

AP Chemistry Chapter 4 Answers - Kotz

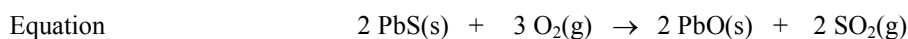
- 4.4 (a) $2 \text{Cr(s)} + 3 \text{Cl}_2\text{(g)} \rightarrow 2 \text{CrCl}_3\text{(s)}$
 (b) $\text{SiO}_2\text{(s)} + 2 \text{C(s)} \rightarrow \text{Si(s)} + 2 \text{CO(g)}$
 (c) $3 \text{Fe(s)} + 4 \text{H}_2\text{O(g)} \rightarrow \text{Fe}_3\text{O}_4\text{(s)} + 4 \text{H}_2\text{(g)}$

4.9 $2.56 \text{ g Al} \cdot \frac{1 \text{ mol Al}}{26.98 \text{ g}} \cdot \frac{3 \text{ mol Br}_2}{2 \text{ mol Al}} \cdot \frac{159.8 \text{ g}}{1 \text{ mol Br}_2} = 22.7 \text{ g Br}_2$

$2.56 \text{ g Al} + 22.7 \text{ g Br}_2 = 25.3 \text{ g Al}_2\text{Br}_6$

- 4.11 (a) $4 \text{Fe(s)} + 3 \text{O}_2\text{(g)} \rightarrow 2 \text{Fe}_2\text{O}_3\text{(s)}$
 (b) $2.68 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{55.85 \text{ g}} \cdot \frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \cdot \frac{159.7 \text{ g}}{1 \text{ mol Fe}_2\text{O}_3} = 3.83 \text{ g Fe}_2\text{O}_3$
 (c) $3.83 \text{ g Fe}_2\text{O}_3 - 2.68 \text{ g Fe} = 1.15 \text{ g O}_2$

4.15 $2.5 \text{ mol PbS} \cdot \frac{3 \text{ mol O}_2}{2 \text{ mol PbS}} = 3.8 \text{ mol O}_2$
 $2.5 \text{ mol PbS} \cdot \frac{2 \text{ mol PbO}}{2 \text{ mol PbS}} = 2.5 \text{ mol PbO}$ $2.5 \text{ mol PbS} \cdot \frac{2 \text{ mol SO}_2}{2 \text{ mol PbS}} = 2.5 \text{ mol SO}_2$



<i>Initial amount</i> (mol)	2.5	3.8	0	0
<i>Change</i> (mol)	-2.5	-3.8	+2.5	+2.5
<i>Amount after reaction</i> (mol)	0	0	2.5	2.5

4.23 (a) $995 \text{ g CH}_4 \cdot \frac{1 \text{ mol CH}_4}{16.04 \text{ g}} = 62.0 \text{ mol CH}_4$ $2510 \text{ g H}_2\text{O} \cdot \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g}} = 139 \text{ mol H}_2\text{O}$

$\frac{139 \text{ mol H}_2\text{O}}{62.0 \text{ mol CH}_4} = \frac{2.24 \text{ mol H}_2\text{O}}{1 \text{ mol CH}_4} > \frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol CH}_4}$ CH_4 is the limiting reactant

(b) $62.0 \text{ mol CH}_4 \cdot \frac{3 \text{ mol H}_2}{1 \text{ mol CH}_4} \cdot \frac{2.016 \text{ g}}{1 \text{ mol H}_2} = 375 \text{ g H}_2$

(c) CH_4 and H_2O react in a 1:1 mole ratio.

