外教社——麦克米伦中学双语教材系列

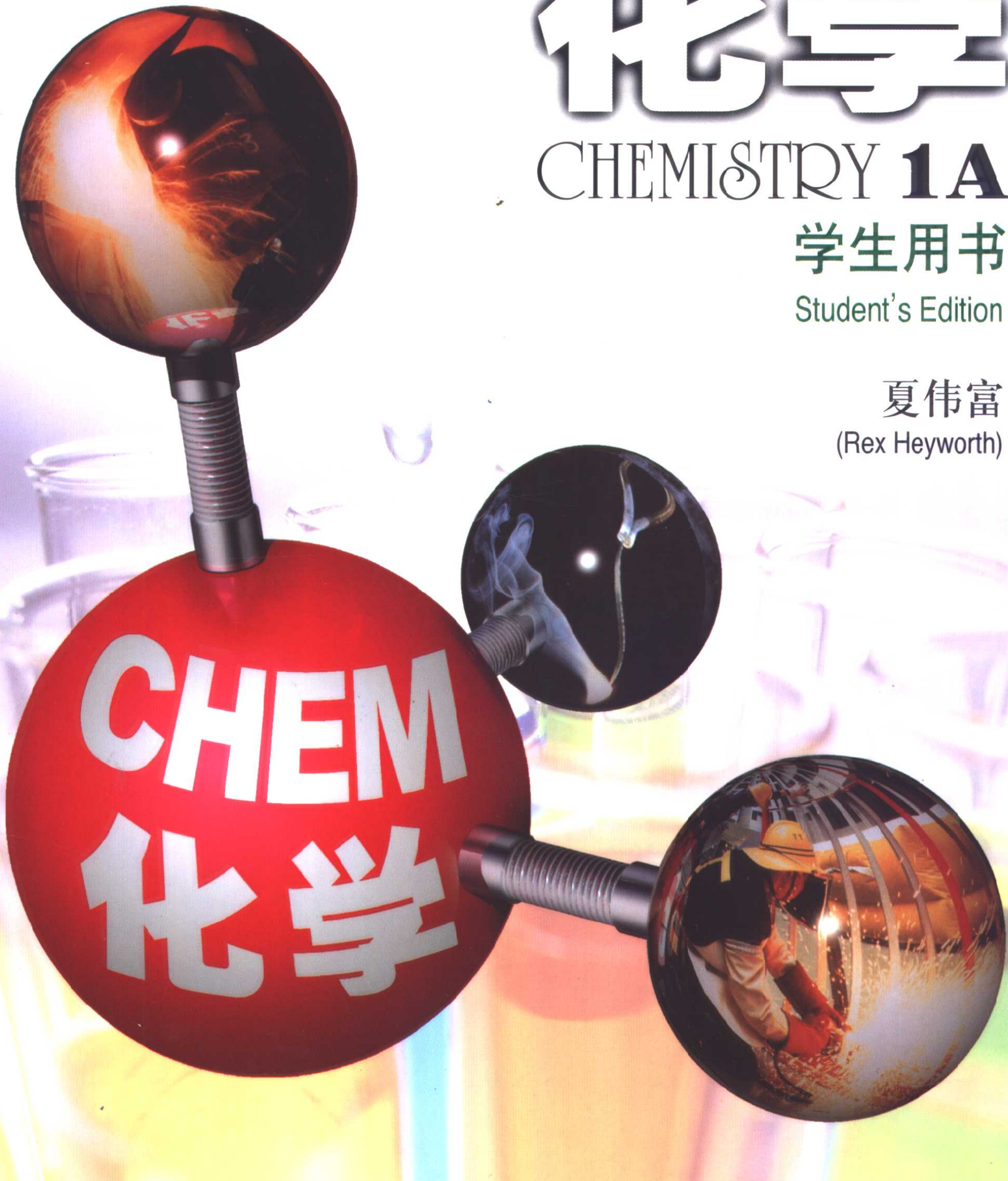
化学

CHEMISTRY 1A

学生用书

Student's Edition

夏伟富
(Rex Heyworth)



