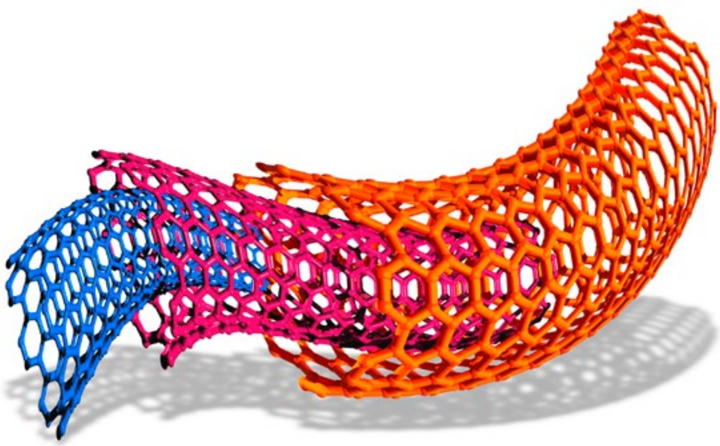
Cambridge Assessment International Education

Interactive

Interactive Learner Guide

Cambridge IGCSE®
Chemistry (9–1) 0971

For examination from 2017



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About this guide

This guide introduces you to your Cambridge IGCSE® Chemistry (9-1) (0971) course and how you will be assessed. You should use this guide alongside the support of your teacher.

By the end of this guide, you should:

✓ have an overview of the course and what you will learn about
✓ understand the structure of the assessment that you will be taking
✓ be able to plan your revision
✓ know how to show your skills to the best of your ability.

Section 1: Syllabus content

Find out what topics you will be learning about. Your teacher can give you more detail.

Section 2: How you will be assessed

Find out:

- how many examinations you will take
- how long each examination lasts
- what different question types the examination will contain
- how to tackle each examination.

Section 3: What skills will be assessed

Find out what areas of knowledge, understanding and skills you will need to demonstrate throughout the course and in your examinations.

Section 4: Example candidate response

Take a look at a learner's response taken from a real examination. Find out:

- how to interpret the question
- how to avoid common mistakes
- how to improve your exam technique.

Section 5: Revision

Discover:

- ways to help you plan your revision
- example revision planners
- some basic revision skills
- some 'top revision tips'
- revision checklist for each topic.

Section 1: Syllabus content - what you need to know about

This section gives you an outline of the syllabus content for this course. Only the top-level topics of the syllabus have been included here, which are the same for both the **Core** and **Extended** course. In the 'overview' column you are given a very basic idea of what each topic covers.

Learners taking the **Extended** course need to know all of the Core content as well as some extra content. This extra content is known as **supplement** content; it requires learners to explore topics and sub-topics of the Core syllabus in more detail, and to learn new sub-topics.

Ask your teacher for more detail about each topic, including the differences between the Core and Extended courses. You can also find more detail in the Revision checklists in this guide.

Topic	Overview
1. The particulate nature of matter	Solids, liquids and gases
2. Experimental techniques	Measurement, purity and purification
3. Atoms, elements and compounds	Atomic structure, the Periodic Table and bonding
4. Stoichiometry	Chemical symbols, chemical formulae and balancing equations
5. Electricity and chemistry	Electrolysis and electroplating
6. Chemical energetics	Energetics of a reaction and energy transfer
7. Chemical reactions	Physical and chemical changes, rates, reversible, redox
8. Acids, bases and salts	Properties of acids and bases, oxides, preparation of salts, identification of ions and gases
9. The Periodic Table	Trends and groups, transition elements, noble gases
10. Metals	Properties, reactivity, extraction and uses
11. Air and water	Chemical tests, pollutants, fertilisers, greenhouse gases
12. Sulfur	Sources and uses
13. Carbonates	Manufacture and uses of lime, calcium carbonate and slaked lime
14. Organic chemistry	Names and properties of organic compounds

In addition to the syllabus content, you are also expected to understand and know **experimental skills**. For Papers 1–4 and Paper 6, you will also need to learn a number of tests and test results for different ions and gases called the '**Notes for use in qualitative analysis**' (these are given in Paper 5). You can find more detail about the experimental skills, and these tests, from your teacher, and also in the Revision checklist.

Section 2: How you will be assessed

You will be assessed using three components:

- Paper 1 or Paper 2 (Multiple choice)
- Paper 3 or Paper 4 (Written paper, Theory)
- **and** either Paper 5 (Practical Test) or Paper 6 (Alternative to Practical).

Your teacher will discuss with you which course is appropriate for you, Core or Extended.

As mentioned in Section 2, the Extended course covers all the same material as the Core course but also includes more to learn in some sub-topics and some additional sub-topics.

Core

You will take **three** examinations at the end of the course:

- Paper 1 – Multiple choice
- Paper 3 – Written paper
- **either** Paper 5 – Practical Test **or** Paper 6 – Alternative to Practical (Written paper)*

Extended

You will take **three** examinations at the end of the course:

- Paper 2 – Multiple choice
- Paper 4 – Written paper
- **either** Paper 5 – Practical Test **or** Paper 6 – Alternative to Practical (Written paper)*

*** Your teacher will tell you if you are going to take Paper 5 or Paper 6.**

Components at a glance

The tables summarise the key information about each component for each syllabus. You can find details and advice on how to approach each component on the following pages.

Component		How long and how many marks	Skills assessed	Details	Percentage of the qualification
Core	Paper 1 (Multiple choice)	45 minutes 40 marks	Knowledge with understanding, handling information and problem solving	You need to answer **all** 40 questions on the Core syllabus content. Each question will have four options to choose from.	30%
	Paper 3 (Written paper, Theory)	1 hour 15 minutes 80 marks	Knowledge with understanding, handling information and problem solving	The questions are short-answer or structured questions on the Core syllabus content. You need to answer **all** questions.	50%
	Paper 5 (Practical Test)	1 hour 15 minutes 40 marks	Experimental skills and investigations	You will take a practical exam that is supervised by your teacher.	20%
	or Paper 6 (Alternative to Practical)	1 hour 40 marks	Experimental skills and investigations	This is a written paper about practical work.	20%

Component		How long and how many marks	Skills assessed	Details	Percentage of the qualification
Extended	Paper 2 (Multiple choice)	45 minutes 40 marks	Knowledge with understanding, handling information and problem solving	You need to answer **all** 40 questions on the Extended (Core and Supplement) syllabus content. Each question will have four options to choose from.	30%
	Paper 4 (Written paper, Theory)	1 hour 15 minutes 80 marks	Knowledge with understanding, handling information and problem solving	The questions are short-answer or structured questions on the Extended (Core and Supplement) syllabus content. You need to answer **all** questions.	50%
	Paper 5 (Practical Test)	1 hour 15 minutes 40 marks	Experimental skills and investigations	You will take a practical exam that is supervised by your teacher.	20%
	or Paper 6 (Alternative to Practical)	1 hour 40 marks	Experimental skills and investigations	This is a written paper about practical work.	20%

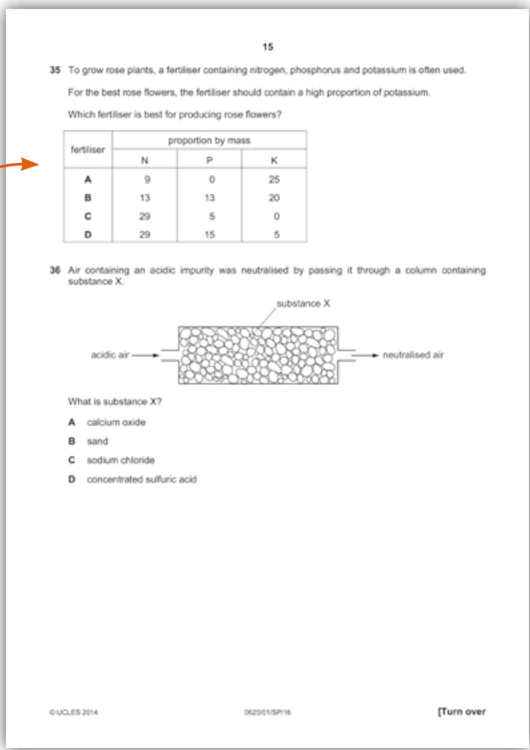
About the components

It is important that you understand the different types of question in each component and how you should approach them.

These papers assess your knowledge with understanding and your skills in handling information and solving problems. You need to answer **all** 40 questions.

For each question, you choose the one answer you consider correct from four possible answers (A, B, C, D).

The Periodic Table is included in the back of the paper.



15

35 To grow rose plants, a fertiliser containing nitrogen, phosphorus and potassium is often used.

For the best rose flowers, the fertiliser should contain a high proportion of potassium.

Which fertiliser is best for producing rose flowers?

fertiliser	proportion by mass		
	N	P	K
A	9	0	25
B	13	13	20
C	29	5	0
D	29	15	5

36 Air containing an acidic impurity was neutralised by passing it through a column containing substance X.

What is substance X?

A calcium oxide
B sand
C sodium chloride
D concentrated sulfuric acid

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Advice

Read each question carefully.

If possible, work out the answer **before** you look at the answer options.

If you cannot work out an answer straight away:

- eliminate options that are clearly incorrect
- choose between those that are left
- **don't** make a guess from all four options
- **never** leave an answer blank

Write down your working on the question paper to help you understand and solve the problems.

There is 45 minutes for Paper 1, so you have about **one minute** to read and answer each question.

Don't look for patterns in the letter answers you give. If your answers mean you are selecting one letter, e.g. A, more often than others, it doesn't matter. Concentrate on answering the question you are doing.

You will likely make fewer mistakes if you write down your working than if you try to work out the answers in your head.

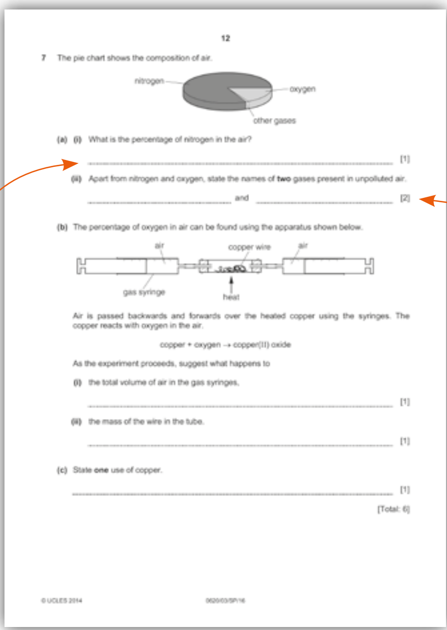
Practise multiple-choice questions and get someone else to mark them. Look for:

- errors
- questions you didn't read carefully
- topics you don't know or understand.

Paper 3 (Core) and Paper 4 (Extended) – Written paper, Theory

These papers assess your knowledge with understanding, and your skills in handling information and solving problems. You need to answer **all** questions.

Write your answers in the spaces provided.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7 The pie chart shows the composition of air.

(a) (i) What is the percentage of nitrogen in the air?

.... [1]

(ii) Apart from nitrogen and oxygen, state the names of **two** gases present in unpolluted air.

.... and .... [2]

(b) The percentage of oxygen in air can be found using the apparatus shown below.

Air is passed backwards and forwards over the heated copper using the syringes. The copper reacts with oxygen in the air.

copper + oxygen → copper(II) oxide

As the experiment proceeds, suggest what happens to

(i) the total volume of air in the gas syringes,

.... [1]

(ii) the mass of the wire in the tube.

.... [1]

(c) State **one** use of copper.

.... [1]

[Total: 6]

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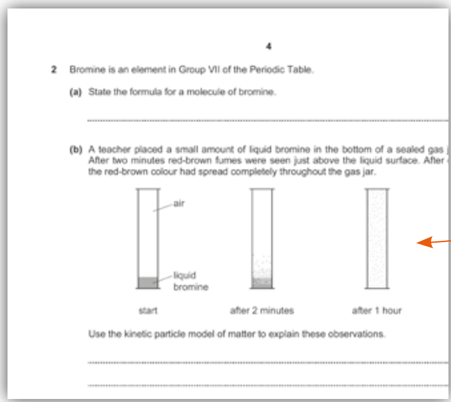
The number of marks for each question or question part often gives you a clue about how many separate points you need to make in your answer.

The Periodic Table is included in the back of the paper.

Question types and advice

Paper 3 and Paper 4 have short-answer and structured questions.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2 Bromine is an element in Group VII of the Periodic Table.

(a) State the formula for a molecule of bromine.

....

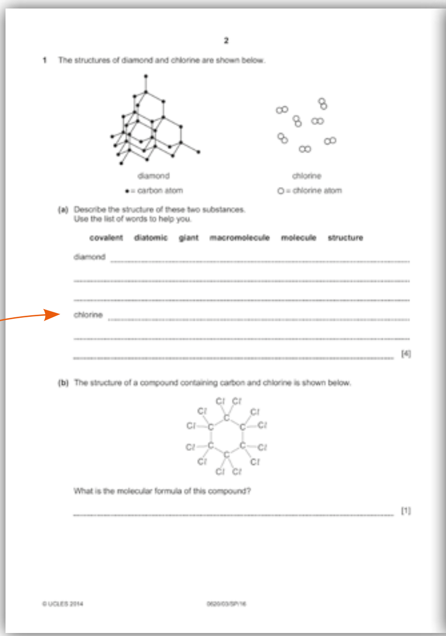
(b) A teacher placed a small amount of liquid bromine in the bottom of a sealed gas j
After two minutes red-brown fumes were seen just above the liquid surface. After
the red-brown colour had spread completely throughout the gas jar.

Use the kinetic particle model of matter to explain these observations.

....

....

Short-answer questions only have one or two parts.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1 The structures of diamond and chlorine are shown below.

(a) Describe the structure of these two substances.
Use the list of words to help you.

covalent diatomic giant macromolecule molecule structure

diamond ....

....

....

chlorine ....

....

.... [4]

(b) The structure of a compound containing carbon and chlorine is shown below.

What is the molecular formula of this compound?

.... [1]

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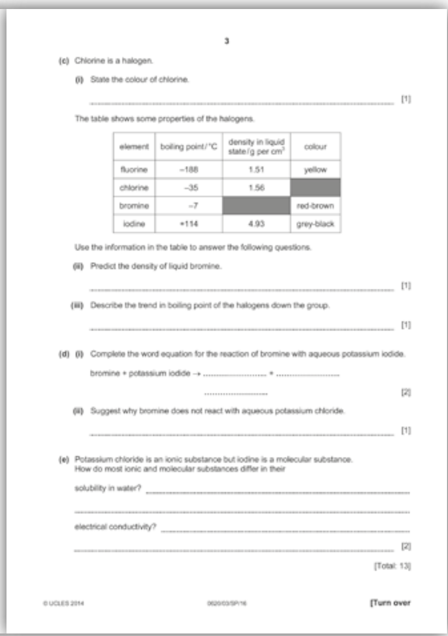
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(c) Chlorine is a halogen.

