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REVISE EDEXCEL GCSE (9–1)

Chemistry

REVISION WORKBOOK

Foundation

For the 9–1 exams

Pearson

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REVISION WORKBOOK

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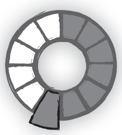

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Look at this scale next to each exam-style question. It tells you how difficult the question is.

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Contents

1-to-1 page match with the Chemistry Revision Guide ISBN 9781292131894

A small bit of small print: Edexcel publishes Sample Assessment Material and the Specification on its website. This is the official content and this book should be used in conjunction with it. The questions have been written to help you practise every topic in the book. Remember: the real exam questions may not look like this.

Formulae

1 Which of the following is the formula for calcium carbonate?

☐ **A** CaCO

☐ **B** $CaCO_2$

☐ **C** $CaCO_3$

☐ **D** $CaCO_4$ **(1 mark)**

Put a cross in **one** box. Always answer multiple-choice questions, even if you don't actually know the answer.

2 Chlorine is used to kill harmful microorganisms in drinking water. Its formula is Cl_2. Place a tick (✓) in each correct box to describe what this formula tells you.

Cl_2 tells you that:	**Tick (✓)**
chlorine is an element	
chlorine is a compound	
chlorine is a mixture of atoms	
chlorine exists as molecules	

(2 marks)

3 Complete the table to show the formulae of some common substances.

Substance	water	carbon dioxide	methane	sulfuric acid	sodium
Formula					

(5 marks)

4 State what is meant by the term '**element**'.

Guided

An element is a substance made from..

with the same number of.. **(2 marks)**

5 The formula for aluminium hydroxide is $Al(OH)_3$.

(a) Deduce the number of elements in the formula $Al(OH)_3$.

.... **(1 mark)**

(b) Deduce the total number of atoms in the formula $Al(OH)_3$.

.... **(1 mark)**

6 The formula for a carbonate ion is CO_3^{2-}.

(a) State how you can tell that this is the formula for an ion.

.... **(1 mark)**

(b) Describe what the numbers in the formula tell you about a carbonate ion.

....

.... **(2 marks)**

Equations

1 Which of these statements describes a chemical reaction?

☐ **A** Reactants form from products.

☐ **B** Products form from reactants.

☐ **C** An element changes into another element.

☐ **D** The total mass of substances goes down.

Answer C cannot be correct because one element cannot change to another element in chemical reactions.

(1 mark)

2 The word equation for the thermal decomposition of copper carbonate is:

copper carbonate → copper oxide + carbon dioxide

Complete the table by placing a tick (✓) in one box in each row to show if a substance is a product or a reactant in this reaction.

Substance	Reactant	Product
copper oxide		
copper carbonate		
carbon dioxide		

(2 marks)

3 Sodium hydroxide solution reacts with dilute hydrochloric acid to form sodium chloride and water.

Write the word equation for this reaction.

.... **(1 mark)**

Guided

4 A teacher adds a piece of sodium metal to some water. The reaction produces sodium hydroxide solution and bubbles of hydrogen. Complete the balanced equation below to show the correct state symbols.

You should be able to use the state symbols (s), (l), (g) and (aq).

$2Na$(........) + $2H_2O$(........) → $2NaOH$(........) + H_2(........) .... **(1 mark)**

5 Balance the following equations by adding balancing numbers in the space provided.

Do not add state symbols unless you are asked for them.

