St Dominics Sixth Form College

Chemistry

Transition Work

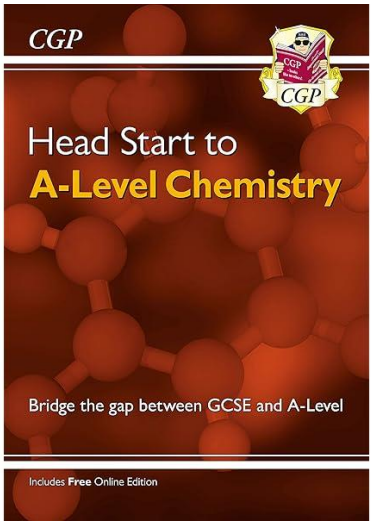
Work through the tasks in this document.

The video links will provide additional information needed to complete the questions.

We will collect this work in your first lesson in September

Recommended Reading: **Head Start to A level Chemistry CGP Book**

ISBN 9781782942801



This book is highly recommended for students who have taken Combined Science GCSE, as there are several topics you have not covered that are required for the A level.

You can also use the Cognition revision videos linked below:

Cognito Revision Video Playlist

Section 1 – Key Words and Definitions – Add the missing key words to the table

Definition	Word/Term
The smallest particle of an element	
Positive nuclei held together by delocalised electrons	
Different physical structures of atoms of the same element	
The change in concentration of a reactant or product over time	
Chemically combined elements in a fixed ratio	
Able to dissolve in a particular solvent	
Breaking a substance apart using an electrical current	
A reaction in which a substance is burned in oxygen	
A substance able to speed up a chemical reaction that remains unchanged after the reaction is complete	
A bond formed by the sharing of a pair of electrons	
Negatively charged particle found within atoms	
The loss of electrons	
The reaction between an acid and a base to produce water and a solution of pH 7	
A bond formed by the exchange of electrons and resulting attraction between ions	
Positively charged particle found within atoms	
A type of reaction that gives out heat and causes a rise in temperature	
Centre of an atom, containing protons and neutrons	
Gain of electrons	
Particle with no charge found within atoms	
The amount of a dissolved substance in a given volume of solvent	
A type of reaction that takes in heat and causes a decrease in temperature	
A charged particle	
A more reactive element taking the place of a less reactive element	

Section 2 – Orbitals and Electron Configuration

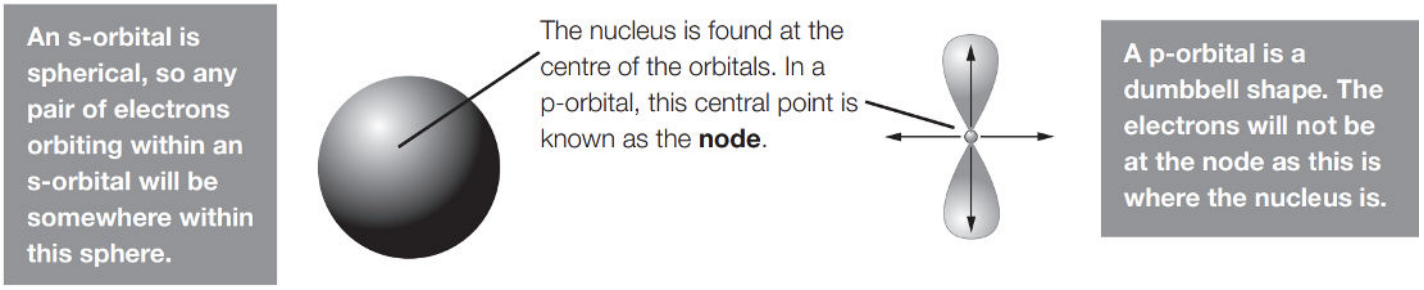
GCSE	A level
At GSCE, you will have described electrons as orbiting the nucleus in fixed 'shells' and described how many electrons can fit in each shell.	At A level, electron 'shells' are defined as quantum energy levels which contain 'orbitals' You will need to: - describe and draw the shapes of various orbitals - state how many electrons orbitals can hold - describe what a sub-shell is

Watch the following video link:

