Cambridge Assessment International Education

Interactive

Learner Guide

Cambridge O Level
Chemistry 5070

For examination from 2023

Version 3

Cambridge Pathway

Contents

About this guide

This guide explains what you need to know about your Cambridge O Level Chemistry course and examinations.

It will help you to:

- ✓ understand what skills you should develop by taking this Cambridge O Level course
- ✓ understand how you will be assessed
- ✓ understand what we are looking for in the answers you write
- ✓ plan your revision programme
- ✓ revise, by providing revision tips and an interactive revision checklist (Section 4).

The aims of this syllabus are to enable you to:

- acquire scientific knowledge and understanding of scientific theories and practice
- develop a range of experimental skills, including handling variables and working safely
- use scientific data and evidence to solve problems and discuss the limitations of scientific methods
- communicate effectively and clearly, using scientific terminology, notation and conventions
- understand that the application of scientific knowledge can benefit people and the environment
- enjoy science and develop an informed interest in scientific matters which support further study.

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

This section gives you an outline of the syllabus content for this course. Ask your teacher for more detail about each topic. You can also find more detail in the Revision checklists of this guide.

1. States of matter
2. Atoms, elements and compounds
3. Stoichiometry
4. Electrochemistry
5. Chemical energetics
6. Chemical reactions
7. Acids, bases and salts
8. The Periodic Table
9. Metals
10. Chemistry of the environment
11. Organic chemistry
12. Experimental techniques and chemical analysis

Make sure you always check the latest syllabus, which is available at www.cambridgeinternational.org

Section 2: How you will be assessed

You will be assessed at the end of the course using three components:

- Paper 1: Multiple Choice
- Paper 2: Theory
- Paper 3: Practical Test or Paper 4: Alternative to Practical.

Find out from your teacher which components you will be taking, and when you will be taking them.

Components at a glance

This table summarises the key information about each examination paper. You can find details and advice on how to approach each component in the 'About each paper' sub-section.

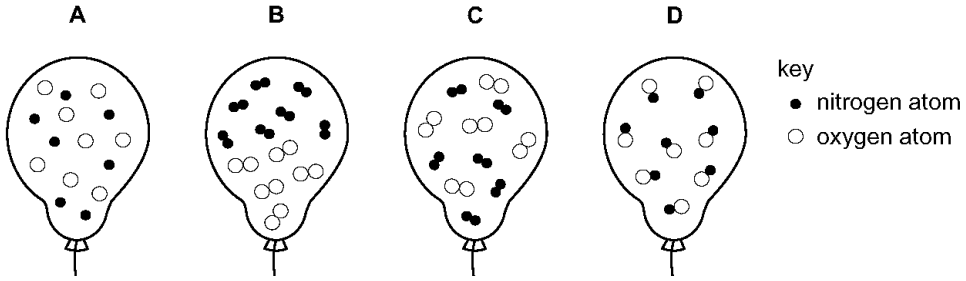
Component	Time and marks	Details	Percentage of qualification
Paper 1: Multiple Choice	1 hour 40 marks	40 four-choice multiple-choice questions. Questions will be based on the full subject content. Tests assessment objectives AO1 and AO2. Externally assessed.	30%
Paper 2: Theory	1 hour 45 minutes 80 marks	Short-answer and structured questions. Questions will be based on the full subject content. Tests assessment objectives AO1 and AO2. Externally assessed.	50%
Paper 3: Practical Test	1 hour 30 minutes 40 marks	Questions will be based on the experimental skills listed in the syllabus. Tests assessment objective AO3 in a practical context. Externally assessed.	20%
Paper 4: Alternative to Practical	1 hour 40 marks	Questions will be based on the experimental skills listed in the syllabus. Tests assessment objective AO3 in a written paper. Externally assessed.	20%

About each paper

Paper 1: Multiple Choice

Each of the 40 multiple choice questions you will answer has four choices.

4 Which diagram shows the arrangement of particles inside a balloon containing a mixture of the gases nitrogen and oxygen?



5 The ion Q^{2+} has three complete shells of electrons.

What is Q?

A calcium

B magnesium

C oxygen

D sulfur

6 The symbols for two ions are shown.

$^{19}_{9}F^{-}$ $^{21}_{11}Na^{+}$

Which statement is correct?

A The fluoride ion contains more electrons than the sodium ion.

B The sodium ion contains more neutrons than the fluoride ion.

C The two ions contain the same number of electrons as each other.

D The two ions contain the same number of protons as each other.

7 Two isotopes of chlorine are ^{35}Cl and ^{37}Cl.

Using these isotopes, how many different relative molecular masses are possible for the compound with molecular formula $C_2H_3Cl_3$?

A 2 **B** 3 **C** 4 **D** 5

Paper 2: Theory

For Paper 2, all questions are compulsory and there are no separate sections.

6 A mixture of ethanoic acid, ethene and oxygen is passed over a catalyst at 200 °C to manufacture ethenyl ethanoate, $CH_3COOCH{=}CH_2$.

$$CH_3COOH + CH_2{=}CH_2 + \tfrac{1}{2}O_2 \rightarrow CH_3COOCH{=}CH_2 + H_2O$$

The reaction is exothermic.

(a) Draw a reaction pathway diagram for this reaction on Fig. 6.1.

On your diagram label:

- the axes
- the reactants and products
- the enthalpy change of the reaction, ΔH
- the activation energy, E_a.

Fig. 6.1 [4]

(b) Explain why the enthalpy change of the reaction is exothermic.

Use ideas about bond breaking and bond making.

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..... [2]

[Total: 6]

Paper 3: Practical Test and Paper 4: Alternative to Practical

Notes for use in qualitative analysis are provided in the question paper itself.

Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white 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_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Both Paper 3 and Paper 4 include a planning question. It will be a 6-mark question focusing solely on the experimental skill of planning. The planning question will be identical in both papers.

3 Plant leaves contain a mixture of coloured substances.

Plan an experiment to find the R_f values of the coloured substances present in plant leaves.

Your plan should describe the use of common laboratory apparatus, plant leaves, sand, ethanol as the solvent and absorbent paper.

You may draw a diagram to help answer the question.

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Section 3: What skills will be assessed

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

The examiners take account of the following skills areas (assessment objectives) in the question papers:

- Knowledge with understanding
- Handling information and problem solving
- Experimental skills and investigations

It is important that you know the different weightings (%) of the assessment objectives, as this affects how the examiner will assess your work.

