Experiment: Physical and Chemical Properties and Changes

Objectives

- Identify various physical and chemical properties of matter
- To distinguish between chemical changes and physical changes.

Materials Needed

Equipment:

- Hot plate
- Glass stirring rod
- 12-Well plate
- Eyedroppers
- Microspatula
- Evaporating dishes

Chemicals:

- Various elements & compounds
- Iodine crystals
- Sucrose crystals
- Acetone
- Steel wool
- Cupric sulfate pentahydrate crystals
- 10% sodium carbonate solution
- 10% sodium sulfate solution
- 1 M HCl
- 10% calcium chloride solution
- 10% sodium chloride solution
- De-ionized water

Introduction

Chemistry is the study of matter. The most thorough description of a sample of matter will usually begin by observing relevant *physical properties*, both *intrinsic* and *extrinsic.* Many physical properties are qualitative such as color, crystal shape, and phase at room temperature. Other physical properties are quantitative (must be measured) such as density, specific heat capacity, and boiling point. Any change is a substance or sample is considered to be a *physical change* when its chemical composition is not altered, e.g. boiling, freezing, expanding, and dissolving.

Matter can also be characterized by its *chemical properties*. The chemical properties of a substance include possible ways it can interact with other matter and transform into new substances. When the chemical composition of a substance changed it is referred to as *chemical change*. During a chemical change, atoms are pulled apart from one another then rearranged to form new substances. Examples of chemical change are burning, rusting, fermenting, and decomposing.

In this experiment, you will first identify and record various physical properties of substances. In the second part, you will look at changes in matter and determine if they are physical or chemical.

Preliminary Questions

1. Classify the following properties of sodium metal as physical or chemical:
   a. Silver metallic color _____
   b. Turns gray in air _____
   c. melts at 98°C _____
   d. Reacts explosively with chlorine _____
2. Classify the following changes as physical or chemical:
   a. Magnesium burns forming a white powder _____
   b. Soda water is poured into a glass producing bubbles _____
   c. Concrete expands on a hot sunny day _____
   d. Bread dough "rises" when yeast is added _____

Part A: Physical Properties

1. Examine the various substances provided by your instructor and record your observations in Table 1. *Note: some substances may be toxic. As a precaution, do not open any containers with out the permission of your instructor.*

Table 1: Physical Properties (complete table)

Name of Substance	Chemical Formula	Phase at Room Temperature	Color	Other Physical Properties Observed	Element, Compound or Mixture?

2. *Solubility* is an intrinsic physical property that describes whether a substance (solute), is dissolvable in a liquid (the solvent). This easily observed property can often suggest profound information regarding molecular structure of a substance.

   For example, a substance is readily *soluble* in water, which is a highly polar molecule due to the presence of 2 oxygen-hydrogen chemical bonds, is likely to:

   (i) be either an ionic compound (consisting of ions) or

   (ii) at least contain strongly polar regions within its molecular structure.

   Substances that are *insoluble* in water yet soluble in non-polar solvents such as acetone are most likely non-polar in structure.

   Exceptions to these generalizations include substances that are soluble in both polar and non-polar solvents such as alcohols. These types of substances, referred to as *amphipathic*, have prominent polar and non-polar molecular structures.

   In this section you will explore the solubility of 2 substances in polar vs non-polar solvents.

   a. Place a small crystal of iodine in one well of a 12 well-plate and a small crystal of sucrose in a second. Use an eyedropper to fill each well with distilled water and stir gently with a microspatula. Record whether each substance is completely soluble, partially soluble, or insoluble. *The iodine should be disposed of into a waste basket and the sucrose into the sink with water.*

   b. Repeat part (a) using acetone as the solvent.

