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Revision Guide

Adam Robbins
Adam Boxer
Philippa
Gardom-Hulme
Editor:
Primrose Kitten
Elizabeth McCullough



OXFORD

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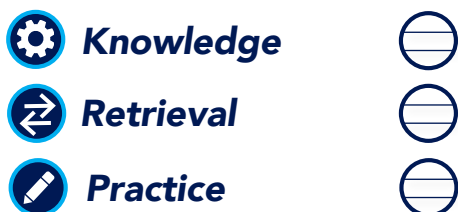
Shade in each level of the circle as you feel more confident and ready for your exam.

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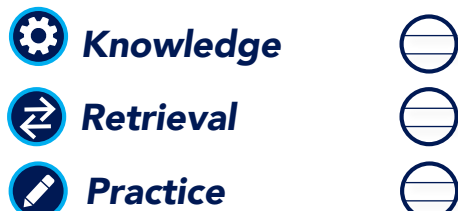


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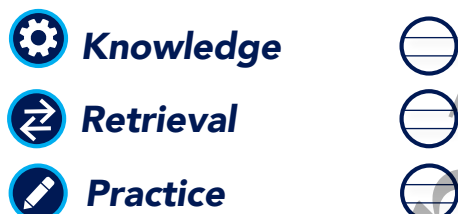


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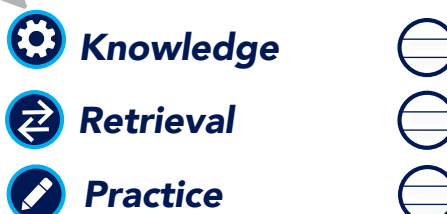


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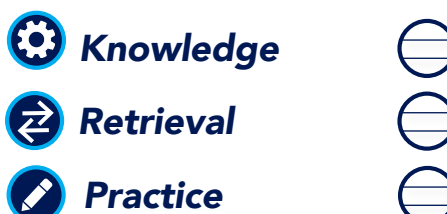


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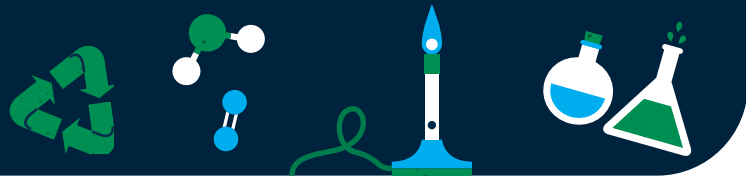


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Answers

All of the **answers** are on the website at www.oxfordsecondary.com/oxfordaqa-revision



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How to use this book



This book uses a three-step approach to revision: **Knowledge**, **Retrieval**, and **Practice**. It is important that you do all three; they work together to make your revision effective.

1 Knowledge

Knowledge comes first. Each chapter starts with a **Knowledge Organiser**. These are clear, easy-to-understand, concise summaries of the content that you need to know for your exam. The information is organised to show how one idea flows into the next so you can learn how all the science is tied together, rather than lots of disconnected facts.



Revision Tip

Revision tips by Primrose Kitten give you quick ways to understand the core concepts and practise remembering them.

Knowledge

C5 Electrolysis

Electrolysis

In the process of **electrolysis**, an electric current is passed through an **electrolyte**. An electrolyte is a liquid or solution that contains ions and so can conduct electricity. This causes the ions to move to the **electrodes**, where they form pure elements.

Electrolysis of molten compounds

Solid ionic compounds do not conduct electricity as the ions cannot move. To undergo electrolysis they must be molten or dissolved, so the ions are free to move. When an ionic compound is molten:

- the positive metal ions are attracted to the **cathode**, where they will gain electrons to form the pure metal (**reduction**).
- the negative non-metal ions are attracted to the **anode**, where they will lose electrons and become the pure non-metal (**oxidation**).

For example, molten sodium chloride, NaCl, can undergo electrolysis to form sodium at the cathode and chlorine at the anode.

Half equations

sodium chloride → sodium + chlorine
 $2\text{NaCl(l)} \rightarrow 2\text{Na(l)} + \text{Cl}_2\text{(g)}$

- at the cathode: $2\text{Na}^+\text{(l)} + 2\text{e}^- \rightarrow 2\text{Na(l)}$
- at the anode: $2\text{Cl}^-\text{(l)} \rightarrow \text{Cl}_2\text{(g)} + 2\text{e}^-$

Products at the cathode

In the electrolysis of a solution, if the metal is **more reactive** than hydrogen then hydrogen gas is formed at the cathode.

