HEINEMANN

CHEMISTRY 1

SKILLS AND ASSESSMENT

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VCE UNITS 1 AND 2 • 2023–2027

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How to use this book

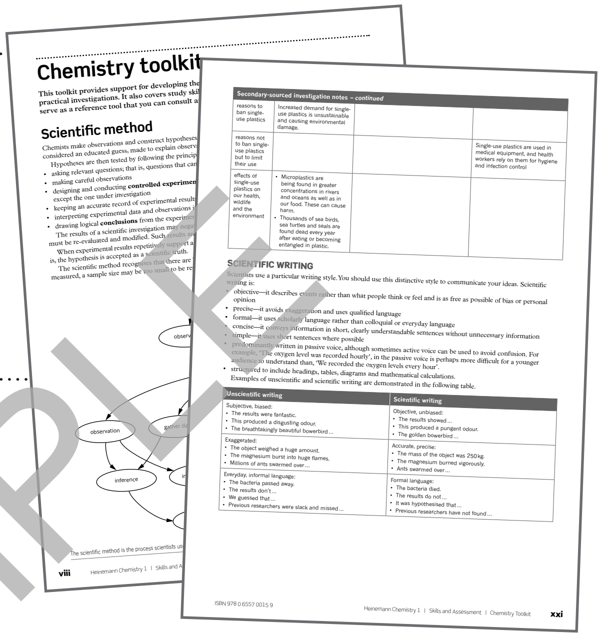
The *Heinemann Chemistry 1 Skills and Assessment* book provides the opportunity to practise, apply and extend your learning through a range of supportive and challenging activities. These activities reinforce key concepts and skills, and enable a flexible approach to learning. There are also regular opportunities for reflection and self-evaluation in the final worksheet in each area of study.

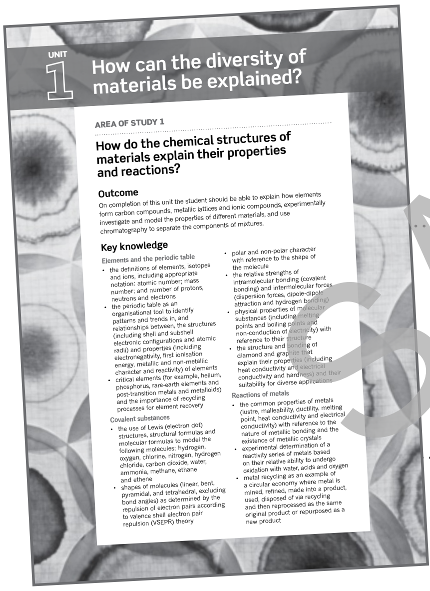
This resource has been written to the VCE Chemistry Study Design 2023–2027 and is divided into six areas of study—three in Unit 1 and three in Unit 2. Areas of study 1 and 2 in each unit consist of four main sections:

- key knowledge
- worksheets
- practical activities
- exam-style questions.

CHEMISTRY TOOLKIT

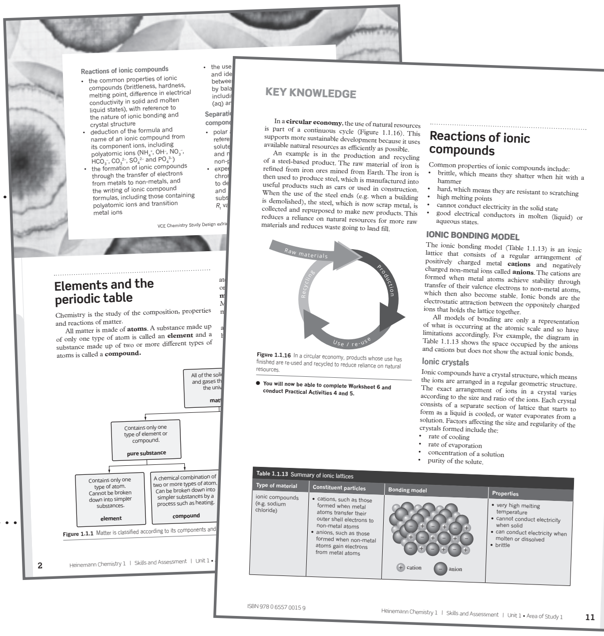
The Chemistry toolkit supports development of the skills and techniques needed to undertake practical and secondary-sourced investigations, and covers examination techniques and study skills. It also includes checklists, models, exemplars and scaffolded steps. The toolkit can serve as a reference tool and be consulted as needed.





AREA OF STUDY OPENER

Heinemann Chemistry 1 Skills and Assessment is structured to follow the study design units and areas of study. The area of study opening page lists the study design key knowledge for easy reference to the activities that follow.

