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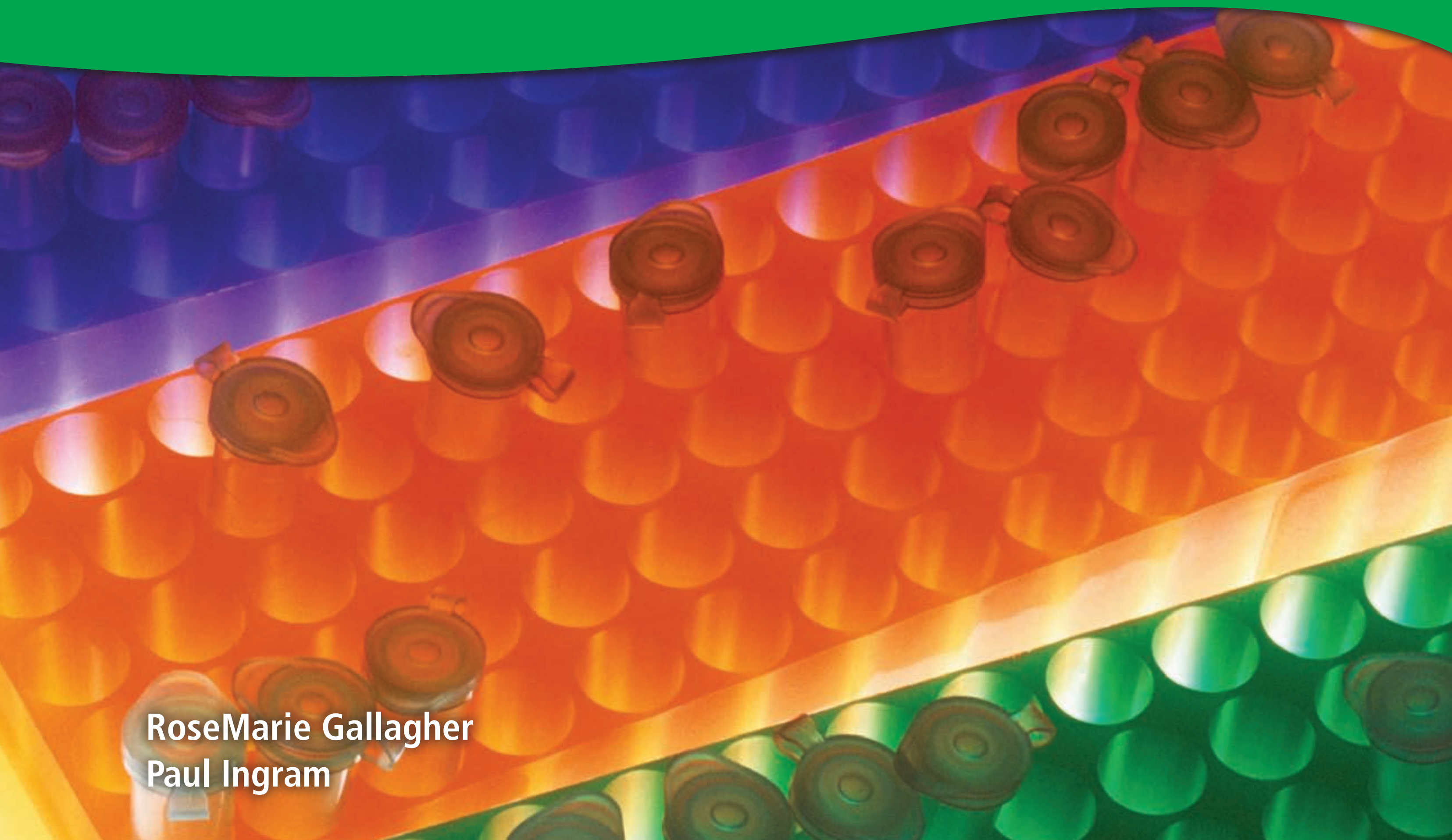

