Lab Handout

Lab 2. Chemical and Physical Changes

What Set of Rules Should We Use to Distinguish Between Chemical and Physical Changes in Matter?

Introduction

Matter has mass and occupies space. Although these two basic characteristics of matter are shared among all the different kinds of matter in the universe, most kinds have even more characteristics that are special to only certain groups or types. Scientists work to understand the special characteristics of the many kinds of matter so that they can also understand what happens when different kinds of matter interact with each other.

Every kind of matter, such as wood, steel, or water, has a unique set of physical and chemical properties. Physical properties of matter include qualities or attributes such as density, odor, color, melting point, boiling point, and magnetism. These properties are often useful for identifying different types of substances. Chemical properties of matter, in contrast, describe how matter interacts with other types of matter. For example, when a metal is added to an acid, it reacts with the acid to form a gas. A chemical property of metal, therefore, is reactivity with acids. All substances have a specific set of physical and chemical properties. Scientists can therefore use physical and chemical properties to identify an unknown substance.

The matter that is around us changes all of the time. Natural events, for example, can change matter in a variety of ways, such as when a forest fire turns wood into ash or when wind breaks down a rock to produce small particles of dust. Another example of a change in matter is when a solid turns into a liquid, which is what happens when a crayon melts (see Figure L2.1). Scientists classify changes in matter as either a chemical change or a physical change. A chemical change is defined as a change in the composition and properties of a substance. Chemical changes involve the rearrangement of molecules or atoms and result in the production of one or more new substances. A physical change is defined as a change in the state or energy of matter. A physical change does not result in the production of a new substance, although the starting and ending materials may look very different from each other.

FIGURE L2.1

A crayon melting

Matter will look very different after it goes through a chemical change because a chemical change transforms a substance into one or more new substances. The appearance of matter, however, can also change when it goes through a physical change. In addition, we cannot see what happens at the level of atoms as matter goes through a change. It is

therefore often difficult to tell the difference between a chemical change and a physical change by just observing the appearance of a substance. Scientists, as a result, have developed several rules to help them classify changes in matter. In this investigation, you will have an opportunity to develop a set of rules that you can use to determine if a change in matter should be classified as a chemical change or a physical change.

Your Task

Use what you know about physical and chemical properties of matter, stability and change, and how to design and carry out an investigation to develop a set of rules you can use to distinguish between a chemical change and a physical change in matter.

The guiding question of this investigation is, **What set of rules should we use to distinguish between chemical and physical changes in matter?**

Materials

You may use any of the following materials during your investigation:

Consumables

- Water
- Baking soda
- Calcium chloride
- Sugar
- Vinegar
- Antacid tablets
- Steel wool
- Paper
- Candle

Equipment

- Well plate
- Beakers (various sizes)
- Electronic or triple beam balance
- Graduated cylinders (various sizes)
- Pipettes
- Spatulas
- Matches
- Mortar and pestle
- pH paper
- Conductivity probe
- Safety glasses or goggles
- Chemical-resistant apron
- Nonlatex gloves

Safety Precautions

Follow all normal lab safety rules. Your teacher will provide important information about working with the chemicals associated with this investigation. In addition, take the following safety precautions:

1. Follow safety precautions noted on safety data sheets for hazardous chemicals.
2. Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant nonlatex gloves and aprons during lab setup, hands-on activity, and takedown.
3. Never put consumables in your mouth.

4. Use caution when working with hot plates or candles. They can burn skin and cause fires.
5. Hot plates also need to be kept away from water and other liquids.
6. Use only GFCI-protected electrical receptacles for hot plates.
7. Clean up any spilled liquid immediately to avoid a slip or fall hazard.
8. Use caution when working with hazardous chemicals in this lab that are corrosive and/or toxic.
9. Handle all glassware with care.
10. Use caution in handling steel wool, because it can cause metal slivers.
11. Never return the consumables to stock bottles.
12. Wash hands with soap and water after completing the lab activity.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

The first step in this investigation is to identify all the various physical properties of matter that are possible to observe or measure using the available materials. Once you know what physical properties you can observe or measure during this investigation, you can then start collecting data about what happens to the physical properties of matter when it goes through a physical or a chemical change. Be sure to observe or measure several different physical properties of the matter you are using before and after the change takes place. Listed below are some examples of actions to cause physical and chemical changes that you can use to document the physical properties of the matter before and after it goes through a change.

Actions to cause a physical change

- Grind an antacid tablet.
- Cut a piece of steel wool to its smallest size.
- Put 1 g of candle wax in a test tube and heat the test tube in a hot-water bath.
- Add 1 g of sugar to 5 ml water.

Actions to cause a chemical change

- Add 1 g of baking soda to 5 ml of vinegar.
- Add 1 g of steel wool to 5 ml of vinegar.
- Add 1 g of antacid tablet to 5 ml water.
- Add 1 g of sugar in a test tube and then heat it using a candle.

The second step in this investigation is to develop a set of rules that you can use to determine if a change in matter is a physical one or a chemical one. Once you have a set of rules, you will need to test them to determine if they allow you to accurately identify a physical or chemical change in matter. It is important for you to test your rules because the results of your test will allow you to demonstrate that your rules are not only valid but also a useful way to identify a change in matter. Be sure to modify your rules as needed if they do not allow you to accurately classify a change in matter. To accomplish this final step of your investigation, you can test your rules using the following examples of actions to cause physical and chemical changes:

Actions to cause a physical change

- Add 1 ml of water to a balloon and tie the balloon so the water inside the balloon cannot escape. Then place the balloon in a microwave and heat the water (in the balloon) for 30 seconds.
- Mix 1 g of calcium chloride and 1 g of baking soda.
- Mix 1 g of crushed antacid and 1 g of sugar.

Actions to cause a chemical change

- Add 1 g of calcium chloride to 5 ml of water.
- Add 1 g of baking soda to 5 ml of water.
- Add 1 g of calcium chloride and 1 g of baking soda to 5 ml of water.

Remember, if you can use your rules to classify these changes in matter correctly, then you will be able to generate the evidence you need to convince others that the rules that you developed are valid and useful.

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

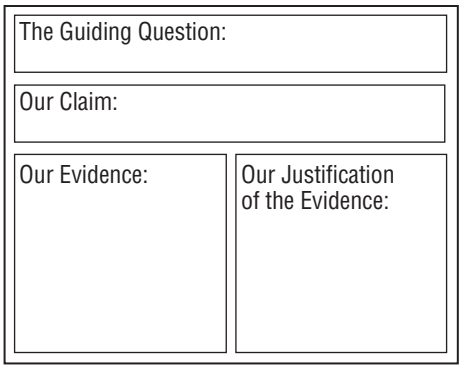
- the importance of identifying patterns,
- stability and change in nature,
- the difference between observations and inferences, and
- the role of imagination and creativity in science.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your argument needs to include a *claim*, *evidence* to support your claim, and a *justification* of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L2.2.

FIGURE L2.2

Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:

- How did you collect your data? Why did you use that method? Why did you collect those data?
- What did you do to make sure the data you collected are reliable? What did you do to decrease measurement error?
- How did your group analyze the data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most acceptable and valid answer to the research question!

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections. Each section should provide an answer to the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable and valid!