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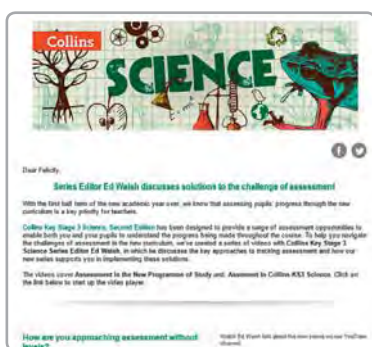
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Key icons used in the catalogue

-  New titles
-  Age range
-  For Key Stage 3
-  For GCSE
-  For AS and A-level

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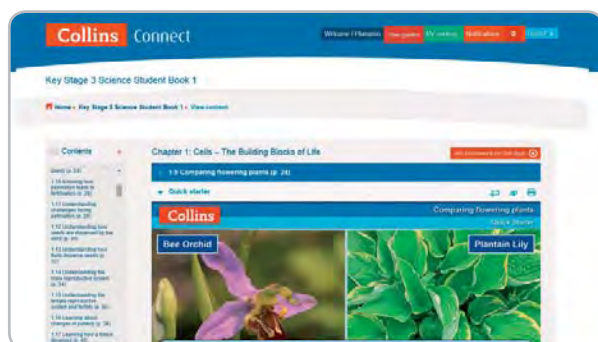


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Sample from Collins Key Stage 3 Science, Student Book 1



Sample from Collins Connect Teacher Homepage

Collins Key Stage 3 Science on Collins Connect

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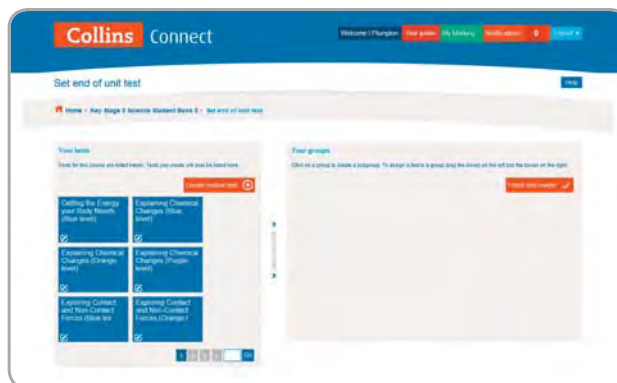
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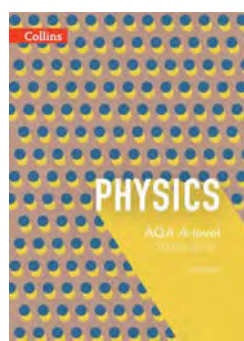
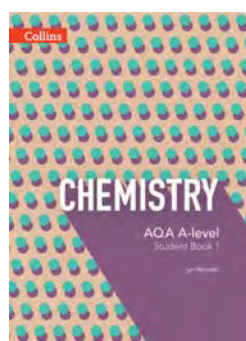
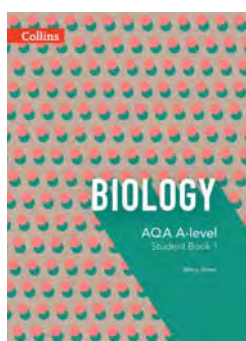
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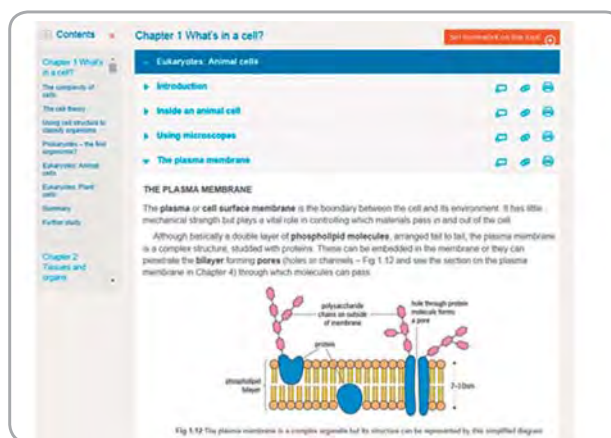
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Collins KS3 Science

Age 11–14 KS3

Collins Connect

Second Edition

Series Editor: **Ed Walsh**

Authors: **Sarah Askey, Tracey Baxter, Sunetra Berry, Pat Dower, Anne Pilling and Pete Robinson**

Collins Key Stage 3 Science, Second Edition has been fully revised to match the 2014 curriculum and designed to help students secure the key skills, knowledge and interest in science to succeed at KS3 and beyond.



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Biology

Understanding unicellular organisms

- We are learning how to:
- Recognise different types of unicellular organisms.
 - Describe the parts of the adaptations of unicellular organisms.
 - Compare and contrast unicellular organisms.

The oldest unicellular organisms were found in rocks dated to 3.8 billion years ago. They used chemicals in the ocean for 'food'. Around 3.5 billion years ago, organisms that could make their own food also evolved. Unicellular organisms were the main form of life on the planet for nearly 2 billion years.

Unicellular organisms

Unicellular organisms are made up of just one cell. They carry out all the life processes needed to exist independently. They differ from each other in their structure, how they feed and how they move. Algae are plant-like unicellular organisms containing chloroplasts and make their own food. Animal-like unicellular organisms take in food through their cell membrane. Some have developed tiny hairs to help them move, so they can find food or escape from predators. Some are themselves predators and will devour other unicellular organisms. Fungus-like unicellular organisms are called yeasts. They have a cell wall but cannot make their own food.

1. Name three different unicellular organisms.
2. List three ways unicellular organisms differ from each other.

Prokaryotes

Unicellular organisms can be classified into two main groups – **prokaryotes** and **eukaryotes**. Prokaryote means 'before life' – prokaryotes are thought to be the first organisms to live on Earth. They do not have a nucleus, and their genetic material floats within the cytoplasm. They can be up to 200 times smaller than eukaryotes. Bacteria are examples of prokaryotes. They come in different shapes and sizes, live in different environments and have a range of food sources. Some bacteria take in chemicals from their environment, such as iron and sulfur, and use these as food. Others contain chloroplasts and use sunlight to make their own food – many

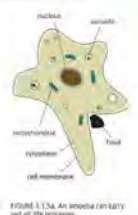


FIGURE 1.1.5A An amoeba can carry out all the processes.

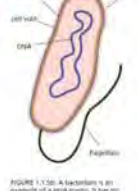


FIGURE 1.1.5B A bacterium has no nucleus.

