Table 1 Thunder Bay Status

Use	Status
fish and wildlife consumption	restricted
degradation of fish and wildlife populations	impaired
deformities (tumours) of fish	impaired
beach access (closures)	restricted
degradation of aesthetics	impaired
loss of fish and wildlife habitat	impaired

Status of the Thunder Bay AOC

Although no objectives have been completed, improvements have been made to several areas of impairment. For example, wildlife and fish populations have been restored to approximately 90% of the projected level.

Thunder Bay is achieving its RAP objectives by encouraging public awareness and support. A "Lake Superior Day," held each year in July in numerous provincial, state, and federal parks around the lake, helps to raise awareness.

Process changes and improved effluent treatment at local pulp and paper mills are helping to address water quality issues. There are also projects involving the restoration or creation of fish and wildlife habitats in the AOC. Rehabilitation programs are also being developed for threatened populations of lake sturgeon in the AOC.

4.7 ACIDS AND BASES

PRACTICE

(Page 300)

Understanding Concepts

1. The evidence that shows that solutions of bases and solutions of acids are composed of separate ions is that both acids and bases are good electrolytes in aqueous solution. This observation suggests that bases dissociate and acids ionize into positively and negatively charged ions.
2. (a) $HNO_{2(aq)}$—acidic solution
   (b) $LiOH_{(aq)}$—basic solution
   (c) $Ba(OH)_{2(aq)}$—basic solution
   (d) $NaCl_{(aq)}$—neutral solution
   (e) $CH_3OH_{(aq)}$—neutral solution
3. (a) $KBr_{(s)} \rightarrow K^+_{(aq)} + Br^-_{(aq)}$ (dissociation)
   (b) $Al(OH)_{3(s)} \rightarrow Al^{3+}_{(aq)} + 3\ OH^-_{(aq)}$ (dissociation)
   (c) $MgCl_{2(s)} \rightarrow Mg^{2+}_{(aq)} + 2\ Cl^-_{(aq)}$ (dissociation)
   (d) $HI_{(aq)} \rightarrow H^+_{(aq)} + I^-_{(aq)}$ (ionization reaction)
4. (a) $KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$
   1 mol $KOH_{(aq)}$ dissociates to produce 1 mol $K^+_{(aq)}$ ions and 1 mol $OH^-_{(aq)}$ ions.
   Therefore, 0.45-mol/L KOH dissociates to produce 0.45-mol/L $K^+_{(aq)}$ ions and 0.45-mol/L $OH^-_{(aq)}$ ions.
   (b) $NaCl_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)}$
   1 mol $NaCl_{(aq)}$ dissociates to produce 1 mol $Na^+_{(aq)}$ ions and 1 mol $Cl^-_{(aq)}$ ions.
   Therefore, 0.50-mol/L $NaCl_{(aq)}$ dissociates to produce 0.50-mol/L $Na^+_{(aq)}$ ions and 0.50-mol/L $Cl^-_{(aq)}$ ions.
   (c) $HI_{(aq)} \rightarrow H^+_{(aq)} + I^-_{(aq)}$
   1 mol $HI_{(aq)}$ ionizes to produce 1 mol $H^+_{(aq)}$ ions and 1 mol $I^-_{(aq)}$ ions.
   Therefore, 0.375-mol/L $HI_{(aq)}$ ionizes to produce 0.375-mol/L $H^+_{(aq)}$ ions and 0.375-mol/L $I^-_{(aq)}$ ions.

PRACTICE

(Page 303)

Understanding Concepts

5. (a) pH = 8
   (b) pH = 6
   (c) pH = 4

6. (a) $[H^+] = 10^{-11}$ mol/L
   (b) $[H^+] = 10^{-2}$ mol/L
   (c) $[H^+] = 10^{-4}$ mol/L

SECTION 4.7 QUESTIONS

(Page 304)