Table 2: Physical Properties - Solubility

Name of Substance	Solvent	Solubility	Polar or Non-Polar	Other Physical Properties Observed

Part B: Physical and Chemical Changes

1. Inspect a small piece of steel wool. Place it in an evaporating dish, and heat on a hot plate set to high. Allow the system to cool to room temperature. Observe and record any changes in the steel wool in Table 3.
2. Inspect some cupric sulfate pentahydrate crystals, $CuSO_4 \cdot 5H_2O$. Place a few crystals in an evaporating dish and heat on a hot plate set to medium. Observe and record any changes in the salt. After the system has cooled to room temperature, add a few drops of water to the crystals. Observe and record any changes.
3. Place a few drops of a 10% sodium carbonate solution, Na_2CO_3, in one well of a well-plate and a few drops of a 10% sodium sulfate solution, Na_2SO_4, in a second well of the same well-plate. Add 2 or 3 drops of 6 M hydrochloric acid to each well. Observe and record any changes.
4. Place a few drops of a 10% sodium chloride solution, NaCl, in one well of a well-plate and a few drops of a 10% calcium chloride solution, $CaCl_2$, into a second well of the same well-plate. Add several drops of a 10% sodium carbonate solution to each well. Observe and record any changes.

Table 3: Physical and Chemical Changes

Procedure	Observation(s)	Physical Change or Chemical Change?	Evidence or Reasoning
1. steel wool + heat			
2a. $CuSO_4 \cdot 5H_2O$ + heat			
2b. $CuSO_4$ + H_2O			
3a. Na_2CO_3 + HCl			
3b. Na_2SO_4 + HCl			
4a. NaCl + Na_2CO_3			
4b. $CaCl_2$ + Na_2CO_3			
5. I_2 + heat			
6. Na (metal) + H_2O			

To be performed by the instructor:

5. Inspect some iodine crystals, I_2. Place a few of the crystals in a dry 250 mL beaker and cover with an evaporating dish that contains ice, as shown in Figure 1. In a fume hood, place the beaker on a hot plate set to medium. Observe and record any changes in Table 3.

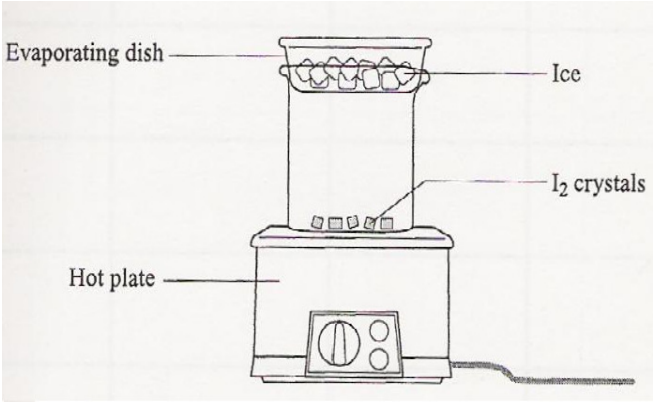

FIGURE 1

6. Fill a 500 or 1000 mL beaker about a third full with de-ionized water. Add a small piece of sodium metal and cover the beaker, as shown in Figure 2. Observe and record any changes in Table 3.

   Let's try it again! This time, add a couple drops of phenolphthalein to the water. Place a piece of sodium metal on a small section of filter paper and place the filter paper, with metal on top, onto the surface of the water.

   How do your observations differ from above??

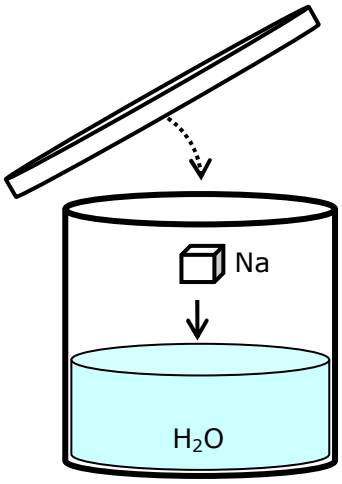

FIGURE 2

Final Questions

1. What are some of the ways, i.e. specific observations, which you used to distinguish between physical vs. chemical changes?

2. Classify the following properties as physical or chemical:
   a. Gas state at 25°C _____
   b. Turns brown & brittle when heated _____
   c. 1.0mL has a mass of 2.7 grams _____
   d. Reacts explosively with water _____
3. Classify the following changes as physical or chemical:
   a. steam condenses to liquid water on a cool surface _____
   b. baking soda dissolves in vinegar, producing bubbles _____
   c. mothballs gradually disappear at room temperature _____
   d. baking soda loses mass as it is heated _____
4. Are any of your answers in Question #3 potentially misleading? Consider your answers to Questions 2 & 3.