Guided

(a) $2Cu + O_2 \rightarrow$ .....CuO **(1 mark)**

(b) .....$Al + Fe_2O_3 \rightarrow Al_2O_3 +$ .....Fe **(1 mark)**

(c) $Mg +$ .....$HNO_3 \rightarrow Mg(NO_3)_2 + H_2$ **(1 mark)**

(d) $Na_2CO_3 +$ .....$HCl \rightarrow$ .....$NaCl + H_2O + CO_2$ **(1 mark)**

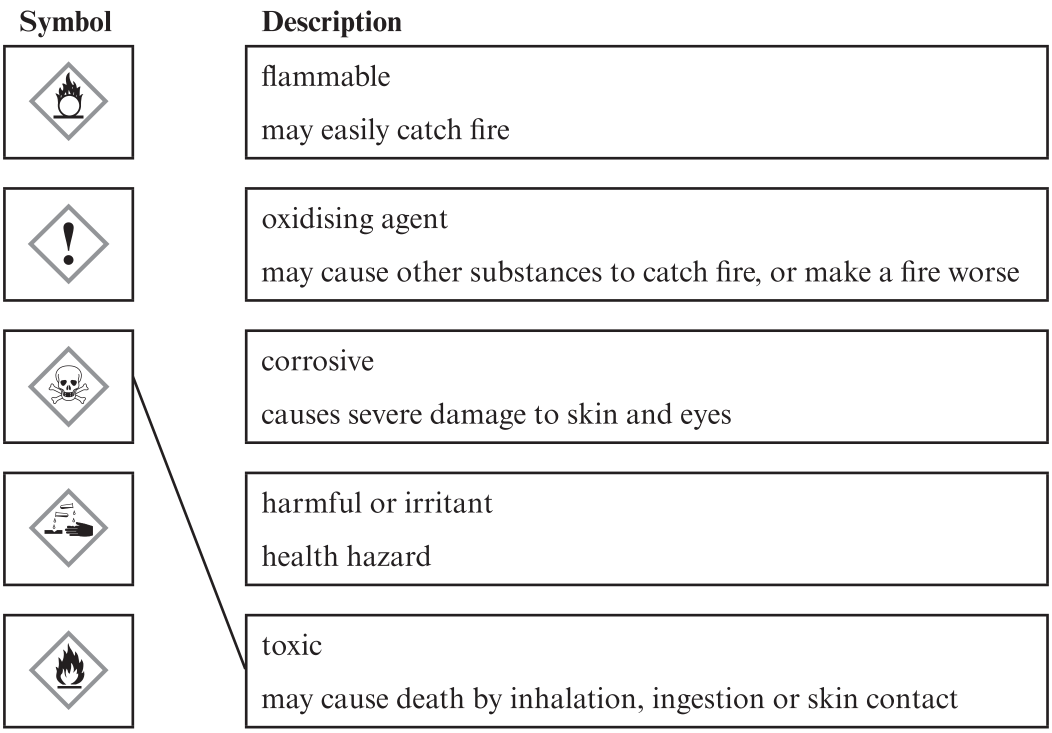
(e) $Cl_2 +$ .....$NaBr \rightarrow$ .....$NaCl + Br_2$ **(1 mark)**

(f) .....$Fe +$ .....$O_2 \rightarrow$ .....Fe_2O_3 **(1 mark)**

Hazards, risks and precautions

Guided

1 Complete the diagram below using a straight line to connect each hazard symbol to its correct description.



(4 marks)

2 Hazard symbols are found on containers. Give **two** reasons why these hazard symbols are used.

1 ....

2 .... **(2 marks)**

Guided

3 Describe what is meant by the term '**hazard**'.

A hazard is something that could cause ....

or cause .... **(2 marks)**

Guided

4 Describe what is meant by the term '**risk**'.

Risk and hazard are **not** the same thing.

Risk is the chance that ....

....

.... **(2 marks)**

5 Copper reacts with concentrated nitric acid. The reaction forms copper nitrate, water and nitrogen dioxide. Nitrogen dioxide is a toxic brown gas with an irritating odour.

(a) Give **one** suitable precaution, other than eye protection, needed for safe working in this experiment.

.... **(1 mark)**

(b) Give a reason that explains your answer to part (**a**).

.... **(1 mark)**

Atomic structure

1 How much smaller is the nucleus of an atom compared with the overall size of the atom?

☐ **A** about 10 times smaller

☐ **B** about 100 times smaller

☐ **C** about 1000 times smaller

☐ **D** about 100 000 times smaller **(1 mark)**

2 Which of these statements correctly describes an atom?

☐ **A** Most of the mass is concentrated in the nucleus.

☐ **B** Most of the charge is concentrated in the nucleus.

☐ **C** The number of neutrons always equals the number of protons.

☐ **D** The number of electrons always equals the number of neutrons. **(1 mark)**

3 Atoms contain protons, neutrons and electrons. Place a tick (✓) in each correct box to show where these particles are found in atoms.

	Protons	**Neutrons**	**Electrons**
Nucleus			
Shells			

(2 marks)

Guided

4 Complete the table to show the relative mass and relative charge of each particle in an atom.

Particle	**Proton**	**Neutron**	**Electron**
Relative mass		1	
Relative charge			-1

(2 marks)

5 Atoms contain equal numbers of protons and electrons. For example, a hydrogen atom contains one proton and one electron.

> Think about the charges carried by protons and electrons.

Explain why the overall charge of an atom is zero.

....

.... **(2 marks)**

6 John Dalton described his model of the atom in 1803.

Suggest a reason to explain why his model did not include protons, neutrons and electrons.

.... **(1 mark)**

Isotopes

1 State what is meant by the **mass number** of an atom.

Guided

The mass number of an atom is the total number of ....

.... **(1 mark)**

2 An atom of an element X has an atomic number 9 and a mass number 19. How many electrons does an atom of element X contain?

☐ **A** 9

☐ **B** 10

☐ **C** 19

☐ **D** 28

(1 mark)

3 Describe, in terms of the particles in its atoms, what an element is.

Guided

An element consists of atoms that have the same number of ....

in the nucleus, and this is different for different .... **(2 marks)**

4 Three isotopes of hydrogen are $^{1}_{1}H$ (hydrogen-1), $^{2}_{1}H$ (hydrogen-2) and $^{3}_{1}H$ (hydrogen-3).

Guided

(a) Complete the table to show the numbers of protons, neutrons and electrons in an atom of each isotope.

Isotope	Protons	Neutrons	Electrons
hydrogen-1	1		1
hydrogen-2		1	
hydrogen-3			

(3 marks)

(b) Explain, in terms of the particles in the atom, why these are isotopes of the same element.

Isotopes of an element have atoms with the same number of ....

but different numbers of .... **(2 marks)**

5 Chlorine has a relative atomic mass of 35.5 but some elements have relative atomic masses that are whole numbers. Explain why the relative atomic masses of some elements are *not* whole numbers.

