Learner Guide

Cambridge O Level

Cambridge O Level

Chemistry

5070

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Cambridge Secondary 2

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Contents

How to use this guide

The guide describes what you need to know about your Cambridge O Level Chemistry examination.

It will help you plan your revision for both the theory and practical papers and will explain what we are looking for in your answers.

The guide contains the following sections:

Section 1: How will you be tested?

This gives you information about the theory papers and the different types of practical assessment.

Section 2: Examination advice

This section gives you advice to help you do as well as you can. Some of the ideas are general advice and some are based on the common mistakes that learners make in exams.

Section 3: What will be tested?

This section describes the areas of knowledge, understanding and skills that we will test you on.

Section 4: What you need to know

This shows the syllabus content in a simple way so that you can check:

- the topics you need to know about
- details about each topic in the syllabus
- how much of the syllabus you have covered

Section 5: Useful websites

A selection of websites containing useful resources to help you study for your Cambridge O Level Chemistry.

Section 6: Appendices

This section covers the other things you need to know such as:

- how to make the most of the copy of the Periodic Table that you are given in the theory papers
- how to use the Qualitative Analysis Notes
- what is the meaning of terms, like describe or explain, used in examination questions.

Section 1: How will you be tested?

About the papers

You will be entered for **three** papers: **two** of these will be theory papers and **one** will be a practical paper. You will need to ask your teacher which practical paper you will be taking. There is no choice in the theory papers that you will take.

Paper	How long?	What is in the paper?	Marks (% of the total exam marks)
Paper 1 Theory Multiple choice	1 hour	40 multiple-choice questions. In each question you choose one answer from the four provided.	40 marks (about 27%)
Paper 2 Theory Structured questions	1½ hours	Section A (45 marks) consists of a number of structured questions. Section B (30 marks) consists of four questions each of 10 marks. You choose three of these questions. In both Section A and Section B you write your answers in the spaces provided.	75 marks (about 52%)
Paper 3 or 4 Practical assessment	see next table	see next table	30 marks (about 21%)

About the practical papers

You will do one of the practical papers shown in the table. Your teacher will tell you which practical paper you will do. While the number of marks differs between the papers, your final mark will be calculated so that it is worth the same percentage of the total exam marks.

Paper	How long and how many marks?	What do you do?
Paper 3 (Practical Test)	1½ hours (40 marks)	You do a practical exam which is supervised by your teacher.
Paper 4 (Alternative to Practical)	1 hour (60 marks)	You answer a written paper about practical work.

Here are some more details about each of the practical papers. If you are unsure of anything, ask your teacher.

Paper 3 Practical Test

You do a practical exam which is supervised by a teacher. In the exam paper you are given instructions about the experiments you must carry out and you are asked to record observations and data which you then interpret or process. You will be given a copy of the Qualitative Analysis Notes but you are not allowed to use any other sources of information such as note books or text books.

The questions in the Practical Test may include:

- a simple titration
- an experiment that involves the measurement of a quantity such as temperature or time
- an investigation of unknown substances using test-tube reactions.

You need to know how to:

- measure volumes of liquids using measuring cylinders, burettes and pipettes
- carry out acid-alkali titrations using methyl orange indicator or other titrations given suitable information. Your burette readings should be given to the nearest 0.1 cm^3 and titrations should be repeated until two titres are within 0.2 cm^3
- measure time and be able to record readings to the nearest second
- measure temperature and be able to record readings to the nearest 0.5°C.
- filter
- identify ions and gases using the Qualitative Analysis Notes
- test for oxidising agents and reducing agents.

Paper 4 Alternative to Practical

This is a written paper about practical work. You should have experience of experimental chemistry so you know how to:

- record readings from diagrams of apparatus, e.g. burette readings
- answer questions on the arrangement of apparatus, e.g. for collecting gases
- suggest suitable apparatus for investigations
- identify sources of error and suggest improvements in experiments
- complete tables of data
- plot and interpret information from graphs
- draw conclusions from information.
- answer questions about experimental data
- perform simple calculations
- answer questions about tests for ions, gases, oxidising and reducing agents – **you will be expected to learn and remember these tests**
- draw conclusions from information.

Section 2: Examination advice

How to use this advice

These ideas provide advice for making the most of your knowledge and understanding in examinations and highlight some common mistakes made by learners. They are collected under various sub-headings to help you prepare for the papers.

General advice

You cannot score marks unless you write answers but this does not mean you should spend all the time writing in an examination. It is important to read the question carefully so that you know what to answer. By knowing what needs to be covered, you can produce an appropriate answer and spend less time writing.

The most basic advice for being successful in examinations is to:

- read each question carefully and then answer it
- write to the point, being specific not vague.

Much of what follows illustrates these points with regard to the papers you will take. There is no magic recipe for being successful in exams. You need to work hard in your study and prepare thoroughly. The advice is about making the most of what you can do in the exam and so allow you to obtain the best result.

- Read the question so that you understand exactly what is required before you start to answer. You must do what the question asks. We often use certain terms to make it clear what is required e.g. explain, describe, suggest. The meaning of these words can be found in the appendices section at the end of this document and also in the syllabus.
- Take careful note of how many marks there are for a question. Generally the number of marks indicates the number of points you need to cover in your answer.
- Provide what the question asks for. If a question asks for two examples, give two – extra wrong answers may lose you marks. 'Describe what you observe' requires you to write down what you see, hear or feel (e.g. the test-tube gets hot).
- Write to the point. There is a lot of time wasted in exams by writing the same answer more than once and by including irrelevant material.
- Read over your answer and check for any contradictions.
- In calculations always show your working – even if your answer is wrong, you may get marks for your method. Give units when needed. Your answer should be given in the manner requested or to the same number of significant figures as the data provided in the question. Make sure that you understand the difference between significant figures and decimal places. For example the mass 11.445 g is to 5 significant figures and 3 decimal places. If it was corrected to 4 significant figures it would become 11.45 g and corrected to 3 significant figures 11.4 g.
- When you draw diagrams, make sure they fill the space given on the paper and they are fully labelled.
- The correct spelling of a chemical name is not always required to obtain the mark as long as it cannot be mistaken for another. However, in questions where you are asked to select the names of chemicals or the like from a list, you are expected to get the spelling correct. Examples like writing 'ammonium' for 'ammonia' or 'chlorine' for 'chloride' will not be given credit because these are chemical mistakes.