- The $\text{H}^+\text{(aq)}$ ions from the ionisation of water are attracted to the cathode and react with it.
- The $\text{H}^+\text{(aq)}$ ions gain electrons from the cathode and form hydrogen gas.
- $2\text{H}^+\text{(aq)} + 2\text{e}^- \rightarrow \text{H}_2\text{(g)}$
- The metal ions remain in solution.

Electrolysis of sodium chloride solution

When sodium chloride solution (brine) is electrolysed, it makes three commercially valuable products:

- hydrogen used in many chemical processes
- chlorine used to make bleach and plastic
- sodium hydroxide used to make soap

Electroplating

Electroplating uses electrolysis to coat one metal with a thin layer of another, more precious and less reactive metal. This makes the object more desirable, more durable, or protects it from corrosion. For example, cheap jewellery can be silver-plated using electroplating.

Electrolysis of aluminium oxide

Electrolysis can be used to extract metals from their ionic compounds. Electrolysis is used if the metal is more reactive than carbon. Aluminium is extracted from aluminium oxide by electrolysis.

- The aluminium oxide is mixed with a substance called **cryolite**, which lowers the melting point.
- The mixture is then heated until it is molten.
- The resulting molten mixture undergoes electrolysis.

aluminium oxide → aluminium + oxygen
 $2\text{Al}_2\text{O}_3\text{(l)} \rightarrow 4\text{Al(l)} + 3\text{O}_2\text{(g)}$

cathode: pure aluminium is formed $\text{Al}^{3+}\text{(l)} + 3\text{e}^- \rightarrow \text{Al(l)}$

anode: oxygen is formed $2\text{O}^{2-}\text{(l)} \rightarrow \text{O}_2\text{(g)} + 4\text{e}^-$

In the electrolysis of aluminium, the anode is made of graphite. The graphite reacts with the oxygen to form carbon dioxide and so slowly wears away. It therefore needs to be replaced frequently.

Key Terms

Extraction of aluminium by electrolysis makes a good six mark question. It's a bit different from the other examples of electrolysis that you need to learn. Make sure you can do the half equations, know the key words and the products.

In an exam, don't PANIC. Here is an easy way to remember which electrode is which:

Positive
Anode
Negative

2 Retrieval

The **Retrieval questions** help you learn and quickly recall the information you've acquired. These are short questions and answers about the content in the Knowledge Organiser. Cover up the answers with some paper and write down as many answers as you can from memory. Check back to the Knowledge Organiser for any you got wrong, then cover the answers and attempt *all* the questions again until you can answer all the questions correctly.

Retrieval

Now use the questions below to check your knowledge from previous chapters.

C5

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

C5 questions	Answers
1 What is electrolysis?	process of using electricity to extract elements from a compound
2 What is an electrode?	the end of a circuit which is placed in the electrolyte
3 What is an electrolyte?	the liquid or solution that electrolysis is carried out in
4 What is the cathode?	the negative electrode
5 What is the anode?	the positive electrode
6 Where are metals formed?	at the cathode
7 Where are non-metals formed?	at the anode
8 How can ionic substances be electrolysed?	by melting or dissolving them
9 Why can solid ionic substances not be electrolysed?	they do not conduct electricity
10 In the electrolysis of aluminium oxide, why is the aluminium oxide mixed with cryolite?	to lower the melting point
11 In the electrolysis of aluminium oxide, why do the anodes need to be replaced?	they react with the oxygen being formed
12 In the electrolysis of solutions, when is the metal not produced at the cathode?	when the metal is more reactive than hydrogen
13 In the electrolysis of solutions, what is produced at the anode?	a halogen or oxygen
14 What are the three products of the electrolysis of sodium chloride solution?	hydrogen, sodium hydroxide, chlorine
15 What are the reasons for electroplating a metal?	increase durability, improve desirability, reduce corrosion
16 Where does oxidation happen in electrolysis?	at the cathode
17 Where does reduction happen in electrolysis?	at the anode
18 What carries the charge through the electrolyte?	the ions that can move

Previous questions

- What is the relative mass of a proton?
- What is the relative mass of a neutron?
- What is the relative mass of an electron?
- How are covalent bonds formed?
- How many electrons go into a covalent bond?
- Between which kinds of atom does covalent bonding occur?
- What are the two main types of covalent structure?
- Describe the structure and bonding of a giant covalent substance.
- What is an ion?