Eukaryotes

Eukaryotes contain a nucleus, surrounded by a nuclear membrane. They also contain many organelles (which prokaryotes do not), including mitochondria, chloroplasts and vacuoles. Examples of eukaryotes are euglena (a type of algae containing chloroplasts), yeast, amoeba, and paramecium – the last two are types of protozoa. Eukaryotes can be up to 200 times bigger than prokaryotes and often have external features to help them to survive. The amoeba can move around because its cytoplasm can flow; paramecium has cilia that beat and enable it to move, and the euglena has a flagella, or tail, to enable it to move.

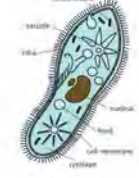


FIGURE 1.1.5C A paramecium.

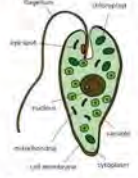


FIGURE 1.1.5D Euglena.

5. Look at Figure 1.1.5d. How does the euglena get its food?
6. Which is the most effective form of movement between the three eukaryotes? Justify your choice.
7. Summarise, in a table, the main similarities and differences between unicellular organisms.

Did you know...?
 Foraminifera are the largest known unicellular organisms. Fossils as large as 16cm in diameter have been found, which is about the size of a tennis ball. Some are thought to have lived for over 100 years.

- Key vocabulary**
- yeast
 - prokaryote
 - eukaryote
 - bacterium
 - protozoa

Objectives for every lesson

Questions at the end of every topic test understanding before moving on

Support students in assessing their own progress and targeting areas they need to focus on

Sample from Key Stage 3 Science, Second Edition Pupil Book 1

Engaging introduction puts the science into context

Lesson plans use the sequence of engage, challenge and develop, explain, consolidate and apply and plenary

Chemistry

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

- Compare the properties of solids, liquids and gases.
- Draw circle diagrams to demonstrate the differences between the arrangement of particles in solids, liquids and different properties.
- Use particle diagrams to explain the differences in density between the particles in different states of matter, accounting for differences in their properties.
- Recognise how theories are developed.
- Use observations to develop hypotheses.
- Change hypotheses in the light of new evidence and use this evidence to develop theories.
- Use correct terminology and the particle model to describe changes of state, including evaporation.
- Interpret and explain data relating to melting and boiling points.
- Use the particle model to explain expansion in solids, liquids and gases.
- Describe how solids, liquids and gases behave when heat is applied to them.
- Describe applications and problems caused by thermal expansion.
- Use the particle model to explain expansion in solids, liquids and gases.
- Describe a model that can be used to represent particles.
- Apply and adapt models to make them more suitable for use.
- Evaluate the strengths and limitations of a particle model.
- Make predictions about floating and sinking using ideas about density.
- Use the particle model to explain density differences between gases and calculate the density of solids.
- Use the particle model to explain factors relating to density.

- Make predictions about floating and sinking using ideas about density.
- Use the particle model to explain density differences between gases and calculate the density of solids.
- Describe what is meant by the terms 'concentration' and 'pressure'.
- Calculate concentrations of solutions.
- Use ideas about particles to explain the effects of pressure.
- Describe how diffusion occurs in liquids and gases.
- Explain observations relating to diffusion in terms of particles.
- Make predictions, using ideas about particles, about factors affecting the rate of diffusion.
- Describe features of physical and chemical change, recognising how mass is conserved.
- Use ideas about particles to describe separation processes.
- Apply the particle model to explain physical and chemical changes, taking conservation of mass into account.
- Describe different types of colloids.
- Explain the properties of different colloids using the particle model.
- Evaluate the particle model in its ability to explain colloids and their properties.
- Use the particle model to describe different separation processes.
- Use the particle model to explain how the solubility of solids and gases changes with temperature.
- Evaluate the effectiveness of the particle model in explaining physical changes.

3.2 Recognising materials, substances and elements

Lesson overview

- Recognise the difference between materials, substances and elements.
- Identify elements by their names and symbols.
- Explain what is meant by a chemically pure substance.

Learning objectives

- Classify substances as materials, pure substances, compounds or elements. [C1]
- Interpret the names and symbols of common elements and compounds. [C2]
- Explain the difference between pure and chemically pure substances. [C3]

Skills development

- Thinking scientifically: Use units and nomenclature.
- Working scientifically: Develop explanations.
- Learning development: Ask questions.

Resources needed Range of substances, names, typical labels

Common misconceptions Materials are all substances; water/salt/iron is not chemically pure or single substances.

Key vocabulary pure, element, compound, symbol, material

Teaching and learning

Engage

- Identify students' prior knowledge by giving them a series of different materials or pictures, e.g. bottle of water/ours orange juice carton, metal, plastic, glass, charcoal or graphite, wood, NaCl salt, fabric. Ask them to identify what the items are made of and then classify them into groups. [C1]
- Explore the idea of materials being made of different substances by means of a group discussion. [C1]

Most able students may raise issue of materials being made of particles by referring to water, liquids and gases.

Challenge and develop

- Ask students to identify the substances that are pure using questions such as, 'How do you know that substances are pure?' [C3]
- Use the labels of water and orange juice packaging to make observations about the number of substances and conduct simple experiments, e.g. evaporate water to show residue of salts. [C1, C2]
- Ask students to list observations about names and symbols of materials e.g. iron (Fe), graphite (C), sodium chloride (NaCl) using questions such as, 'Are they single pure substances?' [C3]
- Discuss how the names and symbols give clues to their composition. Introduce the idea of elements being the simplest pure substances. [C1, C2]

Explain

- Show the Periodic Table and explain that it includes all the chemical elements (symbols as well as names), everything in the universe is made up of a combination of these elements, e.g. NaCl, called compounds. [C2]
- Oriente students with the Periodic Table by choosing element symbols for them to find and name, e.g. Al, H, Fe, Pb. Ask, 'Which elements have you heard of?' 'What are their symbols?' [C3]

More able students may be able to predict symbols from names of elements and identify elements that have symbols not listed in their English names, e.g. Lead (Pb) and Au.

Pair task: Students should study the Periodic Table and identify similarities between, e.g. what air they notice about the symbols? Identify also, always capital first, last, 1 or 2 letters, lower the same. [C1]

Ask students to explain why every element has a different symbol by asking, 'How would you recognise whether a substance was an element or a compound?' [C1]

Consolidate and apply

- Ask students to classify substances, compounds and elements using symbols and record their observations on Worksheet 3.2. This will help to orientate and familiarise students with common names and symbols. [C1]

Most able students should be challenged to explain, with correct terms and examples, the difference between: element, element and compound; 100% chemically pure and naturally pure substances.

