SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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Student Materials

Learning Sequence Item:

961

Patterns Using Metals, Nonmetals and Metalloids

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Contents

Lab Activities

1. A Physical Challenge
2. Elemental Classification
3. Name that Metal
4. Sulfur: A Typical Nonmetal?
5. Elements in the Human Body
6. Metalloids and Their Many Uses
7. Patterns of Classification

Readings

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This micro-unit was adapted by Glenda Burris and Sandra McCann (Northside H.S., Pinetown, N.C.), Ghassem Mozaffari (Jack Yates H.S., Houston, Texas), and Dorothy Gabel (Indiana Univ., Bloomington, Ind.)

Student Sheet

Science as Inquiry

A Physical Challenge

Can elements be classified by physical properties?

Overview:

How do we know something is a metal? This activity provides the physical tests to determine this answer.

Procedure:

Obtain element samples labeled A through G. Make observations of these properties: color, luster, malleability, conductivity and density. Make a data table to record your observations, first recording the color and luster of each sample. Next, tap each sample with a hammer to determine if the element is malleable (flattens out) or brittle (shatters). Gently rub each sample with sandpaper. Construct a conductivity apparatus using the materials provided and test each sample for conductivity. Observe and record whether the results indicate that the material is a conductor or nonconductor. Obtain the density of each sample. To get the volume, drop the sample into a graduated cylinder containing water and note the volume difference. Use your observations and the "Table of Densities" supplied by your teacher to determine which samples are metals, which are nonmetals, and the identity of each metal.

Questions:

1. Which lettered samples of elements were metals? Which were nonmetals?

2. What are some common characteristics of metals?

3. What are some common characteristics of nonmetals?

4. Could any of the elements you tested be called metalloids? Which ones? Why did you classify them in this manner?

5. Is there any generalization you can make about the densities of metals vs. nonmetals?

6. Identify the name of each element you tested, e.g., A=iron, B=zinc, etc.

7. Are the other properties you did not report on or test in this activity that might distinguish a metal from a nonmetal?

8. Are there any properties that you observed that might give you a clue why nonmetals are poor conductors of electricity?

Student Sheet

Science as Inquiry

Elemental Classification

Can elements be classified by chemical properties?

Overview:

Some compounds have very similar names. If the name changes slightly, does this small change affect its characteristics?

Procedure:

Obtain samples of the elements from your teacher. Sand paper the metals to remove tarnish. Obtain and label one test tube for each element you are testing. Caution: You will be using solutions that may be dangerous to skin and clothing—use safe laboratory techniques.

Add 5 mL of water to a test tube using a graduated cylinder. Mark the height of the water with a marker. Pour the water out. Mark the other test tubes at the same height. Place one of the samples in each of the test tubes.

Now add hydrochloric acid (HCl) to each test tube up to the 5-mL mark. Carefully observe and record your observations. After all observations are completed, discard the contents of each test tube. Be sure to use proper disposal techniques.

Once again mark off the 8 test tubes at the same 5-mL mark using the procedures stated above. Add one sample to each of the test tubes and then add copper (II) chloride ($CuCl_2$) to the 5 mL mark. Observe for five minutes. Record you observations.

Questions:

1. How can the chemical properties of an element be determined?

2. How do chemical properties differ from physical properties?

3. Did all the metals react the same way in the hydrochloric acid? Did all the nonmetals react in the same way? Describe the differences.

4. In general describe the reaction of the metals versus nonmetals with hydrochloric acid.

5. Did all the metals react the same way in the copper (II) chloride? Did all the nonmetals react in the same way? Describe the differences.

6. In general describe the reaction of metals versus nonmetals with copper (II) chloride.

7. From the information obtained in Activities 1 and 2, give an operational definition of an acid and a base.

Student Sheet

Science as Inquiry

Name that Metal

How can a metal be identified?

Overview:

What if you have an unknown sample and want to identify it? You can determine certain characteristics, but will these help in the identification process?

Procedure:

Obtain a metal sample for each person in your group. Find the density of each sample. Select a method that will produce good results. Record your method, observations and calculations in a systematic way. Identify the name of each metal using the density table supplied by your teacher. Then find other persons in the class that have sample of the same metal, and compare the dimensions and features of all the samples. with identical densities.

Questions:

1. Make a table listing the names of students with samples of the same densities as those in your group. Describe the dimensions and shapes of the samples.

2. What conclusion can you reach about the density of samples of a substance of different sizes and shapes?

3. What further observations experiments might you perform to confirm the identity of the metals?

4. Why might an engineer need to know the density of various substances?

5. Imagine that you have blocks of each of the metals in this activity that have the dimensions of 5 cm ∞ 10 cm ∞ 3 cm. What is the mass of each metal block? (Density g/m^3.)

Science as Inquiry

Sulfur: A Typical Nonmetal?

Is sulfur a typical nonmetallic element?

Overview:

Are nonmetals just the opposite of metals? Find out by doing this activity.