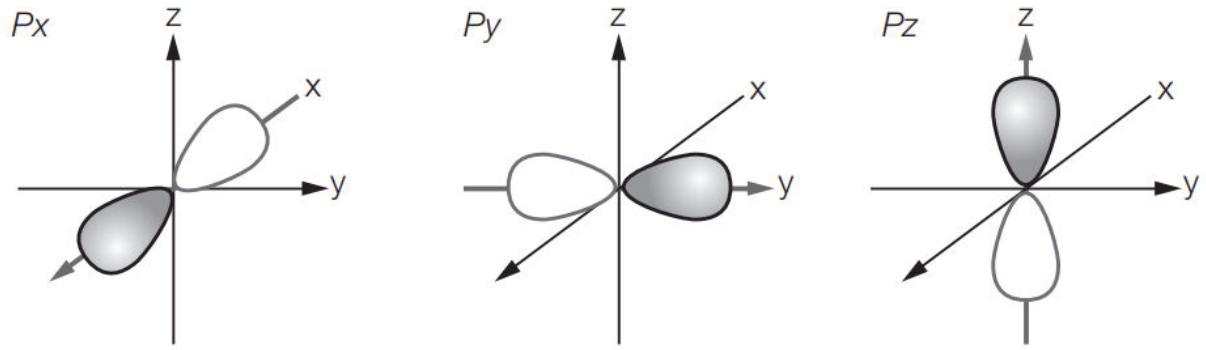
Electron configuration, Paper 1 - AQA A Level Chemistry

There are four different types of orbitals, and they are given letters to identify them: **s**, **p**, **d** and **f**.

s-orbitals have the lowest energy and are closest to the nucleus, then p-orbitals, then d-orbitals and then f-orbitals. Each orbital has a different shape.

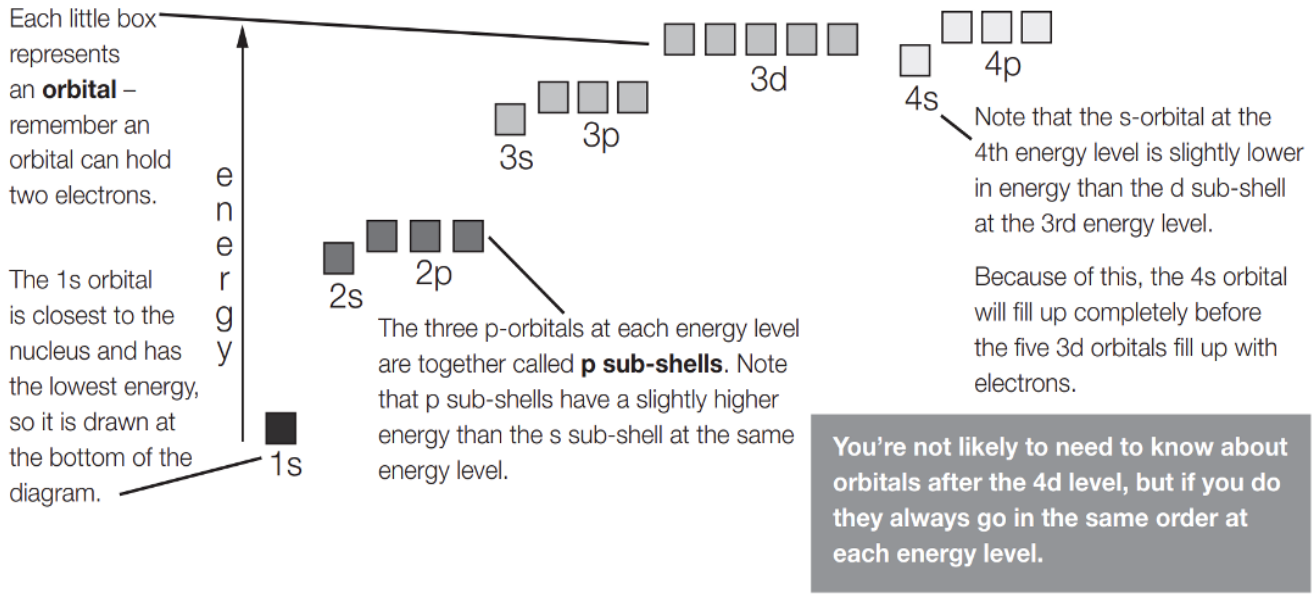


If a quantum energy level contains p-orbitals, it will always have three.