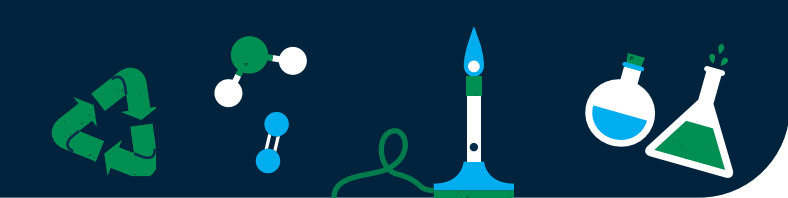
Required Practical 5

Practise answering questions on the required practicals. You need to be able to apply your skills and knowledge to other practicals too.

Electrolysis	Worked example	Practice
You need to be able to describe the method of electrolysis, and label the experimental set-up for electrolysis. Electrolysis uses electricity to break ionic compounds down into simpler compounds or elements. Metals or hydrogen are made at the negative electrode, and non-metal molecules are made at the positive electrode. You will need to be able to apply the principles of electrolysis to any example, as many solutions can undergo electrolysis. This includes predicting the products of electrolysis for different solutions, identifying which ions move to each electrode, and writing equations for the reactions at the two electrodes.	The electrolysis of aqueous copper sulfate gives two products. Identify these products and the electrodes they form at. State three observations you would make. Answer: The two products are copper (Cu) and oxygen gas (O ₂). The copper for electrode anode at the positive. The copper at the negative oxygen will be at the positive bubbles will split. Over copper sulfate	1 State what you would observe at each electrode during the electrolysis of copper(II) chloride. 2 Give the products of the electrolysis of sodium sulfate. 3 Explain why the electrodes must not touch each other during.

Each chapter also has some **Retrieval questions** from **previous chapters**. Answer these to see if you can remember the content from the earlier chapters. If you get the answers wrong, go back and do the Retrieval questions for the earlier chapters again.

The **Skills** boxes cover either a **Practical** or a key **Maths skill**. Read through the worked example then have a go at the practice questions.






Make sure you revisit the retrieval questions on different days to help them stick in your memory. You need to write down the answers each time, or say them out loud, otherwise it won't work.

3 Practice


Once you think you know the Knowledge Organiser and Retrieval answers really well you can move on to the final stage: **Practice**.

Each chapter has lots of **exam-style questions** to help you apply all the knowledge you have learnt and can retrieve.


Each question has a difficulty icon that shows the level of challenge.

-  These questions build your confidence.
-  These questions consolidate your knowledge.
-  These questions stretch your understanding.


Make sure you attempt all of the questions no matter what grade you are aiming for.



Practice

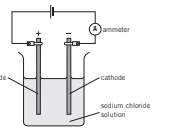


C5



Exam-style questions

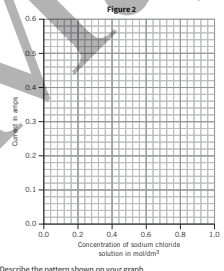
01 A student investigated the electrolysis of sodium chloride solution. Figure 1 shows the apparatus used.



distance that is produced at the cathode. [1 mark]

equation, including state symbols, for the reaction at the anode. [3 marks]

01.5 Plot the data from Table 1 on Figure 2. Draw a line of best fit. [3 marks]




01.6 Describe the pattern shown on your graph. Suggest one reason for this pattern. [2 marks]

pattern: _____

reason: _____

02 A teacher passed an electric current through molten zinc chloride. Figure 3 shows the apparatus.



Exam Tip

Use crosses to plot your points because this clearly shows the examiners which point you are aiming for. Circles can easily be misinterpreted as they can cover a range of points or be too small to be seen by the examiner. Crosses are the best way to ensure you get the mark.

Exam Tip

It's not sodium. Use the reactivity series and the formula of salty water to work out the other product.

Exam Tip

'Independent' is the one we change and 'dependent' is the one we measure. A good way to remember this is that your results depend on the dependent variable.

Exam Tip

Use data from the graph to support your reason.

Questions with the conical flask icon test your practical skills.