139 mol H_2O available – 62.0 mol H_2O used = 77 mol H_2O remains

$77 \text{ mol H}_2\text{O} \cdot \frac{18.0 \text{ g}}{1 \text{ mol H}_2\text{O}} = 1400 \text{ g H}_2\text{O}$



<i>Initial amount</i> (mol)	62.0	139	0	0
<i>Change</i> (mol)	-62.0	-62.0	+62.0	+186
<i>Amount after reaction</i> (mol)	0	77	62.0	186

4.29 (a) $10.0 \text{ g CuSO}_4 \cdot \frac{1 \text{ mol CuSO}_4}{159.6 \text{ g}} \cdot \frac{1 \text{ mol Cu(NH}_3)_4\text{SO}_4}{1 \text{ mol CuSO}_4} \cdot \frac{227.7 \text{ g}}{1 \text{ mol Cu(NH}_3)_4\text{SO}_4} = 14.3 \text{ g Cu(NH}_3)_4\text{SO}_4$
 (b) $\frac{12.6 \text{ g}}{14.3 \text{ g}} \cdot 100\% = 88.3\% \text{ yield}$

4.31 $1.245 \text{ g mixture} - 0.832 \text{ g after heating} = 0.413 \text{ g H}_2\text{O lost}$
 $0.413 \text{ g H}_2\text{O} \cdot \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g}} \cdot \frac{1 \text{ mol CuSO}_4 \cdot 5 \text{ H}_2\text{O}}{5 \text{ mol H}_2\text{O}} \cdot \frac{249.7 \text{ g}}{1 \text{ mol CuSO}_4 \cdot 5 \text{ H}_2\text{O}} = 1.14 \text{ g CuSO}_4 \cdot 5 \text{ H}_2\text{O}$
 $\frac{1.14 \text{ g CuSO}_4 \cdot 5 \text{ H}_2\text{O}}{1.245 \text{ g mixture}} \cdot 100\% = 91.9\% \text{ CuSO}_4 \cdot 5 \text{ H}_2\text{O}$

4.37 $1.481 \text{ g CO}_2 \cdot \frac{1 \text{ mol CO}_2}{44.010 \text{ g}} \cdot \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.03365 \text{ mol C}$
 $0.303 \text{ g H}_2\text{O} \cdot \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g}} \cdot \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.0336 \text{ mol H}$
 $\frac{0.03365 \text{ mol C}}{0.0336 \text{ mol H}} = \frac{1 \text{ mol C}}{1 \text{ mol H}}$ The empirical formula is CH

4.42 $0.3718 \text{ g CO}_2 \cdot \frac{1 \text{ mol CO}_2}{44.010 \text{ g}} \cdot \frac{1 \text{ mol C}}{1 \text{ mol CO}_2} = 0.008448 \text{ mol C}$
 $0.008448 \text{ mol C} \cdot \frac{12.011 \text{ g}}{1 \text{ mol C}} = 0.1015 \text{ g C}$
 $0.1522 \text{ g H}_2\text{O} \cdot \frac{1 \text{ mol H}_2\text{O}}{18.015 \text{ g}} \cdot \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.01690 \text{ mol H}$
 $0.01690 \text{ mol H} \cdot \frac{1.0079 \text{ g}}{1 \text{ mol H}} = 0.01703 \text{ g H}$

mass of O = sample mass – mass of C – mass of H
 $= 0.1523 \text{ g} - 0.1015 \text{ g C} - 0.01703 \text{ g H}$
 $= 0.0338 \text{ g O}$

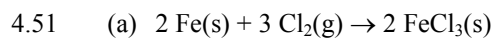
$0.0338 \text{ g O} \cdot \frac{1 \text{ mol O}}{16.00 \text{ g}} = 0.00211 \text{ mol O}$

$\frac{0.008448 \text{ mol C}}{0.00211 \text{ mol O}} = \frac{4 \text{ mol C}}{1 \text{ mol O}}$ $\frac{0.01690 \text{ mol H}}{0.00211 \text{ mol O}} = \frac{8 \text{ mol H}}{1 \text{ mol O}}$

The empirical formula is C₄H₈O

The empirical formula mass is equal to the molar mass. The molecular formula is also C₄H₈O.

