

Exploring Chemical and Physical Changes

Carolina Distance Learning
Investigation Manual

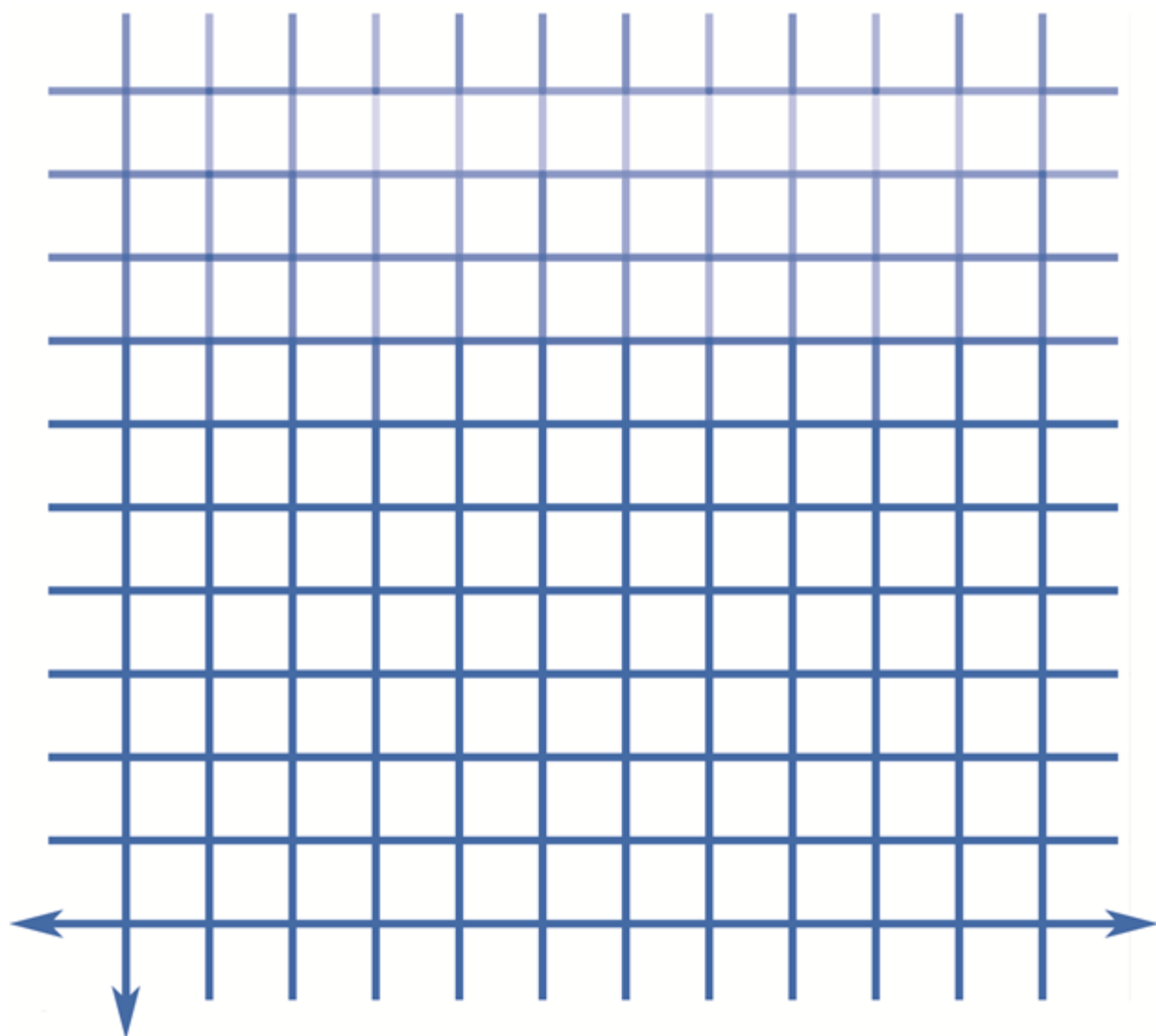


Table of Contents

Overview	3
Objectives.....	3
Time Requirements	3
Background.....	4
Materials.....	5
Safety	6
Preparation.....	7
Activity 1	8
Activity 2.....	9
Activity 3.....	10
Activity 4.....	11
Activity 5.....	12
Activity 6.....	13
Activity 7	14
Activity 8.....	14
Activity 9.....	15
Activity 10.....	15
Activity 11.....	16
Activity 12.....	17
Disposal and Cleanup	18
Data Table: Activities 1 – 5.....	19
Data Table: Activities 6 – 10.....	20
Data Table: Activities 11 – 12	21