Think about whether all the atoms of an element are the same.

....

....

.... **(2 marks)**

Mendeleev's table

1 (a) How did Mendeleev **first** arrange the elements in his periodic table?

☐ **A** in the order of increasing number of protons in the nucleus

☐ **B** in the order of increasing reactivity with other elements

☐ **C** in the order of increasing number of isotopes

☐ **D** in the order of increasing relative atomic mass **(1 mark)**

(b) State **one** factor, other than the one in your answer to part (**a**), that Mendeleev used when he arranged the elements.

What are the similarities and differences between elements?

.... **(1 mark)**

2 The diagram shows part of Mendeleev's 1871 table.

Group

1	2	3	4	5	6	7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K Cu	Ca Zn	*	Ti *	V As	Cr Se	Mn Br
Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

(a) Give **one** similarity between this table and the modern periodic table.

Remember that you will be given a periodic table in the exam. There is also one at the back of this book.

.... **(1 mark)**

(b) The * symbols in the diagram above represent gaps that Mendeleev left in his table.

(i) Give **two** other differences between this table and the modern periodic table.

1: ....

2: .... **(2 marks)**

(ii) Describe one useful thing that Mendeleev was able to do using information about the elements next to the gaps in his table.

....

.... **(1 mark)**

3 Mendeleev had difficulty placing some elements. For example, the order of tellurium $^{128}_{53}$Te and iodine $^{127}_{54}$I appeared to be reversed in his table. Explain, in terms of atomic structure, why the positions of these two elements were actually correct.

Guided

Tellurium has a .... relative atomic mass than iodine does.

However, iodine atoms have .... protons than tellurium atoms. **(2 marks)**

The periodic table

1 How are the elements arranged in the modern periodic table?

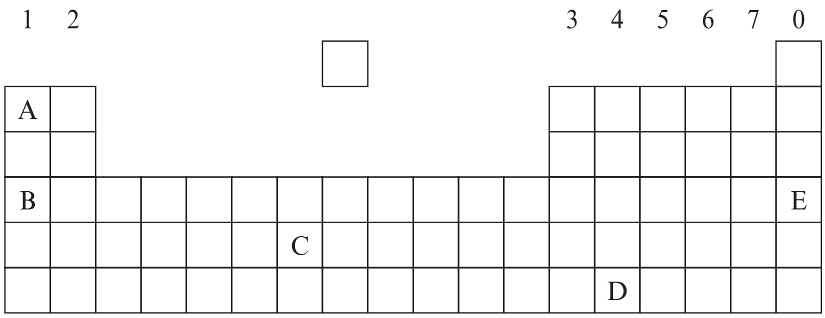
☐ **A** in order of increasing mass number

☐ **B** in order of increasing atomic number

☐ **C** in order of increasing nucleon number

☐ **D** in order of increasing numbers of electron shells **(1 mark)**

2 The positions of five elements (**A**, **B**, **C**, **D** and **E**) are shown in the periodic table below. These letters are **not** the chemical symbols for these elements.



(a) State the name given to a vertical column in the periodic table.

.... **(1 mark)**

(b) Give the letters of **two** elements that have similar chemical properties to each other.

.... **(1 mark)**

(c) Give the letters of **all** the metal elements.

> There are more metallic elements in the periodic table than non-metallic elements.

.... **(1 mark)**

(d) Give the letters of **two** elements in the same period.

.... **(1 mark)**

Guided

3 The meaning of the term '**atomic number**' has changed over time because of the discovery of subatomic particles.

(a) Give the meaning of the term '**atomic number**' as Mendeleev might have understood it in the nineteenth century.

the position of ....

.... **(1 mark)**

(b) Give the modern meaning of the term '**atomic number**'.

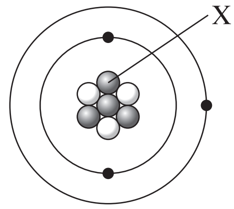
the number of ....

in an atom's .... **(2 marks)**

Had a go ☐ Nearly there ☐ Nailed it! ☐

Electronic configurations

1 The diagram shows a lithium atom. It is not drawn to scale.



(a) State the electronic configuration of lithium.

Count the number of electrons in each shell in the diagram.

.... **(1 mark)**

Guided

(b) Deduce the name of the shaded particle labelled **X**, and explain your answer.

There are three electrons, so there must be three ....

so the four shaded circles must be .... **(2 marks)**

(c) Oxygen (atomic number 8) has eight electrons in its atoms.

Draw a diagram to show the arrangement of electrons in an oxygen atom.

The first electron shell can hold only a maximum of two electrons.

You need to show both electron shells and all eight electrons, but you can show the nucleus as a single dot.

(2 marks)

2 The table shows some information about two non-metal elements, fluorine and chlorine.

Guided

Non-metal	Atomic number	Electronic configuration
F	9	2.7
Cl	17	2.8.7

(a) Explain, in terms of electronic configurations, why fluorine and chlorine are placed in group 7.