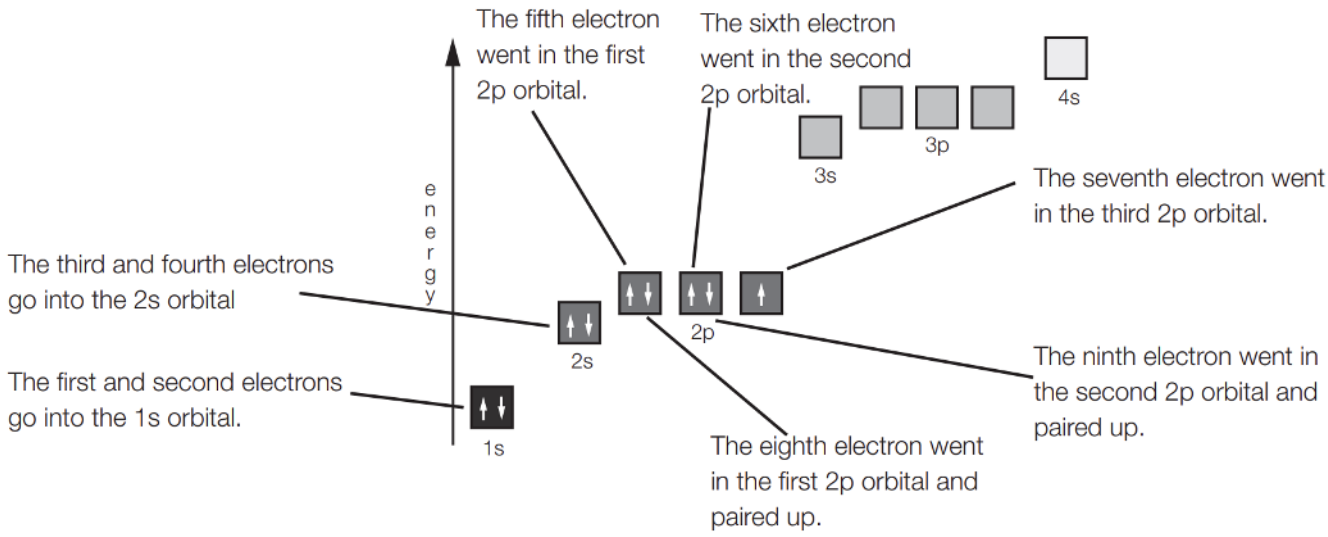


Each p orbital lies on a different plane. Imagine the y plane runs horizontally along the surface of this page, the z plane runs vertically along the surface of this page, and the x plane runs from you into the page and out the back of this page.

We can draw a diagram to represent the orbitals at each energy level:



Consider fluorine's electronic configuration for example:



Shorthand electron configurations

It would take a very long time to draw these diagrams every time you wanted to give an element's electronic configuration.

The shorthand for this diagram is to write a number for the energy level, then the letter for the orbital being used and then the number of electrons in it (this is written in superscript).

For fluorine this would be: **$1s^2$ $2s^2$ $2p^5$**

Task 2a

1. Draw the shape of:

(a) An s orbital:

(b) A p orbital

2. Give the electronic configurations of:

(a) sodium

(b) magnesium

(c) chlorine

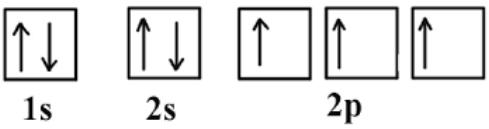
(d) helium

(e) carbon

(f) calcium

3. **Challenge** The electron configuration of nitrogen is $\mathbf{1s^2\ 2s^2\ 2p^3}$.

The electron configuration can be drawn in a box diagram like this:



Explain why each of the p orbitals only contains one electron

_____

_____

_____

_____

_____

Section 3 – Ions, Formulae and Equations

GCSE	A level
At GSCE, you will have - used ions to write the formula of a salt. - balanced equations when all the formulae in an equation are give.	At A level, you are required to construct equations for all the reactions in the specification. You need to recall common ions and formulae, and use this information to write balance equations.

