Chapter 7 Study Guide Answers

7.1

1a The SI unit that measures the amount of substance is the mole. A mole of any substance is composed of Avogadro's number (6.02×10^{23}) of representative particles. The representative particle of most element is the atom. A molecule is the representative particle of diatomic elements and molecular compounds. The representative particle of ionic compounds is a formula unit.

2a. The molar mass of a substance is the mass in grams of one mole of that substance.

a. 22.99 g/mol
b. 58.44 g/mol
c. 18.02 $\frac{g}{mol}$

7.2

3a. $45.98\,g\,Na \times \frac{1\,mol\,Na}{22.99\,g\,Na} = 2\,mol\,Na$

b. $3\,mol\,H_2O \times \frac{18.02\,g\,H_2O}{1\,mol\,H_2O} = 54.06\,g\,H_2O$

4a $9.3 \times 10^{15}\,atoms\,Pb \times \frac{1\,mol\,Pb \quad \cancel{207.2\,g\,Pb}}{6.02 \times 10^{23}\,atoms\,Pb} = \boxed{1.5 \times 10^{-8}\,mol\,Pb}$

4b. $9.3 \times 10^{15}\,atoms\,Pb \times \frac{207.2\,g\,Pb}{6.02 \times 10^{23}\,atoms\,Pb} = \boxed{3.2 \times 10^{-6}\,g\,Pb}$

c. $2.5\,mol\,O_2 \times \frac{22.4\,L\,O_2}{1\,mol\,O_2} = \boxed{56\,L\,O_2}$

4d $2.5\ mol\ O_2 \times \frac{6.02\times10^{23}\ molecules\ O_2}{1\ mol\ O_2} = \boxed{1.5\times10^{24}\ molecules\ O_2}$

7.3

5a $C_6H_{12}O_6$ % Composition

1st calculate molar mass

C: $6\times 12.01 = 72.06$

H: $12\times 1.01 = 12.12$

O: $6\times 16.00 = \underline{96.00}$

$180.18\ \frac{g}{mol}$

$\% C = 72.06 \div 180.18 = 0.3999\times100\% = \boxed{40\%}$

$\% H = 12.12 \div 180.18 = 0.067\times100\% = \boxed{7\%}$

$\% O = 96.00 \div 180.18 = 0.53\times100\% = \boxed{53\%}$

6a $94.1\ g\ O \times \frac{1\ mol\ O}{16\ g\ O} = 5.88\ mol\ O \quad \div 5.84 = 1$

$5.9\ g\ H \times \frac{1\ mol\ H}{1.01\ g\ H} = 5.8416\ mol\ H \div 5.84 = 1$

Empirical formula is: HO

Calculate empirical molar mass of HO = 17.01

Compare to molecular mass of HO @ 34.00

$\frac{34.00}{17.01} = 2$ so the molecular formula is $2(HO) = \boxed{H_2O_2 = \text{hydrogen peroxide}}$

Note: H and O were not calculated as diatomic (HOFBrINCl twins) because it is a compound.

Chapter 8 Study Guide Answers

8.1

1a. $2Al(s) + 6HCl(aq) \rightarrow 3H_2(g) + 2AlCl_3(aq)$

2a $C_2H_2(g) + 2O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$

8.2

Zn^{2+} PO_4^{3-}

4a $2Li_3PO_4(aq) + 3Zn(NO_3)_2(aq) \rightarrow 6LiNO_3(aq) + Zn_3(PO_4)_2(s)$

One of the products of a double replacement reaction must be either a (1) solid (which zinc phosphate is) OR (2) water - usually formed in double replacement rxns which are acid-base reactions or a (3) gas.

b. $C_2H_2(g) + 2O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$
Combustion products are $CO_2 + H_2O$

c $2Al(s) + 6HCl(aq) \rightarrow 3H_2(g) + 2AlCl_3(aq)$
Single replacement - Activity series
Al is above $\boxed{H}$ in the acid. It will replace H.

d. $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$
Combination aka Synthesis

e. $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
Decomposition

Ch 8 Continued

8.3

5a $2Li_3PO_4(aq) + 3Zn(NO_3)_2(aq) \rightarrow 6LiNO_3(aq) + Zn_3(PO_4)_{2(s)}$

$\cancel{6Li^+}(aq) + 2PO_4^{3-}(aq) + 3Zn^{2+}(aq) + \overset{6\,2}{\cancel{6NO_3^-}} \rightarrow \cancel{6Li^+}(aq) + \cancel{6NO_3^-}(aq) + Zn_3(PO_4)_{2(s)}$

$$\boxed{2PO_4^{3-}(aq) + 3Zn^{2+}(aq) \rightarrow Zn_3(PO_4)_{2(s)}}$$

Step 1: Complete the equation
2: Balance equation
3: Add States (aq) (l) (s) etc...
4: Take (aq) apart into ions
5: Cross off spectator Ions
6: Reform Net Ionic Eq.
7: Check charges

9.1 The Arithmetic of Equations

1a. $288 \text{ } \cancel{\text{tricycles}} \times \frac{3 \text{ wheels}}{1 \text{ } \cancel{\text{tricycle}}} = 864 \text{ wheels}$

$288 \text{ } \cancel{\text{tricycles}} \times \frac{1 \text{ seat}}{1 \text{ } \cancel{\text{tricycle}}} = 288 \text{ seats}$