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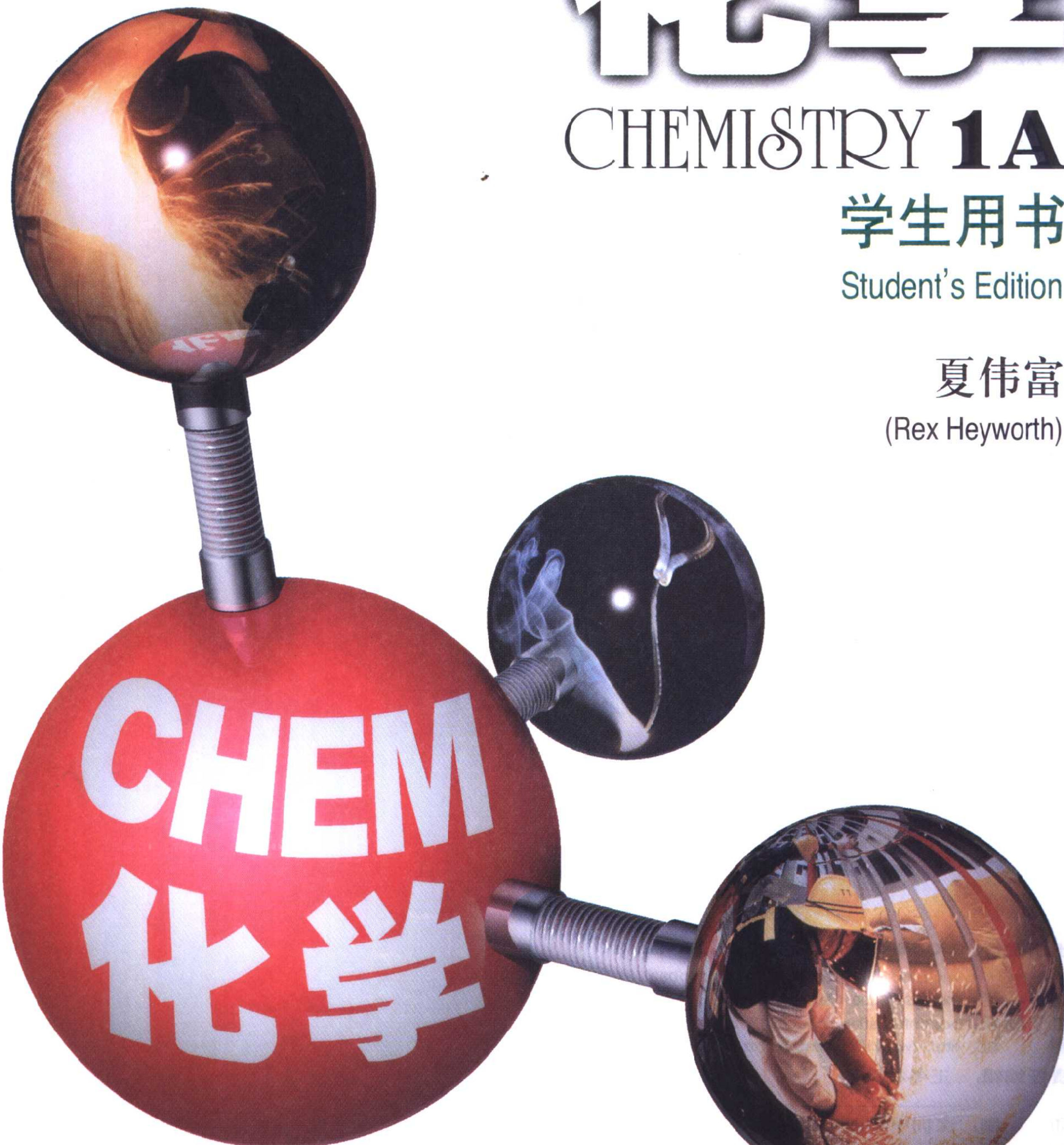

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出版前言

双语教育以外语作为学科的教学语言，直接进行学科知识的教学。这种新的教学尝试引起了教育主管部门、教育工作者、外语专家以及成千上万学子和家长的关注。随着对外开放的不断深入以及成功加入WTO，我国在经济、科技、教育等领域全面步入国际舞台，在更大范围内和更深层次上参与国际竞争，这对我们人才培养的规模和规格提出了崭新的要求。为了培养能够熟练运用外语吸收先进科技知识、参与国际交流的人才，基础教育的改革势在必行。双语教育对教师、学生、教育研究人员以及教育服务机构都是一种新的挑战。这种新的教学方法要取得成功，需要大胆而又科学的摸索与实践，也需要教师、学生、教育研究人员和教育服务机构各方的协同努力。

作为外语教育出版领域的专业出版社，外教社秉承一贯“全心致力中国外语教育事业的发展”的宗旨，为更好地推动双语教育，抓住时机，经过精心策划，从众多的双语教材中选择了原由麦克米伦出版社出版、在我国香港地区广泛使用的教材，供大陆地区进行双语教育试验的学校使用。本套《外教社—麦克米伦中学双语教材系列》主要有以下特点：

