Inquiry Investigation 4-A

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Testing Physical Properties of Substances

Learning how to perform scientific tests is important when studying chemistry. In this investigation, you will perform scientific tests to determine the physical properties of some common elements and compounds.

Question

What are the physical properties of some common elements and compounds?

Prediction

Before beginning the Procedure, examine the substances carefully. Based on your observations, group substances that seem to have similar physical properties.

Safety Precautions

- Put on safety goggles and a lab apron.
- Wipe up any spilled materials immediately.

Materials

- aluminum pieces
- carbon (graphite)
- copper(II) sulfate
- magnesium sulfate
- water
- conductivity tester
- scoopula
- five 25 mL test tubes
- test-tube rack
- 50 mL water
- 10 mL graduated cylinder

Procedure

1. Make a table like the one below to record your observations. Give your table a title.

Element/ Compound	Aluminum	Carbon (graphite)	Copper(II) Sulfate	Magnesium Sulfate	Water
State					
Colour					
Lustre					
Odour					
Conductivity					
Melt Test					
Solubility in Water					

Part 1: Visible Properties

2. Indicate the state of each substance in your table.
3. Describe the colour of each substance in your table.
4. Classify the lustre (appearance of the surface) of each substance, according to how dull or shiny it is. Record your observations in your table.
5. To smell each substance, first take a deep breath and hold it. Then, gently waft the air above the sample toward you. Which substances, if any, have an odour? Record your observations in your table.

Part 2: Electrical Conductivity

6. Your teacher will give you a small battery-powered conductivity tester. Touch the two metal probes of the tester to the substance you want to test. The two metal probes should touch the sample. **Make sure that the substance is clean and dry**. If the substance is an electrical conductor, the conductivity tester will light up. Test each substance in turn. Record your observations as yes or no in your table.

Part 3: Melt Test (Teacher Demonstration)

7. Watch while your teacher puts a small amount of each unknown substance on a small aluminum pan and places all the samples on the hot plate.

8. Observe the behaviour of each substance. Record your observations. Indicate whether or not each substance melted.

Part 4: Solubility in Water

9. Put 10 mL of water into each of five 25 mL test tubes. Add a small amount of each solid substance to each test tube. Agitate the test tubes. Observe after 30 s, and record your observations. If some solid is still present, observe after another 30 s.

10. Dispose of all the substances as directed by your teacher.

Analyze and Interpret

1. Which substances, if any, appear to have a similar set of properties?

2. Which substances, if any, have a unique set of properties, not shared by any of the other substances?

3. Which sets of properties often appear together?

Conclude and Communicate

4. How did your results compare with your initial prediction about substances that have similar physical properties? Explain why your prediction and your results were similar or different.

Extend Your Inquiry and Research Skills

5. **Inquiry** Design a test to help you further distinguish between the different elements and compounds used in this investigation. Use a physical property that was not used in this investigation.

6. **Research** Assess the usefulness and the hazards associated with one of the substances used in this investigation by conducting research.

Gently shake each test tube to test the solubility of the materials.

Inquiry Investigation 4-B

Skill Check

Initiating and Planning

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Chemical Properties of Common Gases

Why is it dangerous to fill balloons and blimps with hydrogen to make them float? In this investigation, you will perform simple tests to better understand the chemical properties of a few common gases.

Question

What tests can you use to identify gases, based on their chemical properties?

Safety Precautions

- Put on safety goggles and a lab apron.
- Be very cautious when testing for gases.
- Be careful when handling the burning splints. Do not wave them in the air or toward other students in the lab.
- Make sure the splints are properly extinguished immediately after being used.
- If you have long hair, make sure that it is tied back.

Materials

- 10 mL 1.0 mol/L hydrochloric acid
- 4 test tubes
- test-tube rack
- mossy zinc
- rubber stopper
- test-tube holder
- 2 wooden splints
- 5 mL 3% hydrogen peroxide
- yeast
- marble or limestone
- 5 mL limewater
- balloon
- cobalt chloride paper

Procedure

1. Work with a partner to perform each of the following tests. Record your observations as you complete each step.
2. Be sure to clean up your work station as you complete each part. Place each substance in the appropriate waste container, as directed by your teacher.

