Precipitation Reactions Worksheet Key

For each of the following reactants, predict whether a precipitation reaction will take place between them. If there is no reaction, write "no reaction". If there is a reaction, write the complete, complete ionic, and net ionic equations that describe the reaction.

a. $Li_2CO_3(aq) + Co(C_2H_3O_2)_2(aq) \rightarrow \mathbf{2LiC_2H_3O_2(aq) + CoCO_3(s)}$

$\mathbf{2Li^+(aq) + CO_3^{2-}(aq) + Co^{2+}(aq) + 2C_2H_3O_2^-(aq) \rightarrow 2Li^+(aq) + 2C_2H_3O_2^-(aq) + CoCO_3(s)}$

$\mathbf{CO_3^{2-}(aq) + Co^{2+}(aq) \rightarrow CoCO_3(s)}$

b. $\mathbf{2}Fe(NO_3)_3(aq) + \mathbf{3}K_2S(aq) \rightarrow \mathbf{Fe_2S_3(s) + 6KNO_3(aq)}$

$\mathbf{2Fe^{3+}(aq) + 6NO_3^-(aq) + 6K^+(aq) + 3S^{2-}(aq) \rightarrow Fe_2S_3(s) + 6K^+(aq) + 6NO_3^-(aq)}$

$\mathbf{2Fe^{3+}(aq) + 3S^{2-}(aq) \rightarrow Fe_2S_3(s)}$

c. $Pb(NO_3)_2(aq) + Li_2SO_4(aq) \rightarrow \mathbf{PbSO_4(s) + 2LiNO_3(aq)}$

$\mathbf{Pb^{2+}(aq) + 2NO_3^-(aq) + 2Li^+(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2Li^+(aq) + 2NO_3^-(aq)}$

$\mathbf{Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)}$

d. $NH_4Cl(aq) + Cu(C_2H_3O_2)_2(aq)$ **No reaction**

CHEMISTRY 151 - PRECIPITATION REACTIONS KEY

For each of the following reactants, predict whether a precipitation reaction will take place between them. If there is no reaction, write "no reaction". If there is a reaction, write the complete, complete ionic, and net ionic equations that describe the reaction.

a. $\mathbf{2}K_3PO_4(aq) + \mathbf{3}Cd(C_2H_3O_2)_2(aq) \rightarrow \mathbf{6KC_2H_3O_2(aq) + Cd_3(PO_4)_2(s)}$

$\mathbf{6K^+(aq) + 2PO_4^{3-}(aq) + 3Cd^{2+}(aq) + 6C_2H_3O_2^-(aq) \rightarrow 6K^+(aq) + 6C_2H_3O_2^-(aq) + Cd_3(PO_4)_2(s)}$

$\mathbf{2PO_4^{3-}(aq) + 3Cd^{2+}(aq) \rightarrow Cd_3(PO_4)_2(s)}$

b. $K_2S(aq) + ZnCl_2(aq) \rightarrow \mathbf{2KCl(aq) + ZnS(s)}$

$\mathbf{2K^+(aq) + S^{2-}(aq) + Zn^{2+}(aq) + 2Cl^-(aq) \rightarrow 2K^+(aq) + 2Cl^-(aq) + ZnS(s)}$

$\mathbf{S^{2-}(aq) + Zn^{2+}(aq) \rightarrow ZnS(s)}$

c. $\mathbf{2}NH_4Br(aq) + Pb(C_2H_3O_2)_2(aq) \rightarrow \mathbf{2NH_4C_2H_3O_2(aq) + PbBr_2(s)}$

$\mathbf{2NH_4^+(aq) + 2Br^-(aq) + Pb^{2+}(aq) + 2C_2H_3O_2^-(aq) \rightarrow 2NH_4^+(aq) + 2C_2H_3O_2^-(aq) + PbBr_2(s)}$

$\mathbf{2Br^-(aq) + Pb^{2+}(aq) \rightarrow PbBr2(s)}$

d. $Na_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow \mathbf{2NaNO_3(aq) + BaSO_4(s)}$