- You must write your answers in black ink. Papers are scanned so that they can be marked online by examiners and other ink colours do not scan well. Dark black pencil (HB) should be used for drawings.

Paper 1 advice

- Attempt every question. There are forty questions and forty marks available.
- Do not make any assumptions about the order of responses – just because the last two answers have been D, it does not mean that the next one cannot be D as well.
- Read each question carefully. If possible work out the answer before you look at the four alternatives provided – you can usually do this with calculations. If this is not possible, eliminate options which are clearly incorrect and then choose between those left. While you must select an answer, you should never be making a guess from four.
- Do not try to work out the answers in your head. Write on the question paper to help you understand and solve the problems.
- Practice is important in making you better at multiple choice. You may find it useful to get your teacher or someone else to mark your answers to a paper and then look over your mistakes without being told the correct answers. This will allow you to spot careless errors, which are the result of poor technique, e.g. poor reading of the question and also to identify material which is not known or well understood.

Paper 2 advice

You need to read the question so that you know what is required to answer it. The following ideas seek to explain the advice given through examples.

- You must answer the question set.

State one specific use of nickel other than its use in alloys. (1 mark)
The word 'specific' is important here. You will get no credit for 'nickel is used as a catalyst' because you must also identify the industrial reaction catalysed i.e. the hydrogenation of vegetable oils.
*Suggest **two** possible consequences of an increase in global warming. (2 marks)*
The answer requires two effects of global warming, e.g. polar ice melting, sea level rising but does not want an explanation of how or why global warming occurs.
Describe how the boiling points of unbranched alkanes vary with the size of their molecules. (1 mark)
An answer like 'the boiling points depend on the size of the molecules' is not good enough. It indicates the candidate knows size affects boiling point but it does not state how changing size changes boiling point. 'As the molecules get larger the boiling points increase' answers the question set.

- You must be specific not vague in writing an answer.

How do fertilisers increase crop yields? (1 mark)
Vague answers simply state that fertilisers contain food for plants or similar whereas a specific answer would note that the fertiliser contains nitrogen and link this to protein and growth.
Explain why carbon monoxide must not be allowed to escape from the furnace. (1 mark)
'Carbon monoxide is toxic or poisonous' is the answer whereas 'pollutant', 'harmful' and 'causes breathing difficulties' are vague.

- The number of marks for a question can give you an indication of the number of points you should make in your answer.

Explain why zinc chloride conducts electricity when molten, not when solid. (2 marks)
'In molten zinc chloride the ions can move' is one point and scores 1 mark. 'The solid does not conduct

because the ions cannot move' is the other scoring point. It is common to find that candidates score the first mark but not the second.

Explain how the processes of photosynthesis and respiration help regulate the amount of carbon dioxide in the atmosphere. (3 marks)

There are three points to make – one about photosynthesis, another about respiration and a final one about 'regulate', i.e. maintaining the balance. Consequently the following answer scores all the marks – 'Plants take up carbon dioxide from the atmosphere in photosynthesis. In respiration carbon dioxide is released to the atmosphere. These processes maintain a balance because the amount of carbon dioxide taken up is equal to the amount being released.'

- It is important that you know what is meant by the scientific terms or phrases used in the questions.

State two differences in the physical properties of the metals potassium and iron. (2 marks)
State one difference in the chemical properties of the metals potassium and iron. (1 mark)

The first question is about properties such as melting point, density, hardness so 'potassium has a low melting point and iron has a high melting point' scores 1 of the 2 marks.

The second question is about the chemical reaction of the metals and an answer such as 'potassium is very reactive and iron is not very reactive' or 'potassium reacts with water and iron does not' will gain the mark.

Write an equation for the complete combustion of methane. (1 mark)

'Write an equation' in the exam means a symbol equation i.e. a balanced formula equation – it must contain the correct formulae for the reactants and products and be balanced. While formula writing and balancing equations are skills acquired through practice, marks are often lost because candidates forget the non-metals made up of diatomic molecules, e.g. O_2, N_2, H_2, Cl_2.

The term 'complete combustion' for a hydrocarbon like methane means plenty of oxygen is available in the burning and so carbon dioxide and water are the products.

Paper 3 advice

Question 1 is a quantitative problem involving measuring, recording data and using the data.

- You should record readings as instructed – burette readings to the nearest cm^3, e.g. 23 cm^3, thermometer readings usually to the nearest 0.5°C and timings to the nearest second.
- In titration-based problems you record burette readings in the table provided. From your titrations you must obtain two results which are within 0.2 cm^3, tick these results and then average them. Some candidates forget to identify the results they average and others average all their results rather than just the ones ticked.
- In experiments where times or temperatures are recorded, the data is often used to produce a graph. Plot the results carefully and use the points to draw a graph line (or lines) as instructed. Usually you are told whether the line is straight or curved but do recognise that 'a line of best fit' can be straight or curved.
- When using your data in calculations, make sure that you act upon the advice in the questions. You should give answers to three significant figures unless instructed otherwise.

Question 2 is an investigation of unknown substance using test-tube reactions.

- The Qualitative Analysis Notes will be on the last page of the exam paper and you must make sure that you have carried out and understand all the tests described.
- You also need to know tests for oxidising and reducing agents and be familiar with other test-tube reactions such as those of acids and metals.
- You must record observations carefully using the correct words. The way the test results are recorded in the Qualitative Analysis Notes is ideal. Substances should always be described – solids have a colour, e.g. a white precipitate, solutions have a colour or are colourless (clear does not mean colourless) and gases are generally colourless but when they are formed in liquids, bubbles are seen.

- You must describe a positive test for a gas before it can be identified. Recording 'the gas is hydrogen' will score no marks but 'the gas pops with a lighted splint (1 mark) and is hydrogen (1 mark) scores 2.

Paper 4 advice

This is a paper which tests your knowledge of practical work so in revision make sure that you study all the experiments you have done and seen demonstrated.

