Experiment 4 Name: _____

15 P HYSICAL AND CHEMICAL PROPERTIES AND PHYSIC 13 Al AND CHEMICAL CHANGES

In this experiment, you will also observe physical and chemical properties and physical and chemical changes.

Physical and Chemical Properties and Physical and Chemical Changes

Physical properties are properties that can be observed without changing the substance. Examples include: (1) appearance which is observed by visual inspection, (2) mass and volume which are measured without changing the sample and (3) boiling point which is determined by allowing a substance to change from liquid to gas but the identity and composition of the substance remaining the same.

Chemical properties are properties that can be observed by changing a substance into another substance. Examples include: (1) iron's resistance to rusting which is determined by allowing iron to form iron oxide (rust) and (2) reactivity which is determined if a substance is allowed to react with another substance forming new substances.

Physical changes are changes that do not change the identity or composition of the substance. Examples are: (1) change in shape like grinding a sugar cube into powder, (2) change in temperature or physical state brought about by heat such as when cold water turns into hot water and hot water turning into steam and (3) a change in volume when two solutions are added together which results in a simple mixing without reaction.

Chemical changes are changes that produce new substances. These are basically chemical reactions and can be indicated by: (1) release of gas, (2) permanent color change or (3) formation of an insoluble solid (called precipitate) upon mixing of two solutions.

PROCEDURE

I. Physical Properties and Physical Changes

TIPS

Time management: Proceed first with the set-up for the boiling water in Part I A. You may work on the other parts of the experiment while waiting for the water to boil.

Waste management: Dispose wastes as soon as you finish a reaction or part, so you can keep track of the test tube contents and place them in their designated containers.

A. Boiling Point

CAUTION: Methyl alcohol is flammable. The vapors must be kept away from flames.

1. Fill a 400 mL beaker halfway with tap water then place it on top of the hot plate. Turn the hot plate on (heat knob to high), bring the water to a boil.

2. Check that the stopper fits in the test tube. Insert the stopper in the test tube and insert the thermometer into the hole of the stopper. Hold the thermometer about 2 cm above the bottom of the test tube and wrap the rubber band around the thermometer. This should keep the thermometer suspended.

3. **When the water is boiling, turn the hot plate off.**

4. Add ~20 drops of methyl alcohol into the large test tube and put a boiling chip. (The boiling chip prevents vigorous bumping and splattering as the liquid boils by providing sites in which bubbles can form.)

5. Put the test tube in the clamp, immersed in the beaker of hot water. Place the stopper atop the test tube lightly, do not push it in to seal. Suspend the thermometer ~1 cm above the alcohol, as shown in Figure 1. Adjust the position of the rubber band if needed.

   Notes
   1. Do not touch the liquid with the tip of the thermometer.
   2. The thermometer must be held by hand. The hole in the rubber stopper is too big to hold the thermometer.

6. Watch the alcohol and tip of thermometer closely. When alcohol drips from the tip of the thermometer you have reached the boiling point. Record the temperature when this happens; this is the boiling temperature.

   If you do not see the alcohol dripping, but the methyl alcohol begins vigorously boiling, you surpassed the boiling point.

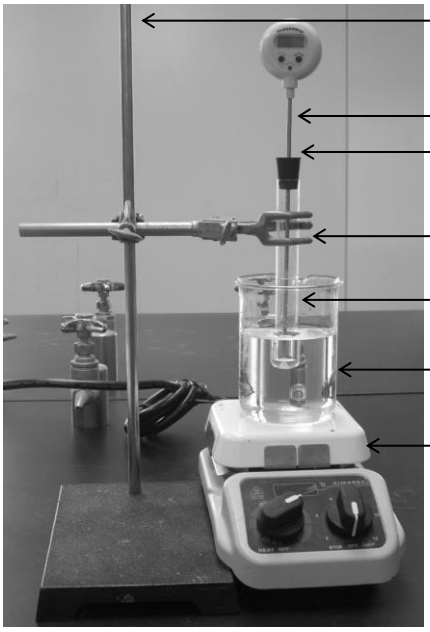
7. Remove the test tube from the hot water and allow the test tube to cool for at least 10 minutes. Meanwhile, turn the heat back on and reheat the water in the beaker.

8. Turn the heat off when the water begins to boil again.

9. Add 10 more drops of methyl alcohol to the test tube and repeat steps 4 and 5 to confirm the boiling point. Record the boiling point.

10. Turn the thermometer off upon completion of this part.

(a)



(b)

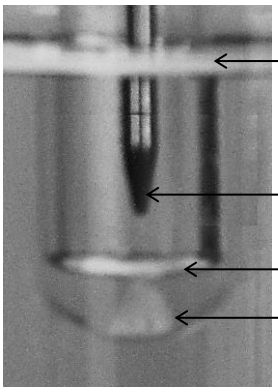


Figure 1. Boiling point determination (a) the whole set-up
(b) close-up of the bottom of the test tube

B. Solubility in Water

1. Solids. Into each of two test tubes, add 20 drops of distilled water. Using a spatula, add a pinch of copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) to one and a pinch of calcium carbonate ($CaCO_3$) to the other. Shake and observe if the solid dissolves in water (forms a homogeneous mixture) or not (forms a heterogeneous mixture). Record as soluble or insoluble, respectively.

