Plan Your Own Investigation 5-A

Skill Check

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

Safety Precautions

- Wear safety goggles, gloves, and a lab apron.
- Sulfuric acid can injure eyes and sensitive skin. Avoid contact.
- Do not touch materials with bare fingers. Use tongs or forceps.
- Clean up all spills immediately.

Suggested Materials

- MSDS for each material
- ammonium carbonate solution
- copper(II) carbonate solution
- magnesium
- sulfuric acid, dilute
- calcium hydroxide (saturated solution)
- universal indicator solution
- test tubes
- test-tube rack
- tongs
- scoop
- any other equipment suggested by your teacher

Science Skills

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

Evidence of Chemical Change

To know when a chemical reaction occurs, you need to know what clues to look for. There are a number of observations you can make that provide evidence of a chemical change.

Question

What types of evidence indicate that a chemical change is occurring?

Plan and Conduct

1. Plan a procedure that permits you to observe as many combinations among the five provided substances as possible. Design a table to record the results of all of your tests.
2. Review the MSDS for each material you intend to use. Write a plan for your investigation that includes the equipment you will use, the procedures (including safety precautions) you will follow, and the table in which you will record your observations. You must obtain your teacher's permission to perform your planned investigation before you begin.
3. Perform your approved procedure. Do not add additional steps without first informing your teacher and receiving the necessary permission. Be sure to make careful and complete records of your observations in your table.
4. Clean up your work area, and put all equipment away.

Analyze and Interpret

1. Examine your data, and list all evidence of a chemical change that you observed. Include any chemical tests that you applied.

Conclude and Communicate

2. Organize and communicate the results of all of your tests. You may use tables, diagrams, paragraphs, or other representations. Check your plan with your teacher before proceeding.
3. Analyze your observations, and infer what new substance or substances you think were formed in each reaction. Give reasons for your answers. Write a word equation for each reaction that you observed.

Extend Your Inquiry and Research Skills

4. **Inquiry** Propose two additional tests that would provide more evidence to support your identification of the new substances formed in this investigation.

Inquiry Investigation 5-B

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Synthesis and Decomposition Reactions

Decomposition reactions and synthesis reactions are two types of chemical reactions that change one kind of matter into another kind of matter. In this investigation, you will observe both of these types of reactions. You will initially perform a decomposition reaction of hydrogen peroxide. The second reaction will be a synthesis reaction between iron and the oxygen that is generated in the first reaction.

Safety Precautions

- Wear safety goggles and a lab apron.
- Burning iron becomes very hot. Be sure to wear thermal gloves.

Materials

- iron (steel wool, about 3 cm × 3 cm)
- 250 mL beaker
- 3% hydrogen peroxide solution
- yeast
- wire gauze pad
- tongs
- striker

Question

What is occurring to the elements and compounds involved in the synthesis and decomposition reactions that are carried out in this investigation?

Procedure

Decomposition Reaction

1. Add 60 mL of hydrogen peroxide to the beaker. Drop a pinch of yeast into the hydrogen peroxide, and cover the beaker with the wire gauze pad. Allow the reaction to proceed until it has slowed considerably, about 3 min.

Cover the beaker with a wire gauze pad immediately after adding yeast to the hydrogen peroxide.

Science Skills

Go to **Science Skills Toolkit 2** for information about generating questions to test experimentally.

Synthesis Reaction

2. Working with a partner, obtain a small piece of steel wool. Fluff it up, so that you can see through the little fibres.

3. With your partner, carry out the following steps:
   - One partner grips the steel wool firmly in the tongs, while the other partner operates the striker to produce sparks that fall into the steel wool.
   - As soon as a spark begins to spread through the steel wool, slide the wire gauze pad to one side, just enough to insert the steel wool.
   - Plunge the burning steel wool into the oxygen gas, and slide the wire gauze pad back over to cover most of the beaker.
   - Hold the steel wool in the middle of the beaker, about 5 cm above the liquid.

Allow sparks to spread through the steel wool before placing it in the beaker.

4. Allow everything to cool. Clean up the glassware and your work area. Dispose of all materials as directed by your teacher.

Analyze and Interpret

1. The yeast acted as a catalyst in the decomposition reaction. What is a catalyst? Why was it used in this investigation?

2. The steel wool in this investigation was a source of iron. Write the chemical formulas for the reactants in the synthesis reaction you performed.

3. The blue-black, crumbly material left after the iron burned is a new substance, Fe_3O_4. Draw a diagram to illustrate the arrangement of the atoms in Fe_3O_4. Explain your thinking in one or two sentences.

Conclude and Communicate

4. Write a paragraph that describes the reactants and products in the reaction of hydrogen peroxide. Use appropriate drawings and a balanced chemical equation in your paragraph.

5. Draw a diagram to show how the atoms of iron and oxygen could become Fe_3O_4. Write a balanced chemical equation to match your diagram.

Extend Your Inquiry and Research Skills

6. **Inquiry** Identify another scientific question that you could investigate based on what you performed in this investigation.