Pair talk/Plenary to focus: Students should test each other on symbols or names to test as many element names as they can in 20 seconds. [C2]

Ask students to identify which elements they think may be present in the body. They should check their ideas against the table in the student book and collaborate to develop answers to the questions. [C1]

Extend

For students making greater their expected progress:

- Ask questions about the relative size of elements: 'Which are bigger – elements/compounds or cells?' 'What are cells made of?' [C1]
- Considerable understanding by making it clear that cells are made of chemical substances and structures. Explain that these cells are made of combinations of the 92 elements, therefore elements and compounds are much smaller than cells. (Particles as atoms are introduced later.) [C1]

Plenary suggestions

- 'Which is the best...?' Name various substances and ask students to identify them as elements, pure substances, compounds or elements. [C1, C2, C3]

Answers to Student Book

1. C
2. Two carbon atoms means two elements – in this case, hydrogen and oxygen. The number sign/plus of hydrogen every one of oxygen.
3. Carbon, hydrogen and oxygen.
4. CO is a compound of carbon and oxygen. O is an element (oxygen).
5. Chemically pure water contains only one substance (a compound, H₂O) but bottled water is a mixture of many substances.
6. It is a compound/chemical substance made of three different elements joined together/has three capital letters and P is not a single element.
7. Water makes things around water, salt, clay and gold for us.
8. Blood is a mixture of water, salts and haemoglobin. Haemoglobin is a compound/compound only one type of substance.
9. Oxygen (see chart to be clear) approximately 20% (20%) and remaining oxygen.

Answers to Worksheet 3.2

1. Evaporation
2. At room temp. (1) moderate, (2) intense, (3) element
3. It should be ground up, must water added to dissolve for smelly temperature. Based on how they have been introduced.
















Colour coding demonstrates how key ideas develop

Suggestions for differentiation throughout to support students of all abilities

Make planning easy with full lesson information clearly laid out, including objectives, outcomes, skills covered, misconceptions, resources and vocabulary

Sample from Key Stage 3 Science, Second Edition Pupil Book 2

Available on **Collins Connect**
 Turn to pages 2–3 for more information.

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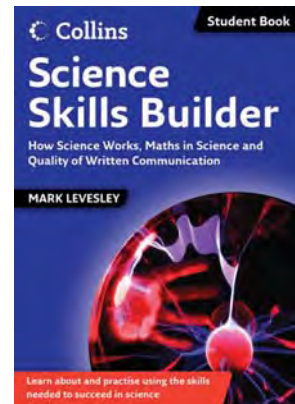
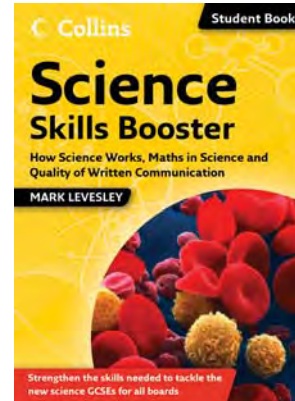
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KS3 GCSE

Author: Mark Levesley

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- Prepare students for writing longer answers with dedicated questions for each activity, booster boxes giving hints and detailed worked examples of good and bad responses
- Encourage self and peer assessment with detailed answers provided in the back of the book
- Set activities in class, as homework or for lesson cover to suit individual students or classes with clear, comprehensive matching charts



Key information is summarised clearly

Questions help students practice the essential skills needed for success in science

30 VARIABLES AND FAIR TESTS

Variable is something that can change. It is sometimes called a **factor**.

In an investigation, you select values for one variable and measure what happens to another. The variable that you change is the **independent variable**. The variable that you measure is the **dependent variable**. The dependent variable depends on the independent variable.

A **control variable** or **fixed variable** is another factor that can affect the dependent variable. You have to try to stop any control variables changing. When planning an investigation you list all the control variables and decide how to stop them changing.

In a **fair test** the only thing that changes the dependent variable is the independent variable. You need to:

- ✱ identify the independent variable
- ✱ identify the dependent variable
- ✱ stop the control variables changing.

Figure A: Anything that can vary (change) is a variable. Shoes can vary in shape, materials, colour, etc.

Figure B: A fair test used to answer the question: Does the current increase, the more cells you have?

Level Booster

✱✱✱ explain how different variables affect one another

✱✱ select the appropriate variables for an investigation

✱ identify different variables in an investigation

1 ✱ John dissolves different amounts of salt in several 100cm³ samples of water. He finds the boiling point of each solution, using the same heating apparatus and thermometer. Identify the different variables.

2 Here are some scientific questions:

- ✱ How does the amount of light affect the number of ladybird maggots found in an area?
- ✱ Are some antacids better than others at neutralising acids?
- ✱ Do bigger magnets pick up more paper clips than small ones do?

✱✱✱ For each investigation select the independent, dependent and control variables.

✱✱✱ Explain how one control variable in each investigation could cause problems.

Links

Learn about controls **S14**
Learn about correlation **S15**

31 CONTROLS

A fair test is not possible if there are too many **control variables**.

A **control experiment** is the same as a fair test, but you include a **control** or a **control group**. The control uses exactly the same set-up as the main part of the experiment, but without the independent variable.

Controls are used when investigating living things because organisms vary so much. The organisms are divided into groups, making sure that the groups are as similar to each other as possible. The independent variable is changed for each group, but one group is a control. The results from the control make it easier to see if changes are due to the independent variable only.

Figure A: Huge numbers of control variables (e.g. sex, age, ethnic background, weight, height in humans) mean that you can't use fair tests.

Figure B: Controls are used in drug tests. The control shows whether it is the drug having an effect, or something else.

Level Booster

✱✱ give reasons for using or not using a control experiment

✱✱ explain what a control experiment is

✱ recognise investigations that cannot be done using a fair test

1 ✱ Which of the following investigations could not use a fair test?
A The current in a circuit when the number of bulbs is changed.
B The effect of an antacid on an acid.
C The effect of an antacid on reducing the effects of heartburn in someone.
D The effect on Arctic foxes of increasing the average temperature.

2 ✱✱ How is a control experiment different from a fair test?

3 ✱✱ Look at the experiment on page 18, in **S13**. Suggest a control.
✱✱✱ Would you not use a control experiment in this case? Explain your reasoning.

4 ✱✱✱ A drug company wants to find out if its new drug for headaches is better than the standard drug. Explain how the trial would be carried out.

