdot 100 \% = \frac{96,0 \text{ g}}{207 \text{ g}} \cdot 100 \% = \underline{46,4 \%}$$

Ü 18 $m(\text{Fe})$ in 1 mol $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 = 7 \text{ mol} \cdot 55,85 \text{ g/mol} = 391,0 \text{ g Fe}$ in $859,3 \text{ g Fe}_4[\text{Fe}(\text{CN})_6]_3$

$$w(\text{Fe}) = \frac{m(\text{Fe})}{m(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)} \cdot 100 \% = \frac{391,0 \text{ g}}{859,3 \text{ g}} \cdot 100 \% = \underline{45,50 \%}$$

$m(\text{C})$ in 1 mol $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 = 18 \text{ mol} \cdot 12,01 \text{ g/mol} = 216,2 \text{ g C}$ in $859,3 \text{ g Fe}_4[\text{Fe}(\text{CN})_6]_3$

$$w(\text{C}) = \frac{m(\text{C})}{m(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)} \cdot 100 \% = \frac{216,2 \text{ g}}{859,3 \text{ g}} \cdot 100 \% = \underline{25,16 \%}$$

$m(\text{N})$ in 1 mol $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3 = 18 \text{ mol} \cdot 14,01 \text{ g/mol} = 252,2 \text{ g N}$ in $859,3 \text{ g Fe}_4[\text{Fe}(\text{CN})_6]_3$

$$w(\text{N}) = \frac{m(\text{N})}{m(\text{Fe}_4[\text{Fe}(\text{CN})_6]_3)} \cdot 100 \% = \frac{252,2 \text{ g}}{859,3 \text{ g}} \cdot 100 \% = \underline{29,35 \%}$$

Ü 19 $m(\text{H}_2\text{O})$ in 1 mol $\text{Na}_2\text{CO}_3 \cdot 10 \text{ H}_2\text{O} = 10 \text{ mol} \cdot 18,01 \text{ g/mol}$
 $= 180,1 \text{ g H}_2\text{O}$ in $286,1 \text{ g Na}_2\text{CO}_3 \cdot 10 \text{ H}_2\text{O}$

$$w(\text{H}_2\text{O}) = \frac{m(\text{H}_2\text{O})}{m(\text{Na}_2\text{CO}_3 \cdot 10 \text{ H}_2\text{O})} \cdot 100 \% = \frac{180,1 \text{ g}}{286,1 \text{ g}} \cdot 100 \% = \underline{62,95 \%}$$

Ü 20 $\varphi(\text{C}_6\text{H}_6) = \frac{V(\text{Benzol})}{V(\text{Benzol}) + V(\text{Toluol})} \cdot 100 \% = \frac{350 \text{ mL}}{350 \text{ mL} + 125 \text{ mL}} \cdot 100 \% = \underline{73,7 \%}$

Ü 21 $\varphi(\text{CO}) = \frac{V(\text{CO})}{V(\text{CO}) + V(\text{CO}_2)} \cdot 100 \% = \frac{156,8 \text{ L}}{156,8 \text{ L} + 291,2 \text{ L}} \cdot 100 \% = \underline{35,0 \%}$

$$\varphi(\text{CO}_2) = \frac{V(\text{CO}_2)}{V(\text{CO}) + V(\text{CO}_2)} \cdot 100 \% = \frac{291,2 \text{ L}}{156,8 \text{ L} + 291,2 \text{ L}} \cdot 100 \% = \underline{65,0 \%}$$

Ü 22 $\varphi(\text{O}_2) = \frac{V(\text{O}_2)}{V(\text{O}_2) + V(\text{N}_2) + V(\text{CO}_2)} \cdot 100 \% = \frac{4,80 \text{ L}}{4,80 \text{ L} + 10,5 \text{ L} + 32,4 \text{ L}} \cdot 100 \% = \underline{10,1 \%}$

$$\varphi(\text{N}_2) = \frac{V(\text{N}_2)}{V(\text{O}_2) + V(\text{N}_2) + V(\text{CO}_2)} \cdot 100 \% = \frac{10,5 \text{ L}}{4,80 \text{ L} + 10,5 \text{ L} + 32,4 \text{ L}} \cdot 100 \% = \underline{22,0 \%}$$