Overview

In this investigation, a series of laboratory activities that feature physical or chemical changes are performed. Differences in chemical and physical changes are explored and discussed. The type of change that is occurring is identified based on defined criteria, and observations that lead to these conclusions are discussed.

Objectives

- Differentiate between chemical and physical changes
- Describe features that identify changes as chemical or physical
- List examples of physical and chemical changes then classify why these are chemical or physical changes.

Time Requirements

Preparation.....5 minutes
Activities15 minutes each

Additional time will be needed for clean-up.

The lab may be stopped after any activity and resumed at a later time. If stopping the lab before it is complete, ensure that all containers of liquids are sealed to prevent evaporation.

Background

Some changes are so much a part of daily life that they are hardly noticed. Paints are mixed; ingredients become meals; tools rust; fuels are consumed; and rain and snow form, fall, and then seem to disappear. Some of these changes are physical, and some are chemical.

A physical change may be associated with a change in the appearance, but not in the chemical composition, of a substance. In other words, the original reactant molecules have not been changed into different molecules in the product. For example, a change in state is a physical change. Solid ice and liquid water have the same chemical composition (H_2O), but the state (solid vs. liquid) of the H_2O is physically different.

Chemical changes result from the formation, breakage, or rearrangement of chemical bonds. Atoms of compounds are rearranged to form product substances that differ from the original reactant substances. A chemical change can be depicted by an equation showing the rearrangement of atoms. Even when the identities of the substances are unknown, some conspicuous indicators tend to suggest a chemical change:

- Production of a gas
- Production of a precipitate, an insoluble solid
- Production of light
- Production/absorption of heat
- A color change that cannot be explained by simple combination of colors (e.g., two colorless chemicals that form a yellow compound when mixed)

These indicators simply suggest the likelihood that a change is chemical; physical changes sometimes produce these effects as well.

Materials

Included in the materials kit:

Sodium carbonate solution (Na_2CO_3), 1M	15 mL
Sodium polyacrylate	2 g
Iron (Fe) nail	1
Aluminum (Al) weigh dish	1

Needed from the chemical kit:

Yellow #5 food coloring
 Blue #1 food coloring
 Magnesium (Mg) ribbon
 Copper(II) sulfate solution (CuSO_4), 0.5 M
 Sodium hydroxide solution (NaOH), 1 M
 Hydrochloric acid solution (HCl), 1 M
 Phenolphthalein solution*, 1%

Needed from the equipment kit:

Polystyrene test tubes
 Test tube rack
 10-mL Graduated cylinder
 Electronic balance
 Thermometer
 Tea candle
 Forceps
 250-mL beaker
 Plastic cups, 2
 Medicine cups, 2
 5 Weigh boats
 Ruler

Needed, but not supplied:

<u>Room temperature</u> Water, bottled or purified	1 L
Sugar	1 g
Table salt (sodium chloride, NaCl)	2 g
Ice cube (small)	
Matches	
Sandpaper or emery board	

* Bottled or purified water should be used to remove most of the solids that are found in tap water. Filtered water from a home water purifier (e.g. Brita or PUR) works well.

Reorder Information: A replacement kit for Exploring Chemical and Physical Changes, item number 580302, can be ordered from Carolina Biological Supply Company. Call 1-800-334-5551 to order.

Safety



Safety goggles, a lab apron and gloves are required at all times while conducting this investigation.