Paper 1 and Paper 2:

- AO1 Knowledge with understanding – 63% of the total mark
- AO2 Handling information and problem solving – 37% of the total mark

Paper 3 and Paper 4:

- AO3 Experimental skills and investigations – 100% of the total mark

Assessment objectives (AO)	What does the AO mean?	What do you need to be able to do?
AO1 Knowledge with understanding	Remembering facts and applying these facts to new situations	You should be able to demonstrate knowledge and understanding of: • scientific phenomena, facts, laws, definitions, concepts and theories • scientific vocabulary, terminology and conventions (including symbols, quantities and units) • scientific instruments and apparatus, including techniques of operation and aspects of safety • scientific and technological applications with their social, economic and environmental implications. You will also be asked questions which require you to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to another.
AO2 Handling information and problem solving	How you extract information and rearrange it in a sensible pattern, and how you carry out calculations and make predictions	You should be able, in words or using other written forms of presentation (i.e. symbolic, graphical and numerical) to: • locate, select, organise and present information from a variety of sources • translate information from one form to another • manipulate numerical and other data • use information to identify patterns, report trends and form conclusions • present reasoned explanations for phenomena, patterns and relationships • make predictions based on relationships and patterns • solve problems, including some of a quantitative nature. Questions testing these skills may be based on information that is unfamiliar to you, requiring you to apply the principles and concepts from the syllabus to a new situation, in a logical, deductive way.
AO3 Experimental skills and investigations	Planning and carrying out experiments and recording and analysing information	You should be able to: • demonstrate knowledge of how to select and safely use techniques, apparatus and materials (including following a sequence of instructions where appropriate) • plan experiments and investigations • make and record observations, measurements and estimates • interpret and evaluate experimental observations and data • evaluate methods suggest possible improvements.

Section 4: Revision

This advice will help you revise and prepare for the examinations. It is divided into general advice for all papers and more specific advice for Paper 1, Paper 2, Paper 3 and Paper 4.

Use the tick boxes ☐ to keep a record of what you have done, what you plan to do or what you understand.

General advice

Before the examination

- ☐ Find out when the examinations are and plan your revision so you have time to revise. Create a revision timetable and divide it into sections to cover each topic.
- ☐ Find out how long each paper is, how many questions you have to answer, how many marks there are for each question, and work out how long you have for each question.
- ☐ Find out the choices you have on each paper, make sure you know how many sections there are and which sections you should answer from.
- ☐ Know the meaning of the command words used in questions and how to apply them to the information given. Look at past examination papers and highlight the command words and check what they mean.
- ☐ Make revision notes. Try different styles of notes.
- ☐ Work for short periods then have a break. Revise small sections of the syllabus at a time.
- ☐ Test yourself by writing out key points, redrawing diagrams, etc.
- ☐ Make sure you define, scientific terms accurately.
- ☐ Definitions must not reuse the words to be defined.
- ☐ Make your own dictionary or draw up a glossary of key terms for each section of the syllabus.
- ☐ Practise drawing clear, simple, neat, fully-labelled diagrams.
- ☐ Learn to spell scientific terms correctly.
- ☐ Have a look at past questions so that you are clear of what to expect in an examination.
- ☐ Look at mark schemes to help you to understand how the marks are awarded for each question.

In the examination

- ☐ Read the instructions carefully and answer the right number of questions from the right sections.
- ☐ Do not answer more questions than are needed, as this will not gain you more marks in the examination.
- ☐ Plan your time according to the marks for each question. For example, a question worth three marks requires less time and a shorter answer than one worth 10 marks. If a question has several parts, then the parts with more marks will need more time and more developed answers.
- ☐ Do not leave out questions or parts of questions. Remember, no answer means no mark.
- ☐ Read each question very carefully.
  - Identify the command words – you could underline or highlight them.
  - Identify the other key words and perhaps underline them too.
  - Try to put the question into your own words to understand what it is really asking.
- ☐ Read all parts of a question before starting your answer. Think carefully about what is needed for each part. You will not need to repeat material.
- ☐ Look very carefully at the resource material you are given.
  - Read the title, key, axes of graphs, etc. to find out exactly what it is showing you.
  - Look for dates, scale, and location.
  - Try using coloured pencils or pens to pick out anything that the question asks you about.

- [ ] **Answer the question.** This is very important!

  Use your knowledge and understanding.

  Do not just write all you know, only write what is needed to answer the question.

- [ ] Plan your answers. Clear, concise, well-ordered, well-argued, well-supported answers get more marks than long, rambling, muddled, repetitious answers. Quality is better than quantity.
- [ ] Use scientific terms in your answers as much as possible.
- [ ] Use the resource material given in the question to support your answer.
- [ ] Make sure your writing is clear and easy to read. It is no good writing a brilliant answer if the examiner cannot read it!

Paper 1 advice

- [ ] There is one hour for Paper 1, so you have one and a half minutes 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 2 advice

- [ ] 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.
- [ ] Structured questions contain many parts. Often later parts can depend on the answer to earlier parts.
- [ ] Answer the question being asked. For example, if you are asked to 'Draw a diagram to show the electron arrangement in a molecule of hydrogen', you are asked to draw a 'molecule', so **two** H atoms with a pair of electrons joining them is needed, not an 'atom'. If the question asks you to name 'three other elements', do not write down the elements which are given in the question.
- [ ] Know the chemical terms used in the questions. For example, if a question asks '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 what the term 'reagent' means in order to answer the question correctly.
- [ ] Know how to write chemical equations in words and using symbols.
- [ ] Ensure that your answers are specific in your answer and not vague. For example, if a question asks '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. For example, if a question asks 'Give two harmful effects of acid rain' and you answer '*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.

Paper 3 advice

- [ ] Paper 3 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.
- [ ] This paper will not test specific topic content from the syllabus content. It only tests experimental skills and investigations (AO3). Any information required to answer the questions in this paper is contained within the paper itself or should be known from the experimental context, and skills listed in the Revision checklist.

- ☐ 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 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.
- ☐ 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.

Paper 4 advice

- ☐ Paper 4 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.
- ☐ This paper will not test specific topic content from the syllabus content, it tests experimental skills and investigations. This is AO3. Any information required to answer the questions in this paper is contained within the paper itself or should be known from the experimental context, and skills listed in the Revision checklist.
- ☐ 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.
- ☐ 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.
- ☐ 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.
- ☐ Record observations in the order the steps are carried out.
- ☐ 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'.
- ☐ 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.

