BERKHAMSTED

1541

Y11 into 12 Summer Work

A-Level Chemistry

Student Name	

To review the OCR Chemistry A-Level Specification click here

Your Physical Chemistry teacher and an Organic Chemistry teacher will split the teaching of the specification between them.

To fulfil the Practical Endorsement aspect of the course you will complete a series of practicals throughout the two-year course, that will also be assessed within the written assessments.

Content Overview	Assessment Overview	
Content is split into six teaching modules: • Module 1 – Development of practical skills in chemistry • Module 2 – Foundations in chemistry • Module 3 – Periodic table and energy • Module 4 – Core organic chemistry • Module 5 – Physical chemistry and transition elements • Module 6 – Organic chemistry and analysis Component 01 assesses content from modules 1, 2, 3 and 5. Component 02 assesses content from modules 1, 2, 4 and 6. Component 03 assesses content from all modules (1 to 6).	Periodic table, elements and physical chemistry (01) 100 marks 2 hours 15 minutes written paper	**37%** of total A level
	Synthesis and analytical techniques (02) 100 marks 2 hours 15 minutes written paper	**37%** of total A level
	Unified chemistry (03) 70 marks 1 hour 30 minutes written paper	**26%** of total A level
	Practical Endorsement in chemistry (04) (non exam assessment)	Reported separately (see Section 5)

Summer Work Guidance

Please complete the tasks in this booklet in preparation for September. There are **14 tasks in total**. Support video links are provided throughout to assist you. **Deadline: The first Chemistry lesson of the school year. This will be followed by a short assessment early in the first half-term.**

If you have any questions or concerns, please do not hesitate to contact me at NBodlaender@Berkhamsted.com. Please note that due to the school being on summer break there may be a slight delay in response.

It is essential that you clearly show and label each step in your working for all calculations, including appropriate units throughout.

The Periodic Table of the Elements

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)
1																	**18**
1 **H** hydrogen 1.0	**2**											**13**	**14**	**15**	**16**	**17**	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

Key
atomic number
Symbol
name
relative atomic mass

57 **La** lanthanum 138.9	58 **Ce** cerium 140.1	59 **Pr** praseodymium 140.9	60 **Nd** neodymium 144.2	61 **Pm** promethium 144.9	62 **Sm** samarium 150.4	63 **Eu** europium 152.0	64 **Gd** gadolinium 157.2	65 **Tb** terbium 158.9	66 **Dy** dysprosium 162.5	67 **Ho** holmium 164.9	68 **Er** erbium 167.3	69 **Tm** thulium 168.9	70 **Yb** ytterbium 173.0	71 **Lu** lutetium 175.0
89 **Ac** actinium	90 **Th** thorium 232.0	91 **Pa** protactinium	92 **U** uranium 238.1	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

© OCR 2020

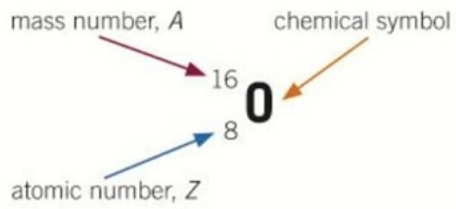
Specification content
2.1.1 **(a)** isotopes as atoms of the same element with different numbers of neutrons and different masses **(b)** atomic structure in terms of the numbers of protons, neutrons, and electrons for atoms and ions, given the atomic number, mass number, and any ionic charge

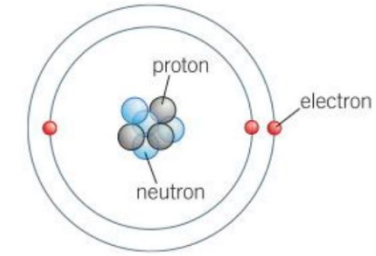
GCSE Atomic Structure Recap

- Atom = the smallest uncharged part of an element
- All atoms of a particular element have the same number of protons

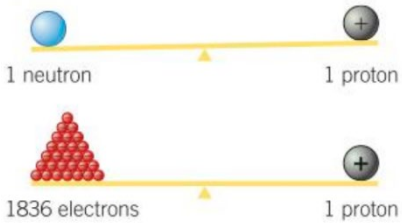
Atomic (proton) number (Z)	number of protons in the nucleus
Mass number (A)	number of protons and neutrons in the nucleus

Number of protons	atomic number
Number of electrons	same as the number of protons in a neutral atom
Number of neutrons	mass number – atomic number





▲ **Figure 1** *The nuclear atom*



▲ **Figure 2** *Relative masses of protons, neutrons, and electrons*

$p^+ = 13$
$e^- = 13$ (neutral atom therefore nos. of p = nos. of e)
n = 27-13 = 14

Particle	Mass/kg	Charge/C	**Relative mass**	**Relative charge**	**Position**
p^+	1.671×10^{-27}	$+1.602 \times 10^{-19}$	1	+1	Nucleus
n	1.674×10^{-27}	0	1	0	Nucleus
e^-	9.109×10^{-31}	-1.602×10^{-19}	1/1836	-1	Outside the nucleus in the electron cloud

Ion	charged atom or group of atoms
Cation	positive ion (nos. of p^+ > nos. of e^-)
Anion	negative ion (nos. of p^+ < nos. of e^-)
Nucleons	subatomic particles in the nucleus (p^++n)
Isoelectronic	ions with the same electronic configuration
Isotope	Atoms of the same element with the same number of protons and electrons, but a different number of neutrons.

- Iso(same) topos (place) in Periodic Table
- Most elements have more than one stable and naturally occurring isotope

▼ **Table 4** *Atomic structures of ions*

Ion	Protons	Neutrons	Electrons	Overall relative charge
$^{24}_{12}Mg^{2+}$	12	12	10	(12+) + (10−) = 2+
$^{35}_{17}Cl^{-}$	17	18	18	(17+) + (18−) = 1−

Isotopes have the same	**Isotopes have different**
Number of protons and electrons	Different number of neutrons
Atomic number	Mass number
Chemical Properties (same number of electrons in their outer shell)	Physical properties

TASK 1

1. Complete the table below

Particle	Location	Relative Charge	Relative Mass
	nucleus		1
p^+			
		-1	

2.

