1) $3H_2SO_4 + 2Al(OH)_3 \rightarrow Al_2(SO_4)_3 + 6H_2O$

a. $(80\text{ g } H_2SO_4)\left(\frac{1\text{ mol}}{98.09\text{ g}}\right) = .816\text{ mol } H_2SO_4$

$(.816\text{ mol } H_2SO_4)\left(\frac{1\text{ mol } Al_2(SO_4)_3}{3\text{ mol } H_2SO_4}\right) = .272\text{ mol } Al_2(SO_4)_3$

$(.75\text{ g } Al(OH)_3)\left(\frac{\text{mol}}{78.01\text{ g}}\right) = .961\text{ mol } Al(OH)_3$

$(.961\text{ mol } Al(OH)_3)\left(\frac{1\text{ mol } Al_2(SO_4)_3}{2\text{ mol } Al(OH)_3}\right) = .481\text{ mol } Al_2(SO_4)_3$

$\therefore H_2SO_4$ is limiting

b. $(.816\text{ mol } H_2SO_4)\left(\frac{2\text{ mol } Al(OH)_3}{3\text{ mol } H_2SO_4}\right) = .544\text{ mol } Al(OH)_3$ used

$.961\text{ mol } Al(OH)_3$ given $- .544\text{ mol}$ used $= .417\text{ mol } Al(OH)_3$ in excess

$(.417\text{ mol } Al(OH)_3)\left(\frac{78.01\text{ g}}{\text{mol}}\right) = 32.53\text{ g } Al(OH)_3$ in excess

c. $(.816\text{ mol } H_2SO_4)\left(\frac{1\text{ mol } Al_2(SO_4)_3}{3\text{ mol } H_2SO_4}\right) = .272\text{ mol } Al_2(SO_4)_3$

$(.272\text{ mol } Al_2(SO_4)_3)\left(\frac{342.14\text{ g}}{\text{mol}}\right) = 96.06\text{ g } Al_2(SO_4)_3$

$(.816\text{ mol } H_2SO_4)\left(\frac{6\text{ mol } H_2O}{3\text{ mol } H_2SO_4}\right) = 1.632\text{ mol } H_2O$

$(1.632\text{ mol } H_2O)\left(\frac{18.02\text{ g}}{\text{mol}}\right) = 29.41\text{ g } H_2O$

2. a. $Sn(NO_3)_4 + 4NaCl \rightarrow SnCl_4 + 4NaNO_3$

b. $(3\text{ mol } Sn(NO_3)_4)\left(\frac{1\text{ mol } SnCl_4}{1\text{ mol } Sn(NO_3)_4}\right) = 3\text{ mol } SnCl_4$

3. a. $Sn(NO_3)_4 + 4NaCl \rightarrow SnCl_4 + 4NaNO_3$

b. $(3\ mol\ Sn(NO_3)_4)\left(\frac{1\ mol\ SnCl_4}{1\ mol\ Sn(NO_3)_4}\right) = 3\ mol\ SnCl_4$

$(5\ mol\ NaCl)\left(\frac{1\ mol\ SnCl_4}{4\ mol\ NaCl}\right) = 1.25\ mol\ SnCl_4$

∴ NaCl is LIMITING

c. $(5\ mol\ NaCl)\left(\frac{1\ mol\ Sn(NO_3)_4}{4\ mol\ NaCl}\right) = 1.25\ mol\ Sn(NO_3)_4$ USED

d. $3\ mol\ Sn(NO_3)_4 - 1.25\ mol = 1.75\ mol\ Sn(NO_3)_4$ IN EXCESS

e. $(5\ mol\ NaCl)\left(\frac{4\ mol\ NaNO_3}{4\ mol\ NaCl}\right) = \frac{5.0\ mol\ NaNO_3}{1.25\ mol\ SnCl_4}$ FROM "b"

4. a. $3AgNO_3 + AlCl_3 \rightarrow 3AgCl + Al(NO_3)_3$

b. $(6\ \cancel{mol\ AgNO_3})\left(\frac{3\ mol\ AgCl}{3\ \cancel{mol\ AgNO_3}}\right) = 6\ mol\ AgCl$

$(5\ mol\ AlCl_3)\left(\frac{3\ mol\ AgCl}{1\ mol\ AlCl_3}\right) = 15\ mol\ AgCl$