$\mathbf{2Na^+(aq) + SO_4^{2-}(aq) + Ba^{2+}(aq) + 2NO_3^-(aq) \rightarrow 2Na^+(aq) + 2NO_3^-(aq) + BaSO_4(s)}$

$\mathbf{SO_4^{2-}(aq) + Ba^{2+}(aq) \rightarrow BaSO_4(s)}$

e. $K_3PO_4(aq) + (NH_4)_2CO_3(aq)$ **No Reaction**

NEUTRALIZATION REACTIONS KEY

For each of the following pairs, predict whether a reaction will take place when they are mixed. If there is no reaction, write "no reaction". If there is a reaction, write the complete, complete ionic, and net-ionic equations for the reaction.

a. $HNO_3(aq) + CsOH(aq) \rightarrow \mathbf{H_2O(}\boldsymbol{l}\mathbf{) + CsNO_3(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{H^+(}\boldsymbol{aq}\mathbf{) + NO_3^-(}\boldsymbol{aq}\mathbf{) + Cs^+(}\boldsymbol{aq}\mathbf{) + OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + Cs^+(}\boldsymbol{aq}\mathbf{) + NO_3^-(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{H^+(}\boldsymbol{aq}\mathbf{) + OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{)}$

b. $HNO_2(aq) + LiOH(aq) \rightarrow \mathbf{H_2O(}\boldsymbol{l}\mathbf{) + LiNO_2(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{HNO_2(}\boldsymbol{aq}\mathbf{) + Li^+(}\boldsymbol{aq}\mathbf{) + OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + Li^+(}\boldsymbol{aq}\mathbf{) + NO_2^-(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{HNO_2(}\boldsymbol{aq}\mathbf{) + OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + NO_2^-(}\boldsymbol{aq}\mathbf{)}$

c. $Na_2CO_3(aq) + 2HBr(aq) \rightarrow \mathbf{2NaBr(}\boldsymbol{aq}\mathbf{) + H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g)}$

$\mathbf{2Na^+(}\boldsymbol{aq}\mathbf{) + CO_3^{2-}(}\boldsymbol{aq}\mathbf{) + 2H^+(}\boldsymbol{aq}\mathbf{) + 2Br^-(}\boldsymbol{aq}\mathbf{) \rightarrow 2Na^+(}\boldsymbol{aq}\mathbf{) + 2Br^-(}\boldsymbol{aq}\mathbf{) + H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g)}$

$\mathbf{CO_3^{2-}(}\boldsymbol{aq}\mathbf{) + 2H^+(}\boldsymbol{aq}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g)}$

d. $HClO_4(aq) + HI(aq)$ **no reaction (both acids)**

e. $2LiOH(aq) + H_2S(aq) \rightarrow \mathbf{Li_2S(}\boldsymbol{aq}\mathbf{) + 2H_2O(}\boldsymbol{l}\mathbf{)}$

$\mathbf{2Li^+(}\boldsymbol{aq}\mathbf{) + 2OH^-(}\boldsymbol{aq}\mathbf{) + H_2S(}\boldsymbol{aq}\mathbf{) \rightarrow 2Li^+(}\boldsymbol{aq}\mathbf{) + S^{2-}(}\boldsymbol{aq}\mathbf{) + 2H_2O(}\boldsymbol{l}\mathbf{)}$

$\mathbf{2OH^-(}\boldsymbol{aq}\mathbf{) + H_2S(}\boldsymbol{aq}\mathbf{) \rightarrow S^{2-}(}\boldsymbol{aq}\mathbf{) + 2H_2O(}\boldsymbol{l}\mathbf{)}$

f. $2HClO_4(aq) + PbCO_3(s) \rightarrow \mathbf{H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g) + Pb(ClO_4)_2(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{2H^+(}\boldsymbol{aq}\mathbf{) + 2ClO_4^-(}\boldsymbol{aq}\mathbf{) + PbCO_3(}\boldsymbol{s}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g) + Pb^{2+}(}\boldsymbol{aq}\mathbf{) + 2ClO_4^-(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{2H^+(}\boldsymbol{aq}\mathbf{) + PbCO_3(}\boldsymbol{s}\mathbf{) \rightarrow H_2O(}\boldsymbol{l}\mathbf{) + CO_2(g) + Pb^{2+}(}\boldsymbol{aq}\mathbf{)}$