Read all instructions for this laboratory activity before beginning, including reviewing the provided MSDS disk. Follow the instructions closely, and observe established laboratory safety practices, including use of appropriate personal protective equipment described in the Safety and Activity sections.

Keep all chemicals tightly sealed and away from children and pets. Wash hands after handling any chemicals.



Magnesium and phenolphthalein are flammable. Keep chemicals away from any heat or flame sources.



Sodium carbonate and sodium polycarylate cause serious eye irritation. Sodium polyacrylate is harmful if swallowed. Copper sulfate causes skin irritation.



Sodium hydroxide and hydrochloric acid cause severe skin burns and eye damage.



Copper sulfate is toxic to aquatic life.



If ingested, phenolphthalein is a suspected carcinogen, mutagen and is suspected of causing genetic defects.



Hydrochloric acid may be toxic if inhaled.

Do not eat, drink, or chew gum while performing this activity. Wash hands with soap and water before and after performing the activity. Clean the work area with soap and water after completing the investigation. Keep laboratory materials and equipment out of the reach of children and pets.

Preparation

1. Read through the Procedure.
2. Obtain all materials.
3. Clean and sanitize work area.
4. Prepare two solutions of colored water (yellow and blue). Use the graduated cylinder to measure 10 mL of water, and add 10 mL water to each of two small cups. Add 1 drop of yellow #5 food coloring to one cup and 1 drop of blue #1 food coloring to the second cup.
5. Add water to a large cup and (if it is not already at room temperature) allow it to come to room temperature. 25 mL will be used for the activities; the remainder will be used to rinse equipment. *Use only room temperature bottled or purified water in all activities.*
6. To prevent the thermometer from rolling off the counter and breaking, wrap a rubber band securely around it, avoiding the bulb. The rubber band can be moved up or down as needed to read temperature values.

Weighing Chemical Reagents

When weighing chemical reagents, place a weigh boat on the balance and tare (zero) the balance. Add the chemical to the weigh boat until the desired weight is reached. Remove the weigh boat and pour the chemical into the reaction container (e.g. test tube).

Measuring Liquids

Use the graduated cylinder to measure liquids. Pour the liquid into the cylinder until the bottom of the meniscus (the curved upper surface of the liquid) is level with the desired volume indicator.

Avoiding Contamination

Rinse all equipment with water and dry after each use, including multiple uses of the same item within one activity. Use a new weigh boat to measure each chemical.

Set up a wash station at the lab bench. Use the 250-mL beaker as a waste container for solutions and rinse water, and use one cup for disposal of solids. Fill a second cup with water for rinsing (as well as for use in experiments). After using the thermometer, fill a pipet with water and, holding the thermometer over the waste beaker, rinse the thermometer with water. After using a test tube or graduated cylinder, fill a pipet with water and use it to rinse the inside of the tube or cylinder. Rinse the pipets by flushing them with clean water. Pour the rinse water into the waste beaker. Repeat all rinses twice or until item is clean. Dry all equipment.

Activity 1

1. Place two test tubes in test tube rack.
2. Using a graduated cylinder, add 2 mL of 1M hydrochloric acid (HCl) to one of the tubes.
3. Rinse and dry the graduated cylinder.
4. With the graduated cylinder, add 2 mL of 1M sodium carbonate solution (Na_2CO_3) to the second test tube.
5. Record the color of the contents of each test tube in Data Table.
6. Use the thermometer to measure the temperature of the hydrochloric acid. Record temperature in the Data Table. Rinse and dry thermometer as described above.
7. Repeat **step 6** with sodium carbonate solution.
8. Combine the HCL of test tube 1 with Na_2CO_3 in test tube. Gently swirl to mix, and insert the thermometer.
9. Measure and record the temperature of the product (final temperature) in the Data Table.
10. Observe solution for 1 minute and record the final color and any additional observations.
11. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
12. Pour all solutions into the 250-mL beaker. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 2