Complete the table about these atoms and ions.

atom / ion	protons	neutrons	electrons	electron structure
$^{24}_{12}Mg^{2+}$				
$^{19}_{9}F^{-}$				
	19	20	18	
	17	18	17	
	8	10		2,8

3. In each case identify the particle. The first one has been done for you.

1	An atom with 6 protons and the same number of neutrons as a ^{14}N atom	$^{13}_{6}C$
2	An atom with one more proton and the same number of neutrons than an atom of ^{39}K	
3	An atom with 10 protons and the same number of neutrons as an atom of ^{24}Mg	
4	An atom with one fewer proton and the same number of neutrons as an atom of ^{66}Zn	
5	An atom with the same number of protons and two more neutrons as an atom of ^{79}Br	
6	An atom with two fewer protons and the same number of neutrons as an atom of ^{50}Cr	
7	An ion with one more proton and two more neutrons as an atom of ^{20}Ne but the same number of electrons	
8	An ion with two fewer protons and two fewer neutrons as an atom of ^{40}Ar but the same number of electrons	
9	An ion with two more protons and two more neutrons as an atom of ^{60}Ni but the same number of electrons	
10	An ion with two more protons and three more neutrons as an atom of ^{20}Ne but the same number of electrons	
11	An ion with one fewer proton, one fewer neutron and the same number of electrons as an atom of ^{129}Xe.	
12	An ion with one more proton, two more neutrons, but the same number of electrons as an ion of $^{85}Rb^{+}$	
13	A particle with two fewer protons, two fewer neutrons and the same number of electrons as an atom of ^{20}Ne	
14	A particle with one fewer proton, two fewer neutrons and one more electron as a $^{48}Ti^{2+}$ ion	
15	A particle with one fewer proton, two more neutrons and the same number of electrons as a $^{127}I^{-}$ ion	

TASK 2: MCQ Check-In

Q1.

Which species does **not** contain a total of 16 neutrons?

☐ **A** a molecule of ethene, $^{12}C_2{}^{1}H_4$

☐ **B** a molecule of oxygen, $^{16}O_2$

☐ **C** an atom of silicon, ^{30}Si

☐ **D** an ion of sulfur, $^{32}S^{2-}$

Q2.

Which species has 54 electrons and 52 protons?

A. $^{128}_{52}Te^{2-}$

B. $^{132}_{54}Xe^{2+}$

C. $^{132}_{54}Xe^{2-}$

D. $^{128}_{52}Te^{2+}$

Q3.

Which statement about the species $^{63}Cu^{2+}$ and $^{65}Cu^{+}$ is correct?

A. Both species have the same number of protons.
B. Both species have the same number of electrons.
C. Both species have the same number of neutrons.
D. Both species have the same electron arrangement.

Q4.

The hydroxide ion, OH^-, has a total of 9 protons.
How many neutrons and electrons are there in this ion?

	Number of neutrons	Number of electrons
☐ **A**	8	8
☐ **B**	8	10
☐ **C**	9	8
☐ **D**	9	9

Q5.

The table below shows the number of protons, neutrons and electrons present in five species.

Species	Number of protons	Number of neutrons	Number of electrons
X	6	8	6
Y	7	7	7
Z	7	7	8
W	8	8	8
Q	8	10	8

Which **two** species are isotopes of the same element?

A. X and W
B. Y and Z
C. Z and W
D. W and Q

Q6.

Which statement about subatomic particles is correct?

☒ **A** neutral atoms always contain the same number of protons and electrons

☒ **B** neutral atoms always contain the same number of protons and neutrons

☒ **C** electrons have a relative mass of 1 and a charge of −1

☒ **D** protons have a relative mass of 1 and no charge

Q7.

An atom of $^{15}_{7}N$ forms a nitride ion, N^{3-}.
What are the numbers of protons, neutrons and electrons in this ion?

	Protons	Neutrons	Electrons
☒ **A**	7	8	7
☒ **B**	7	8	4
☒ **C**	7	8	10
☒ **D**	8	7	10

Q8.
Which statement about the isotopes of an element is correct?

A. They have the same mass number.
B. They have a different atomic number.
C. They have the same chemical properties.
D. They are located in different places in the periodic table.

Extension Reading Task - Uses of Radioisotopes

https://chem.libretexts.org/Courses/Sacramento_City_College/SCC%3A_CHEM_330_-_Adventures_in_Chemistry_(Alviar-Agnew)/11%3A_Nuclear_Chemistry/11.05%3A_Uses_of_Radioisotopes

DP Chemistry: Isotopes in teeth (thinkib.net)

Specification content
2.1.1 **(c)** explanation of the terms *relative isotopic mass* (mass compared with one twelfth the mass of carbon-12) and *relative atomic mass* (weighted mean mass compared with one twelfth the mass of carbon-12), based on the mass of a carbon-12 atom, the standard for atomic masses **(d)** use of mass spectrometry in: **(i)** the determination of relative isotopic masses and relative abundances of the isotope, **(ii)** calculation of the relative atomic mass of an element from the relative abundances of its isotopes **(e)** use of the terms *relative molecular mass*, *Mr*, and *relative formula mass* and their calculation from relative atomic masses.

Some important definitions!

Relative atomic mass	weighted mean mass of an atom of an element compared to 1/12th the mass of a ^{12}C atom
Relative isotopic mass	mass of an atom of an isotope compared to 1/12th the mass of a ^{12}C atom

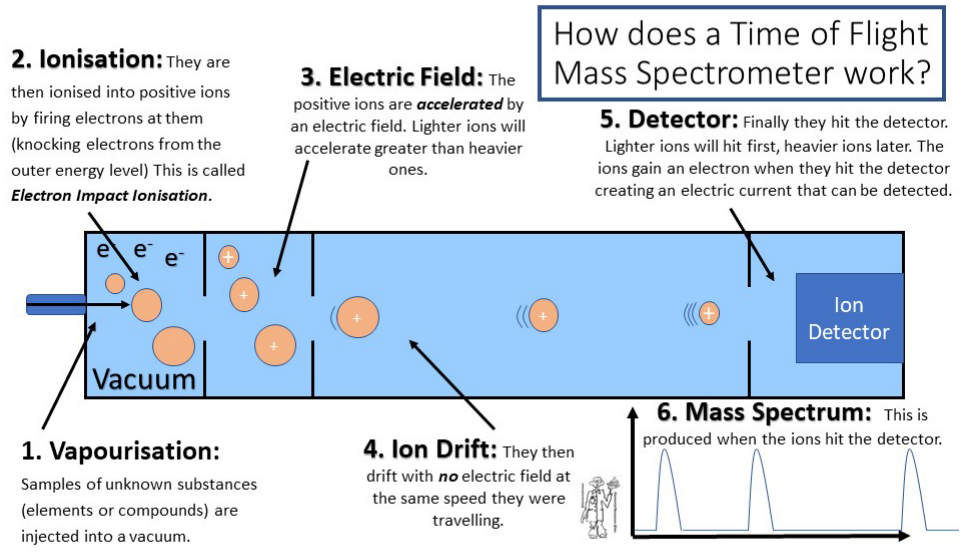
How do we measure the mass of an atom?

