14 HW #4 - Limiting Reactants

a. $HCl + NaOH \rightarrow NaCl + H_2O$

2.0 mol 2.5 mol

$(2.0\ \text{mol HCl})\left(\frac{1\ \text{mol NaCl}}{1\ \text{mol HCl}}\right) = 2.0\ \text{mol NaCl}$ POSSIBLE

$(2.5\ \text{mol NaOH})\left(\frac{1\ \text{mol NaCl}}{1\ \text{mol NaOH}}\right) = 2.5\ \text{mol NaCl}$ POSSIBLE

∴ HCl is limiting

b. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

2.5 mol 4.0 mol

$(2.5\ \text{mol Zn})\left(\frac{1\ \text{mol ZnCl}_2}{1\ \text{mol Zn}}\right) = 2.5\ \text{mol ZnCl}_2$

$(4.0\ \text{mol HCl})\left(\frac{1\ \text{mol ZnCl}_2}{2\ \text{mol HCl}}\right) = 2.0\ \text{mol ZnCl}_2$

∴ HCl is limiting

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c. $2Fe(OH)_3 + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 6H_2O$

4.0 mol 6.5 mol

$(4.0\ \text{mol Fe(OH)}_3)\left(\frac{1\ \text{mol Fe}_2(SO_4)_3}{2\ \text{mol Fe(OH)}_3}\right) = 2.0\ \text{mol Fe}_2(SO_4)_3$

$(6.5\ \text{mol H}_2SO_4)\left(\frac{1\ \text{mol Fe}_2(SO_4)_3}{3\ \text{mol H}_2SO_4}\right) = 2.17\ \text{mol Fe}_2(SO_4)_3$

∴ $Fe(OH)_3$ is limiting

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2. a. $(2.0\ \text{mol HCl})\left(\frac{1\ \text{mol NaOH}}{1\ \text{mol HCl}}\right) = 2.0\ \text{mol NaOH USED (REACTED)}$

$(2.5\ \text{mol NaOH})_{\text{(GIVEN)}} - (2.0\ \text{mol NaOH})_{\text{(USED)}} = .5\ \text{mol NaOH IN EXCESS}$

b. $(4.0\ \text{mol HCl})\left(\frac{1\ \text{mol Zn}}{2\ \text{mol HCl}}\right) = 2.0\ \text{mol Zn USED}$

$(2.5\ \text{mol Zn})_{\text{(GIVEN)}} - (2.0\ \text{mol Zn})_{\text{(USED)}} = .5\ \text{mol Zn IN EXCESS}$

c. $(4.0\ \text{mol Fe(OH)}_3)\left(\frac{3\ \text{mol H}_2\text{SO}_4}{2\ \text{mol Fe(OH)}_3}\right) = 6\ \text{mol H}_2\text{SO}_4\ \text{USED}$

$(6.5\ \text{mol H}_2\text{SO}_4)_{\text{(GIVEN)}} - (6\ \text{mol H}_2\text{SO}_4)_{\text{USED}} = .5\ \text{mol H}_2\text{SO}_4\ \text{IN EXCESS}$

3. a) $(2.0\ \text{mol HCl})\left(\frac{1\ \text{mol NaCl}}{1\ \text{mol HCl}}\right) = 2.0\ \text{mol NaCl PRODUCED}$

$2.0\ \text{mol HCl}\left(\frac{1\ \text{mol H}_2\text{O}}{1\ \text{mol HCl}}\right) = 2.0\ \text{mol H}_2\text{O PRODUCED}$

b) $(4.0\ \text{mol HCl})\left(\frac{1\ \text{mol ZnCl}_2}{2\ \text{mol HCl}}\right) = 2.0\ \text{mol ZnCl}_2\ \text{PRODUCED}$

$(4.0\ \text{mol HCl})\left(\frac{1\ \text{mol H}_2}{2\ \text{mol HCl}}\right) = 2\ \text{mol H}_2\ \text{PRODUCED}$

c) $(4.0\ \text{mol Fe(OH)}_3)\left(\frac{1\ \text{mol Fe}_2(\text{SO}_4)_3}{2\ \text{mol Fe(OH)}_3}\right) = 2\ \text{mol Fe}_2(\text{SO}_4)_3\ \text{PRODUCED}$