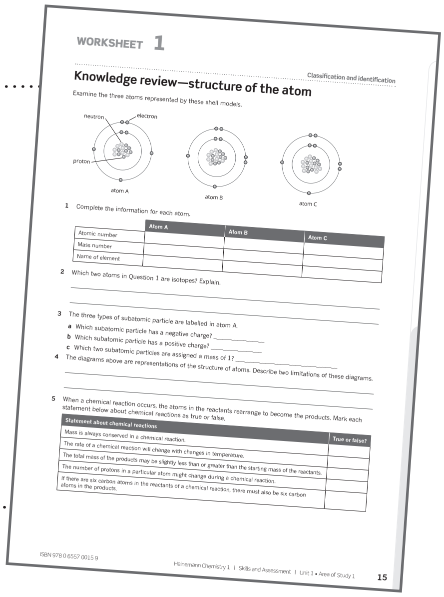


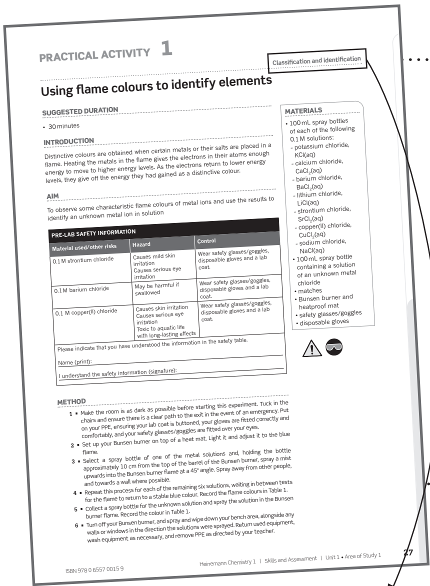
KEY KNOWLEDGE

Each area of study begins with a key knowledge section. This consists of a set of summary notes that cover the key knowledge for that area of study. Key terms are in bold and are included in the glossary of the student book. The section also serves as a ready reference for completing the worksheets and practical activities.

WORKSHEETS

The worksheets feature questions that allow you to practise and apply your knowledge and skills. Each area of study includes a 'Knowledge review' worksheet to activate prior knowledge, a 'Literacy review' worksheet that provides opportunities for vocabulary and literacy support, and a 'Reflection' worksheet, which you can use for self-assessment. Other worksheets provide opportunities to revise, consolidate and further your understanding. All worksheets function as formative assessment and are clearly aligned with the study design. A range of questions building from foundation to challenging is included in each worksheet.





Classification and identification

PRACTICAL ACTIVITIES

Practical activities offer you the chance to complete practical work related to the various themes covered in the study design. You have the opportunity to design and conduct scientific investigations, generate, evaluate and analyse data, appropriately record results, and prepare evidence-based conclusions. Where relevant, you will also need to conduct risk assessments to identify any potential hazards.

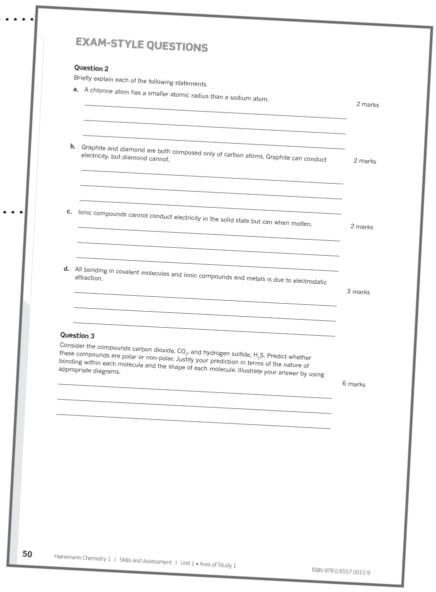
Each practical activity includes a suggested duration. Together with the Area of Study 3 scientific investigations, the practical activities meet the 34 hours of practical work mandated for Units 1 and 2 in the study design.

METHODOLOGIES

Each worksheet and practical activity is mapped to one or more of the scientific investigation methodologies outlined in the study design. Completing these activities gives you experience in applying the methodologies in a wide variety of contexts and prepares you for designing and conducting your own scientific investigation in Unit 2 Area of Study 3.

EXAM-STYLE QUESTIONS

Each area of study finishes with a selection of exam-style questions. These give you the opportunity to gain valuable experience in applying your knowledge and understanding to exam-style questions.



TEACHER SUPPORT

Comprehensive answers and fully worked solutions for all worksheets, practical activities and exam-style questions are provided via the *Heinemann Chemistry 1 eBook + Assessment* or Pearson Places. In-depth support for Unit 1 Area of Study 3 and Unit 2 Area of Study 3 in the form of samples, templates and teacher notes is also included, along with an interactive SPARKlab for every practical activity.

Chemistry toolkit

This toolkit provides support for developing the skills required to undertake research and practical investigations. It also covers study skills and examination preparation. The toolkit can serve as a reference tool that you can consult as needed throughout the year.

Scientific method

Chemists make observations and construct hypotheses to account for their observations. A **hypothesis** can be considered an educated guess, made to explain observations.

