Chemistry: Transition to A Level

Subject: Chemistry   Year Group: Year 11 into Year 12

Exam board: OCR (Chemistry A)

Contents

1. Introduction

Moving from GCSE to A level can be a daunting step. There is a significant difference in terms of the amount you need to be able to recall, the level of detail required, and applying your new knowledge and skills to unfamiliar situations. Chemistry is a practical subject and a significant part of the work involves laboratory work, which is assessed in written examinations. Additionally, practical work is separately certified upon successful completion. This transition document is designed to help you prepare for the transition to A level. It includes sections on several topics which you have met at GCSE, in addition to suggested reading and some careers information. A separate document is supplied which contains tasks to complete, and which must be submitted to your teacher at the start of the course. Important skills to acquire and develop are working independently, organising and planning your work. The best advice is not to leave the tasks and reading to the last minute, nor to complete it in the first few days upon receipt, but to plan the use of your time carefully, producing higher quality work and a deeper and more sustained knowledge base.
The course requirements are a Grade 5 at GCSE in both Chemistry (or Combined Science) and Maths, however experience has shown that to do well and be secure in the subject, a Grade 6 in both Chemistry and Maths is preferred.

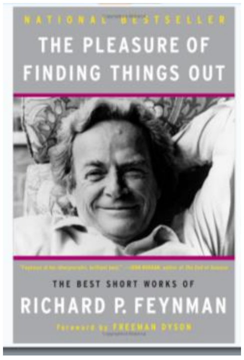
2. Further reading

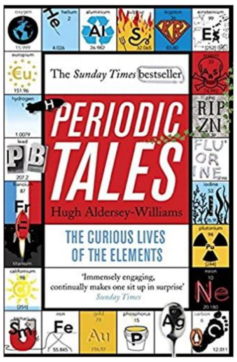
Useful websites:
Chemguide - https://www.chemguide.co.uk/

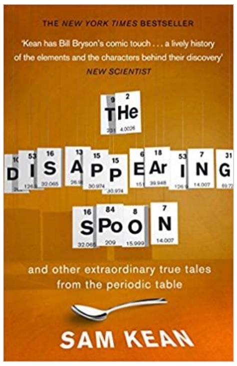
Royal society of Chemistry - https://www.rsc.org/
Seneca - https://www.senecalearning.com/
GCSEPod - https://www.gcsepod.com/
BBC Bitesize - https://www.bbc.co.uk/bitesize/examspecs/z8xtmnb
Physics and Maths Tutor - https://www.physicsandmathstutor.com/chemistry-revision/gcse-aqa/

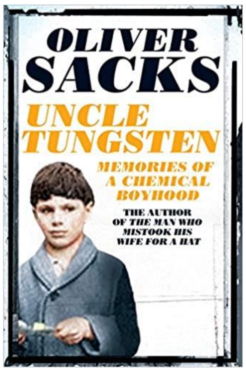
Some book suggestions:

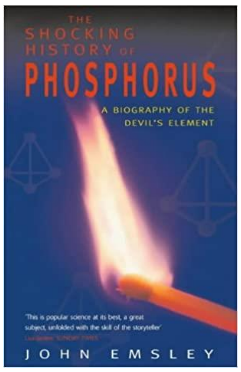
- The Pleasure of Finding Things Out: The Best Short Works of Richard Feynman (Paperback) by Feynman, Richard, Dyson, Freeman. (£12.99)
- Periodic Tales: The Curious Lives of the Elements (Paperback) by Hugh Aldersey-Williams. (£9.99)
- The Disappearing Spoon...and other true tales from the Periodic Table (Paperback) by Sam Kean (£8.17)
- Shocking History of Phosphorus: A Biography of the Devil's Element (Paperback) by John Emsley.
- Uncle Tungsten: Memories of a Chemical Boyhood (Paperback) by Oliver Sacks. (£8.19)





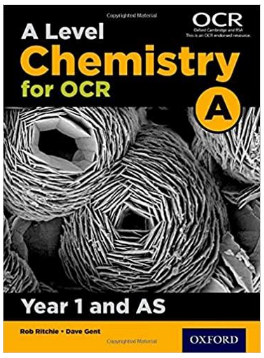






Course textbook:

- A Level Chemistry for OCR A: Year 1 and AS (Paperback) by Rob Ritchie (Author), Dave Gent (Author). (£13.69)



3. Careers

Chemistry is a much sought after qualification for many careers. Many students take a Chemistry related degree opening careers such as medicinal chemist (designing new medicines in the pharma industry), environmental chemist (analysing chemicals in the environment), polymer chemist (biodegradable polymers), food chemist, analytical chemist (industry, health care), chemical engineering and forensic science. Chemistry is a required A level for entry into medicine, dentistry, veterinary science. As a subject, it facilitates entry into many areas of Biology and Physics. Due to the analytical skills, problem solving skills and logical thinking in Chemistry, many students use it as a gateway into finance (accountancy, banking). Academic professions (lecturer, researcher, teacher) too.

4. MOOCS

MOOCS are massive online open courses. Many are free. This one by the University of Kentucky is free and is useful for the GCSE to A level transition. You need to sign up for coursera, this is just an administrative requirement.

https://www.coursera.org/learn/chemistry-1

5. Bridging skills and Knowledge

In each section there are practice questions at the end. The answers to these can be found in Appendix A.

a. Atomic structure

Learning outcomes:

- Be able to calculate the number of protons, neutrons and electrons in an isotope
- Be able to define an isotope
- Be able to calculate the relative atomic mass of an atom

AQA Chemistry student book pages 14-19 (C1.4-C1.6) Freescience lessons: Atomic and mass numbers https://www.youtube.com/watch?v=k8cLFDa8zmY Relative atomic mass: https://www.youtube.com/watch?v=MGLrYaI_UfE

Prior knowledge: You should know the relative mass and charge of protons, electrons and neutrons, the location of these sub-atomic particles, and the number of electrons allowed in each shell.

Definition: An isotope is an atom of an element with the same number of protons and different numbers of neutrons.

Example question on calculating protons, electrons and neutrons.

- State the number of protons, electrons and neutrons in ^{19}F.

From the periodic table (there is one in the appendix), the atomic number of F is 9.

There are therefore 9 protons and 9 electrons. The number of neutrons is the mass number – atomic number, which is 19-9 = 10 neutrons.

Atoms can exist as mixtures of isotopes, each with a different abundancy. To calculate the relative atomic mass of an atom of an element, we use the following method, which takes into account the relative abundancy of each isotope.

Example question to calculate relative atomic mass

- *Chlorine exists as two isotopes, ^{35}Cl which is 75.8% abundant and ^{37}Cl which is 24.2% abundant, calculate the relative atomic mass of chlorine.*

Relative atomic mass = $\frac{(35 \times 75.8) + (37 \times 24.2)}{100}$ *= 35.484 = 35.5 to 3 sig figs*

Practice questions

1. State the number of protons, electrons and neutrons in the following isotopes:

a. ^{23}Na b. ^{9}Be c. ^{51}V d. ^{80}Br e. $^{39}K^{+}$ f. $^{19}F^{-}$

2. State the electron configuration of these atoms and ions.

a. Li b. Mg c. C d. O^{2-} e. Al^{3+}

3. Calculate the relative atomic mass of the following elements:
   a. Gallium has 2 isotopes: Ga-69 60.2% and Ga-71 39.8%
   b. Silver has 2 isotopes: Ag-107 51.35% and Ag-109 48.65%
   c. Thallium has 2 isotopes: Tl-203 29.5% and Tl-205 70.5%

b. Chemical formula and balancing equations

- To be able to state the charges of common ions
- To be able to deduce the formula of ionic compounds
- To be able to write balanced symbol equations

AQA Chemistry student book pages 38-41 (C3.2-C3.3) and pages 6-7 (C1.2)

Freescience lessons:

Charges of Ions: https://www.youtube.com/watch?v=6KqEIfUJoMs

Formula of Ionic Compounds: https://www.youtube.com/watch?v=Ua0DOzmKqIk

Balancing Chemical Equations: https://www.youtube.com/watch?v=vxCyzR6uETs

Ions, formulas and balancing equations

Atoms lose or gain electrons to form ions in order to achieve a stable electron configuration (a full outer shell). The charge of an ion can be deduced from the position of an element on the periodic table (e.g. Mg is in group 2, so it loses two electrons to form the Mg^{2+} ion). Some ions contain more than one atom (e.g. the nitrate ion, NO_3^-). The formulas and charges of these ions must be learned.