g. $HCl(aq) + NaNO_3(aq)$ **no reaction (no base)**

h. $H_3PO_4(aq) + 3NaOH(aq) \rightarrow \mathbf{3H_2O(}\boldsymbol{l}\mathbf{) + Na_3PO_4(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{H_3PO_4(}\boldsymbol{aq}\mathbf{) + 3Na^+(}\boldsymbol{aq}\mathbf{) + 3OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow 3H_2O(}\boldsymbol{l}\mathbf{) + 3Na^+(}\boldsymbol{aq}\mathbf{) + PO_4^{3-}(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{H_3PO_4(}\boldsymbol{aq}\mathbf{) + 3OH^-(}\boldsymbol{aq}\mathbf{) \rightarrow 3H_2O(}\boldsymbol{l}\mathbf{) + PO_4^{3-}(}\boldsymbol{aq}\mathbf{)}$

i. $NH_3(aq) + HI(aq) \rightarrow \mathbf{NH_4I(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{NH_3(}\boldsymbol{aq}\mathbf{) + H^+(}\boldsymbol{aq}\mathbf{) + I^-(}\boldsymbol{aq}\mathbf{) \rightarrow NH_4^+(}\boldsymbol{aq}\mathbf{) + I^-(}\boldsymbol{aq}\mathbf{)}$

$\mathbf{NH_3(}\boldsymbol{aq}\mathbf{) + H^+(}\boldsymbol{aq}\mathbf{) \rightarrow NH_4^+(}\boldsymbol{aq}\mathbf{)}$

Neutralization Reactions 2 Worksheet Key

For each of the following reactants, predict whether a neutralization reaction will take place between them. If there is no reaction, write "no reaction". If there is a reaction, write the complete, complete ionic, and net ionic equations that describe the reaction.

a. $HNO_3(aq) + NaF(aq) \rightarrow \mathbf{HF(aq) + NaNO_3(aq)}$

$\mathbf{H^+(aq) + NO_3^-(aq) + Na^+(aq) + F^-(aq) \rightarrow HF(aq) + Na^+(aq) + NO_3^-(aq)}$

$\mathbf{H^+(aq) + F^-(aq) \rightarrow HF(aq)}$

b. $HBr(aq) + NaNO_3(aq)$ **No reaction (no base)**

c. $HNO_2(aq) + KCN(aq) \rightleftharpoons \mathbf{HCN(aq) + KNO_2(aq)}$

$\mathbf{HNO_2(aq) + K^+(aq) + CN^-(aq) \rightleftharpoons HCN(aq) + K^+(aq) + NO_2^-(aq)}$

$\mathbf{HNO_2(aq) + CN^-(aq) \rightleftharpoons HCN(aq) + NO_2^-(aq)}$

i. $Al(OH)_3(s) + 3HI(aq) \rightarrow \mathbf{AlI_3(aq) + 3H_2O(l)}$

$\mathbf{Al(OH)_3(s) + 3H^+(aq) + 3I^-(aq) \rightarrow Al^{3+}(aq) + 3I^-(aq) + 3H_2O(l)}$

$\mathbf{Al(OH)_3(s) + 3H^+(aq) \rightarrow Al^{3+}(aq) + 3H_2O(l)}$

j. $NH_3(aq) + HBrO(aq) \rightleftharpoons \mathbf{NH_4BrO(aq)}$

$\mathbf{NH_3(aq) + HBrO(aq) \rightleftharpoons NH_4^+(aq) + BrO^-(aq)}$

$\mathbf{NH_3(aq) + HBrO(aq) \rightleftharpoons NH_4^+(aq) + BrO^-(aq)}$

CHEMISTRY 151 - NEUTRALIZATION REACTIONS KEY

For each of the following reactants, predict whether a neutralization reaction will take place between them. If there is no reaction, write "no reaction". If there is a reaction, write the complete, complete ionic, and net ionic equations that describe the reaction.