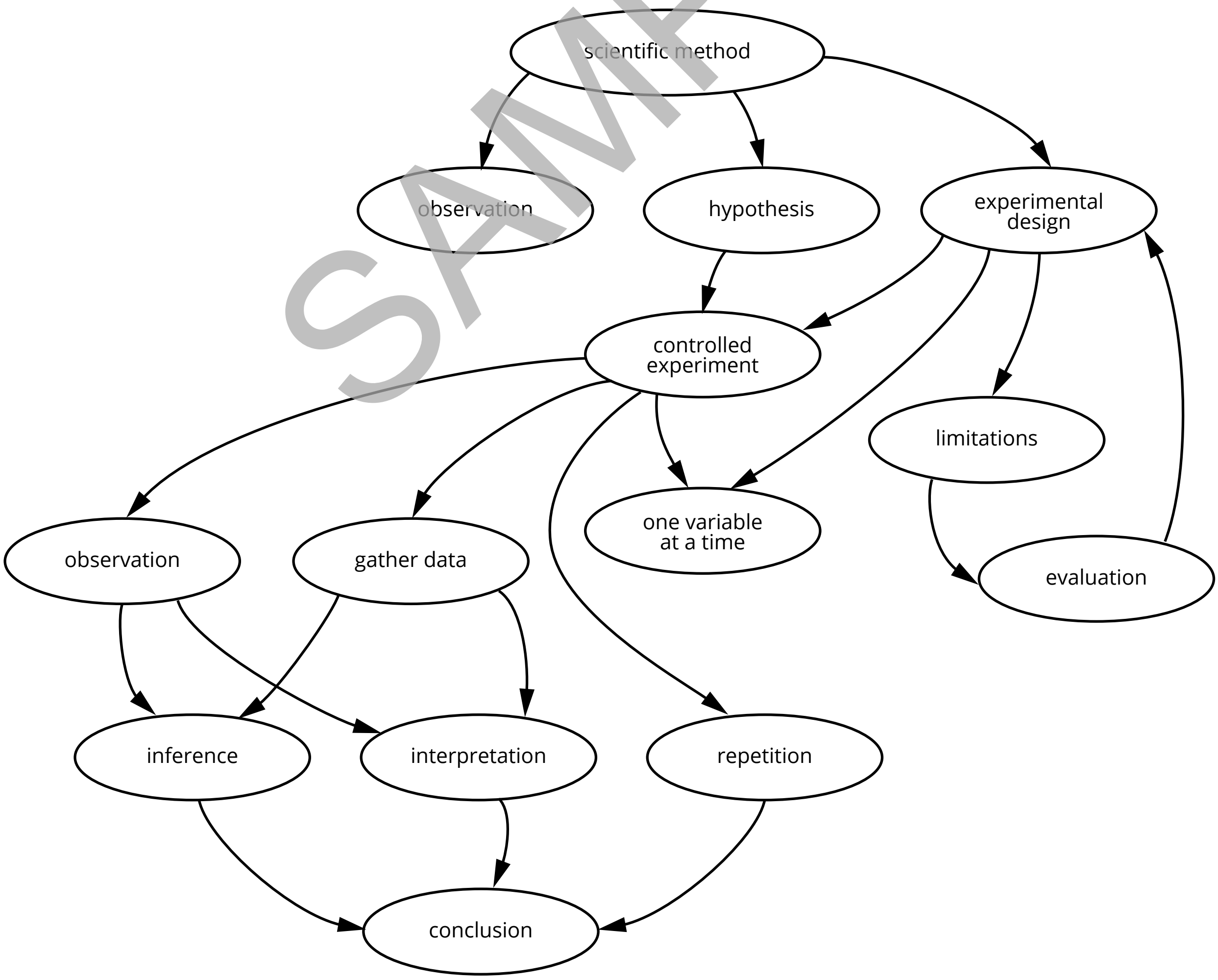
Hypotheses are then tested by following the principles of the **scientific method**. These include:

- asking relevant questions; that is, questions that can be tested
- making careful observations
- designing and conducting **controlled experiments**; in controlled experiments all **variables** are kept constant, except the one under investigation
- keeping an accurate record of experimental results
- interpreting experimental data and observations in a logical manner
- drawing logical **conclusions** from the experimental results.

The results of a scientific investigation may negate or refute the hypothesis being tested. In this case, the hypothesis must be re-evaluated and modified. Such results are useful in redirecting scientific investigation.

When experimental results repetitively support a hypothesis, the hypothesis may become a **theory** or **principle**; that is, the hypothesis is accepted as a scientific truth.

The scientific method recognises that there are limitations in investigations. For example, some factors cannot be measured, a sample size may be too small to be representative, or unknown factors may influence investigations.



The scientific method is the process scientists use to conduct experiments and test hypotheses.

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EXAMPLES OF SCIENTIFIC REPORTS

It can be difficult to gauge whether you have attained a high standard in your completed scientific report. Looking at sample scientific reports can help you identify what is required. Two sample scientific reports are provided here as a reference: one is prepared to a high standard and the second has room for improvement. They include annotations to draw your attention to key points to note on each scientific report. These points are also reflected in the checklist, so you can use this as a tool to evaluate whether all requirements of the scientific investigation are complete.

High standard practical report

What is the effect of concentration on the rate of a chemical reaction?

> State the reason for doing the investigation.

Aim

To investigate whether increasing the concentration of sodium thiosulfate solution will affect the rate of a reaction between sodium thiosulfate and hydrochloric acid

> The hypothesis is based on the aim of the investigation. Student has predicted what will occur with a reason.

Hypothesis

If the concentration of sodium thiosulfate solution is increased, then the rate of a reaction will increase because there will be more reactant particles present in the same volume, meaning reactant particles will collide more frequently.

> Identify the different variables.
> The variable that will be changed is identified. There will almost always be more than one controlled variable.

Variables

Independent variable: concentration of sodium thiosulfate

Dependent variable: rate of reaction (measured by time taken for black cross to disappear)

Controlled variables:

- volume of solutions, 45 mL sodium thiosulfate, 5 mL HCl
- concentration of HCl, 2.0 M

> All chemicals and equipment are listed, including numbers of specific items. The concentration of chemicals is included.

Materials

- 20 mL of 2.0 mol L^{-1} hydrochloric acid
- 100 mL of 0.25 mol L^{-1} sodium thiosulfate solution
- 10 mL measuring cylinder
- 100 mL measuring cylinder
- reaction vessel, 100 mL beaker
- 5 × 100 mL beakers
- stopwatch
- black marking pen

> Warn of potential hazards and how these can be reduced or eliminated.