Links

Learn about samples and bias **S12**
Learn about variables and fair tests **S13**

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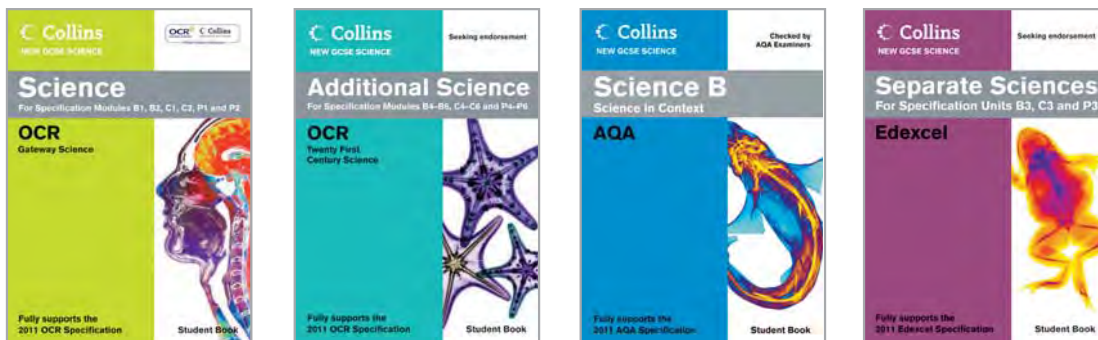
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Series Editors: Gurinder Chadha, Ken Gadd, Chris Sherry, Ed Walsh

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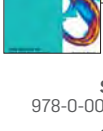
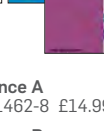




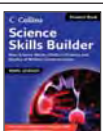








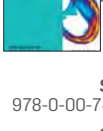
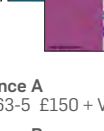






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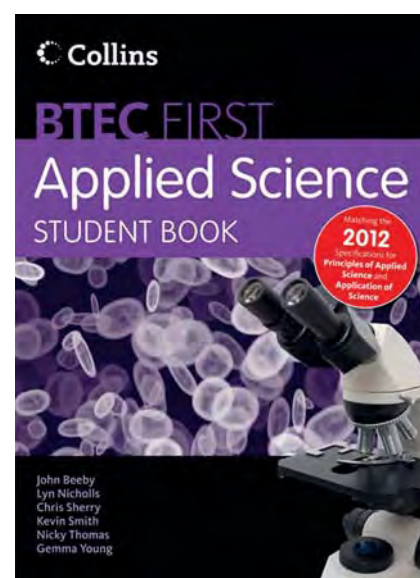
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Authors: **John Beeby, Nicky Thomas, Lyn Nicholls, Chris Sherry, Kevin Smith and Gemma Young**

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Student Book:

- **Enable your students to have access to the information they need** with content for both BTEC qualifications: Principles of Applied Science Award and the Application of Science Award covered in the book
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Collins BTEC First Applied Science contains all units for the 2012 qualifications

- Unit 1: Principles of Science
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- Unit 3: Energy and Our Universe
- Unit 4: Biology and Our Environment
- Unit 5: Application of Chemical Substances
- Unit 6: Application of Physical Science
- Unit 7: Health Application of Life Science
- Unit 8: Scientific Skills

Praise for the 2010 edition:

“*Can I congratulate you on the BTEC book, it's great. The whole department were in agreement that it was the best we have seen and is going to be really useful... and save us time and energy.* **Science Department, Medina High School, Isle of Wight**”

Assessment criteria on the page help your students understand what is required of them in their portfolios

Know more boxes provide interesting facts to engage students

Accessible text with diagrams to help visual learners

Sample from BTEC First Applied Science Student Book

Our Solar System

Your assessment criteria:

- 1C.8 Identify the components of our Solar System
- 1C.10 Describe the dynamic nature of our Universe and Solar System
- 2C.P8 Describe the structure of the Universe and our Solar System
- 2C.M6 Describe how the Universe and the Solar System were formed

Shooting stars

At certain times of the year, showers of 'shooting stars' can be seen in the night sky. Fast-moving intense streaks of light are caused by pieces of rock burning as they race through the night sky, so bright they look like stars. These 'shooting stars' are meteors. Sometimes they hit the ground as rocks called meteorites.

The Solar System

Our Solar System contains these parts:

- The Sun is the star at the centre of the Solar System. The heat and light from the Sun is caused by nuclear reactions in its centre.
- Planets are large balls of rock or gas that travel around the Sun in nearly circular orbits. There are eight planets in our Solar System, and Earth is one of them.
- Dwarf planets also orbit the Sun, but are smaller than planets. Pluto is a dwarf planet.
- Moons are smaller lumps of rock that travel around planets. They are 'natural satellites'. Some planets have several moons.
- Comets travel through space and are formed from small lumps of rock and ice. Some orbit the Sun in long, stretched-out orbits, so that the comet is sometimes far from the Sun and at other times much closer to the Sun. When it is close, the comet appears to have a tail streaking out from behind it.
- Asteroids behave like planets and dwarf planets, but are much smaller. Most are found orbiting between Mars and Jupiter.
- Meteors are seen when rocks burn up as they pass through the Earth's atmosphere.

Know more

The four inner planets have a rocky surface you could walk on. The four outer planets, called the gas giants, are very massive and formed from gases – you would sink into them if you tried to walk on them. The rocky planets are much closer to one another than the gas giants.

Research

Have you heard of a red giant, and a white dwarf? Research the main stages in the life cycle of a star and find out what these names mean.

How was our Solar System formed?

Stars like the Sun form from swirling clouds of dust and gases in space called nebulae.

- Gravity makes the centre of the cloud clump together.
- This clump is so massive that gravity crushes the particles very, very tightly.
- The centre heats up to millions of degrees.
- This is hot enough for nuclear fusion reactions to ignite.
- The star starts to shine and gives out heat.

As the star forms, the outer edges of the cloud are still swirling around the centre. These particles of dust and gas may clump together, attracting other nearby particles. Their gravity is not strong enough for nuclear reactions to ignite, but it is strong enough to hold the particles together. This is how planets are formed. Their movement means that they orbit the star, and the Solar System is complete.

During a star's lifetime, it changes size and colour as different reactions take place in its core. Eventually, some stars explode in a supernova, flinging out elements that have formed in the nuclear reactions in their core. These particles will form part of nebulae, where new stars will form.

star life cycle

Search terms highlighted so students can carry out their own research on topics that interest them

Content is clearly labelled as relevant for Pass, Merit or Distinction level

Unit 2: Chemistry and our Earth

Group 1 and 7 elements (I)

Learning aim

A Identify the elements in group 1 and 7 of the periodic table.

Assessment criteria

1A.1 Identify group 1 and 7 elements based on their physical properties.

2A.P1 Explain the structure and chemical properties of group 1 and 7 elements.

Planning and resources

This resource will take an hour but may run longer. You will need the following resources:

- samples of lithium, sodium and potassium (if allowed under act)
- worksheet, for full paper
- game board
- worksheet of student solution
- labeled solutions
- large copy of periodic table
- Shuffle Deck pages 56-58
- Task sheet: Assignment 2.1 TS.1
- Teacher's guide 2
- Technical Cards (BTEC First Applied Science Interactive Book) (password: password123) and links
- Video: 'The alkali metals' (24:08) and (25:04) (10:24)

Real-life links

A visit may be possible to a local industry using chemicals that require special handling. Students can investigate the safety procedures involved.