When forming an ionic compound, the charges of the ions must cancel out, so that the compound has no overall charge (e.g. one Mg^{2+} ion must bond with two Cl^- ions to form magnesium chloride, $MgCl_2$).

When writing chemical equations, care must be taken to ensure that the equation is balanced. Atoms cannot be created or destroyed, and reactions must obey the law of conservation of mass, so there must be the same number of atoms of an element on each side of the equation. Balancing equations is always achieved by changing the number of molecules of each substance in the equation; never by changing the formula of the substances. For example:

$$Na + O_2 \rightarrow Na_2O$$

This equation is not balanced:

1 Na atom + 2 O atoms → 2 Na atoms + 1 O atom

We are not allowed to change Na_2O to Na_2O_2

Instead, multiply Na_2O by 2

$$Na + O_2 \rightarrow 2Na_2O$$

This equation is still not balanced:

1 Na atom + 2 O atoms → 4 Na atoms + 2 O atoms

Now multiply Na by 4

$$4Na + O_2 \rightarrow 2Na_2O$$

This equation is now balanced:

4Na atoms + 2 O atoms → 4 Na atoms + 2 O atoms

Practice questions

1. Write the formulas of the following ions:

a. Potassium
b. Sulfide
c. Calcium
d. Ammonium
e. Hydroxide
f. Sulfate

2. Write the formula of the following ionic compounds:

a. Potassium oxide
b. Lithium sulfide
c. Calcium nitrate

d. Ammonium chloride   e. Magnesium hydroxide   f. Sodium sulfate

3. Balance the following equations:

a. $H_2 + O_2 \rightarrow H_2O$

b. $Na + H_2O \rightarrow NaOH + H_2$

c. $Fe + O_2 \rightarrow Fe_2O_3$

d. $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

e. $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

f. $Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$

d. The mole and reacting masses

The mole

Learning outcomes:

- To be able to calculate the relative formula mass (Mr) of compounds
- To be able to calculate the number of atoms or particles using Avagadro's constant
- To be able to calculate the number of moles, the mass, or the Mr using the equation n=m/Mr

AQA Chemistry student book pages 62-65 (C4.1-C4.2)

Freescience lessons:

Calculating moles of an element: https://www.youtube.com/watch?v=-_-fNVmDwJk

Calculating moles of a compound: https://www.youtube.com/watch?v=Md4BQL91U6w

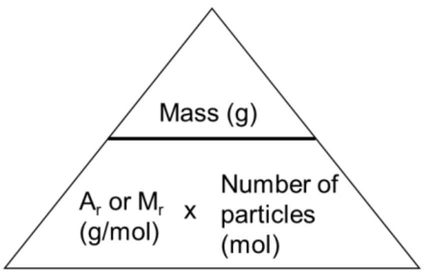
Chemical reactions take place between atoms, molecules or ions. These have very small masses, and chemists need to weigh materials using grammes and measure volumes using cm^3. They therefore use relative atomic mass and use the concept of the mole to link the two together.

The mole is an 'amount of substance'. It is the number of atoms in 12.00 g of the carbon-12 isotope, which is 6.02×10^{23}. This number is given the name Avogadro's constant. So 12.00 g of carbon-12 contains 6.02×10^{23} atoms.

Relative atomic mass (Ar) takes into account the different isotopes of an atom and their relative abundancies. The relative atomic mass of chlorine is 35.5, so 1 mole of chlorine atoms contains 6.02×10^{23} atoms and has a mass of 35.5g.

Relative formula mass (Mr) is used for compounds. For example, the mass of one mole of carbon dioxide CO_2 is 44g, as it contains 1 mole of carbon atoms and 2 moles of oxygen atoms – (12 x 1) + (16 x 2) = 44. Two moles of carbon dioxide would have a mass of 88g (44 x 2).