a. $3HNO_3(aq) + Cr(OH)_3(s) \rightarrow \mathbf{3H_2O(l) + Cr(NO_3)_3(aq)}$

$\mathbf{3H^+(aq) + 3NO_3^-(aq) + Cr(OH)_3(s) \rightarrow 3H_2O(l) + Cr^{3+}(aq) + 3NO_3^-(aq)}$

$\mathbf{3H^+(aq) + Cr(OH)_3(s) \rightarrow 3H_2O(l) + Cr^{3+}(aq)}$

b. $MgCO_3(s) + 2HCl(aq) \rightarrow \mathbf{MgCl_2(aq) + CO_2(g) + H_2O(l)}$

$\mathbf{MgCO_3(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq) + CO_2(g) + H_2O(l)}$

$\mathbf{MgCO_3(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + CO_2(g) + H_2O(l)}$

c. $NaNH_2(aq) + H_2O(l) \rightarrow \mathbf{NaOH(aq) + NH_3(aq)}$

$\mathbf{Na^+(aq) + NH_2^-(aq) + H_2O(l) \rightarrow Na^+(aq) + OH^-(aq) + NH_3(aq)}$

$\mathbf{NH_2^-(aq) + H_2O(l) \rightarrow OH^-(aq) + NH_3(aq)}$

d. $HNO_2(aq) + NH_3(aq) \rightleftharpoons \mathbf{NH_4NO_2(aq)}$

$\mathbf{HNO_2(aq) + NH_3(aq) \rightleftharpoons NH_4^+(aq) + NO_2^-(aq)}$

$\mathbf{HNO_2(aq) + NH_3(aq) \rightleftharpoons NH_4^+(aq) + NO_2^-(aq)}$

e. $MgO(s) + 2HCl(aq) \rightarrow \mathbf{MgCl_2(aq) + H_2O(l)}$

$\mathbf{MgO(s) + 2H^+(aq) + 2Cl^-(aq) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq) + H_2O(l)}$

$\mathbf{MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)}$

f. $Cu(OH)_2(s) + 2HC_2H_3O_2(aq) \rightarrow \mathbf{Cu(C_2H_3O_2)_2(aq) + 2H_2O(l)}$

$\mathbf{Cu(OH)_2(s) + 2HC_2H_3O_2(aq) \rightarrow Cu^{2+}(aq) + 2C_2H_3O_2^-(aq) + 2H_2O(l)}$

$\mathbf{Cu(OH)_2(s) + 2HC_2H_3O_2(aq) \rightarrow Cu^{2+}(aq) + 2C_2H_3O_2^-(aq) + 2H_2O(l)}$

OXIDATION-REDUCTION KEY

For each of the following, identify the oxidation number of each atom in the reaction and identify what is oxidized, what is reduced, what the oxidizing agent is, and what the reducing agent is.

1. $\overset{+1\ -2}{3H_2S(aq)} + \overset{+1\ +5\ -2}{2HNO_3(aq)} \rightarrow \overset{0}{3S(s)} + \overset{+2\ -2}{2NO(g)} + \overset{+1\ -2}{4H_2O(l)}$

   Oxidized **S in H_2S** Reduced **N in HNO_3** Oxidizing agent **HNO_3** Reducing agent **H_2S**

2. $\overset{+2\ +6\ -2}{BaSO_4(s)} + \overset{0}{4C(s)} \rightarrow \overset{+2\ -2}{BaS(s)} + \overset{+2\ -2}{4CO(g)}$

   Oxidized **C in C(*s*)** Reduced **S in $BaSO_4$** Oxidizing agent **$BaSO_4$** Reducing agent **C(*s*)**