Both have ....

in their .... **(2 marks)**

(b) Explain, in terms of electronic configurations, why fluorine and chlorine are **not** in the same period.

Fluorine has ....

but chlorine has .... **(2 marks)**

3 Deduce the electronic configurations of the following elements.

Guided

(a) phosphorus (atomic number 15)

2.8.. **(1 mark)**

(b) calcium (atomic number 20)

.... **(1 mark)**

4 State and explain the number of the group in which helium (electronic configuration 2) is placed.

....

.... **(2 marks)**

Ions

1 Which of the following statements correctly describes the formation of an ion?

You can quickly narrow the alternatives if you know the correct name for each type of ion, or how it forms.

☐ **A** Positively charged ions, called cations, form when atoms or groups of atoms gain electrons.

☐ **B** Positively charged ions, called anions, form when atoms or groups of atoms lose electrons.

☐ **C** Negatively charged ions, called cations, form when atoms or groups of atoms lose electrons.

☐ **D** Negatively charged ions, called anions, form when atoms or groups of atoms gain electrons.

(1 mark)

2 The atomic number of magnesium, Mg, is 12. The symbol for a magnesium ion is Mg^{2+}.

Guided

(a) Deduce the number of electrons in a magnesium **ion**.

12 – …… = ………………………………………………………… **(1 mark)**

(b) The electronic configuration for a calcium atom is 2.8.8.2. Write the electronic configuration of a calcium **ion**, Ca^{2+}.

………………………………………………………………………… **(1 mark)**

3 Complete the table to show the numbers of protons, neutrons and electrons in each ion.

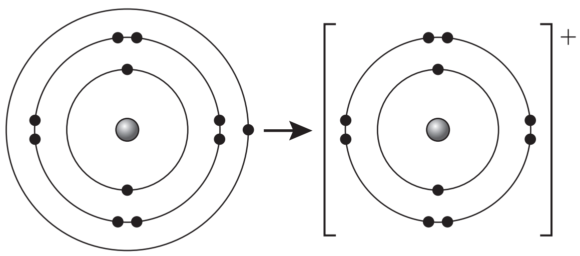
Guided

Maths skills Work out the number of electrons in an atom, then add or subtract electrons according to the charge shown.

Ion	Atomic number	Mass number	Protons	Neutrons	Electrons
N^{3-}	7	15	7	8	10
K^{+}	19	40			
Ca^{2+}	20	40			
S^{2-}	16	32			
Br^{-}	35	81			

(4 marks)

4 The diagram shows the formation of a sodium ion, Na^{+}, from a sodium atom.



Draw a similar diagram to show the formation of a chloride ion, Cl^{-}, from a chlorine atom.

Your diagram should look similar to the one above. However, the electronic configuration of a chlorine atom is 2.8.7 and a chloride ion forms when a chlorine atom gains one electron.

(3 marks)

Had a go ☐ Nearly there ☐ Nailed it! ☐

Formulae of ionic compounds

1 The formula of a sodium ion is Na^+. The formula of a phosphate ion is PO_4^{3-}. Which of the following is the formula for sodium phosphate?

Answer A cannot be correct because the sodium ion has fewer charges than the phosphate ion.

☐ **A** $NaPO_4$ ☐ **B** $Na(PO_4)_3$ ☐ **C** Na_2PO_4 ☐ **D** Na_3PO_4 **(1 mark)**

2 Complete the table to show the formulae of the compounds produced by each pair of ions.

You need to know the formulae of common ions. This helps you work out the formulae of ionic substances.

Maths skills An ionic compound contains equal numbers of positive and negative *charges*, but not always equal numbers of positive and negative *ions*. Look at the completed examples to help you.

Guided

	Cl^-	S^{2-}	OH^-	NO_3^-	SO_4^{2-}
K^+				KNO_3	
Ca^{2+}			$Ca(OH)_2$		$CaSO_4$
Fe^{3+}		Fe_2S_3			
NH_4^+	NH_4Cl				

(15 marks)

3 Magnesium ribbon burns in air. It reacts with oxygen to produce magnesium oxide.

(a) Balance this equation for the reaction.

……Mg + O_2 → ……MgO **(1 mark)**

(b) Magnesium nitride is also formed, as some of the hot magnesium reacts with nitrogen in the air.

Think about how many electrons a nitrogen atom must lose or gain to obtain a full outer shell.

(i) Nitrogen is in group 5. Suggest reasons that explain why the formula for a nitride ion is N^{3-}.

....

.... **(2 marks)**

(ii) Write the formula for magnesium nitride.

The formula for a magnesium ion is Mg^{2+}.

.... **(1 mark)**

(iii) Explain why the NO_3^- ion is called the nitrate ion, but the N^{3-} ion is called the nitride ion.

....

.... **(2 marks)**

4 Complete the table to show the names of the ions.

Remember to use the endings -ide and -ate correctly. Look again at question 3 (b) (iii) to help you.

	S^{2-}	SO_4^{2-}	Cl^-	ClO_3^-
Name				

(4 marks)

S is the chemical symbol for sulfur and Cl is the chemical symbol for chlorine.