- You do not get the Qualitative Analysis Notes in the exam and need to learn all those tests for anions, cations and gases.
- You also need to learn tests for oxidising and reducing agents and know the reactions of acids, metals and organic compounds from the syllabus.
- You will be expected to be familiar with the practical techniques and equipment identified in the Practical assessment section of the syllabus content – use the Checklist in Section 4 to help you with this.
- You need to be able to take readings from diagrams of scales of measuring instruments such as burettes, measuring cylinders or thermometers.
- Questions involving the processing of data, e.g. calculations and graph plotting are set in the context of an experiment such as a titration, measuring temperature changes, reaction rates, using a gas syringe.

Section 3: What will be tested?

The Cambridge O Level Chemistry examination aims to test:

- your knowledge (what you remember) and understanding (how you use what you know and can apply it)
- how you handle information and solve problems
- your use of experimental skills.

These are called the assessment objectives (AOs), and are explained in the table below. The theory papers test mainly AO1 Knowledge with understanding, and AO2 Handling information and solving problems. The practical assessment tests AO3 Experimental skills and investigations. Your teacher will be able to provide you with more detailed information about the assessment objectives.

Assessment objective (AO)	What the AO means	What you need to be able to do
AO1 Knowledge with understanding	remembering facts and applying these facts to new situations	• use scientific ideas, facts and laws • know scientific vocabulary and terms, e.g. what is reduction? • know about chemical apparatus and how it works • know about chemical symbols, quantities, e.g. volume, and units, e.g. dm^3 • know about the importance of science in everyday life
AO2 Handling information and solving problems	how you extract information and rearrange it in a sensible pattern and how you carry out calculations and make predictions	• select and organise information from graphs, tables and written text • change information from one form to another, e.g. draw graphs, construct symbol equations from word equations • arrange data and carry out calculations • identify patterns from information given and draw conclusions • explain scientific relationships, e.g. use the kinetic particle theory to explain ideas about rate of reaction • make predictions and develop scientific ideas • solve problems
AO3 Experimental skills and investigations (the parts in brackets only refer to Paper 3)	planning (and carrying out) experiments and recording and analysing information	• follow instructions (to use apparatus and techniques) • make observations and measurements and record them • analyse experimental results and suggest how valid they are • plan an experiment and suggest improvements

Section 4: What you need to know

The table that follows identifies what you need to know for the examination. It is arranged in 11 themes, e.g. Metals, the Periodic Table. Some of these themes are split into topics, e.g. Properties of metals, Reactivity series, Extraction of metals. The third column gives a list of what you should be able to do.

How to use the table

You can use the table throughout your course to follow or aid your learning.

When you think you have a good knowledge of a topic, you can tick the appropriate box in the Checklist column. The main headings in the topic areas are followed by the details of what you should know.

You can use the table as a revision aid. For instance, test yourself as follows:

- cover up the details in the third column with a piece of paper
- try to remember the details
- when you have remembered them correctly, put a tick in the appropriate box.

You can use the comments column:

- to add further information about the details for each bullet point
- to note relevant page numbers from your text book
- to add learning aids, e.g. OIL RIG – oxidation is loss (of electrons) and reduction is gain (of electrons)
- to highlight areas of difficulty or things which you need to ask your teacher about.

You should note that questions on Section 25, Electronic Systems, only appear in Paper 2 and are always set as an alternative within a question.

Your teacher may have chosen not to cover this Section in your course. In that case you should not need to learn that topic.

Do, however, make sure that you understand section 24, Introductory Electronics.

Theme	Topic	You should be able to:	Comments	Checklist
1 Experimental Chemistry	1.1 Experimental design	• name apparatus for measuring time, temperature, mass and volume. (For volume you need to know burette, pipette, measuring cylinder, gas syringe)		☐
		• suggest apparatus for simple experiments, including collection of gases and measuring rate of reaction.		☐
	1.2 Methods of purification and analysis	• describe methods of purification using a suitable solvent, filtration and crystallisation.		☐
		• describe methods of purification using distillation and fractional distillation (to separate crude oil, liquid air and fermented liquor)		☐
		• suggest methods of purification when given suitable information		☐
		• describe paper chromatography		☐
		• interpret chromatograms (including use of R_f values)		☐
		• explain the use of locating agents in chromatography		☐
		• use melting and boiling point data to identify substances and assess purity		☐
		• recognise the importance of measuring purity in everyday life, e.g. drugs, foods		☐

Theme	Topic	You should be able to:	Comments	Checklist
1 Experimental Chemistry	1.3 Identification of ions and gases	• describe the use of sodium hydroxide and aqueous ammonia to identify aluminium ions		☐
		• describe the use of sodium hydroxide to identify ammonium ions		☐
		• describe the use of sodium hydroxide and aqueous ammonia to identify calcium ions		☐
		• describe the use of sodium hydroxide and aqueous ammonia to identify copper(II) ions		☐
		• describe the use of sodium hydroxide and aqueous ammonia to identify iron(II) and iron(III) ions		☐
		• describe the use of sodium hydroxide and aqueous ammonia to identify zinc ions		☐
		• describe a test to identify carbonate ions		☐
		• describe a test to identify chloride ions		☐
		• describe a test to identify iodide ions		☐
		• describe a test to identify nitrate ions		☐
		• describe a test to identify sulfate ions		☐
		• describe a test for ammonia		☐
		• describe a test for carbon dioxide		☐
		• describe a test for chlorine		☐
		• describe a test for hydrogen		☐
		• describe a test for oxygen		☐
		• describe a test for sulfur dioxide		☐
		• describe a chemical test for water		☐