1. 英语语言纯正流畅，适合中学生水平，学生可以比较轻松地掌握学科知识，并在学习的过程中不知不觉地提高英语应用能力。

2. 教学内容丰富，编写体系完整，例证贴近生活，注重跨学科教育。

3. 版式活泼，插图精美，表格详细，各种知识的表现更加直观易懂，从而提高学生兴趣，增强教学效果。

4. 注意现代化教学手段的运用。页边空白处列出与授课内容相关的网址，为学生了解更多相关知识提供了有益的参考。

尽管可能在编写体系、知识结构、学科内容等方面与大陆地区传统学科教学稍有不同之处，我们相信本套教材纯正地道的英语、丰富的课程资源以及全新的教学理念会对大陆地区的双语教育产生良好的推动作用。

本套教材可供有较好英语基础的双语学校、国际学校、外国语学校以及重点中学进行双语教学使用。

本教材承蒙上海外国语大学双语学校的李秀萍、朱卫、周丽华、余枭然老师仔细审读，在此表示衷心的感谢。同时也欢迎使用本套教材的师生向我们提出宝贵意见。

上海外语教育出版社

2003年5月

Periodic table of elements

Period	Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
1							1 H 1.0 Hydrogen (g)											2 He 4.0 Helium (g)
2	3 Li 6.9 Lithium	4 Be 9.0 Beryllium											5 B 10.8 Boron	6 C 12 Carbon	7 N 14.0 Nitrogen (g)	8 O 16 Oxygen (g)	9 F 19.0 Fluorine (g)	10 Ne 20.2 Neon (g)
3	11 Na 23.0 Sodium	12 Mg 24.3 Magnesium	TRANSITION METALS										13 Al 27.0 Aluminium	14 Si 28.1 Silicon	15 P 31.0 Phosphorus	16 S 32.1 Sulphur	17 Cl 35.5 Chlorine (g)	18 Ar 39.9 Argon (g)
4	19 K 39.1 Potassium	20 Ca 40.1 Calcium	21 Sc 45.0 Scandium	22 Ti 47.9 Titanium	23 V 50.9 Vanadium	24 Cr 52.0 Chromium	25 Mn 54.7 Manganese	26 Fe 55.8 Iron	27 Co 58.9 Cobalt	28 Ni 58.7 Nickel	29 Cu 63.5 Copper	30 Zn 65.4 Zinc	31 Ga 69.7 Gallium	32 Ge 72.6 Germanium	33 As 74.9 Arsenic	34 Se 79 Selenium	35 Br 80.0 Bromine (l)	36 Kr 83.8 Krypton (g)
5	37 Rb 85.5 Rubidium	38 Sr 87.6 Strontium	39 Y 88.9 Yttrium	40 Zr 91.2 Zirconium	41 Nb 92.9 Niobium	42 Mo 95.5 Molybdenum	43 Tc (98) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 127.0 Iodine	54 Xe 131.3 Xenon (g)
6	55 Cs 132.9 Caesium	56 Ba 137.3 Barium	[57 – 71] Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.0 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury (l)	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po (209) Polonium	85* At (210) Astatine	86 Rn (222) Radon (g)
7	87 Fr (223) Francium	88 Ra 226.0 Radium	[89 – 103] Actinides	104* Rf (261) Rutherfordium	105* Db (262) Dubnium	106* Sg (263) Seaborgium	107* Bh (264) Bohrium	108* Hs (265) Hassium	109* Mt (266) Meitnerium	110* Uun	111* Uuu	112* Uub	113* Uut					

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61* Pm (145) Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium
89 Ac 227.0 Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93* Np 237.0 Neptunium	94* Pu (244) Plutonium	95* Am 243 Americium	96* Cm (247) Curium	97* Bk (247) Berkelium	98* Cf (251) Californium	99* Es (252) Einsteinium	100* Fm (258) Fermium	101* Md (258) Mendelevium	102* No (259) Nobelium	103* Lr (260) Lawrencium

Key: atomic number – 8; symbol – O; atomic mass – 16.0; name – Oxygen (g)

state of element at room temperature and pressure
(g) gas
(l) liquid
no entry – solid

metal | metalloid | non-metal

* – element does not occur naturally (man-made element)

Note: element 110 and above are given a temporary IUPAC nomenclature; element 113 has not yet been discovered but is included in the table at its expected position.