7. **Research** The compound Fe_3O_4 is an example of a class of compounds called iron oxides. Research other examples of iron oxide compounds, and discuss their use in cosmetics.

Inquiry Investigation 5-C

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Safety Precautions

- Wear safety goggles, gloves, and a lab apron.
- Avoid skin contact with copper(II) sulfate dust and solution.
- Keep your work area clean. Wipe up any spills and inform your teacher immediately.

Materials

- 3 test tubes
- 3 rubber stoppers
- 15 cm of magnesium ribbon
- copper(II) sulfate crystals, fine
- calcium chloride
- sodium carbonate
- 30 mL of warm water

Displacement Reactions

You have learned about two types of displacement reactions: single displacement and double displacement. In this investigation, you will observe the reactants and products of three chemical reactions to determine which type of reaction is happening.

Question

How can you determine the type of displacement reaction that is occurring?

Procedure

1. Label three test tubes A, B, and C. Measure out 15 cm of magnesium ribbon, and coil it around a pencil.
2. To test tube A, add enough fine copper(II) sulfate crystals to just fill the rounded end of the test tube. To test tube B, add a similar amount of calcium chloride, $CaCl_2$. To test tube C, add the same amount of sodium carbonate, Na_2CO_3. Add only enough to fill the round part of the test tube!

You only need to add enough of the copper(II) sulfate, shown here, and the other solids to fill the rounded bottom of each test tube.

3. Add 10 mL of warm water to each test tube. Place a rubber stopper onto each test tube. Agitate the test tubes safely to dissolve all the crystals.

To shake the test tube safely, hold it as shown. Gentle shaking is all that is needed.

4. Add the coiled magnesium to test tube A. Record all of the changes that you observe.
5. Pour about 5 mL of the clear liquid from test tube A into test tube B. Record your observations.
6. Pour about 5 mL of the clear liquid from test tube A into test tube C. Record your observations.
7. Clean up your work area. Return the clean glassware to its place. Dispose of all materials as directed by your teacher.

Analyze and Interpret

1. When ionic crystals dissolve in water, they dissociate into ions. Name the ions in each solution before they react. Draw a particle diagram of each ion, and label each diagram with its chemical formula.
2. In your notebook, make a table like the one below. Write the names of the reactants for each test tube in the appropriate column. Give your table a title.

Test Tube	Reactants	Products	Reaction Type
A			
B			
C			

3. Based on your observations and the diagrams you drew in question 1, predict the products for each reaction, and write the names in the appropriate column in the table. Give reasons for your answers.
4. Identify the type of reaction you observed in each test tube, and write your answers in your table.

Conclude and Communicate

5. Write a word equation for each reaction that you observed.
6. Write a balanced chemical equation for each change that you observed.
7. Describe the differences in the reactants and products that helped you determine whether a displacement reaction is a single displacement or a double displacement. What was the evidence that suggested that each of the reactions had taken place?

Extend Your Inquiry and Research Skills

8. **Inquiry** How could the ability to test the products made in a chemical reaction be useful for identifying the type of reaction that has occured?
9. **Research** Identify a single displacement or double displacement reaction that has practical applications in society. Describe what those applications are. Research a reaction that you have not already studied in this chapter.

Data Analysis Investigation 5-D

Skill Check

Initiating and Planning

Performing and Recording

✓ **Analyzing and Interpreting**

✓ **Communicating**

Can Metals Be "Active"?

Gold never rusts. Iron, on the other hand, can rust in a few minutes. Iron is more active than gold. But what about the other metals? Each experimental observation for a series of reactions provides evidence of the relative activity of two metals. Based on this evidence, you can arrange the metals in an activity series.

Question

How can evidence from experimental observations be used to arrange metals into a list from most active to least active?

Analyze and Interpret

1. Study the observations for each of the reactions in the table below. Make a list of your interpretations of the results for each reaction.
2. Create a new table, organizing your interpretations to make a clear and convincing pattern.

Conclude and Communicate

3. Arrange the metals in a list from most active to least active.
4. Write a short paragraph to explain why you decided on the order of your list.

Extend Your Inquiry and Research Skills

5. **Inquiry** Provide skeleton and balanced chemical equations for the reactions that appear to occur, based on the observations in the table below.

Zinc metal in an aqueous solution of copper(II) sulfate will undergo a reaction.

Experimental Observations

Reactants	Observations
$Zn(s) + CuSO_4(aq)$	• solid copper metal forms • decrease in blue colour of solution
$Zn(s) + Pb(NO_3)_2(aq)$	• solid lead metal forms
$Pb(s) + AgNO_3(aq)$	• solid silver metal forms
$Pb(s) + ZnCl(aq)$	• no change
$Cu(s) + AgNO_3(aq)$	• solid silver metal forms • solution turns blue
$Cu(s) + Pb(NO_3)_2(aq)$	• no change
$Ag(s) + CuSO_4(aq)$	• no change
$Ag(s) + ZnCl(aq)$	• no change