Setting the scene

Students have learnt about the periodic table in Unit 1. Their role here is as a chemist working for a manufacturing company that uses group 1 and 7 elements in the manufacture of its products. They have to prepare a support material that can be handed out to a group of new employees, with the aim of introducing them to the trends in physical and chemical properties of group 1 and 7. First, students must find out about these properties.

Class activity 1A.1, 2A.P1

- Show students a large periodic table and ask them to give examples of groups and periods. They may need to review the Unit 1 work.
- Describe the names and symbols of the elements in group 1 and 7, and any prior knowledge students have of these elements.

Worksheet 1

Group 1 and 7 elements card sort

| | |
|-----------|-------------------------------------|
| Lithium | Halogens |
| Sodium | Reactivity increases down the group |
| Potassium | Reactivity decreases down the group |
| Group 1 | Metals |

Create exciting lessons that involve students in the learning process with original and inventive activities

See at a glance which learning outcomes and assessment criteria you are covering in a lesson

Sample from BTEC First Applied Science Teacher Pack 1

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OCR Entry Level Science

Authors: **Chris Sherry, Brian Cowie, Louise Smiles**

OCR

Age
14-16

GCSE

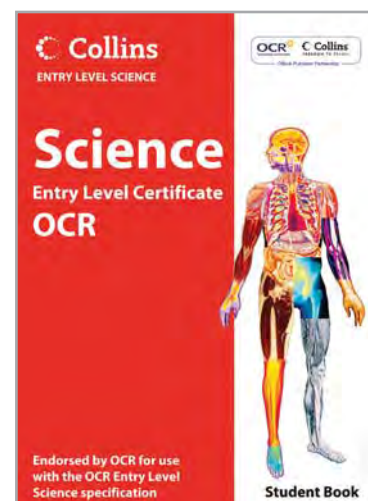
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- **Help students overcome common misconceptions** with Remember boxes
- **Build practical and mathematics skills** with activities at the end of each item
- **Prepare for end-of-item tests** with student-friendly checklists
- **Simplify planning** with flexible, comprehensive lesson support, including practicals and technician guidance
- **Manage a range of different abilities** with differentiated worksheets and activity suggestions

The Teacher Guide:

- **Simplify planning** with comprehensive lesson support, including technician guidance
- **Build practical skills** with clear guidance for students

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Fibres and fabrics

I am a safety clothing designer

My job is to design safety clothes. I make clothing for firefighters, ambulance crews and for the Army, Navy and Air Force. Clothes for rescue workers need to be brightly coloured, tough and waterproof. Clothes for the Army often need to be camouflaged so they cannot be seen easily.



In my job, I need to decide which fibres and fabrics to use to give the properties that are needed. I also need to make the clothes comfortable to wear, while still giving protection.


Fabrics

Clothes are made of fabrics. Fabrics are made by weaving or joining fibres together. Many different fabrics are used to make clothes. The fabrics used to make a garment are shown on its care label.

Natural fibres come from living things. Cotton comes from a plant, wool from sheep or goats and silk from an insect called a silk worm. Natural wool contains lanolin oil making it waterproof, but this is washed out when it is cleaned and made into fabrics.

Synthetic fibres are made by chemical reactions. This means they are man-made. Some man-made materials have replaced natural fibres. Nylon is a lightweight and tough material. It has replaced cotton for making tents, sails and outdoor clothes. Polyester and polythene are also man-made.

Remember: synthetic fibres are made by chemical reactions.



How is raw cotton from plants made into cotton fibres?

QUESTIONS

1 How is a fabric made?
2 Name a natural fibre from a plant.
3 Why is nylon a better material than cotton for making a tent?

CHALLENGE QUESTION:


4 Suggest some properties that a sail for a windsurfer should have.

Key words: fabrics fibres natural synthetic

Stretching fibres

T-shirts need to be made from fibres that stretch a bit so you can get them over your head. If fabrics stretch too much they lose their shape. Fibres also need to be strong and flexible so when clothing is folded, crunched up or washed, the fibres do not snap.

Fibres can be tested to find how strong or stretchy they are. One way to do this is to add weights to threads. When threads are made, they are not always exactly the same, so different bits of thread might give different strength results.



Apparatus to measure how stretchy and strong fibres are.

Waterproof fabrics

Many people who work outdoors need waterproof clothing. Firefighters and mountaineers need to keep dry to stay warm and comfortable.

Scuba divers can keep warm and dry by wearing a dry suit. Dry suits have a tough waterproof outer shell with waterproof neck and wrist seals. The suit is filled with air to insulate the diver from the cold seawater.

Breathable fabrics


Waterproof fabrics keep water out, but also keep sweat in. Waterproof clothing can be improved by adding a breathable layer like Gore-Tex®.

Breathable waterproof fabrics have very small holes that let sweat vapour out, but the holes are too small to let rainwater droplets in.

CAN-DO TASK

Level 3 2 1

I can make measurements to test a property of a fibre or fabric.



How does this dry suit keep the diver warm?

QUESTIONS

5 Why do fabrics need to be stretchy?
6 How could you test the strength of a thread?
7 Give one disadvantage of a waterproof fabric.
8 How do breathable waterproof fabrics work?

CHALLENGE QUESTION:

9 How do dry suits keep a diver dry and warm?

Key words: breathable flexible stretchy strong waterproof

KS3

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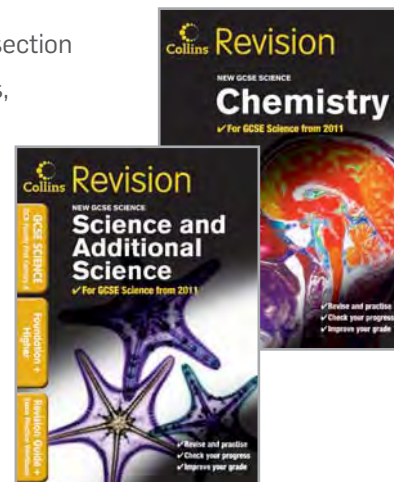
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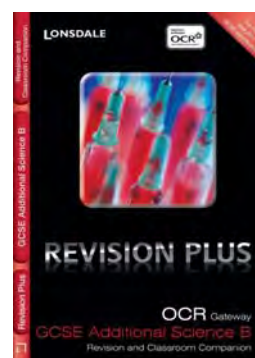
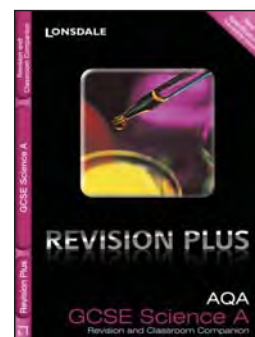
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Inside Living Cells

A fermenter is a controlled environment which provides ideal conditions for the micro-organisms to live, feed and produce the products needed.