Risk assessment

Material	Hazard	Control
sulfur dioxide gas	toxic by inhalation; causes burns; risk of serious damage to eyes	Avoid breathing gas: work in a well-ventilated area and dispose of reaction mixtures in a sink in a fume cupboard. Wear safety glasses.
sulfur powder	highly flammable	Keep away from sources of ignition. Do not breathe dust. Avoid contact with eyes.
2.0 mol L^{-1} hydrochloric acid	splashes to eyes	Wear safety glasses.

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Methodology

A controlled experiment was conducted to determine the effect of concentration on the rate of a reaction between sodium thiosulfate and hydrochloric acid.

Method

1 Mark a cross on a sheet of paper with a black marking pen.
2 Place a 100 mL beaker on top of the cross. Pour 10 mL of 0.25 mol L^{-1} sodium thiosulfate solution and 35 mL of water into the beaker. Add 5 mL of 2 mol L^{-1} hydrochloric acid and commence timing. Measure and record in Table 1 the time taken for the cross to disappear when viewed from above the beaker.
3 Place a 100 mL beaker on top of the cross. Pour 15 mL of 0.25 mol L^{-1} sodium thiosulfate solution and 30 mL of water into the beaker. Add 5 mL of 2 mol L^{-1} hydrochloric acid and commence timing. Measure and record the time taken for the cross to disappear when viewed from above the beaker.
4 Place another 100 mL beaker on top of the cross. Pour 25 mL of the sodium thiosulfate solution and 20 mL of water into the beaker. Add 5 mL of hydrochloric acid and commence timing. Measure and record the time taken for the cross to disappear.
5 Place a 100 mL beaker on top of the cross. Pour 35 mL of 0.25 mol L^{-1} sodium thiosulfate solution and 10 mL of water into the beaker. Add 5 mL of 2 mol L^{-1} hydrochloric acid and commence timing. Measure and record the time taken for the cross to disappear when viewed from above the beaker.
6 Place another 100 mL beaker on top of the cross. Pour 40 mL of sodium thiosulfate solution and 5 mL of water into the beaker. Add 5 mL of hydrochloric acid and commence timing. Measure and record the time taken for the cross to disappear.
7 Calculate a reaction rate according to reaction rate $= \frac{1}{\text{time}}$ taken for cross to disappear and add to Table 1.

Describe the overall approach undertaken in the scientific investigation and the reasons for taking this approach.

Provide clear instructions about each step of the experiment. These should be written in the third person as recipe-style, numbered, easy-to-follow detailed instructions.

UNIT 1

How can the diversity of materials be explained?

AREA OF STUDY 1

How do the chemical structures of materials explain their properties and reactions?

Outcome

On completion of this unit the student should be able to explain how elements form carbon compounds, metallic lattices and ionic compounds, experimentally investigate and model the properties of different materials, and use chromatography to separate the components of mixtures.

Key knowledge

Elements and the periodic table

- the definitions of elements, isotopes and ions, including appropriate notation: atomic number; mass number; and number of protons, neutrons and electrons
- the periodic table as an organisational tool to identify patterns and trends in, and relationships between, the structures (including shell and subshell electronic configurations and atomic radii) and properties (including electronegativity, first ionisation energy, metallic and non-metallic character and reactivity) of elements
- critical elements (for example, helium, phosphorus, rare-earth elements and post-transition metals and metalloids) and the importance of recycling processes for element recovery

Covalent substances

- the use of Lewis (electron dot) structures, structural formulas and molecular formulas to model the following molecules: hydrogen, oxygen, chlorine, nitrogen, hydrogen chloride, carbon dioxide, water, ammonia, methane, ethane and ethene
- shapes of molecules (linear, bent, pyramidal, and tetrahedral, excluding bond angles) as determined by the repulsion of electron pairs according to valence shell electron pair repulsion (VSEPR) theory
- polar and non-polar character with reference to the shape of the molecule
- the relative strengths of intramolecular bonding (covalent bonding) and intermolecular forces (dispersion forces, dipole-dipole attraction and hydrogen bonding)
- physical properties of molecular substances (including melting points and boiling points and non-conduction of electricity) with reference to their structure
- the structure and bonding of diamond and graphite that explain their properties (including heat conductivity and electrical conductivity and hardness) and their suitability for diverse applications

Reactions of metals

- the common properties of metals (lustre, malleability, ductility, melting point, heat conductivity and electrical conductivity) with reference to the nature of metallic bonding and the existence of metallic crystals
- experimental determination of a reactivity series of metals based on their relative ability to undergo oxidation with water, acids and oxygen
- metal recycling as an example of a circular economy where metal is mined, refined, made into a product, used, disposed of via recycling and then reprocessed as the same original product or repurposed as a new product

Reactions of ionic compounds

- the common properties of ionic compounds (brittleness, hardness, melting point, difference in electrical conductivity in solid and molten liquid states), with reference to the nature of ionic bonding and crystal structure
- deduction of the formula and name of an ionic compound from its component ions, including polyatomic ions (NH_4^+, OH^-, NO_3^-, HCO_3^-, CO_3^{2-}, SO_4^{2-} and PO_4^{3-})
- the formation of ionic compounds through the transfer of electrons from metals to non-metals, and the writing of ionic compound formulas, including those containing polyatomic ions and transition metal ions
- the use of solubility tables to predict and identify precipitation reactions between ions in solution, represented by balanced full and ionic equations including the state symbols: (s), (l), (aq) and (g)

Separation and identification of the components in mixtures

- polar and non-polar character with reference to the solubility of polar solutes dissolving in polar solvents, and non-polar solutes dissolving in non-polar solvents
- experimental application of chromatography as a technique to determine the composition and purity of different types of substances, including calculation of R_f values

Elements and the periodic table

Chemistry is the study of the composition, properties and reactions of matter.

