Section 6.1 Identifying Acids and Bases

(Student textbook pages 219 to 228)

Specific Expectations

- **C2.6** plan and conduct an inquiry to classify some common substances as acidic, basic, or neutral
- **C3.1** describe the relationships between chemical formulae, composition, and names of binary compounds
- **C3.8** identify simple ionic compounds, simple compounds involving polyatomic ions, molecular compounds, and acids, using the periodic table and a list of the most common polyatomic ions, and write the formulae

In this section, students learn how to identify common acids and bases, and name and write formulas for binary and polyatomic acids as well as bases.

Common Misconceptions

- All acids and bases may be seen as universally dangerous. *Strong* acids and bases are extremely corrosive whereas *weak* acids and bases (lemon juice and baking soda) are found in foods and soaps. This is not related to their place on the pH scale. Later in the chapter, students will learn that *strong* or *weak* refers to a substance's ability to lose a proton.
- Bases might be considered safe and acids harmful. Both can cause severe burns.
- Students may only look for hydroxide ions in order to identify a base. Some bases do not contain hydroxide ions in their original chemical formula, but will react with water to produce hydroxide ions (e.g., $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$).
- Organic acids containing carboxylic acid are often mistaken for bases because of the OH group at the end (e.g., __COOH). A base, however, usually has a metal ion attached to the hydroxide group.
- Suffixes and prefixes may be incorrectly combined when naming acids (e.g., not hyrdrosulphuric acid or hydronitric acid). Distinguish that the prefix *hydro* is used when naming binary acids while polyatomic acids end in –*ic*.

Background Knowledge

Before the role of hydrogen ions was understood, acids and bases were defined operationally, according to properties such as taste, reactivity, and affect on indicators. The term *acid* comes from the Latin name that means sour.

There are several theories that provide working definitions for acids and bases. The text uses Arrhenius' theory of acids and bases, which states that an acid is a substance that dissociates (releases) hydrogen ions (H^+) in solution. A base is a substance that dissociates in solution to produce hydroxide ions (OH^-). Svante Arrhenius was a Swedish scientist in the late 1800s. His definition will prove useful later in the chapter as it can explain Boyle's observation that acids and bases counteract each other through neutralization (since the H^+ [acid] combines with the OH^- [base] to form neutral H_2O [water]).

Arrhenius' definition has limitations, however. One is that it applies only to aqueous compounds and does not explain why some substances, such as common baking soda ($NaHCO_3$), behave as a base even though they do not contain hydroxide ions. For instance, the base ammonia reacts with water to form hydroxide ions. In this reaction, the electronegative nitrogen atom is able to take a hydrogen ion away from H_2O leaving behind an OH^- (hydroxide ion). NH_3 gains an additional H^+ to become NH_4^+.

$$NH_3(g) + H_2O \rightarrow NH_4^+(aq) + OH^-(aq)$$

Literacy Support

Using the Text

- Have students highlight key terms in their notes and keep a glossary of the new terms.

Before Reading

- Define the key terms used in the section.
- Have students "graffiti" on a large paper, everything they know about acids and bases.
- Have students list three questions they have about acids and bases.

During Reading

- Encourage students to add illustrations and examples to their definitions.
- Give students sticky notes on which to jot summary notes; five bullet points per section.
- Have students use **BLM G-47 Venn Diagram** to compare properties of acids and bases, filling in details and examples as they read.

After Reading

- Survey the class for the three most interesting things in the unit, two things that remain unclear, and one outstanding question.

Using the Images

- Discuss the photo used in the text that illustrates Canada's large freshwater supply. Ask how fresh water contributes to our economy (e.g., serves as drinking water and draws tourists for recreation). Why is the abundance of fresh water such an important asset? (Answer: Distribution is uneven over the world yet needed by everyone.) What factors cause the pollution of the fresh water? (Answer: Improper waste management.)
- After viewing the *National Geographic* feature, discuss possible natural remedies that would ease the pain or itch of a sting.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check question 3, page 223	Students write correct names or formulas.	Have students drill writing names and formulas for acids and bases, or play Activity 6-2 Chemical Card Games. Have students create a flow chart for the naming process.
Activity 6-2 Chemical Card Games, page 225	Students match acid formulas and names.	Review binary and polyatomic acids. Have students complete the practice problems (student textbook page 224). **BLM 6-2 Writing Formulas for Acids** provides scaffolding to get them started.
Section 6.1 Review question 7, page 228	Students state that acids donate hydrogen ions whereas bases donate hydroxide ions to solution.	Have students draw particle diagrams of each process. Have students use **BLM G-47 Venn Diagram** to compare properties of acids and bases.