Atoms are far too small for you to measure their mass directly by weighing (10^{-24} to 10^{-22}g)

1919 F. W. Aston invented the mass spectrometer, allowing scientists to determine the masses of atoms and molecules

Mass Spectrometer	an instrument for obtaining a mass spectrum that can be used to measure the relative masses of isotopes or to find the relative abundances of the isotopes in a sample of an element

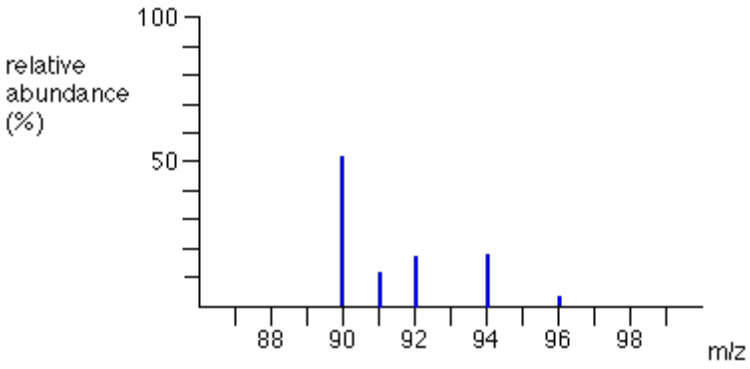
Knowledge of the mass spectrometer NOT required.
EXTENSION BACKGROUND INFO: Time of Flight Mass Spectrometer



The detector is coupled to a computer that calculates the mass to charge (m/z) ratio of each positive ion and its relative abundance compared with the most abundant particle. This is then converted into a % for each positive ion.

NB By first using a reference compound with a known structure and M_r the computer can print a scale on the mass spectrum

Output:

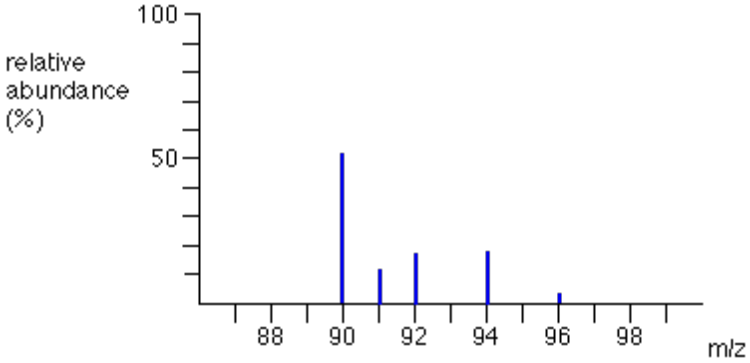


Uses – the determination of A_r of an element

Video: 2.1 Calculate non-integer RAM/abundance of isotopes from given data [SL IB Chemistry]

The peaks equal different isotopes of the element.
The relative heights of the peaks show the relative abundance of the different ions present.

Mass spectrum of zirconium



To calculate the relative atomic mass, you need to calculate the weighted mean to take into account the relative abundances of the different isotopes.

(% abundance x mass of isotope) + (% abundance of isotope x mass of isotope)…
100

Worked example

zirconium-90 51.5%

zirconium-91 11.2%

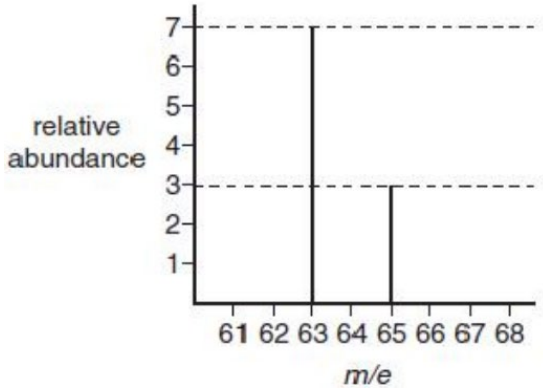
zirconium-92 17.1%

zirconium-94 17.4%

zirconium-96 2.8%

Relative atomic mass = (90 x 51.5 + 91 x 11.2 + 92 x 17.1 + 94 x 17.4 + 96 x 2.8)/100 = 91.3
Or = 90 x 0.515 + 91 x 0.112 + 92 x 0.171 + 94 x 0.174 + 96 x 0.028 = 91.3

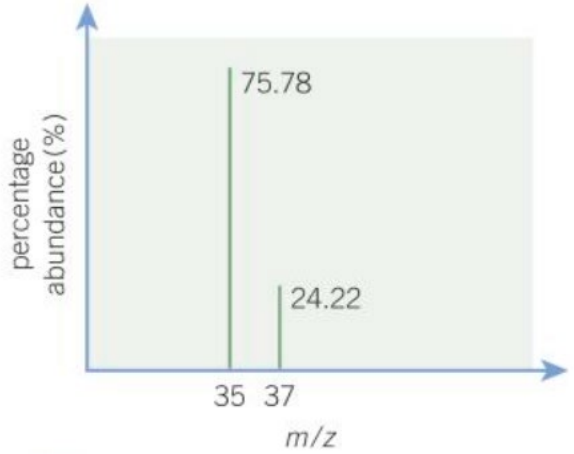
TASK 3

Define the term relative atomic mass	
Define the term relative isotopic mass	
The element sulfur has three isotopes: ^{32}S, ^{33}S, and ^{34}S. I_r / % abundance 31.97 / 95.0 32.07 / 0.77 33.97 / 4.23 Given the above relative isotopic masses (I_r) and percentage abundances, determine the relative atomic mass of sulfur to 2 decimal places.	
The diagram shows the mass spectrum of a sample of naturally occurring copper. What is the relative atomic mass of this copper to 1 decimal place?  	$\%\ \text{abundance} = \frac{\text{peak height}}{\text{total height of all the peaks}} \times 100$

The data below gives the m/z ratio and the relative abundance of different isotopes of an element Z. Determine the relative atomic mass of the element X to 1 d.p.