$288 \text{ } \cancel{\text{tricylces}} \times \frac{2 \text{ pedals}}{1 \text{ } \cancel{\text{tricycle}}} = 576 \text{ pedals}$

2a.

moles	molecules	volumes
$N_2 = 2$	2	$2 \times 22.4 = 44.8 L$
$O_2 = 3$	3	$3 \times 22.4 = 67.2 L$
$N_2O_3 = 2$	2	$2 \times 22.4 = 44.8 L$

mass Reactants: $2 \text{ mol } N_2 = 2(14.01 \times 2) = 56.04 g$

$3 \text{ mol } O_2 = 3(16.00 \times 2) = 96.00 g$

$152.04 g$

Products: $2 \text{ mol } N_2O_3 = 2[(2 \times 14.01) + (3 \times 16.00)]$

$= 152.04 g$

2b. $14 \text{ mol } FeCl_3 \times \frac{3 \text{ mol } Cl_2}{2 \text{ mol } FeCl_3} = 21 \text{ mol } Cl_2$

9.2 Chemical Calculations

3a. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

$$4.8\,g\,O_2 \times \frac{1\,mol\,O_2}{32.00\,g\,O_2} \times \frac{2\,mol\,CO}{1\,mol\,O_2} \times \frac{22.4\,L\,CO}{1\,mol\,CO} = 6.72\,L\,CO$$

3b. $4NH_3(g) + 7O_2(g) \rightarrow 6H_2O(g) + 4NO_2(g)$

$$2.1\times10^{24}\text{ molecules } O_2 \times \frac{1\,mol\,O_2}{6.02\times10^{23}\text{ molecules } O_2} \times \frac{4\,mol\,NH_3}{7\,mol\,O_2}$$

$$\times \frac{17.04\,g\,NH_3}{1\,mol\,NH_3} = \boxed{33.97\,g\,NH_3}$$

4b. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

$$250\,g\,H_2SO_4 \times \frac{1\,mol\,H_2SO_4}{98.09\,g\,H_2SO_4} \times \frac{1\,mol\,Al_2(SO_4)_3}{3\,mol\,H_2SO_4} \times \frac{342.17\,g\,Al_2(SO_4)_3}{1\,mol\,Al_2(SO_4)_3} =$$

9.3 LR + % Yield

$$= \boxed{290.69\,g\,Al_2(SO_4)_3}$$

5a. limiting reagent
5b. used up.
5c. product

5d. $\overset{3.1\,mol}{2SO_2(g)} + \overset{2.7\,mol}{O_2(g)} \rightarrow 2SO_3(g)$

$$3.1\,mol\,SO_2 \times \frac{1\,mol\,O_2}{2\,mol\,SO_2} = \boxed{1.55\text{ mol } O_2\text{ needed, so } SO_2\text{ is LR}}$$

5e. $3.1\,mol\,SO_2 \times \frac{2\,mol\,SO_3}{2\,mol\,SO_2} = 3.10\,mol\,SO_3$ can be formed (248.22g)

$2.7\,mol\,O_2 - 1.55\,mol\,O_2$ used $= 1.15\,mol\,O_2$ in excess (36.80g)

9.3 Continued

5f $\overset{36\,L}{4H_2(g)} + \overset{12\,L}{CS_2(g)} \rightarrow CH_4(g) + 2H_2S(g)$

$$36\,L\ H_2 \times \frac{1\,mol\ H_2}{22.4\,L\ H_2} \times \frac{1\,mol\ CS_2}{4\,mol\ H_2} \times \frac{22.4\,L\ CS_2}{1\,mol\ CS_2} = 9\,L\ CS_2$$

Since only 9 L CS_2 were required, $\boxed{3\,L\ CS_2 \text{ is left over.}}$ $\boxed{\text{(making } CS_2 \text{ the excess reagent)}}$

g. $\overset{54.0g}{2Al(s)} + \overset{319\,g}{3CuSO_4(aq)} \rightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$

$$54.0g\ Al \times \frac{1\,mol\ Al}{26.98g\ Al} \times \frac{3\,mol\ Cu}{2\,mol\ Al} \times \frac{63.55g\ Cu}{1\,mol\ Cu} = 190.79\ g\ Cu$$

$$319\ g\ CuSO_4 \times \frac{1\,mol\ CuSO_4}{159.62g\ CuSO_4} \times \frac{3\,mol\ Cu}{3\,mol\ CuSO_4} \times \frac{63.55g\ Cu}{1\,mol\ Cu}$$

$$= \boxed{127.00\,g\ Cu}$$

6a. theoretical yield
b. maximum
c. actual yield

(produced 4.65g)

6d. $\overset{1.87g}{2Al(s)} + 3CuSO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$

Theoretical Yield:

$$1.87g\ Al \times \frac{1\,mol\ Al}{26.98g\ Al} \times \frac{3\,mol\ Cu}{2\,mol\ Al} \times \frac{63.55g\ Cu}{1\,mol\ Cu} = 6.61\,g\ Cu$$

Actual Yield:

4.65g Cu

$$\%\ Yield = \frac{Actual\ Yield}{Theoretical\ Yield} \times 100\% = \frac{4.65g}{6.61g} \times 100\% = \boxed{70.4\%\ \text{Yield}}$$