- **A fermenter is a large vessel used to culture microorganisms. It requires:**
 - **aseptic sterile conditions** - the microorganisms must not become contaminated by other microorganisms
 - **nutrients** - the fermenter must contain the nutrients that the bacteria/microorganisms need in order to grow
 - **an optimum temperature** - suitable for the microorganisms. (In some, the optimum temperature is kept at a maximum of 25°C. In industry, higher temperatures can be used to speed up some useful growth.)
 - **the correct pH level**
 - **aeration** - microorganisms need oxygen to survive
 - **agitation (stirring)** - to mix in all the ingredients

Microorganisms and Food Production

Microorganisms can be used in some types of food production. The table below gives some examples:

| Food | Organism used | Process |
|---------|---------------|--------------------------|
| Bread | Yeast | Alcoholic fermentation |
| Beer | Yeast | Alcoholic fermentation |
| Wine | Yeast | Alcoholic fermentation |
| Yoghurt | Lactobacillus | Lactic acid fermentation |
| Cheese | Streptococcus | Lactic acid fermentation |
| Butter | Streptococcus | Lactic acid fermentation |
| Cheddar | Streptococcus | Lactic acid fermentation |
| Swiss | Streptococcus | Lactic acid fermentation |
| Blue | Penicillium | Blue cheese |
| Soft | Penicillium | Soft cheese |
| Hard | Penicillium | Hard cheese |

Yeast is a single-celled microorganism. In the presence of oxygen it converts glucose to make and carbon dioxide. In the absence of oxygen it converts glucose to ethanol (alcohol) and carbon dioxide - this process is called fermentation.

The advantages of using microorganisms to produce food are that they:

- grow and reproduce quickly
- are easy to handle and manipulate
- can be produced in large quantities (they are not dependent on climate)
- can make use of waste products from other industrial processes.

Aerobic Respiration

Energy is produced by aerobic respiration. Blood transports oxygen and food, in the form of glucose, to the body's cells. Special enzymes in the cells break the glucose and oxygen to release and energy is released. The energy can then be used for work in a cell. This process is called **aerobic respiration**.

Glucose, oxygen and carbon dioxide move between the capillaries and the working cells by **diffusion**.

A Working Muscle Cell

The Equation

| | | | |
|-----------------------|---|------------------------|----------------------|
| Glucose + Oxygen | → | Carbon dioxide + Water | + Energy |
| $C_6H_{12}O_6 + 6O_2$ | → | $6CO_2 + 6H_2O$ | + $36H_2O$ + $36ATP$ |

Glucose and oxygen are brought to the working cells by the bloodstream. Carbon dioxide is taken away by the blood as the lungs, where it is swept, most breath and out.

Water enters each fibre through the blood and is lost as sweat, most breath and out.

Energy is used for muscle contraction, metabolism and maintaining temperature.

Increased Diffusion

When muscle cells are working hard (contracting and relaxing) a lot, their respiration rates increase because more energy is being used up. This means that more oxygen needs to be absorbed and more carbon dioxide needs to be removed. This gas exchange takes place by diffusion in the lungs, at an increased rate.

Muscle Cells Working in the Leg

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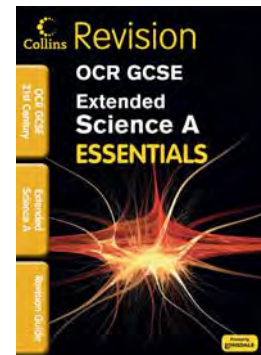
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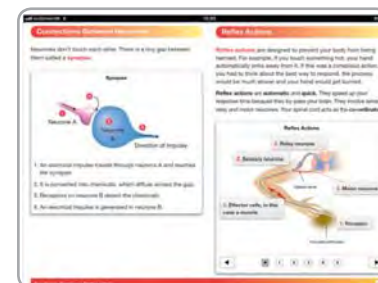
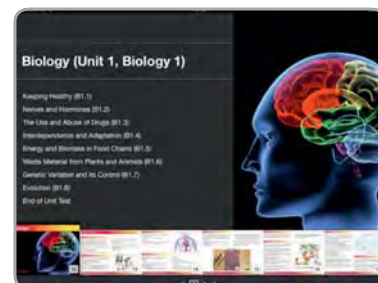
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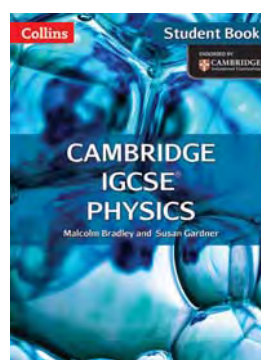
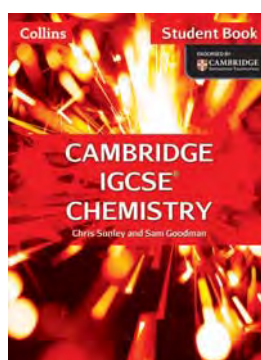
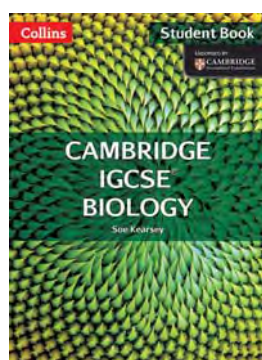
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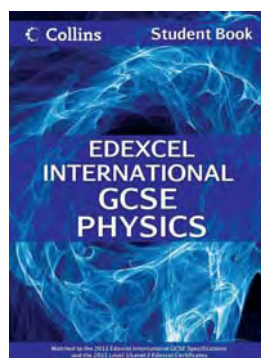
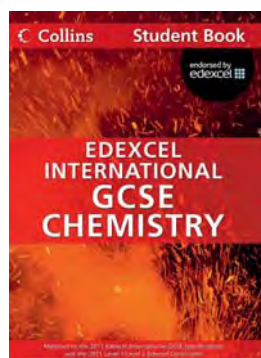
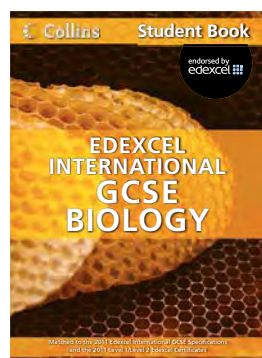
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Lots of questions to test understanding of every topic

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QUESTIONS

- Find the element calcium in the Periodic Table. Answer these questions about calcium:
 - What is its atomic number?
 - What information does the atomic number give about the structure of a calcium atom?
 - Which group of the Periodic Table is calcium in?
 - Which period of the Periodic Table is calcium in?
 - Is calcium a metal or a non-metal?
- What is the family name for the Group 7 elements?
- Are the Group 7 elements metals or non-metals?