Suggest an identity for X.

m/z	abundance
204	2.7
205	0.0
206	46.0
207	42.2
208	100.0



▲ **Figure 4** *Mass spectrum of chlorine*

3 The accurate relative isotopic masses for the isotopes chlorine-35 and chlorine-37 are 34.968 852 721 69 (^{35}Cl) and 36.965 902 621 1 (^{37}Cl).

a Calculate the relative atomic mass of chlorine, as shown in the worked example, using these accurate isotopic masses. (*2 marks*)

b Comment on whether the difference from use of mass numbers is significant. (*1 mark*)

Determining the percentage abundance of each isotope from the atomic mass

Videos:
CALCULATING % ABUNDANCE OF ISOTOPES - SIMPLE 'TUG OF WAR' METHOD
CALCULATING % ABUNDANCE OF ISOTOPES FROM R.A.M. - MATHEMATICAL APPROACH

Worked Example

The atomic mass of chlorine is 35.5. The naturally occurring isotopes are ^{35}Cl and ^{37}Cl. Determine the percentage abundance of each isotope.

% abundance ^{35}Cl = 100 - y
% abundance ^{37}Cl = y

(35(100-y) + 37y)/100 = 35.5
3500 - 35y + 37y = 3550
2y = 50
y = 25
% abundance ^{35}Cl = 100 - 25 = 75%
% abundance ^{37}Cl = 25%

TASK 4

Q. The relative atomic mass of copper is 63.5. Calculate the relative abundance of the two copper isotopes with relative isotopic masses of 63.0 and 65.0.

(4) The element boron (B) exists as two isotopes: $^{10}_{5}B$ and $^{11}_{5}B$. Given that the relative atomic mass of a sample of boron is 10.8, calculate the percentage abundance of each isotope in the sample. (2 marks)

Q. Samples of germanium consist of five isotopes, four of which are stable.
The fifth isotope, germanium-76, is radioactive but with a very long half-life.
This means that the isotopic composition is almost constant.
The table shows data for four of the isotopes.

Atom	^{70}Ge	^{73}Ge	^{74}Ge	^{76}Ge
Mass number	70	73	74	76
Abundance / %	20.5	7.8	36.5	7.8

(a) (i) Calculate the mass number of the fifth isotope of germanium. The relative atomic mass of germanium is 72.6. You must show your working. **(3)**

(ii) Give the main reason why the answer in (a)(i) should not be quoted to more than 2 significant figures.
(1)

.....
.....
.....

Rel. **molecular** mass (RMM/M_r) – **simple** molecules Rel. **formula** mass (RFM/M_r) – **giant** structure	M_r = **Sum of A_r** of all the atoms in a given formula

Questions

(5) Calculate the relative molecular mass of:
(a) iodine (I_2) **(b)** nitrogen dioxide (NO_2) (2 marks)

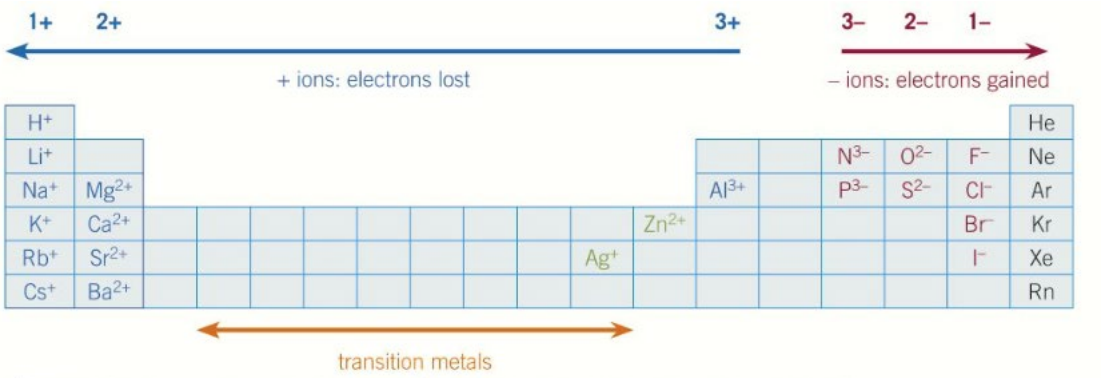
(6) Calculate the relative formula mass of:
(a) calcium hydroxide ($Ca(OH)_2$) **(b)** ethanol (C_2H_5OH) (2 marks)

Total: 15 marks

Assume the following relative atomic masses:
H = 1; C = 12; N = 14; O = 16; Ca = 40; I = 127

Specification content
2.1.2 **(a)** the writing of formulae of ionic compounds from ionic charges, including: **(i)** prediction of ionic charge from the position of an element in the periodic table **(ii)** recall of the names and formulae for the following ions: NO_3^-, CO_3^{2-}, SO_4^{2-}, OH^-, NH_4^+, Zn^{2+}, and Ag^+ construction of balanced chemical equations (including ionic equations), including state symbols, for reactions studied and for unfamiliar reactions given appropriate information.

Ionic Charges



▲ **Figure 1** *The charges of some simple ions can often be deduced from their position in the periodic table*

Polyatomic ions:

Name	**Formula**
Hydroxide	OH^-
Nitrate	NO_3^-
Carbonate	CO_3^{2-}
Sulphate	SO_4^{2-}
Ammonium	NH_4^+

Do not confuse ions like sulph**ate** with sulf**ide**. A name like sodium sulf**ide** means that it contains sodium and sulfur **only**. Once you have an '**ate**' ending it means that there is something else there as well – often, but not always, oxygen. (There are also '**ite**' endings, although these are a bit old-fashioned. These also have oxygen as well as the other element, but not as much as if it were an 'ate' ending. We will visit the modern way of naming compounds when we reach the redox topic)

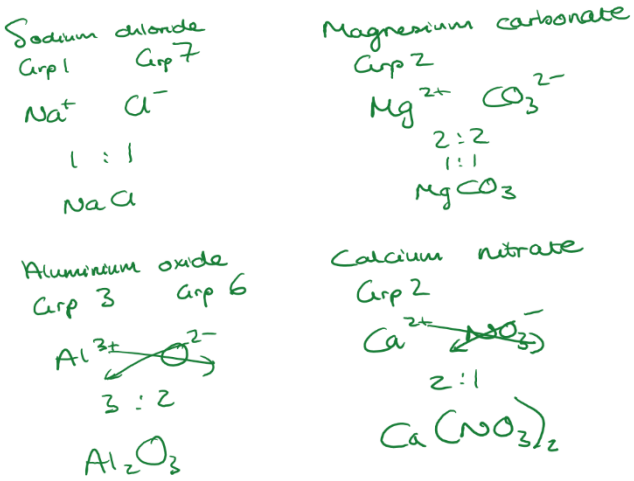
Quizlet: GCSE Formulae of Ions

Valency	Number of electrons used by an atom in bonding

Ionic Formulae

1. Write down the formulae of the ions given in the chemical name of the compound
2. Simplest valency ratio
3. Swap and drop the numbers