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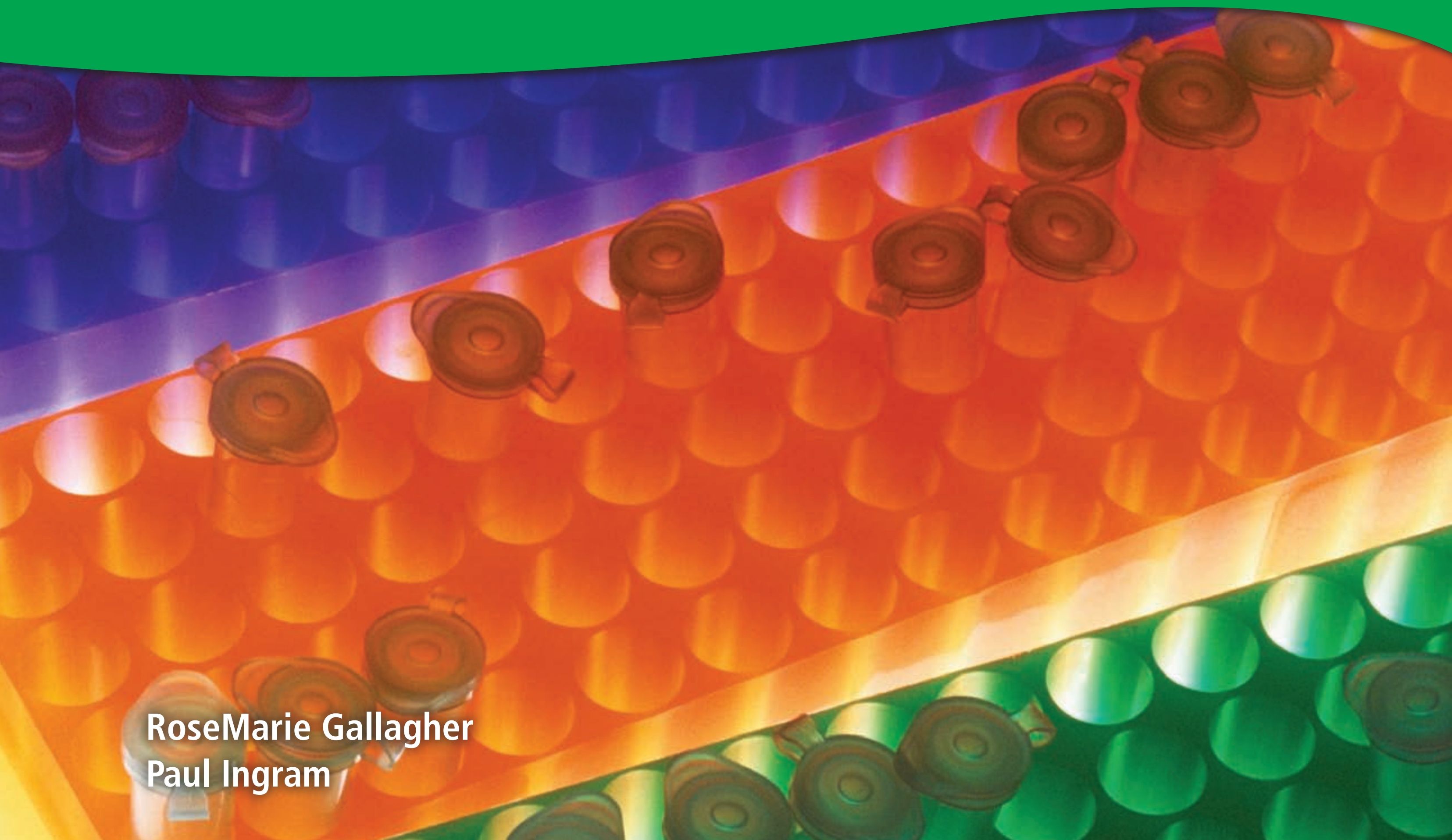

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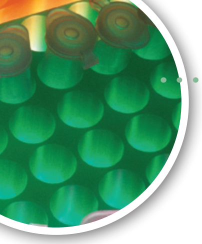


Introduction

If you are taking IGCSE chemistry, using the Cambridge International Examinations syllabus 0620, then this book is for you. It covers the syllabus fully, and has been endorsed by the exam board.