Understanding Concepts

1. Ionic solutes are electrolytes when they dissolve in water to form solutions. When ionic compounds dissolve in water, they dissociate into positive and negative ions. These charged ions, or electrolytes, conduct an electric current through the aqueous solution. Most molecular compounds are not electrolytes when dissolved in water. However, acid solutes, which are molecular, are electrolytes when they ionize in water.
2. (a) $NaI_{(s)} \rightarrow Na^+_{(aq)} + I^-_{(aq)}$
   (b) $HCl_{(g)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$
   (c) $Sr(OH)_{2(s)} \rightarrow Sr^{2+}_{(aq)} + 2\ OH^-_{(aq)}$
3. (a) Arrhenius' theory of acids states that acids ionize into positively charged hydrogen ions, H^+, and negatively charged anions when dissolved in water.
   (b) Arrhenius' theory of bases states that bases dissociate into negatively charged hydroxide ions, OH^-, and positively charged metal ions when dissolved in water.
4. (a) potassium hydroxide: $K^+_{(aq)}$, $OH^-_{(aq)}$, $H_2O_{(l)}$
   (b) hydrogen nitrate: $H^+_{(aq)}$, $NO^-_{3(aq)}$, $H_2O_{(l)}$
   (c) hydrogen acetate: $H^+_{(aq)}$, $C_2H_3O^-_{2(aq)}$, $H_2O_{(l)}$
   (d) sodium bromide: $Na^+_{(aq)}$, $Br^-_{(aq)}$, $H_2O_{(l)}$
5. (a) $LiOH_{(s)} \rightarrow Li^+_{(aq)} + OH^-_{(aq)}$
   (b) $Al(OH)_{3(s)} \rightarrow Al^{3+}_{(aq)} + 3\ OH^-_{(aq)}$
   (c) $Ba(OH)_{2(s)} \rightarrow Ba^{2+}_{(aq)} + 2\ OH^-_{(aq)}$
6. The evidence for strong and weak acids is that the electrical conductivity of a strong acid is greater that the electrical conductivity of a weak acid when solutions of the same concentration and temperature are compared. Strong acids are good conductors of electricity because they completely (100%) ionize into $H^+_{(aq)}$ and negatively charged ions when dissolved in water. A weak acid is a poor conductor of electricity because it only partially (<50%) ionizes into $H^+_{(aq)}$ and negatively charged ions when dissolved in water.
7. A concentrated solution has a relatively large amount of solute dissolved per unit volume of solution. A dilute solution has a relatively small amount of solute dissolved per unit volume of solution.
8. (a) 10^{-7} mol/L
   (b) 10^{-11} mol/L
   (c) 10^{-2} mol/L
   (d) 10^{-4} mol/L
   (e) 10^{-14} mol/L
9. (a) pH = 3
   (b) pH = 5
   (c) pH = 7
   (d) pH = 10
10. The pH of pure water, or any neutral solution, at 25°C is 7.

11. water sample pH = 5
Thus, $[H^+_{(aq)}] = 10^{-5}$ mol/L
neutral pH = 7
$[H^+_{(aq)}] = 10^{-7}$ mol/L

$$\frac{10^{-5}\ \text{mol/L}}{10^{-7}\ \text{mol/L}} = 100$$

Therefore, to neutralize the water sample, the hydrogen ion concentration must be decreased by a factor of 100.

12. (a) $HBr_{(aq)} \rightarrow H^+_{(aq)} + Br^-_{(aq)}$
1 mol $HBr_{(aq)}$ dissociates to produce 1 mol $H^+_{(aq)}$ ions and 1 mol $Br^-_{(aq)}$ ions.
Therefore, 0.15-mol/L $HBr_{(aq)}$ dissociates to produce 0.15-mol/L $H^+_{(aq)}$ ions and 0.15-mol/L $Br^-_{(aq)}$ ions.
(b) $KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$
1 mol $KOH_{(aq)}$ dissociates to produce 1 mol $K^+_{(aq)}$ ions and 1 mol $OH^-_{(aq)}$ ions.
Therefore, 0.15-mol/L $KOH_{(aq)}$ dissociates to produce 0.15-mol/L $K^+_{(aq)}$ ions and 0.15-mol/L $OH^-_{(aq)}$ ions
(c) $NH_4Cl_{(aq)} \rightarrow NH^+_{4(aq)} + Cl^-_{(aq)}$
1 mol $NH_4Cl_{(aq)}$ dissociates to produce 1 mol $NH^+_{4(aq)}$ ions and 1 mol $Cl^-_{(aq)}$ ions.
Therefore, 0.15-mol/L $NH_4Cl_{(aq)}$ dissociates to produce 0.15-mol/L $NH^+_{4(aq)}$ ions and 0.15-mol/L $Cl^-_{(aq)}$ ions.

13. $[H^+_{(aq)}]$ = 0.2 mg/100 mL = 2 mg/L
$[H^+_{(aq)}]$ = 3 ppm = 3 mg/L
Therefore, the 3-ppm solution has a higher concentration of hydrogen ions than the 0.2-mg/100 mL solution.

Applying Inquiry Skills

14. A litmus paper test would be a simple way to distinguish acidic or basic solutions. Acidic solutions turn blue litmus paper red, while basic solutions turn red litmus paper blue.
15. The chemicals are identified in **Table 1.**

Table 1 Chemical Identification and Explanation

Chemical	Identity	Explanation
1	$HC_2H_3O_{2(l)}$	Acetic acid would turn blue litmus red. Acetic acid has low electrical conductivity because it is a weak acid.
2	$NaOH_{(s)}$	Sodium hydroxide is a strong base that would turn red litmus blue. It has high electrical conductivity because it is a strong base.
3	$Mg_{(s)}$	Solid metals have very low solubility in water.
4	$C_{12}H_{22}O_{11(s)}$	Sucrose is a soluble molecular compound that has low electrical conductivity in solution.
5	$KCl_{(s)}$	Potassium chloride is a soluble ionic compound that has high conductivity in solution.

4.8 EXPLORE AN ISSUE: THE DISPOSAL OF HOUSEHOLD PRODUCTS

CAREER CONNECTION: WASTE TREATMENT ENGINEER

(Page 306)

(i) The types of work that a waste treatment engineer would typically do include designing waste treatment equipment, developing chemical processes for treating waste, assessing existing facilities for efficiency and increases in volume or complexity of waste to be treated, promoting good waste management practices and environmental sustainability, developing residential composting programs, preparing cost estimates, and deciding the most appropriate treatment for different categories of waste.
(ii) There are many programs that prepare students for employment as a waste treatment engineer. For example, the University of Waterloo and the University of Western Ontario both offer programs.