METALS AND NON-METALS

Most elements can be classified as either metals or non-metals. In the Periodic Table, the metals are arranged on the left and in the middle, and the non-metals are on the right.

Metalloid elements are between metals and non-metals. They have properties of metals and some of non-metals. Examples of metalloids are antimony (Sb) and germanium (Ge).

Metals and non-metals have quite different physical and chemical properties.

Typical properties of metals

- Good conductors of electricity
- High melting points
- Good conductors of heat
- Shiny
- Malleable (can be hammered into shape)
- Ductile (can be drawn into a wire)
- Sonorous (ring when struck)

Exceptions:

- The alkali metals have low melting points and are not sonorous.
- Mercury has a low melting point.

Fig. 2.3 Properties of metals.

Fig. 2.4 Metals: chromium, manganese, iron, cobalt, nickel, copper and zinc.

Metal oxides form **basic oxides**. Basic oxides, which do not dissolve in water, will react with acids to form chemicals called **salts** (for more detail see page 209). Metal oxides, which dissolve in water, form **alkalis** (for more detail see page 208).

Poor conductors of electricity **Low melting points** **Poor conductors of heat**

Typical properties of non-metals

Exceptions:

- Carbon in the form of graphite is a good conductor of electricity.
- Carbon and silicon have high melting points.

Fig. 2.5 Properties of non-metals.

Fig. 2.6 Non-metals from left: silicon, chlorine, sulfur.

Non-metals that dissolve in water typically form **acidic oxides** and react with alkalis to form salts.

Topic 11: Electrolysis

C11.3b The electrolysis of sodium chloride solution

Sodium chloride is an electrolyte and so it will allow an electric current to pass through it when in solution. It will also be broken down by this electric current. In this experiment you will be able to predict the products of the electrolysis and then test your predictions.

Apparatus

electrolysis cell with carbon electrodes
power supply 6 V DC
electrical leads, crocodile clips
sodium chloride solution
eye protection

SAFETY INFORMATION

Wear eye protection.
Do not run for a long time, otherwise a lot of chlorine gas will be evolved.

Method

- Put on your eye protection.
- Using the apparatus shown carefully fill the electrolysis cell about two-thirds full with sodium chloride solution.
- Fill the ignition tubes with sodium chloride solution and carefully invert them over the carbon electrodes.
- Connect the circuit and record your observations.

Make observations and measurements

- Record your observations in the table below:

| Observations at the anode | Observations at the cathode |
|---------------------------|-----------------------------|
| | |

Analyse and interpret data

- The ion that is discharged at the cathode will have what charge? What do you think this ion is?
- What do you think is the gas produced at the cathode? What test could you do on the gas to check your prediction? What result would confirm your prediction?
- The ion that is discharged at the anode will have what charge? What do you think the ion is?
- What do you think is the gas produced at the anode? What test could you do on the gas to check your prediction? What result would confirm your prediction?
- Why do you think so little gas collects at the anode?

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Topic 11: Electrolysis

Activity C11.4 Quantitative electrolysis

Learning objectives

- To introduce the link between half equations and the mole of electrons (the faraday)

Learning outcomes

- Be able to write half-equations to represent the reactions that occur at electrodes
- Know that a faraday is a mole of electrons
- Understand how to calculate the amounts of products formed in the electrolysis of molten compounds and aqueous solutions from the half equations involved

Resources

Student Book page 98
Worksheet C11.4a To find out how many faradays of electricity are needed to produce 1 mole of copper
Files on CD-ROM: C11.4a_worksheet, C11.4a_tech_notes
Resources for class practical (see below)

Approach

Introduce the faraday as a mole of electrons and relate this to some of the half-equations already encountered in the topic. Use the questions in the Student Book to provide practice for students. Worksheet C11.4a provides quantitative work related to the quantity of electricity needed to produce 1 mole of copper.

The calculation of the quantity of electricity from current (I) and time (t) is not a requirement of the course specification, but students should be able to cope with the necessary calculations. It provides a very useful reinforcement of the link between the half-equation and moles of electrons.

Technician's notes

You will need the following resources for a class practical.
Be sure to check the latest safety notes on these resources before proceeding.

| |
|---|
| power supply, rheostat, ammeter, leads, crocodile clips |
| balance accurate to 2 decimal places |
| stopwatch |
| 2 copper electrodes |
| sandpaper or emery cloth |
| copper(II) sulfate solution (0.5M) |
| 100 cm ³ beaker |

Answers

Page 98

- 2 faradays of electricity are needed to produce 1 mole of calcium atoms.
- 2 moles of chlorine gas will be produced by 4 faradays of electricity.
- 0.5 faradays will produce 0.25 moles of hydrogen gas (H₂) = 0.5 g (2H⁺(aq) + 2e⁻ → H₂(g))

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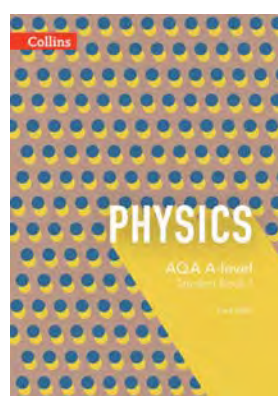
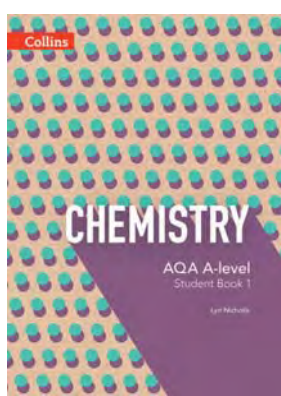
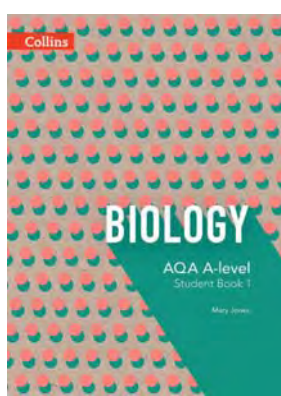
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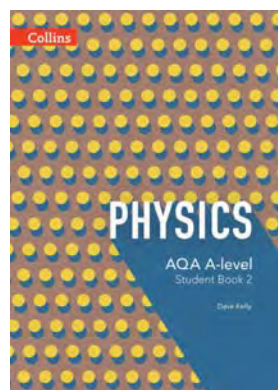
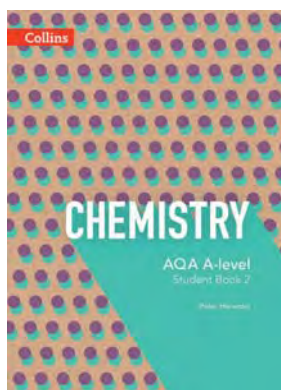
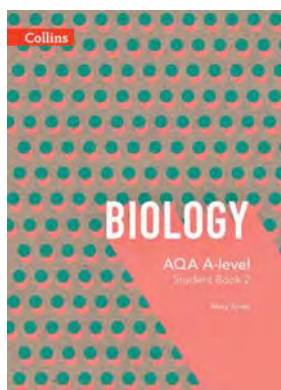
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2.3 THE IDEAL GAS EQUATION

Measuring the mass of a gas is not easy. Gases are usually measured by volume, but the volume of a gas depends upon its temperature and pressure. So, to find the mass of a gas, after measuring its volume, you need to understand the way that gases change in volume when temperature and pressure change. Each gas behaves very slightly differently compared with other gases but, for most practical purposes, the differences are small enough to assume that gases all behave like an imaginary 'ideal gas'.