3. $\overset{+1}{12H^+(aq)} + \overset{+7\ -2}{4MnO_4^-(aq)} + \overset{-2\ +1\ -2\ +1}{5CH_3OH(aq)} \rightarrow \overset{+2}{4Mn^{2+}(aq)} + \overset{+1\ +2\ -2\ +1}{5HCO_2H(aq)} + \overset{+1\ -2}{11H_2O(l)}$

   Oxidized **C in CH_3OH** Reduced **Mn in MnO_4^-** Oxidizing agent **MnO_4^-** Reducing agent **CH_3OH**

4. $\overset{+1\ -2}{2H_2O(l)} + \overset{+1}{2H^+(aq)} + \overset{+3\ -2}{As_2O_3(s)} + \overset{+5\ -2}{2NO_3^-(aq)} \rightarrow \overset{+1\ +5\ -2}{2H_3AsO_4(aq)} + \overset{+3\ -2}{N_2O_3(aq)}$

   Oxidized **As in As_2O_3** Reduced **N in NO_3^-** Oxidizing agent **NO_3^-** Reducing agent **As_2O_3**

5. $\overset{-2\ +1}{2OH^-(aq)} + \overset{+1\ -1}{4H_2O_2(aq)} + \overset{+7\ -2}{Cl_2O_7(aq)} \rightarrow \overset{+3\ -2}{2ClO_2^-(aq)} + \overset{0}{4O_2(g)} + \overset{+1\ -2}{5H_2O(l)}$

   Oxidized **O in H_2O_2** Reduced **Cl in Cl_2O_7** Oxidizing agent **Cl_2O_7** Reducing agent **H_2O_2**

6. $\overset{-2\ +1}{2OH^-(aq)} + \overset{0}{Cl_2(g)} \rightarrow \overset{-1}{Cl^-(aq)} + \overset{+1\ -2}{ClO^-(aq)} + \overset{+1\ -2}{H_2O(l)}$

   Oxidized **Cl in Cl_2** Reduced **Cl in Cl_2** Oxidizing agent **Cl_2** Reducing agent **Cl_2**

7. $\overset{+1}{6H^+(aq)} + \overset{+5\ -2}{IO_3^-(aq)} + \overset{-1}{8I^-(aq)} \rightarrow \overset{0\ \&\ -1}{3I_3^-(aq)} + \overset{+1\ -2}{3H_2O(l)}$

   Oxidized **I in I^-** Reduced **I in IO_3^-** Oxidizing agent **IO_3^-** Reducing agent **I^-**

8. $\overset{+2\ -2\ +1}{2Fe(OH)_2(s)} + \overset{+1\ -1}{H_2O_2(aq)} \rightarrow \overset{+3\ -2\ +1}{2Fe(OH)_3(s)}$

   Oxidized **Fe in $Fe(OH)_2$** Reduced **O in H_2O_2** Oxidizing agent **H_2O_2** Reducing agent **$Fe(OH)_2$**

CHEMISTRY 151 - REDOX EQUATIONS KEY

For each of the following redox equations, write the oxidation number for each atom above its symbol and identify what is oxidized, what is reduced, what the reducing agent is, and what the oxidizing agent is.

a. $\overset{0}{6Sb}(s) + 10\overset{+1\ +5\ -2}{HNO_3}(aq) \rightarrow 3\overset{+5\ -2}{Sb_2O_5}(s) + 10\overset{+2\ -2}{NO}(g) + 5\overset{+1\ -2}{H_2O}(l)$

Oxidized **Sb in Sb(*s*)** Reduced **N in HNO_3** Reducing agent **Sb** Oxidizing agent **HNO_3**

b. $\overset{-2\ +1}{8OH^-}(aq) + 8\overset{+7\ -2}{MnO_4^-}(aq) + \overset{-1}{I^-}(aq) \rightarrow 8\overset{+6\ -2}{MnO_4^{2-}}(aq) + \overset{+7\ -2}{IO_4^-}(aq) + 4\overset{+1\ -2}{H_2O}(l)$