Watch the video link: **A Level Chemistry - 2 - Compounds, formulae and equations**

For A level Chemistry, you need to learn the formula and charges of common ions.

Learn the formulas of the ions in the table below (you may want to make flash cards!)

Positive ions		**Simple negative ions** **ions ending in -ide contain one element*	
Group 1 ions	**+1 charge**	**Group 7 ions**	**-1 charge**
lithium	Li^+	fluoride	F^-
sodium	Na^+	chloride	Cl^-
potassium	K^+	bromide	Br^-
Group 2 ions	**+2 charge**	iodide	I^-
magnesium	Mg^{2+}	hydride	H^-
calcium	Ca^{2+}	**Group 6 ions**	**-2 charge**
strontium	Sr^{2+}	oxide	O^{2-}
Group 3 ions	**+3 charge**	sulfide	S^{2-}
aluminium	Al^{3+}	**Group 5 ions**	**-3 charge**
Other metal ions		nitride	N^{3-}
zinc	Zn^{2+}	**Compound negative ions** **ions ending in -ate contain oxygen*	
silver	Ag^+		
Compound ions		sulfate	SO_4^{2-}
ammonium	NH_4^+	nitrate	NO_3^-
Metals with a roman numeral	roman numeral = charge on ion	carbonate	CO_3^{2-}
		hydrogen carbonate	HCO_3^-
iron(III)	Fe^{3+}	phosphate	PO_4^{3-}
copper (II)	Cu^{2+}	hydroxide	OH^-
Compound ions			
ammonium	NH_4^+		

Working out the formula of an ionic compounds

In the formula of an ionic compound, the charges must cancel out.

eg magnesium chloride is $MgCl_2$ **NOT** MgCl

Use brackets where more than one of a compound ion is needed in formula.

eg calcium hydroxide is $Ca(OH)_2$ **NOT** $CaOH_2$

Do not include any charges in the formula of an ionic compound.

Task 3a: Use the charges on the ions to work out the formulas of the ionic compounds listed in the table:

Compound Name	Formula	Compound Name	Formula
silver bromide		sodium sulfate	
sodium carbonate		lead (II) oxide	
potassium oxide		sodium phosphate	
Magnesium phosphate		zinc hydrogencarbonate	
chromium (III) chloride		ammonium sulphate	
calcium hydroxide		iron (III) oxide	
aluminium nitrate		lithium carbonate	
silver sulfate		aluminium sulfate	
Challenge - use a periodic table to answer these questions:			
strontium selenide		radium sulfate	
gallium hydroxide		aluminium astatide	

Other common formulae

Acids: Learn these formulae of common acids:

Name	Formula
hydrochloric acid	HCl
nitric acid	HNO_3
sulfuric acid	H_2SO_4
phosphoric acid	H_3PO_4
ethanoic acid	CH_3COOH

Diatomic Elements: Most gases, as well as the group 7 halogens, exist as diatomic molecules. Chlorine exists as Cl_2, NOT Cl.

Covalent molecules: You can work out the formula from the **prefixes** in the name of a compound, eg sulfur **tri**oxide = SO_3, carbon **tetra**chloride = CCl_4

Table of prefixes:

Prefix	Number of atoms in a formula
mono	1
di	2
tri	3
tetra	4
penta	5
hexa	6

Task 3b: Complete the table below with the formula of each substance.

Compound	Formula	Compound	Formula
oxygen		water	
nitrogen		hydrogen peroxide	
fluorine		phosphorous pentachloride	
chlorine		sulfur hexafluoride	
bromine		nitrogen dioxide	
carbon monoxide		carbon dioxide	
ammonia		methane	

Writing balanced equations

When writing equations, you **must** make sure that the **formula** of each substance is correct, before you try to balance the equation!

Use the steps below to construct an equation:

Step 1: **Ions**: For any ionic compounds, recall the ions needed.

Step 2: **Formula**: Write the correct formula for each substance in the equation.

Step 3: **Equation**: Add the formulae into the equation

Step 4: **Balancing**: Now balance the equation!

Step 5: **State symbols**: Add the state symbols: (s), (l), (g), (aq).

Example: Write an equation for the reaction of zinc metal with nitric acid to form zinc nitrate and hydrogen.