All matter is made of **atoms**. A substance made up of only one type of atom is called an **element** and a substance made up of two or more different types of atoms is called a **compound.**

Elements can be monatomic (existing as single atoms), exist as clusters of atoms called molecules or form into large networks called lattices or **giant molecules**. Compounds can be molecules or lattices. Molecules and lattices form the basis of all of the materials that are used in everyday life.

Matter can be classified as a pure substance or a mixture. A mixture can be further classified as homogeneous or heterogeneous (Figure 1.1.1).

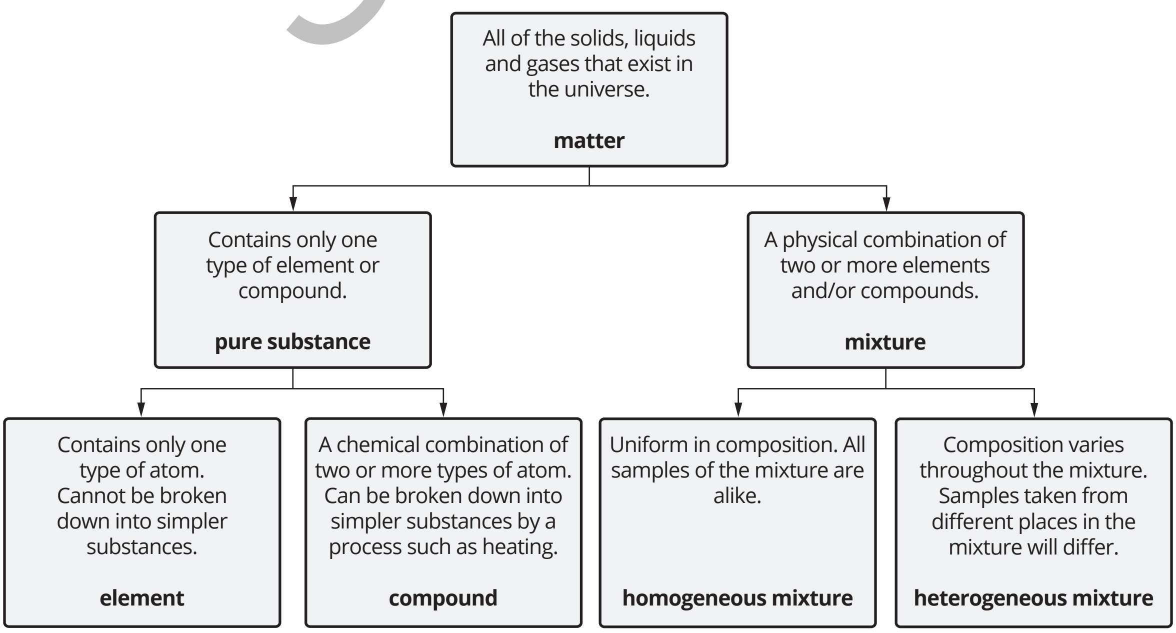

Figure 1.1.1 Matter is classified according to its components and how they are arranged.

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KEY KNOWLEDGE

ATOMIC STRUCTURE

Each element is made up of one type of atom. Atoms contain three types of smaller subatomic particles called **neutrons**, **protons** and **electrons** (Table 1.1.1). The type of atom is determined by the number of protons in the nucleus. Atoms of the same type of element always contain the same number of protons.

Table 1.1.1 Subatomic particles

Particle	Relative mass	Charge	Location
neutron	1	neutral	nucleus
proton	1	positive	nucleus
electron	$\frac{1}{1800}$	negative	cloud surrounding the nucleus

The nucleus of an atom contains neutrons and protons held together by the nuclear strong force. The **atomic number** of an element indicates the number of protons in the nucleus and is given the symbol *Z*. The **mass number** of an element indicates the total number of nucleons (protons plus neutrons) (Figure 1.1.2).

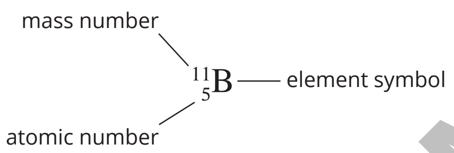

Figure 1.1.2 representation of a boron atom

Isotopes

All atoms of the same element have identical atomic numbers. However, atoms of the same element can have different mass numbers that is, they can have different numbers of neutrons. Atoms of the same element with different masses are called **isotopes** (Figure 1.1.3).

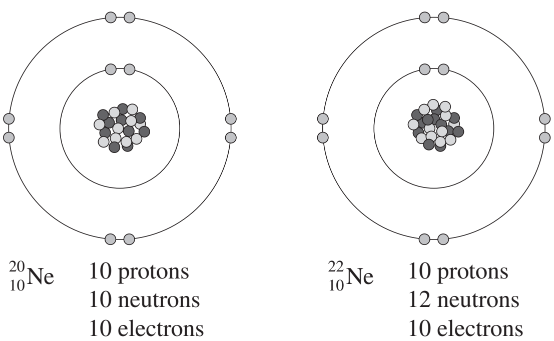

Figure 1.1.3 Isotopes of neon

ELECTRONIC STRUCTURE OF ATOMS

The Bohr model of the atom places electrons in certain well-defined orbits of fixed energies called **electron shells** (Figure 1.1.4).