(i) State the colour of chlorine.

.... [1]

The table shows some properties of the halogens.

element	boiling point/°C	density in liquid state/g per cm^3	colour
fluorine	–188	1.51	yellow
chlorine	–35	1.56	
bromine	–7		red-brown
iodine	+114	4.93	grey-black

Use the information in the table to answer the following questions.

(ii) Predict the density of liquid bromine.

.... [1]

(iii) Describe the trend in boiling point of the halogens down the group.

.... [1]

(d) (i) Complete the word equation for the reaction of bromine with aqueous potassium iodide.

bromine + potassium iodide → .... + ...

.... [2]

(ii) Suggest why bromine does not react with aqueous potassium chloride.

.... [1]

(e) Potassium chloride is an ionic substance but iodine is a molecular substance.
How do most ionic and molecular substances differ in their

solubility in water? ....

....

electrical conductivity? ....

.... [2]

[Total: 13]

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Structured questions contain many parts. Often later parts can depend on the answer to earlier parts.

Make sure you:

- answer the question being asked

Draw a diagram to show the electron arrangement in a molecule of hydrogen.

Predict how the reaction of potassium with water compares with the reaction of lithium with water. In your answer, include any differences in observations.

Two of the elements present in a sample of coal are carbon and sulfur. A sample of coal was heated in the absence of air and the products included water, ammonia and hydrocarbons. Name three other elements present in this sample of coal.

You are asked to draw a 'molecule', so **two** H atoms with a pair of electrons joining them is needed, **not** an 'atom'.

The question asks you to 'compare' and include any 'differences', so you need to say that 'potassium produces *more* bubbles *than lithium*', **not** just that 'potassium produces bubbles'.

The question asks you to name 'three **other** elements', so 'hydrogen, oxygen and nitrogen' is needed – **not** 'carbon' or 'sulfur', which are given in the question.

- look at how many marks are available for a question, this gives you a good idea of how many different points you need to make

Explain why zinc chloride conducts electricity when molten, not when solid. [2]

There are 2 marks available, so 2 **separate** points are needed.

- know the chemical terms used in the questions

State two differences in the physical properties of the metals potassium and iron.

Carboxylic acids can be made by the oxidation of alcohols. Name a reagent, other than oxygen, which can oxidise alcohols to carboxylic acids.

You need to understand the term 'physical properties' in order to answer the question correctly.

You need to understand what the term 'reagent' means in order to answer the question correctly.

- know how to write chemical equations in words **and** using symbols

In **Paper 3** you will be told in the question to write either a 'word' equation or a 'symbol' equation.

Do not combine symbols and words in the same answer.

In **Paper 4** you may be asked to give a word equation, but if you are asked to write an equation for a particular reaction you need to provide a balanced equation using symbols and formulae. For example, 'Write an equation for the complete combustion of methane' would require the answer:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

- are specific in your answer and not vague

Copper(II) sulfate is heated strongly. The products are copper(II) oxide and sulfur trioxide. Sulfur trioxide is an acidic gas.

What precautions must be taken when heating copper(II) sulfate in the laboratory?

Vague answers such as 'keep away from the reaction' or 'don't breathe in the gas' will not get the mark. You would need to be specific such as 'use a fume cupboard' or 'carry out the reaction in a well-ventilated area'.

- do not contradict yourself

Give two harmful effects of acid rain.

Acidifies lakes ✓ and raises the pH ✗

'Acidifies lakes' is correct, but 'raises the pH' has the opposite meaning, that the lakes are more alkaline.

- keep an eye on the time.

Make sure you have time to answer all the questions and return at the end to check your answers.

1 hour 15 mins

Paper 5 (Practical Test)

Paper 5 assesses experimental skills and investigations. You take the exam in a laboratory under teacher supervision; you will have your own working space and set of apparatus. It is important that you learn and practise experimental skills during your course.

The questions in Paper 5 are structured. Each question includes the instructions for the experiments you must carry out, space for you to record observations and data, and space for you to then interpret or process your results. You need to answer **all** questions.

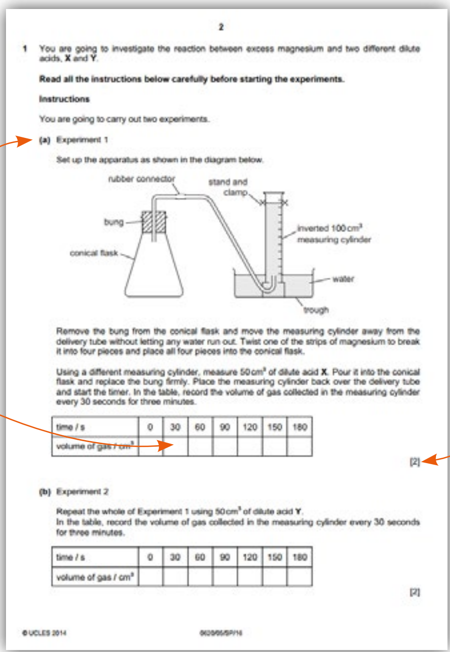
The questions might, for example, require you to:

- measure, record and then use data
- investigate an unknown substance using test-tube reactions
- plan an experiment or an investigation

Each of the questions contains a number of parts.

Write your answers on the question paper.

Tests to identify ions and gases (known as **Notes for use in qualitative analysis**) are included in the exam paper to help you identify ions and gases.



2

1 You are going to investigate the reaction between excess magnesium and two different dilute acids, **X** and **Y**.

Read all the instructions below carefully before starting the experiments.

Instructions

You are going to carry out two experiments.

(a) Experiment 1

Set up the apparatus as shown in the diagram below.

Remove the bung from the conical flask and move the measuring cylinder away from the delivery tube without letting any water run out. Twist one of the strips of magnesium to break it into four pieces and place all four pieces into the conical flask.

Using a different measuring cylinder, measure 50 cm^3 of dilute acid **X**. Pour it into the conical flask and replace the bung firmly. Place the measuring cylinder back over the delivery tube and start the timer. In the table, record the volume of gas collected in the measuring cylinder every 30 seconds for three minutes.

time / s	0	30	60	90	120	150	180
volume of gas / cm^3							

[2]

(b) Experiment 2

Repeat the whole of Experiment 1 using 50 cm^3 of dilute acid **Y**.
In the table, record the volume of gas collected in the measuring cylinder every 30 seconds for three minutes.

time / s	0	30	60	90	120	150	180
volume of gas / cm^3							

[2]

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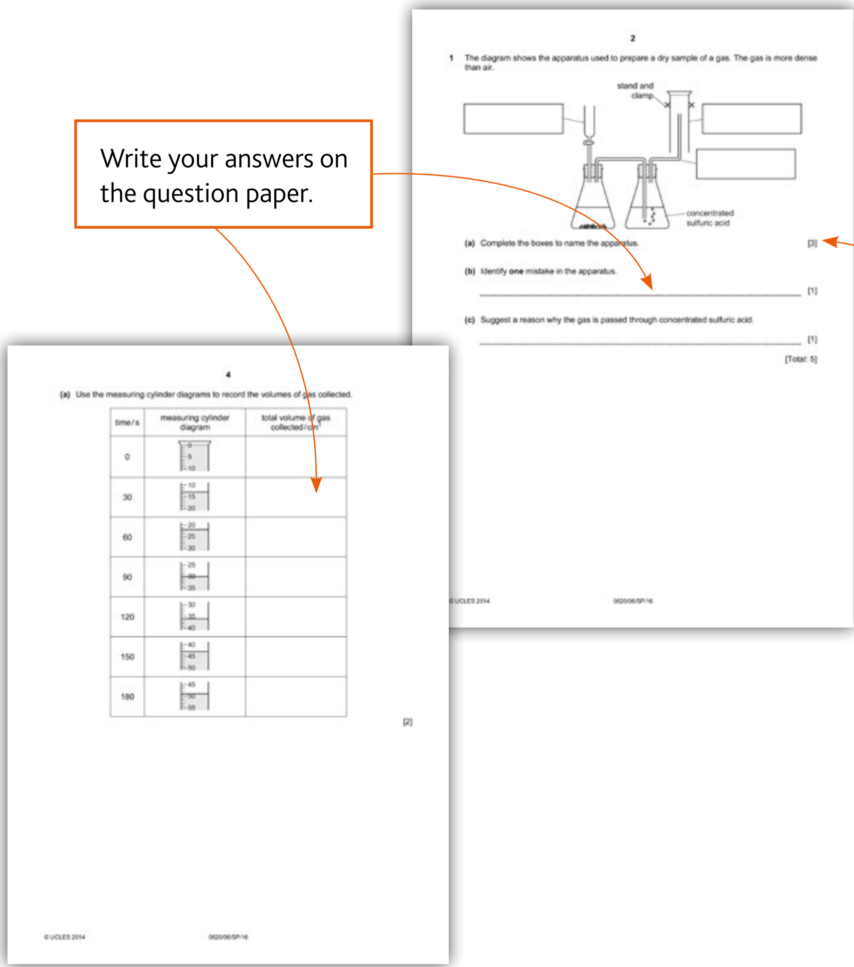
The number of marks for each question or question part often gives you a clue about how many separate points you need to make in your answer.

Paper 6 (Alternative to Practical)

Paper 6 assesses experimental skills and investigations. It is a written paper about practical work, so make sure that you study all the experiments you have done in the classroom and seen demonstrated. You will take this examination under the same conditions as other **written papers**. It is important that you learn and practise experimental skills during your course.

The paper consists of short-answer questions and/or structured questions. You need to answer **all** questions.



Write your answers on the question paper.

The number of marks for each question or question part often gives you a clue about how many separate points you need to make in your answer.

You will need to **learn** tests for ions and gases (known as **Notes for use in qualitative analysis**) as they are **not** in the exam paper. See the Revision checklists.

Advice for Paper 5 (Practical Test) and Paper 6 (Alternative to Practical)

These papers will not test specific topic content from the syllabus content, they test experimental skills and investigations. This is assessment objective AO3. Any information required to answer the questions in these papers is contained within the paper itself or should be known from the experimental context, and skills listed in the Revision checklist.

Questions might include:

- the measurement of a quantity such as volume or mass
- investigation of rates (speeds) of reaction
- measurement of temperature using a thermometer with 1°C graduations
- investigations of some aspect of chemistry, possibly including organic compounds
- filtration
- electrolysis
- identification of ions and gases.

Record readings using suitable accuracy

For example,

- volume to the nearest 0.1 cm^3
- thermometer readings usually to the nearest 0.5°C
- time to the nearest second.

See the '**Notes for use in qualitative analysis**' later in this guide for the tests to identify ions and gases. You need to **learn** these for Paper 6. The tests and results are given in Paper 5.

Record observations carefully

Record observations in the order the steps are carried out.

Try to use the same language as used in the '**Notes for use in qualitative analysis**' tests later in this guide.

Observations might include:

- the **colour** of solids
- the **colour** of solutions – use **colourless** if the solution has no colour ('clear' is not the same as colourless)
- what you see if you test for a gas, such as **bubbles**, or **fizzing**, or **effervescence** – not just 'a gas is given off'.

You will need to be able to:

- describe, explain or comment on experimental arrangements and techniques
- take accurate readings from apparatus / diagrams of apparatus, such as cylinders, burettes and pipettes to measure the volume of liquids, thermometers to record temperature, clocks to measure time
- fill in tables of data, and process data, using a calculator where necessary
- draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation
- interpret and evaluate observations and experimental data
- plot and interpret information from graphs
- identify sources of error and suggest possible improvements in experiments
- plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques.

See the notes on drawing graphs in Section 5: Revision.

Write **notes** before writing the plan.

Clearly state:

- details of apparatus
- quantities of substances to be used
- practical procedures you think should be carried out
- a conclusion.

Make sure any diagrams fill the space given on the paper and are fully labelled.

Section 3: What skills will be assessed

The areas of knowledge, understanding and skills that you will be assessed on are called **assessment objectives** (AOs).

AO1 Knowledge with understanding	AO2 Handling information and problem solving	AO3 Experimental skills and investigations

The tables explain what each assessment objective means and what percentage of the whole qualification is assessed using that objective. Your teacher will be able to give you more information about how each of the assessment objectives are tested.

AO 1	What this means	Where
Candidates should be able to demonstrate knowledge and understanding of: 1. scientific phenomena, facts, laws, definitions, concepts and theories 2. scientific vocabulary, terminology and conventions (including symbols, quantities and units) 3. scientific instruments and apparatus, including techniques of operation and aspects of safety 4. scientific and technological applications with their social, economic and environmental implications.	**Knowledge with understanding** This is all about remembering facts and applying these facts to new situations. You need to be able to: • use scientific ideas, facts and laws • know definitions and the meaning of scientific terms, e.g. what is reduction? • know about chemical apparatus and how it works • know chemical symbols, quantities (e.g. volume) and units (e.g. dm^3) • understand the importance of science in everyday life.	Two out of three components: Paper 1 or 2 Paper 3 or 4 Percentage of IGCSE: 50%

The syllabus content is the factual material that you might need to recall and explain. You will also be asked to apply this material to unfamiliar contexts, and to apply knowledge from one area of the syllabus to another.

AO2	What this means	Where
Candidates should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical), to: 1. locate, select, organise and present information from a variety of sources 2. translate information from one form to another 3. manipulate numerical and other data 4. use information to identify patterns, report trends and draw inferences 5. present reasoned explanations for phenomena, patterns and relationships 6. make predictions and hypotheses 7. solve problems, including some of a quantitative nature.	**Handling information and problem solving** This is all about how you extract information and rearrange it in a sensible way, how you carry out calculations, and how you make predictions. You need to be able to: • select and organise information from graphs, tables and written text • change information from one form to another, e.g. draw graphs from data, construct symbol equations from word equations • arrange data and carry out calculations • identify trends and patterns from information given and draw conclusions • explain scientific relationships, e.g. increasing the temperature of a gas increases the speed of its particles • make predictions and develop scientific ideas • solve problems.	Two out of three components: Paper 1 or 2 Paper 3 or 4 Percentage of IGCSE: 30%

Questions that test AO2 skills might be based on information that is unfamiliar to you, meaning that you have to apply the principles and concepts from the syllabus to a new situation in a logical, deductive way.

