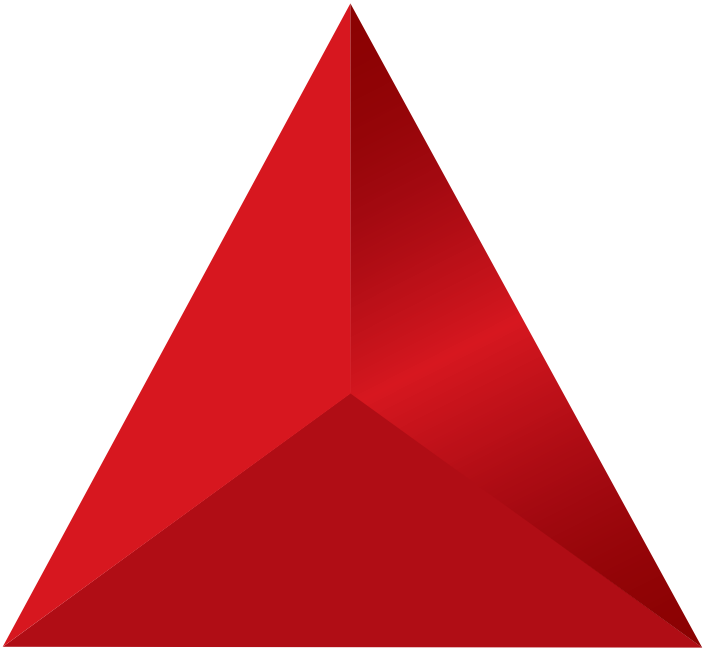
CHEMISTRY



3RD EDITION

detailed contents

chapter 9

Molecular geometry and bonding theories 292

chapter 10

Intermolecular forces: Gases 336

chapter 11

Intermolecular forces: Liquids and solids 376

chapter 12

Properties of solutions 426

chapter 18

Additional aspects of aqueous equilibria 706

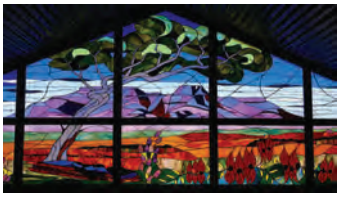
chapter 19

Electrochemistry 752

chapter 20
Chemistry of the non-metals 802

chapter 21

Chemistry of the transition metals 850



chapter 22

The chemistry of organic compounds 890

chapter 23

Stereochemistry of organic compounds 926

chapter 24

Chemistry of alkenes and alkynes 952

chapter 25

Alcohols, haloalkanes and ethers 994

preface

Philosophy

This is the third Australian edition of a text that has enjoyed significant global success over a number of decades. Our original aim in adapting *Chemistry: The Central Science* for a wider market was to ensure that the text remained a central, indispensable learning tool for the student of chemistry. In this book we aim to provide a comprehensive coverage of all aspects of chemistry that may be used at introductory university level. It will provide students with the depth of knowledge they require in their first-year undergraduate curriculum and to arm chemistry academics across Australia with a broad and balanced view of chemistry with which to set their curricula. Throughout the text we have maintained a conversational style of explaining information rather than simply stating facts. We have found that this style has been highly appreciated by the student.

Organisation and Contents

In this edition the first four chapters give a largely macroscopic overview of chemistry. The basic concepts presented—such as atomic structure, the nature of chemical reactions, stoichiometry, measurement and quantification and the main types of reaction in aqueous solution—provide a necessary background for many of the laboratory experiments usually performed in first year general chemistry.

The following five chapters (Chapters 5–9) focus on the atomic scale, starting with the transformations that occur within the nucleus of an atom before moving on to deal with the electronic structure of the atom, the consequent effects on the properties of the elements and the basic theories of chemical bonding and molecular geometry. Chapters 10 and 11 consider the macroscopic properties of the three states of matter—gas, liquid and solid—and the forces which influence their behaviour. A more detailed look at solubility and solutions and our interaction with the atmosphere and oceans are examined in the next two chapters (Chapters 12 and 13). All chemical reactions involve energy changes and Chapter 14 comprehensively covers the thermodynamic processes operating in all chemical reactions.

The next several chapters examine the factors that determine the speed and extent of chemical reactions: kinetics (Chapter 15) and equilibria (Chapters 16–18). These are followed by electrochemistry, which discusses the use of chemical reactions to produce electrical energy and *vice versa* (Chapter 19). Chapters 20 and 21 introduce the chemistry of non-metals, metals and coordination compounds. Throughout Chapters 1–21 there are extensive areas of modern chemistry that are dealt with broadly. For example, we introduce students to descriptive inorganic chemistry by integrating examples throughout the text. You will find pertinent and relevant examples of organic and inorganic chemistry woven into all chapters as a means of illustrating principles and applications and the relationship between all areas of chemistry. Some chapters, of course, more directly address the properties of elements and their compounds, especially Chapters 7, 20 and 21.