Theme	Topic	You should be able to:	Comments	Checklist
2 The particulate nature of matter	2.1 Kinetic particle theory	• describe the solid, liquid and gas states		☐
		• use the kinetic particle theory to explain changes in state e.g. solid to liquid		☐
		• explain the energy changes involved in changes of state		☐
		• describe and explain evidence for the movement of particles in liquids and gases		☐
		• explain everyday effects of diffusion in terms of particle movement		☐
		• state how molecular mass affects rate of diffusion (no calculation required)		☐
		• explain how temperature affects rate of diffusion		☐
		• state and explain how pressure affects the volume of a gas (no calculation required)		☐
		• state and explain how temperature affects the volume of a gas (no calculation required)		☐
	2.2 Atomic structure	• state the relative charges and relative masses of a proton, neutron and electron		☐
		• use diagrams to describe the structure of the atom – protons and neutrons (nucleons) in the nucleus and electrons arranged in shells (energy levels)		☐
		• define proton number and nucleon number		☐
		• understand and use symbols such as $^{12}_{6}C$		☐
		• define the term *isotopes*		☐
		• work out the number of protons, electrons and neutrons in atoms and ions given proton and nucleon numbers		☐
		• state that some isotopes are radioactive		☐

Theme	Topic	You should be able to:	Comments	Checklist
2 The particulate nature of matter	2.3 Structure and properties of materials	• describe the differences between elements, compounds and mixtures		☐
		• describe the structure and properties of simple molecular substances		☐
		• describe the structure and properties of giant molecular substances		☐
		• work out the structure and bonding of a substance from its properties and vice versa		☐
		• compare the bonding and structures of diamond and graphite		☐
		• relate the bonding and structures of diamond and graphite to their properties, e.g. electrical conductivity, lubricating ability, cutting action		☐
	2.4 Ionic bonding	• describe the formation of ions by gain or loss of electrons to form the electronic structure of an inert gas		☐
		• describe the formation of ionic bonds between metals and non-metals		☐
		• state that in ionic compounds, the ions are held in a giant lattice by electrostatic attraction		☐
		• work out the formulae of ionic compounds from diagrams of lattice structures		☐
		• relate the physical properties of ionic compounds to their lattice structure		☐

Theme	Topic	You should be able to:	Comments	Checklist
2 The particulate nature of matter	2.5 Covalent bonding	• describe covalent bonding as sharing electron pairs to gain the electronic structure of an inert gas		☐
		• use 'dot and cross' diagrams to describe the bonding between atoms of non-metals in molecules, e.g. H_2, Cl_2, O_2, N_2 HCl, H_2O, CH_4, C_2H_4, CO_2		☐
		• work out the arrangement of electrons in other covalent molecules		☐
		• relate the physical properties of covalent compounds to their structure and bonding		☐
	2.6 Metallic bonding	• describe metals as a lattice of positive ions in a 'sea of electrons'		☐
		• relate the malleability of metals to their structure		☐
		• relate the electrical conductivity of metals to the mobility of the electrons in the structure		☐
3 Formulae, stoichiometry and the mole concept		• state the symbols of the elements named in the syllabus		☐
		• state the formulae of the compounds named in the syllabus		☐
		• work out the formula of a simple compound from the ratio of the number of atoms present and vice versa		☐
		• work out the formula of an ionic compound from the sizes of the charges on the ions present and vice versa		☐

Theme	Topic	You should be able to:	Comments	Checklist
3 Formulae, stoichiometry and the mole concept		• write and use chemical equations		☐
		• write and use ionic equations		☐
		• use state symbols in equations		☐
		• define relative atomic mass, A_r		☐
		• define relative molecular mass, M_r		☐
		• calculate relative molecular mass and relative formula mass		☐
		• calculate the percentage mass of an element in a compound		☐
		• calculate the empirical formula of a compound		☐
		• calculate the molecular formula of a compound from its empirical formula and relative molecular mass		☐
		• calculate the reacting masses of chemicals using information from equations and relative masses		☐
		• understand the concept of the mole		☐
		• calculate the volume of gas present given the number of moles of gas and vice versa		☐
		• calculate solution concentration using number of moles (or grams) of solute and volume of solution		☐
		• calculate number of moles (or grams) of solute from solution concentration and volume		☐
		• calculate percentage yield		☐
		• calculate percentage purity		☐

Theme	Topic	You should be able to:	Comments	Checklist
4 Electrolysis		• describe electrolysis as the decomposition of an electrolyte		☐
		• understand the meaning of the term electrolyte		☐
		• understand that ionic compounds conduct electricity when molten or dissolved in water		☐
		• explain that electrolysis provides evidence for the existence of ions held in a lattice when solid but free to move when molten or in solution		☐
		• describe and explain the products of electrolysis of molten lead bromide		☐
		• predict the products of electrolysis of a molten compound containing two simple ions		☐
		• use the idea of selective discharge of ions to understand the products of electrolysis of concentrated aqueous sodium chloride		☐
		• use the idea of selective discharge of ions to understand the products of electrolysis of dilute sulfuric acid		☐
		• use the idea of selective discharge of ions to understand the products of electrolysis of aqueous copper(II) sulfate		☐
		• predict the products of electrolysis of an aqueous electrolyte		☐
		• construct equations for the reactions at the anode and cathode during electrolysis		☐
		• describe the electrolysis of aluminium oxide to manufacture aluminium – see Topic 9.5		☐

Theme	Topic	You should be able to:	Comments	Checklist
4 Electrolysis		• describe the electrolysis of aqueous copper(II) sulfate with copper electrodes for purifying copper		☐
		• describe the electroplating of metals		☐
		• recall a use of electroplating		☐
		• describe the production of electrical energy from simple cells (i.e. two electrodes in an electrolyte) linked to the reactivity series		☐
5 Energy from chemicals		• describe enthalpy change in terms of exothermic (ΔH negative) and endothermic (ΔH positive) reactions		☐
		• show energy changes using energy profile diagrams which include enthalpy changes and activation energies		☐
		• describe bond breaking as endothermic and bond making as exothermic		☐
		• explain overall enthalpy changes in terms of energy changes in bond making and bond breaking		☐
		• describe the combustion of fuels as exothermic		☐
		• describe the use of hydrogen in fuel cells to generate electricity		☐
		• discuss the advantages and disadvantages of hydrogen as a fuel		☐
		• name natural gas, mainly methane, and petroleum as sources of energy		☐
		• describe petroleum as a mixture of hydrocarbons		☐