Instructional Strategies

- Engage students by creating a map of the acid/base receptors on the tongue. Have students taste a series of distinct flavours (sour, bitter, sweet, and salty) and sketch where on the tongue each flavour is detected.
- Survey the class for existing knowledge and experience with acids and bases. For example, acid indigestion, pH-balanced shampoos, acid rain, alpha hydroxyl acid, citric acid, acetylsalicylic acid (aspirin), carbonic acid (soda), hydrochloric acid (digests food), antacids (aluminum hydroxide), or soap.
- Make a class list of the observable properties of acids and bases, before moving into the chemical definitions.
- As the class examines the general equations that define acids and bases, use a molecular model kit to illustrate acid and base production.
- Use molecular models to emphasize the difference in the *poly*–atomic and *bi*–nary acids. Students may wish to review their Chapter 4 notes on polyatomic ions.
- Develop a mnemonic for the properties of bases (e.g., bases = bitter and slippery).

- As a class, walk through the Practice Problems (student textbook pages 224 and 227). Students may find that **BLM 6-2 Writing Formulas for Acids** and **BLM 6-3 Writing Formulas for Bases** provides scaffolding to get them started.
- Have students begin an organizer for information on acids and bases. **BLM G-47 Venn Diagram** scaffolds this process. Use **BLM A-15 Venn Diagram Checklist** to assess students' work.

Activity 6-2 Chemical Card Games (Student textbook page 225)

Pedagogical Purpose

This activity reactivates prior learning about chemical names and formulas by having students match names and formulas of acids.

Planning	
Materials	**BLM 6-4 Acid Playing Cards** One day before, copy the BLM and cut apart the cards.
Time	30 min

Activity Notes and Troubleshooting

- Distribute sets of acid playing cards. Laminate the card sets to make them durable.
- Instruct students to follow the rules of "go fish."
- Encourage students to verify each other's matches.
- Encourage students to use a periodic table or Tables 6.1 and 6.2 in the student textbook to resolve disputes.
- Use **BLM A-39 Co-operative Group Work Rubric** to assess students' interpersonal performance.

Additional Support

- ELL Perform drills with English language learners to practise identifying the root chemical name within each acid's name, matching the stems to elements and their symbols on the periodic table.
- This is an excellent activity, addressing many learning styles and challenges.

Answers

1. Students may have recognized acids encountered in previous chapters, or by their taste (e.g., food).
2. Example: HF etches glass; HCl, H_2SO_4, and H_3PO_4 remove surface rust and other dirt; H_2SO_4 is an electrolyte in car batteries; HCl is stomach acid, H_2SO_4 and H_3PO_4 is used in synthesis of many pharmaceuticals; HCl maintains swimming pool pH; H_2CO_3 carbonates soft drinks; H_3PO_4 in cola soft drinks

Learning Check Answers (Student textbook page 223)

1. Produce hydrogen ions when dissolved in water, taste sour, (may be) corrosive
2. Example: etching glass, fertilizer
3. **a.** hydrochloric acid *or* hydrogen chloride
   b. hydrofluoric acid *or* hydrogen fluoride
   c. sulfuric acid *or* hydrogen sulfate
   d. phosphoric acid *or* hydrogen phosphate
4. Example: citrus juice and vinegar

Section 6.1 Review Answers (Student textbook page 234)

Please also see **BLM 6-5 Section 6.1 Review (Alternative Format).**

1. hydrogen ion and anion of the non-metal
2. Example:

Acid name ending	ion name ending
hydro__ic acid e.g., hydrochloric acid	__ide e.g., chloride
__ic acid e.g., sulfuric acid	__ate e.g., sulfate
__ous acid e.g., phosphorous acid	__ite e.g., phosphite

3. an acid
4. produce hydroxide ions when dissolved in water, taste bitter or feel slippery
5. **a.** calcium hydroxide
   b. phosphorous acid
   c. hydrogen fluoride
   d. potassium hydroxide
6. **a.** H_3PO_4
   b. HBr
   c. $Mg(OH)_2$
   d. $Al(OH)_3$
7. **a.** $HClO_3(aq) \rightarrow H^+(aq) + ClO_3^-(aq)$, acid
   b. $KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$, base
8. Example: Group into either acid (HCl, H_2SO_4, and $HClO_3$) or base (NaOH, $Ca(OH)_2$, and LiOH), since each solution contains either a hydrogen ion or an oxide ion.