Organic chemistry is central to all living things and Chapters 22–30 lead us on a journey from elementary hydrocarbons to elaborate bioorganic molecules. Much of what we discuss is treated

from a fundamental level so your transition to tertiary studies in organic chemistry is smooth and rapid. We place emphasis on the core reactions observed in organic chemistry and treated many cases mechanistically. This fosters a deep understanding of why organic molecules react in the way they do thereby giving you an opportunity to understand much more chemistry than is discussed. Chapter 22 provides a foundation to our examination of organic chemistry by using hydrocarbons to illustrate how we represent and name organic molecules. It goes on to provide an overview of the functional groups—the reactive parts of the molecule—on which we build our understanding of organic chemistry. The shape of a molecule may be pivotal in determining its reactivity, particularly in a biological context, and Chapter 23 leads to an in-depth discussion of stereochemistry.

The next six chapters cover the fundamental reactions encountered in organic chemistry, at each step building to the application of these reaction in a modern world (for example, polymerisation in Chapters 24 and 27) and their essential role in the chemistry of life (for example, carbohydrates in Chapter 26, fats in Chapter 27, proteins and nucleic acids in Chapter 29). Chapter 28 investigates aromatic compounds as a separate class. Here it is important for the student to note the differences in reactivity to the alkenes studied in Chapter 24.

Finally, Chapter 30 stands alone as a reference guide to mass spectrometry, NMR spectroscopy and IR spectroscopy. Whether these topics are taught with much emphasis on the technology is up to the instructor. What we believe is most important is students' development at complex problem-solving, bringing two or more concepts together to draw a logical conclusion. The approach to solving molecular structure also confirms their knowledge of the basic principles of organic chemistry, bonding, functional groups and drawing structural formulae. Our coverage of organic chemistry gives students a unique perspective and challenges the very 'standard format' often seen in a first-year text.

Our topic sequence provides a logical progression through chemistry, but we recognise that not everyone teaches all the topics in exactly the order we have chosen. We have therefore made sure that instructors can make common changes in teaching sequence with no loss in student comprehension. In particular, many instructors prefer to introduce gases (Chapter 10) after stoichiometry or after thermochemistry rather than with states of matter. The chapter on gases has been written to permit this change with no disruption in the flow of material. It is also possible to treat the balancing of redox equations (Sections 19.1 and 19.2) earlier, after the introduction of redox reactions in Section 4.4. Finally, some instructors like to cover organic chemistry (Chapters 22 to 30) earlier than its position in this text. Throughout the text we have introduced linkages (indicated by the symbol ⇔) to sections in other parts of the book. This allows the reader to quickly find relevant material and highlights the integrated nature of chemistry. A glossary of terms provides succinct definitions for quick reference and a comprehensive index ensures the extensive information contained in this book is easily accessible.

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guided tour for students

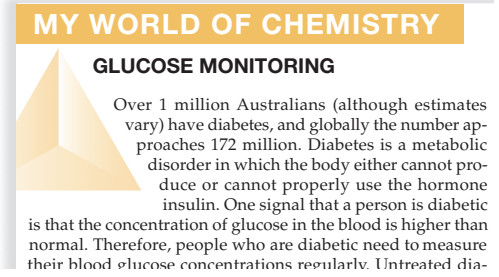
MAKING CONNECTIONS

The 3rd edition of *Chemistry: The Central Science* includes several key features to help you see the bigger picture: to move beyond memorisation and have a deeper understanding of the relationships between concepts in chemistry.

Making connections across different topics

New enhanced blue links are featured in the margins and include voice balloons which direct you to other relevant sections that will enrich your understanding of the current topic.

Making connections between chemistry and the real world


MY WORLD OF CHEMISTRY

GLUCOSE MONITORING

Over 1 million Australians (although estimates vary) have diabetes, and globally the number approaches 172 million. Diabetes is a metabolic disorder in which the body either cannot produce or cannot properly use the hormone insulin. One signal that a person is diabetic is that the concentration of glucose in the blood is higher than normal. Therefore, people who are diabetic need to measure their blood glucose concentrations regularly. Untreated dia-

My World of Chemistry

Chemistry occurs all around us, throughout every day. Recognising the importance of chemistry in your daily life can improve your understanding of chemical concepts. *My World of Chemistry* showcases chemistry's connection to world events, scientific discoveries, and medical breakthroughs throughout the text.

