2 Investigating Elements

LABORATORY

1–2 CLASS SESSIONS

ACTIVITY OVERVIEW

NGSS CONNECTIONS

Students carry out an investigation of the physical and chemical properties of a set of elements. They analyze and interpret the data they collect on these elements and begin to explore how this data can help identify pure substances. Finally, students assess how their new data can be used as evidence to determine if aluminum is a good choice for making a drink container.

NGSS CORRELATIONS

Performance Expectations

Working toward MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

Working toward MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Disciplinary Core Ideas

MS-PS1.A Structure and Properties of Matter:

Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information: Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used and describe how they are supported or not supported by evidence.

Planning and Carrying Out Investigations: Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.

Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in findings.

Crosscutting Concepts

Structure and Function: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Connections to Engineering, Technology, and Applications of Science: Interdependence of Science, Engineering, and Technology: Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

Connections to Engineering, Technology, and Applications of Science: Influence of Science, Engineering, and Technology on Society and the Natural World: The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus, technology use varies from region to region and over time.

Common Core State Standards—ELA/Literacy

RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

INVESTIGATIVE PHENOMENA AND SENSEMAKING

Materials like plastics, metals, and glass are all useful, but they can also affect the environment.

Students investigate the physical properties of different elements. They engage in sensemaking as they relate what they learn to their debate in the "Exploring Materials" activity regarding the best material for a single-use drink container.

WHAT STUDENTS DO

Students investigate the physical properties of a set of elements. They investigate physical properties including appearance, malleability, density, and solubility in water at room temperature. They are introduced to the concept that each element is composed of a specific type of atom.

MATERIALS AND ADVANCE PREPARATION

- *For the teacher*
  - 1 Visual Aid 2.1, "Periodic Table of the Elements" (optional)

- *For each group of four students*
  - 1 set of 4 elements: aluminum, carbon, copper, and iron
  - 1 9-ounce plastic cup
  - 1 stir stick
  - * water
  - * paper towels

- *For each student*
  - 1 Student Sheet 2.1, "Physical Properties of Elements"
  - * 1 pair of chemical splash goggles

* *not included in kit*

The aluminum strips in this activity can be used again in the "Physical and Chemical Properties of Materials" activity. However, they should only be used once in that activity.

TEACHING SUMMARY

GET STARTED

1. The class discusses what elements are.

   Introduce the concept of elements.

DO THE ACTIVITY

2. Students explore select physical properties of eight elements.
   a. Identify element samples for students.
   b. Review the term *property* and how to test an element for properties.
   c. Have groups perform the tests and record their results.

BUILD UNDERSTANDING

3. Students analyze their experimental results.
   a. Have students discuss their experimental results.
   b. Students complete the Analysis items.

TEACHING STEPS

GET STARTED

1. The class discusses what elements are.

   Introduce the concept of *elements*.

   Have students read the introduction. Write the list of elements they will investigate in the activity on the board (aluminum, carbon, copper, germanium, iron, mercury, nitrogen, and sulfur). Ask students if they know of

any other elements, and add those to the list. If students name compounds, make a separate list to refer to in the "Physical and Chemical Properties of Materials" activity, when compounds are introduced. Do not explain what compounds are; simply tell students that the substance they named is not an element. You may wish to use Visual Aid 2.1, "Periodic Table of the Elements," to give students a brief introduction to the Periodic Table. It will not be covered extensively in this unit, but it may be helpful to point out that approximately 90 of the elements are the building blocks of nearly all materials on Earth, both natural and synthetic. Note that atoms are introduced here, but students will not explore them in detail until later activities.

DO THE ACTIVITY

2. Students explore select physical properties of eight elements.

   a. Identify element samples for students.

      Hand out a set of four element samples to each group and distribute Student Sheet 2.1, "Physical Properties of Elements." As you identify each element, have students find the corresponding element in their sets. Stress to students that because they and other classes will use these materials, they must not break any of them. The carbon breaks easily, so they should not test its malleability.

   b. Review the term *property* and how to test an element for properties.

Science and Engineering Practices

      Introduce the science and engineering practice of *planning and carrying out investigations*, and explain that students will be gathering data about the properties of various materials. Make sure that students understand the term property. If necessary, remind them that a property is a quality or trait that characterizes a material or an object. Scientists frequently distinguish between physical and chemical properties of substances. Physical properties can be determined without a chemical reaction. Chemical properties are determined only by adding another chemical to see if a reaction occurs. Students will examine only physical properties in this activity. They will explore chemical properties in the "Physical and Chemical Properties of Materials" activity.

      Tell students that in this activity, they will investigate five physical properties:

      - State: Is it a solid, liquid, or gas? (Distinguish this from the more common meaning of the word *state*. If students are familiar with the term *phase*, as in phases of matter, clarify that it has the same meaning as *state* in this context.)

- Color: What color do you observe?
- Malleability: Does it bend easily without breaking? (Caution students, again, not to bend the carbon—it will bend but will also break easily.)
- Solubility in water: Does it dissolve in water?
- Density: How much matter does it contain? (Does it sink or float in water?)

Reading Scientific Procedures

Review the testing procedures with the class, as explained in the "Testing Physical Properties" table. Some students may need support in reading and following procedures. One way to do this is to model strategies they might use if they struggle while reading a scientific procedure. You may wish to refer students to "Reading Scientific Procedures" in Appendix E in the Student Book, and explain how the strategies might help if students become stuck while performing the investigation. As they practice strategies, students learn to comprehend and follow written procedures independently.

c. Have groups perform the tests and record their results.