$$\varphi(\text{CO}_2) = \frac{V(\text{CO}_2)}{V(\text{O}_2) + V(\text{N}_2) + V(\text{CO}_2)} \cdot 100 \% = \frac{32,4 \text{ L}}{4,80 \text{ L} + 10,5 \text{ L} + 32,4 \text{ L}} \cdot 100 \% = \underline{67,9 \%}$$

$$\begin{aligned}\text{Ü 23} \quad \varphi(\text{O}_2) &= \frac{V_2(\text{O}_2)}{V_1(\text{N}_2) + V_2(\text{O}_2)} = \frac{V_2(\text{O}_2)}{750 \text{ mL} + V_2(\text{O}_2)} \\ 0,125 \cdot 750 \text{ mL} &= V_2(\text{O}_2) - 0,125 \cdot V_2(\text{O}_2) = 0,875 \cdot V_2(\text{O}_2) \\ V_2(\text{O}_2) &= \frac{0,125 \cdot 750 \text{ mL}}{0,875} = \underline{107 \text{ mL}}\end{aligned}$$

$$\begin{aligned}\text{Ü 24} \quad \varphi(\text{H}_2) &= 100 \% - \varphi(\text{Ar}) = 100 \% - 0,775 \% = 99,225 \% \\ \varphi(\text{H}_2) &= \frac{V_2(\text{H}_2)}{V_1(\text{Ar}) + V_2(\text{H}_2)} = \frac{V_2(\text{H}_2)}{2,64 \text{ mL} + V_2(\text{H}_2)} \\ 0,99225 \cdot 2,64 \text{ mL} &= V_2(\text{H}_2) - 0,99225 \cdot V_2(\text{H}_2) = 0,00775 \cdot V_2(\text{H}_2) \\ V_2(\text{H}_2) &= \frac{0,99225 \cdot 2,64 \text{ mL}}{0,00775} = \underline{338 \text{ mL}}\end{aligned}$$

$$\begin{aligned}\text{Ü 25} \quad V(\text{He}) &= V(\text{Gasgemisch}) - V(\text{Ne}) = 500 \text{ mL} - 175 \text{ mL} = 325 \text{ mL} \\ \varphi(\text{He}) &= \frac{V(\text{He})}{V(\text{Gemisch})} \cdot 100 \% = \frac{325 \text{ mL}}{500 \text{ mL}} \cdot 100 \% = \underline{65,0 \%}\end{aligned}$$

$$\begin{aligned}\text{Ü 26} \quad n(\text{CH}_3\text{OH}) &= \frac{m(\text{CH}_3\text{OH})}{M(\text{CH}_3\text{OH})} = \frac{256 \text{ g}}{32,0 \text{ g/mol}} = 8,00 \text{ mol} \\ n(\text{C}_2\text{H}_5\text{OH}) &= \frac{m(\text{C}_2\text{H}_5\text{OH})}{M(\text{C}_2\text{H}_5\text{OH})} = \frac{552 \text{ g}}{46,0 \text{ g/mol}} = 12,0 \text{ mol} \\ \chi(\text{C}_2\text{H}_5\text{OH}) &= \frac{n(\text{C}_2\text{H}_5\text{OH})}{n(\text{CH}_3\text{OH}) + n(\text{C}_2\text{H}_5\text{OH})} \cdot 100 \% = \frac{12,0 \text{ mol}}{8,00 \text{ mol} + 12,0 \text{ mol}} \cdot 100 \% = \underline{60,0 \%}\end{aligned}$$