AO3	What this means	Where
Candidates should be able to: 1. demonstrate knowledge of how to safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate) 2. plan experiments and investigations 3. make and record observations, measurements and estimates 4. interpret and evaluate experimental observations and data 5. evaluate methods and suggest possible improvements.	**Experimental skills and investigations** This is all about planning and carrying out experiments and recording and analysing information. You need to be able to: • set up and use apparatus safely • make observations and measurements and record them • analyse experimental results and suggest how valid they are • plan and carry out your own experiment, describe to what extent your plan worked and suggest improvements.	One out of three components: Paper 5 or 6 Percentage of IGCSE: 20%

Section 4: Example candidate response

This section takes you through an example question and candidate response from a Cambridge IGCSE Chemistry (9-1) (0971) past paper. It will help you to see how to identify words within questions and to understand what is required in your response. Understanding the questions will help you to know what you need to do with your knowledge, for example, you might need to describe something, explain something, argue a point of view or list what you know.

All information and advice in this section is specific to the example question and response being demonstrated. It should give you an idea of how your responses might be viewed by an examiner but it is not a list of what to do in all questions. In your own examination, you will need to pay careful attention to what each question is asking you to do.

This section is structured as follows:

A. Question

Words in the question have been highlighted and their meaning explained. This should help you to understand clearly what is required by the question.

B. Mark scheme

This tells you as clearly as possible what an examiner expects from an answer to award marks.

C. Example candidate response

This is an answer by a real candidate in exam conditions. Good points and problems have been highlighted.

D. How the answer could have been improved

This summarises what could be done to gain more marks.

E. Common mistakes

This will help you to avoid common mistakes made by candidates. So often candidates lose marks in their exams because they misread or misinterpret the questions.

A. Question

The question used in this example is a structured question that you might find in Paper 3 and Paper 4. This means that the question is split into parts, often with later parts linked to the answer of earlier parts of the paper. This example is taken from a Core paper, but the comments are still relevant for Extended papers.

5 (a) Match the phrases on the left with the definitions on the right.
The first one has been done for you.

relative formula mass	an atom that has become charged
molecule	the smallest part of an element which can take part in a chemical change
atom	two or more atoms covalently bonded together
ion	the sum of the relative atomic masses in a compound

[3]

(b) Sodium hydroxide, NaOH, is an ionic compound which dissolves in water to form a strongly alkaline solution.

(i) Which **one** of the following best describes the pH of a concentrated aqueous solution of sodium hydroxide?
Put a ring around the correct answer.

pH 2 **pH 5** **pH 7** **pH 8** **pH 13** [1]

(ii) Calculate the relative formula mass of sodium hydroxide.

[1]

(iii) The equation describes how sodium hydroxide reacts with hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

What type of chemical reaction is this?

.... [1]

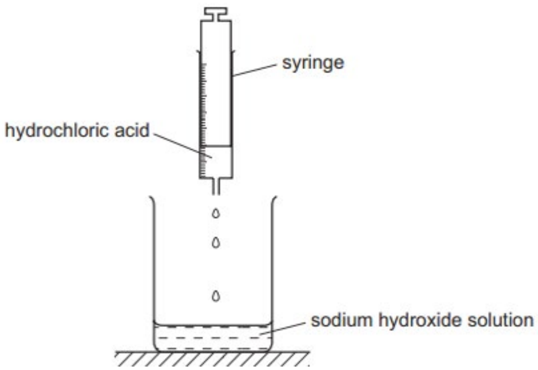
Match…The first one has been done for you. This means that you are expected to connect a phrase with its correct definition. The example shows you that you need to match by drawing a line from **one** box to **one** other. If you join one box to two boxes, you would **not** be awarded the mark for that phrase.

one… this instruction is in bold to emphasise that there is only one correct answer.

Put a ring round … tells you how to select/show your answer.

Calculate… this means you need to use numbers to do a calculation. Sometimes the numbers will be given in the question, other times you will need to know them or find them. Here, you are expected to know the relative atomic masses of each of the atoms in sodium hydroxide, or to find them in the Periodic table if you do not know them from memory.

(iv) A student used a syringe to add 1 cm^3 portions of hydrochloric acid to an aqueous solution of sodium hydroxide.



Describe how the pH of the solution in the beaker changes as the hydrochloric acid is added until the acid is in excess.

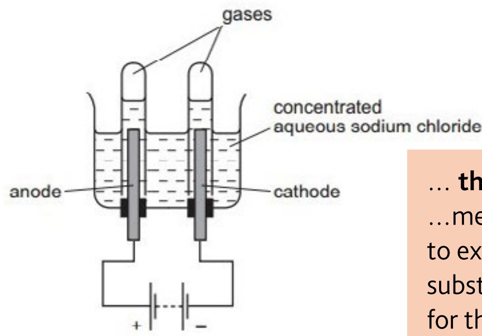
....

....

.... [2]

Describe … means you must state, in words, the main points of the topic in the question. You might need to recall facts, events or processes in an accurate way. Here, you are asked to **describe how** something changes during a particular reaction, so you should state what change occurs in the reaction. You do not need to explain why things happen, just what happens.

(c) The diagram shows the apparatus used to electrolyse concentrated aqueous sodium chloride.



Give a description of this electrolysis.
In your description include

- what substance the electrodes are made from and the reason for using this substance
- what you would observe during the electrolysis
- the names of the substances produced at each electrode.

....

....

....

… **the reason for** …means you need to explain *why* the substances is used for this purpose.

Give a description … means the same thing as 'Describe'. In this question however, you are asked to describe a more complex process and there are more marks available, so more detail is required than for part (b)(iv). Bullet points are given to help you structure your answer; it is a good idea to make sure you cover *each* bullet in your answer.

… **would observe** … where you see the *word observe* you need to state something you would see or smell. 'A gas is given off' is not an observation, it is a statement of a fact. Saying 'bubbles of gas' is an observation as the bubbles can be seen.

B. Mark scheme

The mark scheme provides the final answer for each sub-part of a question and, when appropriate, the required lines of working to reach that answer. Sometimes the answer has to be exactly as given in the mark scheme. Other times there will be an acceptable range of answers. The presence of a '/' between items in the mark scheme means 'or', and indicates a list of possible answers. Look at the mark scheme below.

5 (a) *Each item should be joined to the correct definition box. There is no mark if a box is joined to more than one other box. Correct pairs are:*

molecule → two or more atoms covalently bonded together [1]

atom → the smallest part of an element which can take part in a chemical change [1]

ion → an atom that has become charged [1]

(b) (i) pH 13 [1]

(ii) 40 [1]

(iii) neutralisation [1]

(iv) *The first part of the answer must refer to pH getting lower/less/decreases, e.g.* [1]

pH decreases / pH goes from higher to lower pH / pH changes from pH 12 to pH 8.

The second part of the answer must refer to the pH going below 7, e.g. [1]

final pH below 7 / state a pH values less than 7

The statements above are examples only, any suitable comment can be awarded marks. Using actual values e.g. changes from pH 12 to pH 8 and then to pH 5 gains marks but simply stating that the solution becomes 'less alkaline' or 'more acidic' is not correct. ***pH must be mentioned.***

(c) *The following are examples of correct answers relating to each bullet point. A maximum of 6 marks can be awarded.* ***If the candidate provides an answer that is not listed but which is accurate and relevant, award marks accordingly.***

- Electrodes are made from carbon / graphite / platinum [1]
  because it is unreactive / inert / conducts electricity / electrons move in [1]
- Any two from:
  - bubbles (of gas from the electrodes) [1]
  - smell of chlorine / swimming pools [1]
  - solution goes (pale) green(ish) / yellow(ish) [1]
- Chlorine is produced at the anode / chloride (ions) go to anode [1]
- Hydrogen is produced at the cathode / hydrogen (ions) go to the cathode [1]
  If candidate says that hydrogen is produced at the anode and chlorine at the cathode, award just 1 mark maximum for this point.

Additional marks (up to a maximum of six) can be scored from the following points:

Ions are attracted to oppositely charged electrodes [1]

Ions move through the solution [1]

Electrons move through the electrodes [1]

Electrolyte conducts electricity [1]

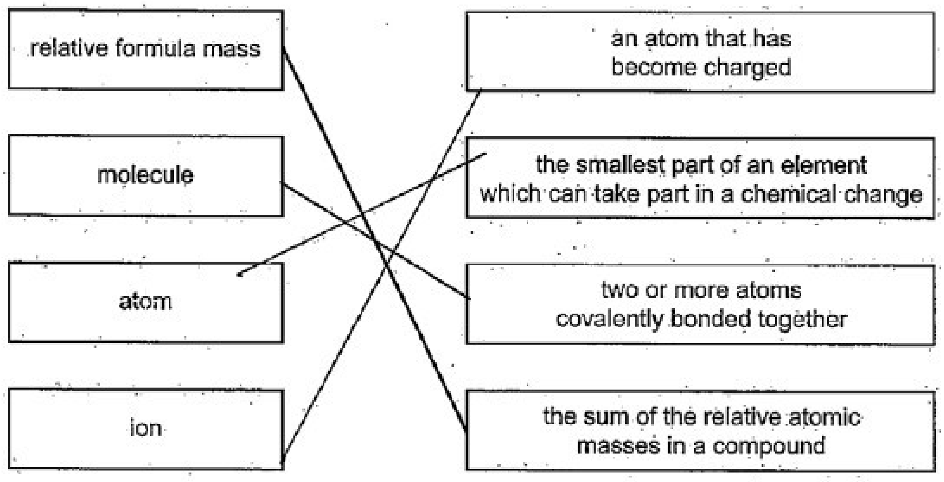
'Hydroxide ions' does ***not*** *score a mark.*

Now let's look at the sample candidate's response to question 9 and the examiner's comments on this response.

C. Example candidate response and examiner comments

An extract from a real candidate's exam paper has been used. The examiner comments are included inside the orange boxes.

5 (a) Match the phrases on the left with the definitions on the right.
The first one has been done for you.



[3]

Mark awarded: 3

The phrases are perfectly matched with the definitions.

Note that if they had matched a phrase with more than one definition, they would not score a mark for that phrase, even if one of the two connected definitions was correct.

(b) Sodium hydroxide, NaOH, is an ionic compound which dissolves in water to form a strongly alkaline solution.

(i) Which one of the following best describes the pH of a concentrated aqueous solution of sodium hydroxide?
Put a ring around the correct answer.

pH 2 pH 5 pH 7 pH 8 pH 13 [1]

Mark awarded: 1

The correct answer has been circled.

(ii) Calculate the relative formula mass of sodium hydroxide.

relative formula mass = $\underset{Na}{23} + \underset{O}{16} + \underset{H}{1}$

= 40

The relative atomic masses of the atoms in sodium hydroxide are added together to find the relative formula mass. If you didn't know the relative atomic masses of each atom, you could use the Periodic Table provided in the back of the paper

Mark awarded: 1

The mark is awarded for the final answer of '40'. However, it is always a good idea to show your working.

[1]

(iii) The equation describes how sodium hydroxide reacts with hydrochloric acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

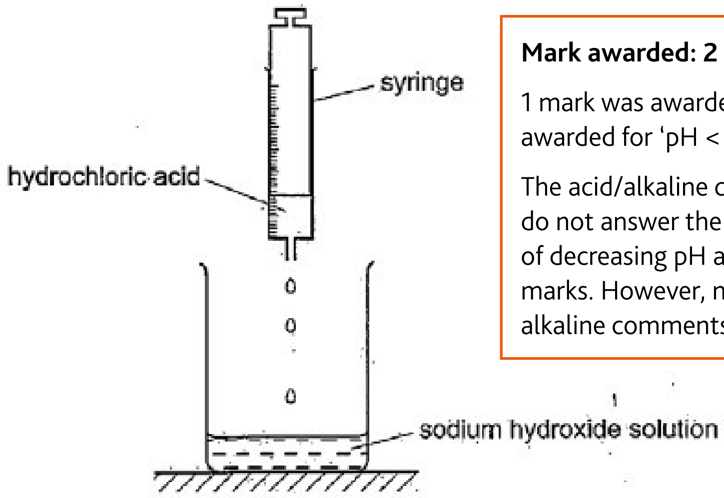
What type of chemical reaction is this?

neutralisation [1]

Mark awarded: 1

This is the only acceptable answer.

(iv) A student used a syringe to add 1 cm^3 portions of hydrochloric acid to an aqueous solution of sodium hydroxide.



Describe how the pH of the solution in the beaker changes as the hydrochloric acid is added until the acid is in excess.

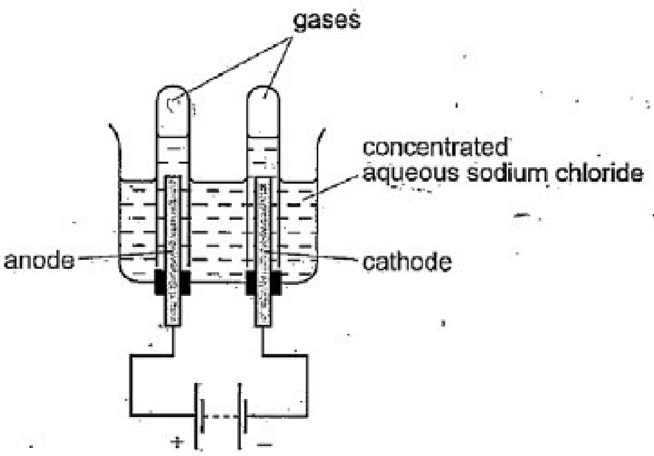
The solution is less alkaline. So, the pH decreases. Until the acid is in excess, the solution is acidic. (pH <7) [2]

Mark awarded: 2

1 mark was awarded for 'the pH decreases' and1 mark was awarded for 'pH < 7'.

The acid/alkaline comments do not gain marks because they do not answer the question, which is about pH. It is the ideas of decreasing pH and going down to less than pH 7 that got the marks. However, no marks are taken away by including the acid/alkaline comments.

(c) The diagram shows the apparatus used to electrolyse concentrated aqueous sodium chloride.



Give a description of this electrolysis.
In your description include

- what substance the electrodes are made from and the reason for using this substance
- what you would observe during the electrolysis
- the names of the substances produced at each electrode.

• Electrodes are made from graphite or platinum.
Because it is inert.
• The gas bubbles off at anode.
The metal attachs at cathode.
• Anode : chlorine gas
Cathode : Sodium metal
[6]

Mark awarded: 4

This extended writing about electrolysis was well laid out in bullet points. Answering each bullet like this meant that they were awarded marks for the correct statements even though some of the answer was incorrect.