Revision checklists

In the next part of this guide we have provided some revision checklists. These include information from the syllabus that you should revise. They don't contain all the detailed knowledge you need to know, just an overview. For more detail see the syllabus and talk to your teacher.

The table headings are explained below:

Topic	You should be able to	R	A	G	Comments
These are the topics you will learn.	Content in the syllabus you need to cover	You can use the tick boxes to show when you have revised an item and how confident you feel about it. R = RED means you are really unsure and lack confidence; you might want to focus your revision here and possibly talk to your teacher for help. A = AMBER means you are reasonably confident but need some extra practice. G = GREEN means you are very confident. As your revision progresses, you can concentrate on the RED and AMBER items in order to turn them into GREEN items. You might find it helpful to highlight each topic in red, orange or green to help you prioritise.			You can: • Add further information of your own. • add learning aids, such as rhymes, poems or word play • pinpoint areas of difficulty you need to check further with your teacher or textbooks • include reference to a useful resource

Note: the tables below cannot contain absolutely everything you need to know, but it does use examples wherever it can.

1 States of matter

Topic	You should be able to	R	A	G	Comments
1.1 Solids, liquids and gases					
1	State the distinguishing properties of solids, liquids and gases				
2	Describe the structure of solids, liquids and gases in terms of particle separation, arrangement and motion				
3	Describe and explain changes of state (melting, boiling, evaporating, freezing and condensing) in terms of kinetic particle theory				
4	Interpret and explain heating and cooling curves in terms of kinetic particle theory				
5	Describe and explain in terms of kinetic particle theory the effects of temperature and pressure on the volume of a gas				
1.2 Diffusion					
1	Describe and explain diffusion in terms of kinetic particle theory				
2	Describe and explain the effect of relative molecular mass on the rate of diffusion of gases				

2 Atoms, elements and compounds

Topic	You should be able to	R	A	G	Comments
2.1 Elements, compounds and mixtures					
1	Describe the differences between elements, molecules, compounds and mixtures				
2.2 Atomic structure and the Periodic Table					
1	Describe the structure of the atom as a central nucleus containing neutrons and protons surrounded by electrons in shells				
2	State the relative charges and relative masses of a proton, a neutron and an electron				
3	Define proton number / atomic number as the number of protons in the nucleus of an atom				
4	Define mass number / nucleon number as the total number of protons and neutrons in the nucleus of an atom				

Topic	You should be able to	R	A	G	Comments
5	Determine the electronic configuration of elements with proton number 1 to 20, e.g. 2,8,3	☐	☐	☐	
6	State that: a. Group VIII noble gases have a full outer shell b. the number of outer shell electrons is equal to the group number in Groups I to VII c. the number of occupied electron shells is equal to the period number	☐	☐	☐	
2.3 Isotopes					
1	Define isotopes as different atoms of the same element that have the same number of protons but different numbers of neutrons	☐	☐	☐	
2	State that isotopes of the same element have the same chemical properties because they have the same number of electrons and therefore the same electronic configuration	☐	☐	☐	
3	Interpret and use symbols for atoms, e.g. $^{12}_{6}C$ and ions, e.g. $^{35}_{17}Cl^-$	☐	☐	☐	
4	Calculate the relative atomic mass of an element from the relative masses and abundances of its isotopes	☐	☐	☐	
2.4 Ions and ionic bonds					
1	Describe the formation of positive ions, known as cations and negative ions, known as anions	☐	☐	☐	
2	Describe the giant lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions	☐	☐	☐	
3	State that an ionic bond is a strong electrostatic attraction between oppositely charged ions	☐	☐	☐	
4	Describe the formation of ionic bonds between ions of metallic and non-metallic elements, including the use of dot-and-cross diagrams	☐	☐	☐	
5	Describe and explain in terms of structure and bonding the properties of ionic compounds: a. high melting points and boiling points b. good electrical conductivity when aqueous or molten and poor when solid	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
2.5 Simple molecules and covalent bonds					
1	State that a covalent bond is formed when a pair of electrons is shared between two atoms leading to noble gas electronic configurations	☐	☐	☐	
2	Describe the formation of covalent bonds in simple molecules, including H_2, Cl_2, H_2O, CH_4, NH_3, HCl, CH_3OH, C_2H_4, O_2, CO_2 and N_2. Use dot-and-cross diagrams to show the electronic configurations in these and similar molecules.	☐	☐	☐	
3	Describe and explain in terms of structure and bonding the properties of simple molecular compounds: a. low melting points and boiling points in terms of weak intermolecular forces (specific types of intermolecular forces are not required) b. poor electrical conductivity	☐	☐	☐	
2.6 Giant covalent structures					
1	Describe the giant covalent structures of graphite and diamond	☐	☐	☐	
2	Describe the giant covalent structure of silicon(IV) oxide, SiO_2	☐	☐	☐	
3	Relate the structures and bonding of graphite and diamond to their uses, limited to: a. graphite as a lubricant and as an electrode b. diamond in cutting tools	☐	☐	☐	
4	Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures	☐	☐	☐	
2.7 Metallic bonding					
1	Describe metallic bonding as the electrostatic attraction between the positive ions in a giant metallic lattice and a 'sea' of delocalised electrons	☐	☐	☐	
2	Explain in terms of structure and bonding the properties of metals: a. good electrical conductivity b. malleable and ductile	☐	☐	☐	

3 Stoichiometry

Topic	You should be able to	R	A	G	Comments
3.1 Formulae					
1	State the formulae of the elements and compounds named in the subject content				
2	Define the molecular formula of a compound as the number and type of different atoms in one molecule				
3	Define the empirical formula of a compound as the simplest whole number ratio of the different atoms or ions in a compound				
4	Deduce the formula of a simple molecular compound from the relative numbers of atoms or ions present in a model or a diagrammatic representation				
5	Deduce the formula of an ionic compound from the charges on the ions				
6	Construct word equations, symbol equations and ionic equations to show how reactants form products, including state symbols				
7	Deduce the symbol equation with state symbols for a chemical reaction, given relevant information				
3.2 Relative masses of atoms and molecules					
1	Describe relative atomic mass, A_r, as the average mass of the isotopes of an element compared to 1/12th of the mass of an atom of ^{12}C				
2	Define relative molecular mass, M_r, as the sum of the relative atomic masses. Relative formula mass, M_r, will be used for ionic compounds.				
3.3 The mole and the Avogadro constant					
1	State that the mole, mol, is the unit of amount of substance. One mole contains 6.02×10^{23} particles, e.g. atoms, ions, molecules. This number is the Avogadro constant				
2	Use the relationship amount of substance (mol) = $\frac{\text{mass (g)}}{\text{molar mass } \frac{\text{(g)}}{\text{mol}}}$ to calculate: a. amount of substance b. mass c. molar mass d. relative atomic mass or relative molecular / formula mass e. number of particles, using the value of the Avogadro constant				

