CHM 130LL: Chemical and Physical Changes

Objective

In this experiment you will

- make and record observations of properties of substances.
- cause changes to occur and classify these changes as physical or chemical based on evidence provided by your observations.

Introduction

Every pure substance can be described by a unique set of chemical and physical properties. For example, sugar looks, tastes and behaves the same, whether it is from your cupboard or your neighbor's. You count on this fact whenever you use sugar and would be surprised if its behavior were different. If you needed to decide whether an unlabeled canister contained sugar or something else, you would take a look at it, feel it, taste it—this is OK in the kitchen, but not OK in chemistry lab! (Of course, to know for sure that its sugar, you should determine several physical properties. Some sugar-substitutes look and taste remarkably like the real thing but do not behave the same way in the body.) While you may not realize it, you were using a basic principle of chemistry—**that every pure chemical is unique, but every sample of one pure chemical behaves the same way.**

Practicing chemists in industry are interested in converting chemicals to better serve the marketplace, and research chemists are interested in making new chemicals. Thus, it is of vital importance for chemists to recognize what changes have occurred, to predict what kinds of changes may occur, and to understand how to control these changes.

Two general types of changes are involved:

Physical changes: These involve only a change in physical state but no change in the composition of the individual atoms or molecules present. For example, dissolving sugar in water still results in a sweet taste because the sugar molecules are still present.

Chemical changes: These do change the composition of the substance. Burning the sugar in a saucepan results in a dark caramel, a substance that is different from the original sugar! Some of the sugar molecules have been converted to caramel molecules!

To determine if a change was physical or chemical, a chemist must observe what happens to the the individual atoms or molecules. If they are converted to other kinds of molecules, the change was chemical; if not, the change was physical. Because such observations are impossible, chemists rely on evidence that can be observed. In general, if the properties of the substance change, one can assume that the substance has undergone a change in composition (chemical change). If the properties are the same, then no change in composition has occurred (physical change). A change in just one property of a substance does not always mean that a chemical change has occurred.

For example, the particle size and appearance of granulated sugar can be changed by grinding into powdered sugar, but tasting it will convince you that it is still sugar. Changes in appearance can be deceiving. Tests of reactivity are better indicators of chemical change.

In this experiment, you will cause changes in several pure substances then test the substances before and after the changes occur. Record detailed observations, especially with respect to any change in appearance (color, texture) and/or change in physical state indicating a new substance was produced—e.g. fizzing which indicates a gas is given off or cloudiness which indicates a solid precipitate has formed. Based on your tests and observations, you will classify the changes as **physical** or **chemical.**

If the test results are the same for the original and the changed sample, then the change was **physical**.

If the test results are different for the original and the changed sample, then the change was **chemical**.

An example is shown below:

Heating Copper(II) Sulfate Pentahydrate

	Original Sample	Heated Sample
Appearance of Sample	Blue crystals	Gray chunky solid
sample + H_2O	Blue solution, solid at bottom	Blue solution, solid at bottom

The evidence above indicates that heating the original sample results in a _**physical**__ change.

Experimental Procedure

Note: You will need 2 dry test tubes for part A only. The rest of the tests can be done in *clean wet* test tubes.

Waste disposal: A waste jar will be provided for all waste generated in this lab.

A. Copper Carbonate and Heat

1. Exchange two wet clean test tubes for two dry test tubes. Use the tip of the spatula to place a very small pea-size amount of copper (II) carbonate, $CuCO_3$, into each of the two dry test tubes. There is a sample test tube at the instructor station that shows you how much copper (II) carbonate you should use. Record the color and the appearance of the sample.
2. Gently tap the tubes on the bench top so any sample clinging to the sides falls to the bottom.
3. Heat one sample directly over a Bunsen burner flame for about 5 minutes. Record the color and the appearance of the sample after heating.
4. Allow the test tube to cool for about 10 minutes in a beaker. (Do not put the hot test tube in a plastic test tube rack, or it will melt the plastic!)
5. Add 5-6 drops of 2 M HCl to both samples. Compare the results and record your observations for both samples.

B. Silver Nitrate and Copper Metal

CAUTION: Silver nitrate stains skin and clothing. Rinse spills immediately.