If an element has more than one valency e.g. transition metal ions, Roman numerals in the name of the compound gives the valency to be used e.g. copper (I) = Cu^{+}, copper (II) = Cu^{2+}



TASK 5

1. Name each compound from the formula.

NH_4Cl		Cu_2O	
AlN		$Cu(NO_3)_2$	
$Fe_2(SO_4)_3$		AgI	
Li_3PO_4		$Mg(OH)_2$	

2. Write formulae for the following:

Sodium chloride		Potassium sulfate	
Barium nitrate		Calcium carbonate	
Aluminium fluoride		Aluminium oxide	
Copper (II) oxide		Zinc (II) nitride	
Silver (I) oxide		Ammonium sulfate	
Magnesium phosphide		Iron (III) hydroxide	
Ammonium hydroxide		Iron (II) nitrate	

Hydrated ionic substances

Many solid ionic compounds contain water of crystallisation. The number of water molecules in the formula of a hydrated compound is given by a fall stop followed by the number of molecules of water. For instance, a formula unit of hydrated sodium carbonate contains ten molecules of water of crystallisation, so its formula is $Na_2CO_3.10H_2O$

NB If an ionic compound contains water of crystallisation, the mass of water must be taken into account when calculating molar masses.

2.1.2 b	Can you construct balanced chemical equations (including ionic equations), including state symbols, for reactions studied and for unfamiliar reactions given appropriate information?

General equations from GCSE

General Reaction	Examples
substance + oxygen → oxides	$2\ Mg + O_2 \rightarrow 2\ MgO$ $2\ H_2S + 3\ O_2 \rightarrow 2\ H_2O + 2\ SO_2$ $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
metal + water → metal hydroxide + hydrogen	$2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$
metal + acid → salt + hydrogen	$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$
oxide + acid → salt + water	$MgO + 2\ HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$
hydroxide + acid → salt + water	$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
carbonate + acid → salt + water + carbon dioxide	$CuCO_3 + 2\ HCl \rightarrow CuCl_2 + H_2O + CO_2$
hydrogencarbonate + acid → salt + water + carbon dioxide	$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$
ammonia + acid → ammonium salt	$NH_3 + HCl \rightarrow NH_4Cl$
metal carbonate → metal oxide + carbon dioxide (on heating)	$CaCO_3 \rightarrow CaO + CO_2$

Quizlet: GCSE Generic Equations

Chemical Equations

The law of conservation of matter (Lavoisier, 1774)

Matter cannot be created or destroyed in a chemical reaction

Video: The law of conservation of mass - Todd Ramsey

The law of conservation of mass or principle of mass conservation states that for any system closed to all transfers of matter and energy, the mass of the system must remain constant over time, as system's mass cannot change, so quantity cannot be added nor removed. Hence, the quantity of mass is conserved over time.

The law of constant composition (Proust, 1797)

A pure compound always consists of the same elements combined in the same proportion by mass

Equation writing with formulae:

1. Write word equation
2. Write symbol equation
3. Add state symbols

State symbols:

(s)	solid
(l)	liquid
(g)	gas
(aq)	solution in water

4. Balance

Left + right-hand side must have the same number of each type of atom

Equations must balance for total charge (2 positives on left, must also be on right etc.)

→ reaction goes to completion
⇌ reversible reaction

NB The small subscripted numbers inside formula only refer to the atom immediately in front of them, e.g. the 4 in H_2SO_4 only refers to the oxygen and not to the sulphur as well. The only exception to this is if you put brackets around something, e.g. $Ca(OH)_2$, the 2 applies to both the oxygen and the hydrogen.

A big number in front of a formula (coefficient) multiples up the whole of the that formula, e.g. $5CH_4$ means 5 lots of CH_4 – in other words 5 carbon atoms and 20 hydrogen atoms.
$5 \times CH_4 = CH_4 + CH_4 + CH_4 + CH_4 + CH_4 = 5 \times C + 20 \times H$

Some elements exist naturally in pairs, these are known as **diatomic elements** and there are seven of them. They can be remembered using a mnemonic.

Element	Symbol	Mnemonic
Iodine	I_2	I
Hydrogen	H_2	Have
Nitrogen	N_2	No
Bromine	Br_2	Bright
Oxygen	O_2	Or
Chlorine	Cl_2	Clever
Fluorine	F_2	Friends

Balancing equations

Online Game: https://phet.colorado.edu/en/simulation/balancing-chemical-equations

- Work across the equation from left to right checking one element after another, except if an element appears in several places in the equation. Leave it until the end – often, you will find that it has sorted itself out.
- If you have a group of atoms (like a sulphate group, for example) which is unchanged from one side of the equation to the other, there is no reason why you can't just count that up as a whole group, rather than counting individual sulfurs and oxygens. It saves time.
- Double check your final answer

NB The quantitative relationship in moles of the reactants and products is called the **stoichiometry** of the reaction.

Balancing equations with polyatomic ions:

Iron (III) oxide + nitric acid → iron (III) nitrate + water

$Fe^{3+}O^{2-}$ $Fe^{3+}(NO_3^-)_3$

$Fe_2O_3 + 6HNO_3 \rightarrow 2Fe(NO_3)_3 + 3H_2O$

2 × Fe ✓ 6 × 1 × H ✓ 2 × 1 × Fe ✓ 3 × 2 × H

3 × O ✓ 1 × NO_3 2 × 3 × NO_3 ✓ 3 × 1 × O

keep NO_3 together when balancing

Using non-integer numbers with molecules of elements and idea of ratios: ONLY

Ethane + oxygen --> carbon dioxide + water

$C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

2 × C ✓ $\frac{7}{2} \times 2 \times O = 7 \times O$ ✓ 2 × 1 × C ✓ 3 × 2 × H

6 × H ✓ 2 × 2 × O 3 × 1 × O

$\frac{7}{2}$ or 3.5 7 × O

Monkeys 1 × C

Gar 2 × C

Peanut / Pealed 3 × C

Butter / Bananas 4 × C

General formula alkanes = C_nH_{2n+2}

$1 : \frac{7}{2} : 2 : 3$

$2 : 7 : 4 : 6$ simplest whole nos. ratio.

