CHM 130LL: Chemical and Physical Changes

In this experiment you will observe and record observations of properties of substances and you will cause changes to occur and classify these changes as physical or chemical based or evidence provided by your observations.

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 be sure, you should determine a large number of 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.**

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, so the **chemical formula stays the same**. 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, so the **chemical formula changes**. 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 solid crystals	Gray chunky solid
sample + H_2O	Blue clear solution, solid at bottom	Blue clear solution, solid at bottom

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

Procedure

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 **good observation** includes Color, State of matter and Clarity for liquids (cloudy vs clear). All 3 must be included for liquids. Ex: blue clear liquid, white solid, pink cloudy liquid, etc…

A. Copper(II) Carbonate and Heat

1. Exchange two wet clean test tubes for two dry test tubes. Place approximately a pea-size amount of copper (II) carbonate, $CuCO_3$, into each of the two dry test tubes. Record the color of the sample.
2. Tap the tubes on the bench top so any sample clinging to the sides falls to the bottom.
3. Heat one sample very strongly over a Bunsen burner flame for at least 4 minutes. Carefully shake the test tube to thoroughly mix the contents. Record the color of the sample immediately 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 2M HCl to each of the two samples. Compare the results.

B. Silver Nitrate and Copper Metal

CAUTION: Silver nitrate stains skin and clothing. Rinse spills immediately.
Note: You may use a wet test tube for this test as long as it is clean.

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 ten 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 a wet test tube for this test as long as it is clean.

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 additional drops of HCl no longer cause

a reaction even when the test tube is agitated or stirred. (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 a wet test tube for this test as long as it is clean.

1. Obtain two short strips of Mg metal 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 of the unburned sample.
3. Grasp one end of the other strip with your crucible tongs, and hold the Mg strip directly in the flame of your burner until the magnesium ignites, then hold it over the watch glass. **Do NOT look directly at the burning metal, instead look about 6 inches to the side. Do NOT burn the Mg strip in a test tube.**
4. Collect the ash by tapping the tongs so that the ash falls into a clean test tube. If the ash has already fallen on the watch glass, scrape it into a test tube.
5. Record the appearance of the product ash that forms.
6. Treat this product ash with HCl as in step 2 above. Record your observations of this burned sample.

E. Ammonium Chloride and Heat

Note: You may use a wet test tube for this test as long as it is clean.

1. Cover the bottom of your evaporating dish with a thin layer of NH_4Cl (ammonium chloride), a white solid. Support this on a ring stand and wire gauze. Cover the evaporating dish with a watch glass with the concave side up so the watch glass doesn't slide off the dish.
2. Heat the bottom of the evaporating dish **gently** with your Bunsen burner for about 10-12 minutes. A white coating should form on the underside of the watch glass. Turn off your Bunsen burner, and **let the equipment cool.**
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 a small piece of the white deposit into the test tube. Dissolve this in a **minimum** amount of deionized water.
4. In a second test tube, place about the same small sized piece of unheated NH_4Cl, and also dissolve this in a minimum amount of deionized water.
5. Add two drops of $AgNO_3$ solution to each test tube, record your observations, 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, evaporating dish and watch glass. Shake out any excess water from the inside of the test tubes, and dry the outside of each. Put your clean test tubes back in the plastic test tube rack. Put any test tubes that cannot be cleaned on the cart. 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 a gas or gases will be demonstrated. The gas is either H_2O gas or both O_2 and H_2 gases. Observe what happens when the gas or gases are exposed to a flame. 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.

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Name: ____________________

Partner: ____________________

Section Number: _______________

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

	Unburned Sample	Burned Sample
Appearance		
sample + 2M HCl (aq)		

The evidence indicates that the change from heating magnesium metal is a ______________ change.

E. Ammonium Chloride and Heat

	Unheated Sample	Heated Sample
Appearance of the solid		
sample + $AgNO_3$		

The evidence indicates that the change from heating ammonium chloride is a ________________ change.

F. Water and Electricity

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

What did you **observe** in this apparatus when electricity was applied? _____________________________

What did you **observe** when the gas(es) were exposed to a flame? _________________________________

____

Give the **formula(s)** for the gas(es) formed in the electrolysis apparatus: __________________________

Is the liquid the same substance with the same molecular formula as the gases? YES NO

Explain how you know what the gases are based on what you observed when the gases were exposed to a flame.

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.

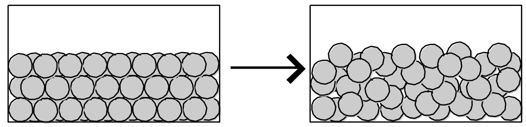
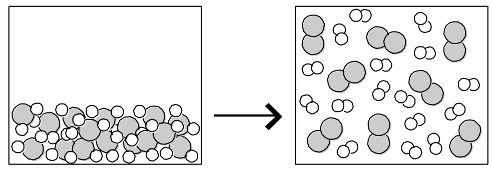
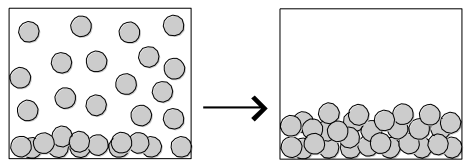
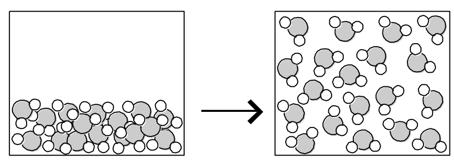
1. A sample of table salt is dissolved in a small glass of water. Consider if the dissolved sample tastes similar to the original solid to determine what kind of change occurred.

   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 and colorless. When a sample of the heated solid is dissolved in water and treated with 10 drops of silver nitrate, the solution becomes very cloudy and white.

   Based on the results, heating potassium chlorate is a _______________ change.
   Support your answer based on the observations of adding silver nitrate.

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 represents the descriptions below:

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

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

5. For each change below identify as physical or chemical in the blank.

a. $H_2O_2(l) \rightarrow H_2(g) + O_2(g)$ ______________________ change

b. $CH_4(g) \rightarrow CH_4(l)$ ______________________ change

c. $Br_2(l) \rightarrow Br_2(g)$ ______________________ change

d. $2\ NH_3(g) \rightarrow N_2(g) + 3\ H_2(g)$ ______________________ change