Finding your way around the book

The contents list on the next page shows how the book is organised. Take a look. Note the extra material at the back of the book too: for example the questions from past exam papers, and the glossary.

Finding your way around the chapters

Each chapter is divided into two-page units. Some colour coding is used within the units, to help you use them properly. Look at these notes:

Core curriculum
If you are following the Core curriculum, you can ignore any material with a red line beside it.

Extended curriculum
For this, you need *all* the material on the white pages, including the material marked with a red line.

Extra material
Pages of this colour contain extra material for some topics. We hope that you will find it interesting – but it is not needed for the exam.

Chapter checkups
There is a revision checklist at the end of each chapter, and also a set of exam-level questions about the chapter, on a coloured background.

Making the most of the book and CD

We want you to understand chemistry, and do well in your exams. This book, and the CD, can help you. So make the most of them!

Work through the units The two-page units will help you build up your knowledge and understanding of the chemistry on your syllabus.

Use the glossary If you come across a chemical term that you do not understand, try the glossary. You can also use the glossary to test yourself.

Answer the questions It is a great way to get to grips with a topic. This book has lots of questions: at the end of each unit and each chapter, and questions from past exam papers at the end of the book.

Answers to the numerical questions are given at the back of the book. Your teacher can provide the answers for all the others.

Use the CD The CD has an interactive test for each chapter, advice on revision, sample exam papers, and more.

And finally, enjoy! Chemistry is an important and exciting subject. We hope this book will help you to enjoy it, and succeed in your course.

RoseMarie Gallagher
Paul Ingram

Contents

1.1 Everything is made of particles

Made of particles

Rock, air, and water look very different. But they have one big thing in common: they are all made of very tiny pieces, far too small to see. For the moment, we will call these pieces **particles**.

In fact everything around you is made of particles – and so are you!

▲ All made of particles!

Particles on the move

In rock and other solids, the particles are not free to move around. But in liquids and gases, they move freely. As they move they collide with each other, and bounce off in all directions.

So the path of one particle, in a liquid or gas, could look like this:

The particle moves in a random way, changing direction every time it hits another particle. We call this **random motion**.

Some evidence for particles

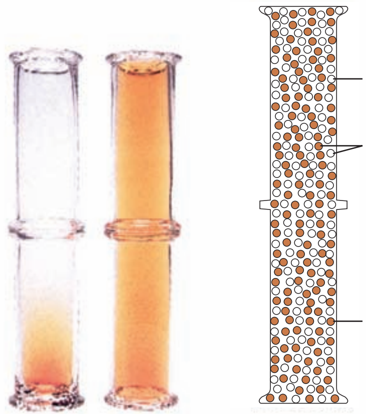
There is evidence all around you that things are made of particles, and that they move around in liquids and gases. Look at these examples.

Evidence outside the lab

1 Cooking smells can spread out into the street. This is because 'smells' are caused by gas particles mixing with, and moving through, the air. They dissolve in moisture in the lining of your nose.

2 You often see dust and smoke dancing in the air, in bright sunlight. The dust and smoke are clusters of particles. They dance around because they are being bombarded by tiny particles in the air.

Evidence in the lab



1 Place a crystal of potassium manganate(VII) in a beaker of water. The colour spreads through the water. Why? First, particles leave the crystal – it **dissolves**. Then they mix among the water particles.

2 Place an open gas jar of air upside down on an open gas jar containing a few drops of red-brown bromine. The colour spreads upwards because particles of bromine vapour mix among the particles of air.

Diffusion

In all those examples, particles mix by colliding with each other and bouncing off in all directions. This mixing process is called **diffusion**.

The overall result is the flow of particles from where they are more concentrated to where they are less concentrated, until they are evenly spread out.

So what are these particles?