$$\begin{aligned}\text{Ü 27} \quad n(\text{Cu}) &= \frac{m(\text{Cu})}{M(\text{Cu})} = \frac{165,8 \text{ g}}{63,55 \text{ g/mol}} = 2,609 \text{ mol} \\ n(\text{Ni}) &= \frac{m(\text{Ni})}{M(\text{Ni})} = \frac{131,3 \text{ g}}{58,69 \text{ g/mol}} = 2,237 \text{ mol} \\ n(\text{Mn}) &= \frac{m(\text{Mn})}{M(\text{Mn})} = \frac{3,315 \text{ g}}{54,94 \text{ g/mol}} = 0,06034 \text{ mol} \\ \chi(\text{Cu}) &= \frac{n(\text{Cu})}{n(\text{Cu}) + n(\text{Ni}) + n(\text{Mn})} \cdot 100 \% \\ &= \frac{2,609 \text{ mol}}{2,609 \text{ mol} + 2,237 \text{ mol} + 0,06034 \text{ mol}} \cdot 100 \% = \underline{53,18 \%} \\ \chi(\text{Ni}) &= \frac{n(\text{Ni})}{n(\text{Cu}) + n(\text{Ni}) + n(\text{Mn})} \cdot 100 \% \\ &= \frac{2,237 \text{ mol}}{2,609 \text{ mol} + 2,237 \text{ mol} + 0,06034 \text{ mol}} \cdot 100 \% = \underline{45,59 \%} \\ \chi(\text{Mn}) &= \frac{n(\text{Mn})}{n(\text{Cu}) + n(\text{Ni}) + n(\text{Mn})} \cdot 100 \% \\ &= \frac{0,06034 \text{ mol}}{2,609 \text{ mol} + 2,237 \text{ mol} + 0,06034 \text{ mol}} \cdot 100 \% = \underline{1,230 \%}\end{aligned}$$

$$\text{Ü 28 } n(\text{KCl}) = \frac{m(\text{KCl})}{M(\text{KCl})} = \frac{333,3 \text{ g}}{74,55 \text{ g/mol}} = 4,471 \text{ mol}$$

$$n(\text{KBr}) = \frac{m(\text{KBr})}{M(\text{KBr})} = \frac{333,3 \text{ g}}{119,0 \text{ g/mol}} = 2,801 \text{ mol}$$

$$n(\text{KI}) = \frac{m(\text{KI})}{M(\text{KI})} = \frac{333,3 \text{ g}}{166,0 \text{ g/mol}} = 2,008 \text{ mol}$$

$$\begin{aligned} \chi(\text{KBr}) &= \frac{n(\text{KBr})}{n(\text{KCl}) + n(\text{KBr}) + n(\text{KI})} \cdot 100 \% \\ &= \frac{2,801 \text{ mol}}{4,471 \text{ mol} + 2,801 \text{ mol} + 2,008 \text{ mol}} \cdot 100 \% = \underline{30,18 \%} \end{aligned}$$

Ü 29 Bei $m(\text{Legierung}) = 100 \text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{Sn}) = \frac{m(\text{Sn})}{M(\text{Sn})} = \frac{26,85 \text{ g}}{118,7 \text{ g/mol}} = 0,2262 \text{ mol}$$

$$n(\text{Cu}) = \frac{m(\text{Cu})}{M(\text{Cu})} = \frac{73,15 \text{ g}}{63,55 \text{ g/mol}} = 1,151 \text{ mol}$$

$$\chi(\text{Sn}) = \frac{n(\text{Sn})}{n(\text{Sn}) + n(\text{Cu})} \cdot 100 \% = \frac{0,2262 \text{ mol}}{0,2262 \text{ mol} + 1,151 \text{ mol}} \cdot 100 \% = \underline{16,42 \%}$$

Ü 30 Bei $m(\text{Lösemittelgemisch}) = 100 \text{ g}$ und Summe aller Bestandteile = 100 %, $\Rightarrow w \triangleq$ Masse in g

$$n(\text{CH}_3\text{-CO-CH}_3) = \frac{m(\text{CH}_3\text{-CO-CH}_3)}{M(\text{CH}_3\text{-CO-CH}_3)} = \frac{32,0 \text{ g}}{58,0 \text{ g/mol}} = 0,552 \text{ mol}$$

$$n(\text{CH}_2\text{Cl}_2) = \frac{m(\text{CH}_2\text{Cl}_2)}{M(\text{CH}_2\text{Cl}_2)} = \frac{68,0 \text{ g}}{85,0 \text{ g/mol}} = 0,800 \text{ mol}$$

$$\begin{aligned} \chi(\text{CH}_3\text{-CO-CH}_3) &= \frac{n(\text{CH}_3\text{-CO-CH}_3)}{n(\text{CH}_3\text{-CO-CH}_3) + n(\text{CH}_2\text{Cl}_2)} \cdot 100 \% \\ &= \frac{0,552 \text{ mol}}{0,800 \text{ mol} + 0,552 \text{ mol}} \cdot 100 \% = \underline{40,8 \%} \end{aligned}$$

