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. Li₂CO₃(aq) + Co(C₂H₃O₂)₂(aq) → 2LiC₂H₃O₂(aq) + CoCO₃(s)
   2Li⁺(aq) + CO₃²⁻(aq) + Co²⁺(aq) + 2C₂H₃O₂⁻(aq) → 2Li⁺(aq) + 2C₂H₃O₂⁻(aq) + CoCO₃(s)
   CO₃²⁻(aq) + Co²⁺(aq) → CoCO₃(s)

b. 2Fe(NO₃)₃(aq) + 3K₂S(aq) → Fe₂S₃(s) + 6KNO₃(aq)
   2Fe³⁺(aq) + 6NO₃⁻(aq) + 6K⁺(aq) + 3S²⁻(aq) → Fe₂S₃(s) + 6K⁺(aq) + 6NO₃⁻(aq)
   2Fe³⁺(aq) + 3S²⁻(aq) → Fe₂S₃(s)

c. Pb(NO₃)₂(aq) + Li₂SO₄(aq) → PbSO₄(s) + 2LiNO₃(aq)
   Pb²⁺(aq) + 2NO₃⁻(aq) + 2Li⁺(aq) + SO₄²⁻(aq) → PbSO₄(s) + 2Li⁺(aq) + 2NO₃⁻(aq)
   Pb²⁺(aq) + SO₄²⁻(aq) → PbSO₄(s)

d. NH₄Cl(aq) + Cu(C₂H₃O₂)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. 2K₃PO₄(aq) + 3Cd(C₂H₃O₂)₂(aq) → 6KC₂H₃O₂(aq) + Cd₃(PO₄)₂(s)
   6K⁺(aq) + 2PO₄³⁻(aq) + 3Cd²⁺(aq) + 6C₂H₃O₂⁻(aq)
   → 6K⁺(aq) + 6C₂H₃O₂⁻(aq) + Cd₃(PO₄)₂(s)
   2PO₄³⁻(aq) + 3Cd²⁺(aq) → Cd₃(PO₄)₂(s)

b. K₂S(aq) + ZnCl₂(aq) → 2KCl(aq) + ZnS(s)
   2K⁺(aq) + S²⁻(aq) + Zn²⁺(aq) + 2Cl⁻(aq) → 2K⁺(aq) + 2Cl⁻(aq) + ZnS(s)
   S²⁻(aq) + Zn²⁺(aq) → ZnS(s)

c. 2NH₄Br(aq) + Pb(C₂H₃O₂)₂(aq) → 2NH₄C₂H₃O₂(aq) + PbBr₂(s)
   2NH₄⁺(aq) + 2Br⁻(aq) + Pb²⁺(aq) + 2C₂H₃O₂⁻(aq)
   → 2NH₄⁺(aq) + 2C₂H₃O₂⁻(aq) + PbBr₂(s)
   2Br⁻(aq) + Pb²⁺(aq) → PbBr₂(s)

d. Na₂SO₄(aq) + Ba(NO₃)₂(aq) → 2NaNO₃(aq) + BaSO₄(s)
   2Na⁺(aq) + SO₄²⁻(aq) + Ba²⁺(aq) + 2NO₃⁻(aq)
   → 2Na⁺(aq) + 2NO₃⁻(aq) + BaSO₄(s)
   SO₄²⁻(aq) + Ba²⁺(aq) → BaSO₄(s)

e. K₃PO₄(aq) + (NH₄)₂CO₃(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. HNO₃(aq) + CsOH(aq) → H₂O(l) + CsNO₃(aq)
   H⁺(aq) + NO₃⁻(aq) + Cs⁺(aq) + OH⁻(aq) → H₂O(l) + Cs⁺(aq) + NO₃⁻(aq)
   H⁺(aq) + OH⁻(aq) → H₂O(l)

b. HNO₂(aq) + LiOH(aq) → H₂O(l) + LiNO₂(aq)
   HNO₂(aq) + Li⁺(aq) + OH⁻(aq) → H₂O(l) + Li⁺(aq) + NO₂⁻(aq)
   HNO₂(aq) + OH⁻(aq) → H₂O(l) + NO₂⁻(aq)