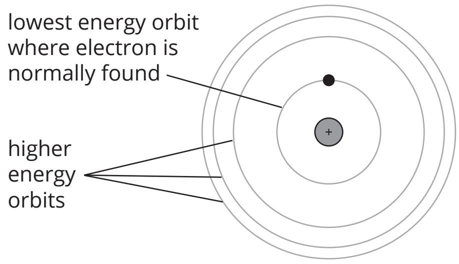

Figure 1.1.4 Bohr's shell model of the atom

Electrons in the same shell are a similar distance from the nucleus and have similar energy. Shells are numbered 1, 2, 3, 4, 5 and so on, from the nucleus outwards. A maximum number of electrons can occupy each shell (Table 1.1.2).

Table 1.1.2 Maximum number of electrons that can occupy each electron shell of an atom

Electron shell number (*n*)	Maximum number of electrons
1	2
2	8
3	18
4	32
n	$2n^2$

Electrons fill lower energy shells before higher energy shells. An **electron configuration** for an element lists the number of electrons in each shell. For example, sodium has an atomic number of 11 and contains 11 electrons. Shells 1 and 2 are filled and shell 3 holds the 11th electron. The electronic configuration of sodium is 2,8,1.

The electron(s) in the outer shell of an atom are called valence electrons. Sodium has one valence electron. The valence electrons determine an element's chemical properties.

Subshell electronic configuration

Erwin Schrödinger refined Bohr's model by proposing that electrons should be regarded as having wave-like properties. In Schrödinger's model, electrons are not restricted to a given orbit but behave as negative clouds of charge in regions of space called **orbitals** (Figure 1.1.5).

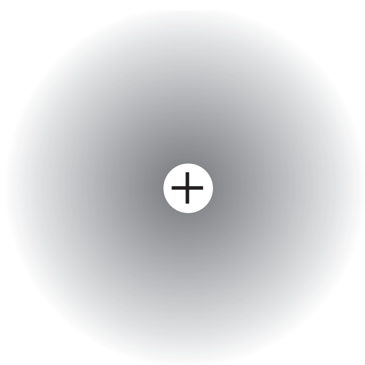

Figure 1.1.5 An electron cloud around a nucleus

Electrons make up most of the volume of an atom. Orbitals are located in **subshells** within shells (Table 1.1.3).

Table 1.1.3 Different levels of organisation of electrons

Level of organisation	Definition	Label used
shell	a major energy level within an atom	1, 2, 3, 4, 5 etc.
subshell	an energy level within a shell	*s, p, d, f*
orbital	a region in a subshell in which electrons move	

The Pauli exclusion principle states that each orbital may hold a maximum of 2 electrons (Figure 1.1.6).

- An *s* subshell has 1 orbital and can hold up to 2 electrons.
- A *p* subshell has 3 orbitals and can hold up to 6 electrons.
- A *d* subshell has 5 orbitals and can hold up to 10 electrons.
- An *f* subshell has 7 orbitals and can hold up to 14 electrons.

The subshells closest to the nucleus have the lowest energy and are filled first.

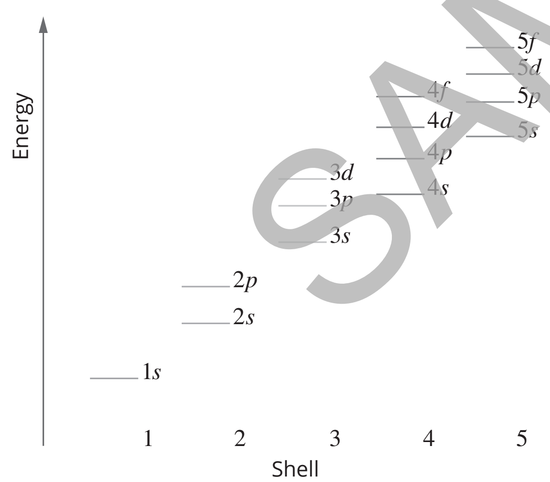

Figure 1.1.6 The energy levels in the atom

Note that some subshells are higher in energy than the subshells of the next shell (Figure 1.1.6). For instance, the unfilled 3*d* subshell is higher in energy than the unfilled 4*s* subshell. Therefore, the 4*s* subshell is filled before the 3*d* subshell.

Condensed electron configuration

The condensed electron configuration is an abbreviated version of the full configuration. The symbol of a noble gas, enclosed in square brackets, is used in the electron configuration to represent the inner-shell electrons. Only the valence electrons are shown in their shells or subshells.

The full and condensed electronic configurations of lithium, nitrogen, potassium and nickel are shown in Table 1.1.4.

Table 1.1.4 Electronic configurations of some elements

Element	Atomic number	Electronic configuration using subshell model	Condensed electronic configuration
lithium	3	$1s^2 2s^1$	$1s^2 2s^1$
nitrogen	7	$1s^2 2s^2 2p^3$	[He] $2s^2 2p^3$
potassium	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$	[Ar] $4s^1$
nickel	28	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$	[Ar] $3d^8 4s^2$

Chromium and copper are exceptions to the usual order of subshell filling. In these cases, there is increased stability in having a half or completely full *d* subshell, so an electron from the 4*s* subshell is excited and is promoted to a 3*d* orbital. Their electronic configurations are:

Cr $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

Cu $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

Ions

Atoms are electrically neutral because they contain an equal number of negative electrons and positive protons.