Theme	Topic	You should be able to:	Comments	Checklist
5 Energy from chemicals		• describe the separation of petroleum into useful fractions by fractional distillation		☐
		• state the use of petrol (gasoline), naphtha, paraffin (kerosene), diesel, lubricating oil and bitumen		☐
		• describe photosynthesis as the reaction between carbon dioxide and water in the presence of chlorophyll, using sunlight energy to produce glucose		☐
		• explain how photosynthesis can provide a renewable energy resource		☐
6 Chemical reactions	6.1 Rate of reaction	• describe the effect of concentration on the rate of reaction and explain this in terms of collisions between particles		☐
		• describe the effect of pressure on the rate of reaction and explain this in terms of collisions between particles		☐
		• describe the effect of particle size on the rate of reaction and explain this in terms of collisions between particles		☐
		• describe the effect of temperature on the rate of reaction and explain this in terms of collisions between particles		☐
		• define the term *catalyst* and describe the effect of catalysts on the rates of reactions		☐
		• explain how pathways with lower activation energy result in faster reactions		☐
		• state that enzymes are biological catalysts		☐
		• state that transition metals and their compounds are used as catalysts in industrial processes – see Topic 8.3		☐

Theme	Topic	You should be able to:	Comments	Checklist
6 Chemical reactions		• suggest practical methods of investigating the effect of concentration, pressure, particle size and temperature on the rate of a reaction		☐
		• interpret data, from graphs and tables, about the rate of reaction		☐
	6.2 Redox	• describe redox reactions as involving oxidation and reduction		☐
		• define oxidation as gain of oxygen and reduction as loss of oxygen		☐
		• define oxidation as loss of hydrogen and reduction as gain of hydrogen		☐
		• define oxidation as loss of electrons and reduction as gain of electrons		☐
		• define redex in terms of electron transfer		☐
		• describe the colour change when aqueous potassium iodide is used to identify an oxidising agent		☐
		• describe the colour change when aqueous acidified potassium manganate(VII) is used to identify a reducing agent		☐
	6.3 Reversible reactions	• understand that some reactions can be reversed by changing the conditions		☐
		• describe what is meant by a dynamic equilibrium		☐
		• predict the effect of changing the conditions on an equilibrium reaction		☐
		• predict the effect of changing the concentration of a reactant or a product on an equilibrium reaction		☐

Theme	Topic	You should be able to:	Comments	Checklist
6 Chemical reactions		• predict the effect of changing the pressure on an equilibrium reaction		☐
		• predict the effect of changing the temperature on an equilibrium reaction		☐
7 The chemistry and uses of acids, bases and salts	7.1 The characteristic properties of acids and bases	• describe the meaning of the terms acid and alkali in terms of the ions they contain or produce in aqueous solution		☐
		• describe how to test for relative acidity/ hydrogen ion concentration using the pH scale		☐
		• describe how acids react with metals		☐
		• describe how acids react with bases		☐
		• describe how acids react with carbonates		☐
		• describe the difference between strong and weak acids in terms of amount of ionisation		☐
		• describe neutralisation as a reaction between hydrogen ions and hydroxide ions to produce water.		☐
		• describe the importance of controlling soil pH		☐
		• describe how excess soil acidity can be treated using calcium hydroxide		☐
		• describe how bases react with acids		☐
		• describe how bases react with ammonium salts		☐
		• classify oxides as acidic, basic or amphoteric based on metallic/non-metallic character		☐

Theme	Topic	You should be able to:	Comments	Checklist
7 The chemistry and uses of acids, bases and salts	7.2 Preparation of salts	• describe the preparation of a pure sample of a salt by precipitation		☐
		• describe the preparation of a pure sample of a salt by titration		☐
		• describe the preparation of a pure sample of a salt by the reaction of an acid with a metal, an insoluble base or an insoluble carbonate		☐
		• describe nitrate, Group I and ammonium compounds as soluble in water		☐
		• describe chlorides, except lead and silver, as soluble in water		☐
		• describe sulfates, except lead, barium, and calcium, as soluble in water		☐
		• describe carbonates and hydroxides, except Group I and ammonium, as insoluble in water		☐
		• suggest a method of preparing a given salt from suitable starting materials		☐
		• describe the meaning of the trms hydrated and anhydrated		☐
		• describe the meaning of the term water of crystallisation		☐
7 The chemistry and uses of acids, bases and salts	7.3 Properties and uses of ammonia	• describe the use of nitrogen, from air, and hydrogen, from cracking, in the manufacture of ammonia by the Haber process		☐
		• state that the reaction of nitrogen with hydrogen to make ammonia is reversible		☐

Theme	Topic	You should be able to:	Comments	Checklist
7 The chemistry and uses of acids, bases and salts		• describe the conditions used for the Haber process i.e. 450 °C, 200atm pressure and an iron catalyst		☐
		• explain the conditions used for the Haber process		☐
		• describe the use of nitrogen-containing fertilisers in improving plant growth and crop yield		☐
		• calculate the percentage mass of nitrogen in salts used for fertilisers		☐
		• describe water pollution problems caused by the use of nitrates as fertilisers		☐
		• describe the process of eutrophication		☐
		• explain why the high solubility of nitrates increases these problems		☐
		• describe the loss of ammonia from ammonium salts by their reaction with bases		☐
		• explain why adding calcium hydroxide to soil can cause the loss of nitrogen from added nitrogenous fertiliser.		☐
7 The chemistry and uses of acids, bases and salts	7.4 Sulfuric acid	• describe the manufacture of sulfuric acid from sulfur, air and water by the Contact process		☐
		• describe the conditions used in the Contact process i.e. atmospheric pressure, 450 °C and vanadium(V) oxide as catalyst		☐
		• state the uses of sulfur dioxide as a bleach, in the making of paper from wood pulp and as a food preservative (by killing bacteria)		☐
		• state the uses of sulfuric acid as battery acid and in the manufacture of detergents and fertilisers		☐