Note: You may use clean wet test tubes for this test.

1. Clean a small piece of copper wire with sandpaper, coil it, and drop it into a small test tube. Add enough 0.1M $AgNO_3$ to completely cover it. Also add an

approximately equal volume of the 0.1M $AgNO_3$ to a second test tube. Wait at least 5 minutes and observe the contents of the first test tube carefully.

2. Pour the $AgNO_3$ solution off the piece of copper into a third test tube. Add 3-4 drops of 3M NH_4OH to this solution, and also to the solution that was not in contact with the copper metal. Compare the results.

C. Sodium Bicarbonate and Hydrochloric Acid.

CAUTION: Hydrochloric acid is corrosive and can burn skin and damage clothing.

Note: You may use clean wet test tubes for this test.

1. Place about 10 drops of saturated $NaHCO_3$ (sodium bicarbonate) in each of two test tubes. To one, add 2M HCl (hydrochloric acid) dropwise until you no longer see any bubbles forming when additional drops of HCl are added and the contents of the tube are mixed. (Be sure to mix the contents of the tube after each addition of HCl.)
2. Add 3 drops of 0.1M $Ca(NO_3)_2$ to each and compare the results.

D. Magnesium Ribbon and Heat

Note: You may use clean wet test tubes for this test.

1. Obtain two short strips of Mg ribbon. Record the appearance of the metal.
2. Holding a test tube with a clamp, place one strip into the test tube. Carefully add 10 drops of 2M HCl into the test tube. Record your observations.
3. Grasp one end of the other strip with your crucible tongs, and hold the strip in the flame of your burner until the magnesium ignites. **Do NOT look directly at the burning metal.**
4. Record the appearance of the combustion product that forms.
5. Collect some of the product that forms (making sure not to include any unburned metal), and place it in a test tube. Treat the product with HCl as in step 2 above. Record your observations.

E. Ammonium Chloride and Heat

Note: You may use clean wet test tubes for this test.

1. Cover the bottom of your evaporating dish with a thin layer of NH_4Cl (ammonium chloride). Support this on a ring stand and wire gauze. Cover the evaporating dish with a watch glass.
2. Heat the bottom of the evaporating dish with your bunsen burner until you notice white fumes escaping from the spout of the evaporating dish or until a white coating forms on the watch glass. Turn off your bunsen burner, and **let the equipment cool.** You should notice a white deposit on the underside of the watch glass.
3. Wait at least 5 minutes for the watch glass to cool, then carefully remove it with your hand. Holding the edges of the watch glass securely over a test tube, scrape

the white deposit into the test tube.

4. In a second test tube, place about the same amount of unheated NH_4Cl so that you will use the same amount of heated and unheated NH_4Cl for the next test.
5. Dissolve both samples with a minimum amount of deionized water.
6. Add two drops of $AgNO_3$ solution to each test tube and compare the results.

Waste disposal: Dispose of all waste in the waste container in the hood. Wash and rinse all of your test tubes, shake out any excess water from the inside of each, and dry the outside of each. Make sure the gas in your area is turned off. Use paper towels to wash then wipe up your entire lab bench before leaving lab.

F. Water and Electricity: DEMO

The electrolysis of water to produce hydrogen and oxygen gas will be demonstrated. Your instructor will verify that hydrogen and oxygen gas are being produced. Classify the change observed as chemical or physical.

G. Questions and Molecular-Level Images

Answer the questions and classify each set of descriptions and corresponding molecular-level images as chemical or physical.

CHM 130LL:
Chemical and Physical Changes

Name: ________________________

Partner: ________________________

Section Number: ________________

LAB REPORT

A. Copper(II) Carbonate and Heat

	Unheated Sample	Heated Sample
Appearance		
sample + 2M HCl (aq)		

The evidence indicates that heating copper(II) carbonate causes a _____________ change.

B. Silver Nitrate and Copper Metal

	Unexposed to $AgNO_3$ solution	Exposed to $AgNO_3$ solution
Appearance of Copper Metal		

	Original 0.1M $AgNO_3$	$AgNO_3$ exposed to Copper Metal
Appearance of Solution		
sample + 3M NH_4OH		

The evidence indicates that mixing silver nitrate and copper metal causes a ______________ change.