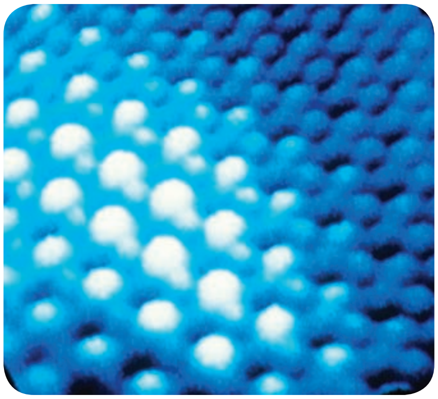
The very smallest particles, that we cannot break down further by chemical means, are called **atoms**.

- In some substances, the particles are just single atoms. For example argon, a gas found in air, is made up of single argon atoms.
- In many substances, the particles consist of two or more atoms joined together. These particles are called **molecules**. Water, bromine, and the gases nitrogen and oxygen in air, are made up of molecules.
- In other substances the particles consist of atoms or groups of atoms that carry a charge. These particles are called **ions**. Potassium manganate(VII) is made of ions.

You'll find out more about all these particles in Chapters 2 and 3.

'Seeing' particles

We are now able to 'see' the particles in some solids, using very powerful microscopes. For example the image on the right shows palladium atoms sitting on carbon atoms. In this image, the atoms appear over 70 million times larger than they really are!



▲ This image was taken using a tunneling electron microscope. The white blobs are palladium atoms, the blue ones are carbon. (The colour was added to help us see them.)

Q

1 The particles in liquids and gases show *random motion*. What does that mean, and why does it occur?

2 Why does the purple colour spread when a crystal of potassium manganate(VII) is placed in water?

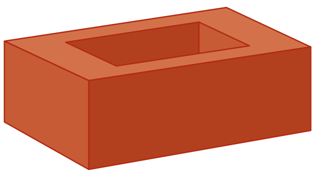
3 Bromine vapour is heavier than air. Even so, it spreads upwards in the experiment above. Why?

4 **a** What is *diffusion*? **b** Use the idea of diffusion to explain how the smell of perfume travels.

1.2 Solids, liquids, and gases

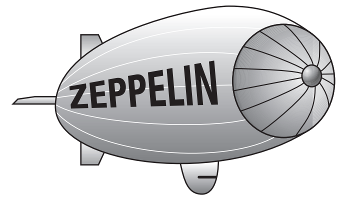
What's the difference?

It is easy to tell the difference between a solid, a liquid and a gas:



A solid has a fixed shape and a fixed volume. It does not flow. Think of all the solid things around you: their shapes and volumes do not change.

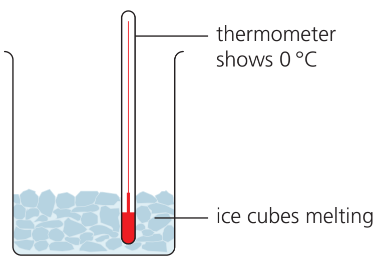
A liquid flows easily. It has a fixed volume, but its shape changes. It takes the shape of the container you pour it into.



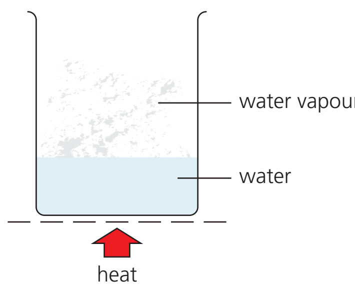
A gas does not have a fixed volume or shape. It spreads out to fill its container. It is much lighter than the same volume of solid or liquid.

Water: solid, liquid and gas

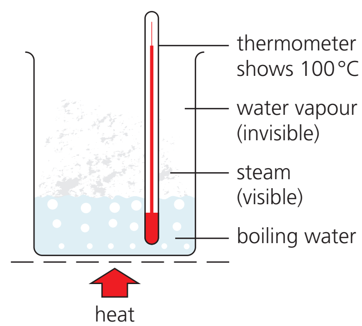
Water can be a solid (ice), a liquid (water), and a gas (water vapour or steam). Its state can be changed by heating or cooling:



1 **Ice** slowly changes to **water**, when it is put in a warm place. This change is called **melting**. The thermometer shows 0 °C until all the ice has melted. So 0 °C is called its **melting point**.