Atoms can lose or gain valence electrons to form charged particles called ions. Ions can be positively or negatively charged, and have different-sized charges depending on the number of electrons lost or gained. Some examples are shown in Table 1.1.5.

Table 1.1.5 Charge on different ions

Ion	Number of protons	Number of electrons	Explanation for charge on ion
Na^+	11	10	one more proton than electron, so has a +1 charge
Mg^{2+}	12	10	two more protons than electrons, so has a +2 charge
Cl^-	17	18	one more electron than proton, so has a –1 charge
N^{3-}	7	10	three more electrons than protons, so has a –3 charge

- **You will now be able to complete Worksheets 1 and 2 and conduct Practical Activity 1.**

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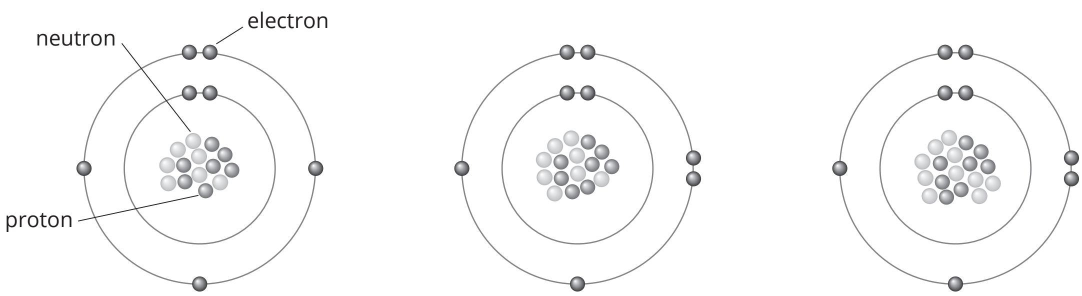
Knowledge review—structure of the atom

Examine the three atoms represented by these shell models.



atom A　　atom B　　atom C

1 Complete the information for each atom.

	Atom A	Atom B	Atom C
Atomic number			
Mass number			
Name of element			

2 Which two atoms in Question 1 are isotopes? Explain.

3 The three types of subatomic particle are labelled in atom A.

a Which subatomic particle has a negative charge? ________________

b Which subatomic particle has a positive charge? ________________

c Which two subatomic particles are assigned a mass of 1? ________________________________

4 The diagrams above are representations of the structure of atoms. Describe two limitations of these diagrams.

5 When a chemical reaction occurs, the atoms in the reactants rearrange to become the products. Mark each statement below about chemical reactions as true or false.

Statement about chemical reactions	True or false?
Mass is always conserved in a chemical reaction.	
The rate of a chemical reaction will change with changes in temperature.	
The total mass of the products may be slightly less than or greater than the starting mass of the reactants.	
The number of protons in a particular atom might change during a chemical reaction.	
If there are six carbon atoms in the reactants of a chemical reaction, there must also be six carbon atoms in the products.	

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Literacy review—comparing similar terms

In Area of Study 1, you learnt a number of new terms. Demonstrate your understanding of some of these terms by comparing the meaning of each pair of terms. Include examples wherever possible.

1 atomic number and mass number

2 electronegativity and electrostatic attraction

3 mobile phase and stationary phase

4 critical element and rare-earth element

5 electron configuration and condensed electron configuration

6 anion and cation

7 adsorption and desorption

8 ionic bond and covalent bond

9 polar molecule and non-polar molecule

WORKSHEET 12

Reflection—How do the chemical structures of materials explain their properties and reactions?

The following table lists the key knowledge covered in this area of study.

1 Reflect on how well you understand the concepts listed. Rate your learning by shading the circle that corresponds to your current level of understanding for each one.

Key knowledge	Not confident ◄			► Very confident
Elements, isotopes and ions—notation, atomic number, mass number and numbers of protons, electrons and neutrons	○	○	○	○
Electron structure of atoms—electronic configuration, shells, subshells and orbitals	○	○	○	○
Periodic table—trends in physical and chemical properties of elements in periods and groups	○	○	○	○
Covalent bonding—shape and polarity of molecules and intermolecular forces	○	○	○	○
Chemical structures—metallic bonding and ionic bonding	○	○	○	○
Solubility of ionic substances and precipitation reactions	○	○	○	○
Chromatography—separation and identification of polar and non-polar components in a mixture	○	○	○	○

2 Consider the points you have shaded from 'Not confident' to 'Very confident'. List specific ideas you can identify that were challenging.

3 Write down two different strategies that you will apply to help further your understanding of these ideas.

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Using flame colours to identify elements

SUGGESTED DURATION

- 30 minutes

INTRODUCTION

Distinctive colours are obtained when certain metals or their salts are placed in a flame. Heating the metals in the flame gives the electrons in their atoms enough energy to move to higher energy levels. As the electrons return to lower energy levels, they give off the energy they had gained as a distinctive colour.