The number of separate / different points made should equal the number of marks available. The candidate has recognised this and made two points for the three suggested bullets, but due to errors they were only awarded four of the available six marks.

2 marks were awarded for the first bullet: 1 mark for 'electrodes are made from graphite or platinum' and 1 mark for 'Because it is inert'.

1 mark was awarded for 'gas bubbles off at anode'.

'The metal attaches at cathode' is not correct. No mark is awarded or taken away for this point

1 mark was awarded for 'Anode: 'chlorine gas'.

'cathode: sodium metal' is not correct so they do not get a mark for this statement but no mark is taken away.

Total mark awarded = 12 out of 14.

D. How the answer could have been improved

This answer was a good attempt and demonstrated a good understanding of acid-base reactions and definitions. The candidate structured their answer to part (c) well, using the bullet points as guidance and writing two points for each of the three bullets, taking note of the six possible marks for the question. However, although they made six points, only four of them were correct.

They could have been awarded one more mark for the second bullet point if they had also said any one of the following:

- there is a smell of chlorine / swimming pools
- the solution changes colour to pale green / yellow
- ions are attracted to oppositely charged electrodes
- ions move through the solution
- electrons move through the electrodes
- electrolyte conducts electricity

They could have scored one more mark for their last bullet if they had also said that hydrogen is produced at the cathode.

Note that the answers in the mark scheme are not the only possible answers, and other suggestions from candidates that are accurate and relevant would also be awarded marks.

E. Common mistakes

On this question, common mistakes made by candidates in the examination were as follows for each part:

a) Not using the given example as a guide to answering the question, and therefore matching a phrase to two definitions – a mark was not awarded for the phrase if it is matched to more than one definition.

b) (i) Not knowing or understanding how pH relates to acidity and alkalinity, or, not knowing about a solution of sodium hydroxide. A solution of sodium hydroxide is a strong alkali, so the only possible answer from the list is pH 13. An answer of pH 8 was a common error; this shows some understanding that the solution is alkaline but no appreciation of the strength. Other mistakes were pH 5 or pH 7, which either shows a lack of understanding of acidity and alkalinity in relation to pH, or a lack of knowledge about the solution itself.

b) (ii) Errors during the calculation. For example, multiplying the masses together rather than adding them.

Another common mistake was using the Periodic Table incorrectly, using the atomic number rather than the atomic mass of each element.

b) iii) Not knowing the content well enough. There is nowhere to hide in a question like this. The only possible answer is 'neutralisation', so common answers such as 'exothermic' and 'displacement' do not get a mark.

b) (iv) Many candidates hardly mentioned pH in their answers. 'The solution gets more acidic' was a common answer scoring no marks. Many thought the pH would increase as it got more acidic. Even those who correctly wrote about pH often didn't go on to refer to what happened when excess acid was added. They lost a mark by only writing about what happens until the solution is neutral.

(c) There were a number of different common mistakes for this part:

- the description did not relate to the experiment given in the question, e.g. general statements about electrolysis without referring to the particular example in the question
- the focus was on details that weren't required, e.g. the definitions of an anode and cathode; no marks were taken away for including this detail but it is a waste of time as it doesn't get awarded marks
- there were factual errors, e.g. writing about the bulb lighting up but there is no bulb in the circuit; copper electrodes rather than graphite; and sodium being produced.
- candidates did not include what would be observed during the electrolysis.

The suggested points in the bullet of the question are intended to help guide the candidate in their answer, so it's a good idea to follow them. However, credit is always given for correct chemistry that also answers the question, even if the bullets are not followed.

General advice

- **Read the question carefully**.

  This may seem obvious but some candidates write answers that contain factually correct chemistry but that do not answer the question. In such cases, marks cannot be awarded. Don't just write down everything you know or remember about the topic; focus on what is being asked. For example, if a question asks 'what happens to the pH' during a given reaction, a response of 'the solution becomes more acidic' cannot be awarded any marks. Although this response is scientifically correct, it doesn't mention pH and therefore doesn't answer the question.

- **Show your working when answering a 'calculate' question.**

  You may get some credit even if your answer is wrong. Writing down your working can also help you to spot errors you have made.

- **Know the names of different reactions, processes and experiments and what they all mean.**

  Your answers have to be accurate; often there is only one acceptable and precise answer.

- **Look at the number of marks available for a question or question part.**

  The number of marks is usually a clue to how many different points you need to make. For example, if a question has two marks allocated to it, two pieces of information are needed. However, each point has to be accurate!

- **Describe the experiment or reaction given in the question.**

  Don't describe a general experiment or reaction if a specific example has been requested in the question. When describing an experiment, a labelled diagram often helps the description (diagrams would not help the description of a reaction).

- **Know how to read and use the Periodic Table accurately.**

  Remember that there is a Periodic Table provided at the back of Paper 1, Paper 2, Paper 3 and Paper 4. You can use the Periodic Table to help answer some questions, so it's important that you know how to use it.

Section 5: Revision

It is important that you plan your revision in plenty of time for the examinations and that you develop a revision technique that works for you.

Planning your revision

A well-structured revision plan can give you the best chance of success in your examinations. As early as possible (at least six weeks before the examinations for each subject) identify the time you will spend revising and **schedule** slots for revision of this subject alongside your other subjects.

To create a revision schedule, you could use an overall planner for the weeks leading up to the examinations. You could then create weekly revision plans at the start of each week, which include the detail of which subjects you will revise and when. There are some example planners on the next page but there are lots of other ways you can do this. Planning takes time but will help you be more productive.

Use the following as a checklist to help you create your schedule:

- [ ] Write down the dates and times of each of the examinations you are taking, in a calendar, diary or planner.

- [ ] Work out how much time you have before each examination, so you can leave yourself plenty of time to revise each subject.

For each subject make sure you:

- [ ] know how long each examination paper is
- [ ] know what each examination paper is going to assess
- [ ] work out how much time you can spend on each topic so that you revise all topics.

It is important to have breaks in order to stay alert and productive, so make sure you:

- [ ] include one rest day per week, or break this up into shorter rest breaks across a week
- [ ] include at least two hours of rest before bed time; working too late is unlikely to be productive
- [ ] take regular breaks during revision; revising for hours without a break will overload you
- [ ] have short revision sessions and short breaks between each session
- [ ] know ways to relax during your breaks; for example, physical exercise can be good during breaks.

It is important to be flexible and realistic, so make sure you:

- [ ] include most days leading up to the exams **and** include any days or times when you are not able to revise (for example due to attending school, eating meals, participating in sports and hobbies)
- [ ] are honest with yourself about how much time you can really spend on each subject and topic
- [ ] don't get upset about plans that did not work – think of new plans that are easier to achieve.

It might help to:

- [ ] include a mixture of subjects each day
- [ ] break up the material in your subjects into manageable chunks.

- [ ] Plan to **return** to topics and **review** them; revisiting a topic means that you can check that you still remember the material and it should help you to recall more of the topic.

- [ ] Include doing past paper examinations in your plan.

Revision planners

There are many different planners, calendars and timetables you could use to plan your revision. The ones provided in this section are just examples. They range from an overview of all the weeks leading up to the first examination, to the detail of what you will be revising each day.

Use colour-coding for different subjects, time off, examinations and so on. Plan which subjects you are going to revise in which slots. You could then add more detail such as topics to be covered. The planner can be as detailed, large and colourful as you like. Remember to tick off sections as you complete them and to review your plans if needed.

Overview planner

In the example below, imagine that the first examination is on 1 June. Here, the box has just been highlighted but you should write down the paper number, the subject and the time of the examination. You should do this for **all the examinations** you have. This helps you to visualise how much time you have before each examination. You can use this to block out whole or half days when you can't revise. You can also include as much or as little detail about your daily or weekly revision plan as you like.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
17	18	19	20	21	22	23
24	25	26	27	28	29	30
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

Weekly planner

This allows you to input greater detail about what you will revise each week. In the example below, each day is split into three.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning							
Afternoon							
Evening							

In the example below, each day has been split into 1-hour slots so you can include even more detail.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
08:00 - 09:00							
09:00 - 10:00							
10:00 - 11:00							
11:00 - 12:00							
12:00 - 13:00							
13:00 - 14:00							
14:00 - 15:00							
15:00 - 16:00							
16:00 - 17:00							
17:00 - 18:00							
18:00 - 19:00							
19:00 - 20:00							
20:00 - 21:00							

General revision advice

Here are some useful tips to help you with your revision. Use this as a checklist.

- [ ] Make accurate notes during the course.
- [ ] Look at the revision checklists and be really clear what topics you need to know.
- [ ] Check that your notes are complete and make sense.

If you need to improve your notes, you could:

- [ ] ask your teacher for help, especially if you don't understand some of your notes
- [ ] ask a friend if you can copy missed work, but make sure you understand it
- [ ] find more information on topics using your teacher, textbook, the library or the internet; your teacher will have a full copy of the syllabus
- [ ] use different note-taking methods such as colour-coded notes, tables, spider-diagrams and mind maps; Venn diagrams can be very useful when you need to compare and contrast things.

- [ ] Make lots of new notes: they don't have to be neat, you can use scrap paper or a digital notepad. Remember that the process of writing and reviewing your notes helps you to remember information.
- [ ] Be organised: keep your notes, textbooks, exercise books and websites to hand.
- [ ] Find a revision method that works for you; this might be working alone, with friends, with parents, online, at school, at home or a mixture of many different methods.
- [ ] Have a clear revision plan, schedule or timetable for each subject you are studying.
- [ ] Vary your revision activities: your revision programme should do more than remind you what you can and cannot do – it should help you to improve.
- [ ] Use revision checklists to analyse how confident you feel in each topic.
- [ ] Try doing some past examination papers; use the mark schemes to assess yourself.
- [ ] Use plenty of pens, colours, paper and card of different sizes to make your notes more fun.

Test yourself in different ways, for example by:

- [ ] playing 'Teach the topic'
- [ ] using Question and answer cards
- [ ] answering real exam questions

- [ ] Buy a good revision guide.

You might also find it helpful to:

☐	Target single issues such as correcting those little things you always get wrong, or reminding yourself about any facts/issues/skills that you have never been too sure of.
☐	Spend most of your time on specific skills, knowledge or issues that you have found more difficult when practising them, either during revision or earlier in the course during tests or mock exams.
☐	Spend some time focussing on your strengths as well, so that you can improve.

Top tips for revision of Cambridge IGCSE Chemistry (9-1)

1. Using the Periodic Table

The Periodic Table is included at the back of Papers 1, 2, 3 and 4. It is not included in Papers 5 and 6.

Make sure that you are familiar with the layout of the table and know that:

- the Groups are the columns in the table numbered I–VIII
- the Periods are the rows across the table
- the first Period only contains two elements, hydrogen and helium
- the key shows the position of the proton number (atomic number) and relative atomic mass of each element
- the volume of one mole of gas at room temperature and pressure (r.t.p.) is shown at the bottom of the Periodic Table.

Groups

I	II	Group										III	IV	V	VI	VII	VIII
			Key: atomic number atomic symbol name relative atomic mass					1 H hydrogen 1									2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

4 Be beryllium 9 — Key: atomic number, atomic symbol, name, relative atomic mass

Periods

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

2. Mind maps

Mind maps are a great way to revise the links between different factors or to explore a larger topic. They can also be used to brainstorm your ideas.

i. Use a blank sheet of paper and turn it on its side (landscape).

ii. Put the topic title in the middle of the page and build the mind map outwards using lines called 'branches'.

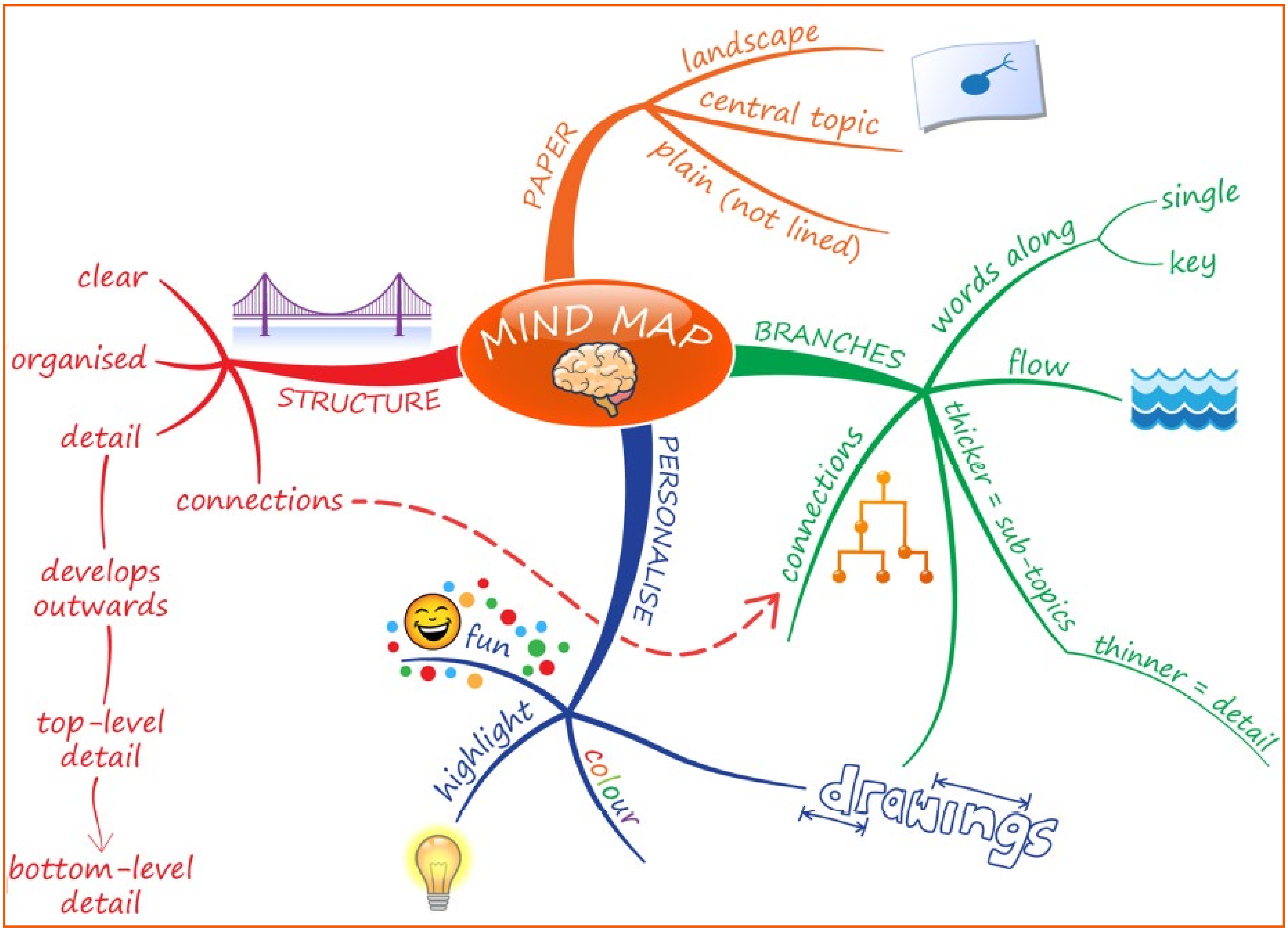
- The first branches are from the central topic to sub-topics; draw these as thick lines.
- Add new branches from the sub-topics to include more detail; draw these as thinner lines.
- Add even more detail to a point by adding more branches.