Topic	You should be able to	R	A	G	Comments
3	Use the molar gas volume, taken as 24 dm^3 at room temperature and pressure, r.t.p. in calculations involving gases				
4	State that concentration can be measured in g / dm^3 or mol / dm^3				
5	Calculate stoichiometric reacting masses, limiting reactants, volumes of gases at r.t.p., volumes of solutions and concentrations of solutions expressed in g / dm^3 and mol / dm^3, including conversion between cm^3 and dm^3				
6	Use experimental data to calculate the concentration of a solution in a titration				
7	Calculate empirical formulae and molecular formulae, given appropriate data				
8	Calculate percentage yield, percentage composition by mass and percentage purity, given appropriate data				

4 Electrochemistry

Topic	You should be able to	R	A	G	Comments
4.1 Electrolysis					
1	Define electrolysis as the decomposition of an ionic compound, when molten or in aqueous solution, by the passage of an electric current				
2	Identify in simple electrolytic cells: a. the anode as the positive electrode b. the cathode as the negative electrode c. the electrolyte as the molten or aqueous substance that undergoes electrolysis				
3	Describe the transfer of charge during electrolysis to include: a. the movement of electrons in the external circuit b. the loss or gain of electrons at the electrodes c. the movement of ions in the electrolyte				
4	Identify the products formed at the electrodes and describe the observations made during the electrolysis of: a. molten lead(II) bromide b. concentrated aqueous sodium chloride c. dilute sulfuric acid using inert electrodes made of platinum or carbon / graphite				

Topic	You should be able to	R	A	G	Comments
5	Identify the products formed at the electrodes and describe the observations made during the electrolysis of aqueous copper(II) sulfate using inert carbon / graphite electrodes and when using copper electrodes				
6	State that metals or hydrogen are formed at the cathode and that non-metals (other than hydrogen) are formed at the anode				
7	Predict the identity of the products at each electrode for the electrolysis of a binary compound in the molten state				
8	Predict the identity of the products at each electrode for the electrolysis of halide in dilute or concentrated aqueous solution				
9	Construct ionic half-equations for reactions at the anode (to show oxidation) and at the cathode (to show reduction)				
10	State that metal objects are electroplated to improve their appearance and resistance to corrosion				
11	Describe how metals are electroplated				
4.2 Hydrogen–oxygen fuel cells					
1	State that a hydrogen–oxygen fuel cell uses hydrogen and oxygen to produce electricity with water as the only chemical product				
2	Describe the advantages and disadvantages of using hydrogen–oxygen fuel cells in comparison with gasoline or petrol engines in vehicles				

5 Chemical energetics

Topic	You should be able to	R	A	G	Comments
5.1 Exothermic and endothermic reactions					
1	State that an exothermic reaction transfers thermal energy to the surroundings leading to an increase in the temperature of the surroundings.				
2	State that an endothermic reaction transfers thermal energy from the surroundings leading to a decrease in the temperature of the surroundings				
3	State that the transfer of thermal energy during a reaction is called the enthalpy change, ΔH, of the reaction. ΔH is negative for exothermic reactions and positive for endothermic reactions.				
4	Define activation energy, E_a, as the minimum energy that colliding particles must have in order to react				

Topic	You should be able to	R	A	G	Comments
5	Draw, label and interpret reaction pathway diagrams for exothermic and endothermic reactions using information provided, to include: a. reactants b. products c. enthalpy change of reaction, ΔH d. activation energy, E_a	☐	☐	☐	
6	State that bond breaking is an endothermic process and bond making is an exothermic process and explain the enthalpy change of a reaction in terms of bond breaking and bond making	☐	☐	☐	
7	Calculate the enthalpy change of a reaction using bond energies	☐	☐	☐	

6 Chemical reactions

Topic	You should be able to	R	A	G	Comments
6.1 Physical and chemical changes					
1	Identify physical and chemical changes, and understand the differences between them	☐	☐	☐	
6.2 Rate of reaction					
1	Describe collision theory in terms of: a. number of particles per unit volume b. frequency of collisions between particles c. kinetic energy of particles d. activation energy	☐	☐	☐	
2	State that a catalyst increases the rate of a reaction and is unchanged at the end of a reaction	☐	☐	☐	
3	Describe and explain the effect on the rate of reactions of: a. changing the concentration of solutions b. changing the pressure of gases c. changing the surface area of solids d. changing the temperature e. adding or removing catalysts including enzymes using collision theory	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
4	Describe and evaluate practical methods for investigating the rate of a reaction, including change in mass of a reactant or a product and gas evolution	☐	☐	☐	
5	Interpret data, including graphs, from rate of reaction experiments	☐	☐	☐	
6.3 Reversible reactions and equilibrium					
1	State that some chemical reactions are reversible as shown by the symbol ⇌	☐	☐	☐	
2	Describe how changing the conditions can change the direction of a reversible reaction for: a. the effect of heat on hydrated compounds b. the addition of water to anhydrous compounds including copper(II) sulfate and cobalt(II) chloride	☐	☐	☐	
3	State that a reversible reaction in a closed system is at equilibrium when: a. the rate of the forward reaction is equal to the rate of the reverse reaction b. the concentrations of reactants and products are no longer changing	☐	☐	☐	
4	Predict and explain, for any reversible reaction, how the position of equilibrium is affected by: a. changing temperature b. changing pressure c. changing concentration d. using a catalyst using information provided	☐	☐	☐	
5	State the symbol equation for the production of ammonia in the Haber process, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	☐	☐	☐	
6	State the sources of the hydrogen (methane) and nitrogen (air) in the Haber process	☐	☐	☐	
7	State the typical conditions in the Haber process as 450 °C, 20 000 kPa and an iron catalyst	☐	☐	☐	
8	State the symbol equation for the Contact process, $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$	☐	☐	☐	
9	State the sources of the sulfur dioxide (burning sulfur or roasting sulfide ores) and oxygen (air) in the Contact process	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
10	State the typical conditions in the Contact process as 450 °C, 200 kPa and a vanadium(V) oxide catalyst	☐	☐	☐	
11	Explain, in terms of rate of reaction and position of equilibrium, why the typical conditions stated are used in the Haber process and in the Contact process, including safety considerations and economics	☐	☐	☐	
6.4 Redox					
1	Use a Roman numeral to indicate the oxidation number of an element	☐	☐	☐	
2	Define redox reactions as involving simultaneous reduction and oxidation	☐	☐	☐	
3	Define oxidation in terms of: a. gain of oxygen b. loss of electrons c. an increase in oxidation number	☐	☐	☐	
4	Define reduction in terms of: a. loss of oxygen b. gain of electrons c. a decrease in oxidation number	☐	☐	☐	
5	Identify redox reactions as reactions involving gain and loss of oxygen, or gain and loss of electrons	☐	☐	☐	
6	Identify redox reactions by changes in oxidation number using: a. the oxidation number of elements in their uncombined state is zero b. the oxidation number of a monatomic ion is the same as the charge on the ion c. the sum of the oxidation numbers in a compound is zero d. the sum of the oxidation numbers in a molecular ion is equal to the charge on the ion	☐	☐	☐	
7	Identify redox reactions by the colour changes involved when using acidified aqueous potassium manganate(VII) or potassium iodide	☐	☐	☐	
8	Define an oxidising agent as a substance that oxidises another substance and is itself reduced during a redox reaction	☐	☐	☐	
9	Identify oxidation, oxidising agents, reduction and reducing agents in redox reactions	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
10	Identify oxidation, oxidising agents, reduction and reducing agents in redox reactions	☐	☐	☐	