AIM

To observe some characteristic flame colours of metal ions and use the results to identify an unknown metal ion in solution

MATERIALS

- 100 mL spray bottles of each of the following 0.1 M solutions:
  - potassium chloride, $KCl(aq)$
  - calcium chloride, $CaCl_2(aq)$
  - barium chloride, $BaCl_2(aq)$
  - lithium chloride, $LiCl(aq)$
  - strontium chloride, $SrCl_2(aq)$
  - copper(II) chloride, $CuCl_2(aq)$
  - sodium chloride, $NaCl(aq)$
- 100 mL spray bottle containing a solution of an unknown metal chloride
- matches
- Bunsen burner and heatproof mat
- safety glasses/goggles
- disposable gloves

PRE-LAB SAFETY INFORMATION

Material used/other risks	Hazard	Control
0.1 M strontium chloride	Causes mild skin irritation Causes serious eye irritation	Wear safety glasses/goggles, disposable gloves and a lab coat.
0.1 M barium chloride	May be harmful if swallowed	Wear safety glasses/goggles, disposable gloves and a lab coat.
0.1 M copper(II) chloride	Causes skin irritation Causes serious eye irritation Toxic to aquatic life with long-lasting effects	Wear safety glasses/goggles, disposable gloves and a lab coat.

Please indicate that you have understood the information in the safety table.

Name (print): ______________________

I understand the safety information (signature): ______________________

METHOD

1. Make the room is as dark as possible before starting this experiment. Tuck in the chairs and ensure there is a clear path to the exit in the event of an emergency. Put on your PPE, ensuring your lab coat is buttoned, your gloves are fitted correctly and comfortably, and your safety glasses/goggles are fitted over your eyes.
2. Set up your Bunsen burner on top of a heat mat. Light it and adjust it to the blue flame.
3. Select a spray bottle of one of the metal solutions and, holding the bottle approximately 10 cm from the top of the barrel of the Bunsen burner, spray a mist upwards into the Bunsen burner flame at a 45° angle. Spray away from other people, and towards a wall where possible.
4. Repeat this process for each of the remaining six solutions, waiting in between tests for the flame to return to a stable blue colour. Record the flame colours in Table 1.
5. Collect a spray bottle for the unknown solution and spray the solution in the Bunsen burner flame. Record the colour in Table 1.
6. Turn off your Bunsen burner, and spray and wipe down your bench area, alongside any walls or windows in the direction the solutions were sprayed. Return used equipment, wash equipment as necessary, and remove PPE as directed by your teacher.

RESULTS

Table 1 Flame colours of different metal chlorides

Type of metal in carbonate	Flame colour
unknown	
potassium	
calcium	
barium	
strontium	
copper(II)	
lithium	
sodium	

DISCUSSION

1 Identify which ion causes the flame colour: the metal cation or the chloride anion. Justify your answer.

2 Explain, in terms of the movement of electrons, why light is produced by these metals when they are heated in the Bunsen burner flame. Draw a labelled diagram as part of your answer.

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3 Explain how each metal produces a different flame colour.

4 Identify which metal ion you think was in the solid labelled 'unknown'. Describe the evidence you have used to make this choice.

5 **a** Identify the independent variable:

b Identify the dependent variable:

c Identify any controlled variables:

6 Identify at least two limitations of using a flame test to determine which metal ions are present in an unknown compound.

CONCLUSION

EXAM-STYLE QUESTIONS

Multiple-choice questions

Question 1

Identify the particles in the isotope of iodine that is represented by the symbol $^{131}_{53}I$.

A. The isotope has 53 protons and 78 neutrons.

B. The isotope has 53 neutrons and 78 protons.

C. The isotope has 53 neutrons and 131 protons.

D. The isotope has 53 protons and 131 neutrons.

Question 2

Which of the following electronic configurations could be for a $^{52}_{24}Cr$ atom in an excited state?

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4 4s^2$

B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$

C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$

D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4p^1$

Question 3

Identify the correct formula of the ionic compound made from strontium and chlorine.

A. SrCl

B. $SrCl_2$

C. Sr_2Cl

D. Sr_2Cl_2

Question 4

Identify which of the following molecules is polar.

A. O_2

B. CH_4

C. CO_2

D. NH_3

Question 5

Select the number of lone electron pairs in a molecule of methane, CH_4.

A. 0

B. 1

C. 2

D. 4

Question 6

Select the best description of the shape of a molecule of methane, CH_4.

A. bent

B. linear

C. pyramidal

D. tetrahedral

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EXAM-STYLE QUESTIONS

Question 7

Select the strongest type of bond.

A. ionic

B. metallic

C. covalent

D. dispersion forces

Question 8

Which of the following ionic compounds is insoluble in water?

A. potassium sulfate

B. iron nitrate

C. ammonium hydroxide

D. magnesium carbonate

Question 9

When silver nitrate reacts with sodium chloride, a precipitate forms according to the equation:

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

Identify the spectator ions.

A. Ag^+ and Cl^-

B. Na^+ and Cl^-

C. Na^+ and NO_3^-

D. Ag^+ and NO_3^-

Question 10

Under a particular set of conditions of thin-layer chromatography, component A adsorbs more strongly to the polar stationary phase than component B. Which of the following options best describes their polarity and retention factor?

A. Component A is more polar than component B and will have a higher retention factor.

B. Component A is less polar than component B and will have a higher retention factor.

C. Component A is more polar than component B and will have a lower retention factor.

D. Component A is less polar than component B and will have a lower retention factor.

Short-answer questions

Question 1

The electronegativities of C, H and Cl are 2.6, 2.1 and 3.2 respectively. What is the most polar bond out of C–Cl, C–H and H–Cl? Justify your answer.

3 marks