The equation that links the number of moles (n), mass (m) and relative formula mass (Mr) is shown below, rearranged for each subject, so too is the formula triangle.



$$n = \frac{m}{M_r} \quad ; \quad m = n \times M_r \quad ; \quad M_r = \frac{m}{n}$$

Example questions

1. *Work out the relative formula mass of these elements and compounds.*

a. F_2 b. $MgSO_4$ c. $Ca(OH)_2$

a. *The relative atomic mass of F is 19. The Mr is 2 x 19 = 38*
b. *The Ar of Mg is 24, S is 32, O is 16. There are 4 O atoms. Mr = 24 + 32 + (4 x 16) = 120*
c. *The brackets around OH means there are 2 lots of OH. One OH has an Mr of 17 (16 + 1). Mr = 40 + (17 x 2) = 78.*

2. *What is the mass of*
   a. *2 moles of helium atoms?*
   b. *6 moles of water molecules?*
   c. *12.3 moles of carbon monoxide molecules?*

   a. *m = n x Ar. The Ar of He is 2. Mass = 2 x 2 = 4g*
   b. *The Mr of H_2O is 18 (16 + 1 + 1). Mass = 6 x 18 = 108g*
   c. *The Mr of CO_2 = 44. Mass = 12.3 x 44 = 541.2g*

3. *Calculate the number of moles for*
   a. *24g of carbon*
   b. *50g of $CaCO_3$*

   a. *n = m/Mr n = 24/12 = 2 moles*
   b. *Mr of CaCO3 = 100. n = 50/100 = 0.5 moles*

Practice questions

1. Calculate the relative formula mass of these elements and compounds.

a. N_2 b. CaI c. $SrSO_4$ d. KNO_3 e. $Al(OH)_3$ f. $Al_2(SO_4)_3$

2. Calculate the mass of:

a. 3 moles of Na atoms
b. 0.4 moles of chlorine (Cl_2) molecules
c. 22 moles of methane CH_4
d. 0.12 moles of ethanol C_2H_5OH

3. How many moles are there in:

a. 78g of potassium?
b. 0.2g of argon?
c. 4.1g of HCl?
d. 0.9g of sodium hydroxide NaOH?

Reacting masses

Learning outcomes:

- To be able to calculate the masses of reactants and products in a chemical reaction given a balanced equation for the reaction and the mass of one reactant or product.

AQA Chemistry student book pages 64-65 (C4.2) Freescience lessons: Reacting masses 1: https://www.youtube.com/watch?v=TV6n5MFH6IU Reacting masses 2: https://www.youtube.com/watch?v=5zOpoeN0dV0

Chemists need to be able to calculate the masses of reactants and products in a chemical reaction, so that they know how much of the reactants to weigh out to make a certain amount of the product. To do this, they need a balanced equation for the reaction, and then follow a 3 step method using the mole equation n = m/Mr.

Example 1 – the thermal decomposition of calcium carbonate produces calcium oxide and carbon dioxide. A chemist heated 40g of calcium carbonate, how much calcium oxide would be made?

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

<u>Step 1</u>. Calculate the number of moles of calcium carbonate (step 1 is always to calculate the number of moles from the mass of the substance we have been given in the question).

Firstly, we will need to calculate the Mr of $CaCO_3$, which is 100.

n = m /Mr, so the number of moles of $CaCO_3$ = 40 / 100 = 0.4 moles

<u>Step 2</u>. Look at the ratio of the number of moles of each substance in the balanced equation, and calculate the number of moles of the substance we are interested in.

In this case there is 1 mole each of $CaCO_3$, CaO and CO_2 (although we do not show the 1 in the balanced equation). 1 mole of $CaCO_3$ produces 1 mole of CaO.

So 0.4 moles of $CaCO_3$ produces 0.4 moles of CaO.

<u>Step 3.</u> Calculate the mass of CaO using the equation m = n x Mr.

Mr of CaO = 56. Mass of CaO = 0.4 moles x 56 = <u>22.4g</u>.

Example 2 – Sodium reacts with chlorine to produce sodium chloride. What mass of chlorine is required to react exactly with 5g of sodium?

$2Na + Cl_2 \rightarrow 2NaCl$

<u>Step 1</u>. Calculate the number of moles of sodium (note we have ignored the ratio of the reactants, this always used in step 2, never in step 1).

Number of moles of Na = m/Ar = 5/23 = 0.217 moles

<u>Step 2</u>. Calculate the number of moles of chlorine.

2 moles of Na react with 1 mole of Na from the balanced equation.