Preface

The course

The course consists of the following:

- two textbooks for students. They are both divided into two sections, book A and book B.
- two activity books (book 1 and 2) for students

The textbooks

Great attention has been paid to the presentation of the textbooks. Special features include:

- Careful choice of vocabulary, with use of Chinese terms to facilitate student comprehension.
- Full-colour diagrams and illustrations to maximize students' attention and interest.
- Study tips for students to aid learning.
- Cross reference to material in other parts of the book and to related material in other subjects, e.g. Biology and Physics.
- Carefully constructed examination-type questions to reflect the new emphasis of the syllabus.
- Full solutions to end-of-chapter questions.
- Material of social relevance.
- Techniques from educational psychology shown to be effective in facilitating learning and understanding. These techniques are found in a special students' introduction, in innovative chapter summaries, in section reviews and in margin references.
- 'Chemistry and Us' sections which stimulate interest and develop an appreciation of chemistry and its application in daily life.
- I.T. on the net sections provide web-sites for further information on selected topics.

The activity books

The basis of the course is the work in the activity books. They are designed mainly for small-group work and to help students think for themselves as much as possible. Special features include the following:

- The use of hazard warning symbols and safety warnings for experimental work.
- A variety of innovative activities to develop process skills including: decision-making exercises, problem-solving investigations, experimental design tasks, discussions or debates, data/information collection and communication tasks such as short talks.

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Student's notes – learning with the textbook

When we read a textbook, we want to understand and remember ideas. What is the best way to do this? Many students use repetition. This is not a good way. Repeating sentences sometimes helps us to remember. But it does not help us to understand.

The best way to remember is to understand. And the best way to understand is to think deeply about what we read. Some ways of doing this are described below.

How can we learn terms and their meanings?

Here are some ways to understand and remember terms. They work because they make us think deeply.

To remember chemical terms

Here is a useful method if you also know the Chinese word for a term. Do this:

1 Think of a Chinese word with a similar sound to the English chemical term.

2 Think of a picture to link this sound word with the Chinese word. Use any picture. Silly or weird pictures are often the best because these tend to stick in the mind.

EXAMPLE 1

To remember the chemical term 'bond'.

bond ⟷ 键

sound link

帮

picture link

a gang of friends forming a friendship bond

To remember the picture is easy. From the picture, you can recall the chemical term.

To remember meanings of chemical terms

This is similar to the previous method. First, understand the meaning. Then do this:

1 Think of a familiar Chinese or English word with a similar sound.

2 Make a picture link using some or all of the meaning.

EXAMPLE 2

To remember the meaning of the term 'cation'.

A cation is an ion with a positive charge.

cation ⟷ ion/positive charge

sound link

cat + iron

picture link

cat (with a +) using an electric iron

Word analysis

Many terms in chemistry are made of smaller parts joined together. Each part has a meaning. The parts can help us to work out the meaning of the term. 'Word analysis' gives a list of many common word parts. Also, 'STUDY TIPS' throughout the book gives you help.

EXAMPLE 3

What is the meaning of the term 'dehydrate'?

Dehydrate consists of the parts 'de-' and '– hydrate'.

From Word analysis, 'de-' = reverse, opposite to

'–hydr' = water

So, hydrate = adding water

dehydrate = removing water

deepty 深入地 | recall 记起 | repetition 重复学习 | silly 傻里傻气的 | Word analysis 词语分析

Sets of related words

Many words are related to other words. When possible, learn sets of related words. The study tips will help you. For example in Chapter 11:

electrolysis (noun)
electrolyte (noun)
electrode (noun)
electrolytic (adjective)
to electrolyse (verb)

To remember lists of words

Sometimes we need to remember a list of words. One way is to make a sentence with the words, or with the first letters of the words.

EXAMPLE 4

To remember the names and symbols of the first nine elements. Consider this sentence:

Harry **He**ung **Li**kes **Be**ef **B**ut **C**andy **N**g **O**rders **F**ish.

As this sentence is easy to remember, we can recall the symbols and the names for the elements. For example, Harry gives H (hydrogen), Fish gives F (fluorine).

EXAMPLE 5

Suppose you read the words in the box below. The ideas around the box are examples of elaboration.

Related words – e.g. electrolysis

Electrolytes Substances that conduct electricity when molten or in aqueous solution (i.e. dissolved in water). During conduction, they decompose. Compounds made of metals and non-metals are electrolytes.

Meaning of this word

Example – lead(II) bromide → lead + bromine

Examples – sodium chloride, lead(II) bromide, copper(II) sulphate

Elements cannot be electrolytes

Previous work – metals conduct electricity but they are not electrolytes

How can we understand ideas?