Questions with the calculator icon test your mathematical skills.

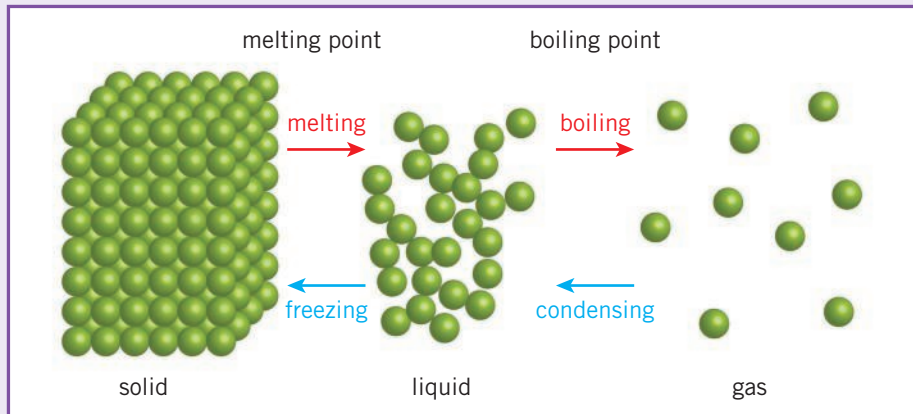
Exam tips written by **Primrose Kitten** show you how to interpret the questions, what you need to do in your answers, and advice on how to secure as many marks as possible.



C1 Atomic structure

Particle model

The three states of matter can be represented in the particle model.



This model assumes that:

- there are no forces between the particles
- that all particles in a substance are spherical
- that the spheres are solid.

The amount of energy needed to change the state of a substance depends on the forces between the particles. The stronger the forces between the particles, the higher the melting or boiling point of the substance.



Revision Tip

The higher the melting or boiling point of a substance, the more energy is needed for the change of state.

Atoms, elements, and compounds

All substances are made of **atoms**.

Elements are substances made of only one type of atom. Each atom of an element will have the same number of protons in the **nucleus**. Elements are shown in the **Periodic Table**. Atoms of each element are represented by a chemical symbol, e.g., O represents an atom of oxygen.

Compounds are made of two or more different types of atoms chemically bonded together. The atoms in a compound have different numbers of protons.

Sub-atomic discoveries

The discovery of electrons allowed scientists to work out that elements with the same number of electrons in their outer shell had similar **chemical properties**.

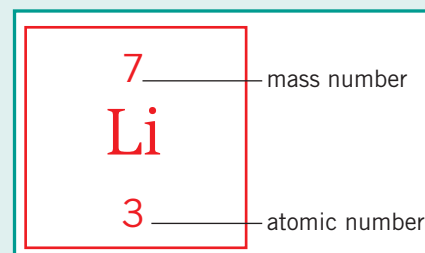
The discovery of protons allowed scientists to order the elements in the Periodic Table by their atomic number.

The discovery of neutrons led to scientists discovering isotopes. Isotopes explained why some elements didn't seem to fit when the Periodic Table was organised by atomic mass (like iodine and tellurium).

Atomic and mass numbers

The Periodic Table shows the atomic number and mass number of each element.

Atomic number is the number of protons in an atom of that element. Mass number is the total number of protons and neutrons in an atom of that element.



Relative charge and mass

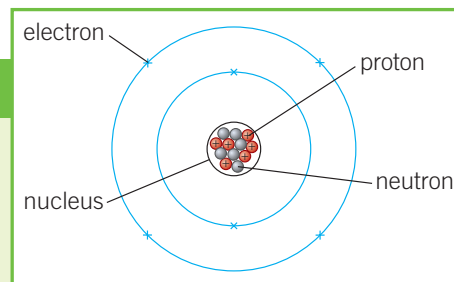
	Relative charge	Relative mass	
Proton	+1	1	= atomic number
Neutron	0	1	= mass number – atomic number
Electron	-1	0 (very small)	= same as the number of protons

All atoms have equal numbers of protons and electrons, meaning they have no overall charge:

total negative charge from electrons = total positive charge from protons

The structure of the atom

Atoms have a small dense nucleus made of protons and neutrons. They then have electrons orbiting on energy levels (also called shells). The attraction between the protons in the nucleus and the electrons prevents them from escaping.