Oxidized I in **I^-** Reduced **Mn in MnO_4^-** Reducing agent **I^-** Oxidizing agent **MnO_4^-**

c. $2\overset{+2\ -2}{S_2O_3^{2-}}(aq) + \overset{0}{I_2}(s) \rightarrow 2\overset{-1}{I^-}(aq) + \overset{+2.5\ -2}{S_4O_6^{2-}}(aq)$

Oxidized **S in $S_2O_3^{2-}$** Reduced **I in I_2** Reducing agent **$S_2O_3^{2-}$** Oxidizing agent **I_2**

d. $\overset{0}{3Cu}(s) + 8\overset{+1\ +5\ -2}{HNO_3}(aq) \rightarrow 3\overset{+2\ +5\ -2}{Cu(NO_3)_2}(aq) + 2\overset{+2\ -2}{NO}(g) + 4\overset{+1\ -2}{H_2O}(l)$

Oxidized **Cu in Cu(*s*)** Reduced **N in HNO_3** Reducing agent **Cu(*s*)** Oxidizing agent **HNO_3**

e. $\overset{-2}{3S^{2-}} + 4\overset{+1\ -2}{H_2O} + 2\overset{+7\ -2}{MnO_4^-} \rightarrow \overset{0}{3S} + 2\overset{+4\ -2}{MnO_2} + 8\overset{-2\ +1}{OH^-}$

Oxidized **S in S^{2-}** Reduced **Mn in MnO_4^-** Reducing agent **S^{2-}** Oxidizing agent **MnO_4^-**

f. $\overset{+1\ -1}{2H_2O_2} \rightarrow \overset{+1\ -2}{2H_2O} + \overset{0}{O_2}$

Oxidized **O in H_2O_2** Reduced **O in H_2O_2** Reducing agent **H_2O_2** Oxidizing agent **H_2O_2**

Chemistry 151 - Types of Reactions Key

1. Classify each of these reactions with respect to the following categories: combination reaction, decomposition reaction, combustion reaction, and single displacement reaction.
   a. $2NaH(s) \rightarrow 2Na(s) + H_2(g)$ **decomposition**
   b. $2KI(aq) + Cl_2(g) \rightarrow 2KCl(aq) + I_2(s)$ **single displacement**
   c. $2C_2H_5SH(l) + 9O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l) + 2SO_2(g)$ **combustion**
   d. $H_2(g) + CuO(s) \rightarrow Cu(s) + H_2O(l)$ **single displacement**
   e. $P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$ **combination and combustion**
   f. $Fe_2(CO_3)_3(s) \rightarrow Fe_2O_3(s) + 3CO_2(g)$ **decomposition**
   g. $2C_6H_{11}OH(l) + 17\ O_2(g) \rightarrow 12CO_2(g) + 12H_2O(l)$ **combustion**
   h. $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$ **combination**
   i. $2C(s) + MnO_2(s) \rightarrow Mn(s) + 2CO(g)$ **single displacement**
   j. $2NaClO_3(s) \rightarrow 2NaCl(s) + 3O_2(g)$ **decomposition**
2. Write balanced equations for the complete combustion of each of the following substances.
   a. $C_3H_8(g)$
      $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$
   b. $C_4H_9OH(l)$
      $C_4H_9OH(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$
   c. $CH_3COSH(l)$
      $CH_3COSH(l) + 7/2O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) + SO_2(g)$
      or
      $2CH_3COSH(l) + 7O_2(g) \rightarrow 4CO_2(g) + 4H_2O(l) + 2SO_2(g)$

MOLARITY WORKSHEET KEY

1. Given solid ammonium chloride, NH_4Cl, deionized water and a collection of volumetric flasks, how would you make 250 mL of 4.50 M NH_4Cl?

$$\text{? g } NH_4Cl = 250 \text{ mL soln} \left(\frac{4.50 \text{ mol } NH_4Cl}{10^3 \text{ mL soln}}\right)\left(\frac{53.492 \text{ g } NH_4Cl}{1 \text{ mol } NH_4Cl}\right) = 60.2 \text{ g } NH_4Cl$$

Dissolve 60.2 g NH_4Cl in a minimum amount of water and dilute with water to 250 mL total.