c. Na₂CO₃(aq) + 2HBr(aq) → 2NaBr(aq) + H₂O(l) + CO₂(g)
   2Na⁺(aq) + CO₃²⁻(aq) + 2H⁺(aq) + 2Br⁻(aq) → 2Na⁺(aq) + 2Br⁻(aq) + H₂O(l) + CO₂(g)
   CO₃²⁻(aq) + 2H⁺(aq) → H₂O(l) + CO₂(g)

d. HClO₄(aq) + HI(aq) no reaction (both acids)

e. 2LiOH(aq) + H₂S(aq) → Li₂S(aq) + 2H₂O(l)
   2Li⁺(aq) + 2OH⁻(aq) + H₂S(aq) → 2Li⁺(aq) + S²⁻(aq) + 2H₂O(l)
   2OH⁻(aq) + H₂S(aq) → S²⁻(aq) + 2H₂O(l)

f. 2HClO₄(aq) + PbCO₃(s) → H₂O(l) + CO₂(g) + Pb(ClO₄)₂(aq)
   2H⁺(aq) + 2ClO₄⁻(aq) + PbCO₃(s) → H₂O(l) + CO₂(g) + Pb²⁺(aq) + 2ClO₄⁻(aq)
   2H⁺(aq) + PbCO₃(s) → H₂O(l) + CO₂(g) + Pb²⁺(aq)

g. HCl(aq) + NaNO₃(aq) no reaction (no base)

h. H₃PO₄(aq) + 3NaOH(aq) → 3H₂O(l) + Na₃PO₄(aq)
   H₃PO₄(aq) + 3Na⁺(aq) + 3OH⁻(aq) → 3H₂O(l) + 3Na⁺(aq) + PO₄³⁻(aq)
   H₃PO₄(aq) + 3OH⁻(aq) → 3H₂O(l) + PO₄³⁻(aq)

i. NH₃(aq) + HI(aq) → NH₄I(aq)
   NH₃(aq) + H⁺(aq) + I⁻(aq) → NH₄⁺(aq) + I⁻(aq)
   NH₃(aq) + H⁺(aq) → NH₄⁺(aq)
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. \( \text{HNO}_3(aq) + \text{NaF}(aq) \rightarrow \text{HF}(aq) + \text{NaNO}_3(aq) \)
\( \text{H}^+(aq) + \text{NO}_3^-(aq) + \text{Na}^+(aq) + \text{F}^-(aq) \rightarrow \text{HF}(aq) + \text{Na}^+(aq) + \text{NO}_3^-(aq) \)
\( \text{H}^+(aq) + \text{F}^-(aq) \rightarrow \text{HF}(aq) \)

b. \( \text{HBr}(aq) + \text{NaNO}_3(aq) \quad \text{No reaction (no base)} \)

c. \( \text{HNO}_2(aq) + \text{KCN}(aq) \quad \rightleftharpoons \quad \text{HCN}(aq) + \text{KNO}_2(aq) \)
\( \text{HNO}_2(aq) + \text{K}^+(aq) + \text{CN}^-(aq) \quad \rightleftharpoons \quad \text{HCN}(aq) + \text{K}^+(aq) + \text{NO}_2^-(aq) \)
\( \text{HNO}_2(aq) + \text{CN}^-(aq) \quad \rightleftharpoons \quad \text{HCN}(aq) + \text{NO}_2^-(aq) \)

d. \( \text{Al(OH)}_3(s) + 3\text{H}^+(aq) \rightarrow \text{Al}^3+(aq) + 3\text{H}_2\text{O}(l) \)
\( \text{Al(OH)}_3(s) + 3\text{H}^+(aq) + 3\text{I}^-(aq) \rightarrow \text{Al}^3+(aq) + 3\text{I}^-(aq) + 3\text{H}_2\text{O}(l) \)
\( \text{Al(OH)}_3(s) + 3\text{H}^+(aq) \rightarrow \text{Al}^3+(aq) + 3\text{H}_2\text{O}(l) \)

e. \( \text{NH}_3(aq) + \text{HBrO}(aq) \quad \rightleftharpoons \quad \text{NH}_4^+(aq) + \text{BrO}^-(aq) \)
\( \text{NH}_3(aq) + \text{HBrO}(aq) \quad \rightleftharpoons \quad \text{NH}_4^+(aq) + \text{BrO}^-(aq) \)