This creates a hierarchy of information from 'overview' (the thick branches) to 'fine detail' (thinnest branches).

iii. Write single key words or phrases along a branch and add drawings for visual impact.

iv. Use different colours, highlighter pens, symbols and arrows to highlight key facts or issues.

It is a good idea to use a large piece of plain A3 (or larger) paper and lots of coloured pens.



3. Teach the topic

This is a very simple but effective technique that focusses on knowledge recall. It tests the brain and rehearse the information you need to know for a certain topic and so will help your revision.

i. Create some topic cards with key bullet points of information on. Leave space for ticks.
ii. Give these to your parents, family or friends for example.
iii. Give yourself 10 minutes maximum to teach your audience the main points of the topic. You could use a mini-whiteboard or flip chart to help.
iv. Your audience tick off all the points you mention in your presentation and give you a final score.

The brain loves competition, so if you do not score full marks, you can try again the next day, or compete against friends. This system of repeat and rehearsal is very effective, especially with more complex topics, and doesn't take much preparation.

4. Question and answer (Q&A) cards

This is very similar to 'Teach the topic' but less formal and less public for those who dislike performing in front of others. It tests knowledge recall and rehearses the information you need to know for a certain topic.

i. Pick a topic and create two sets of cards: question cards and answer cards. You might find it helpful to make the question cards a different size or use different coloured card for answers.
ii. Make sure you have the topic, or something appropriate depending on what you are focusing on, as a heading on each card. The questions should test your knowledge and understanding of key areas of the course.
iii. A friend or family member uses the cards to test you in short 5 or 10 minute periods at any time during the day.
iv. You could also do this alone by reading the questions to yourself, giving the answer and then checking the correct answer card.
v. This game can be adapted by using the cards to find matching pairs: turn all cards face down across the space in front of you. Turn over two cards, leaving them where they are. If they match (one is a question card and the other is the corresponding answer card) pick up the pair and put them to one side. If they don't match, try to remember where they are and what is on each card, then turn them back over. Turn over two other cards. Continue until you have matched all pairs.

5. Question paper and mark schemes

Looking at past question papers and the mark scheme helps you to familiarise yourself with what to expect and what the standard is.

i. Ask your teacher for past paper questions with mark schemes for the course – ask your teacher for help to make sure you are answering the correct questions and to simplify the mark scheme.
ii. Look at the revision checklist and identify which topic a given question relates to – you might need to ask your teacher to help you do this.
iii. Once you have finished revising a topic or unit, time yourself answering some appropriate exam questions. Check the mark schemes to see how well you would have scored, or give the answers to your teacher to check.
iv. Add details or notes to the mark scheme where you missed out on marks in your original answers using a different coloured pen. Use these notes when you revise and try the question again later.

You can find plenty of past exam papers and mark schemes on the Cambridge International public website:

http://www.cambridgeinternational.org/programmes-and-qualifications/cambridge-igcse-chemistry-9-1-uk-0971/past-papers/

Other useful revision advice for Cambridge IGCSE Chemistry (9-1)

Before you start, look through the paper to see how many marks are allocated to each question. Then work out the time you should spend on each question.

Calculations

Calculators are allowed in all the papers.

Make sure you know the difference between significant figures and decimal places. For example, the number **11.45** is given here to:

- four significant figures (all the digits)
- two decimal places (the number of digits after the point)

Always show your working in calculations. You might gain marks for your method even if your final answer is wrong.

Ask yourself if your answer is sensible and in context.

Example calculation:

Calculate the rate of reaction using

$$\text{rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

rate = 50.5 cm3 / 30 secs

= 1.7 cm3 / s

Don't forget to include the units if they are not already in the answer space.

Notes for use in qualitative analysis (Tests for ions and gases)

The 'Notes for use in qualitative analysis' are chemical tests for various ions and gases, and the expected results. These tests are given on pages 106–108 in the Revision checklist. You must learn these tests for Papers 1–4 and for Paper 6.

Remember:

anions: are negatively charged ions

cations are positively charged ions

aqueous: means dissolved in water

ppt. means precipitate

in excess: in the tests for aqueous cations, this means that you add a lot more of the aqueous sodium hydroxide or ammonia to see if any precipitate formed remains or dissolves

in solution: the tests for anions, this means that the substance is dissolved in water

Chemical names

Be clear about the chemical names you use. You will not get a mark if you write, for example, 'ammonium' when you mean 'ammonia', or if you write 'chlorine' when you mean 'chloride', as these are different chemicals.

Drawing graphs

Practise drawing graphs, remembering the following points:

1. Use a sharp pencil and make sure you have a clean eraser in case you need to rub anything out.
2. Use a ruler for drawing the axes.
3. Unless the question tells you otherwise, plot the
   - *independent* variable (the variable you control, such as the time you take on observations) on the ***x*-axis** (horizontal axis)
   - *dependent* variable (the variable you are measuring) on the ***y*-axis** (vertical axis).
4. Choose a scale that uses most of the grid provided on the exam paper.
5. Choose a simple scale. Do not use a scale that makes it difficult for you to plot points on the given graph paper.
6. Plot the points carefully using a cross (x) or a dot in a circle. Do not use a single dot as it may not be seen after you have drawn your line. Your dots should be small because large dots do not show exactly where you intended to plot the point.
7. Draw the points lightly so that you can rub them out if you need to. Make them more definite when you are sure they are right.
8. If you are asked to draw a line of best fit, remember that this could be straight or curved.
9. Draw straight lines with a ruler, but do not use a ruler to join the points on a curve. Avoid any points that don't fit the general pattern.

Now use the revision checklists on the next pages to help guide your revision.

Revision checklists for Cambridge IGCSE Chemistry

The tables below can be used as a revision checklist: **It doesn't contain all the detailed knowledge you need to know, just an overview**. For more detail see the syllabus and talk to your teacher.

You can use the tick boxes in the checklists to show when you have revised and are happy that you do not need to return to it. Tick the 'R', 'A', and 'G' column to record your progress. The 'R', 'A' and 'G' represent different levels of confidence, as follows:

- R = RED: means you are really unsure and lack confidence in that area; you might want to focus your revision here and possibly talk to your teacher for help
- A = AMBER: means you are reasonably confident in a topic but need some extra practice
- G = GREEN: means you are very confident in a topic

As your revision progresses, you can concentrate on the RED and AMBER topics, in order to turn them into GREEN topics. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.

You can use the 'Comments' column to:

- add more information about the details for each point
- include a reference to a useful resource
- add learning aids such as rhymes, poems or word play
- highlight areas of difficulty or things that you need to talk to your teacher about.

Click on the relevant link below to go directly to the appropriate checklist:

Core syllabus content

Extended syllabus content

Core and Extended: Mathematical skills – Core and Extended

Experimental skills – Core and Extended

Notes for use in qualitative analysis (Tests for ions and gases) – Core and Extended

Core syllabus content

Core: 1. The particulate nature of matter

You should be able to	R	A	G	Comments
State the distinguishing properties of solids, liquids and gases				
Describe the structure of solids, liquids and gases in terms of particle separation, arrangement and types of motion				
Describe changes of state in terms of melting, boiling, evaporation, freezing, condensation and sublimation				
Describe qualitatively the pressure and temperature of a gas in terms of the motion of its particles				
Show an understanding of the random motion of particles in a suspension (sometimes known as Brownian motion) as evidence for the kinetic particle (atoms, molecules or ions) model of matter				
Describe and explain diffusion				

Core: 2. Experimental techniques

You should be able to	R	A	G	Comments
2.1 Measurement				
Name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders	☐	☐	☐	
2.2.1 Criteria of purity				
Demonstrate knowledge and understanding of paper chromatography	☐	☐	☐	
Interpret simple chromatograms	☐	☐	☐	
Identify substances and assess their purity from melting point and boiling point information	☐	☐	☐	
Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs	☐	☐	☐	
2.2.2 Methods of purification				
Describe and explain methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation including use of fractionating column. (This is linked to fractional distillation of petroleum in sub-topic 14.2 and products of fermentation in sub-topic 14.6.).	☐	☐	☐	
Suggest suitable purification techniques, given information about the substances involved	☐	☐	☐	

Core: 3. Atoms, elements and compounds

You should be able to	R	A	G	Comments
3.1 Atomic structure and the Periodic Table				
State the relative charges and approximate relative masses of protons, neutrons and electrons				
Define *proton number* (atomic number) as the number of protons in the nucleus of an atom				
Define *nucleon number* (mass number) as the total number of protons and neutrons in the nucleus of an atom				
Use proton number and the simple structure of atoms to explain the basis of the Periodic Table (see Topic 9 for more detail about the Periodic Table), with special reference to the elements of proton number 1 to 20				
Define *isotopes* as atoms of the same element which have the same proton number but a different nucleon number				
State the two types of isotopes as being radioactive and non-radioactive				
State one medical and one industrial use of radioactive isotopes				
Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of the outer shell electrons				
3.2.1 Bonding: the structure of matter				
Describe the differences between elements, mixtures and compounds, and between metals and non-metals				
Describe an alloy, such as brass, as a mixture of a metal with other elements				

Core: 3. Atoms, elements and compounds

You should be able to	R	A	G	Comments
3.2.2 Ions and ionic bonds				
Describe the formation of ions by electron loss or gain				
Describe the formation of ionic bonds between elements from Groups I and VII				
3.2.3 Molecules and covalent bonds				
Describe the formation of single covalent bonds in H_2, Cl_2, H_2O, CH_4, NH_3 and HCl as the sharing of pairs of electrons leading to the noble gas configuration				
Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds				
3.2.4 Macromolecules				
Describe the giant covalent structures of graphite and diamond				
Relate their structures to their uses, e.g. graphite as a lubricant and a conductor, and diamond in cutting tools				

Core: 4. Stoichiometry

You should be able to	R	A	G	Comments
4.1 Stoichiometry				
Use the symbols of the elements and write the formulae of simple compounds				
Deduce the formula of a simple compound from the relative numbers of atoms present				
Deduce the formula of a simple compound from a model or a diagrammatic representation				
Construct word equations and simple balanced chemical equations				
Define *relative atomic mass*, *Ar* , as the average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units				
Define relative molecular mass, M_r, as the sum of the relative atomic masses (Relative f*ormula mass* or M_r will be used for ionic compounds.)				
Calculations involving reacting masses in simple proportions				

Core: 5. Electricity and chemistry

You should be able to	R	A	G	Comments
Define electrolysis as the breakdown of an ionic compound, molten or in aqueous solution, by the passage of electricity				
Describe the electrode products and the observations made during the electrolysis of:				
• molten lead(II) bromide				
• concentrated hydrochloric acid				
• concentrated aqueous sodium chloride				
• dilute sulfuric acid				
between inert electrodes (platinum or carbon)				
State the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that non-metals (other than hydrogen) are formed at the positive electrode (anode)				
Predict the products of the electrolysis of a specified binary compound in the molten state				
Describe the electroplating of metals				
Outline the uses of electroplating				
Describe the reasons for the use of copper and (steel-cored) aluminium in cables, and why plastics and ceramics are used as insulators				

Core: 6. Chemical energetics

What I need to do	R	A	G	Comments
6.1 Energetics of a reaction				
Describe the meaning of *exothermic* and *endothermic* reactions	☐	☐	☐	
Interpret energy level diagrams showing exothermic and endothermic reactions	☐	☐	☐	
6.2 Energy transfer				
Describe the release of heat energy by burning fuels	☐	☐	☐	
State the use of hydrogen as a fuel	☐	☐	☐	
Describe radioactive isotopes, such as ^{235}U, as a source of energy	☐	☐	☐	

Core: 7. Chemical reactions

What I need to do	R	A	G	Comments
7.1 Physical and chemical changes				
Identify physical and chemical changes, and understand the differences between them	☐	☐	☐	

Core: 7. Chemical reactions

You should be able to	R	A	G	Comments
7.2 Rate (speed) of reaction				
Describe and explain the effect of concentration, particle size, catalysts (including enzymes) and temperature on the rate of reactions				
Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. methane in mines)				
Demonstrate knowledge and understanding of a practical method for investigating the rate of a reaction involving gas evolution				
Interpret data obtained from experiments concerned with rate of reaction				
Try to use the term *rate* rather than *speed*.				
7.3 Reversible reactions				
Understand that some chemical reactions can be reversed by changing the reaction conditions				
(For example, the effects of heat and water on hydrated and anhydrous copper(II) sulfate and cobalt(II) chloride.)				
7.4 Redox				
Define oxidation and reduction in terms of oxygen loss/gain.				
Oxidation state in terms of its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)				

Core: 8. Acids, bases and salts

You should be able to	R	A	G	Comments
8.1 The characteristic properties of acids and bases				
Describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus and methyl orange	☐	☐	☐	
Describe the characteristic properties of bases as reactions with acids and with ammonium salts and effect on litmus and methyl orange	☐	☐	☐	
Describe neutrality and relative acidity and alkalinity in terms of pH measured using Universal Indicator paper (whole numbers only)	☐	☐	☐	
Describe and explain the importance of controlling acidity in soil	☐	☐	☐	
8.2 Types of oxides Classify oxides as either acidic or basic, related to metallic and non-metallic character	☐	☐	☐	
8.3 Preparation of salts Demonstrate knowledge and understanding of preparation, separation and purification of salts as examples of some of the techniques specified in sub-topic 2.2.2 and the reactions specified in sub-topic 8.1.	☐	☐	☐	