Properties of ionic compounds

1 Which statement about the formation of ionic compounds, such as sodium chloride, is correct?

☐ **A** Electrons are transferred from metal atoms to non-metal atoms, producing cations and anions.

☐ **B** Electrons are transferred from cations to anions, producing metal atoms and non-metal atoms.

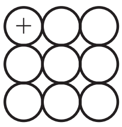
☐ **C** Electrons are shared between metal atoms and non-metal atoms.

☐ **D** Electrons are shared between cations and anions. **(1 mark)**

2 Ionic compounds have a lattice structure.

(a) Complete the diagram, using the symbols + and –, to show the positions of positive and negative ions in an ionic lattice.

Maths skills Remember that opposite charges will attract each other and like charges will repel.



You should be able to visualise and represent 2D and 3D forms, including 2D models of 3D objects.

(1 mark)

Guided

(b) Describe what ionic bonds are.

There are strong ....

between .... **(2 marks)**

3 Explain why ionic compounds have high melting points and boiling points.

Bonds between the particles in an ionic substance must be broken during melting and boiling. Think about whether this involves a relatively low or high amount of energy, and why.

....

.... **(2 marks)**

4 Ionic compounds such as sodium chloride can conduct electricity in some situations.

(a) Complete the table by placing a tick (✓) in each **correct** box to show where ionic compounds conduct electricity.

You do not need to tick all the boxes.

Ionic compound is:	solid	liquid	dissolved in water
conducts electricity			

(1 mark)

(b) State what the ions in an ionic compound must be able to do for it to conduct electricity.

.... **(1 mark)**

Had a go ☐ Nearly there ☐ Nailed it! ☐

Covalent bonds

1 What are the typical sizes of atoms and small molecules?

Maths skills: The quantities are shown in standard form. For example, 10^{-3} is greater than 10^{-6}.

	Atoms	Molecules
☐ **A**	10^{-10} m	10^{-11} m
☐ **B**	10^{-9} m	10^{-12} m
☐ **C**	10^{-10} m	10^{-9} m
☐ **D**	10^{-12} m	10^{-9} m

Answer A cannot be correct because it shows atoms as being larger than small molecules.

(1 mark)

2 Explain how a covalent bond forms.

How many electrons are involved in a covalent bond?

Guided

A covalent bond forms when ....

between .... **(2 marks)**

3 Hydrogen reacts with fluorine to form hydrogen fluoride: $H_2 + F_2 \rightarrow 2HF$

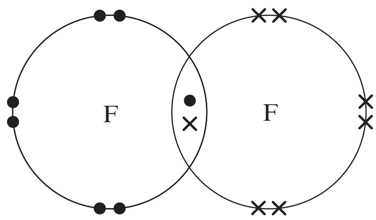
The electronic configuration of hydrogen is 1 and the electronic configuration of fluorine is 2.7.

(a) Describe what the structure, H–F, tells you about a hydrogen fluoride molecule.

....

.... **(2 marks)**

(b) A dot-and-cross diagram for a molecule of fluorine, F_2, is shown below.



Show each chemical symbol. Show one atom's electrons as dots and the other atom's electrons as crosses.

Draw a dot-and-cross diagram for a molecule of hydrogen fluoride, HF. Show the outer electrons only.

(2 marks)

4 Oxygen atoms have six electrons in their outer shell.
Draw a dot-and-cross diagram for an oxygen molecule, O_2.
Show the outer electrons only.

The displayed formula for oxygen is O=O.

(2 marks)

Simple molecular substances

1 Carbon dioxide, CO_2, is found in the air. Why does it have a low boiling point?

Answer A cannot be correct because covalent bonds are strong.

☐ **A** There are weak covalent bonds between carbon atoms and oxygen atoms.

☐ **B** There are weak forces of attraction between carbon atoms and oxygen atoms.

☐ **C** There are weak forces of attraction between carbon dioxide molecules.

☐ **D** There are weak covalent bonds between carbon dioxide molecules. **(1 mark)**

2 The table shows the properties of four different substances (**A**, **B**, **C** and **D**).

Substance	Melting point (°C)	Conducts electricity when solid?	Conducts electricity when liquid?	Solubility in water (g per 100 g of water)
A	290	no	yes	43
B	–39	yes	yes	0
C	–95	no	no	0.001
D	660	yes	yes	0

(a) State which substance (**A**, **B**, **C** or **D**) is a simple molecular substance.

.... **(1 mark)**

(b) Explain your answer to part (**a**).

Which of the properties of your chosen substance are typical of simple molecular substances?

....

.... **(2 marks)**

3 Sulfur hexafluoride, SF_6, exists as simple molecules. It is used as an insulating gas for electrical equipment.

(a) Explain why sulfur hexafluoride does not conduct electricity.

Substances that conduct electricity have electrically charged particles that are free to move around. Think about whether simple molecules are electrically charged or contain electrons that are free to move.

....

.... **(2 marks)**

Guided

(b) Suggest reasons to explain why sulfur hexafluoride does not dissolve in water.

The intermolecular forces between ....