$(4.0\ \text{mol Fe(OH)}_3)\left(\frac{6\ \text{mol H}_2\text{O}}{2\ \text{mol Fe(OH)}_3}\right) = 12\ \text{mol H}_2\text{O PRODUCED}$

Q4 HW #4

4. $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

2.5 mol 5.5 mol

$(2.5\ mol\ Cu)\left(\frac{1\ mol\ Cu(NO_3)_2}{1\ mol\ Cu}\right) = 2.5\ mol\ Cu(NO_3)_2$

$(5.5\ mol\ AgNO_3)\left(\frac{1\ mol\ Cu(NO_3)_2}{2\ mol\ AgNO_3}\right) = 2.75\ mol\ Cu(NO_3)_2$

(Cu. IS LIMITING REACTANT)

a) $(2.5\ mol\ Cu)\left(\frac{2\ mol\ AgNO_3}{1\ mol\ Cu}\right) = 5\ mol\ AgNO_3$

$5.5\ mol\ AgNO_3 - 5\ mol\ AgNO_3 = .5\ mol\ AgNO_3$ LEFT OVER

b) $2.5\ mol\ Cu \rightarrow 2.5\ mol\ Cu(NO_3)_2$

$\rightarrow 5\ mol\ Ag$

c) $(2.5\ mol\ Cu(NO_3)_2)\left(\frac{187.57\ g}{mol}\right) = 468.93\ g\ Cu(NO_3)_2$

$(5\ mol\ Ag)\left(\frac{107.87\ g}{mol\ Ag}\right) = 539.35\ g$

$\rightarrow (2.5\ mol\ Cu)\left(\frac{1\ mol\ Cu(NO_3)_2}{1\ mol\ Cu}\right) = 2.5\ mol\ Cu(NO_3)_2$ FORMED

$(2.5\ mol\ Cu)\left(\frac{2\ mol\ Ag}{1\ mol\ Cu}\right) = 5\ mol\ Ag$ FORMED

HW #4

5. $3H_2SO_4 + 2Al(OH)_3 \rightarrow 6H_2O + Al_2(SO_4)_3$

30g 25g

a) $(30\text{g } H_2SO_4)\left(\frac{1\text{ mol}}{98.08\text{g}}\right) = .306\text{ mol } H_2SO_4$

$(25\text{g } Al(OH)_3)\left(\frac{1\text{ mol}}{78.01\text{g}}\right) = .320\text{ mol } Al(OH)_3$

$(.306\text{ mol } H_2SO_4)\left(\frac{6\text{ mol } H_2O}{3\text{ mol } H_2SO_4}\right) = .612\text{ mol } H_2O$

$(.32\text{ mol } Al(OH)_3)\left(\frac{6\text{ mol } H_2O}{2\text{ mol } Al(OH)_3}\right) = .96\text{ mol } H_2O$

$\therefore H_2SO_4$ IS LIMITING REACTANT

b) $(.306\text{ mol } H_2SO_4)\left(\frac{2\text{ mol } Al(OH)_3}{3\text{ mol } H_2SO_4}\right) = .204\text{ mol } Al(OH)_3 \text{ USED}$

$.32\text{ mol } Al(OH)_3 - .204\text{ mol } Al(OH)_3 = .116\text{ mol in EXCESS}$

$(.116\text{ mol } Al(OH)_3)\left(\frac{78.01\text{g}}{\text{mol}}\right) = 9.05\text{g } Al(OH)_3 \text{ IN EXCESS}$

c) $(.612\text{ mol } H_2O)\left(\frac{18.02\text{g}}{\text{mol}}\right) = 11.03\text{g } H_2O \text{ FORMED}$

$(.306\text{ mol } H_2SO_4)\left(\frac{1\text{ mol } Al_2(SO_4)_3}{3\text{ mol } H_2SO_4}\right) = .102\text{ mol } Al_2(SO_4)_3$