2. Liquids. Into each of two test tubes, add 20 drops of distilled water. Add a 10 drops of methyl alcohol to one and amyl alcohol to the other. Shake and observe the solubilities. The alcohol is soluble in water if the liquids mix completely without forming layers. It is insoluble if it does not mix with the water but forms a separate layer.

Notes

1. Most things take time to dissolve. Give your sample time to dissolve. Shaking the test tube encourages mixing.
2. A homogeneous mixture is transparent and a heterogeneous is translucent or opaque (cloudy) or layered.

II. Physical and Chemical Changes

A. Element

Obtain a piece of copper wire ~1.5 cm in length and inspect. Use crucible tongs to hold it, then bring to a Bunsen burner (blue) flame until it glows red. Allow it to cool and re-inspect. Record your observations of the copper wire before heating up and after cooling down and classify a physical or chemical change.

B. Compounds

CAUTION: Point the opening of the test tube to a safe direction as you heat the contents of the test tube.

1. Place ~1 g ammonium bicarbonate (NH_4HCO_3) into a dry test tube. Using a test tube holder, heat gently and note any changes including odor. Classify as a physical or chemical change.

2. Place ~1 g sodium bicarbonate ($NaHCO_3$) into a dry test tube. Add 20 drops of acetic acid ($HC_2H_3O_2$). Record your observations. Classify as a physical or chemical change.

3. Place ~0.2 g of copper in a 100-mL beaker. **Proceed to the fume hood** where the concentrated HNO_3 (16 M solution) is. Measure 3 mL of it with a graduated cylinder, transferring to from the bottle to the graduated with a dropper. Then, add it to the beaker. Brown NO_2 fumes will evolve vigorously. The reaction beaker should be kept in the hood until the reaction is completed, that is, when fumes are no longer released and **all the copper wire has disappeared**.

CAUTION: HNO_3 is very corrosive to the skin. Handle carefully. If spilled on skin, immediately wash off with plenty of water for several minutes. Since NO_2 is toxic, the reaction must be carried out only in the hood. Clean up spills.

C. Solutions

1. Obtain two test tubes. Add 20 drops of sodium carbonate (Na_2CO_3) solution to one and 20 drops of sodium sulfate (Na_2SO_4) solution to the other. Then, to each test tube, add 20 drops of hydrochloric acid (HCl) solution. Note any changes and then classify as a physical or chemical change.

2. Obtain two test tubes. Add 20 drops calcium nitrate ($Ca(NO_3)_2$) solution to one and 20 drops of copper(II) nitrate ($Cu(NO_3)_2$) solution to the other. Then, to each test tube, add 20 drops of sodium hydroxide (NaOH) solution. Note any changes and then classify as a physical or chemical change.

CLEAN-UP

- Dispose of wastes in the designated containers.
- Wash all glassware used. Return materials where they belong. Shake off excess water from washed test tubes and return to the test tube racks on your work station.
- Make sure the Bunsen burner and gas valve are off, disconnect the tubing from the gas valve.
- Make sure the thermometer is off.

Name: _____ **Date:** _____
Partner's Name: _____

PHYSICAL AND CHEMICAL PROPERTIES AND PHYSICAL AND CHEMICAL CHANGES

DATA AND OBSERVATIONS

A. Boiling point of methyl alcohol

Trial 1: _____

Trial 2: _____

Average boiling point: _____

B. Solubility in Water

	Chemical	Soluble/Insoluble
Solids	copper sulfate	
	calcium carbonate	
Liquids	methyl alcohol	
	amyl alcohol	

II. Physical and Chemical Changes

Procedure	Observations/ Evidence	Physical/ Chemical Change
A. copper wire + heat		
B1. ammonium bicarbonate + heat		
B2. sodium bicarbonate + acetic acid		
B3. copper + nitric acid **(Do in the fume hood)**		
C1a. sodium carbonate + hydrochloric acid		
C1b. sodium sulfate + hydrochloric acid		
C2a. calcium nitrate + sodium hydroxide		
C2b. copper(II) nitrate + sodium hydroxide		

POST-LAB EXERCISES

1. Classify as element, compound, homogeneous mixture or heterogeneous mixture.

    a. sodium, Na _____

    b. drip coffee with cream and sugar _____

    c. pizza _____

    d. carbon dioxide, CO_2 _____

    e. perfume/cologne _____

    f. table salt, NaCl _____

    g. orange juice with pulp _____

    h. nitrogen gas, N_2 _____

    i. 14 carat gold _____

    j. Rust, Fe_2O_3 _____

2. Classify the following as physical property or chemical property. Write P or C for physical or chemical property, respectively.

    a. Lead melts at 327.5 °C. _____

    b. Methanol is flammable. _____

    c. Stainless steel is a good heat conductor. _____

    d. Gold is a malleable and ductile metal. _____

    e. Hydrogen sulfide smells like rotten eggs. _____

3. Classify the following as physical change or chemical change. Write P or C for physical or chemical change, respectively.

    a. A slice of apple turns brown. _____

    b. Paper is torn into pieces. _____

    c. Acetone evaporates when left in an open container. _____

    d. When a magnesium strip is immersed in acid, bubbles form. _____

    e. Water is added to orange juice. _____