....

are weaker than those between ....

and those between .... **(3 marks)**

Had a go ☐ Nearly there ☐ Nailed it! ☐

Giant molecular substances

1 Silica, SiO_2, does not dissolve in water. It does not conduct electricity, even when molten, and its melting point is very high.

Which statement describes a molecule of silica?

Answer D cannot be correct because metals, not molecules, contain metallic bonds.

☐ **A** a giant molecule with ionic bonds

☐ **B** a giant molecule with covalent bonds

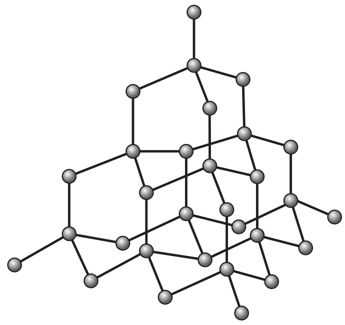
☐ **C** a simple molecule with covalent bonds

☐ **D** a simple molecule with metallic bonds

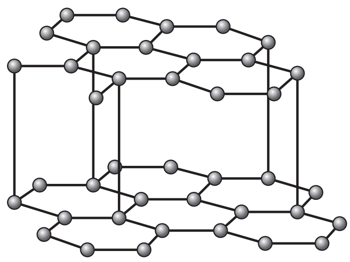
(1 mark)

2 The diagrams show the structures of diamond and graphite.

You should be able to visualise and represent 2D and 3D forms, including 2D representations of 3D objects.



diamond



graphite

(a) Name the element with atoms that form both diamond and graphite.

.... **(1 mark)**

(b) State the maximum number of bonds present between each atom in a molecule of diamond.

Count the bonds between the atoms in the diagram of diamond. What is the highest number you get?

.... **(1 mark)**

(c) Name the type of structure shown in both diagrams.

.... **(1 mark)**

3 Refer to structure and bonding in your answers to the following questions.

Guided

(a) Explain why graphite is suitable for use as a lubricant.

Lubricants must be slippery.

The layers in graphite can ....

because .... **(2 marks)**

(b) Explain why graphite is used to make electrodes.

You need to explain why graphite can conduct electricity, just as metals can.

Atoms in graphite can form only three ....

so graphite has .... **(2 marks)**

(c) Explain why diamond is suitable for use in cutting tools.

You need to explain why diamond is very hard.

Diamond has a .... structure, and its atoms

....

are joined by many .... **(2 marks)**

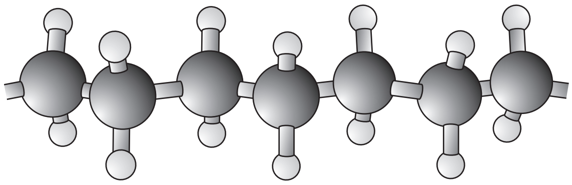
Other large molecules

1 Ethene, C_2H_4, can be made into a polymer. What is the name of this polymer?

☐ **A** poly(ethanol) ☐ **C** poly(ethene)

☐ **B** poly(ethane) ☐ **D** poly(ethyne) **(1 mark)**

2 The diagram is a model of a section of a simple polymer.



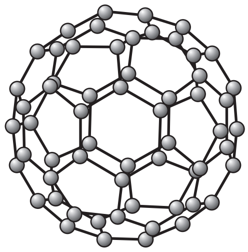
(a) Name the element with atoms represented by the larger, dark-grey balls in the diagram.

.... **(1 mark)**

(b) Name the type of bonding present in a molecule of this polymer.

.... **(1 mark)**

3 Fullerenes are forms of carbon that include hollow balls, such as buckminsterfullerene, C_{60}.



(a) Explain why buckminsterfullerene is a simple molecule, rather than a giant covalent substance.

....

....

.... **(2 marks)**

Guided

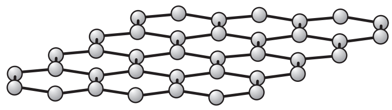
(b) Explain, in terms of its structure and bonding, why buckminsterfullerene has a much lower melting point than graphite.

> The strong covalent bonds between the carbon atoms in these molecules do *not* break during melting.

Buckminsterfullerene has a .... structure

so it has weak .... that are easily overcome. **(2 marks)**

4 Graphene is a form of carbon. It is a good conductor of electricity and has a very high melting point.



The diagram is a model of part of the structure of graphene.

Explain, in terms of its structure and bonding, why graphene has a very high melting point.

> Include the type of bonds that must be broken during melting.

....

....

.... **(3 marks)**

Metals

1 Which of the following correctly describes two typical properties of metals?

☐ **A** shiny with high densities
☐ **B** shiny with low densities
☐ **C** dull with low densities
☐ **D** dull with high densities **(1 mark)**

2 Metal elements and non-metal elements have different typical properties.

Complete the table below by placing a tick (✓) in each correct box.

	Low melting points	High melting points	Good conductors of electricity	Poor conductors of electricity
Metals				
Non-metals				

(4 marks)

3 Metals are insoluble in water. Some metals react with water, forming soluble hydroxides and hydrogen. For example, a piece of sodium reacts with water to produce sodium hydroxide and hydrogen.

(a) State why fizzing is observed during this reaction.

