Name Date

Section 5.1 Summary

Acids and Bases

Textbook pages 220–233

Before You Read

Many acids and bases can be found in your home. Describe one acid and one base that you are familiar with. Record your answer in the lines below.

What are acids and bases?

Many common pure substances can be classified according to whether they are acids or bases. Acids produce **hydrogen ions** (H^+) and bases produce **hydroxide ions** (OH^-) when dissolved in solution. The **concentration** of hydrogen ions refers to the number of hydrogen ions in a specific volume of solution. Solutions with a high concentration of hydrogen ions are highly acidic. Similarly, solutions with a high concentration of hydroxide ions are highly basic. When an acidic solution is mixed with a basic solution, the solutions can **neutralize** each other, which means that the acidic and basic properties are in balance.

What is pH?

Testing the pH of a solution is a way of measuring its concentration of hydrogen ions, $H^+(aq)$. The **pH scale** is a number scale that indicates how acidic or basic a solution is. **Acids** have a pH below 7 and **bases** have a pH above 7. Neutral solutions have a pH of 7. On the pH scale, one unit of change represents a 10-fold change in the degree of acidity or basicity. For example, a two unit drop in pH is a 10^2 or 100 times increase in acidity.

What are pH indicators?

pH indicators are chemicals that change colour depending on the pH of a solution.

- **Litmus paper** can determine whether a solution is acidic or basic. Blue litmus paper turns red in an acidic solution (below pH 7). Red litmus paper changes to blue in a basic solution (above pH 7),

Create a Quiz

After you have read this section, create a five-question quiz on acids. Answer your questions until you get them all correct.

Reading Check

What is the pH of a neutral solution?

- A universal indicator contains a number of indicators that turn different colours depending on the pH of the solution.
- **Phenolphthalein, bromothymol blue, indigo carmine, methyl orange**, and **methyl red** are other common pH indicators. Each determines pH within a different range.

Reading Check

Provide the name of a common pH indicator.

A digital pH meter or pH computer probe that measures the electrical properties of a solution can also be used to determine pH.

How are acids and bases named?

Generally, the chemical formula for an acid starts with H (hydrogen) on the left hand side of the formula. Acids can be named in several ways. Many compounds take on acidic properties only when mixed with water. If no state of matter is given, the name may be begin with hydrogen, as in hydrogen chloride (HCl). However, if the acid is shown as being aqueous (dissolved in water), a different name may be used—one that ends in **-ic acid**, as in hydrochloric acid. Other acids that do not contain oxygen, such as hydrofluoric acid, HF(aq); nitric acid, HNO_3(aq); and sulphuric acid, H_2SO_4(aq), also follow this naming system.

Another naming system is followed when oxygen is present in the formula. Names that begin with hydrogen and end with the suffix **-ate** (i.e., hydrogen carbonate, H_2CO_3) can be changed by dropping "hydrogen" from the name and changing the suffix to **-ic acid** (i.e., carbonic acid, H_2CO_3(aq)). When the name begins with hydrogen and ends with the suffix **-ite** (i.e., hydrogen sulphite, H_2SO_3), then the name can be changed to end with the suffix **-ous acid** (i.e., sulphurous acid, H_2SO_3(aq)).

Bases generally have OH on the right hand side of their chemical formulas. Common names of bases include sodium hydroxide (NaOH) and magnesium hydroxide ($Mg(OH)_2$).

What are the properties of acids and bases?

Some of the properties of acids and bases are compared in the table below.