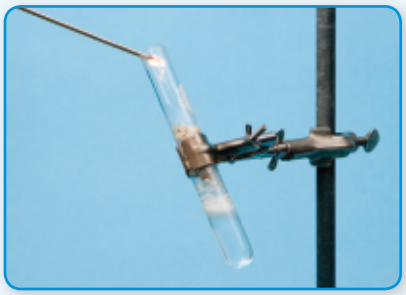
Part 1: Test for Hydrogen Gas

3. Obtain 5 mL of hydrochloric acid in a test tube, a piece of mossy zinc, and a wooden splint. Have the wooden splint nearby.
4. One partner holds the test tube at a 45° angle, using a test-tube holder, and then slides the zinc down the side of the test tube into the acid. A reaction should begin. Trap some of the gas in the tube using a rubber stopper.
5. **Test for Hydrogen:** Your teacher will show you how to light the splint. The other partner brings the flaming splint close to the mouth of the test tube. Hydrogen gas will ignite and burn rapidly down the test tube with a "whoop" sound.
6. Extinguish the wooden splint.

If hydrogen is present, it will ignite rapidly.

Part 2: Test for Oxygen Gas

7. Obtain 5 mL of 3% hydrogen peroxide in a test tube, some yeast, and a wooden splint.
8. One partner adds the yeast to the hydrogen peroxide. A reaction should begin. Trap some of the gas in the tube using a rubber stopper.
9. **Test for Oxygen:** Your teacher will show you how to light the splint and produce a glowing ember. The other partner brings the ember to the mouth of the test tube and inserts the glowing ember into the test tube. If oxygen is present, the glowing ember will burst into a bright flame.
10. Extinguish the wooden splint.



If oxygen is present, a flame will form from the ember.

Part 3: Test for Carbon Dioxide Gas

11. Obtain 5 mL of hydrochloric acid in a test tube, a small piece of marble or limestone, and a second test tube containing 5 mL of limewater.
12. One partner holds the test tube with the acid at a 45° angle, and slides the piece of marble down the side of the tube into the acid. The other partner places the balloon over the top of the test tube. The balloon will inflate with any gas that is produced.

Slide the marble down the side of the test tube.

13. **Test for Carbon Dioxide:** Keep the new gas inside the balloon by twisting the balloon closed. While the balloon is still twisted closed, attach it to the mouth of the test tube containing limewater. Once attached, invert the balloon-covered test tube so the limewater will mix with the gas in the balloon. Then, return the test tube to an upright position. If carbon dioxide is present, the limewater will turn white and milky.

Part 4: Test for Water Vapour

14. Your teacher will give you a fresh piece of dry blue cobalt chloride paper.
15. **Test for Water Vapour:** Hold the cobalt chloride paper close to your mouth. Breathe on it, like you would breathe on a pair of sunglasses before wiping them. Cobalt chloride paper turns from blue to pink in the presence of water.

Analyze and Interpret

1. Could you have used physical properties to identify the gases that you studied in this investigation? Explain.
2. Which chemical properties did you use to identify the different gases?

Conclude and Communicate

3. What advice would you give a person who handles hydrogen and oxygen gas in their workplace?

Extend Your Inquiry and Research Skills

4. **Inquiry** Based on your observations of the gas tests done in this investigation, identify two scientific questions that can be tested through an experiment.
5. **Research** Choose one of the gases tested in this investigation. Identify the chemical and physical properties that make it both useful and hazardous in the workplace.

Plan Your Own Investigation 4-C

Skill Check

- ✓ Initiating and Planning
- ✓ Performing and Recording
- ✓ Analyzing and Interpreting
- ✓ Communicating

Properties of Common Substances

Substances that you see almost every day and use on a regular basis have characteristic properties. Often, these properties are linked to how the substances are used. In this investigation, you will plan a series of tests to identify important properties of some common substances.

Question

What are the physical and chemical properties of some common substances, and which properties can be used to tell each substance apart?

Safety Precautions

- Put on safety goggles and a lab apron.
- Treat all substances as if they are chemicals in a lab. Do not taste them.
- If checking for odour, take a deep breath and keep it while wafting the air above the sample toward you. Do not inhale directly from the sample.
- Clean up all spills immediately, and inform your teacher.