3.2 Konzentrationen

$$\text{Ü 31 } \beta(\text{Zucker}) = \frac{m(\text{Zucker})}{V(\text{Lösung})} = \frac{7,25 \text{ g}}{0,500 \text{ L}} = \underline{14,5 \text{ g/L}}$$

Seite 49

$$\text{Ü 32 } \beta(\text{H}_2\text{SO}_4) = \frac{m(\text{H}_2\text{SO}_4)}{V(\text{Lösung})} = \frac{48,5 \text{ g} \cdot 1000 \text{ mg/g}}{250 \text{ mL}} = \underline{194 \text{ mg/mL}}$$

Seite 50

$$\text{Ü 33 } \beta(\text{Na}_2\text{SO}_4) = \frac{m(\text{Na}_2\text{SO}_4)}{V(\text{Lösung})} = \frac{3,25 \text{ kg} \cdot 1000 \text{ g/kg}}{50,0 \text{ L}} = \underline{65,0 \text{ g/L}}$$

$$\text{Ü 34 } m(\text{NaNO}_3) = \beta(\text{NaNO}_3) \cdot V(\text{Lösung}) = 3,82 \text{ mg/mL} \cdot 250 \text{ mL} = 955 \text{ mg} = \underline{0,955 \text{ g}}$$

$$\text{Ü 35 } m(\text{HNO}_3) = \beta(\text{HNO}_3) \cdot V(\text{Lösung}) = 14,5 \text{ g/L} \cdot 5,80 \text{ L} = \underline{84,1 \text{ g}}$$

$$\text{Ü 36 } m(\text{Wirkstoff}) = \beta(\text{Wirkstoff}) \cdot V(\text{Lösung}) = 3,74 \text{ mg/L} \cdot 4,25 \text{ L} = \underline{15,9 \text{ mg}}$$