Number of moles of Cl_2 = 0.217/2 = 0.1087 moles

<u>Step 3</u>. Calculate the mass of Cl_2

mass m = n x Mr = 0.1087 x 71 = <u>7.72g</u>

<u>Practice questions</u>

1. 3g of sulfur was heated in oxygen. What mass of sulfur dioxide was produced?

   $S + O_2 \rightarrow SO_2$

2. Copper can be prepared by displacing copper from copper sulfate using magnesium, since magnesium is more reactive than copper. If 12g of magnesium was used, how much copper could be prepared?

   Mg + CuSO4 $\rightarrow$ Cu + MgSO4

3. 32g of methane was combusted in air, all of the methane reacted. What mass of carbon dioxide was made?

   $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$

4. Magnesium (3.2g) was reacted with an excess of bromine, what mass of magnesium bromide was produced?

   $2Mg + Br_2 \rightarrow 2MgBr_2$

5. A chemist aimed to make 10g of sodium chloride by neutralising sodium hydroxide with hydrochloric acid, how much sodium hydroxide should the chemist use?

   $HCl + NaOH \rightarrow NaCl + H_2O$

6. A student prepared aluminium chloride by reacting aluminium with an excess of chlorine gas. How much aluminium chloride was prepared if the student used 3.5g of aluminium?

   $2Al + 3Cl_2 \rightarrow 2AlCl_3$

7. A technician was asked to prepare iron oxide by heating 0.16g of iron in air. How much iron oxide did the technician make?

   $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

8. How much HCl is needed to prepare 10.0g of magnesium chloride from magnesium?

   $Mg + 2HCl \rightarrow MgCl_2 + H_2$

d. Bonding

- To be able to explain the differences between ionic and covalent bonding
- To be able to represent the bonding in compounds using dot-and-cross diagrams
- To be able to use knowledge of the bonding and structure of substances to explain their properties (to include covalent, ionic and metallic structures)

AQA Chemistry student book pages 38-55 (C3.2-C3.10)

Freescience lessons:

Structure and Bonding Playlist:

https://www.youtube.com/watch?v=Ku0oTu8ZWqk&list=PL9IouNCPbCxXmFgiKCM60Sglh-qOG_vlE

Chemical Bonds

There are two main types of bonding found in compounds - ionic bonding and covalent bonding. Atoms bond together in order to achieve a stable electron configuration (a full outer shell of electrons).

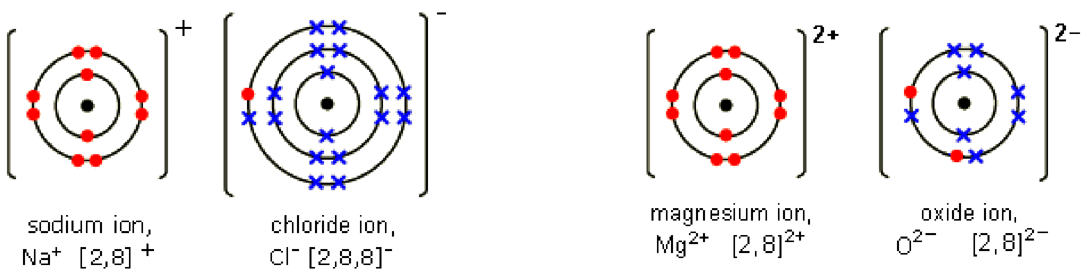
In ionic bonding, metal atoms lose electrons to form positive ions and non-metal atoms gain electrons to form negative ions. The electrostatic attraction between the oppositely charged ions bonds the compound together.

In covalent bonding, non-metals atoms share pairs of electrons in order to achieve a full outer shell. The bonding within the structure of a metal relies on the electrostatic attraction between positive metal ions and delocalised electrons.

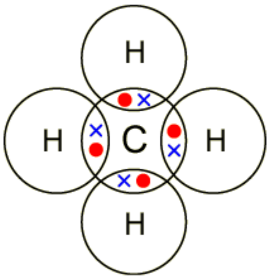
The nature of the chemical bonds within a substance determines the properties of the substance (e.g. melting point, electrical conductivity).