TASK 6

1. Balance the following equations:
    a. $Ca + H_2O \rightarrow Ca(OH)_2 + H_2$

    b. $Al + O_2 \rightarrow Al_2O_3$

    c. $NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$

    d. $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$

    e. $NH_3 + O_2 \rightarrow NO + H_2O$

2. Rewrite the following equations as balanced symbol equations (state symbols are **not** required):
    a. Reaction of magnesium and oxygen

    b. Neutralisation of hydrochloric acid by sodium carbonate

    c. Neutralisation of sulfuric acid with sodium hydroxide

d. The complete combustion of butane

e. Reaction of lithium with water

f. The preparation of boron trichloride (BCl_3) from its elements

g. The extraction of iron from iron (III) oxide using carbon monoxide (redox reaction) forming iron and carbon dioxide.

h. The formation of one molecule of ClF_3 from chlorine and fluorine molecules

i. The reaction of nitrogen dioxide with water and oxygen to form nitric acid

j. Reaction of ammonia and nitric acid to form ammonium nitrate

TASK 7: MCQ Check-in Quiz

1. What is the sum of the coefficients when the following equation is balanced using the smallest whole numbers?

___ $C_6H_{12}O_{6(aq)}$ --> ___ $C_2H_5OH_{(aq)}$ + ___ $CO_{2(g)}$

A	4
B	5
C	9
D	10

2. Granular urea, CON2H4, can be used to remove NO2 from the flue gases of power stations, converting it into harmless nitrogen.

$2CON_2H_4 + xNO_2 \rightarrow 2CO_2 + yH_2O + zN_2$

What are the values of x, y and z in a balanced equation?

	x	y	z
A	1 1/2	2	1 1/4
B	2	4	3
C	3	4	3 1/2
D	3	4	3

3. In following equations the letters W, X, Y and Z all represent whole numbers. When correctly balanced, which equations requires one of the letters W, X, Y or Z to be 5?

A	$WC_3H_7COOH + XO_2 \rightarrow YCO_2 + ZH_2O$
B	$WC_4H_8 + XO_2 \rightarrow YCO_2 + ZH_2O$
C	$WH_3PO_4 + XNaOH \rightarrow YNa_2HPO_4 + ZH_2O$
D	$WNH_3 + XO_2 \rightarrow YN_2 + ZH_2O$

4. Write a balanced equation for the reaction between nickel (II) carbonate and dilute nitric acid, including state symbols

TASK 8

Please complete the below checklist activity. If you answered "no" to any of the questions below, please review the earlier section. To support your learning, you may find it helpful to use AI to generate additional practice questions. Simply copy and paste examples of the question types you'd like to focus on and ask ChatGPT to create similar questions—tailored to help you bridge the gap from GCSE to A-Level Chemistry.

Oxford A Level Sciences

OCR Chemistry A

2 Atoms, ions, and compounds Checklist

Atoms, ions, and compounds

Specification reference	Checklist questions	
2.1.1a	Can you describe isotopes as atoms of the same element with different numbers of neutrons and different masses?	☐
2.1.1 b	Can you describe atomic structure in terms of the numbers of protons, neutrons and electrons for atoms and ions, given the atomic number, mass number and any ionic charge?	☐
2.1.1 c	Can you explain the terms *relative isotopic mass* (mass compared with 1/12th mass of carbon-12) and *relative atomic mass* (weighted mean mass compared with 1/12th mass of carbon-12), based on the mass of a ^{12}C atom, the standard for atomic masses?	☐
2.1.1 d	Can you use mass spectrometry?	☐
2.1.1 d i	Can you use mass spectrometry to determine relative isotopic masses and relative abundances of the isotope?	☐
2.1.1 d ii	Can you use mass spectrometry to calculate the relative atomic mass of an element from the relative abundances of its isotopes?	☐
2.1.2 a	Can you write formulae of ionic compounds from ionic charges?	☐
2.1.2 a i	Can you predict ionic charge from the position of an element in the periodic table?	☐
2.1.2 a ii	Can you recall the names and formulae for the following ions: NO_3^-, CO_3^{2-}, SO_4^{2-}, OH^-, NH_4^+, Zn^{2+}, and Ag^+?	☐
2.1.2 b	Can you construct balanced chemical equations (including ionic equations), including state symbols, for reactions studied and for unfamiliar reactions given appropriate information?	☐

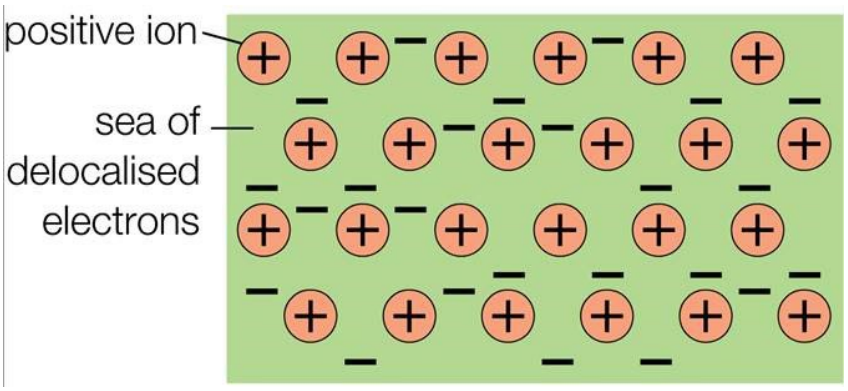
GCSE Structure and Bonding Review

Metallic Bonding (GIANT lattice) (new content for Double Award students)

Watch the following video: https://youtu.be/b1y2Q6YX1bQ?feature=shared

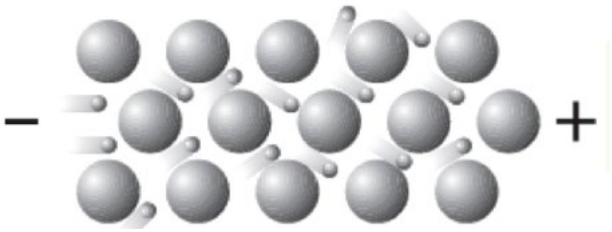
Metallic bonding	Electrostatic attraction between a lattice of positive ions (cations) and delocalised electrons

In metallic lattice, electrons from the outer shell of each metal atom are delocalised and free to move throughout the whole structure. The cations are in fixed positions.