1. Place two test tubes in test tube rack.
2. Add 10 mL of water to one test tube with a graduated cylinder.
3. Add 0.3 g of preweighed sodium polyacrylate to the second test tube.
4. Record the color of the contents of each test tube.
5. Measure the temperature of the water and record it in the Data Table.
6. Add the water to the test tube containing sodium polyacrylate. Gently swirl to mix, and insert the thermometer.
7. Measure and record the temperature of the product.
8. Observe for 1 minute and record the final color of the product and any additional observations.
9. Indicate on the Data Table whether a chemical or physical change has occurred and explain why.
10. Dispose of the product in the trash. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 3

1. Place two test tubes in test tube rack.
2. Add 2 mL of 0.5 M copper(II) sulfate solution (CuSO_4) to a test tube.
3. Add 2 mL of 1 M sodium carbonate solution (Na_2CO_3) to a second test tube.
4. Record the color of the contents of each test tube.
5. Use the thermometer to measure the temperature of the CuSO_4 . Record temperature in the Data Table. Rinse and dry thermometer as described above.
6. Repeat **step 4** with Na_2CO_3 solution.
7. Combine the contents of the two test tubes in one. Gently swirl to mix, and insert the thermometer.
8. Measure and record the temperature of the product (final temperature) in the Data Table.
9. Observe for 1 minute and record the final color and any additional observations.
10. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
11. Pour all solutions into the 250-mL beaker. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 4

Part A

1. Place the tea candle on a flat surface away from any flammable materials. Record the color of the tea candle.
2. Light the tea candle using a match.
3. Observe the tea candle for 1 minute and record the final color and any additional observations.
4. Based only on your observations of the tea candle, indicate in the Data Table whether a chemical or physical change has occurred and explain why.

Part B

1. Place one small ice cube in the aluminum (Al) weigh dish. Record the color of the ice.
2. Hold the aluminum dish over the flame of the candle using forceps.
3. Observe for 1 minute and record the final color and any additional observations of the ice cube. Place hot aluminum dish on a plate or heat-safe surface.
4. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
5. Extinguish the candle.
6. Save the aluminum dish for Activity 12.

Activity 5

1. Place two test tubes in test tube rack. Add 5 mL of water to one test tube.
2. Add 1 g of sugar to second test tube.
3. Record the color of the contents of each test tube.
4. Measure the temperature of the water and record it in the Data Table.
5. Add the water to the test tube containing the sugar. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations. Record any temperature change that may have occurred.
8. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
9. Pour all solutions into the 250-mL beaker. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 6

Part A

1. Place one test tube in test tube rack. Add 2 mL of 1 M sodium hydroxide solution (NaOH) to test tube.
2. Record the color of the solution.
3. Observe the solution of 1% phenolphthalein solution and record the color.
4. Measure the temperature of the NaOH and record it on the Data Table.
5. Using a pipet, add 1 drop of phenolphthalein to the NaOH solution. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations.
8. Indicate on the Data Table whether a chemical or physical change has occurred and explain why.
9. Save the NaOH/phenolphthalein solution for use in **Part B**.

Part B

1. Place one test tube in test tube rack. Add 2 mL of 1 M hydrochloric acid solution (HCl) to test tube.
2. Record the color of the HCl.
3. Measure the temperature of the HCl and record it in the Data Table.
4. Add the HCl to the NaOH/phenolphthalein solution prepared in **Part A**. Gently swirl to mix, and insert the thermometer.
5. Measure and record the temperature of the product.
6. Observe for 1 minute and record the final color and any additional observations.
7. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
8. Pour all solutions into the 250-mL beaker. Discard pipet used to dispense phenolphthalein solution in trash. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 7

1. Place two test tubes in test tube rack. Add 2 mL of copper(II) sulfate solution (CuSO_4) to one test tube.
2. Add 2 mL of sodium hydroxide solution (NaOH) to the second test tube.
3. Record the color of the contents of each test tube.
4. Measure the temperature of the CuSO_4 and NaOH solutions and record them in the Data Table.
5. Add the contents of one test tube to the other test tube. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations.
8. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
9. Pour all solutions into the 250-mL beaker. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 8