Core: 8. Acids, bases and salts

You should be able to	R	A	G	Comments
8.4 Identification of ions and gases				
Describe the following tests to identify:				
aqueous cations: aluminium, ammonium, calcium, chromium(III), copper(II), iron(II), iron(III) and zinc (using aqueous sodium hydroxide and aqueous ammonia as appropriate) (Formulae of complex ions are **not** required.)	☐	☐	☐	
cations: use of the flame test to identify lithium, sodium, potassium and copper(II)	☐	☐	☐	
anions:				
• carbonate (by reaction with dilute acid and then limewater)	☐	☐	☐	
• chloride, bromide and iodide (by reaction under acidic conditions with aqueous silver nitrate)	☐	☐	☐	
• nitrate (by reduction with aluminium)	☐	☐	☐	
• sulfate (by reaction under acidic conditions with aqueous barium ions)	☐	☐	☐	
• sulfite (by reaction with dilute acids and then aqueous potassium manganate(VII))	☐	☐	☐	
gases:				
• ammonia (using damp red litmus paper)	☐	☐	☐	
• carbon dioxide (using limewater)	☐	☐	☐	
• chlorine (using damp litmus paper)	☐	☐	☐	
• hydrogen (using lighted splint)	☐	☐	☐	
• oxygen (using a glowing splint)	☐	☐	☐	
• sulfur dioxide (using aqueous potassium manganate(VII)) See also ‘Notes for use in qualitative analysis’ later in this guide.	☐	☐	☐	

Core: 9. The Periodic Table

You should be able to:	R	A	G	Comments
9.1 The Periodic Table				
Describe the Periodic Table as a method of classifying elements and its use to predict properties of elements	☐	☐	☐	
9.2 Periodic trends				
Describe the change from metallic to non-metallic character across a period	☐	☐	☐	
9.3 Group properties				
Describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and reaction with water	☐	☐	☐	
Predict the properties of other elements in Group I, given data, where appropriate	☐	☐	☐	
Describe the halogens, chlorine, bromine and iodine in Group VII, as a collection of diatomic non-metals showing a trend in colour and density and state their reaction with other halide ions	☐	☐	☐	
Predict the properties of other elements in Group VII, given data where appropriate	☐	☐	☐	
9.4 Transition elements				
Describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts	☐	☐	☐	
9.5 Noble gases				
Describe the noble gases, in Group VIII or 0, as being unreactive, monoatomic gases and explain this in terms of electronic structure	☐	☐	☐	
State the uses of the noble gases in providing an inert atmosphere, i.e. argon in lamps, helium for filling balloons	☐	☐	☐	

Core: 10. Metals

You should be able to:	R	A	G	Comments
10.1 Properties of metals				
List the general physical properties of metals	☐	☐	☐	
Describe the general chemical properties of metals e.g. reaction with dilute acids and reaction with oxygen	☐	☐	☐	
Explain in terms of their properties why alloys are used instead of pure metals	☐	☐	☐	
Identify representations of alloys from diagrams of structure	☐	☐	☐	
10.2 Reactivity series				
Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the metals with:				
• water or steam	☐	☐	☐	
• dilute hydrochloric acid	☐	☐	☐	
• and the reduction of their oxides with carbon	☐	☐	☐	
Deduce an order of reactivity from a given set of experimental results	☐	☐	☐	
10.3 Extraction of metals				
Describe the ease in obtaining metals from their ores by relating the elements to the reactivity series	☐	☐	☐	
Describe and state the essential reactions in the extraction of iron from hematite	☐	☐	☐	
Describe the conversion of iron into steel using basic oxides and oxygen	☐	☐	☐	
Know that aluminium is extracted from the ore bauxite by electrolysis	☐	☐	☐	
Discuss the advantages and disadvantages of recycling metals (iron/steel and aluminium)	☐	☐	☐	

Core: 10. Metals

You should be able to:	R	A	G	Comments
10.4 Uses of metals				
Name the uses of aluminium:				
• in the manufacture of aircraft because of its strength and low density	☐	☐	☐	
• in food containers because of its resistance to corrosion	☐	☐	☐	
Name the uses of copper related to its properties (electrical wiring and in cooking utensils)	☐	☐	☐	
Name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)	☐	☐	☐	

Core: 11. Air and water

You should be able to:	R	A	G	Comments
11.1 Water				
Describe chemical tests for water using cobalt(II) chloride and copper(II) sulfate	☐	☐	☐	
Describe, in outline, the treatment of the water supply in terms of filtration and chlorination	☐	☐	☐	
Name some of the uses of water in industry and in the home	☐	☐	☐	

Core: 11. Air and water

You should be able to:	R	A	G	Comments
11.2 Air				
State the composition of clean, dry air as being approximately 78% nitrogen, 21% oxygen and the remainder as being a mixture of noble gases and carbon dioxide				
Name the common pollutants in the air as being carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds				
State the source of each of these pollutants:				
• carbon monoxide from the incomplete combustion of carbon-containing substances				
• sulfur dioxide from the combustion of fossil fuels which contain sulfur				
• compounds (leading to 'acid rain')				
• oxides of nitrogen from car engines				
• lead compounds from leaded petrol				
State the adverse effect of these common pollutants on buildings and on health and discuss why these pollutants are of global concern				
State the conditions required for the rusting of iron				
Describe and explain methods of rust prevention, specifically paint and other coatings to exclude oxygen				
11.3 Nitrogen and fertilisers				
Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers				
Describe the displacement of ammonia from its salts				

Core: 11. Air and water

You should be able to:	R	A	G	Comments
11.4 Carbon dioxide and methane				
State that carbon dioxide and methane are greenhouse gases and explain how they may contribute to climate change	☐	☐	☐	
State the formation of carbon dioxide:				
• as a product of complete combustion of carbon-containing substances	☐	☐	☐	
• as a product of respiration	☐	☐	☐	
• as a product of the reaction between an acid and a carbonate	☐	☐	☐	
• from the thermal decomposition of a carbonate	☐	☐	☐	
State the sources of methane, including decomposition of vegetation and waste gases from digestion in animals	☐	☐	☐	

Core: 12. Sulfur

You should be able to:	R	A	G	Comments
Name some sources of sulfur	☐	☐	☐	
Name the use of sulfur in the manufacture of sulfuric acid	☐	☐	☐	
State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)	☐	☐	☐	

Core: 13. Carbonates

You should be able to:	R	A	G	Comments
Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of thermal decomposition				
Name some uses of lime and slaked lime such as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulfurisation				
Name the uses of calcium carbonate in the manufacture of iron and cement				

Core: 14. Organic chemistry

You should be able to:	R	A	G	Comments
14.1 Names of compounds				
Name and draw the structures of methane, ethane, ethene, ethanol, ethanoic acid and the products of the reactions stated in sub-topics 14.4–14.6				
State the type of compound present, given a chemical name ending in *-ane*, *-ene*, *-ol*, or *-oic* acid or a molecular structure				
14.2 Fuels				
Name the fuels: coal, natural gas and petroleum				
Name methane as the main constituent of natural gas				
Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation				
Describe the properties of molecules within a fraction				

Core: 14. Organic chemistry

You should be able to:	R	A	G	Comments
14.2 Fuels (continued) Name the uses of the fractions as:				
• refinery gas for bottled gas for heating and cooking				
• gasoline fraction for fuel (petrol) in cars				
• naphtha fraction for making chemicals				
• kerosene/paraffin fraction for jet fuel				
• diesel oil/gas oil for fuel in diesel engines				
• fuel oil fraction for fuel for ships and home heating systems				
• lubricating fraction for lubricants, waxes and polishes				
• bitumen for making roads				
14.3 Homologous series Describe the concept of homologous series as a 'family' of similar compounds with similar chemical properties due to the presence of the same functional group				
14.4 Alkanes Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning				
Describe the bonding in alkanes				

Core: 14. Organic chemistry

You should be able to:	R	A	G	Comments
14.5 Alkenes				
Describe the manufacture of alkenes and of hydrogen by cracking	☐	☐	☐	
Distinguish between saturated and unsaturated hydrocarbons:				
• from molecular structures	☐	☐	☐	
• by reaction with aqueous bromine	☐	☐	☐	
Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units	☐	☐	☐	
14.6 Alcohols				
Describe the manufacture of ethanol by fermentation and by the catalytic addition of steam to ethene	☐	☐	☐	
Describe the properties of ethanol in terms of burning	☐	☐	☐	
Name the uses of ethanol as a solvent and as a fuel	☐	☐	☐	
14.7 Carboxylic acids				
Describe the properties of aqueous ethanoic acid	☐	☐	☐	
14.8.1 Polymers				
Define polymers as large molecules built up from small units (monomers)	☐	☐	☐	
14.8.2 Synthetic polymers				
Name some typical uses of plastics and of man-made fibres such as nylon and *Terylene*	☐	☐	☐	
Describe the pollution problems caused by non-biodegradable plastics	☐	☐	☐	
14.8.3 Natural polymers				
Name proteins and carbohydrates as constituents of food	☐	☐	☐	

Extended syllabus content

Extended: 1. The particulate nature of matter

Core material					Supplemental material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
State the distinguishing properties of solids, liquids and gases									
Describe the structure of solids, liquids and gases in terms of particle separation, arrangement and types of motion									
Describe changes of state in terms of melting, boiling, evaporation, freezing, condensation and sublimation					Explain changes of state in terms of the kinetic theory				
Describe qualitatively the pressure and temperature of a gas in terms of the motion of its particles									
Show an understanding of the random motion of particles in a suspension (sometimes known as Brownian motion) as evidence for the kinetic particle (atoms, molecules or ions) model of matter					Describe and explain Brownian motion in terms of random molecular bombardment				
Describe and explain diffusion					State evidence for Brownian motion				
					Describe and explain dependence of rate of diffusion on molecular mass				

Extended: 2. Experimental techniques

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
2.1 Measurement Name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders	☐	☐	☐		*There is no supplement material for this sub-topic.*				
2.2.1 Criteria of purity Demonstrate knowledge and understanding of paper chromatography	☐	☐	☐		**2.2.1 Criteria of purity** Interpret simple chromatograms, including the use of R_f values	☐	☐	☐	
Interpret simple chromatograms	☐	☐	☐		Outline how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents (Knowledge of *specific* locating agents is **not** required.)	☐	☐	☐	
Identify substances and assess their purity from melting point and boiling point information	☐	☐	☐						
Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs	☐	☐	☐						

Extended: 2. Experimental techniques

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
2.2.2 Methods of purification Describe and explain methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation (including use of fractionating column).	☐	☐	☐		*There is no supplement material for this sub-topic.*				
(See fractional distillation of petroleum in sub-topic 14.2 and products of fermentation in sub-topic 14.6.)	☐	☐	☐						
Suggest suitable purification techniques, given information about the substances involved	☐	☐	☐						

Extended: 3. Atoms, elements and compounds

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
3.1 Atomic structure and the Periodic Table					**3.1 Atomic structure and the Periodic Table**				
State the relative charges and approximate relative masses of protons, neutrons and electrons	☐	☐	☐						
Define *proton number* (atomic number) as the number of protons in the nucleus of an atom	☐	☐	☐						
Define *nucleon number* (mass number) as the total number of protons and neutrons in the nucleus of an atom	☐	☐	☐						
Use proton number and the simple structure of atoms to explain the basis of the Periodic Table (see topic 9), with special reference to the elements of proton number 1 to 20	☐	☐	☐						
Define *isotopes* as atoms of the same element which have the same proton number but a different nucleon number	☐	☐	☐		Understand that isotopes have the same properties because they have the same number of electrons in their outer shell	☐	☐	☐	
State the two types of isotopes as being radioactive and non-radioactive	☐	☐	☐						
State one medical and one industrial use of radioactive isotopes	☐	☐	☐						

Extended: 3. Atoms, elements and compounds

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
3.1 Atomic structure and the Periodic Table, (continued) Describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of the outer shell electrons	☐	☐	☐		*There is no more supplement material for this sub-topic.*				
3.2.1 Bonding: the structure of matter Describe the differences between elements, mixtures and compounds, and between metals and non-metals	☐	☐	☐		*There is no supplement material for this sub-topic.*				
Describe an alloy, such as brass, as a mixture of a metal with other elements	☐	☐	☐						
3.2.2 Ions and ionic bonds Describe the formation of ions by electron loss or gain	☐	☐	☐		**3.2.2 Ions and ionic bonds** Describe the formation of ionic bonds between metallic and non-metallic elements	☐	☐	☐	
Describe the formation of ionic bonds between elements from Groups I and VII	☐	☐	☐		Describe the lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions	☐	☐	☐	

Extended: 3. Atoms, elements and compounds

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
3.2.3 Molecules and covalent bonds					**3.2.3 Molecules and covalent bonds**				
Describe the formation of single covalent bonds in H_2, Cl_2, H_2O, CH_4, NH_3 and HCl as the sharing of pairs of electrons leading to the noble gas configuration	☐	☐	☐		Describe the electron arrangement in more complex covalent molecules such as N_2, C_2H_4, CH_3OH and CO_2	☐	☐	☐	
Describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds	☐	☐	☐		Explain the differences in melting point and boiling point of ionic and covalent compounds in terms of attractive forces	☐	☐	☐	
3.2.4 Macromolecules					**3.2.4 Macromolecules**				
Describe the giant covalent structures of graphite and diamond	☐	☐	☐		Describe the macromolecular structure of silicon(IV) oxide (silicon dioxide)	☐	☐	☐	
Relate their structures to their uses, e.g. graphite as a lubricant and a conductor, and diamond in cutting tools	☐	☐	☐		Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures	☐	☐	☐	
There is no core content for '3.2.5 Metallic bonding'.					**3.2.5 Metallic bonding**				
					Describe metallic bonding as a lattice of positive ions in a 'sea of electrons' and use this to describe the electrical conductivity and malleability of metals	☐	☐	☐	

Extended: 4. Stoichiometry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
4.1 Stoichiometry					**4.1 Stoichiometry**				
Use the symbols of the elements and write the formulae of simple compounds	☐	☐	☐		Determine the formula of an ionic compound from the charges on the ions present	☐	☐	☐	
Deduce the formula of a simple compound from the relative numbers of atoms present	☐	☐	☐		Construct equations with state symbols, including ionic equations	☐	☐	☐	
Deduce the formula of a simple compound from a model or a diagrammatic representation	☐	☐	☐		Deduce the balanced equation for a chemical reaction, given relevant information	☐	☐	☐	
Construct word equations and simple balanced chemical equations	☐	☐	☐						
Define relative atomic mass, A_r, as the average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units	☐	☐	☐						
Define *relative molecular mass*, M_r, as the sum of the relative atomic masses (*Relative formula mass* or M_r will be used for ionic compounds.)	☐	☐	☐						
Calculations involving reacting masses in simple proportions	☐	☐	☐						

