Investigation Activity *Science Inquiry Skills Focus*

— Double Replacement and Neutralization Reactions —

Purpose

To observe changes that take place during some double replacement and neutralization reactions, and to write chemical equations for these reactions

Materials and Equipment

- dropper bottles containing the following solutions:
  - ▹ nickel(II) chloride ($NiCl_2$)
  - ▹ sodium hydroxide ($NaOH$)
  - ▹ silver nitrate ($AgNO_3$)
  - ▹ sodium iodide (NaI)
  - ▹ lead(II) nitrate ($Pb(NO_3)_2$)
  - ▹ ammonium hydroxide (NH_4OH)
  - ▹ copper(II) sulphate ($CuSO_4$)
  - ▹ hydrochloric acid (HCl)
  - ▹ sulphuric acid (H_2SO_4)
- phenolphthalein indicator
- 6 test tubes
- test-tube rack

Safety Notes

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

Procedure

Part 1: Double Replacement Reactions

1. For each pair of solutions below, combine 5 drops of each solution in a test tube. Use a separate test tube for each pair. It does not matter which solution in a pair you add first. Note whether a precipitate forms. If one forms, note its colour.
   a) nickel(II) chloride solution and sodium hydroxide solution
   b) silver nitrate solution and sodium iodide solution
   c) lead(II) nitrate solution and sodium iodide solution
   d) sodium hydroxide solution and sodium iodide solution
   e) ammonium hydroxide solution and silver nitrate solution
   f) copper(II) sulphate solution and sodium hydroxide solution
2. Dispose of the solutions as instructed by your teacher, and wash out the test tubes.

Part 2: Acid-Base Neutralization Reactions

3. Use a separate test tube for each reaction. Place 5 drops of phenolphthalein indicator into each test tube. Then add 5 drops of the first solution, followed by enough of the second solution to cause a colour change.
   a) first add hydrochloric acid solution followed by sodium hydroxide solution
   b) first add sodium hydroxide solution followed by hydrochloric acid solution
   c) first add sulphuric acid solution followed by ammonium hydroxide solution
   d) first add ammonium hydroxide solution followed by sulphuric acid solution
   e) first add hydrochloric acid solution followed by ammonium hydroxide solution
   f) first add ammonium hydroxide solution followed by hydrochloric acid solution
4. Dispose of the solutions as instructed by your teacher, and wash out the test tubes.

Continued

Questions

1. In part 1, all the combinations except one should have produced a precipitate. Which combination did not? Explain why no precipitate should be expected from that pair of reactants.
2. a) Write balanced formula equations for the five combinations in part 1 that formed a precipitate.
   b) Write the state after each formula in each equation. The reactants were all aqueous. All products that contain either the sodium ion (Na^+) or the ammonium ion (NH_4^+) are aqueous. The other compound is solid.
3. What colour is phenolphthalein indicator in a base? In an acid?
4. Write balanced formula equations for each of the three different neutralizations observed in part 2.

Conclusion

Write a statement that describes how you can tell whether a double replacement reaction may have occurred in a solution. Write another statement that describes how you can tell whether an acid-base neutralization may have occurred in a solution.

Classifying Five Types of Reactions

Many thousands of reactions fit into the five categories that you have now studied. Table 3.22 summarizes these five categories of reaction.

TABLE 3.22 Summary of Reaction Types

Reaction Type	Reactants		Products
Synthesis	A + B	→	AB
Decomposition	AB	→	A + B
Single replacement			
A is a metal	A + BC	→	B + AC
D is a non-metal	D + BC	→	C + BD
Double replacement	AB + CD	→	AD + CB
Neutralization	HX + MOH	→	$MX + H_2O$

A visual representation with symbols may be useful in comparing the patterns of the combinations in the five types of reactions. Table 3.23 shows examples of this kind of representation. It also includes some notes to help you remember the patterns.