7 Acids, bases and salts

Topic	You should be able to	R	A	G	Comments
7.1 The characteristic properties of acids and bases					
1	State that aqueous solutions of acids contain H^+ ions and aqueous solutions of alkalis contain OH– ions	☐	☐	☐	
2	Define acids as proton donors and bases as proton acceptors	☐	☐	☐	
3	State that bases are oxides or hydroxides of metals and that alkalis are soluble bases	☐	☐	☐	
4	Describe the characteristic properties of acids in terms of their reactions with: a. metals b. bases c. carbonates	☐	☐	☐	
5	Describe the characteristic properties of bases in terms of their reactions with: a. acids b. ammonium salts	☐	☐	☐	
6	State that a neutralisation reaction occurs between an acid and a base	☐	☐	☐	
7	Describe the neutralisation reaction between an acid and an alkali to produce water, $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	☐	☐	☐	
8	Describe acids and alkalis in terms of their effects on: a. litmus b. thymolphthalein c. methyl orange	☐	☐	☐	
9	Define a strong acid as an acid that is completely dissociated in aqueous solution and a weak acid as an acid that is partially dissociated in aqueous solution	☐	☐	☐	
10	State examples of strong acids, including hydrochloric acid, nitric acid and sulfuric acid and construct the symbol equations to show their complete dissociation, e.g. $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
11	State examples of weak acids, including carboxylic acids and construct the symbol equations to show their partial dissociation, e.g. for ethanoic acid, $CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$	☐	☐	☐	
12	Describe how to compare hydrogen ion concentration, neutrality, relative acidity and relative alkalinity in terms of colour and pH using universal indicator paper	☐	☐	☐	
7.3 Preparation of salts					
1	Describe the preparation, separation and purification of soluble salts by reaction of an acid with: a. an alkali by titration b. excess metal c. excess insoluble base d. excess insoluble carbonate	☐	☐	☐	
2	Describe the preparation of insoluble salts by precipitation	☐	☐	☐	
3	Describe the general solubility rule for salts: a. sodium, potassium and ammonium salts are soluble b. nitrates are soluble c. chlorides are soluble, except lead and silver d. sulfates are soluble, except barium, calcium and lead e. carbonates and hydroxides are insoluble, except sodium, potassium and ammonium	☐	☐	☐	
4	Define a hydrated substance as a substance that is chemically combined with water and an anhydrous substance as a substance containing no water	☐	☐	☐	
5	Define the term water of crystallisation as the water molecules present in crystals, e.g. $CuSO_4 \cdot 5H_2O$ and $CoCl_2 \cdot 6H_2O$	☐	☐	☐	

8 The Periodic Table

Topic	You should be able to	R	A	G	Comments
8.1 Arrangement of elements					
1	Describe the Periodic Table as an arrangement of elements in periods and groups and in order of increasing proton / atomic number	☐	☐	☐	
2	Describe the change from metallic to non-metallic character across a period	☐	☐	☐	
3	Describe the relationship between group number and the charge on ions formed from elements in that group	☐	☐	☐	
4	Explain similarities in the chemical properties of elements in the same group of the Periodic Table in terms of their electronic configuration	☐	☐	☐	
5	Explain how the position of an element in the Periodic Table can be used to predict its properties	☐	☐	☐	
6	Identify trends in groups, given information about the elements	☐	☐	☐	
8.2 Group I properties					
1	Describe the Group I alkali metals, lithium, sodium and potassium, as relatively soft metals with general trends down the group, limited to: a. decreasing melting point b. increasing density c. increasing reactivity	☐	☐	☐	
2	Predict the properties of other elements in Group I, given information about the elements	☐	☐	☐	
3	Describe and explain the displacement reactions of halogens with other halide ions	☐	☐	☐	
4	Predict the properties of other elements in Group VII, given information about the elements	☐	☐	☐	
8.4 Transition elements					
1	Describe the transition elements as metals that: a. have high densities b. have high melting points c. have variable oxidation numbers d. form coloured compounds e. often act as catalysts as elements and as compoun	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
8.5 Noble gases					
1	Describe the Group VIII noble gases as unreactive, monatomic gases and explain this in terms of electronic configuration				