2. What volume of 0.60 M NaCl solution must be measured out to yield 50.0 g of NaCl?

$$\text{? mL soln} = 50.0 \text{ g NaCl} \left(\frac{1 \text{ mol NaCl}}{58.443 \text{ g NaCl}}\right)\left(\frac{10^3 \text{ mL soln}}{0.60 \text{ mol NaCl}}\right) = \mathbf{1.4 \times 10^3 \text{ mL soln}}$$

3. 25.0 mL of a phosphoric acid solution is fully neutralized with 16.2 mL of 1.025 M NaOH. What is the molarity of the H_3PO_4?

$$\frac{\text{? mol } H_3PO_4}{\text{L soln}} = \frac{16.2 \text{ mL NaOH soln}}{25.0 \text{ mL } H_3PO_4 \text{ soln}}\left(\frac{10^3 \text{ mL}}{1 \text{ L}}\right)\left(\frac{1.025 \text{ mol NaOH}}{10^3 \text{ mL NaOH soln}}\right)\left(\frac{1 \text{ mol } H_3PO_4}{3 \text{ mol NaOH}}\right)$$

$$= \mathbf{0.221 \text{ M } H_3PO_4}$$

4. How many milliliters of 0.100 M silver nitrate, $AgNO_3$, would be necessary to precipitate all of the chlorine from 75.0 mL of 0.0500 M $MgCl_2$? The precipitate is AgCl.

$$2AgNO_3(aq) + MgCl_2(aq) \rightarrow 2AgCl(s) + Mg(NO_3)_2(aq)$$

$$\text{? mL } AgNO_3 \text{ soln} = 75.0 \text{ mL } MgCl_2 \text{ soln} \left(\frac{0.0500 \text{ mol } MgCl_2}{10^3 \text{ } MgCl_2 \text{ soln}}\right)\left(\frac{2 \text{ mol } AgNO_3}{1 \text{ mol } MgCl_2}\right)\left(\frac{10^3 \text{ mL } AgNO_3 \text{ soln}}{0.100 \text{ mol } AgNO_3}\right)$$

$$= \mathbf{75.0 \text{ mL } AgNO_3 \text{ soln}}$$

5. How would you make 100.0 mL of 2.5 M H_2SO_4 from concentrated sulfuric acid that is 18 M H_2SO_4?

Two ways

$$M_D V_D = M_C V_C \qquad V_C = \frac{M_D V_D}{M_C} = \frac{2.5 \text{ M } (100.0 \text{ mL})}{18 \text{ M}} = 14 \text{ mL conc } H_2SO_4$$

$$\text{or ? mL conc soln} = 100.0 \text{ mL dil soln} \left(\frac{2.5 \text{ mol } H_2SO_4}{10^3 \text{ mL dil soln}}\right)\left(\frac{10^3 \text{ mL conc soln}}{18 \text{ mol } H_2SO_4}\right) = 14 \text{ mL conc } H_2SO_4$$

Add 14 mL of 18 M H_2SO_4 to water keeping the total volume less than 100 mL. Dilute with water to 100 mL total.

6. What is the molarity of a solution of potassium hydroxide that is prepared by diluting 15.0 mL of 1.75 M KOH to 250.0 mL?

Two ways

$$M_D V_D = M_C V_C \qquad M_D = \frac{M_C V_C}{V_D} = \frac{1.75 \text{ M } (15.0 \text{ mL})}{250.0 \text{ mL}} = 0.105 \text{ M KOH}$$

$$\text{or } \frac{\text{? mol KOH}}{\text{L dil soln}} = \left(\frac{15.0 \text{ mL conc soln}}{0.2500 \text{ L dil soln}}\right)\left(\frac{1.75 \text{ mol KOH}}{10^3 \text{ mL conc soln}}\right) = \mathbf{0.105 \text{ M KOH}}$$