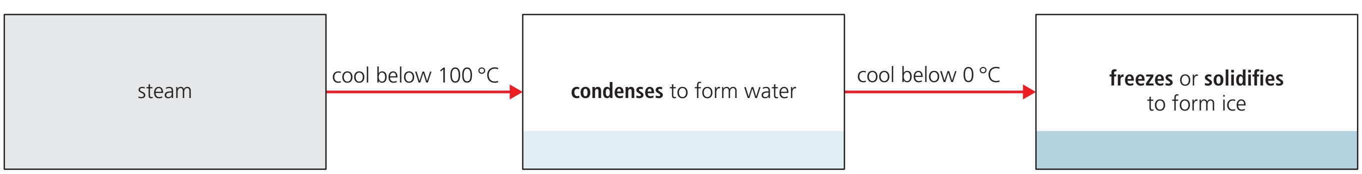


2 When the water is heated its temperature rises, and some of it changes to **water vapour**. This change is called **evaporation**. The hotter the water gets, the more quickly it evaporates.



3 Soon bubbles appear in the water. It is **boiling**. The water vapour shows up as steam. The thermometer stays at 100 °C while the water boils off. 100 °C is the **boiling point** of water.

And when steam is cooled, the opposite changes take place:



You can see that:

- condensing is the opposite of evaporating
- freezing is the opposite of melting
- the freezing point of water is the same as the melting point of ice, 0 °C.

Other things can change state too

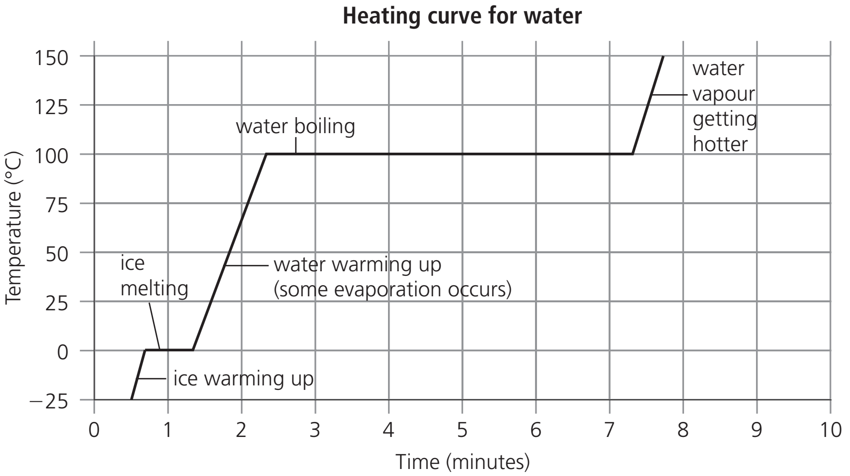
It's not just water! Nearly all substances can exist as solid, liquid and gas. Even iron and diamond can melt and boil! Some melting and boiling points are given below. Look how different they are.

Substance	Melting point/°C	Boiling point/°C
oxygen	–219	–183
ethanol	–15	78
sodium	98	890
sulfur	119	445
iron	1540	2900
diamond	3550	4832

▲ Molten iron being poured out at an iron works. Hot – over 1540 °C!

Showing changes of state on a graph

Look at this graph. It shows how the temperature changes as a block of ice is steadily heated. First the ice melts to water. Then the water gets warmer and warmer, and eventually turns to steam:



A graph like this is called a **heating curve**.

Look at the step where the ice is melting. Once melting starts, the temperature stays at 0 °C until *all* the ice has melted. When the water starts to boil, the temperature stays at 100 °C until *all* the water has turned to steam. So the melting and boiling points are clear and sharp.

▲ Evaporation in the sunshine …

Q

1. Write down two properties of a solid, two of a liquid, and two of a gas.
2. Which word means the opposite of:
   a boiling? **b** melting?
3. Which has a lower freezing point, oxygen or ethanol?
4. Which has a higher boiling point, oxygen or ethanol?
5. Look at the heating curve above.
   a About how long did it take for the ice to melt, once melting started?
   b How long did boiling take to complete, once it started?
   c Try to think of a reason for the difference in **a** and **b**.
6. See if you can sketch a heating curve for sodium.