Property	Acid	Base
Taste CAUTION: Never taste chemicals in the laboratory.	• Acids taste sour. Lemons, limes, and vinegar are common examples.	• Bases taste bitter. The quinine in tonic water is one example.
Touch CAUTION: Never touch chemicals in the laboratory with your bare skin.	• Many acids will burn your skin. Sulfuric acid (battery acid) is one example.	• Bases feel slippery. • Many bases will burn your skin. Sodium hydroxide (lye) is one example.
Indicator tests	• Acids turn blue litmus paper red. • Phenolphthalein is colourless in an acidic solution.	• Bases turn red litmus blue. • Phenolphthalein is colourless in slightly basic solutions and pink in moderate to strongly basic solutions.
Reaction with some metals, such as magnesium or zinc	• Acids corrode metals.	• No reaction
Electrical conductivity	• Conductive	• Conductive
pH	• Less than 7	• More than 7
Production of ions	• Acids form hydrogen (H^+) ions when dissolved in solution.	• Bases form hydroxide (OH^-) ions when dissolved in solution.

What are some common acids and bases?

Formula	Name	Examples of uses
CH_3COOH	ethanoic acid or acetic acid	in vinegar
H_2SO_4	sulphuric acid	automobile batteries
NaOH	sodium hydroxide	drain and overn cleaners
$Mg(OH)_2$	magnesium hydroxide	antacids
HCl	hydrochloric acid	digestion in stomach

Use with textbook pages 220–224.

pH scale and pH indicators

1. Define the following terms:

(a) pH indicator _____

(b) pH scale _____

Figure 1: pH values of common substances

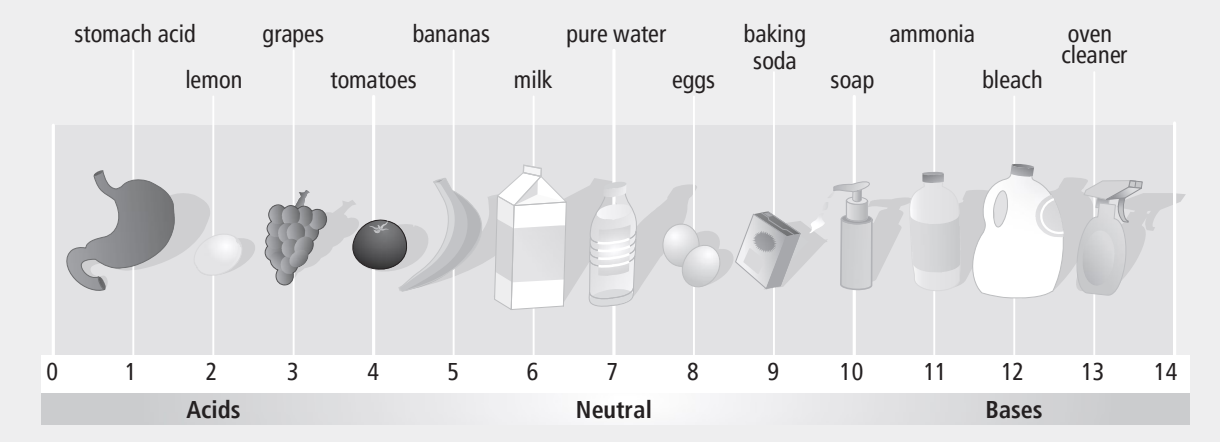
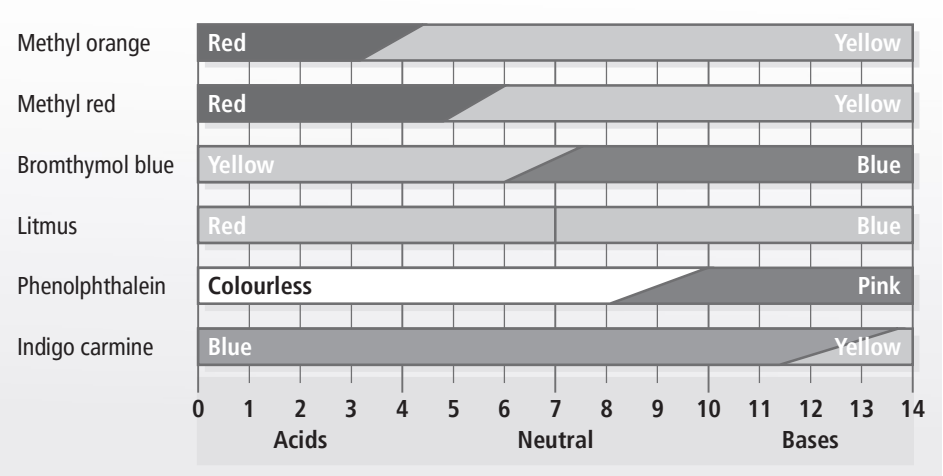