Remind students to also include the data from the additional four elements that are presented with photos and data in the Student Book.

BUILD UNDERSTANDING

3. Students analyze their experimental results.

a. Have students discuss their experimental results.

Have students discuss Analysis item 1 as a group prior to responding to it. This will allow students to synthesize their data and understand why they collected the data. Students should be able to explain the idea that each element has specific properties that can be used to identify it.

b. Students complete the Analysis items.

You may want to have students work together to answer some of the Analysis items. Analysis item 5 has students incorporate data from this activity with data from the previous activity to continue exploring the choice of aluminum as a material for making a drink container.

STRATEGIES FOR TEACHING DIVERSE LEARNERS

Below are suggestions for differentiating instruction and assessment in this activity for diverse learners in your classroom:

- Students with learning disabilities: Have student groups test fewer materials and share their results with one another. Demonstrate the tests as needed.

Vocabulary Log

- English learners: Demonstrate the tests as needed. Add the words *atom*, *element*, *matter*, and *physical property* to the word wall, and have students enter the words and their definitions in the glossary in their science notebooks or in their personal vocabulary logs. Have students work together to complete Student Sheet 2.1.

SAMPLE RESPONSES TO ANALYSIS

1. Why do you think it is important for scientists to observe multiple physical properties in order to identify an element? Use examples from the data you collected in this activity to support your ideas.

   If scientists only look at one or two physical properties, they might identify the element incorrectly. Looking at multiple properties means that they are more likely to be correct.

   For example, in this activity, we observed that aluminum is a solid, but so are many other elements. But aluminum also bends more easily than carbon and has a more shiny gray color than carbon or iron.

2. Copy the lists of words below:

element	gas	~~metal~~
iron	solid	property
carbon	liquid	malleable
~~water~~	~~metal~~	soluble
nitrogen	state	dense

   a. Look for a relationship between the words in each list. Cross out the word that does not belong.

   b. Circle the word or phrase that includes all the other words.

   c. Explain how the word or phrase you circled is related to the other words in the list.

   Each of the words I circled (element, state, and property) are categories that contain the other words in their list. For example, iron, carbon, and nitrogen are all elements, so I circled element.

3. Based on the eight elements you have observed so far, and assuming that the rest of the elements fit the same pattern, would you expect most elements to be solid, liquid, or gas at room temperature? Explain.

   Most of the elements we observed are solids, so based on that pattern I would expect most elements to be solids.

4. When added to water at room temperature, most gases form bubbles that float to the top of the water and release into the air. What does this tell you about the density of gases?

   The pattern that most gases form bubbles that float to the top of the water and go into the air tells me that most gases are less dense than water.

5. **Revisit the issue:** Describe what you have learned about the physical properties of aluminum in this activity and the "Exploring Materials" activity. What information, if any, from these activities would be helpful in deciding if aluminum would be a good choice for making a drink container?

   In this activity, we learned that aluminum is malleable but does not break easily, which would be good for a drink container because you could make it a certain shape and it would not break. However, it also might mean that the container would dent easily.

6. In this activity, you recorded the appearance of each element you observed. Think of and explain two examples from this activity in which appearance does not help identify an element.

   Aluminum and iron are both gray, so the appearance is not very helpful in identifying the material unless you are comparing it to something like sulfur, which is bright yellow.

EXTENSION

Have students use interactive Periodic Tables to explore additional elements. Students can visit the *SEPUP Third Edition Chemistry of Materials* page of the SEPUP website at **www.sepuplhs.org/middle/third-edition** and go to the Investigating Elements links.

REVISIT THE GUIDING QUESTION

How can scientists use physical properties to identify elements?

You may wish to have students share their responses to Analysis items 1 and 6. Be sure that students discuss when properties are and are not helpful in identifying

elements.

ACTIVITY RESOURCES

KEY VOCABULARY

atom

density

dissolve

element

malleability

matter

physical property

property

solubility

state

Name_____ Date_____

STUDENT SHEET 2.1

PHYSICAL PROPERTIES OF ELEMENTS

Element name and symbol	State (solid, liquid, or gas?)	Appearance	Malleability (flexible?)	Solubility (dissolves in water?)	Density (sinks or floats?)
Aluminum (Al)					
Carbon (C)					
Copper (Cu)					
Germanium (Ge)					
Iron (Fe)					
Mercury (Hg)					
Nitrogen (N)					
Sulfur (S)					

Name *Sample student response* Date

STUDENT SHEET 2.1

PHYSICAL PROPERTIES OF ELEMENTS

Element name and symbol	State (solid, liquid, or gas?)	Appearance	Malleability (flexible?)	Solubility (dissolves in water?)	Density (sinks or floats?)
Aluminum (Al)	*Solid*	*Gray*	*Yes*	*No*	*Sinks*
Carbon (C)	*Solid*	*Black*	*No*	*No*	*Sinks*
Copper (Cu)	*Solid*	*Reddish-orangish-brown*	*Yes*	*No*	*Sinks*
Germanium (Ge)	*Solid*	*Silvery-white*	*No*	*No*	*Sinks*
Iron (Fe)	*Solid*	*Gray*	*Yes*	*No*	*Sinks*
Mercury (Hg)	*Liquid*	*Gray, shiny*	*Yes*	*No*	*Sinks*
Nitrogen (N)	*Gas*	*Colorless*	*Does not apply*	*No*	*Floats*
Sulfur (S)	*Solid*	*Yellow*	*No*	*No*	*Floats*

Periodic Table of the Elements