- Ü 37** $V(\text{Lösung}) = \frac{m(\text{Kalilauge})}{\rho} = \frac{167,5 \text{ g}}{1235 \text{ g/L}} = 0,13563 \text{ L}$
 $\beta(\text{KOH}) = \frac{m(\text{KOH})}{V(\text{Lösung})} = \frac{41,25 \text{ g}}{0,13563 \text{ L}} = \underline{304,1 \text{ g/L}}$
- Ü 38** $V(\text{Lösung}) = \frac{m(\text{Benzoesäure-Lösung})}{\rho} = \frac{733,0 \text{ g}}{1001 \text{ g/L}} = 0,7323 \text{ L}$
 $\beta(\text{C}_6\text{H}_5\text{COOH}) = \frac{m(\text{C}_6\text{H}_5\text{COOH})}{V(\text{Lösung})} = \frac{1,546 \text{ g}}{0,7323 \text{ L}} = \underline{2,111 \text{ g/L}}$
- Ü 39** $\beta(\text{HCl}) = \frac{V_1(\text{HCl}) \cdot w(\text{HCl}) \cdot \rho(\text{HCl})}{V_2} = \frac{62,50 \text{ mL} \cdot 0,1500 \cdot 1,073 \text{ g/mL}}{1,000 \text{ L}} = \underline{10,06 \text{ g/L}}$
- Ü 40** $\sigma(\text{C}_2\text{H}_5\text{OH}) = \frac{V(\text{C}_2\text{H}_5\text{OH})}{V(\text{Lösung})} \cdot 100 \% = \frac{102 \text{ mL}}{755 \text{ mL}} \cdot 100 \% = \underline{13,5 \%}$
- Ü 41** $\sigma(\text{CH}_3\text{OH}) = \frac{V(\text{CH}_3\text{OH})}{V(\text{Lösung})} \cdot 100 \% = \frac{1000 \text{ mL}}{1225 \text{ mL}} \cdot 100 \% = \underline{81,63 \%}$
- Ü 42** $\sigma(\text{C}_3\text{H}_7\text{OH}) = \frac{V(\text{C}_3\text{H}_7\text{OH})}{V(\text{Lösung})} \cdot 100 \% = \frac{44,2 \text{ mL}}{132 \text{ mL}} \cdot 100 \% = \underline{33,5 \%}$
- Ü 43** $V(\text{Lösung}) = \frac{V(\text{C}_4\text{H}_9\text{OH})}{\sigma(\text{Lösung})} = \frac{95,5 \text{ mL}}{0,148} = \underline{645 \text{ mL}}$
- Seite 51** **Ü 44** $V(\text{Lösung}) = \frac{V(\text{CH}_3\text{OH})}{\sigma(\text{Lösung})} = \frac{1,28 \text{ L}}{0,382} = \underline{3,35 \text{ L}}$
- Ü 45** $V(\text{Ethanol}) = V(\text{Lösung}) \cdot \sigma(\text{C}_2\text{H}_5\text{OH}) = 625,0 \text{ mL} \cdot 0,4700 = \underline{293,8 \text{ mL}}$
 $m(\text{Lösung}) = V(\text{Lösung}) \cdot \rho(\text{Lösung}) = 625,0 \text{ mL} \cdot 0,9360 \text{ g/mL} = 585,0 \text{ g}$
 $m(\text{Ethanol}) = V(\text{Ethanol}) \cdot \rho(\text{Ethanol}) = 293,8 \text{ mL} \cdot 0,7892 \text{ g/mL} = 231,9 \text{ g}$
 $m(\text{Wasser}) = m(\text{Lösung}) - m(\text{Ethanol}) = 585,0 \text{ g} - 231,9 \text{ g} = 353,1 \text{ g}$
 $V(\text{Wasser}) = \frac{m(\text{Wasser})}{\rho(\text{Wasser})} = \frac{353,1 \text{ g}}{0,9982 \text{ g/mL}} = \underline{353,7 \text{ mL}}$
- Ü 46** $\sigma(\text{Ethanol}) = \frac{V(\text{Ethanol})}{V(\text{Lösung})} \cdot 100 \% = \frac{200,0 \text{ mL}}{800,0 \text{ mL}} \cdot 100 \% = \underline{25,00 \%}$
 $m(\text{Lösung}) = V(\text{Lösung}) \cdot \rho(\text{Lösung}) = 800,0 \text{ mL} \cdot 0,9670 \text{ g/mL} = 773,6 \text{ g}$
 $m(\text{Ethanol}) = V(\text{Ethanol}) \cdot \rho(\text{Ethanol}) = 200 \text{ mL} \cdot 0,7892 \text{ g/mL} = 157,8 \text{ g}$
 $m(\text{Wasser}) = m(\text{Lösung}) - m(\text{C}_2\text{H}_5\text{OH}) = 773,6 \text{ g} - 157,8 \text{ g} = 615,8 \text{ g}$
 $V(\text{Wasser}) = \frac{m(\text{Wasser})}{\rho(\text{Wasser})} = \frac{615,8 \text{ g}}{0,9982 \text{ g/mL}} = \underline{619,9 \text{ mL}}$
- Ü 47** $n(\text{NaOH}) = c(\text{NaOH}) \cdot V(\text{Lösung}) = 0,200 \text{ mol/L} \cdot 3,00 \text{ L} = 0,600 \text{ mol}$
 $m(\text{NaOH}) = n(\text{NaOH}) \cdot M(\text{NaOH}) = 0,600 \text{ mol} \cdot 40,0 \text{ g/mol} = \underline{24,0 \text{ g}}$
- Ü 48** $n(\text{C}_6\text{H}_{12}\text{O}_6) = c(\text{C}_6\text{H}_{12}\text{O}_6) \cdot V(\text{Lösung}) = 1,20 \text{ mol/L} \cdot 0,500 \text{ L} = 0,600 \text{ mol}$
 $m(\text{C}_6\text{H}_{12}\text{O}_6) = n(\text{C}_6\text{H}_{12}\text{O}_6) \cdot M(\text{C}_6\text{H}_{12}\text{O}_6) = 0,600 \text{ mol} \cdot 180 \text{ g/mol} = \underline{108 \text{ g}}$
- Ü 49** $m(\text{H}_2\text{SO}_4) = c(\text{H}_2\text{SO}_4) \cdot V \cdot M(\text{H}_2\text{SO}_4) = 0,500 \text{ mol/L} \cdot 0,750 \text{ L} \cdot 98,1 \text{ g/mol} = \underline{36,8 \text{ g}}$