Physical properties of metals

- ***High melting and boiling points*** – strong attractive forces between the cations and the 'sea' of delocalised electrons must be broken, requiring large amounts of energy
- ***High density*** – close-packing of metal atoms in one layer allows it to get as close as possible to those in the next
- ***Conduct electricity*** – delocalised electrons are free to move and act as charge carriers when a potential difference is applied



- ***Good conductors of heat*** – when a metal is heated, energy is transferred to the electrons. The delocalised electrons move around faster (increased kinetic energy) and conduct the heat (energy) rapidly to other parts of the metal
- ***Malleable*** (can be bent or hammered into different shapes) and ***ductile*** (can be pulled out into wires)– the bonding in metals is non-directional and so the layers of cations can slide over one another without breaking the metallic bond

TASK 9

1. Define the following:

Ionic bond

Covalent bond

Metallic bond

Intermolecular force

2. Complete the table below. You may use the following word to help you.

Ionic covalent giant simple metallic

Substance	Type of bonding	Type of structure
Hydrogen sulfide		
Graphite		
Silicon dioxide		
Methane		
Calcium		
Magnesium chloride		

3. (tetra = 4)

Chlorine forms compounds with magnesium and with carbon.

a Draw a dot-and-cross diagram to show the electronic structure of the compound magnesium chloride (only the outer electrons need be shown). Include the charges present.

(2 marks)

b Draw a dot-and-cross diagram to show the electronic structure of the compound tetrachloromethane (only the outer electrons need be shown).

(2 marks)

c Draw a dot-and-cross diagram of a molecule of carbon dioxide. Show outer electrons only.

(2 marks)

4. The properties of elements and their compounds are determined by their structure and bonding.

   Element **X** has the typical appearance of a metal.
   Predict **two** other distinct physical properties that element **X** would exhibit if it is a metal.
   Explain your choices in terms of structure and bonding. **(4 marks)**

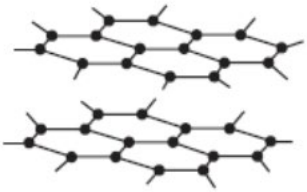
5. The table shows some properties of lithium fluoride and carbon tetrafluoride.

Compound	Melting point	Ability to conduct electricity when molten or liquid
lithium fluoride	high	good
carbon tetrafluoride	low	poor

   Explain these properties of each compound. **(4)**

6. Diamond and graphite are two naturally-occurring forms of carbon.

   The diagrams below show the arrangement of the carbon atoms in diamond and in graphite. The black dots (•) represent carbon atoms.

Diamond	Graphite
	

   By referring to their structure and bonding explain why diamond and graphite relative hardness and electrical conductivity. **(6)**

GCSE Moles Review

TASK 10: Moles and Avogadro's Constant

GCSE Chemistry Revision "Avogadro's Constant 1"
GCSE Chemistry Revision "Avogadro's Constant 2"

1. Which contains the greatest number of moles of oxygen atoms?

A. 0.05 mol $Mg(NO_3)_2$

B. 0.05 mol $C_6H_4(NO_2)_2$

C. 0.1 mol H_2O

D. 0.1 mol NO_2

2. What is the number of hydrogen atoms in 2.00 moles of $Ca(HCO_3)_2$?

Avogadro's constant, L or N_A: 6.02×10^{23} mol^{-1}

A. 2.00

B. 4.00

C. 1.20×10^{24}

D. 2.41×10^{24}

3. What is the number of atoms of oxygen in 2.0 mol of hydrated sodium carbonate, $Na_2CO_3 \bullet 10H_2O$?
Avogadro's constant, L or N_A: 6.02×10^{23} mol^{-1}

A. 6

B. 26

C. 3.6×10^{24}

D. 1.6×10^{25}

4. The value of the Avogadro constant is equal to the number of

A. grams of carbon in one mole of carbon

B. atoms in one mole of oxygen gas

C. atoms in one mole of helium gas

D. ions in one mole of sodium chloride

TASK 11: Reacting Masses and Percentage Yield

GCSE Chemistry Revision "Reacting Masses 1"
GCSE Chemistry Revision "Reacting Masses 2"
GCSE Chemistry Revision "Limiting reactant"
GCSE Chemistry Revision "Calculating Percentage Yield 1" (Triple)
GCSE Chemistry Revision "Calculating Percentage Yield 2" (Triple)

1. When 0.127 g of copper is added to excess silver nitrate solution, the following reaction occurs.

   $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

   What mass of silver is formed?

2. 5.0mol of $Fe_2O_3(s)$ and 6.0mol of $CO(g)$ react according to the equation below. What is the limiting reactant and how many moles of the excess reactant remain unreacted?

   $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

3. In an experiment, 1.226 g of potassium chlorate(V), $KClO_3$, was heated. A mass of 0.320 g of oxygen gas, O_2, was collected.

   $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

   Use the molar mass of $KClO_3$ = 122.6 g mol^{-1} and relative atomic mass O = 16.
   The percentage yield of oxygen in this experiment is

4. Hydrogen is manufactured using the reaction

   $CH_4 + H_2O \rightarrow CO + 3H_2$

   The percentage yield of hydrogen in this process is 90%.
   The mass of hydrogen, in tonnes, which can be produced from 160 tonnes of methane is

5. Sodium peroxide, Na_2O_2, is formed by the reaction of sodium oxide with oxygen.

   $2Na_2O\ (s) + O_2\ (g) \rightarrow 2Na_2O_2\ (s)$

   Calculate the percentage yield of sodium peroxide if 5.00 g of sodium oxide produces 5.50 g of sodium peroxide.

TASK 12: Empirical and Molecular Formulae

GCSE Chemistry Revision "Calculating Percentage by Mass"
Calculating Empirical Formula
Calculating Water of Crystallisation

1. Calculate the percentage by mass of chlorine in $CCl_2F_2CCl_2F_2$.

2. A compound X contains carbon, hydrogen and oxygen only. X contains 54.54% of carbon by mass, 9.09% of hydrogen by mass and 36.37% of oxygen by mass.

   (i) Calculate the empirical formula of compound X.

   (ii) Compound X has a relative molecular mass of 88. Deduce the molecular formula of compound

3. Copper(II) nitrate forms a series of hydrates with the formula $Cu(NO_3)_2.xH_2O$. All these hydrates decompose to form copper(II) oxide. 1 mole of $Cu(NO_3)_2.xH_2O$ forms 1 mole of CuO.

$2Cu(NO_3)_2 \rightarrow 2CuO + 4NO_2 + O_2$

7.26 g of a hydrate, $Cu(NO_3)_2.xH_2O$, formed 2.4 g copper(II) oxide. Calculate the value of x.

4. A mineral of the type $FeSO_4.xH_2O$ contains 37.2% of water. Complete the calculation to determine x. M_r $FeSO_4$ = 152, H_2O = 18.