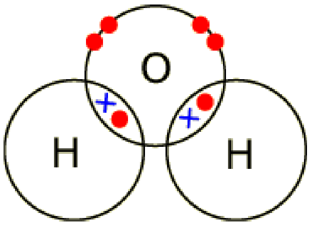
Examples of dot-and-cross diagrams

Ionic Bonding



Covalent Bonding





<u>Practice questions</u>

1. Identify whether these substances are ionic or covalent:

a. LiF b. Cl_2 c. O_2 d. NH_3 e. Na_2O f. $AlCl_3$

2. Draw dot-and-cross diagrams of the substances listed in question 1

3. Explain the following properties of ionic compounds:

a. High melting point

b. Conduct electricity only when molten or aqueous

4. Explain the following properties of simple covalent molecules:

a. Low melting point

b. Do not conduct electricity

5. Explain the following properties of metals:

a. High melting point

b. Good conductors of electricity

c. Alloys are harder than pure metals

6. Compare the structures and properties of diamond and graphite

e. Mathematical skills

- To be able to represent numbers in standard form and to an appropriate number of significant figures
- To be able to rearrange algebraic equations and calculate percentages
- To be able to plot graphs, draw lines of best fit and calculate gradients

AQA Chemistry student book pages

Corbettmaths:

Standard form: https://www.youtube.com/watch?v=cxGyZ3Yx9ow

Rearranging equations: https://www.youtube.com/watch?v=8U9u_itcs7k

Reverse percentages: https://www.youtube.com/watch?v=qg7pYqeFRig

Freesciencelessons:

Using tangents to determine rate: https://www.youtube.com/watch?v=6LV63WtuvJg

Standard Form

In science, very large and very small numbers are usually written in standard form. Standard form is writing a number in the format $A \times 10^B$ where A is a number from 1 to 10 and B is the number of places you move the decimal place.

For example, to express a large number such as 50,000 in standard form, A = 5 and B = 4 as there are four numbers after the initial 5. Therefore, it would be written as 5×10^4.

To express a small number such as 0.00002 in standard form, A = 2 and there are five numbers before it so B = −5. So it is written as 2×10^{-5}

Significant Figures

In chemistry, you are often asked to express numbers to either three or four significant figures. The word significant means to 'have meaning'. A number that is expressed in significant figures will only have digits that are important to the number's precision.

It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

For example, 6.9301 becomes 6.93 if written to three significant figures.

Likewise, 0.00043456 is 0.000435 to three significant figures. Notice that the zeros before the figure are not significant – they just show you how large the number is by the position of the decimal point. Here, a 5 follows the last significant digit, so just as with decimals, it must be rounded up.

Any zeros between the other significant figures are significant. For example, 0.003018 is 0.00302 to three significant figures.

Rearranging Equations

In chemistry, you sometimes need to rearrange an equation to find the desired values. For example, you may know the amount of a substance (n) and the mass of it you have (m) and need to find its molar mass (M). The amount of substance (n) is equal to the mass you have (m) divided by the molar mass (M):

$n = m/M$

You need to rearrange the equation to make the molar mass (M) the subject.

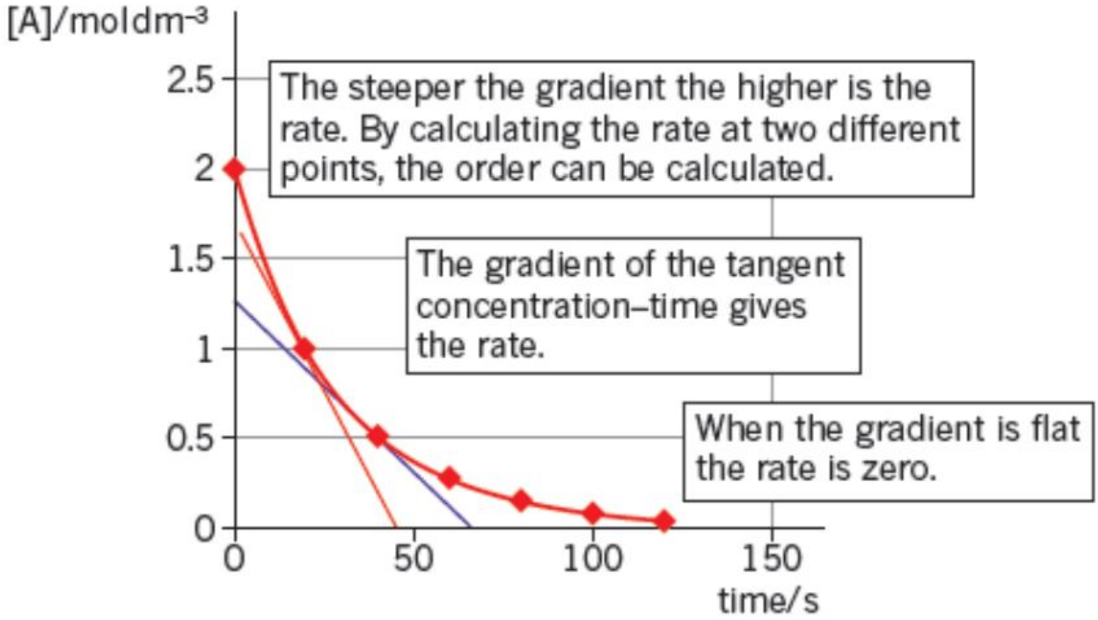
Multiply both sides by the molar mass (M):