1. Place two test tubes in test tube rack. Add 5 mL of blue or yellow water, prepared in **Preparation** section above, to test tubes.
2. Record the color of the contents of each tube.
3. Use the thermometer to measure the temperature of the blue water. Record temperature in the Data Table. Rinse and dry thermometer.
4. Repeat **step 3** with yellow water.
5. Add the contents of one test tube to the other test tube. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations.
8. Indicate on the Data Table whether a chemical or physical change has occurred and explain why.
9. Pour all solutions into the 250-mL beaker. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 9

1. Place one test tube in test tube rack. Add 5 mL of hydrochloric acid solution (HCl) to test tube.
2. Measure the temperature of the HCl and record it on the Data Table.
3. Record the color of the HCl.
4. Record the color of the magnesium ribbon.
5. Cut a 0.5 cm length of magnesium ribbon and add it to the HCl. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations.
8. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
9. Pour all solutions into the 250-mL beaker. Discard any solids in the trash. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Activity 10

1. Place two test tubes in test tube rack. Add 5 mL of copper(II) sulfate (CuSO_4) to one test tube.
2. Add 2 g of table salt (sodium chloride, NaCl) to the second test tube.
3. Record the color of the contents of each test tube.
4. Measure the temperature of the CuSO_4 solution and record it in the Data Table.
5. Add the CuSO_4 solution to the test tube containing the salt. Gently swirl to mix, and insert the thermometer.
6. Measure and record the temperature of the product.
7. Observe for 1 minute and record the final color and any additional observations.
8. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
9. Save the CuSO_4 /salt solution for use in Activity 12.

Activity 11

1. Cut several pieces of aluminum (approximately 1 cm × ½ cm each) from the aluminum dish used in **Activity 4**.
2. Record the color of the aluminum pieces and record in the Data Table.
3. Measure the temperature of the CuSO₄/salt solution prepared in **Activity 11** and record it in the Data Table. Rinse thermometer as described above.
4. Record the initial color of the of the CuSO₄/salt solution and record it in the Data Table.
5. Place the aluminum metal pieces in the CuSO₄/salt solution.
6. Measure and record the temperature of the product.
7. Record any observations.
8. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
9. Pour all solutions into the 250-mL beaker. Discard any solids in the trash. Rinse the test tubes and thermometer with water and dry.

Activity 12

1. Place one test tube in test tube rack. Add 5 mL of copper(II) sulfate solution (CuSO_4) to test tube.
2. Measure the temperature of the CuSO_4 and record it on the Data Table.
3. Using a small piece of sand paper or emery board, lightly sand the exterior of the iron (Fe) nail.
4. Record the color of the CuSO_4 solution and the nail.
5. Place the nail in the CuSO_4 . Allow it to remain there for 1 minute.
6. Using forceps, remove the nail from the solution.
7. Measure and record the temperature of the solution.
8. Examine the nail and the solution. Record the final color of the CuSO_4 solution and the nail and any additional observations.
9. Indicate in the Data Table whether a chemical or physical change has occurred and explain why.
10. Pour all solutions into the 250-mL beaker. Discard any solids in the trash. Rinse the test tubes, thermometer, and graduated cylinder with water and dry.

Disposal and Cleanup

1. Dispose of all liquid waste in sink, flushing with copious amounts of tap water. Return all unused chemicals to the chemical supply kit.
2. Clean and dry all equipment and return to the equipment kit.
3. Clean and sanitize work space.

Data Table: Activities 1 – 5

Activity	Color of Initial Items	Color of Final Items	Initial Temp. (°C)	Final Temp. (°C)	Observations	Type of Change	Explanation
1							
2							
3							
4A							
4B							
5							

Data Table: Activities 6 – 10

Activity	Color of Initial Items	Color of Final Items	Initial Temp. (°C)	Final Temp. (°C)	Observations	Type of Change	Explanation
6A							
6B							
7							
8							
9							
10							

Data Table: Activities 11 – 12

Activity	Color of Initial Items	Color of Final Items	Initial Temp. (°C)	Final Temp. (°C)	Observations	Type of Change	Explanation
11							
12							