9 Metals

Topic	You should be able to	R	A	G	Comments
9.1 Properties of metals					
1	Compare the general physical properties of metals and non-metals, including: a. thermal conductivity b. electrical conductivity c. malleability and ductility d. melting and boiling points				
2	Describe the general chemical properties of metals, limited to their reactions with: a. dilute acids b. cold water and steam c. oxygen				
9.2 Uses of metals					
1	Describe the uses of metals in terms of their physical properties, including: a. aluminium in the manufacture of aircraft because of its low density b. aluminium in the manufacture of overhead electrical cables because of its low density and good electrical conductivity c. aluminium in food containers because of its resistance to corrosion d. copper in electrical wiring because of its good electrical conductivity and ductility				
9.3 Alloys and their properties					
1	Describe an alloy as a mixture of a metal with other elements, including: a. brass as a mixture of copper and zinc b. stainless steel as a mixture of iron and other elements such as chromium, nickel and carbon				

Topic	You should be able to	R	A	G	Comments
2	Explain, in terms of structure, how alloys can be harder or stronger than the pure metals because the different sized atoms or ions in alloys mean the layers can no longer slide over each other				
3	Describe the uses of alloys in terms of their physical properties, including stainless steel in cutlery because of its hardness and resistance to rusting				
4	Identify representations of alloys from diagrams of structure				
9.4 Reactivity series					
1	State the order of the reactivity series as: potassium, sodium, calcium, magnesium, aluminium, carbon, zinc, iron, hydrogen, copper, silver, gold				
2	Describe the relative reactivities of metals in terms of their tendency to form positive ions, by displacement reactions, if any, with the aqueous ions of magnesium, zinc, iron, copper and silver				
3	Describe the reactions, if any, of: a. potassium, sodium and calcium with cold water b. magnesium with steam c. magnesium, zinc, iron, copper, silver and gold with dilute hydrochloric acid and explain these reactions in terms of the position of the metals and hydrogen in the reactivity series				
4	Explain the apparent unreactivity of aluminium in terms of its oxide layer				
5	Deduce an order of reactivity from a given set of experimental results				
9.5 Corrosion of metals					
1	State the conditions required for the rusting of iron and steel to form hydrated iron(III) oxide				
2	Describe how barrier methods prevent rusting by excluding oxygen or water				
3	State some common barrier methods, including painting, greasing and coating with plastic				
4	Explain sacrificial protection in terms of the reactivity series and in terms of electron loss				
5	Describe the use of zinc in galvanising as an example of a barrier method and sacrificial protection				

Topic	You should be able to	R	A	G	Comments
9.6 Extraction of metals					
1	Describe the ease of obtaining metals from their ores, related to the position of the metal in the reactivity series	☐	☐	☐	
2	Describe the extraction of iron from hematite in the blast furnace, including symbol equations for each step, limited to: a. the burning of carbon (coke) in air to provide heat and produce carbon dioxide b. the reduction of carbon dioxide to carbon monoxide c. the reduction of iron(III) oxide by carbon monoxide d. the thermal decomposition of calcium carbonate / limestone to produce calcium oxide e. the formation of slag	☐	☐	☐	
3	Describe the extraction of aluminium from purified bauxite (aluminium oxide), including: a. the role of cryolite b. why the carbon anode needs to be regularly replaced c. the reactions at the electrodes, including ionic half-equations Details of purification of bauxite are **not** required	☐	☐	☐	

10 Chemistry of the environment

Topic	You should be able to	R	A	G	Comments
10.1 Water					
1	Describe chemical tests for the presence of water using anhydrous cobalt(II) chloride and anhydrous copper(II) sulfate	☐	☐	☐	
2	Describe how to test for the purity of water using melting point and boiling point	☐	☐	☐	
3	Explain that distilled water is used in practical chemistry rather than tap water because it contains fewer chemical impurities	☐	☐	☐	
3	State that water from natural sources contains a variety of substances, including: a. dissolved oxygen b. metal compounds c. plastics	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
	d. sewage e. harmful microbes f. nitrates from fertilisers g. phosphates from fertilisers and detergents	☐	☐	☐	
5	State that some of these substances are beneficial, including: a. dissolved oxygen for aquatic life b. some metal compounds provide essential minerals for life	☐	☐	☐	
6	State that some of these substances are potentially harmful, including: a. some metal compounds are toxic b. plastics harm aquatic life c. sewage contains harmful microbes which cause disease d. nitrates and phosphates cause lead to deoxygenation of water and damage to aquatic life Details of the eutrophication process are **not** required.	☐	☐	☐	
7	Describe the purification of the domestic water supply in terms of: a. sedimentation and filtration to remove solids b. use of carbon to remove tastes and odours c. chlorination to kill microbes	☐	☐	☐	
10.2 Fertilisers					
1	State that ammonium salts and nitrates are used as fertilisers	☐	☐	☐	
2	Describe the use of NPK fertilisers to provide the elements nitrogen, phosphorus and potassium for improved plant growth	☐	☐	☐	
10.3 Air quality and climate					
1	State the composition of clean, dry air as approximately 78% nitrogen, N_2, 21% oxygen, O_2 and the remainder as a mixture of noble gases and carbon dioxide, CO_2	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
2	State the source of each of these air pollutants: a. carbon dioxide from the complete combustion of carbon-containing fuels b. carbon monoxide and particulates from the incomplete combustion of carbon-containing fuels c. methane from the decomposition of vegetation and waste gases from digestion in animals d. oxides of nitrogen from car engines e. sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds	☐	☐	☐	
3	State the adverse effects of these air pollutants: a. carbon dioxide: higher levels of carbon dioxide leading to increased global warming, which leads to climate change b. carbon monoxide: toxic gas c. particulates: increased risk of respiratory problems and cancer d. methane: higher levels of methane leading to increased global warming, which leads to climate change e. oxides of nitrogen: acid rain, photochemical smog and respiratory problems f. sulfur dioxide: acid rain	☐	☐	☐	
4	Describe how the greenhouse gases carbon dioxide and methane cause global warming, limited to: a. the absorption, reflection and emission of heat b. reducing heat loss to space	☐	☐	☐	
5	State and explain strategies to reduce the effects of these environmental issues, limited to: a. climate change: planting trees, reduction in livestock farming, decreasing use of fossil fuels, increasing use of hydrogen and renewable energy, e.g. wind, solar b. acid rain: use of catalytic converters in vehicles, reducing emissions of sulfur dioxide by using low-sulfur fuels and flue gas desulfurisation with calcium oxide	☐	☐	☐	
6	Explain how oxides of nitrogen form in car engines and describe their removal by catalytic converters, e.g. $2CO + 2NO \rightarrow 2CO_2 + N_2$	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
7	Describe photosynthesis as the reaction between carbon dioxide and water to produce glucose and oxygen in the presence of chlorophyll and using energy from light	☐	☐	☐	
8	State the word equation and symbol equation for photosynthesis	☐	☐	☐	