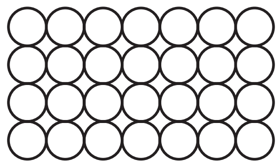
.... **(1 mark)**

(b) Suggest reasons to explain why the piece of sodium seems to dissolve in water.

....

.... **(2 marks)**

4 Copper is a metal used in electricity cables. It is a good conductor of electricity and is malleable (it will bend without shattering). The diagram is a model for the structure of copper. Each circle is a copper ion.



(a) State two improvements to the diagram that will make it a more accurate model of the structure of copper.

Remember that metal atoms form positively charged ions by losing electrons.

(i) ....

(ii) .... **(2 marks)**

Guided

(b) Explain why copper is malleable.

It has layers of ....

which can .... **(2 marks)**

(c) Explain why copper is a good conductor of electricity.

A substance conducts electricity if it contains charged particles that are free to move around.

....

.... **(2 marks)**

Limitations of models

1 The formula of a substance can be given in different ways.

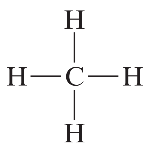
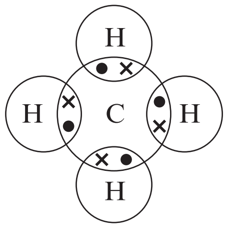
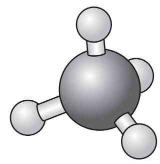
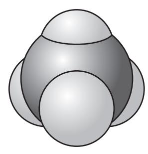
Which row (**A**, **B**, **C** or **D**) correctly shows the different formulae for ethene?

Answer A cannot be correct because it describes ethane, not ethene.

	Molecular formula	Empirical formula	Structural formula
☐ **A**	C_2H_6	CH_3	CH_3CH_3
☐ **B**	C_2H_4	CH_2	$CH_2{=}CH_2$
☐ **C**	CH_2	C_2H_4	$CH_2{=}CH_2$
☐ **D**	$CH_2{=}CH_2$	C_2H_4	CH_2

(1 mark)

2 The diagrams (**A**, **B**, **C** and **D**) show four different models for a molecule of methane, CH_4.

A	B	C	D
			
Structure	**Dot-and-cross diagram**	**Ball-and-stick model**	**Space-filling model**

State the letters (**A**, **B**, **C** or **D**) for all the models that:

You may need to identify more than one model in your answers.

(a) show the covalent bonds present in a molecule .... **(1 mark)**

(b) identify the elements present in a molecule .... **(1 mark)**

(c) represent the three-dimensional shape of a molecule .... **(1 mark)**

(d) show the electrons involved in bonding.. **(1 mark)**

(e) show the relative sizes of each atom in a molecule. .... **(1 mark)**

Guided

3 A student wants to represent a water molecule. She decides to draw a dot-and-cross diagram rather than a ball-and-stick model because she finds this easier to do.

Think about what a ball-and-stick model shows that a dot-and-cross diagram does not.

(a) Give one strength of a ball-and-stick model compared with a dot-and-cross diagram.

Unlike a dot-and-cross diagram, a ball-and-stick model ....

.... **(1 mark)**

(b) Other than the student's reason, give two weaknesses of a ball-and-stick model compared with a dot-and-cross diagram.

Think about what a dot-and-cross model shows that a ball-and-stick model does not.

Unlike a dot-and-cross diagram, a ball-and-stick model does not show ....

....

or .... **(2 marks)**

Relative formula mass

Use the relative atomic masses, A_r, in the table below when you answer the questions.

Element	Al	Ca	Cl	Cu	H	N	O	S
A_r	27	40	35.5	63.5	1	14	16	32

If relative atomic masses are not given in the question, you can find them in the periodic table.

1 Calculate the relative formula mass, M_r, of each of the following substances.

You do not need to show your working out, but it will help you to check the accuracy of your answers.

Guided (a) chlorine, Cl_2

You do not need to show a decimal point in your answer to this question.

2 × 35.5 = ... **(1 mark)**

Guided (b) water, H_2O

(2 × 1) + 16 = 2 + 16 = ... **(1 mark)**

(c) sulfur dioxide, SO_2 .... **(1 mark)**

(d) aluminium oxide, Al_2O_3 .... **(1 mark)**

(e) ammonium chloride, NH_4Cl .... **(1 mark)**

Do not round the answer to this question to a whole number.

(f) calcium chloride, $CaCl_2$ .... **(1 mark)**

(g) aluminium chloride, $AlCl_3$ .... **(1 mark)**

2 Calculate the relative formula mass, M_r, of each of the following substances.

Guided (a) calcium hydroxide, $Ca(OH)_2$

16 + 1 = 17, 17 × 2 = 34, 40 + 34 = ... **(1 mark)**

Maths skills: You could also enter the calculation into your calculator as: 40 + [2 × (16 + 1)] =