Figure 2: Common acid-base indicators and their pH colour change



2. Complete the following tables by using the two figures shown on the previous page. Identify whether the substance is an acid or a base and indicate what colour the pH indicator will turn.

(a)

Substance	pH Value	Acid or Base	Methyl Orange	Bromothymol Blue	Litmus
lemon					
ammonia					
milk					

(b)

Substance	pH Value	Acid or Base	Methyl Red	Phenolphthalein	Indigo Carmine
tomato					
oven cleaner					
egg					

3. Complete the following table. Identify whether the substance is an acid or a base and indicate what colour the pH indicator will turn.

Substance	pH Value	Acid or Base	pH Indicator	Colour of pH Indicator
black coffee	5		litmus	
milk of magnesia	10		phenolphthalein	
battery acid	0		bromothymol blue	
sea water	8		indigo carmine	
orange juice	3		methyl orange	
liquid drain cleaner	14		methyl red	

Use with textbook pages 220–229.

Acids versus bases

1. Compare and contrast acids and bases by completing the following table.

	Acids	Bases
definition		
pH		
what to look for in chemical formula		
production of ions		
electrical conductivity		
taste		
touch		
examples		

2. Classify each of the following as an acid or a base.

(a) + H_3PO_4 _____

(b) NH_4OH _____

(c) $Mg(OH)_2$ _____

(d) has a pH of 4 _____

(e) has a pH of 9 _____

(f) sulphurous acid _____

(g) hydrogen bromide _____

(h) potassium hydroxide _____

(i) causes methyl orange to turn red _____

(j) causes phenolphthalein to turn pink _____

(k) causes indigo carmine to turn yellow _____

(l) causes bromothymol blue to turn yellow _____

Use with textbook pages 220–229.

Acids and bases

Match the Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.

Term	Descriptor
1. _____acid **2.** _____base **3.** _____neutral **4.** _____pH scale **5.** _____corrosive **6.** _____pH indicator **7.** _____concentration of hydrogen	**A.** a solution with a pH of 7 **B.** can burn skin or eyes on contact **C.** number of hydrogen ions in a specific volume of solution **D.** a chemical compound that produces a solution with a pH less than 7 **E.** a number scale for measuring how acidic or basic a solution is **F.** a chemical compound that produces a solution with a pH greater than 7 **G.** a chemical that changes colour depending on the pH of the solution it is placed in

8. Which of the following describes acids?

I.	has a pH of less than 7
II.	can conduct electricity
III.	produce hydroxide ions when dissolved in solution

A. I and II only

B. I and III only

C. II and III only

D. I, II, and III

9. What happens to the number of H^+ after H_2SO_4 is added to water?

A. it increases

B. it decreases

C. it stays the same

10. Which of the following is a base?

A. KCl **C.** LiOH

B. HBr **D.** HNO_3

11. What is the name for $HClO_3$?

A. chloric acid

B. chlorous acid

C. perchloric acid

D. hypochlorous acid

12. What is the chemical formula for sulphurous acid?

A. HS **C.** H_2SO_3

B. HSO_4^- **D.** H_2SO_4

13. What is the pH of a substance that causes methyl orange to turn yellow and methyl red to turn red?

A. 3 **C.** 6.5

B. 4.5 **D.** 8

14. Which of the following would occur if eggs were tested with various pH indicators?

I.	indigo carmine turns blue
II.	phenolphthalein turns pink
III.	bromothymol blue turns blue

A. I and II only

B. I and III only

C. II and III only

D. I, II, and III