7. Concentrated ammonia is 28 % by mass NH_3 and has a density of 0.90 g/mL. How many milliliters of concentrated NH_3 are necessary to prepare 175 mL of 2.75 M NH_3?

$$\text{? mL conc soln} = 175 \text{ mL dil soln}\left(\frac{2.75 \text{ mol } NH_3}{10^3 \text{ mL dil soln}}\right)\left(\frac{17.0306 \text{ g } NH_3}{1 \text{ mol } NH_3}\right)\left(\frac{100 \text{ g conc soln}}{28 \text{ g } NH_3}\right)\left(\frac{1 \text{ mL conc soln}}{0.90 \text{ g conc soln}}\right)$$

$$= \mathbf{33 \text{ mL conc } NH_3 \text{ soln}}$$

CHEMISTRY 151 - MOLARITY CALCULATIONS KEY

1. How would you prepare 500.00 mL of 0.750 M Na_2SO_4 from solid anhydrous sodium sulfate.

$$? \text{ g } Na_2SO_4 = 500.00 \text{ mL } Na_2SO_4 \text{ soln}\left(\frac{0.750 \text{ mol } Na_2SO_4}{10^3 \text{ mL } Na_2SO_4 \text{ soln}}\right)\left(\frac{142.043 \text{ g } Na_2SO_4}{1 \text{ mol } Na_2SO_4}\right)$$

$$= 53.3 \text{ g } Na_2SO_4$$

Dissolve 53.3 g Na_2SO_4 in water and dilute with water to 500.0 mL total.

2. Write a description of how you would prepare 250 mL of 0.650 M KOH from 7.5 M KOH.

$$M_D V_D = M_C V_C \qquad V_C = \frac{M_D V_D}{M_C} = \frac{0.650 \text{ M } (250 \text{ mL})}{7.5 \text{ M}} = 22 \text{ mL}$$

Dilute 22 mL of 7.5 M KOH to 250 mL total with water.

3. Sodium hydroxide and phosphoric acid react in a neutralization, double exchange reaction.

   a. Write a balanced equation for the reaction between sodium hydroxide and phosphoric acid.

$$\mathbf{3NaOH}(\boldsymbol{aq}) + \mathbf{H_3PO_4}(\boldsymbol{aq}) \rightarrow \mathbf{Na_3PO_4}(\boldsymbol{aq}) + \mathbf{3H_2O}(\boldsymbol{l})$$

   b. What volume of 1.45 M sodium hydroxide is necessary to completely neutralize 50.0 mL of 0.78 M phosphoric acid?

$$? \text{ mL NaOH soln} = 50.0 \text{ mL } H_3PO_4 \text{ soln}\left(\frac{0.78 \text{ mol } H_3PO_4}{10^3 \text{ mL } H_3PO_4 \text{ soln}}\right)\left(\frac{3 \text{ mol NaOH}}{1 \text{ mol } H_3PO_4}\right)\left(\frac{10^3 \text{ mL NaOH soln}}{1.45 \text{ mol NaOH}}\right)$$

$$= \mathbf{81 \text{ mL NaOH soln}}$$

4. A 2.50 g sample of a mixture of sodium nitrate and sodium chloride is dissolved in water. The resulting solution requires 30.0 mL of 0.600 M silver nitrate to precipitate all of the chloride as silver chloride. What percentage of the mixture is sodium chloride?

$$\% \text{ NaCl} = \frac{1.05 \text{ g NaCl}}{2.50 \text{ g sample}} \text{ x } 100 = \mathbf{42.0 \% \text{ NaCl}}$$

$$? \text{ g NaCl} = 30.0 \text{ mL } AgNO_3 \text{ soln}\left(\frac{0.600 \text{ mol } AgNO_3}{10^3 \text{ mL } AgNO_3 \text{ soln}}\right)\left(\frac{1 \text{ mol NaCl}}{1 \text{ mole } AgNO_3}\right)\left(\frac{58.4425 \text{ g NaCl}}{1 \text{ mol NaCl}}\right)$$

$$= \mathbf{1.05 \text{ g NaCl}}$$