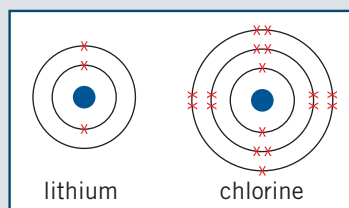


Drawing atoms

Electrons in an atom are placed in fixed **shells**, or **energy levels**. We represent electrons using dots or crosses. You can put:

- up to two electrons in the first shell
- eight electrons each in the second and third shells.

You must fill up a shell before moving on to the next one. You can use a shorthand to show the electron configuration. Write the number of electrons in each shell separated by a comma, starting with the first shell. For example, Li is 2,1 and Cl is 2,8,7.



Relative atomic mass

All relative atomic masses are relative to the mass of an atom of ^{12}C , which has a mass of exactly 12.

relative atomic mass,

$$A_r = \frac{\text{average mass of 1 atom}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$$

Isotopes

Atoms of the same element can have a different number of neutrons, giving them a different overall mass number. Atoms of the same element with different numbers of neutrons are called **isotopes**.

The **relative atomic mass** is the average mass of all the atoms of an element (note that **abundance** means the percentage of atoms with a certain mass):

$$\text{relative atomic mass} = \frac{(\text{abundance of isotope 1} \times \text{mass of isotope 1}) + (\text{abundance of isotope 2} \times \text{mass of isotope 2}) \dots}{100}$$

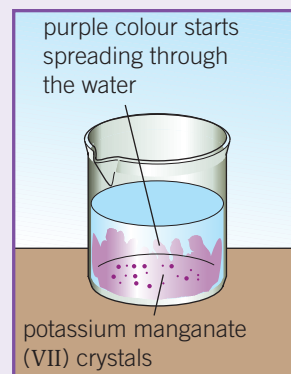
Diffusion

In liquids and gases, the random movement of particles mixes substances in a process called diffusion.

Diffusion takes place faster in a gas than in a liquid. Small, light particles diffuse faster than large, heavy ones.

Examples are:

- 1 potassium permanganate(VII) in water
- 2 ammonia and hydrochloric acid
- 3 bromine in air.



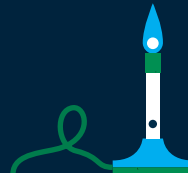
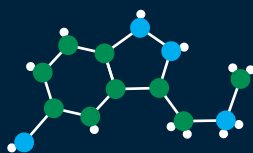
Key Terms

Make sure you can write a definition for these key terms.

abundance atom atomic number compound electron element energy level isotope neutron
nucleus proton relative atomic mass relative charge relative mass shell



Retrieval



Learn the answers to the questions below then cover the answers column with a piece of paper and write down as many as you can. Check and repeat.

C1 questions

Answers

1	What is an atom?	Put paper here	smallest part of an element that can exist
2	What is an element?	Put paper here	substance made of one type of atom
3	What do we call the change of state when we heat a liquid?	Put paper here	boiling
4	What do we call the change of state when a gas cools?	Put paper here	condensation
5	Where are protons and neutrons?	Put paper here	in the nucleus
6	What is the relative mass of a proton?	Put paper here	1
7	What is the relative mass of a neutron?	Put paper here	1
8	What is the relative mass of an electron?	Put paper here	0 (very small)
9	What is the relative charge of a proton?	Put paper here	+1
10	What is the relative charge of a neutron?	Put paper here	0
11	What is the relative charge of an electron?	Put paper here	-1
12	How can you find out the number of protons in an atom?	Put paper here	the atomic number on the Periodic Table
13	How can you calculate the number of neutrons in an atom?	Put paper here	mass number – atomic number
14	Why do atoms have no overall charge?	Put paper here	equal numbers of positive protons and negative electrons
15	How many electrons would you place in the first, second, and third shells?	Put paper here	up to 2 in the first shell and up to 8 in the second and third shells
16	What is a compound?	Put paper here	substance made of more than one type of atom chemically joined together
17	Where are all the elements recorded?	Put paper here	on the Periodic Table
18	What are isotopes?	Put paper here	atoms of the same element (same number of protons) with different numbers of neutrons
19	Describe the structure of the atom.	Put paper here	a dense nucleus of protons and neutrons with electrons orbiting around
20	What is relative mass?	Put paper here	the average mass of all the atoms of an element