Theme	Topic	You should be able to:	Comments	Checklist
8 The Periodic Table	8.1 Periodic trends	• describe the Periodic Table as an arrangement of the elements in increasing proton number order		☐
		• describe how the position of an element in the Periodic Table is related to proton number and electronic structure		☐
		• describe how the charge on the ion of an element is related to its Group number		☐
		• explain the similarities between the elements in the same Group in terms of electronic structure		☐
		• describe the change from metallic to non-metallic character across a period in the Periodic Table		☐
		• describe the relationship between Group number, number of valency electrons and metallic/non-metallic character		☐
		• predict the properties of elements in Group I, VII and the transition metals		☐
	8.2 Group properties	• describe Group I (the alkali metals Li, Na, K) as soft, low density metals whose melting points decrease down the group		☐
		• describe the reaction of Group I metals with water and how this shows the metals' increase in reactivity down the group		☐
		• describe Group VII (the halogens Cl, Br, I) as non-metals made up of diatomic molecules showing trends in colour and state		☐

Theme	Topic	You should be able to:	Comments	Checklist
8 The Periodic Table		• describe the displacement reactions of Group VII elements with halide ions and how these reactions show the halogens' decrease in reactivity down the group		☐
		• describe Group VIII (the noble gases also known as Group 0) as monatomic elements that are chemically unreactive		☐
		• state uses of helium, neon and argon		☐
		• describe the lack of reactivity of the noble gases in terms of their electronic structures		☐
	8.3 Transition elements	• describe transition elements as metals with high melting points, high density, variable oxidation state and forming coloured compounds.		☐
		• state transition metals (or their compounds) are used as catalysts, e.g. iron in the Haber process, vanadium(V) oxide in the Contact process, nickel in hydrogenation of alkenes.		☐
		• describe how catalysts are used to lower the energy demands in industry and help reduce costs and conserve energy sources		☐
9 Metals	9.1 Properties of metals	• describe the physical properties of metals (solids with fairly high melting points, malleable, good conductors of heat and electricity) by reference to their structure.		☐
		• describe an alloy as a mixture of a metal with another element.		☐
		• identify metals and alloys from diagrams of their structures		☐
		• explain why alloys have different properties from the pure elements they are made from.		☐

Theme	Topic	You should be able to:	Comments	Checklist
9 Metals	9.2 Reactivity series	• place in reactivity order the elements Ca, Cu, (H), Fe, Pb, Mg, K, Ag, Na, Zn by reference to their reactions with water and steam		☐
		• place in reactivity order the elements Ca, Cu, (H), Fe, Pb, Mg, K, Ag, Na, Zn by reference to their reactions with dilute hydrochloric acid		☐
		• place in reactivity order the elements Ca, Cu, (H), Fe, Pb, Mg, K, Ag, Na, Zn by reference to the reduction of their oxides by carbon or hydrogen		☐
		• describe the reactivity series in terms of the ease which a metal forms its positive ion by reference to the reaction of the metal with aqueous ions of other metals		☐
		• describe the reactivity series in terms of the ease which a metal forms its positive ion by reference to the reaction of the metal with the oxides of other metals		☐
		• work out the order of reactivity given experimental results		☐
		• describe the effect of heat on the carbonates of metals in this topic		☐
		• relate the thermal stability of a metal carbonate to the metal's position in the reactivity series		☐
9 Metals	9.3 Extraction of metals	• relate the ease of obtaining a metal from its ore to the metal's position in the reactivity series		☐
		• describe metal ores as a finite resource and so the need to recycle metals		☐

Theme	Topic	You should be able to:	Comments	Checklist
9 Metals		• discuss the social, economic and environmental advantages and disadvantages of recycling metals		☐
	9.4 Iron	• describe the extraction of iron from haematite in the blast furnace		☐
		• describe the reduction reactions taking place in a blast furnace		☐
		• describe the thermal decomposition of the limestone added to the blast furnace and its reaction with silicon dioxide		☐
		• describe steels as alloys which are mixtures of iron with carbon or other metals		☐
		• describe how the controlled addition of elements such as carbon to iron changes its properties, e.g. high carbon steels are strong but brittle and low carbon steels are softer and more malleable		☐
		• state uses of mild steel and stainless steel		☐
		• describe the conditions needed for iron to rust		☐
		• describe the methods used to prevent iron from rusting by coating it with paint, grease, plastic or zinc		☐
		• describe and explain the sacrificial protection of iron by a metal higher in the reactivity series		☐
	9.5 Aluminium	• outline the manufacture of aluminium from pure aluminium oxide dissolved in molten cryolite including the equations for the electrode reactions		☐
		• explain the apparent lack of reactivity of aluminium		☐

Theme	Topic	You should be able to:	Comments	Checklist
9 Metals		• state uses of aluminium and relate them to the properties of the metal and its alloys, e.g. in the manufacture of aircraft, food containers, electrical cables		☐
10 Atmosphere and environment	10.1 Air	• state dry air contains 78% nitrogen and 21% oxygen by volume		☐
		• describe the rest of the air as being mainly argon with a small amount of other noble gases and carbon dioxide		☐
		• describe the separation of oxygen, nitrogen and the noble gases from liquid air by fractional distillation		☐
		• state uses of oxygen, e.g. in steelmaking, oxygen tents in hospitals, in welding		☐
		• name the atmospheric pollutants carbon monoxide, methane, nitrogen oxides (NO and NO_2), ozone, sulfur dioxide, hydrocarbons		☐
		• state carbon monoxide is formed by incomplete combustion of carbon-containing substances		☐
		• state methane is formed by bacterial decay of vegetable matter		☐
		• state nitrogen oxides are formed by lightning activity and car engines		☐
		• state ozone is formed by photochemical reactions		☐
		• state sulfur dioxide is formed in volcanoes and by combustion of fossil fuels		☐
		• state unburned hydrocarbons come from car engines		☐

Theme	Topic	You should be able to:	Comments	Checklist
10 Atmosphere and environment		• describe how redox reactions in catalytic converters remove combustion pollutants		☐
		• describe the use of calcium carbonate to reduce the effect of acid rain and in flue gas desulfurisation		☐
		• state that carbon monoxide is poisonous		☐
		• describe how nitrogen dioxide and sulfur dioxide form acid rain and the effect of acid rain on buildings and breathing		☐
		• describe the importance of the ozone layer		☐
		• describe the problems caused by the loss of ozone due to its reaction with chlorine from CFCs		☐
		• describe the carbon cycle in terms of combustion, respiration and photosynthesis		☐
		• describe how the carbon cycle controls the amount of carbon dioxide in the atmosphere		☐
		• state that carbon dioxide and methane are greenhouse gases which contribute to global warming and state the sources of these gases		☐
		• describe the consequences of an increase in global warming		☐
	10.2 Water	• state that water from natural sources contains a variety of dissolved substances, e.g. mineral salts, oxygen, organic matter		☐