(b) aluminium hydroxide, $Al(OH)_3$ .... **(1 mark)**

(c) calcium nitrate, $Ca(NO_3)_2$ .... **(1 mark)**

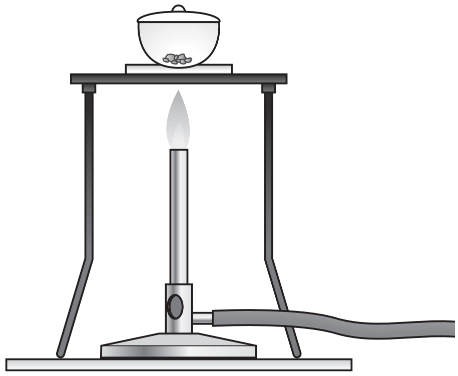
(d) ammonium sulfate, $(NH_4)_2SO_4$ .... **(1 mark)**

(e) aluminium sulfate, $Al_2(SO_4)_3$ .... **(1 mark)**

Practical skills

Empirical formulae

1 A student carries out an experiment to determine the empirical formula of magnesium oxide. He heats a piece of magnesium ribbon in a crucible. He continues until the contents of the crucible stop glowing.



The table shows his results.

Object	Mass (g)
empty crucible and lid	20.25
crucible, lid and contents before heating	20.49
crucible, lid and contents after heating	20.65

(a) Suggest a reason to explain why:

(i) the student continued heating until the glowing stopped.

.... **(1 mark)**

(ii) the student briefly lifted the lid a few times during the experiment.

.... **(1 mark)**

(b) The hot crucible is a hazard. Explain one precaution to control the risk of harm from this hazard.

Say what the student should do to avoid being harmed, and what harm this will prevent.

....

.... **(2 marks)**

2 Calculate the empirical formula of magnesium oxide using the student's results.

Guided

(A_r of Mg = 24 and A_r of O = 16)

mass of magnesium used = 20.49 g − 20.25 g = 0.24 g

mass of oxygen reacted = 20.65 g − 20.49 g = ...

Mg	O
$\frac{0.24}{24}$ = 0.010	$\frac{\dots}{16}$ = ...
$\frac{0.010}{\dots}$ = ...	$\frac{\dots}{\dots}$ = ...

Divide the mass of each element by its A_r.

Divide both numbers by the smallest number to find the ratio.

Empirical formula is ....

Write down the empirical formula. **(4 marks)**

3 The empirical formula of a sample of gas is NO_2. Its relative formula mass, M_r, is 92.

Guided

Deduce the molecular formula of the gas. (A_r of N = 14 and A_r of O = 16)

M_r of NO_2 = 14 + (2 × 16) = ...

factor needed = $\frac{92}{\dots}$ =

Molecular formula is ....

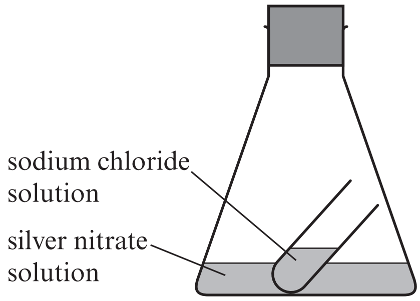
Maths skills: Calculate the M_r of NO_2. Then work out how many times this will go into 92. Multiply each number in the empirical formula by this factor to obtain the molecular formula.

(2 marks)

Conservation of mass

1 Sodium chloride solution reacts with silver nitrate solution. Sodium nitrate solution and a white precipitate of solid silver chloride form:
$NaCl(aq) + AgNO_3(aq) \rightarrow NaNO_3(aq) + AgCl(s)$

A student investigates the change in mass during this reaction. He sets up the apparatus shown in the diagram, then shakes the flask to mix the two solutions.



(a) State whether the reaction happens in a closed or a non-enclosed system. Give a reason for your answer.

type of system:..

reason:.. **(1 mark)**

(b) The student records the mass of the flask and its contents before and after the reaction.

(i) What happens to the mass during the reaction? Underline the correct answer.

It increases. | It decreases. | It stays the same. **(1 mark)**

(ii) Give a reason for your answer to part (**i**).

.... **(1 mark)**

2 Copper carbonate decomposes, when heated, to form copper oxide and carbon dioxide:

$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$

You do not need to calculate relative formula masses for this question.

8.2 g of copper carbonate formed 5.3 g of copper oxide.
Calculate the mass of carbon dioxide produced. Answer = ... **(1 mark)**

3 Sodium reacts with chlorine to form sodium chloride: $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

Guided

Calculate the maximum mass of sodium chloride that can be made from 142 g of chlorine.

(M_r of Cl_2 = 71 and M_r of NaCl = 58.5)

(1 × 71) = 71 g of Cl_2 makes (2 × 58.5) = 117 g of NaCl

142 g of Cl_2 makes 117 × (142/71) g of NaCl

= .... g **(1 mark)**

4 Magnesium reacts with oxygen to form magnesium oxide: $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Guided

Calculate the maximum mass of magnesium oxide that can be made from 12.6 g of oxygen.

Remember to calculate the relative formula mass, M_r, of oxygen gas and magnesium oxide first.

(A_r of O = 16 and A_r of Mg = 24)

M_r of O_2 = ... M_r of MgO = ...

.... g of O_2 makes .... g of MgO

12.6 g of O_2 makes .... g of MgO

= .... g of MgO **(3 marks)**