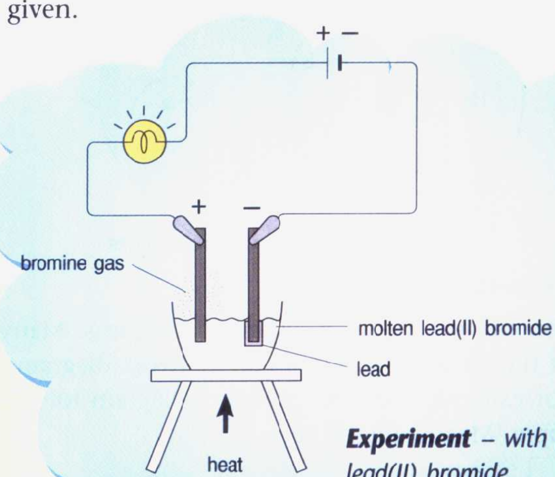
Understanding involves joining ideas together. Here are three ways to do this joining.

Elaboration

When you read something, think of other ideas related to the ideas in the text. You can:

- think of *examples*
- think of *diagrams* or *pictures*; you can even make your own mental pictures
- recall *experiments*
- join the ideas to work in *other subjects*, e.g. Biology, EPA
- recall *previous work*

The book helps you to elaborate by reminding you to 'THINK ABOUT' information from other subjects. References to 'MORE ABOUT' the subject are also given.



Experiment *– with molten lead(II) bromide*

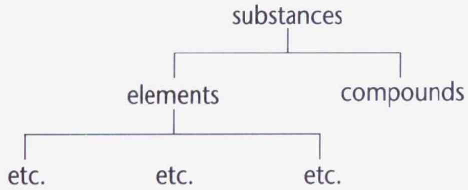
elaboration
扩大法

Organization

Organizing ideas also helps understanding. Some ways used in this book are shown below. Use these examples to help when you make your own organization.

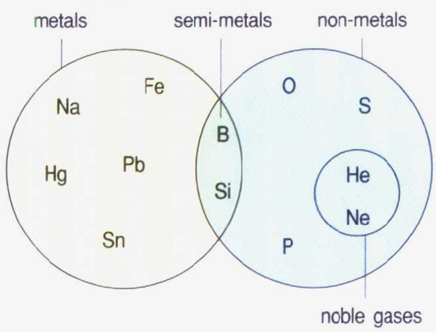
(a) Tree diagrams

For example, for a classification of substances (see the summary for Chapter 1).



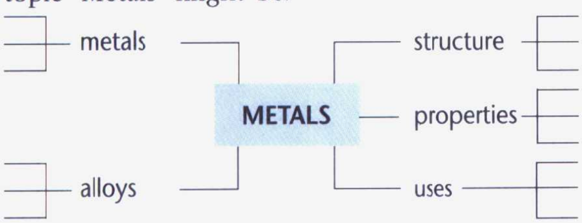
(b) Set diagrams

For example, for groups of elements (see Book 1A, page 6).



(c) Network diagrams

You can use these to organize any ideas. Many of the chapter summaries are network diagrams. For example, part of a network diagram for the topic 'Metals' might be:

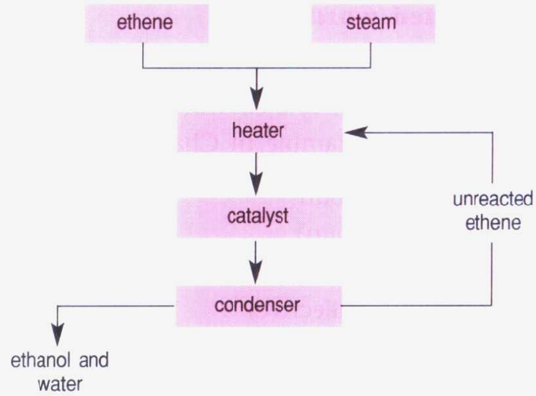


(d) Tables

A lot of information in Science is organized into tables. This book contains many tables. For example, look at the table in Chapter 5 for the structures of substances (see Book 1A, page 114).

(e) Flow charts

Flow charts are useful when one idea follows another. For example, in Chapter 18 we use a flow chart to explain the manufacture of ethanol (see Book 2A, page 139).



Reorganization

When something is organized one way, try to organize it another way. This will make your understanding even better. For example:

- If you have a table, reorganize it as a network diagram.
- Use the ideas in a network diagram to write sentences.

How can we study a chapter?

Here are three steps to follow when you study a chapter in the book.

Preview

To get an idea of what you will learn:

- Look at the headings in the chapter.
- Look at the summary.