Extended: 4. Stoichiometry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
There is no Core material for '4.2 The mole concept'.					**4.2 The mole concept**				
					Define the *mole* and the *Avogadro constant*	☐	☐	☐	
					Use the molar gas volume, taken as 24 dm^3 at room temperature and pressure	☐	☐	☐	
					Calculate stoichiometric reacting masses, volumes of gases and solutions, and concentrations of solutions expressed in g / dm^3 and mol / dm^3	☐	☐	☐	
					Calculations involving the idea of limiting reactants	☐	☐	☐	
					Calculate empirical formulae and molecular formulae	☐	☐	☐	
					Calculate percentage yield and percentage purity	☐	☐	☐	

Extended: 5. Electricity and chemistry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
Define electrolysis as the breakdown of an ionic compound, molten or in aqueous solution, by the passage of electricity	☐	☐	☐		Relate the products of electrolysis to the electrolyte and electrodes used, exemplified by the specific examples in the Core together with aqueous copper(II) sulphate using carbon electrodes and using copper electrodes (as used in the refining of copper)	☐	☐	☐	
Describe the electrode products and the observations made during the electrolysis of:					Describe electrolysis in terms of the ions present and reactions at the electrodes in the examples given	☐	☐	☐	
• molten lead(II) bromide	☐	☐	☐						
• concentrated hydrochloric acid	☐	☐	☐						
• concentrated aqueous sodium chloride	☐	☐	☐						
• dilute sulfuric acid between inert electrodes (platinum or carbon)	☐	☐	☐						
State the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that non-metals (other than hydrogen) are formed at the positive electrode (anode)	☐	☐	☐						
Predict the products of the electrolysis of a specified binary compound in the molten state	☐	☐	☐		Predict the products of electrolysis of a specified halide in dilute or concentrated aqueous solution	☐	☐	☐	
Describe the electroplating of metals	☐	☐	☐		Construct ionic half-equations for reactions at the cathode	☐	☐	☐	

Extended: 5. Electricity and chemistry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
Outline the uses of electroplating					Describe the transfer of charge during electrolysis to include:				
Describe the reasons for the use of copper and (steel-cored) aluminium in cables, and why plastics and ceramics are used as insulators					• the movement of electrons in the metallic conductor				
					• the removal or addition of electrons from the external circuit at the electrodes				
					• the movement of ions in the electrolyte				
					Describe the production of electrical energy from simple cells, i.e. two electrodes in an electrolyte (This is linked with the reactivity series in sub-topic 10.2 and redox in sub-topic 7.4.)				
					Describe, in outline, the manufacture of:				
					• aluminium from pure aluminium oxide in molten cryolite (see sub-topic 10.3)				
					• chlorine, hydrogen and sodium hydroxide from concentrated aqueous sodium chloride				
					(You should give starting materials and essential conditions but you do **not** need to give the technical details or diagrams.)				

Extended: 6. Chemical energetics

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
6.1 Energetics of a reaction					**6.1 Energetics of a reaction**				
Describe the meaning of *exothermic* and *endothermic* reactions					Describe bond breaking as an endothermic process and bond forming as an exothermic process				
Interpret energy level diagrams showing exothermic and endothermic reactions					Draw and label energy level diagrams for exothermic and endothermic reactions using data provided				
					Calculate the energy of a reaction using bond energies				
6.2 Energy transfer					**6.2 Energy transfer**				
Describe the release of heat energy by burning fuels					Describe the use of hydrogen as a fuel reacting with oxygen to generate electricity in a fuel cell				
State the use of hydrogen as a fuel					(You do **not** need details of the construction and operation of a fuel cell.)				
Describe radioactive isotopes, such as ^{235}U, as a source of energy									

Extended: 7. Chemical reactions

Core material You should be able to:	R	A	G	Comments	Supplement material You should be able to:	R	A	G	Comments
7.1 Physical and chemical changes Identify physical and chemical changes, and understand the differences between them	☐	☐	☐		*There is no supplement material for this sub-topic.*				
7.2 Rate (speed) of reaction Describe and explain the effect of concentration, particle size, catalysts (including enzymes) and temperature on the rate of reactions	☐	☐	☐		**7.2 Rate (speed) of reaction** Devise and evaluate a suitable method for investigating the effect of a given variable on the rate of a reaction	☐	☐	☐	
Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. methane in mines)	☐	☐	☐						
Demonstrate knowledge and understanding of a practical method for investigating the rate of a reaction involving gas evolution	☐	☐	☐		Describe and explain the effects of temperature and concentration in terms of collisions between reacting particles, e.g. an increase in temperature causes an increase in collision rate **and** more of the colliding molecules have sufficient energy (activation energy) to react whereas an increase in concentration only causes an increase in collision rate	☐	☐	☐	
Interpret data obtained from experiments concerned with rate of reaction	☐	☐	☐						
Try to use the term *rate* rather than *speed*.	☐	☐	☐						

Extended: 7. Chemical reactions

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
7.2 Rate (speed) of reaction, continued.					**7.2 Rate (speed) of reaction, continued.**				
					Describe and explain the role of light in photochemical reactions and the effect of light on the rate of these reactions	☐	☐	☐	
					Describe the use of silver salts in photography as a process of reduction of silver ions to silver; and photosynthesis as the reaction between carbon dioxide and water in the presence of chlorophyll and sunlight (energy) to produce glucose and oxygen	☐	☐	☐	

Extended: 7. Chemical reactions

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
7.3 Reversible reactions					**7.3 Reversible reactions**				
Understand that some chemical reactions can be reversed by changing the reaction conditions (For example, the effects of heat and water on hydrated and anhydrous copper(II) sulfate and cobalt(II) chloride.)	☐	☐	☐		Predict the effect of changing the conditions (concentration, temperature and pressure) on other reversible reactions	☐	☐	☐	
					Demonstrate knowledge and understanding of the concept of equilibrium	☐	☐	☐	
7.4 Redox					**7.4 Redox**				
Define *oxidation* and *reduction* in terms of oxygen loss/gain.	☐	☐	☐		Define *redox* in terms of electron transfer	☐	☐	☐	
Oxidation state in terms of its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)	☐	☐	☐		Identify redox reactions by changes in oxidation state and by the colour changes involved when using acidified potassium manganate(VII), and potassium iodide.	☐	☐	☐	
					Define *oxidising* agent as a substance which *oxidises* another substance during a redox reaction.	☐	☐	☐	
					Define *reducing agent* as a substance which reduces another substance during a redox reaction.	☐	☐	☐	
					Identify oxidising agents and reducing agents from simple equations	☐	☐	☐	

Extended: 8. Acids, bases and salts

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
8.1 The characteristic properties of acids and bases					**8.1 The characteristic properties of acids and bases**				
Describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus and methyl orange	☐	☐	☐		Define *acids* and *bases* in terms of proton transfer, limited to aqueous solutions	☐	☐	☐	
Describe the characteristic properties of bases as reactions with acids and with ammonium salts and effect on litmus and methyl orange	☐	☐	☐		Describe the meaning of weak and strong acids and bases	☐	☐	☐	
Describe neutrality and relative acidity and alkalinity in terms of pH measured using Universal Indicator paper (whole numbers only)	☐	☐	☐						
Describe and explain the importance of controlling acidity in soil	☐	☐	☐						
8.2 Types of oxides					**8.2 Types of oxides**				
Classify oxides as either acidic or basic, related to metallic and non-metallic character	☐	☐	☐		Classify more oxides as neutral or amphoteric	☐	☐	☐	

Extended: 8. Acids, bases and salts

Core material You should be able to:	R	A	G	Comments	Supplement material You should be able to:	R	A	G	Comments
8.3 Preparation of salts Demonstrate knowledge and understanding of preparation, separation and purification of salts as examples of some of the techniques specified in sub-topic 2.2.2 and the reactions specified in sub-topic 8.1.	☐	☐	☐		**8.3 Preparation of salts** Demonstrate knowledge and understanding of the preparation of insoluble salts by precipitation	☐	☐	☐	
					Suggest a method of making a given salt from a suitable starting material, given appropriate information	☐	☐	☐	

Core material You should be able to:	R	A	G	Comments	Supplement material
8.4 Identification of ions and gases Describe the following tests to identify:					*There is no supplement material for this sub-topic.*
aqueous cations: aluminium, ammonium, calcium, chromium(III), copper(II), iron(II), iron(III) and zinc (using aqueous sodium hydroxide and aqueous ammonia as appropriate) (Formulae of complex ions are **not** required.)	☐	☐	☐		
cations: use of the flame test to identify lithium, sodium, potassium and copper(II)	☐	☐	☐		
anions: carbonate (by reaction with dilute acid and then limewater), chloride, bromide and iodide (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium), sulfate (by reaction under acidic conditions with aqueous barium ions) and sulfite (by reaction with dilute acids and then aqueouspotassium manganate(VII))	☐	☐	☐		
gases: ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using lighted splint), oxygen (using a glowing splint), and sulfur dioxide (using aqueous potassium manganate(VII))	☐	☐	☐		

Extended: 9. The Periodic Table

You should be able to: (Core material)	R	A	G	Comments	You should be able to: (Supplement material)	R	A	G	Comments
9.1 The Periodic Table Describe the Periodic Table as a method of classifying elements and its use to predict properties of elements	☐	☐	☐		*There is no supplement material for this sub-topic.*				
9.2 Periodic trends Describe the change from metallic to non-metallic character across a period	☐	☐	☐		**9.2 Periodic trends** Describe and explain the relationship between Group number, number of outer shell electrons and metallic/non-metallic character	☐	☐	☐	
9.3 Group properties Describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and reaction with water	☐	☐	☐		**9.3 Group properties** Identify trends in Groups, given information about the elements concerned	☐	☐	☐	
Predict the properties of other elements in Group I, given data, where appropriate	☐	☐	☐						
Describe the halogens, chlorine, bromine and iodine in Group VII, as a collection of diatomic non- metals showing a trend in colour and density and state their reaction with other halide ions	☐	☐	☐						
Predict the properties of other elements in Group VII, given data where appropriate	☐	☐	☐						

Extended: 9. The Periodic Table

Core material You should be able to:	R A G	Comments	Supplement material You should be able to:	R A G	Comments
9.4 Transition elements Describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts	☐ ☐ ☐		**9.4 Transition elements** Know that transition elements have variable oxidation states	☐ ☐ ☐	
9.5 Noble gases Describe the noble gases, in Group VIII or 0, as being unreactive, monoatomic gases and explain this in terms of electronic structure	☐ ☐ ☐		*There is no supplement material for this sub-topic.*		
State the uses of the noble gases in providing an inert atmosphere, i.e. argon in lamps, helium for filling balloons	☐ ☐ ☐				

Extended: 10. Metals

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
10.1 Properties of metals					*There is no supplement material for this sub-topic.*				
List the general physical properties of metals	☐	☐	☐						
Describe the general chemical properties of metals e.g. reaction with dilute acids and reaction with oxygen	☐	☐	☐						
Explain in terms of their properties why alloys are used instead of pure metals	☐	☐	☐						
Identify representations of alloys from diagrams of structure	☐	☐	☐						
10.2 Reactivity series					**10.2 Reactivity series**				
Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the metals with:	☐	☐	☐		Describe the reactivity series as related to the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with:	☐	☐	☐	
• water or steam	☐	☐	☐		• the aqueous ions	☐	☐	☐	
• dilute hydrochloric acid	☐	☐	☐		• the oxides of the other listed metals	☐	☐	☐	
• and the reduction of their oxides with carbon	☐	☐	☐		Describe and explain the action of heat on the hydroxides, carbonates and nitrates of the listed metals	☐	☐	☐	
Deduce an order of reactivity from a given set of experimental results	☐	☐	☐		Account for the apparent unreactivity of aluminium in terms of the oxide layer which adheres to the metal	☐	☐	☐	

Extended: 10. Metals

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
10.3 Extraction of metals					**10.3 Extraction of metals**				
Describe the ease in obtaining metals from their ores by relating the elements to the reactivity series	☐	☐	☐		Describe in outline, the extraction of zinc from zinc blende	☐	☐	☐	
Describe and state the essential reactions in the extraction of iron from hematite	☐	☐	☐						
Describe the conversion of iron into steel using basic oxides and oxygen	☐	☐	☐						
Know that aluminium is extracted from the ore bauxite by electrolysis	☐	☐	☐		Describe in outline, the extraction of aluminium from bauxite including the role of cryolite and the reactions at the electrodes	☐	☐	☐	
Discuss the advantages and disadvantages of recycling metals (iron/steel and aluminium)	☐	☐	☐						

Extended: 10. Metals

You should be able to:	Core material R	A	G	Comments	You should be able to:	Supplement material R	A	G	Comments
10.4 Uses of metals Name the uses of aluminium:					**10.4 Uses of metals** Explain the uses of zinc for galvanising and for making brass	☐	☐	☐	
• in the manufacture of aircraft because of its strength and low density	☐	☐	☐						
• in food containers because of its resistance to corrosion	☐	☐	☐						
Name the uses of copper related to its properties (electrical wiring and in cooking utensils)	☐	☐	☐						
Name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)	☐	☐	☐		Describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys	☐	☐	☐	

Extended: 11. Air and water

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
11.1 Water Describe chemical tests for water using cobalt(II) chloride and copper(II) sulfate					**11.1 Water** Discuss the implications of an inadequate supply of water, limited to safe water for drinking and water for irrigating crops				
Describe, in outline, the treatment of the water supply in terms of filtration and chlorination									
Name some of the uses of water in industry and in the home									
11.2 Air State the composition of clean, dry air as being approximately 78% nitrogen,					**11.2 Air** Describe the separation of oxygen and nitrogen from liquid air by fractional distillation				
21% oxygen and the remainder as being a mixture of noble gases and carbon dioxide									
Name the common pollutants in the air as being carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds									

Extended: 11. Air and water

Core material You should be able to:	R	A	G	Comments	Supplement material You should be able to:	R	A	G	Comments
11.2 Air (continued) State the source of each of these pollutants:					**11.2 Air (continued)** Describe and explain the presence of oxides of nitrogen in car engines and their catalytic removal	☐	☐	☐	
• carbon monoxide from the incomplete combustion of carbon-containing substances	☐	☐	☐						
• sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to 'acid rain')	☐	☐	☐						
• oxides of nitrogen from car engines	☐	☐	☐						
• lead compounds from leaded petrol	☐	☐	☐						
State the adverse effect of these common pollutants on buildings and on health and discuss why these pollutants are of global concern	☐	☐	☐						
State the conditions required for the rusting of iron	☐	☐	☐						
Describe and explain methods of rust prevention, specifically paint and other coatings to exclude oxygen	☐	☐	☐		Describe and explain sacrificial protection in terms of the reactivity series of metals and galvanising as a method of rust prevention	☐	☐	☐	