An **ideal gas** has a number of assumed properties:

- It is made up of identical particles in continuous random motion.
- The particles can be thought of as pointlike, with position but with zero volume which means that the volume of the gas particles is taken to be zero.
- The particles do not react when they collide.
- Collisions between particles are perfectly elastic – the total kinetic energy (energy of motion) of the particles after a collision is the same as that before the collision.
- The particles have no intermolecular forces, meaning they do not attract or repel each other. (We will look out more about intermolecular forces in Chapter 3.)

As shown in Figure 5, an ideal gas follows this model exactly. In an ideal gas there are no intermolecular forces, so the particles are not attracted to each other. In a real gas, attractive intermolecular forces divert the paths of particles. These forces explain why under the right conditions, gases can be liquefied. Some gases do behave like an ideal gas over a limited range of temperatures and pressures. Hydrogen, nitrogen, oxygen and the inert noble gases behave most like ideal gases.

The effect of pressure

Robert Boyle was one of the first chemists to study the behaviour of gases under different conditions. He realised that when he kept the number of moles of gas and the temperature constant, but increased the pressure on the gas, then its volume became smaller. In 1662, based on this evidence, he stated:

‘At constant temperature, the volume of a fixed mass of gas is inversely proportional to the pressure applied to it.’

When this theory proved generally to be true, it became known as Boyle’s Law. You can write it mathematically as:

$$p \propto \frac{1}{V}$$

$$pV = \text{constant}$$

when T and the mass of gas are constant,
which is the same as:

$$p_1 V_1 = p_2 V_2$$

when T and the mass of gas are constant.

The effect of temperature

About a hundred years after Robert Boyle made his conclusions, the Frenchman Jacques Charles was studying during a period when ballooning was all the rage in France. Balloons were usually filled with hydrogen. Since the density of hydrogen was less than that of air, balloons filled with enough hydrogen floated up from the ground. Charles was, like most people of his time, not an expert on the use of hydrogen, however. Balloons were subsequently filled with air that was heated to reduce its density. As soon as the total mass of the balloon, passengers and air in the balloon was less than that of the air displaced the balloon could rise into the air. This is the method that is still used today (Figure 7).

| Element | Mass of 1 mole | Percentage of the Earth's | Mass in the Earth's | Number of atoms |
|-----------|----------------|---------------------------|-----------------------|-----------------------|
| Iron | 55.9 | 35 | 3.99×10^{23} | 2.26×10^{26} |
| Oxygen | 16.0 | 30 | 4.79×10^{23} | 8.75×10^{26} |
| Silicon | 28.1 | 15 | 8.97×10^{22} | 1.92×10^{26} |
| Magnesium | 24.3 | 15 | 7.77×10^{22} | 1.93×10^{26} |
| Sulphur | 32.1 | 2 | 1.30×10^{22} | 2.24×10^{26} |
| Calcium | 40.1 | 1 | 5.96×10^{21} | 8.88×10^{26} |
| Aluminium | 27.0 | 1 | 5.98×10^{21} | 1.55×10^{26} |

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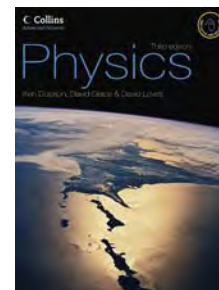
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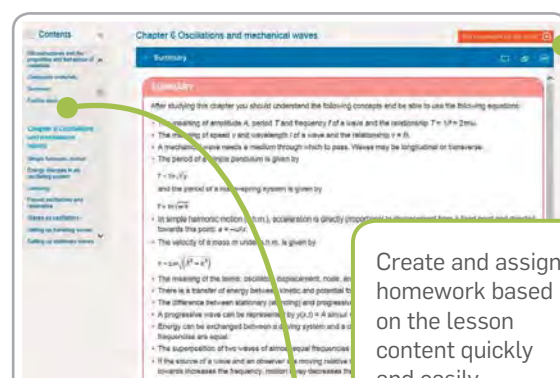
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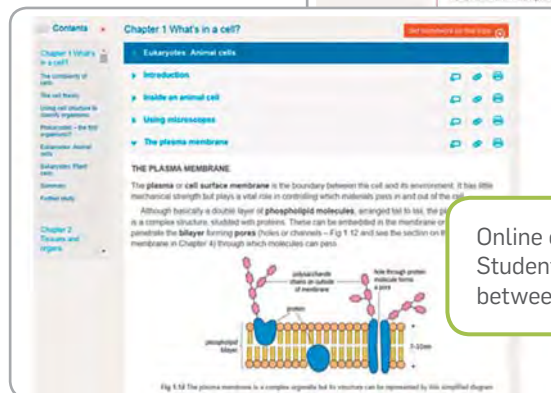
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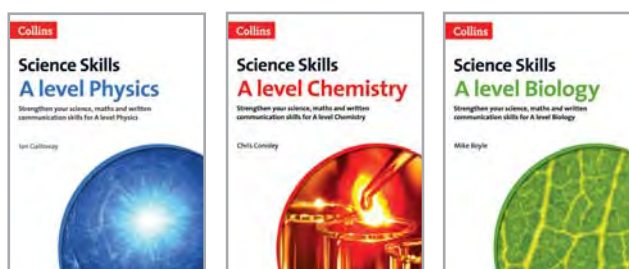
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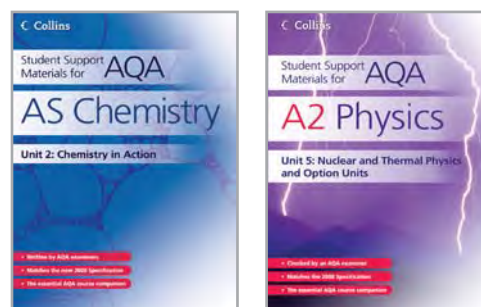
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