5. A hydrocarbon, C_xH_y, is burned in excess oxygen, forming 26.4 g of carbon dioxide and 5.4 g of water.

   The relative formula mass of C_xH_y is 78.

   Calculate the molecular formula of the hydrocarbon C_xH_y.

   (relative atomic masses: H = 1.0, C = 12;
   relative formula masses: H_2O = 18, CO_2 = 44)

6. The complete combustion of 15.0cm^3 of a gaseous hydrocarbon **X** produces 60.0 cm^3 of carbon dioxide gas and 75.0 cm^3 of water vapour. What is the molecular formula of **X**? (All volumes are measured at the same temperature and pressure.)

TASK 13: Volumetric Moles

GCSE Chemistry - Moles, Concentration & Volume Calculations #29

1. What mass of NaCl (in grams) is required to prepare 250 cm^3 of a 0.200 mol dm^{-3} solution?

2. What volume, in cm^3, of 0.20 mol dm^{-3} NaOH (aq) is needed to neutralize 0.050 mol of $H_2S(g)$?

   $H_2S(g) + 2NaOH(aq) \rightarrow Na_2S(aq) + 2H_2O(l)$

3. 25.0 cm^3 H_2SO_4 is neutralised by 35.0 cm^3 of 0.150 mol dm^{-3} NH_3.

   $H_2SO_4 + 2NH_3 \rightarrow (NH_4)_2SO_4$

   Calculate the concentration of the sulfuric acid.

4. Which of the following solutions will produce a neutral solution when reacted with 0.05 mol of sulfuric acid?

   A.50.0 cm^3 of 1.00 mol dm^{-3} NaOH 50.0 cm^3 of 1.00 mol dm^{-3} NaOH

   B.100.0 cm^3 of 2.00 mol dm^{-3} NaOH 100.0 cm^3 of 2.00 mol dm^{-3} NaOH

   C.100.0 cm^3 of 2.00 mol dm^{-3} $Ca(OH)_2$ 100.0 cm^3 of 2.00 mol dm^{-3} $Ca(OH)_2$

   D.25.0 cm^3 of 2.00 mol dm^{-3} $Ca(OH)_2$ 25.0 cm^3 of 2.00 mol dm^{-3} $Ca(OH)_2$

5. 3.26 g of iron powder are added to 80.0 cm^3 of 0.200 mol dm^{-3} copper(II) sulfate solution. The following reaction occurs:

$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$

(i) Determine the limiting reactant showing your working.

The mass of copper obtained experimentally was 0.872 g.

(ii) Calculate the percentage yield of copper.

TASK 14: Gaseous Moles

GCSE Chemistry Revision "Using Gas Volumes 2" (Triple)

1. What volume of ethane gas, in cm^3, will produce $40cm^3$ of carbon dioxide gas when mixed with $140cm^3$ of oxygen gas, assuming the reaction goes to completion?

   $2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(g)}$

2. Calcium carbonate is heated to produce calcium oxide, CaO.

   $CaCO_3\,(s) \rightarrow CaO\,(s) + CO_2\,(g)$

   Calculate the volume of carbon dioxide produced at RTP when 555 g of calcium carbonate decomposes. Molar volume of gas = 24 dm^3mol^{-1}

3. What volume of oxygen, in dm^3 at RTP, is needed when 5.8 g of butane undergoes complete combustion? Molar volume of gas = 24 dm^3mol^{-1}

$2C_4H_{10(g)} + 13O_{2(g)} \rightarrow 8CO_{2(g)} + 10H_2O_{(l)}$

4. What volume of carbon dioxide, CO_2 (g), can be obtained by reacting 1 dm^3 of methane, CH_4 (g), with 1 dm^3 of oxygen, O_2 (g)?

   CH_4 (g) + $2O_2$ (g) → CO_2 (g) + $2H_2O$ (l)

5. What is the maximum volume, in dm^3, of CO_2(g) produced when 1.00 g of $CaCO_3$(s) reacts with 20.0 cm^3 of 2.00 mol dm^{-3} HCl(aq)?

   $CaCO_3$(s) + 2HCl(aq) → $CaCl_2$(aq) + H_2O(l) + CO_2(g)

   Molar volume of gas = 24 dm^3mol^{-1}

6. 150 cm^3 of ethane is mixed with 700 cm^3 of oxygen. The equation for the reaction is

   $C_2H_6(g) + 3\frac{1}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

   What is the total volume of gas when the reaction is complete?

   All gas volumes are measured at the same temperature and pressure.

Further Reading (optional)

Berko Library Science page:
https://berkhamstedschools.sharepoint.com/sites/BSG-Students/SitePages/Senior-Subjects-Library-Resources.aspx

General:
https://www.chemistryworld.com/
C&EN | Chemistry news from around the world (acs.org) (includes monthly magazine)

Podcasts:
Periodic Table: Podcast (rsc.org)
Our chemistry podcasts (rsc.org)
Chemistry podcasts & science storytelling | Chemistry World
Stereo Chemistry podcast | C&EN - American Chemical Society (acs.org)
Brought to you by chemistry (podcast)
https://www.imperial.ac.uk/molecular-science-engineering/publications-and-outputs/podcast/
https://www.bbc.co.uk/programmes/b07dx75g
https://www.thenakedscientists.com/science-podcasts
https://www.newscientist.com/podcasts/
https://www.oxfordsparks.ox.ac.uk/oxford-sparks-podcasts/page/4/
https://player.fm/podcasts/university-of-oxford-chemistry-department
https://podcasts.ox.ac.uk/series/chemistry-future-incredible-machines

YouTube Channels
https://www.youtube.com/nilered
https://www.youtube.com/@periodicvideos

Webinars:
https://www.imperial.ac.uk/be-inspired/schools-outreach/secondary-schools/stem-events/meet-the-researcher-webinar-series/

Reading for Edge (starting point, more recommendations to follow!):

Title	**Author**	**Berkhamsted School Libraries**	**Hertfordshire Library Network**
Why Chemical reactions Happen	Keeler, J., Wothers, P.	Castle + Kings	No
The Disappearing Spoon	Kean, S	Castle + Kings	Yes
Periodic Tales: The Curious Lives of the Elements	Aldersey-Williams, H.	Castle Kings	No
Stuff Matters: The Strange Stories of the Marvelous Materials that Shape our Man-made World	Miodownik, M.	Castle Kings	No
Napoleon's Buttons: 17 molecules that changed history	Le Couteur, P	Chemistry Dept. has a copy for borrowing	No
Bad Science	Goldacre, B.	Castle Kings	Yes