Honors Chemistry

Answers to Chapter 3 Study Questions

1. a) 3(12.0) + 8(1.01) + 3(16.0) = 92.1 g/mole b) 92.1 g c) 6.02 x 10^{23} molecules

   d) 0.217 moles x $\frac{92.1\,g}{1\,mole}$ = 20.0 g

2. a) 4 atoms (one N + 3 H)

   b) 1 mole NH_3 x $\frac{6.02 \times 10^{23}\ molecules}{1\ mole\ NH_3} \times \frac{4\ atoms}{1\ molecule}$ = 2.41 x 10^{24} atoms

   c) 3.40 g NH_3 $\times \frac{1\ mole\ NH_3}{17.0\ g\ NH_3} \times \frac{6.02 \times 10^{23}\ molecules}{1\ mole\ NH_3} \times \frac{4\ atoms}{1\ molecule}$ = 4.82 x 10^{23} atoms

3. Molar mass of $NaNO_2$ = 23.0 + 14.0 + 2(16.0) = 69.0 g/mole
   % Na = 23.0/69.0 = 33.3% Na; % N = 14.0/69.0 = 20.3% N; %O = 2(16.0)/69.0 = 46.4% O
   33.3% Na, 20.3% N and 46.4% O.

4. a) In 100 g of this compound, there are 40.7 g C, 5.1 g H, and 54.2 g O

   40.7 g C x $\frac{1\,mole\,C}{12.0\,g\,C}$ = 3.39 moles C 3.39/3.39 = 1 x 2 = 2

   5.1 g H x $\frac{1\,mole\,H}{1.0\,g\,H}$ = 5.1 moles H 5.1/3.39 = 1.5 x 2 = 3

   54.2 g O x $\frac{1\,mole\,O}{16.0\,g\,O}$ = 3.39 moles O 3.39/3.39 = 1 x 2 = 2

   empirical formula = $C_2H_3O_2$

   b) Molar mass of $C_2H_3O_2$ = 2(12.0) + 3(1.0) + 2(16.0) = 59.0 g/mole
   118/59.0 = 2 $\rightarrow$ molecular formula = $C_4H_6O_4$

5. a) In 25.0 g of compound, there are 7.20 g Mg, 3.55 g C and 25.0-(7.20+3.55) = 14.25 g O.

   7.20 g Mg x $\frac{1\,mole\,Mg}{24.3\,g\,Mg}$ = 0.296 moles Mg 0.296/0.296 = 1

   3.55 g C x $\frac{1\,mole\,C}{12.0\,g\,C}$ = 0.296 moles C 0.296/0.296 = 1

   14.25 g O x $\frac{1\,mole\,O}{16.0\,g\,O}$ = 0.891 moles O 0.891/0.296 = 3

   formula = $MgCO_3$

   b) % Mg = 7.20/25.0 = 28.8% Mg; %C = 3.55/25.0 = 14.2 % C; % O = 14.25/25.0 = 57.0% O. (You should get the same result using molar mass and atomic masses.)

   c) 13.9 g compound x $\frac{28.8\,g\,Mg}{100\,g\,compound}$ = 4.00 g Mg

5. d) 0.290 mol C x $\frac{12.0\ g\ C}{1\ mole\ C}$ x $\frac{100\ g\ compound}{14.2\ g\ C}$ = 24.5 g compound

6. mass of Zn = 33.64 g - 32.00 g = 1.64 g Zn
   mass of O = 34.04 g - 33.64 g = 0.40 g O.

   # moles Zn: 1.64 g Zn x $\frac{1\ mole\ Zn}{65.4\ g\ Zn}$ = 0.0251 moles Zn 0.251/0.25 = 1

   # moles O: 0.40 g O x $\frac{1\ mole\ O}{16.0\ g\ O}$ = 0.025 moles O 0.25/0.25 = 1

   formula = ZnO

7. a) $B_2H_6(l)$ + **3** $O_2(g)$ → $B_2O_3(s)$ + **3** $H_2O(l)$
   b) **4** $PH_3(g)$ + **8** $O_2(g)$ → **6** $H_2O(l)$ + $P_4O_{10}(s)$

8. a) 6 Li(*s*) + $N_2(g)$ → 2 $Li_3N(s)$
   b) $Co(NO_3)_3(aq)$ + 3 NaOH(*aq*) → 3 $NaNO_3(aq)$ + $Co(OH)_3$ (*s*)
   c) Zn(*s*) + 2 HCl(*aq*) → $ZnCl_2(aq)$ + $H_2(g)$
   d) (a) is a combination (synthesis) reaction. (b) is a double replacement reaction.

9. a) 8.20 moles SO_2 x $\frac{2\ mol\ H_2S}{2\ mol\ SO_2}$ = 8.20 moles H_2S

   b) 1.00 mole H_2S x $\frac{3\ mol\ O_2}{2\ mol\ H_2S}$ x $\frac{32.0\ g\ O_2}{1\ mol\ O_2}$ = 48.0 g O_2

   c) 6.82 g H_2S x $\frac{1\ mol\ H_2S}{34.1\ g\ H_2S}$ x $\frac{2\ mol\ H_2O}{2\ mol\ H_2S}$ x $\frac{18.0\ g\ H_2O}{1\ mol\ H_2O}$ = 3.60 g H_2O

   d) 7.98 g H_2S x $\frac{1\ mol\ H_2S}{34.1\ g\ H_2S}$ x $\frac{2\ mol\ SO_2}{2\ mol\ H_2S}$ x $\frac{64.1\ g\ SO_2}{1\ mol\ SO_2}$ = 15.0 g SO_2

   % yield = $\frac{actual\ yield}{theoretical\ yield}$ x 100% = $\frac{12.0\ g\ SO_2}{15.0\ g\ SO_2}$ x 100% = 80.0%

   e) 2.66 g H_2S x $\frac{1\ mol\ H_2S}{34.1\ g\ H_2S}$ × $\frac{2\ mol\ SO_2}{2\ mol\ H_2S}$ × $\frac{64.1\ g\ SO_2}{1\ mol\ SO_2}$ = 5.00 g SO_2

   3.00 g O_2 x $\frac{1\ mol\ O_2}{32.0\ g\ O_2}$ × $\frac{2\ mol\ SO_2}{3\ mol\ O_2}$ × $\frac{64.1\ g\ SO_2}{1\ mol\ SO_2}$ = 4.01 g SO_2

   O_2 is limiting; 4.01 g SO_2 is produced

10. a) $H_2(g)$ + $Cl_2(g)$ → 2 HCl(*g*)
    b) H_2 is limiting (H_2 and Cl_2 react in a ratio 1:1 ratio and there is less H_2.)

    c) 7.50 mol H_2 x $\frac{2\ mol\ HCl}{1\ mol\ H_2}$ = 15.0 mol HCl

    d) 9.00 – 7.50 = 1.50 mol Cl_2 left