Ions: Zinc = **Zn^{2+}** and nitrate = **NO_3^-**

Formula: hydrochloric acid = **HNO_3**; Zinc nitrate = **$Zn(NO_3)_2$**, hydrogen = **H_2**

Equation: $Zn + HNO_3 \rightarrow Zn(NO_3)_2 + H_2$

Balancing: $Zn + 2HNO_3 \rightarrow Zn(NO_3)_2 + H_2$

State symbols: $Zn_{(s)} + 2HNO_{3\,(aq)} \rightarrow Zn(NO_3)_{2\,(aq)} + H_{2\,(g)}$

Task 3c: Write balanced symbol equations for the following reactions:

(a) sodium + oxygen → sodium oxide

_____

(b) chlorine + fluorine → chlorine tetrafluoride

_____

(c) aluminium + chlorine → aluminium chloride

_____

(d) calcium + hydrochloric acid → calcium chloride + hydrogen

_____

(e) ammonia + sulphuric acid → ammonium sulphate

_____

(f) magnesium oxide + nitric acid →

_____

(g) strontium carbonate + hydrochloric acid →

_____

(h) ammonia + phosphoric acid →

_____

(i) Phosphine, PH_3, is a poisonous gas. Phosphine reacts with oxygen gas to form phosphorus(V) oxide, P_4O_{10}, and water.

Give the equation for this reaction.

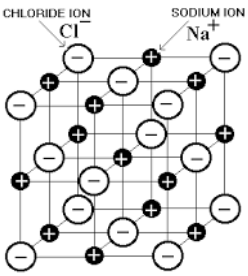
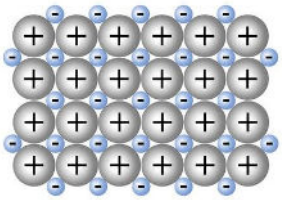
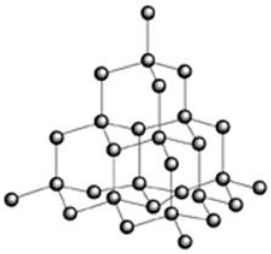
_____

Section 4 – Structure and Bonding

GCSE	A level
At GSCE, you will have learnt the following types of structures: - simple covalent - giant covalent - metallic bonding - giant ionic lattice In simple covalent structures, the molecules are held together by *weak intermolecular forces*.	At A level, you learn about the four types of crystal structure: • **ionic** • **metallic** • **macromolecular** (giant covalent) • **molecular** (simple covalent) You will learn about the different types of intermolecular forces present in molecular structures: • permanent dipole–dipole forces • Van der Waals forces (aka induced dipole–dipole, dispersion, London forces) • hydrogen bonding.

Types of crystal structure

Watch the video link: **Predicting Bonding Types | A Level Chemistry**

	ionic	**metallic**	**macromolecular** (giant covalent)	**molecular** (simple covalent)
Diagram				
Description	Alternating oppositely charged ions	Lattice of positive metal ions surrounded by delocalised electrons	A lattice of many covalently bonded atoms	Simple molecules containing covalent bonds
What holds it together?	strong electrostatic forces	strong electrostatic forces	strong covalent bonds	Van der Waals forces Permanent dipole – dipole forces Hydrogen bonding

Task 4a : Complete the table to show the type of crystal structure present in each of the substances.

Substance	**Monoatomic** *(single atoms only)*	**Molecular**	**Macromolecular**	**Metallic**	**Ionic**
bromine					
silver nitrate					
calcium					
neon					
ammonia					
hydrogen sulfide					
graphite					
ammonia					
water					

Task 4b: What are Van Der Waal's forces of attraction?

Watch the video link **Van der Waals force of attraction**

(a) Describe how Van der Vaal's forces arise

(b) Explain, in terms of Van der Waal's forces, why chlorine has a higher boiling point than fluorine.

Section 5 – Maths Skills

GCSE	A level
At GSCE (double science), you will have completed calculations on reacting masses. At GCSE (triple science) you will have completed calculations on reacting masses, solutions and gases at RTP, including titration calculations. A mole contains 6.02 x 10^{23} particles. This is Avogadro's number.	At A level, you will complete unstructured calculations on reacting masses, solutions and gases, including the ideal gas equation for gases not under standard conditions. You will need to convert units, and confidently use standards form and logarithms.

