# CHEMICAL REACTIONS

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**Apparatus**

| | |
|---|---|
| Small (13x100mm) test tubes (8) | test tube holder |
| Medium (16x150mm) test tubes (2) | scoopula |
| glass stir rod | watch glass |
| crucible bottom with lid | wire triangle |
| Bunsen burner | 10 mL graduated cylinder |

**Chemicals**

| | |
|---|---|
| 0.1 M silver nitrate ($AgNO_3$) | copper wire |
| 1.0 M hydrochloric acid (HCl) | magnesium ribbon |
| 12 M sulfuric acid ($H_2SO_4$) | magnesium metal |
| sodium chloride (NaCl) | zinc metal |
| sodium carbonate ($Na_2CO_3$) | copper metal |
| sodium bromide (NaBr) | sodium iodide (NaI) |

copper sulfate penta-hydrate ($CuSO_4 \cdot 5H_2O$)

Qualitative chemistry is the area of chemistry that involves the observance of reactions. Chemical reactions can be categorized by the type of reagents and products formed. The four main types of chemical reactions are as follows:

Combination: Two or more substances combine to form one product.

Example: $A + B \rightarrow AB$

Decomposition: One substance is broken down to produce two or more other substances.

Example: $AB \rightarrow A + B$

Single displacement: The cation of an aqueous salt solution is displaced by a cation produced from the oxidation of a solid metal.

Example: $AB_{(aq)} + C_{(s)} \rightarrow CB_{(aq)} + A_{(s)}$

Double displacement: The cation of one aqueous salt solution is displaced by the cation of a second aqueous salt solution. This is also referred to as metathesis. Precipitation reactions are those in which a solid is formed as a product.

Example: $AB_{(aq)} + CD_{(aq)} \rightarrow CB_{(s,l,aq)} + AD_{(s,l,aq)}$

In order to understand this laboratory exercise, you will need to read Chapter 3, Sections 1 and 2 (pp 80-87) and Chapter 4, Sections 2, 3, and 4 (pp 124-142) in the lecture text, Chemistry The Central Science, 11 ed. (Brown, LeMay and Bursten). The quiz will be based on material covered in this assigned reading.

**PROCEDURE**

## A. Create a Silver Tree

1. Place 3mL of 0.1M silver nitrate in a dry 13x100mm test tube. Record an initial observation of the silver nitrate solution on your data sheet.
2. Obtain a piece of copper wire from your instructor. Record an initial observation of the copper wire.
3. Form the wire into a tight coil by wrapping it around your glass stir rod, leaving 2-3cm of the wire uncoiled at the top. Bend the top of the uncoiled portion of the wire to create a hook.
4. Suspend the copper wire in the silver nitrate solution. Allow the test tube to sit undisturbed for 30 minutes.
5. Make an observation of the contents of the test tube on your data sheet. Note the shiny crystal deposits on the copper coil. Write a balanced molecular equation for the reaction of copper with silver nitrate.

## B. Formation of a Metal Oxide

1. Obtain a piece of magnesium ribbon (labeled for Part B) and record an observation of its appearance.
2. Shape the ribbon into a coil so that it will lay flat in the bottom of a crucible.
3. Following your instructor's directions, place the crucible in a wire triangle on a ring stand. Place the lid on the crucible so that it is ajar. About 1/3 of the crucible should be open so that oxygen from the air can react with the Mg.
4. Gently heat the bottom of the crucible until the ribbon has oxidized to an ash. CAUTION: Make sure not to look directly at the burning magnesium. Heat the crucible slowly to avoid cracking the porcelain. The bottom of the crucible may glow red. If the Mg flares-up, remove the heat and close the lid to smother the flame. Wait until the flame has ceased before resuming the reaction.
5. Record your observation of the reaction and resulting product.
6. Write a balanced molecular equation for the reaction of magnesium with air in the presence of heat.

## C. Metals in Acid

1. Place 2mL of 1.0 M HCl into a dry 13x100mm test tube. Record an initial observation of the acid on your data sheet.
2. Obtain a piece of magnesium metal (labeled for Part C) and record an initial observation of the metal on your data sheet.
3. Place the piece of magnesium into the test tube containing the HCl. Record your observation on your data sheet.
4. Allow the tube to sit for 5 minutes and record your observation.
5. Write a balanced molecular equation for the reaction of magnesium with HCl.
6. Repeat Steps 1-5 with a piece of zinc metal.
7. Repeat Steps 1-5 with a piece of copper metal.

## D. Gas Production with Sulfuric Acid (MUST BE PERFORMED UNDER THE HOOD!)

**CAUTION:** ***Concentrated $H_2SO_4$ causes severe burns. Do not get it on your skin. If you come in contact with it, immediately wash the area with copious amounts of water.)***

1. Place a pea-sized (enough to fill the rounded bottom of the tube) sample of sodium chloride into a dry 13x100mm test tube. Record an initial observation of the salt on your data sheet.

   NOTE: Use your test tube holder to hold the test tubes for the following steps.

2. Add 5 drops of concentrated (12 M ) sulfuric acid to the test tube and record your observation. If no reaction is observed repeat the procedure on a small watch glass. Remember to do an odor test.
3. Repeat Steps 1-3 with a pea-sized sample of sodium carbonate.
4. Repeat Steps 1-3 with a pea-sized sample of sodium bromide.
5. Repeat Steps 1-3 with a pea -sized sample of sodium iodide.