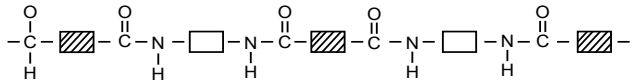
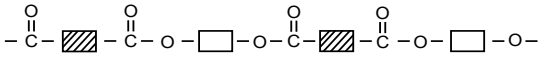
11 Organic chemistry

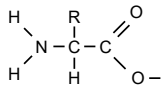
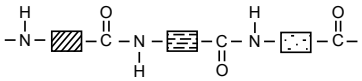
Topic	You should be able to	R	A	G	Comments
11.1 Formulae, functional groups and terminology					
1	State that a structural formula is an unambiguous description of the way the atoms in a molecule are arranged, including $CH_2=CH_2$, CH_3CH_2OH, CH_3COOCH_3	☐	☐	☐	
2	Draw and interpret the displayed formula of a molecule to show all the atoms and all the bonds	☐	☐	☐	
3	Write and interpret general formulae of compounds in the same homologous series, limited to: a. alkanes, C_nH_{2n+2} b. alkenes, C_nH_{2n} c. alcohols, $C_nH_{2n+1}OH$ d. carboxylic acids, $C_nH_{2n+1}COOH$	☐	☐	☐	
4	Define structural isomers as compounds with the same molecular formula, but different structural formulae, including C_4H_{10} as $CH_3CH_2CH_2CH_3$ and $CH_3CH(CH_3)CH_3$ and C_4H_8 as $CH_3CH_2CH=CH_2$ and $CH_3CH=CHCH_3$	☐	☐	☐	
5	Identify a functional group as an atom or group of atoms that determine the chemical properties of a homologous series	☐	☐	☐	
6	Describe the general characteristics of a homologous series: a. having the same functional group b. having the same general formula c. differing from one member to the next by a $–CH_2–$ unit d. displaying a trend in physical properties e. sharing similar chemical properties	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
7	State that a saturated compound has molecules in which all carbon–carbon bonds are single bonds	☐	☐	☐	
8	State that an unsaturated compound has molecules in which one or more carbon–carbon bonds are double bonds or triple bonds	☐	☐	☐	
11.2 Naming organic compounds					
1	Name and draw the structural and displayed formulae of unbranched: a. alkanes b. alkenes, including but-1-ene and but-2-ene c. alcohols, including propan-1-ol, propan-2-ol, butan-1-ol and butan-2-ol d. carboxylic acids e. the products of the reactions stated in sections 11.4–11.7 containing up to four carbon atoms per molecule	☐	☐	☐	
2	State the type of compound present given the chemical name ending in -ane, -ene, -ol, or -oic acid or from a molecular, structural or displayed formula	☐	☐	☐	
3	Name and draw the displayed formulae of the unbranched esters which can be made from unbranched alcohols and carboxylic acids, each containing up to four carbon atoms	☐	☐	☐	
11.3 Fuels					
1	Name the fossil fuels: coal, natural gas and petroleum	☐	☐	☐	
2	Name methane as the main constituent of natural gas	☐	☐	☐	
3	State that hydrocarbons are compounds that contain hydrogen and carbon only	☐	☐	☐	
4	State that petroleum is a mixture of hydrocarbons	☐	☐	☐	
5	Describe the separation of petroleum into useful fractions by fractional distillation	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
6	Describe how the properties of fractions obtained from petroleum change as they are collected in a fractionating column from the bottom to the top of the column, limited to: a. decreasing chain length b. higher volatility c. lower boiling points d. lower viscosity	☐	☐	☐	
7	Name the uses of the fractions as: a. refinery gas fraction for gas used in heating and cooking b. gasoline / petrol fraction for fuel used in cars c. naphtha fraction as a chemical feedstock d. kerosene/paraffin fraction for jet fuel e. diesel oil/gas oil fraction for fuel used in diesel engines f. fuel oil fraction for fuel used in ships and home heating systems g. lubricating fraction for lubricants, waxes and polishes h. bitumen fraction for making roads	☐	☐	☐	
11.4 Alkanes					
1	State that the bonding in alkanes is single covalent and that alkanes are saturated hydrocarbons	☐	☐	☐	
2	Describe the properties of alkanes as being generally unreactive, except in terms of combustion and substitution by chlorine	☐	☐	☐	
3	State that in a substitution reaction one atom or group of atoms is replaced by another atom or group of atoms	☐	☐	☐	
4	Describe the substitution reaction of alkanes with chlorine as a photochemical reaction, with ultraviolet light providing the activation energy, E_a, and draw the structural or displayed formulae of the products, limited to monosubstitution	☐	☐	☐	
11.5 Alkenes					
1	State that the bonding in alkenes includes a double carbon–carbon covalent bond and that alkenes are unsaturated hydrocarbons	☐	☐	☐	
2	Describe the manufacture of alkenes and hydrogen by the cracking of larger alkane molecules using a high temperature and a catalyst	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
3	Describe the reasons for the cracking of larger alkane molecules	☐	☐	☐	
4	Describe the test to distinguish between saturated and unsaturated hydrocarbons by their reaction with aqueous bromine	☐	☐	☐	
5	State that in an addition reaction only one product is formed	☐	☐	☐	
6	Describe the properties of alkenes in terms of addition reactions with: a. bromine or bromine water b. hydrogen in the presence of a nickel catalyst c. steam in the presence of an acid catalyst and draw the structural or displayed formulae of the products	☐	☐	☐	
11.6 Alcohols					
1	Describe the manufacture of ethanol by: a. fermentation of glucose solution at 25–35 °C in the presence of yeast and in the absence of oxygen b. catalytic addition of steam to ethene at 300 °C and 6000 kPa in the presence of an acid catalyst including a comparison of the advantages and disadvantages of the two methods	☐	☐	☐	
2	Describe the combustion of alcohols	☐	☐	☐	
3	State the uses of ethanol as: a. a solvent b. a fuel	☐	☐	☐	
11.7 Carboxylic acids					
	Describe the reactions of carboxylic acids with: a. metals b. bases c. carbonates including names and formulae of the salts produced	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
2	Describe the formation of ethanoic acid by the oxidation of ethanol: a. with acidified aqueous potassium manganate(VII) b. by bacterial oxidation during vinegar production	☐	☐	☐	
3	Describe the reaction of a carboxylic acid with an alcohol using an acid catalyst to form an ester	☐	☐	☐	
11.8 Polymers					
1	Define polymers as large molecules built up from many smaller molecules called monomers	☐	☐	☐	
2	Identify the repeat units and/or linkages in addition polymers and in condensation polymers	☐	☐	☐	
3	Deduce the structure or repeat unit of an addition polymer from a given alkene and vice versa	☐	☐	☐	
4	Deduce the structure or repeat unit of a condensation polymer from given monomers and vice versa, limited to: a. polyamides from a dicarboxylic acid and a diamine b. polyesters from a dicarboxylic acid and a diol	☐	☐	☐	
5	Describe the difference between addition and condensation polymerisation	☐	☐	☐	
6	State that plastics are made from polymers	☐	☐	☐	
7	Describe how the properties of plastics have implications for their disposal	☐	☐	☐	
8	Describe the environmental challenges caused by plastics, limited to: a. disposal in land fill sites b. accumulation in oceans c. formation of toxic gases from burning	☐	☐	☐	
	Describe and draw the structure of a. nylon, a polyamide  b. PET, a polyester  The full name for PET, polyethylene terephthalate, is **not** required.	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
10	State that PET can be converted back into monomers and re-polymerised	☐	☐	☐	
11	Describe proteins as natural polyamides and are formed from amino acid monomers with the general structure  , where R represents different types of side chain	☐	☐	☐	
12	Describe and draw the structure of proteins as: 	☐	☐	☐	