$M \times n = m$

Then divide both sides by the amount of substance (n):

$M = m/n$

Using tangents to determine rate



By measuring the gradient (slope) of the graph, you can calculate the rate of the reaction. In the graph above, you can see that the gradient changes as the graph is a curve.

If you want to know the rate of reaction when the graph is curved, you need to determine the gradient of the curve. So, you need to plot a tangent. The tangent is the straight line that just touches the curve. The gradient of the tangent is the gradient of the curve at the point where it touches the curve.

Looking at the graph above, when the concentration of A has halved to 1.0 mol dm^{-3}, the tangent intercepts the y-axis at 1.75 and the x-axis at 48. The gradient is 1.75/48 = 0.0365 (3 s.f.). So the rate is 0.0365 $moldm^{-3}s^{-1}$.

<u>Practice Questions</u>

1. Change the following values to standard form.

a. boiling point of sodium chloride: 1413 °C

b. largest nanoparticles: 0.0001×10^{-3} m

c. number of atoms in 1 mol of water: 1806×10^{21}

2. Change the following values to ordinary numbers.

a. 5.5×10^{-6} b. 2.9×10^{2} c. 1.115×10^{4} d. 1.412×10^{-3} e. 7.2×10^{1}

3. Give the following values in the stated number of significant figures (s.f.).

a. 36.937 (3 s.f.) b. 258 (2 s.f.) c. 0.04319 (2 s.f.) d. 7,999,032 (1 s.f.)

4. Rearrange the equation c = n/V to make:

a. n the subject of the equation b. V the subject of the equation

5. Rearrange the equation PV = nRT to make:

   a. n the subject of the equation   b. T the subject of the equation

6. Answer these questions about percentages:

   a. Calculate 62% of 128

   b. 45% of a number is 18. What is the original number?

   c. A chemical reaction has a percentage yield of 84% and produces 3.68g of the product. What mass of the product could be made if the reaction had a yield of 100%?

6. Using the graph above, calculate the rate of reaction when the concentration of A is 0.5 $moldm^{-3}$.

7. Contact details

If you have any queries regarding this document or on any matter regarding A level Chemistry at Kimberley College, please email
mslater@wootton.beds.sch.uk

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Food for thought (Parable of the pebbles)

A man was out walking in the desert when a voice said to him, "Pick up some pebbles and put them in your pocket, and tomorrow you will be both happy and sad."

The man obeyed. He stooped down and picked up a handful of pebbles and put them in his pocket. The next morning he reached into his pocket and found diamonds and rubies and emeralds. And he was both happy and sad. Happy he had taken some - sad that he hadn't taken more.

And so it is with education.

More food for thought

Did you hear about oxygen's date with potassium?

It went OK.

I heard oxygen was also seeing magnesium?

OMg.

Appendix I. Answers to Practice questions

a. Atomic structure.

1. a. 12 protons, 12 electrons, 13 neutrons b. 4 protons, 4 electrons, 5 neutrons
   c. 23 protons, 23 electrons, 28 neutrons d. 35 protons, 35 electrons, 45 neutrons
   e. 39 protons, 38 electrons, 20 neutrons (this is an ion, the atom has lost one electron)
   f. 9 protons, 10 electrons, 10 neutrons (this is an ion, the atom has gained one electron)

2. a. 2,1 b. 2,8,2 c. 2.4. d. 2,8 e. 2,8

3. a. 69.8 to 1 dp (69.796) b. 108.0 to 1 dp (107.973) c. 204.4 to 1 dp (204.41)

b. Chemical formula and balancing equation.