Converting Units

We use prefixes as shorthand for standard form when using commonly occurring very large or very small numbers.

For example, the length 0.0000000023 m may be written as 2.3×10^{-9} m

2.3 is the *digit number* and is kept. 10^{-9} is known as the *exponential number* and can be replaced with the prefix *'n'* pronounced as 'nano'.

Hence:

$$0.0000000023 \text{ m} = 2.3 \times 10^{-9} \text{ m} = 2.3 \text{ nm}$$

Watch the video to find out how units are converted when using the ***Ideal gas equation***

AQA A level Chemistry - Amount of substance PART 2

Converting units (volume)

Number		Exponential number	Prefix	
billion	1 000 000 000	10^{9}	G	'giga'
million	1 000 000	10^{6}	M	'mega'
thousand	1000	10^{3}	k	'kilo'
tenth	0.1	10^{-1}	d	'deci'
hundredth	0.01	10^{-2}	c	'centi'
thousandth	0.001	10^{-3}	m	'milli'
millionth	0.000 000 1	10^{-6}	μ	'micro'
billionth	0.000 000 000 1	10^{-9}	n	'nano'

Manipulating units

- A number and a unit (like 3 m) is a magnitude (3) multiplied by a unit (metre).
- The rules of algebra apply not only to the numbers you are manipulating, but also to the units attached to them. For example:

3 m × 3 m = 3 × 3 × m × m = 9 × m × m = 9 × m^2 = 9 m^2

- Units can be multiplied and divided just like a regular number. For example:

$$\frac{6\ \mathrm{m}^3}{2\ \mathrm{m}^2} = 3\frac{\mathrm{m}^3}{\mathrm{m}^2} = 3\frac{\mathrm{m}\ \times\ \mathrm{m}\ \times \mathrm{m}}{\mathrm{m}\ \times \mathrm{m}} = 3\ \frac{\mathrm{m}\ \times\ \cancel{\mathrm{m}}\ \times \cancel{\mathrm{m}}}{\cancel{\mathrm{m}}\ \times \cancel{\mathrm{m}}} = 3\ \mathrm{m}$$

- At A-level, rather than write m/s to mean metres per second, we will write ms^{-1}.
- This makes it easier to combine units via the following rules:

$$unit^a \times unit^b = unit^{a+b}$$

$$\frac{unit^a}{unit^b} = unit^{a-b}$$

This means that: $\frac{1}{\mathrm{kg}^{-1}} = \mathrm{kg}$ or more generally $\frac{1}{a^{-n}} = a^n$

Task 5a. Convert the following numbers into metres:

(a) 3 km

(b) 20 cm

(c) 2.3 mm

(d) 550 nm

(e) 5.1 μm

(f) 13.7 Gm

(g) 0.0025 km

(h) 1.0001 km

Task 5b. Simplify the units in the table below

(a) cm × cm		(e) $\frac{\mathrm{cm}^3}{\mathrm{cm}}$	
(b) cm^2 × cm		(f) $\frac{\mathrm{cm\ x\ cm}^3}{\mathrm{cm}}$	
(c) $\frac{\mathrm{kg\ m}}{\mathrm{m}}$		(g) $\frac{\mathrm{cm}}{\mathrm{cm}^2}$	
(d) $\mathrm{nm}^2 \times \mathrm{nm}^{-1}$		(h) $\frac{\mathrm{g\ cm}^3}{\mathrm{cm}^{-1}}$	

Standard Form

We use standard form to easily manage very large or very small numbers.

For example, the number 0.00000000000087 may be written as 8.7×10^{-13}

In this form, 8.7×10^{-13} is the product of two numbers: 8.7 is the **digit number**, and 10^{-13} is the **exponential number**.

A number is in standard form when it is written as $a \times 10^n$, where $1 \leq a < 10$

Here are some further examples of numbers in standard form.

Decimal	Standard Form
134 000	1.34×10^5
0.0034	3.4×10^{-3}
270	2.7×10^2
0.000 000 000 026	2.6×10^{-11}

Standard Form – Using your calculator

To type a number in standard form on your calculator,

- Input the digit number followed by the multiplication sign.
- Locate the "10^x" symbol, and use this to insert the exponent.
- Check your equation for any needed brackets.

