

LaGuardia Community College

Natural Sciences Department

SCC205 Introduction to Chemistry

## Experiment # 4

### Classification of Solid Substances

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#### Objectives

At the end of this experiment, you will be able to classify substances as ionic, molecular or metallic based on their physical properties and a few simple tests.

#### Introduction

While many thousands of substances are known, they can be classified into a few simple categories based on the type of bonding that exists among the atoms in the substance. Bonds are the chemical forces that hold atoms together to form molecules or compounds. These categories are ionic, molecular (or covalent) and metallic substances.

In ionic compounds, valence electrons are transferred from one atom to another, resulting in the formation of ions of opposite charge. Metals will lose electrons to form cations (positively charged) and nonmetals can gain electrons to form anions (negatively charged); these oppositely charged ions attract each other and form an ionic compound. Because the attraction of the ions is so strong, ionic compounds are always solid at room temperature and usually are crystalline with high melting and boiling points. They usually are soluble in water and form solutions that will conduct electricity because free ions are formed in solution. They will also conduct electricity when melted. They are usually insoluble in organic liquids.

In molecular compounds, the atoms share valence electrons and are said to be joined by covalent bonds. Molecular compounds can be gases, liquids or low-melting solids formed from nonmetals or metalloids. They usually have lower melting, boiling points and densities than ionic compounds and many are insoluble in water but soluble in organic liquids. They do not conduct electricity when melted or dissolved.

Metallic bonding is a special type of bonding found in samples of pure metals or alloys (mixtures of metals). In a metal, the nucleus and core electrons (i.e. cations) are surrounded by a "sea" of valence electrons. Since the valence electrons are free to roam over the entire sample (they are described as delocalized), metals are good conductors of

electricity in the solid state. Metals are typically lustrous (shiny), flexible, malleable (can be beaten into thin sheets) and ductile (can be drawn into thin wires).

### Materials

Sodium chloride (ionic); benzophenone (molecular); copper (metal); three unknown compounds labeled A, B and C; distilled water; organic solvent (50:50 mixture of hexane and acetone), test tubes, 25 mL graduated cylinder; 100 mL beakers; Bunsen burner, conductivity tester.

### Safety

1. Wear your safety goggles at all times during this lab.

***Keep the organic solvent away from the Bunsen burner flame!***

2. When heating the test tube, keep it moving in the flame and do not point it directly at yourself or others.

### Procedure

For the **copper metal**, carry out the following tests:

1. Describe the physical characteristics of the substance on your report sheet.
2. Bring the copper to the conductivity tester. Touch the electrodes simultaneously to two different spots on the metal. If the bulb lights up, the circuit is completed and confirms a metallic material. Record Y if the substance conducts and N if it does not.

For **sodium chloride and benzophenone**, carry out the following tests:

3. Describe the physical characteristics of the substance on your report sheet.
4. Using a spatula, transfer a pea-sized amount to solid to a clean test tube. Add about 2 -3 mL of water and stir with a stirring rod. Record whether the solid dissolves or not (Y for yes, N for no).  
Repeat the test using a new sample with 2-3 mL of the organic solvent.

Using a spatula, transfer a pea-sized amount of solid to a clean, dry test tube. Heat the sample **gently** (use a very low flame) in the Bunsen burner flame. If it melts under gentle heating, record the melting point as low. If it does not melt, increase the heat: if it melts under these conditions, record the melting point as medium. If it does not melt no matter how long you heat it (***be careful not to overheat the test tube***), record the melting point as high.

Using a 25 mL graduated cylinder, measure and transfer 20 mL of distilled water to a 100 mL beaker. Add 2 spatulas of sodium chloride to the beaker and stir until dissolved. Place the electrodes of the conductivity tester into the solution. ***Make sure that the electrodes do not touch each other!*** If the bulbs lights up, the solution is conductive and indicates an ionic compound. Record Y if the substance conducts and N if it does not on the report sheet.

Repeat tests 3 – 6 on unknowns A, B and C and record the results on your report sheet. Based on your results, classify each unknown as ionic or molecular.

SCC205 Introduction to Chemistry:

**Experiment 5: Classification of Solid Substances**

Report Sheet

Name \_\_\_\_\_ Section \_\_\_\_\_ Date \_\_\_\_\_

A. Knowns

Substance	Appearance	Solubility in water	Solubility in organic liquid	Conductivity	Classification
Copper		N/A	N/A		Metallic
Sodium Chloride					Ionic
Benzophenone					Covalent

B. Unknowns

Substance	Appearance	Solubility in water	Solubility in organic liquid	Conductivity in water	Classification
A					

B					
C					