Suggested Materials

- table sugar (sucrose)
- baking soda (sodium bicarbonate)
- aluminum strips
- tin strips
- cooking oil
- vinegar (5% acetic acid in water)
- test tubes
- test-tube rack
- scoopula
- other equipment, as needed, to perform tests

Science Skills

Go to **Science Skills Toolkit 7** for information about creating data tables.

Plan and Conduct

1. Your teacher will give you six substances to investigate. Plan a procedure to identify four physical properties and two chemical properties of each substance. Choose properties that are listed in the table below. If you cannot remember what a property is or how to determine it, go back to the relevant information in the chapter.

Common Properties

Physical Properties		Chemical Properties
colour	viscosity	reactivity with water
odour	melting point	reactivity with acid
state	boiling point	reactivity with oxygen
texture	solubility in water	reactivity with another pure substance
lustre	conductivity	
malleability	density	

2. Prepare a table to record the results of your tests. Include a title for your table. Make sure that you include enough headings in your table to keep all your observations organized. If you wish, you can include the list of equipment you use in your table.
3. Have your teacher review your procedure, your observations table, and your list of equipment. You must not begin your tests until your teacher has approved your procedure.
4. Perform your tests for the physical and chemical properties of the different substances. Make sure that you complete your tests exactly as you planned them. Do not add additional steps without getting your teacher's approval.
5. Make complete notes for each test. For some tests, you may need to include descriptions (such as colour), or a yes/no answer, or an indication of a rating (such as the hardness of a substance relative to another substance).

6. Share your group's results with your teacher, who will record them in a chart on the board. Add any information that you have not already recorded in your own table.

Analyze and Interpret

1. Examine your observations table. Look for patterns you can use to group the substances, according to common physical and/or chemical properties. What groupings of substances can you make? Explain what these groupings are based on.
2. Analyze your observations to determine if there are certain properties that seem to distinguish one substance from the others. For some substances, it may be one particular property. For other substances, it may be a combination of properties.

Conclude and Communicate

3. Evaluate your tests to determine whether they were useful for distinguishing all the substances from each other, according to their properties. What improvements could you make?

Extend Your Inquiry and Research Skills

4. **Inquiry** Identify each substance that you studied as either an element, a compound, or a mixture. Did each type of matter share particular properties? If so, which properties?
5. **Research** Think about how each substance you studied is used. If necessary, use the Internet or a dictionary to help you. How do you think the physical and/or chemical properties of each substance are related to its function?

Real World Investigation 4-D

Skill Check

Initiating and Planning

Performing and Recording

✓ **Analyzing and Interpreting**

✓ **Communicating**

Materials

- graph paper
- ruler

CFC Production and Canada's Ozone Layer

You have been asked to write a blog post about the effects of chlorofluorocarbons, or CFCs, on Canada's ozone layer. CFCs are compounds once used as coolants in refrigerators and as propellants in aerosols. In the 1970s, however, scientists discovered a "hole" in the ozone layer of Earth's stratosphere. CFCs were identified as the main cause of ozone depletion. International agreements have now almost eliminated CFC production. To help write your post, you find a table of data for a main type of CFC, trichlorofluoromethane (CCl_3F).

Effect of CCl_3F on Canada's Ozone Layer

Year	CCl_3F Production (1000 tonnes)	CCl_3F in the Stratosphere (parts per trillion)	Ozone Levels (Dobson units*)
1945	0.4	0	–
1955	26.3	4	366
1965	123	28	363
1975	314	121	364
1985	326	217	352
1995	33	267	340
2005	2	251	332

*A measurement that ozone researchers use to indicate how much ozone is present.

Question

How has the production of CFCs affected Canada's ozone layer?

Math Skills

Go to **Math Skills Toolkit 3** for information about constructing graphs.

Organize the Data

1. Draw a line graph for each of the three data sets. Decide on a scale and how to label the *x*-axis and *y*-axis for each graph.

Analyze and Interpret

1. CCl_3F was first produced around 1930. How many years did it take for CCl_3F to enter the stratosphere?
2. In what year did the ozone layer above Canada begin to decline?
3. Once the production of CCl_3F was drastically reduced, how many years did it take for CCl_3F levels to decrease in the stratosphere?

Conclude and Communicate

4. Write a one-page blog entry to explain how the production of CFCs affected, and continues to affect, Canada's ozone layer.

Extend Your Inquiry and Research Skills

5. **Research** Find out how a reduced ozone layer has affected Earth.