Making connections visually

Micro to Macro Art

These illustrations offer three parts: a macroscopic image (what you can see with your eyes); a molecular image (what the molecules are doing); and a symbolic representation (how chemists represent the process with symbols and equations).

A new intermediate step has been added, showing where chemistry occurs in the problem-solving process.

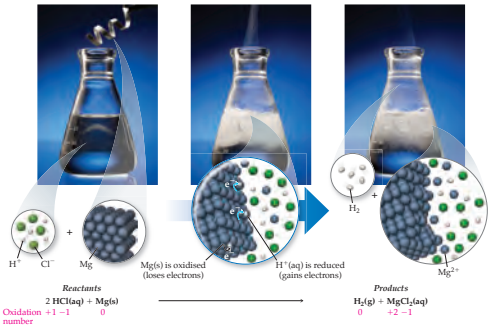
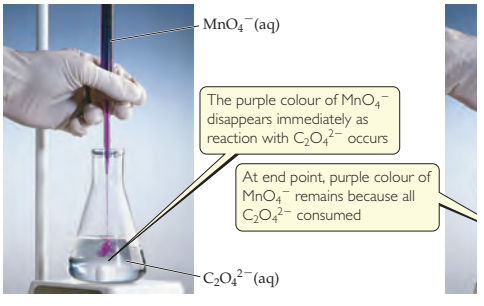


FIGURE IT OUT

Which species is reduced in this reaction? Which specie



(a)

NEW Figure It Out questions and Voice Balloons

Figure It Out questions encourage you to stop and analyse the artwork in the text, for conceptual understanding. 'Voice Balloons' in selected figures help you break down and understand the components of the image.

SAMPLE EXERCISE 3.9 Calculating mo

What is the molar mass of glucose, $C_6H_{12}O_6$?

SOLUTION

Analyse We are given a molecular formula wh their number in the molecule.

Plan The molar mass of any substance is nu which will have units of u, whereas the molar proceed as in Sample Exercise 3.5.

Solve Our first step is to determine the formula

6 C atoms = 6(12.0 u
12 H atoms = 12(1.0 u
6 O atoms = 6(16.0 u

Because glucose has a formula mass of 180.0 u, c of 180.0 g. In other words, $C_6H_{12}O_6$ has a molar

Check The magnitude of our answer seems rea ate unit for the molar mass.

Making connections to problem-solving and critical thinking skills

Analyse/Plan/Solve/Check

This four-step problem-solving method helps you understand what you are being asked to solve, to plan how you will solve each problem, to work your way through the solution, and to check your answers. This method is introduced in Chapter 3 and reinforced throughout the book.

Dual-Column Problem-Solving Strategies

Found in Selected Sample Exercises, these strategies explain the thought process involved in each step of a mathematical calculation using a unique layout for clarity. They help you develop a conceptual understanding of those calculations.

Solve The number of moles of Na_2SO_4 is obtained by dividing its mass by its molar mass:

$$\text{Moles } Na_2SO_4 = \frac{23.4\text{ g}}{142\text{ g mol}^{-1}} = 0.165\text{ mol}$$

Converting the volume of the solution to litres:

$$\text{Litres solution} = \left(\frac{125}{1000}\right)\text{dm}^3 = 0.125\text{ dm}^3$$

Thus the molarity is

$$\text{Molarity} = \frac{0.165\text{ mol}}{0.125\text{ dm}^3} = 1.32\frac{\text{mol}}{\text{dm}^3} = 1.32\text{ M}$$

Strategies in Chemistry

Strategies in Chemistry teach ways to analyse information and organise thoughts, helping to improve your problem-solving and critical-thinking abilities.

STRATEGIES IN CHEMISTRY

PROBLEM SOLVING

Practice is the key to success in solving problems. As you practise, you can improve your skills by following these steps.

Step 1: Analyse the problem. Read the problem carefully. What is it asking you to do? What information does it provide you with? List both the data you are given and the quantity you need to obtain (the unknown).

Step 2: Develop a plan for solving the problem. Consider a possible path between the given information and the unknown. This is usually a formula, an equation or some principle you learnt earlier. Recognise that some data may not be given explicitly in the problem; you may be expected to know certain quantities (such as Avogadro's number) or look them up in tables (such as atomic masses). Recognise also that your plan may involve either a single step or a series of steps with intermediate answers.

Step 3: Solve the problem. Use the known information and suitable equations or relationships to solve for the unknown. Be careful with significant figures, signs and units.

Step 4: Check the solution. Read the problem again to make sure you have found all the solutions asked for in the problem. Does your answer make sense? That is, is the answer outrageously large or small or is it in the ballpark? Finally, are the units and significant figures correct?