∴ $AgNO_3$ IS LIMITING

c. $AlCl_3$ IS IN EXCESS

d. $(6\ \cancel{mol\ AgNO_3})\left(\frac{1\ mol\ AlCl_3}{3\ \cancel{mol\ AgNO_3}}\right) = 2\ mol\ AlCl_3$ USED

c. $(6\ \text{mol}\ AgNO_3)\left(\frac{1\ \text{mol}\ Al(NO_3)_3}{3\ \text{mol}\ AgNO_3}\right) = \boxed{2\ \text{mol}\ Al(NO_3)_3}$

$+$ (6 mol AgCl (FROM 'b'))

5. a. $2\ C_4H_{10} + 13O_2 \rightarrow 8\ CO_2 + 10\ H_2O$

b. C_4H_{10} MUST BE LIMITING AS THE O_2 COMES FROM AIR.

c. $(.25\ \text{mol}\ C_4H_{10})\left(\frac{8\ \text{mol}\ CO_2}{2\ \text{mol}\ C_4H_{10}}\right) = \boxed{1\ \text{mol}\ CO_2}$

$(.25\ \text{mol}\ C_4H_{10})\left(\frac{10\ \text{mol}\ H_2O}{2\ \text{mol}\ C_4H_{10}}\right) = \boxed{1.25\ \text{mol}\ H_2O}$

d. $(1\ \text{mol}\ CO_2)\left(\frac{44.01\ g}{\text{mol}}\right) = \boxed{44.01\ g\ CO_2}$

$(1.25\ \text{mol}\ H_2O)\left(\frac{18.02\ g}{\text{mol}}\right) = \boxed{22.53\ g\ H_2O}$

6. $3\ CaCl_2 + 2\ Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6\ NaCl$

a. $(50\ g\ CaCl_2)\left(\frac{1\ \text{mol}}{110.98\ g}\right) = .451\ \text{mol}\ CaCl_2$

$(.451\ \text{mol}\ CaCl_2)\left(\frac{1\ \text{mol}\ Ca_3(PO_4)_2}{3\ \text{mol}\ CaCl_2}\right) = .150\ \text{mol}\ Ca_3(PO_4)_2$

$(100\ g\ Na_3PO_4)\left(\frac{1\ \text{mol}}{163.94\ g}\right) = .610\ \text{mol}\ Na_3PO_4$

$(.61\ \text{mol}\ Na_3PO_4)\left(\frac{1\ \text{mol}\ Ca_3(PO_4)_2}{2\ \text{mol}\ Na_3PO_4}\right) = .305\ \text{mol}\ Ca_3(PO_4)_2$

$\therefore$ $CaCl_2$ IS LIMITING

c. Na_3PO_4 IS IN EXCESS

d. $(.451\ \text{mol}\ CaCl_2)\left(\frac{2\ \text{mol}\ Na_3PO_4}{3\ \text{mol}\ CaCl_2}\right) = .301\ \text{mol}\ Na_3PO_4$

5.43 $CaCl_2 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 6NaCl$

b. $(50\text{ g } CaCl_2)\left(\frac{1\text{ mol}}{110.98\text{ g}}\right) = .451\text{ mol } CaCl_2$

$(.451\text{ mol } CaCl_2)\left(\frac{1\text{ mol } Ca_3(PO_4)_2}{3\text{ mol } CaCl_2}\right) = .150\text{ mol } Ca_3(PO_4)_2$

$(100\text{ g } Na_3PO_4)\left(\frac{1\text{ mol}}{163.94\text{ g}}\right) = .610\text{ mol } Na_3PO_4$

$(.61\text{ mol } Na_3PO_4)\left(\frac{1\text{ mol } Ca_3(PO_4)_2}{2\text{ mol } Na_3PO_4}\right) = .305\text{ mol } Ca_3(PO_4)_2$

$\therefore CaCl_2$ is limiting

c. Na_3PO_4 is in excess

d. $(.451\text{ mol } CaCl_2)\left(\frac{2\text{ mol } Na_3PO_4}{3\text{ mol } CaCl_2}\right) = .301\text{ mol } Na_3PO_4$ used

$.610\text{ mol } Na_3PO_4$ (given) $- .301\text{ mol}$ used $= .309\text{ mol } Na_3PO_4$ in excess

e. $(.451\text{ mol } CaCl_2)\left(\frac{6\text{ mol } NaCl}{3\text{ mol } CaCl_2}\right) = .90\text{ mol } NaCl$

$.15\text{ mol } Ca_3(PO_4)_2$ produced from 'b'