4.49 $125 \text{ mg acetoacetic acid} \cdot \frac{1 \text{ g}}{10^3 \text{ mg}} \cdot \frac{1 \text{ mol acetoacetic acid}}{102.1 \text{ g}} \cdot \frac{1 \text{ mol acetone}}{1 \text{ mol acetoacetic acid}} \cdot \frac{58.08 \text{ g}}{1 \text{ mol acetone}}$
 $= 0.0711 \text{ g acetone}$



(b) $10.0 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{55.85 \text{ g}} \cdot \frac{3 \text{ mol Cl}_2}{2 \text{ mol Fe}} \cdot \frac{70.91 \text{ g}}{1 \text{ mol Cl}_2} = 19.0 \text{ g Cl}_2$

$10.0 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{55.85 \text{ g}} \cdot \frac{2 \text{ mol FeCl}_3}{2 \text{ mol Fe}} \cdot \frac{162.2 \text{ g}}{1 \text{ mol FeCl}_3} = 29.0 \text{ g FeCl}_3$

(c) $\frac{18.5 \text{ g}}{29.0 \text{ g}} \cdot 100\% = 63.7\% \text{ yield}$

(d) 10.0 g Fe requires 19.0 g Cl₂ for complete reaction, so chlorine is the limiting reactant if 10.0 g of each reactant is combined.

$$10.0 \text{ g Cl}_2 \cdot \frac{1 \text{ mol Cl}_2}{70.91 \text{ g}} \cdot \frac{2 \text{ mol FeCl}_3}{3 \text{ mol Cl}_2} \cdot \frac{162.2 \text{ g}}{1 \text{ mol FeCl}_3} = 15.2 \text{ g FeCl}_3$$

4.60 $11.64 \text{ g SiO}_2 \cdot \frac{1 \text{ mol SiO}_2}{60.084 \text{ g}} \cdot \frac{1 \text{ mol Si}}{1 \text{ mol SiO}_2} = 0.1937 \text{ mol Si}$

$$6.980 \text{ g H}_2\text{O} \cdot \frac{1 \text{ mol H}_2\text{O}}{18.015 \text{ g}} \cdot \frac{2 \text{ mol H}}{1 \text{ mol H}_2\text{O}} = 0.7749 \text{ mol H}$$

$$\frac{0.7749 \text{ mol H}}{0.1937 \text{ mol Si}} = \frac{4 \text{ mol H}}{1 \text{ mol Si}}$$

The empirical formula is SiH₄

4.65 $0.376 \text{ g CO}_2 \cdot \frac{1 \text{ mol CO}_2}{44.01 \text{ g}} \cdot \frac{1 \text{ mol MCO}_3}{1 \text{ mol CO}_2} = 0.00854 \text{ mol MCO}_3$

$$\frac{1.056 \text{ g}}{0.00854 \text{ mol}} = 124 \text{ g/mol}$$

124 g/mol (MCO₃) – 60 g/mol (CO₃) = 64 g/mol The metal is (b) copper, Cu

4.79 (a) 10.8 g product – 2.0 g Fe = 8.8 g Br₂

(b) $2.0 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{55.8 \text{ g}} = 0.036 \text{ mol Fe}$

$$8.8 \text{ g Br}_2 \cdot \frac{1 \text{ mol Br}_2}{160. \text{ g}} \cdot \frac{2 \text{ mol Br}}{1 \text{ mol Br}_2} = 0.11 \text{ mol Br}$$

$$\frac{0.11 \text{ mol Br}}{0.036 \text{ mol Fe}} = \frac{3 \text{ mol Br}}{1 \text{ mol Fe}}$$

(c) FeBr₃

(d) $2 \text{ Fe(s)} + 3 \text{ Br}_2(\ell) \rightarrow 2 \text{ FeBr}_3(\text{s})$

(e) Iron(III) bromide

(f) (i) When 1.00 g of Fe is added to the Br₂, Fe is the limiting reagent.

4.80 Panel (b) represents the outcome of the reaction. Cl₂ is the limiting reactant.