12 Experimental techniques and chemical analysis

Topic	You should be able to	R	A	G	Comments
12.1 Experimental design					
1	Name appropriate apparatus for the measurement of time, temperature, mass and volume, including: a. stop-watches b. thermometers c. balances d. burettes e. volumetric pipettes f. measuring cylinders g. gas syringes	☐	☐	☐	
2	Suggest advantages and disadvantages of experimental methods and apparatus	☐	☐	☐	
3	Describe a: a. solvent as a substance that dissolves a solute b. solute as a substance that is dissolved in a solvent c. solution as a liquid mixture composed of two or more substances d. saturated solution as a solution containing the maximum concentration of a solute dissolved in the solvent e. residue as a substance that remains after evaporation, distillation, filtration or any similar process f. filtrate as a liquid or solution that has passed through a filter	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
12.2 Acid–base titrations					
1	Describe an acid–base titration to include the use of a: a. burette b. volumetric pipette c. suitable indicator	☐	☐	☐	
2	Describe how to identify the end-point of a titration using an indicator	☐	☐	☐	
12.3 Chromatography					
1	Describe how paper chromatography is used to separate mixtures of soluble substances, using a suitable solvent	☐	☐	☐	
2	Describe the use of locating agents when separating mixtures including colourless substances. Knowledge of specific locating agents is not required.	☐	☐	☐	
3	Interpret simple chromatograms to identify: a. unknown substances by comparison with known substances b. pure and impure substances	☐	☐	☐	
4	State and use the equation for the retention factor, R_f: $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$	☐	☐	☐	
12.4 Separation and purification					
1	Describe and explain methods of separation and purification using: a. a suitable solvent b. filtration c. crystallisation d. simple distillation e. fractional distillation	☐	☐	☐	
2	Suggest suitable separation and purification techniques, given information about the substances involved	☐	☐	☐	
3	Identify substances and assess their purity using melting point and boiling point information	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
12.5 Identification of ions and gases					
1	Describe tests to identify the anions: a. carbonate, CO_3^{2-}, by reaction with dilute acid and then testing for carbon dioxide gas b. chloride, Cl^-, bromide, Br^-, and iodide, I^-, by acidifying with dilute nitric acid then adding aqueous silver nitrate c. nitrate, NO_3^-, by reduction with aluminium and aqueous sodium hydroxide and then testing for ammonia gas d. sulfate, SO_4^{2-}, by acidifying with dilute nitric acid then adding aqueous barium e. nitrate f. sulfite, SO_3^{2-}, by reaction with acidified aqueous potassium manganate(VII)	☐	☐	☐	
2	Describe tests using aqueous sodium hydroxide and aqueous ammonia to identify the aqueous cations: a. aluminium, Al^{3+} b. ammonium, NH^{4+} c. calcium, Ca^{2+} d. chromium(III), Cr^{3+} e. copper(II), Cu^{2+} f. iron(II), Fe^{2+} g. iron(III), Fe^{3+} h. zinc, Zn^{2+}	☐	☐	☐	
3	Describe tests to identify the gases: a. ammonia, NH_3, using damp red litmus paper b. carbon dioxide, CO_2, using limewater c. chlorine, Cl_2, using damp litmus paper d. hydrogen, H_2, using a lighted splint e. oxygen, O_2, using a glowing splint f. sulfur dioxide, SO_2, using acidified aqueous potassium manganate(VII)	☐	☐	☐	

Topic	You should be able to	R	A	G	Comments
4	Describe the use of a flame test to identify the cations: a. lithium, Li^+ b. sodium, Na^+ c. potassium, K^+ d. calcium, Ca^{2+} e. barium, Ba^{2+} f. copper(II), Cu^{2+}	☐	☐	☐	

Section 5: Useful websites

The resources listed below will help you to revise and study for your Cambridge O Level Chemistry course.

These resources have not been through the Cambridge quality assurance process but have been found suitable for use with various parts of the syllabus. This list includes website links providing direct access to internet resources. Cambridge is not responsible for the accuracy or content of information contained in these resources. The inclusion of a link to an external website should not be understood to be an endorsement of that website or the site's owners (or their products/services).

https://www.chemguide.co.uk
A general chemistry resources website.

https://phet.colorado.edu/
Interactive simulations for science and maths subjects.

https://www.rsc.org/
The Royal Society of Chemistry website is full of different resources and information including an interactive periodic table and much more.

https://www.bbc.co.uk/bitesize/subjects/zs6hvcw
Online study material for chemistry from the BBC.

You can find a resource list, including endorsed resources to support Cambridge O Level Chemistry on our public website [here]

Endorsed resources have been written to be closely aligned to the syllabus they support, and have been through a detailed quality assurance process. All textbooks endorsed by Cambridge International for this syllabus are the ideal resource to be used alongside this Learner Guide.

In addition to reading the syllabus, you should refer to the past and specimen papers.

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