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. \( 3\text{HNO}_3(aq) + \text{Cr(OH)}_3(s) \rightarrow 3\text{H}_2\text{O}(l) + \text{Cr(NO}_3)_3(aq) \)
\( 3\text{H}^+(aq) + 3\text{NO}_3^-(aq) + \text{Cr(OH)}_3(s) \rightarrow 3\text{H}_2\text{O}(l) + \text{Cr}^3+(aq) + 3\text{NO}_3^-(aq) \)
\( 3\text{H}^+(aq) + \text{Cr(OH)}_3(s) \rightarrow 3\text{H}_2\text{O}(l) + \text{Cr}^3+(aq) \)

b. \( \text{MgCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l) \)
\( \text{MgCO}_3(s) + 2\text{H}^+(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Mg}^{2+}(aq) + 2\text{Cl}^-(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l) \)
\( \text{MgCO}_3(s) + 2\text{H}^+(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l) \)

c. \( \text{NaNH}_2(aq) + \text{H}_2\text{O}(l) \rightarrow \text{NaOH}(aq) + \text{NH}_3(aq) \)
\( \text{Na}^+(aq) + \text{NH}_2^-(aq) + \text{H}_2\text{O}(l) \rightarrow \text{Na}^+(aq) + \text{OH}^-(aq) + \text{NH}_3(aq) \)
\( \text{NH}_2^-(aq) + \text{H}_2\text{O}(l) \rightarrow \text{OH}^-(aq) + \text{NH}_3(aq) \)

d. \( \text{HNO}_2(aq) + \text{NH}_3(aq) \quad \rightleftharpoons \quad \text{NH}_4\text{NO}_2(aq) \)
\( \text{HNO}_2(aq) + \text{NH}_3(aq) \quad \rightleftharpoons \quad \text{NH}_4^+(aq) + \text{NO}_2^-(aq) \)
\( \text{HNO}_2(aq) + \text{NH}_3(aq) \quad \rightleftharpoons \quad \text{NH}_4^+(aq) + \text{NO}_2^-(aq) \)

e. \( \text{MgO}(s) + 2\text{HCl}(aq) \rightarrow \text{MgCl}_2(aq) + \text{H}_2\text{O}(l) \)
\( \text{MgO}(s) + 2\text{H}^+(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Mg}^{2+}(aq) + 2\text{Cl}^-(aq) + \text{H}_2\text{O}(l) \)
\( \text{MgO}(s) + 2\text{H}^+(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{H}_2\text{O}(l) \)

f. \( \text{Cu(OH)}_2(s) + 2\text{HCl}(aq) \rightarrow \text{CuCl}_2(aq) + 2\text{H}_2\text{O}(l) \)
\( \text{Cu(OH)}_2(s) + 2\text{H}^+(aq) + 2\text{Cl}^-(aq) \rightarrow \text{Cu}^{2+}(aq) + 2\text{H}_2\text{O}(l) \)
\( \text{Cu(OH)}_2(s) + 2\text{H}^+(aq) \rightarrow \text{Cu}^{2+}(aq) + \text{H}_2\text{O}(l) \)
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. 3H₂S(aq) + 2HNO₃(aq) → 3S(s) + 2NO(g) + 4H₂O(l)
   Oxidized S in H₂S  Reduced N in HNO₃  Oxidizing agent HNO₃  Reducing agent H₂S
   +2  +6  −2  0  +2  −2  +1  −2

2. BaSO₄(s) + 4C(s) → BaS(s) + 4CO(g)
   Oxidized C in C(s)  Reduced S in BaSO₄  Oxidizing agent BaSO₄  Reducing agent C(s)
   +1  +7  −2  −2  +1  −2  +1  −2  +1  −2

3. 12H⁺(aq) + 4MnO₄⁻(aq) + 5CH₃OH(aq) → 4Mn²⁺(aq) + 5HCO₂H(aq) + 11H₂O(l)
   Oxidized C in CH₃OH  Reduced Mn in MnO₄⁻  Oxidizing agent MnO₄⁻  Reducing agent CH₃OH
   +1  −2  +1  +3  −2  +5  −2  +1  +5  −2  +1  −2

4. 2H₂O(l) + 2H⁺(aq) + As₂O₃(s) + 2NO₃⁻(aq) → 2H₃AsO₄(aq) + N₂O₅(aq)
   Oxidized As in As₂O₃  Reduced N in NO₃⁻  Oxidizing agent NO₃⁻  Reducing agent As₂O₃
   −2  +1  −1  +7  −2  +3  −2  +0  +1  −2