Theme	Topic	You should be able to:	Comments	Checklist
10 Atmosphere and environment		• state water can be polluted by metal compounds, sewage, nitrates form fertilisers, phosphates from fertilisers and detergents, harmful microbes		☐
		• state that some substances dissolved in water may be beneficial, e.g. oxygen and mineral salts for aquatic life		☐
		• state that some substances dissolved in water may be harmful to health, or cause eutrophication		☐
		• describe in outline how water is purified, i.e. by filtration to remove solids, with carbon to remove tastes and odours, and by chlorination to kill harmful microbes		☐
		• state that seawater can be converted to drinking water by desalination		☐
11 Organic chemistry	11.1 Alkanes	• state that the naphtha fraction from crude oil is the main source of hydrocarbons used as the feedstock for making a wide range of organic compounds		☐
		• describe issues about the competing uses of oil as an energy source and as a chemical feedstock		☐
		• describe a homologous series as a family of compounds with the same general formula which have similar chemical properties		☐
		• describe the trend in properties, e.g. melting and boiling points, viscosity, flammability, in a homologous series as the size and mass of the molecules increase		☐

Theme	Topic	You should be able to:	Comments	Checklist
11 Organic chemistry		• describe the alkanes as a homologous series of saturated hydrocarbons with general formula C_nH_{2n+2}		☐
		• draw the structures of the branched and unbranched C1-C4 alkanes		☐
		• name the unbranched C1–C4 alkanes i.e. methane to butane		☐
		• define isomerism and identify isomers		☐
		• state that alkanes are generally unreactive except for combustion and substitution by chlorine		☐
	11.2 Alkenes	• describe the alkenes as a homologous series of unsaturated hydrocarbons with general formula C_nH_{2n}		☐
		• draw the structures of the branched and unbranched C2–C4 alkenes		☐
		• name the unbranched C2–C4 alkenes i.e. ethene to butene		☐
		• describe the manufacture of alkenes and hydrogen by cracking hydrocarbons		☐
		• understand that cracking is essential to meet the demand for fractions containing smaller molecules		☐
		• distinguish saturated from unsaturated hydrocarbons by reference to the bonds present and by using aqueous bromine		☐
		• describe the combustion of alkenes		☐
		• describe the polymerisation of alkenes		☐
		• describe the addition reaction of alkenes with bromine		☐

Theme	Topic	You should be able to:	Comments	Checklist
11 Organic chemistry		• describe the addition reaction of alkenes with steam		☐
		• describe the addition reaction of alkenes with hydrogen		☐
		• state the meaning of the term *polyunsaturated* as applied to food products		☐
		• describe the manufacture of margarine by the addition of hydrogen to unsaturated vegetable oils to form a solid product		☐
	11.3 Alcohols	• describe the alcohols as a homologous series containing –OH		☐
		• draw the structures of the C1–C4 alcohols		☐
		• name the unbranched C1–C4 alcohols i.e. methanol to butanol		☐
		• describe the combustion of alcohols		☐
		• describe the oxidation of alcohols to carboxylic acids		☐
		• describe the formation of ethanol by addition of steam to ethene using a catalyst		☐
		• describe the formation of ethanol by fermentation of glucose		☐
		• state uses of ethanol, e.g. as a solvent, as a renewable fuel, in alcoholic drinks		☐

Theme	Topic	You should be able to:	Comments	Checklist
11 Organic chemistry	11.4 Carboxylic acids	• describe carboxylic acids as a homologous series containing $-CO_2H$		☐
		• draw the structures of the C1–C4 unbranched carboxylic acids		☐
		• name the C1–C4 unbranched carboxylic acids i.e. methanoic to butanoic acid		☐
		• describe carboxylic acids as weak acids		☐
		• describe the reaction of carboxylic acids with carbonates, bases and some metals		☐
		• describe the formation of ethanoic acid by the oxidation of ethanol using atmospheric oxygen or acidified potassium manganate(VII)		☐
		• describe the reaction of alcohols with carboxylic acids to form esters		☐
		• draw the structures of the esters formed from C1–C4 alcohols and C1-C4 carboxylic acids		☐
		• name the esters formed from C1–C4 unbranched alcohols and C1–C4 unbranched carboxylic acids		☐
		• state uses of esters, e.g. as perfumes, flavourings, solvents		☐
	11.5 Macro molecules	• describe macromolecules as large molecules built from small units		☐
		• state that different macromolecules have different units and/or linkages		☐
		• describe the formation of poly(ethene) from ethene monomers as an example of addition polymerisation		☐
		• state uses of poly(ethene), e.g. plastic bags, clingfilm		☐

Theme	Topic	You should be able to:	Comments	Checklist
11 Organic chemistry		• work out the structure of a polymer from a given monomer		☐
		• work out the structure of a monomer from a given polymer		☐
		• describe the polyamide, nylon, and the polyester, *Terylene*, as condensation polymers		☐
		• describe the simplified structure of nylon and *Terylene* as shown in the syllabus		☐
		• state uses of polymers such as nylon and *Terylene*, e.g. clothing, certain materials, fishing line, parachutes, sleeping bags		☐
		• describe the pollution problems caused by the disposal of non-biodegradable plastics		☐
		• identify carbohydrates, proteins and fats as natural macromolecules		☐
		• describe proteins as having the same amide links as nylon but with different monomer units		☐
		• describe fats as esters having the same linkages as *Terylene* but with different units		☐
		• describe the hydrolysis of proteins to amino acids		☐
		• describe the hydrolysis of complex carbohydrates, e.g. starch to simple sugars		☐

Section 5: Useful websites

The websites listed below provide useful resources to help you study for your Cambridge O Level Chemistry.

GCSE Chemistry
www.gcsechemistry.com/
This is a well-organised and easy-to-use site which provides good coverage of the chemistry needed for O Level.