$(.102\text{ mol } Al_2(SO_4)_3)\left(\frac{342.14\text{g}}{\text{mol}}\right) = 34.9\text{g } Al_2(SO_4)_3 \text{ FORMED}$

HW #5

6. a) $AgNO_3 + NaCl \rightarrow NaNO_3 + AgCl$

b) $(3\ mol\ AgNO_3) \rightarrow 3\ mol\ NaNO_3$ (3.0)
$5\ mol\ NaCl \rightarrow 5\ mol\ NaNO_3$ (5.0)
$AgNO_3$ IS THE LIMITING REACTANT

c) NaCl IS IN EXCESS

d) $(3\ mol\ AgNO_3)\left(\frac{1\ mol\ NaCl}{1\ mol\ AgNO_3}\right) = 3\ mol\ NaCl$ (USED)

$5\ mol\ NaCl - 3\ mol = 2\ mol\ NaCl$ IN EXCESS

e) 3 mol $NaNO_3$ & 3 mol AgCl PRODUCED

HW #4

7. a) $N_2 + 3H_2 \rightarrow 2NH_3$

b) $(12\ mol\ N_2)\left(\frac{2\ mol\ NH_3}{1\ mol\ N_2}\right) = 24\ mol\ NH_3$ (12 mol, 12 mol)

$(12\ mol\ H_2)\left(\frac{2\ mol\ NH_3}{3\ mol\ H_2}\right) = 8\ mol\ NH_3$

H_2 IS LIMITING REACTANT

c) N_2 IS IN EXCESS

d) $(12\ mol\ H_2)\left(\frac{1\ mol\ N_2}{3\ mol\ H_2}\right) = 4\ mol\ N_2$ USED

$12\ mol\ N_2 - 4\ mol = 8\ mol\ N_2$ IN EXCESS

e) SEE b) → 8 mol NH_3 PRODUCED

HW#4

8.a) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

b) 10 mol C_3H_8 & UNLIMITED O_2 FROM ATMOSPHERE
∴ YES, C_3H_8 IS LIMITING

c) $(10\ mol\ C_3H_8)\left(\frac{3\ mol\ CO_2}{1\ mol\ C_3H_8}\right) = 30\ mol\ CO_2$ PRODUCED

$(10\ mol\ C_3H_8)\left(\frac{4\ mol\ H_2O}{1\ mol\ C_3H_8}\right) = 40\ mol\ H_2O$ PRODUCED

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

b) $(100\ g\ CaCl_2)\left(\frac{1\ mol\ CaCl_2}{110.98\ g}\right) = .901\ mol\ CaCl_2$

$(100\ g\ Na_3PO_4)\left(\frac{1\ mol\ Na_3PO_4}{163.94\ g}\right) = .61\ mol\ Na_3PO_4$

$(.901\ mol\ CaCl_2)\left(\frac{1\ mol\ Ca_3(PO_4)_2}{3\ mol\ CaCl_2}\right) = .3\ mol\ Ca_3(PO_4)_2$

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

∴ $CaCl_2$ IS LIMITING REACTANT

c) Na_3PO_4 IS IN EXCESS

d) $(.901\ mol\ CaCl_2)\left(\frac{2\ mol\ Na_3PO_4}{3\ mol\ CaCl_2}\right) = .6\ mol\ Na_3PO_4$ USED

$.61 - .6 = .01\ mol\ Na_3PO_4$ LEFT

e) $(.3\ mol\ Ca_3(PO_4)_2)\left(\frac{310.18\ g}{1\ mol}\right) = 93.05\ g\ Ca_3(PO_4)_2$

$(.901\ mol\ CaCl_2)(6\ mol\ NaCl)/3\ mol\ CaCl_2 = 1.802\ mol\ NaCl$

HW #4

#9 e) CONTINUED

$$(1.902 \text{ mol NaCl})\left(\frac{58.44 \text{ g}}{\text{mol}}\right) = 105.31 \text{ g NaCl}$$