Study each section

- Look at each heading. Many are in the form of questions. Think of other questions.
- Read the section. Underline important parts.
- Think deeply about the section. For example, use word analysis, elaboration.
- Answer the questions given. Also try to answer your own questions. This is important. If you cannot answer a question, study the section again.

Review

After you finish the chapter:

- Study the summary. Try to recall the ideas without looking at the summary.
- Try some of the examination-type problems at the end of the chapter.

flow charts 流程图　network diagrams 网络图解　preview 预习　review 复习　underline 划底线于

Introducing Chemistry

People have always wanted to understand the world. Science is one way to find out about the world. In Science, we find out about animals, plants, the air, the sea and rocks. We also learn about rockets, the sun, the moon and the planets. The word 'science' means 'knowledge'. Science provides us with knowledge about the world.

Science has many parts. Chemistry, Physics and Biology are some of the sciences studied in school. Other sciences include Geology, Astronomy, Medicine and Agriculture.

IT ON THE NET

What is Chemistry?
http://www.chemistry.co.nz/what_is_chemistry.htm
http://library.advanced.org/3659/intro/

What is Chemistry?

Chemistry is the study of matter.

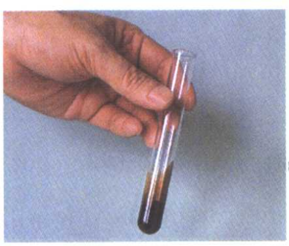
Matter means anything that has mass and occupies space. Each kind of matter is called a **substance**. Gold, water and salt are examples of substances.

How is Chemistry useful?

Chemistry is not just something we study at school. It is a subject closely related to our daily lives.

- **Chemistry in the home**

  Plastics are substances made from materials in oil. Why can one plastic be used to make a saucepan handle, while another melts if it becomes too hot?



Oil.

Objects made of plastic.

- **Chemistry in medicine**

  Many substances in plants can be used as medicines. What substances cure diseases?

- **Chemistry in transport**

  Aircraft are made from special alloys. Why are these alloys better than other metals for making aircraft?

- **Chemistry in food**

  Substances are added to preserve food. How do substances do this?

- **Chemistry in clothes**

  Many of our clothes are made from synthetic fibres such as nylon and polyester. They are also produced from chemicals found in oil.

Clothes made from synthetic fibres.

The answers to all these questions can be found out by studying Chemistry. If you think about life without plastics, medicines, aircraft and canned food, you will understand how important Chemistry is.

QUESTION 1

Everyone uses the products of Chemistry. Write down some chemical products used by the following people:

teacher, doctor, hairdresser, policeman, cook, taxi driver

alloys	Astronomy	cure	Geology	hairdresser	matter	oil	preserve
合金	天文学	医治	地质学	理发师	物质	原油	防腐

How does a chemist work?

A person who studies Chemistry is called a chemist. To find out about matter, a chemist does three main things.

The chemist
- makes **observations** and takes **measurements**
- looks for **patterns** in the observations
- seeks **explanations**

Observations and measurements

1 To find things out, we must make observations. To observe accurately, we can use instruments to take measurements.

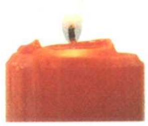
For example:
- a ruler to measure length
- a thermometer to measure temperature
- a balance to measure mass

The observations and measurements we make are called facts or **data**.

Here are some facts:
- Salt is a white solid.
- A lemon has a sour taste.
- The temperature of boiling water is 100°C at 1 atmospheric pressure.

2 Observations often make us think of questions. The questions lead to experiments, which give us more observations.

For example:
- We observe a candle flame is hot. We may ask "Which part of the candle flame is the hottest"?



- We observe the sour taste of a lemon. We may ask "What other substances taste sour"?

QUESTION 2

To observe, we use our senses.

(a) Name our five senses.

(b) Chemists do not usually use the sense of taste. Why not?

QUESTION 3

Look again at the flame of the candle opposite.

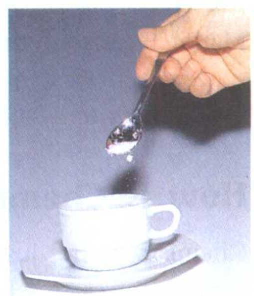
(a) Write down five or more observations.

(b) Write down some more questions about the flame.

(c) Take one of your questions. Think of an experiment to answer it. Describe your experiment, or draw a diagram of the apparatus.

Looking for patterns

1 When we have made many observations, we may see patterns among them.



For example:
- Sugar always dissolves in water.
- All lemons taste sour.
- Carbon dioxide always turns limewater milky.

It is not always easy to see patterns in data, so people often guess. Chemists also guess. In Science, a good guess is called a **hypothesis**.