5. 2OH⁻(aq) + 4H₂O₂(aq) + Cl₂O₇(aq) → 2ClO₂⁻(aq) + 4O₂(g) + 5H₂O(l)
   Oxidized O in H₂O₂  Reduced Cl in Cl₂O₇  Oxidizing agent Cl₂O₇  Reducing agent H₂O₂
   −2  +1  0  −1  +1  −2  +1  −2

6. 2OH⁻(aq) + Cl₂(g) → Cl⁻(aq) + ClO⁻(aq) + H₂O(l)
   Oxidized Cl in Cl₂  Reduced Cl in Cl₂  Oxidizing agent Cl₂  Reducing agent Cl₂

7. 6H⁺(aq) + IO₃⁻(aq) + 8I⁻(aq) → 3I₃⁻(aq) + 3H₂O(l)
   Oxidized I in I⁻  Reduced I in IO₃⁻  Oxidizing agent IO₃⁻  Reducing agent I⁻
   +1  +5  −2  −1  0 & −1  +1  −2

8. 2Fe(OH)₂(s) + H₂O₂(aq) → 2Fe(OH)₃(s)
   Oxidized Fe in Fe(OH)₂  Reduced O in H₂O₂  Oxidizing agent H₂O₂  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.

\[
\begin{array}{cccccc}
0 & +1 & +5 & -2 & +7 & +2 & +1 & -2 \\
\end{array}
\]

a. \(6\text{Sb}(s) + 10\text{HNO}_3(aq) \rightarrow 3\text{Sb}_2\text{O}_5(s) + 10\text{NO}(g) + 5\text{H}_2\text{O}(l)\)

Oxidized \text{Sb in Sb}(s) Reduced \text{N in HNO}_3 Reducing agent \text{Sb} Oxidizing agent \text{HNO}_3

\[
\begin{array}{cccccc}
-2 & +1 & +7 & -2 & -1 & +6 & -2 & +7 & -2 & +1 & -2 \\
\end{array}
\]

b. \(8\text{OH}^-(aq) + 8\text{MnO}_4^{2-}(aq) + 1^-(aq) \rightarrow 8\text{MnO}_4^{2-}(aq) + 1\text{O}_2(aq) + 4\text{H}_2\text{O}(l)\)

Oxidized I in I\(^-\) Reduced Mn in MnO\(_4\)\(^-\) Reducing agent I\(^-\) Oxidizing agent MnO\(_4\)\(^-\)

\[
\begin{array}{cccccc}
+2 & -2 & 0 & -1 & +2.5 & -2 \\
\end{array}
\]

c. \(2\text{S}_2\text{O}_3^{2-}(aq) + \text{I}_2(s) \rightarrow 2\text{I}^-(aq) + \text{S}_4\text{O}_6^{2-}(aq)\)

Oxidized S in S\(_2\)O\(_3\)\(^-\) Reduced I in I\(_2\) Reducing agent S\(_2\)O\(_3\)\(^-\) Oxidizing agent I\(_2\)

\[
\begin{array}{cccccc}
0 & +1 & +5 & -2 & +2 & +5 & -2 & +2 & -2 & +1 & -2 \\
\end{array}
\]

d. \(3\text{Cu}(s) + 8\text{HNO}_3(aq) \rightarrow 3\text{Cu(NO}_3)_2(aq) + 2\text{NO}(g) + 4\text{H}_2\text{O}(l)\)

Oxidized Cu in Cu\((s)\) Reduced N in HNO\(_3\) Reducing agent Cu\((s)\) Oxidizing agent HNO\(_3\)

\[
\begin{array}{cccccc}
-2 & +1 & -2 & +7 & -2 & 0 & +4 & -2 & -2 & +1 \\
\end{array}
\]

e. \(3\text{S}^2^- + 4\text{H}_2\text{O} + 2\text{MnO}_4^- \rightarrow 3\text{S} + 2\text{MnO}_2 + 8\text{OH}^-\)

Oxidized S in S\(^2-\) Reduced Mn in MnO\(_4\)\(^-\) Reducing agent S\(^2-\) Oxidizing agent MnO\(_4\)\(^-\)

\[
\begin{array}{cccccc}
+1 & -1 & +1 & -2 & 0 \\
\end{array}
\]

f. \(2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2\)

Oxidized O in H\(_2\)O\(_2\) Reduced O in H\(_2\)O\(_2\) Reducing agent H\(_2\)O\(_2\) Oxidizing agent H\(_2\)O\(_2\)