To check, multiply 6.1×10^4 and 2×10^3. The answer should be 1.22×10^8

Example

0.0125 moles of a salt were dissolved in 2.5 dm^3 of water.

What is the concentration of this substance in mol dm^{-3}?
Give your answer in **standard form**.

$c = n / v = 0.0125 / 2.5 = 0.005$ mol $dm^{-3} = 5 \times 10^{-3}$ mol dm^{-3}

Task 5c Convert the following numbers into standard form:

32000		9 230 000	
0.0006		0.000 040 5	
104 000		0.002 019	
18 200 000		30 200	

Task 5d Convert the following numbers from standard form into decimal notation:

3.26×10^{4}		8×10^{-6}	
8.4×10^{-3}		1.3×10^{8}	
7.29×10^{7}		2.3×10^{-4}	
1.26×10^{2}		5.001×10^{6}	

Task 5e Challenge Question

The data in the following table were obtained in two experiments about the rate of the reaction between substances **B** and **C** at constant temperature.

Experiment	Initial concentration of **B** / mol dm^{-3}	Initial concentration of **C** / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	4.2×10^{-2}	2.6×10^{-2}	8.4×10^{-5}
2	6.3×10^{-2}	7.8×10^{-2}	To be calculated

k is the known as the rate constant. ***k*** is the same for both experiments.

The rate equation for this reaction is known to be:

Rate = $k[B]^2[C]$

Which can also be written as:

Rate of reaction = *k* x [concentration of B]^2 x [concentration of C]

(a) Use the data from Experiment **1** to calculate a value for the rate constant ***k***

Give your answer in **standard form** to **3 significant figures**

State the **units** of the rate constant

(b) Use your value of ***k*** to calculate the rate of reaction for Experiment **2**.

Section 6 – Mole Calculations

If you have taken Combined Science GCSE, you may not have covered all of the GCSE mole calculations.

Watch the following videos to revise mole calculations:

GCSE Chemistry The Mole

GCSE Chemistry Moles Concentration and Volume Calculations

Task 6: Complete the calculation questions. Show all your working!

Q1

Explain what the Avogadro constant is. .....

.....

.....

..... (1)

Q2

Calculate the number of molecules of water in 90.0 g of water. (Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1})

.....

.....

.....

.....

..... (2)

Q3

Calculate the relative formula mass (M_r) of the following substances.

a) O_2 ..... (1)

b) K_2SO_4 ..... (1)

c) $Mg(NO_3)_2$ ..... (1)

d) $CuSO_4.5H_2O$ ..... (1)

Q4

Calculate the mass of each of the following.

a) 5.00 moles of Fe_2O_3 .....

..... (1)

b) 0.250 moles of hydrogen .....

..... (1)

c) 1.50×10^{-4} moles of aluminium iodide .....

..... (1)

Q5

Calculate the number of moles of each of the following.

a) 23.6 g of Cu……

…… (1)

b) 43.8 mg of fluorine ……

…… (1)

c) 1.25 tonnes of vanadium(V) oxide ……

…… (1)

Q6

Convert these quantities into the units shown.

a) 18 mmol to mol …… (1)

b) 20 MPa to Pa …… (1)

c) 65 mg to g …… (1)

d) 20°C to K …… (1)

e) 125 pm to m …… (1)

f) 50 cm^3 to dm^3 …… (1)

g) 200 cm^3 to m^3 …… (1)

Q7

250 cm^3 of aqueous solution contains 2.0 g of dissolved sodium hydroxide. Calculate the concentration of the solution in mol dm^{-3}

……

……

…… (2)

Q8

What mass of oxygen reacts with 2.30 g of sodium? $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

……

……

……

……

…… (3)

Q9

Which is the limiting reagent and what mass of aluminium chloride is formed when 1.35 g of aluminium is heated with 4.26 g of chlorine?

$$2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$$

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.....

.....

..... (4)

Q10

In a titration, it was found that 25.0 cm^3 of 0.150 mol dm^{-3} sulfuric acid reacts with 23.58 cm^3 of sodium hydroxide solution. Calculate the concentration of the sodium hydroxide solution in mol dm^{-3}.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

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.....

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..... (3)