2 Once we have a hypothesis about a pattern, we can make **predictions**.

For example:
- Next time we put sugar in water, it will dissolve.
- The next lemon we try will also taste sour.
- In the next experiment, carbon dioxide will still turn limewater milky.

3 We do experiments to test our predictions. For example, we taste a lemon to see if it is sour. If the prediction is wrong, we must suggest another pattern.

data 数据 | hypothesis 假说 | predictions 预测 | senses 官感

Two important ways of forming patterns are **classifications**, and **laws**.

> Classification means to put things into groups.
> Each group has similar patterns.

For example, there are many different substances but we can classify them into solids, liquids and gases. We will use many classifications in this book. Classifications are also used in other sciences; for example, the classification of plants and animals in Biology.

> Laws are statements of important patterns.

An important law in Chemistry is Avogadro's law. For examples of laws in other subjects, see the law of moments, Newton's laws of motion and the gas laws in Physics.

Explanations

1 Chemists seek explanations for their observations.

That is, they try to answer the question 'Why or how does something happen?'

For example:

- A candle burns with a yellow flame. Why?
- Sugar, but not sand, dissolves in water. Why?
- Iron rusts. How does this happen?

2 It is not always easy to give an explanation. So again we make a hypothesis.

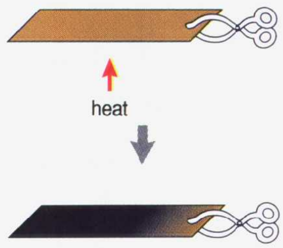
A good explanation will:

- Explain many facts (not just one).
- Predict new facts. In Science, we do experiments to test these predictions. If the experiment shows the prediction is wrong, we try to think of a better explanation. We then test this new explanation. This process never ends because in Science we never get a perfect explanation.

Example

Observation

We heat a piece of copper in a Bunsen flame.



The copper changes from a reddish brown colour to a black colour. Why?

Explanation

We see that the Bunsen flame appears dirty. Therefore we suggest this explanation:

Soot from the flame covers the surface of the copper.

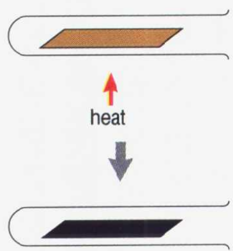
Prediction

If the hypothesis is correct, we can make this prediction:

If we heat copper so that the flame does not touch the copper, the metal will not become black.

Experiment

To test the prediction, we set up the apparatus in the diagram below.



The flame does not touch the copper. However, we observe that the copper again becomes black. Therefore, our explanation is wrong. We must try again!

Second explanation

We know the copper is heated in air. Therefore, we make the following hypothesis:

Copper turns black because it reacts with air.

laws 定律　　rusts 生锈　　soot 煤烟

Prediction

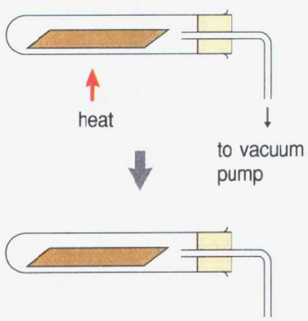
If the second hypothesis is correct, we predict:

The colour will not change if we heat copper in a vacuum.

Experiment

To test this prediction, we set up the apparatus as shown below. We use a vacuum pump to remove air from the test tube. Then we heat the test tube.

We observe that the colour remains brown.



Our second explanation explains the prediction.

Is this explanation correct? We do not know. We must make other predictions and test them too.

QUESTION 4

Look at the experiment shown in the diagram.

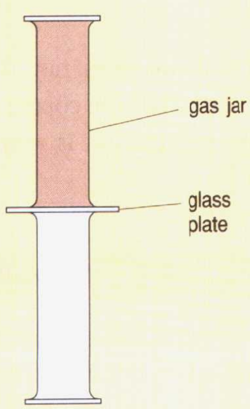
The top gas jar contains a red-brown gas (denser than air). The bottom gas jar contains air. The glass plate is removed.

The red-brown gas moves slowly into the bottom gas jar. Why?

A student gave this explanation:

The red-brown gas falls because it is denser than air.

Describe an experiment to show that this explanation is wrong.



QUESTION 5

Here are three observations.

(a) The light in a room suddenly goes off.

(b) Many fish in Tolo Harbour have died.

(c) A candle flame is yellow-black in colour.

For each observation:

(i) suggest an explanation (i.e. a hypothesis).

(ii) describe an experiment to test your hypothesis.

What do chemists investigate?

Chemists try to find out three things about substances:

1 the structure of substances.

