Answers to Chapters 8 & 9 Study Questions

1. a) $3\ Na_2CO_3(aq) + 2\ FeCl_3(aq) \rightarrow 6\ NaCl(aq) + Fe_2(CO_3)_3(s)$

   b) $6\ Na^+(aq) + 3\ CO_3^{2-}(aq) + 2\ Fe^{3+}(aq) + 6\ Cl^-(aq) \rightarrow 6\ Na^+(aq) + 6\ Cl^-(aq) + Fe_2(CO_3)_3(s)$

   c) $2\ Fe^{3+}(aq) + 3\ CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$

2. a) $Fe^{3+}(aq) + 3\ OH^-(aq) \rightarrow Fe(OH)_3(s)$

   b) No Reaction ($(NH_4)_2CO_3$ and LiCl are both soluble)

   c) $Ni^{2+}(aq) + S^{2-}(aq) \rightarrow NiS(s)$

3. a) S, OR; $2\ Li(s) + Cl_2(g) \rightarrow 2\ LiCl(s)$
   b) DD, P; $Sr(NO_3)_2(aq) + K_2SO_4(aq) \rightarrow 2\ KNO_3(aq) + SrSO_4(s)$
   c) C, OR; $2\ C_3H_6(g) + 9\ O_2(g) \rightarrow 6\ CO_2(g) + 6\ H_2O(l)$
   d) DD; $CaCl_2(aq) + 2\ NaNO_3(aq) \rightarrow$ No reaction (all products are soluble)
   e) SR, OR; $Fe(s) + MgSO_4(aq) \rightarrow$ No reaction (Mg is more active than Fe)
   f) D, OR; $2\ KI(l) \rightarrow 2\ K(s) + I_2(s)$
   g) SR, OR; $2\ Al(s) + 6\ HCl(aq) \rightarrow 3\ H_2(g) + 2\ AlCl_3(aq)$
   h) DD, AB; $HNO_3(aq) + KOH(aq) \rightarrow H_2O(l) + KNO_3(aq)$

4. $Fe(NO_3)_3(s) \rightarrow Fe^{3+}(aq) + 3\ NO_3^-(aq)$

5. a) $1.60\ mol\ CrCl_3 \times \frac{6\ mol\ HCl}{2\ mol\ CrCl_3} = 4.80\ moles\ HCl$

   b) $0.450\ mol\ HCl \times \frac{2\ mol\ Cr}{6\ mol\ HCl} \times \frac{52.0\ g\ Cr}{1\ mol\ Cr} = 7.80\ g\ Cr$

   c) $12\ mol\ H_2 \times \frac{2\ mol\ Cr}{3\ mol\ H_2} \times \frac{6.02 \times 10^{23}\ atoms\ Cr}{1\ mol\ Cr} = 4.8 \times 10^{24}\ atoms\ Cr$

   d) $3.20\ g\ H_2 \times \frac{1\ mol\ H_2}{2.016\ g\ H_2} \times \frac{2\ mol\ Cr}{3\ mol\ H_2} \times \frac{52.0\ g\ Cr}{1\ mol\ Cr} = 55.0\ g\ Cr$

   e) $8.30\ g\ HCl \times \frac{1\ mol\ HCl}{36.46\ g\ HCl} \times \frac{2\ mol\ CrCl_3}{6\ mol\ HCl} \times \frac{158.35\ g\ CrCl_3}{1\ mol\ CrCl_3} = 12.0\ g\ CrCl_3$

   theoretical yield = 12.0 g $CrCl_3$

   $\%\ Yield = \frac{actual\ yield}{theoretical\ yield} \times 100\% = \frac{10.2\ g}{12.0\ g} \times 100\% = 85.0\%$

f) 6.0 moles Cr x $\frac{2\ mol\ CrCl_3}{2\ mol\ Cr}$ = 6.0 moles $CrCl_3$

12.0 moles HCl x $\frac{2\ mol\ CrCl_3}{6\ mol\ HCl}$ = 4.0 moles $CrCl_3$; therefore, HCl is limiting

4.0 moles $CrCl_3$ x $\frac{2\ mol\ Cr}{2\ mol\ CrCl_3}$ = 4.0 moles Cr used up.

6.0 - 4.0 = 2.0 moles Cr left over.

g) 13.0 g Cr x $\frac{1\ mol\ Cr}{52.0\ g\ Cr}$ x $\frac{2\ mol\ CrCl_3}{2\ mol\ Cr}$ x $\frac{158\ g\ CrCl_3}{1\ mol\ CrCl_3}$ = 39.5 g $CrCl_3$

43.8 g HCl x $\frac{1\ mol\ HCl}{36.5\ g\ HCl}$ x $\frac{2\ mol\ CrCl_3}{6\ mol\ HCl}$ x $\frac{158\ g\ CrCl_3}{1\ mol\ CrCl_3}$ = 63.2 g $CrCl_3$

since 39.5 g < 63.2 g, 39.5 g $CrCl_3$ is produced.