Bitesize Chemistry
www.bbc.co.uk/schools/websites/11_16/site/science.shtml
While the site is organised around UK syllabuses, there is much helpful information to aid the study of Cambridge O Level Chemistry. The site contains revision material, tests, videos and provides access to other useful websites.

S-cool! GCSE Chemistry Revision Guide
www.s-cool.co.uk
This is a good general site which can be used in various ways to assist your learning.

Doc Brown's
docbrown.info
The site contains a lot of material suitable for Cambridge O Level in the GCSE Chemistry sections. It is good for studying and revising individual topics.

Royal Society of Chemistry
www.rsc.org/Learn-Chemistry/
This is part of the Royal Society for Chemistry site – go to resources for students where there is much stimulating material to help you in your study. For revision you might find gridlocks a good way of learning the facts you need for various topics.

Section 6: Appendices

Other things you need to know

There are three other things you need to know about your chemistry course.

Using the Periodic Table

A copy of the Periodic Table is given on the back cover of the theory papers. You need to 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-VII
- the periods are the rows across the table
- the first period only contains two elements, hydrogen and helium.
- the key shows the relative atomic masses and the proton (atomic) number 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.

A copy of the Periodic Table you will use is shown on the next page

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	VIII
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum* 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium† 89															

*58-71 Lanthanoid series

†90-103 Actinoid series

Key

a
X
b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

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

Qualitative Analysis Notes

The chemical tests for various ions and gases are provided in these notes. You must learn these tests for Papers 1 and 2, and for Paper 4, Alternative to Practical. However, if you are entered for Paper 3, Practical Test, you will be given a copy of the notes in the examination.

You should note the following points:

- Anions are negatively charged ions.
- Cations are positively charged ions.
- In the tests for anions, [in solution] means that the substance is dissolved in water.
- Aqueous means dissolved in water.
- Ppt. means precipitate.
- In the tests for aqueous cations, 'in excess' means that you add a lot more of the aqueous sodium hydroxide or ammonia to see if any precipitate formed remains (i.e. is insoluble in excess) or disappears (i.e. is soluble in excess).

Glossary of terms used in science papers

We use terms, sometimes called command words, to help you to understand what examiners are looking for in your answer. This table explains what each of these words or phrases means and will help you to understand the kind of answer you should write. The list of command words is in alphabetical order. You should remember that the meaning of a term may vary slightly according to how the question is worded. It is always best to read the whole question before you start to answer it.

Term	Meaning
Calculate	A numerical answer is needed. You should show any working, especially when there are two or more steps in a calculation. *e.g. Calculate the concentration of potassium hydroxide in the solution*
Deduce	This may be used in two ways: i. You find the answer by working out the patterns in the information given to you and drawing logical conclusions from it. You may need to use information from tables and graphs and do chemical calculations *e.g. deduce what will happen to the level of carbon dioxide if …* ii. You find the answer by referring to a scientific law or theory, *e.g. use your knowledge of the kinetic theory to deduce what will happen when …*
Define	You need to state the meaning of something, *e.g. reduction is gain of electrons;* *a hydrocarbon is a compound containing only hydrogen and carbon.*

Section 6: Appendices

Term	Meaning
Describe	You need to state the main points about something (using labelled diagrams if this helps you), *e.g. describe how metals and non-metals differ in their properties .* You may also be asked to describe either observations, *e.g. describe what you see when sodium reacts with water,* or how to do particular experiments, *e.g. describe how to separate a mixture of coloured inks.*
Determine	You are expected to use a formula that you know to calculate a quantity, *e.g. determine the relative molecular mass of ethanol.*
Discuss	You have to write down points for and against an argument, *e.g. discuss points for and against the use of petrol as a fuel.*
Estimate	This may be used in two ways: i. You need to work out an approximate value for a quantity, based on your knowledge of theory and the information provided, *e.g. estimate the boiling point of butanol.* ii. For titrations, 'estimate' may also mean that you need to calculate an exact quantity, *e.g. estimate the concentration of sodium hydroxide.*
Explain	You have to give reasons for your answer OR refer to a particular theory, *e.g. explain why reaction rate increases with temperature.*
Find	This is a general term which can mean several similar things, such as calculate, measure, determine, etc.
List	Write down a number of separate points. Where the number of points is stated in the question, you should not write more than this number, *e.g. list three properties of metals.*
Meant What is meant by the term…)	See 'Understand'
Measure	You are expected to find a quantity by using a measuring instrument, *e.g. length (by using a ruler), volume (by using a measuring cylinder).*
Outline	State the main points briefly, *e.g. outline the process of extracting aluminium from pure aluminium oxide.*
Predict	This can be used in two ways: i. You find the answer by working out the patterns in the information provided and drawing logical conclusions from this. You may need to use information from tables and graphs and do chemical calculations, *e.g. predict what will happen to the level of carbon dioxide if …* ii. It may also mean giving a short answer stating what might happen next *e.g. predict what you would see when X reacts with bromine water.*

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Term	Meaning
Sketch	i. When drawing graphs, this means that you may draw the approximate shape and/or position of the graph BUT you need to make sure that any important details, such as the line passing through the origin or finishing at a certain point, are drawn accurately. ii. When drawing apparatus or other diagrams, a simple line drawing is all that is needed, but you must make sure the proportions are correct and the most important details are shown. You should always remember to label your diagrams.
State	You should give a short answer without going into any detail, *e.g. state the name of the compound with the formula* $CuSO_4$. BUT, remember that *'state the meaning of…'* is different. It is more like '*understand*'.
Suggest	This may be used in two ways: i. There may be more than one correct answer to the question, *e.g. after adding aqueous sodium hydroxide to the solution a white ppt was seen, suggest an ion that may be present.* ii. You are being asked to apply your general knowledge of chemistry or reasoning skills to a topic area that is not on the syllabus, *e.g. applying ideas about reduction to a question on the extraction of zinc.*
Understand (what do you understand by the term…)	You should (i) define something and (ii) make a more detailed comment about it, *e.g. what do you understand by the term diffusion.* The amount of detail depends on the number of marks awarded.

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