2 the properties of substances.

3 the way substances change.

Structure of substances

Structure, in chemistry, means the way matter is put together.

Chemists believe that everything in the world is made up of very small particles. Water, rocks, our bodies, this book and air are made up of particles. But the particles are too small to see even with a powerful microscope. Our ideas about the particles of matter are summarized in the **kinetic theory of matter**.

The main points of this theory are as follows:

1 All matter is made up of very small particles.

2 There are spaces between the particles.

3 Particles are in constant motion and posses kinetic energy.

4 An increase in temperature increases the average kinetic energy of particles.

Because it is not possible to see particles of matter, chemists use models to give a picture of what solids, liquids and gases look like.

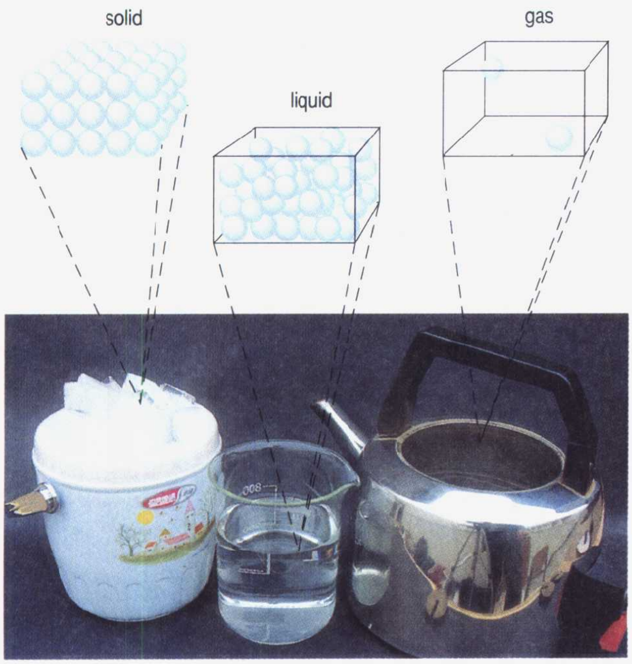
In solids, the particles are packed close together with little space between them. This gives solids a fixed

models
模型

volume and makes them almost incompressible. The particles are not free to move though they can vibrate about their fixed positions. A solid therefore also has a definite shape.

In liquids, the particles are slightly further apart than in solids. This gives liquids a fixed volume but makes them difficult to compress. The particles are free to move as they are not arranged in a fixed pattern. Therefore a liquid does not have a shape of its own but takes the shape of its container.

In gases, the particles are widely separated. Thus gases are easily compressed. The particles move freely and rapidly. A gas spreads into any available space, filling the whole container.



A particle model of matter.

Properties of substances

The word property means 'what something is like'. We classify properties into **physical** and **chemical properties**.

Physical properties can be measured without a substance changing into another substance. Common physical properties are colour, smell, hardness, density, electrical conductivity, solubility in water (or other solvents), melting point and boiling point.

Chemical properties describe the change of a substance into another substance. Rusting is a chemical property of iron.

QUESTION 6

List the following physical properties for:

(a) copper, and

(b) water.

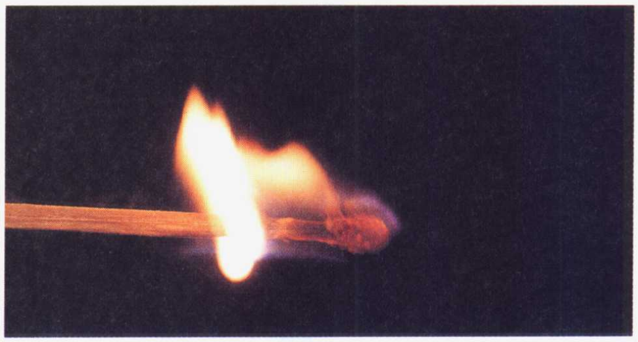
state, colour, density, melting point, boiling point

(Use Datatables 3 and 4 to help.)

Changes in substances

The way substances change can be classified as either **physical** or **chemical changes**.

Physical changes are those where no new substance is formed, e.g. melting ice, boiling water and dissolving sugar in water.



Burning – a chemical change.

In a chemical change, a substance changes into one or more new substances. For example, burning a match or rusting of iron. The new substances have different properties from the original substances.

QUESTION 7

Look at the following changes. For each change, say if it is a physical or a chemical change.

(a) ice melts

(b) copper metal reacts with air

(c) iron rusts

(d) water on the road evaporates

(e) gas burns

(f) salt dissolves in water

rusting
生锈

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