## E. A Colorful Transition with Hydrate Chemistry

1. Place a pea-sized sample of copper sulfate penta-hydrate into a 16x150mm test tube. Record an initial observation on your data sheet.
2. Using your test tube holder, hold the test tube at an angle so that the solid spreads out into a thin layer. Heat the test tube gently over a Bunsen burner flame until a change is observed. Record your observation. Note the appearance of the upper portion of the test tube as well as the solid material.
3. After allowing test tube and contents to cool, hold the test tube in an upright position. Add 4-5 drops of deionized water to the solid in the tube and record your observation.
4. Write a balanced molecular equation for the reaction of the hydrate with heat and a second balanced molecular equation for the reaction of anhydrous $CuSO_4$ with water.

## F. How Does a Fire Extinguisher Really Work?

1. Place 2mL of 1.0 M hydrochloric acid in a dry 16x150mm test tube.
2. Add a pea-size sample of sodium carbonate to the acid in the test tube. Record an observation on your data sheet.
3. While the reaction is still occurring, place a burning/lit flint into the top of the test tube. (Use a Bunsen burner to light the flint.) What happens to the flame?
4. Write a balanced molecular equation for the reaction of sodium carbonate with hydrochloric acid.

Name_____ Desk_____
Date_____ Laboratory Instructor_____

REPORT SHEET

# CHEMICAL REACTIONS

## A. Create a Silver Tree

A.1 Initial Observation, silver nitrate _____

_____

A.2 Initial Observation, Cu wire _____

_____

A.3 Final Observation, silver nitrate + Cu wire _____

_____

_____

A.4 Molecular equation for reaction of silver nitrate with copper wire (states of reactants and products must be shown)

_____

## B. Formation of a Metal Oxide

B.1 Initial Observation, Mg Ribbon _____

_____

B.2 Observation of Reaction _____

_____

B.3 Observation of Final Product _____

_____

B.4 Molecular equation for reaction of magnesium with air in the presence of heat (states of reactants and products must be shown)

_____

## C. Metals in Acid

| | | Magnesium | Zinc | Copper |
|---|---|---|---|---|
| C.1 | Initial Observation of Metal | | | |
| C.2 | Initial Observation of Acid | | | |
| C.3 | Reaction Observation Initially | | | |
| C.4 | Reaction Observation After 5 Minutes | | | |

C.5 Molecular equation for reaction of each metal with hydrochloric acid (states of reactants and products must be shown)

Magnesium:

_____

Zinc:

_____

Copper:

_____

C.6 Rank the metals according to their reactivity with HCl.

Least Reactive Most Reactive

_____ _____ _____

Name_____ Desk_____

**D. Gas Production with Sulfuric Acid**

| | D.1<br>Initial Observation of Salt | D.2<br>Observation of Reaction of Salt with Sulfuric Acid |
|---|---|---|
| Sodium Chloride | | |
| Sodium Carbonate | | |
| Sodium Bromide | | |
| Sodium Iodide | | |

D.3 Write the balanced molecular equation for the reaction of each salt with sulfuric acid (states of reactants and products must be shown)

Sodium Chloride:

_____

Sodium Carbonate:

_____

D.4 Sodium Bromide + $H_2SO_4$: What compound accounts for the reddish/brown color you observed? _____

Sodium Iodide + $H_2SO_4$: What gas accounts for the rotten egg odor produced by this reaction? _____

## E. A Colorful Transition with Hydrate Chemistry

E.1 Initial Observation, copper sulfate penta-hydrate

E.2 Observation of Reaction after Heating

E.3 Observation of Reaction with Water

E.4.a Molecular equation for reaction of copper sulfate penta-hydrate with heat (states of reactants and products must be shown)

E.4.b Molecular equation for reaction of anhydrous copper sulfate with water (states of reactants and products must be shown)

## F. How Does a Fire Extinguisher Really Work?

F.1 Observation of Reaction of Sodium Carbonate with Hydrochloric Acid

F.2 What Happens to the Flame? Why?

F.3 Molecular equation for reaction of sodium carbonate with hydrochloric acid (states of reactants and products must be shown)

**QUESTIONS**

Balance the following molecular equations and state the type of reaction that occurred.

1. _____$Al_{(s)}$ + _____$O_{2(g)}$ → _____$Al_2O_{3(s)}$

   Type of reaction_____

2. _____$CaCl_{2(aq)}$ + _____$Na_3PO_{4(aq)}$ → _____$Ca_3(PO_4)_{2(s)}$ + _____$NaCl_{(aq)}$

   Type of reaction_____

3. _____$KClO_{3(s)}$ → _____$KCl_{(s)}$ + _____$O_{2(g)}$

   Type of reaction_____

4. _____$Cu_{(s)}$ + _____$HNO_{3(aq)}$ → _____$Cu(NO_3)_{2(aq)}$ + _____$H_2O_{(l)}$ + _____$NO_{2(g)}$

   Type of reaction_____

5. _____$Al_{(s)}$ + _____$HCl_{(aq)}$ → _____$AlCl_{3(aq)}$ + _____$H_{2(g)}$

   Type of reaction_____