Investigation Activity

Science Inquiry Skills Focus

— Synthesis, Decomposition, and Single Replacement Reactions —

Purpose

To observe changes during synthesis, decomposition, and single replacement reactions, and to write chemical equations for these reactions

Safety Notes

- Put on approved safety eyewear before starting this investigation.
- Handle glassware with care.
- **Caution**: Acids and hydrogen peroxide are corrosive. Wash off any spills immediately with water. Wipe spills off the table with paper towels. These may be placed in the garbage.

Materials and Equipment

Station 1

- Bunsen burner
- tongs
- 10-mL graduated cylinder
- Erlenmeyer flask
- steel wool pieces
- 3% hydrogen peroxide solution (H_2O_2)
- manganese(IV) oxide powder (MnO_2)

Station 2

- test tube
- copper(II) chloride solution ($CuCl_2$)
- aluminum foil
- paper towel
- wooden splint
- Bunsen burner

Station 3

- sodium sulphate solution (Na_2SO_4)
- beaker
- universal indicator and colour code chart
- pencil lead electrodes, wires, and battery

Station 4

- microscope or magnifying glass
- magnesium metal
- microscope slide
- silver nitrate solution ($AgNO_3$)

Procedure

Work at stations. Do stations 1 to 4 in any order. Do as many stations as time allows, but you may not have time to get to them all. It is better to do each one carefully than to rush through them all.

Station 1: Synthesis Reaction: Oxygen + Iron $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

1. Light a Bunsen burner. Use tongs to pick up a fresh piece of steel wool and hold the steel wool in the flame. Note what happens as the iron in the steel wool burns in the air.
2. Measure about 10 mL of 3% hydrogen peroxide solution (H_2O_2) and pour it into an Erlenmeyer flask. Place about 1 g of manganese(IV) oxide powder (MnO_2) into the hydrogen peroxide solution. Note bubbles forming. This is pure oxygen gas (O_2).
3. Use tongs to pick up another fresh piece of steel wool. Light the steel wool and quickly plunge it into the Erlenmeyer flask, keeping it above the solution. Note how it burns in pure oxygen. The product of this reaction is iron(III) oxide.
4. Follow your teacher's instructions for disposing of the materials you have used at this station. Wash your hands thoroughly.

$2Al + 3CuCl_2 \rightarrow 3Cu + 2AlCl_3$

Station 2: Single Replacement Reaction: Aluminum + Copper(II) Chloride

5. Fill a test tube three-quarters full with copper(II) chloride solution ($CuCl_2$). Note the blue colour of the solution.
6. Roll a small piece of aluminum foil into a tube, and place it in the copper(II) chloride solution. Decant or pour out the liquid into a waste container. Dump the brown solid onto a piece of paper towel. Use a wooden splint to examine the brown product. It is metallic copper.
7. Demonstrate that the brown solid is copper by placing a small amount of it onto the wooden splint, and then placing the end of the splint into the flame of a Bunsen burner. If it is copper, it will cause the flame to turn green. Observe what happens.
8. The products of this reaction are copper and aluminum chloride.
9. Follow your teacher's instructions for disposing of the materials you have used at this station.

Station 3: Decomposition Reaction: Water $2H_2O \rightarrow 2H_2 + O_2$

10. Even though several chemicals are present in this reaction, running electricity through the solution causes only the water to decompose.
11. Place about 20 mL of sodium sulphate solution into a beaker.
12. Add 5 drops of universal indicator to the sodium sulphate solution.
13. Connect the pencil lead electrodes to the battery and place the ends of the electrodes into the solution but far apart from each other. Wait a few minutes and observe the solution. Note any colour changes or formation of bubbles.
14. Use the colour code chart for the universal indicator to estimate the pH of the solution near each electrode. If the pH is above 7, the solution is basic. If the pH is below 7, the solution is acidic. Record whether the solution near each electrode is acidic, basic, or neutral.
15. The products of this reaction are hydrogen (H_2) and oxygen (O_2). Other chemical changes have also occurred that caused the pH to change near the electrodes. These changes do not appear in the equation showing the decomposition of water.
16. Follow your teacher's instructions for disposing of the materials you have used at this station.

Station 4: Single Replacement Reaction: Magnesium + Silver Nitrate $Mg + 2AgNO_3 \rightarrow 2Ag + Mg(NO_3)_2$

17. Observe this reaction with a microscope or a magnifying glass.
18. Place a piece of magnesium metal in the centre of a clean microscope slide, and place the slide onto the microscope. Focus on the edge of the piece of magnesium.
19. Place a drop of silver nitrate solution onto the piece of magnesium. Observe the reaction. With the microscope it should possible to see the rapid growth of needles of pure silver. The products of this reaction are silver and magnesium nitrate.
20. Follow your teacher's instructions for disposing of the materials you have used at this station.

Question

1. For each of the reactions in stations 1 to 4:
   a) write the word equation
   b) write the balanced formula equation

Conclusion

The main purpose behind almost every lab is really to give the student experience working safely in a lab setting. What did you enjoy the most and the least about the experience of doing the lab? Why were these enjoyable or not enjoyable?