**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. \(2\text{NaH}(s) \rightarrow 2\text{Na}(s) + \text{H}_2(g)\) \hspace{1cm} \text{decomposition}
   b. \(2\text{KI}(aq) + \text{Cl}_2(g) \rightarrow 2\text{KCl}(aq) + \text{I}_2(s)\) \hspace{1cm} \text{single displacement}
   c. \(2\text{C}_2\text{H}_5\text{SH}(l) + 9\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 6\text{H}_2\text{O}(l) + 2\text{SO}_2(g)\) \hspace{1cm} \text{combustion}
   d. \(\text{H}_2(g) + \text{CuO}(s) \rightarrow \text{Cu}(s) + \text{H}_2\text{O}(l)\) \hspace{1cm} \text{single displacement}
   e. \(\text{P}_4(s) + 5\text{O}_2(g) \rightarrow \text{P}_4\text{O}_{10}(s)\) \hspace{1cm} \text{combination and combustion}
   f. \(\text{Fe}_2(\text{CO}_3)_3(s) \rightarrow 2\text{FeO}(s) + 3\text{CO}_2(g)\) \hspace{1cm} \text{decomposition}
   g. \(2\text{CaH}_2\text{OH}(l) + 17\text{O}_2(g) \rightarrow 12\text{CO}_2(g) + 12\text{H}_2\text{O}(l)\) \hspace{1cm} \text{combustion}
   h. \(\text{P}_4\text{O}_{10}(s) + 6\text{H}_2\text{O}(l) \rightarrow 4\text{H}_3\text{PO}_4(aq)\) \hspace{1cm} \text{combination}
   i. \(2\text{C}(s) + \text{MnO}_2(s) \rightarrow \text{Mn}(s) + 2\text{CO}(g)\) \hspace{1cm} \text{single displacement}
   j. \(2\text{NaClO}_3(s) \rightarrow 2\text{NaCl}(s) + 3\text{O}_2(g)\) \hspace{1cm} \text{decomposition}

2. Write balanced equations for the complete combustion of each of the following substances.

   a. \(\text{C}_3\text{H}_8(g)\)
   \[
   \text{C}_3\text{H}_8(g) + 5\text{O}_2(g) \rightarrow 3\text{CO}_2(g) + 4\text{H}_2\text{O}(l)
   \]
   b. \(\text{C}_4\text{H}_9\text{OH}(l)\)
   \[
   \text{C}_4\text{H}_9\text{OH}(l) + 6\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 5\text{H}_2\text{O}(l)
   \]
   c. \(\text{CH}_3\text{COSH}(l)\)
   \[
   \text{CH}_3\text{COSH}(l) + 7/2\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 2\text{H}_2\text{O}(l) + \text{SO}_2(g)
   \]
   or
   \[
   2\text{CH}_3\text{COSH}(l) + 7\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 4\text{H}_2\text{O}(l) + 2\text{SO}_2(g)
   \]
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?

\[ ? \text{ g NH}_4\text{Cl} = 250 \text{ mL soln} \left( \frac{4.50 \text{ mol NH}_4\text{Cl}}{10^3 \text{ mL soln}} \right) \left( \frac{53.492 \text{ g NH}_4\text{Cl}}{1 \text{ mol NH}_4\text{Cl}} \right) = 60.2 \text{ g NH}_4\text{Cl} \]

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?

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

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?

\[ \frac{? \text{ mol H}_3\text{PO}_4}{\text{L soln}} = \frac{16.2 \text{ mL NaOH soln}}{25.0 \text{ mL H}_3\text{PO}_4 \text{ soln}} \left( \frac{10^3 \text{ mL}}{1 \text{ L}} \right) \left( \frac{1.025 \text{ mol NaOH}}{1 \text{ mol H}_3\text{PO}_4} \right) \left( \frac{3 \text{ mol NaOH}}{} \right) = 0.221 \text{ M H}_3\text{PO}_4 \]

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.