Procedure:

Wear safety goggles for this activity. You will be taking careful observations when you melt and eventually boil sulfur so that you can compare it to a familiar substance—like water—when it melts and boils. You will begin by filling a test tube about 1/2 full of roll sulfur and heating it very slowly by moving it back and forth through the flame at as low a temperature as possible. Note the color of the liquid when it has melted, and immediately remove the test tube from the flame. Turn off the burner and pour the liquid into a dry filter paper in a funnel. As soon as a crust has formed, puncture the crust with a pencil or other sharp object and open the filter paper. Use a magnifying lens to observe the crystals.

By now you have observed three forms of sulfur, two solids, and one liquid. The solid you began with is called rhombic sulfur, the liquid is called lambda, and the resulting solid is called monoclinic sulfur. Make a new data table to include the name, appearance, phase, how it was formed, formula, and structure. Complete as much of the table as possible from your observations thus far.

Now, add additional pieces of sulfur to the same test tube until it is half filled again. Heat the test tube gently at first until the sulfur melts. Continue to heat it until it turns thick and changes color. Note the color of any vapor that escapes into the air. CAUTION: This sulfur vapor may catch on fire. Do not panic. SMOTHER IT WITH A TOWEL. Immediately pour the thick sulfur into a beaker half-filled with cold water. Remove from the water and observe. Store the sulfur as directed by your teacher and observe it again—at least 24 hours later.

You have now observed three additional forms of sulfur: one liquid, one solid-liquid mixture, and one vapor. The liquid is called Mu, the solid-liquid mixture is called amorphous, and the vapor is simply called sulfur vapor. Now add you observations and this additional information to your data table.

You can see from this activity that sulfur exists in various forms. Chemists have found that solid sulfur has the formula S_8 and exist as puckered rings. When it is heated strongly the rings break open and turn into chains. These can become entangled. If enough heat is added it boils as enters the air as S_{2-} molecules. Use this information to try to identify the formula and the structure of the allotropes of sulfur.

Questions:

1. In what ways does the behavior of sulfur resemble the behavior of ice when it melts and boils? In what ways is it different?

2. Does water have allotropes? Explain.

3. There is no such thing as “soft ice,” it is either hard or liquid. Is there such a thing as soft sulfur?

4. Margarine becomes soft as it melts. Compare its melting to that of sulfur.

5. Do you think that sulfur is a typical nonmetal? Give pros and cons.

Science and Technology

Elements in the Human Body

Which elements are the most common and important in the human body?

Overview:

Does the human body need any of these metals and nonmetals? Find out through this research activity.

Procedure:

Homework. Use media resources such a magazines, scientific journals, electronic encyclopedias, the Internet, and any other resources available through the media/computer center to research the elements found in the human body. Make a table, chart, or graph showing how these elements are used in the body. Find out the health conditions that result from the lack of certain elements or excesses in the human diet. Then create diagrams, graphs and pictures to display the percentage of each element found in the body.

Questions:

1. How would you accurately describe the composition of the human body using only five words?

2. How would you accurately describe the composition of the human body using only one word?

3. One myth concerning the effects of body composition is that our bodies are affected by the tidal effects of the moon. How could we test this idea?

Science and Technology

Metalloids and Their Many Uses

What are the metalloids and how are they used?

Overview:

This library project will reveal the uses of metalloids.

Procedure:

Homework. Engage in research to determine the properties and uses of metalloids. Compare the properties of metals, nonmetals and metalloids. This information should be contained in a short paragraph. Using one sheet of paper for each metalloid, list the name of the element, its symbol as well as general properties and uses of the element. Also draw pictures or diagrams which represent special properties—or find pictures and diagrams which you copy and include on the page. Finally add a page of reference information. Your report should be neatly typed and placed in a booklet. Be creative.

Questions:

1. What are the general characteristics of metalloids?

2. How has the use of metalloids affected the electronics industry?

3. Where on earth is silicon usually found?

Teacher Sheet

Science as Inquiry

Patterns of Classification

How did scientists construct the Periodic Table?

Overview:

Use these element cards to reveal their patterns.

Procedure:

You will be provided with a set of classification cards. These cards contain values for different properties of a particular element. The value of the property always appears at the same place for each element in your set. Some cards representing elements may be missing. Sometimes values of a given property of a particular element are missing. Look at the cards and note patterns for particular properties. Using these patterns arrange the cards into a larger pattern of horizontal and vertical rows—creating a periodic table. Keep in mind that even though your finished layout may not be like those of other groups of students in your class, any pattern is acceptable if you can state the logical reasoning that was used to form it. Make a quick sketch of your pattern for later reference.

Questions:

1. State your reasoning for developing your pattern of cards. Be sure to mention the properties used for organizing both the horizontal and the vertical rows.

2. Your teacher will give you one more card. Decide where this card will fit within your pattern. State your reason for placing the card in the position you selected.

3. What additional difficulties do you think that the chemists of the mid-19th century had in devising periodic tables?