Extended: 11. Air and water

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
11.3 Nitrogen and fertilisers Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers	☐	☐	☐		**11.3 Nitrogen and fertilisers** Describe and explain the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air	☐	☐	☐	
Describe the displacement of ammonia from its salts	☐	☐	☐						
11.4 Carbon dioxide and methane State that carbon dioxide and methane are greenhouse gases and explain how they may contribute to climate change	☐	☐	☐		**11.4 Carbon dioxide and methane**				
State the formation of carbon dioxide: • as a product of complete combustion of carbon-containing substances	☐	☐	☐		Describe the carbon cycle, in simple terms, to include the processes of combustion, respiration and photosynthesis	☐	☐	☐	
• as a product of respiration	☐	☐	☐						
• as a product of the reaction between an acid and a carbonate	☐	☐	☐						
• from the thermal decomposition of a carbonate	☐	☐	☐						
State the sources of methane, including decomposition of vegetation and waste gases from digestion in animals	☐	☐	☐						

Extended: 12. Sulfur

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
Name some sources of sulfur	☐	☐	☐		Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions	☐	☐	☐	
Name the use of sulfur in the manufacture of sulfuric acid	☐	☐	☐						
State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)	☐	☐	☐		Describe the properties and uses of dilute and concentrated sulfuric acid	☐	☐	☐	

Extended: 13. Carbonates

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
Describe the manufacture of lime (calcium oxide) from calcium carbonate (limestone) in terms of thermal decomposition	☐	☐	☐		*There is no supplement material for this sub- topic.*				
Name some uses of lime and slaked lime such as in treating acidic soil and neutralising acidic industrial waste products, e.g. flue gas desulfurisation	☐	☐	☐						
Name the uses of calcium carbonate in the manufacture of iron and cement	☐	☐	☐						

Extended: 14. Organic chemistry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
14.1 Names of compounds Name and draw the structures of methane, ethane, ethene, ethanol, ethanoic acid and the products of the reactions stated in sub-topics 14.4–14.6	☐	☐	☐		**14.1 Names of compounds** Name and draw the structures of the unbranched alkanes, alkenes (**not** *cis-trans*), alcohols and acids containing up to four carbon atoms per molecule	☐	☐	☐	
State the type of compound present, given a chemical name ending in *-ane*, *-ene*, -ol, or -oic acid or a molecular structure	☐	☐	☐		Name and draw the structural formulae of the esters which can be made from unbranched alcohols and carboxylic acids, each containing up to four carbon atoms	☐	☐	☐	
14.2 Fuels Name the fuels: coal, natural gas and petroleum	☐	☐	☐		*There is no supplement material for this subtopic.*				
Name methane as the main constituent of natural gas	☐	☐	☐						
Describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation	☐	☐	☐						
Describe the properties of molecules within a fraction	☐	☐	☐						

Extended: 14. Organic chemistry

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
14.2 Fuels (continued) Name the uses of the fractions as:					*There is no supplement material for this sub-topic.*				
• refinery gas for bottled gas for heating and cooking									
• gasoline fraction for fuel (petrol) in cars									
• naphtha fraction for making chemicals									
• kerosene/paraffin fraction for jet fuel									
• diesel oil/gas oil for fuel in diesel engines									
• fuel oil fraction for fuel for ships and home heating systems									
• lubricating fraction for lubricants, waxes and polishes									
• bitumen for making roads									

Extended: 14. Organic chemistry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
14.3 Homologous series Describe the concept of homologous series as a 'family' of similar compounds with similar chemical properties due to the presence of the same functional group	☐	☐	☐		**14.3 Homologous series** Describe the general characteristics of an homologous series	☐	☐	☐	
					Recall that the compounds in a homologous series have the same general formula	☐	☐	☐	
					Describe and identify structural isomerism	☐	☐	☐	
14.4 Alkanes Describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning	☐	☐	☐		**14.4 Alkanes** Describe substitution reactions of alkanes with chlorine	☐	☐	☐	
Describe the bonding in alkanes	☐	☐	☐						

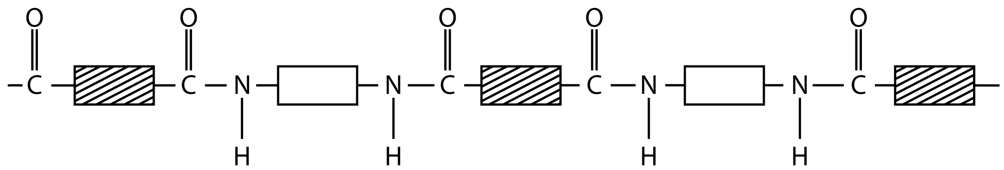
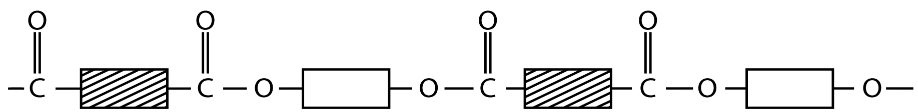
Extended: 14. Organic chemistry

Core material You should be able to:	R	A	G	Comments	Supplement material You should be able to:	R	A	G	Comments
14.5 Alkenes					**14.5 Alkenes**				
Describe the manufacture of alkenes and of hydrogen by cracking	☐	☐	☐		Describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam	☐	☐	☐	
Distinguish between saturated and unsaturated hydrocarbons:									
• from molecular structures	☐	☐	☐						
• by reaction with aqueous bromine	☐	☐	☐						
Describe the formation of poly(ethene) as an example of addition polymerisation of monomer units	☐	☐	☐						
14.6 Alcohols					**14.6 Alcohols**				
Describe the manufacture of ethanol by fermentation and by the catalytic addition of steam to ethene	☐	☐	☐		Outline the advantages and disadvantages of these two methods of manufacturing ethanol	☐	☐	☐	
Describe the properties of ethanol in terms of burning	☐	☐	☐						
Name the uses of ethanol as a solvent and as a fuel	☐	☐	☐						

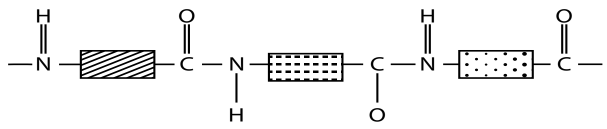
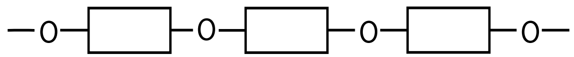
Extended: 14. Organic chemistry

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
14.7 Carboxylic acids Describe the properties of aqueous ethanoic acid	☐	☐	☐		**14.7 Carboxylic acids** Describe the formation of ethanoic acid by the oxidation of ethanol by fermentation and with acidified potassium manganate(VII)	☐	☐	☐	
					Describe ethanoic acid as a typical weak acid	☐	☐	☐	
					Describe the reaction of a carboxylic acid with an alcohol in the presence of a catalyst to give an ester	☐	☐	☐	
14.8.1 Polymers Define polymers as large molecules built up from small units (monomers)	☐	☐	☐		**14.8.1 Polymers** Understand that different polymers have different units and/or different linkages	☐	☐	☐	

Extended: 14. Organic chemistry

Core material: You should be able to:	R	A	G	Comments	Supplement material: You should be able to:	R	A	G	Comments
14.8.2 Synthetic polymers Name some typical uses of plastics and of man-made fibres such as nylon and *Terylene* Describe the pollution problems caused by non-biodegradable plastics					**14.8.2 Synthetic polymers** Explain the differences between condensation and addition polymerisation Deduce the structure of the polymer product from a given alkene and *vice versa* Describe the formation of nylon (a polyamide) and *Terylene* (a polyester) by condensation polymerisation, the structure of nylon being represented as:				
					 and the structure of *Terylene* as:  (You do **not** need to know details of manufacture and mechanisms of these polymerisations.)				

Extended: 14. Organic chemistry

Core material You should be able to:	R	A	G	Comments	Supplement material You should be able to:	R	A	G	Comments
14.8.3 Natural polymers Name proteins and carbohydrates as constituents of food					**14.8.3 Natural polymers** Describe proteins as possessing the same (amide) linkages as nylon but with different units				
					Describe the structure of proteins as: 				
					Describe the hydrolysis of proteins to amino acids (you do not need to know structures and names)				
					Describe complex carbohydrates in terms of a large number of sugar units, considered as  joined together by condensation polymerisation, e.g. 				
					Describe the hydrolysis of complex carbohydrates (e.g. starch), by acids or enzymes to give simple sugars				

Extended: 14. Organic chemistry

Core material					Supplement material				
You should be able to:	R	A	G	Comments	You should be able to:	R	A	G	Comments
There is no more Core material for this sub-topic.					**14.8.3 Natural polymers (continued)**				
					Describe the fermentation of simple sugars to produce ethanol (and carbon dioxide) (You will **not** be expected to give the molecular formulae of sugars.)	☐	☐	☐	
					Describe, in outline, the usefulness of chromatography in separating and identifying the products of hydrolysis of carbohydrates and proteins	☐	☐	☐	

Mathematical skills – Core and Extended

You can use a calculator for all components.

You should be able to:	Supplement material R	A	G	Comments
Add Subtract Multiply Divide				
Use: • averages • decimals • fractions • percentages • ratios • reciprocals				
Use standard notation, including positive and negative indices				
Understand significant figures and use them appropriately				
Recognise and use direct and inverse proportion				
Use positive, whole number indices in algebraic expressions				

Mathematical skills – Core and Extended

You can use a calculator for all components.

You should be able to:	Supplement material R	A	G	Comments
Use numbers in standard form, e.g. $1 \times 10^2 = 100$				
Draw charts and graphs from given data				
Draw graphs with line of best fit				
Interpret charts and graphs				
Find the gradient and intercept of a graph				
Select suitable scales and axes for graphs				
Make approximate evaluations of numerical expressions i.e. approximate				

Mathematical skills – Core and Extended

You can use a calculator for all components.

You should be able to:	Supplement material R	A	G	Comments
Understand the meaning of:				
• angle	☐	☐	☐	
• curve	☐	☐	☐	
• circle	☐	☐	☐	
• radius	☐	☐	☐	
• diameter	☐	☐	☐	
• circumference	☐	☐	☐	
• square	☐	☐	☐	
• rectangle	☐	☐	☐	
• diagonal	☐	☐	☐	
Solve equations of the form $x = y + z$ and $x = yz$ for any one term when the other two are known	☐	☐	☐	

Experimental skills – Core and Extended

For **Paper 5** and **Paper 6** you might be asked questions on the following experimental contexts.

You should be able to:	Supplement material R	A	G	Comments
Simple quantitative experiments involving the measurement of volumes and/or masses				
Rates (speeds) of reaction				
Measurement of temperature based on a thermometer with 1°C graduations				
Problems of an investigatory nature, possibly including suitable organic compounds				
Filtration				
Electrolysis				
Identification of ions and gases (**Paper 5** will include notes for use in qualitative analysis for the use in the examination. For **Paper 6** you will need to learn these.)				

Experimental skills – Core and Extended

For **Paper 5** and **Paper 6** you might be asked to do the following.

You should be able to:	Supplement material R	A	G	Comments
Take and record readings from apparatus, including:				
– reading a scale with appropriate accuracy and precision	☐	☐	☐	
– interpolating between scale divisions	☐	☐	☐	
– taking repeated measurements, where appropriate	☐	☐	☐	
Describe, explain or comment on experimental arrangements and techniques	☐	☐	☐	
Fill in tables of data, and process data, using a calculator where necessary	☐	☐	☐	
Draw an appropriate conclusion, justifying it by reference to the data and using an appropriate explanation	☐	☐	☐	
Interpret and evaluate observations and experimental data	☐	☐	☐	
Plot graphs and/or interpret graphical information	☐	☐	☐	
Identify sources of error and suggest possible improvements in procedures	☐	☐	☐	
Plan an experiment or investigation, including making reasoned predictions of expected results and suggesting suitable apparatus and techniques	☐	☐	☐	

Notes for use in qualitative analysis (Tests for ions and gases) – Core and Extended

The tables below show some tests for ions and gases and the result that you should get. These tables are given in Paper 5. They are not given in Papers 1–4 or Paper 6, so you must learn these tests and their results. The notes for use in qualitative analysis cover:

- Tests for anions
- Tests for aqueous cations
- Tests for gases
- Flame tests for metal ions

Tests for anions

Anion	Test	Test result	R	A	G	Comments
carbonate (CO^{2-})	add dilute acid	effervescence, carbon dioxide produced				
chloride (Cl^{-}) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white precipitate (ppt.)				
bromide (Br^{-}) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.				
iodide (I^{-}) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.				
nitrate (NO^{3}) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced				
sulfate (SO^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.				
sulfite (SO^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless				

Notes for use in qualitative analysis (Tests for ions and gases) – Core and Extended

Tests for aqueous cations

Cation	Effect of aqueous sodium hydroxide	Effect of aqueous ammonia	R	A	G	Comments
aluminium (Al 3+)	white precipitate (ppt.), soluble in excess giving a colourless solution	White ppt., insoluble in excess				
ammonium (+)	ammonia produced on warming	–				
calcium (Ca2+)	white ppt., insoluble in excess	no ppt. or very slight white ppt.				
chromium(III) (Cr3+)	green ppt., soluble in excess	grey-green ppt., insoluble in excess				
copper (Cu2+)	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution				
iron(II) (Fe2+)	green ppt., insoluble in excess	green ppt., insoluble in excess				
iron(III) (Fe3+)	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess				
zinc (Zn2+)	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution				

Notes for use in qualitative analysis (Tests for ions and gases) – Core and Extended

Tests for gases

Gas	Test and test result	R	A	G	Comments
ammonia (NH_3)	turns damp, red litmus paper blue				
carbon dioxide (CO_2)	turns limewater milky				
chlorine (Cl_2)	bleaches damp litmus paper				
hydrogen (H_2)	'pops' with a lighted splint				
oxygen (O_2)	relights a glowing splint				
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless				

Flame tests for metal ions

Metal ion	Test and test result	R	A	G	Comments
lithium (Li^+)	red				
sodium (Na^+)	yellow				
potassium (K^+)	lilac				
copper(II) (Cu^{2+})	blue-green				

Cambridge Assessment International Education
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
t: +44 1223 553554   f: +44 1223 553558
e: **info@cambridgeinternational.org**   **www.cambridgeinternational.org**