\[ 2\text{AgNO}_3(aq) + \text{MgCl}_2(aq) \rightarrow 2\text{AgCl(s)} + \text{Mg(NO}_3)_2(aq) \]

\[ ? \text{ mL AgNO}_3 \text{ soln} = 75.0 \text{ mL MgCl}_2 \text{ soln} \left( \frac{0.0500 \text{ mol MgCl}_2}{10^3 \text{ MgCl}_2 \text{ soln}} \right) \left( \frac{2 \text{ mol AgNO}_3}{1 \text{ mol MgCl}_2} \right) \left( \frac{10^3 \text{ mL AgNO}_3 \text{ soln}}{0.100 \text{ mol AgNO}_3} \right) = 75.0 \text{ mL AgNO}_3 \text{ soln} \]

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

\[ M_DV_D = M_CV_C \]

\[ V_C = \frac{M_DV_D}{M_C} = \frac{2.5 \text{ M (100.0 mL)}}{18 \text{ M}} = 14 \text{ mL conc H}_2\text{SO}_4 \]

or \[ ? \text{ mL conc soln} = 100.0 \text{ mL dil soln} \left( \frac{2.5 \text{ mol H}_2\text{SO}_4}{10^3 \text{ mL dil soln}} \right) \left( \frac{10^3 \text{ mL conc soln}}{18 \text{ mol H}_2\text{SO}_4} \right) = 14 \text{ mL conc H}_2\text{SO}_4 \]

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

\[ M_DV_D = M_CV_C \]

\[ M_D = \frac{M_CV_C}{V_D} = \frac{1.75 \text{ M (15.0 mL)}}{250.0 \text{ mL}} = 0.105 \text{ M KOH} \]

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

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?

\[ ? \text{ mL conc soln} = 175 \text{ mL dil soln} \left( \frac{2.75 \text{ mol NH}_3}{10^3 \text{ mL dil soln}} \right) \left( \frac{17.0306 \text{ g NH}_3}{1 \text{ mol NH}_3} \right) \left( \frac{100 \text{ g conc soln}}{28 \text{ g NH}_3} \right) \left( \frac{1 \text{ mL conc soln}}{0.90 \text{ g conc soln}} \right) = 33 \text{ mL conc NH}_3 \text{ soln} \]
1. How would you prepare 500.00 mL of 0.750 M Na$_2$SO$_4$ from solid anhydrous sodium sulfate.

\[
\text{? g Na}_2\text{SO}_4 = 500.00 \text{ mL Na}_2\text{SO}_4 \text{ soln} \left( \frac{0.750 \text{ mol Na}_2\text{SO}_4}{10^3 \text{ mL Na}_2\text{SO}_4 \text{ soln}} \right) \left( \frac{142.043 \text{ g Na}_2\text{SO}_4}{1 \text{ mol Na}_2\text{SO}_4} \right)
\]

\[
= 53.3 \text{ g Na}_2\text{SO}_4
\]

Dissolve 53.3 g Na$_2$SO$_4$ 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.

\[
M_D V_D = M_C V_C \quad V_C = \frac{M_D V_D}{M_C} = \frac{0.650 \text{ M (250 mL)}}{7.5 \text{ M}} = 22 \text{ mL}
\]

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.

   \[3\text{NaOH}(aq) + \text{H}_3\text{PO}_4(aq) \rightarrow \text{Na}_3\text{PO}_4(aq) + 3\text{H}_2\text{O}(l)\]

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

\[
\text{? mL NaOH soln} = 50.0 \text{ mL H}_3\text{PO}_4 \text{ soln} \left( \frac{0.78 \text{ mol H}_3\text{PO}_4}{10^3 \text{ mL H}_3\text{PO}_4 \text{ soln}} \right) \left( \frac{3 \text{ mol NaOH}}{1 \text{ mol H}_3\text{PO}_4} \right) \left( \frac{10^3 \text{ mL NaOH soln}}{1.45 \text{ mol NaOH}} \right)
\]

\[
= 81 \text{ mL NaOH soln}
\]

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?

\[
\% \text{NaCl} = \frac{1.05 \text{ g NaCl}}{2.50 \text{ g sample}} \times 100 = 42.0 \% \text{NaCl}
\]

\[
\text{? g NaCl} = 30.0 \text{ mL AgNO}_3 \text{ soln} \left( \frac{0.600 \text{ mol AgNO}_3}{10^3 \text{ mL AgNO}_3 \text{ soln}} \right) \left( \frac{1 \text{ mol NaCl}}{1 \text{ mole AgNO}_3} \right) \left( \frac{58.4425 \text{ g NaCl}}{1 \text{ mol NaCl}} \right)
\]

\[
= 1.05 \text{ g NaCl}
\]