C. Sodium Bicarbonate and Hydrochloric Acid

	Original $NaHCO_3$ Solution	$NaHCO_3$ + Hydrochloric Acid
Appearance		
sample + 0.1M $Ca(NO_3)_2$		

The evidence indicates that mixing $NaHCO_3$ and hydrochloric acid causes a ______________ change.

D. Magnesium Ribbon and Heat

	Unheated Sample	Heated Sample
Appearance		
sample + 2M HCl (aq)		

The evidence indicates that heating magnesium metal causes a _______________ change.

E. Ammonium Chloride and Heat

	Unheated Sample	Heated Sample
Appearance		
sample + $AgNO_3$		

The evidence indicates that heating ammonium chloride causes a ________________ change.

F. Water and Electricity

Give the formula for the liquid in the electrolysis apparatus: ___________________

Give the formulas for the gases formed in the electrolysis apparatus: __________________

Is the liquid the same substance as the gases? YES NO

Explain

Thus, the electrolysis of water is a _________________ change.

G. QUESTIONS AND MOLECULAR-LEVEL IMAGES

Classify each change described below as **chemical** or **physical** based on the observations.

1. A sample of table salt is dissolved in a small glass of water. Consider if the dissolved sample tastes similar to the original solid to determine what kind of change occurred.

   The process of salt dissolving in water is a _______________ change.

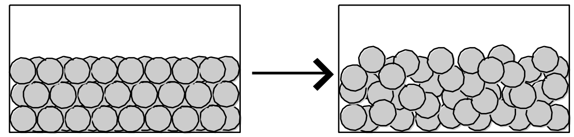
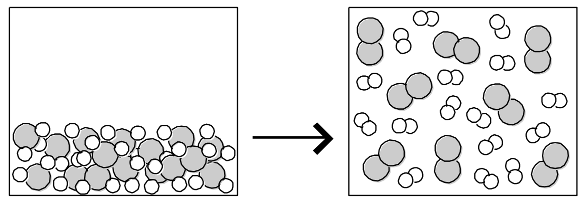
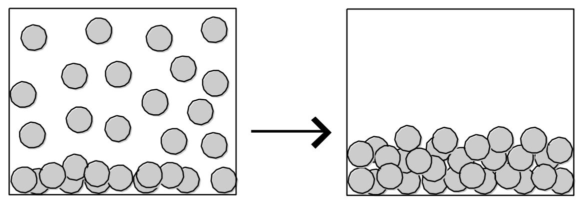
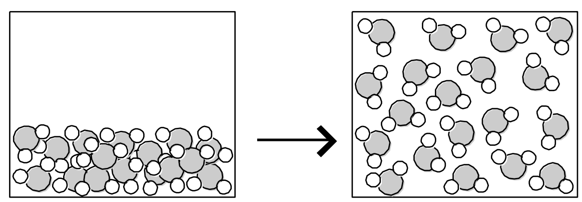
   Explain your answer.

2. A white sample of solid potassium chlorate is heated strongly for 30 minutes. The sample melts, and bubbles of gas escape during the heating. Upon cooling, the heated sample is solid white. When a sample of unheated solid is dissolved in water and 10 drops of silver nitrate solution are added, the solution remains clear. When a sample of the heated solid is dissolved in water and treated with 10 drops of silver nitrate, the solution becomes very cloudy.

   Based on the results, heating potassium chlorate is a _______________ change.

   Support your answer based on the observations.

3. For each of the following sets of molecular-level images, indicate if the change shown is a **chemical** or a **physical** change. The first one has been completed as an example.

A. These images represent a ____physical____ change.	
B. These images represent a ________________ change.	
C. These images represent a ________________ change.	
D. These images represent a ________________ change.	

4. Give the letter for the set of images in #3 above that represent the descriptions below:

_____ i. Water boiling: $H_2O(l) \rightarrow H_2O(g)$

_____ ii. The electrolysis of water: $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$

5. Explain how you could tell which image is showing boiling water and which image is showing the electrolysis of water.