1. Write the formulas of the following ions:

a. Potassium = K^+ b. Sulfide = S^{2-} c. Calcium = Ca^{2+}

d. Ammonium = NH_4^+ e. Hydroxide = OH^- f. Sulfate = SO_4^{2-}

2. Write the formula of the following ionic compounds:

a. Potassium oxide = K_2O b. Lithium sulfide = Li_2S

c. Calcium nitrate = $Ca(NO_3)_2$ d. Ammonium chloride = NH_4Cl

e. Magnesium hydroxide = $Mg(OH)_2$ f. Sodium sulfate = Na_2SO4

3. Balance the following equations:

a. $2H_2 + O_2 \rightarrow 2H_2O$ b. $2Na + 2H_2O \rightarrow 2NaOH + H_2$

c. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$ d. $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

e. $C_2H_6 + 3\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$ f. $Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

c. The mole and reacting masses.

The mole

1. a. 28 b. 167 c. 101 d. 78 e. 342
2. a. 69g b. 28.4g c. 352g d. 5.52g
3. a. 2 moles b. 0.005 moles c. 0.112 moles d. 0.0225 moles

Reacting masses

1. 6g 2. 31.75g 3. 88g 4. 24.5g 5. 6.8g 6. 17.3g 7. 0.23g 8. 7.68g

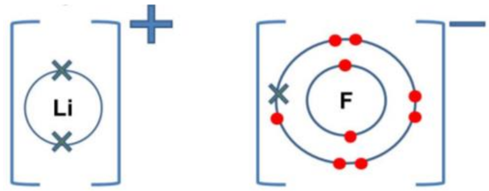
d. Bonding.

1. Identify whether these substances are ionic or covalent:

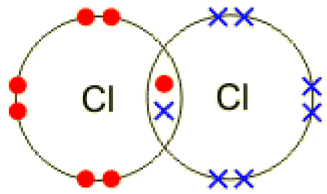
a. LiF = ionic	b. Cl_2 = covalent	c. O_2 = covalent
d. NH_3 = covalent	e. Na_2O = ionic	f. $AlCl_3$ = ionic

2. Draw dot-and-cross diagrams of the substances listed in question 1

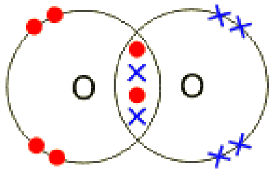
a.



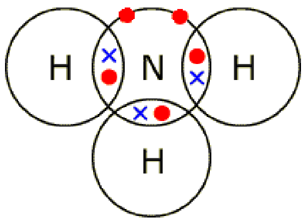
b.



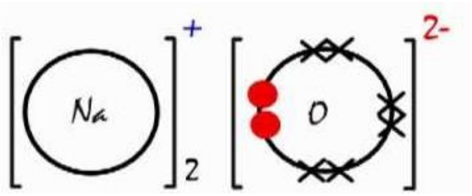
c.



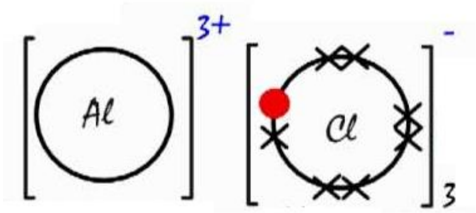
d.



e.



f.



3. Explain the following properties of ionic compounds:

a. High melting point - due to the strong electrostatic attraction between oppositely charged ions. This attraction requires a lot of energy to overcome, and there are many such attractions in the giant lattice structure

b. Conduct electricity only when molten or aqueous - due to the ability of the ions to move freely in a liquid/solution. In solid ionic compounds, the ions are unable to move and therefore the solid compound does not conduct electricity.

4. Explain the following properties of simple covalent molecules:

a. Low melting point - due to the weak intermolecular forces between the simple molecules. These weak forces do not require much energy to overcome.

b. Do not conduct electricity - due to the lack of free ions or delocalised electrons.

5. Explain the following properties of metals:

a. High melting point - due to the strong electrostatic attraction between positive metal ions and delocalised electrons. This attraction requires a lot of energy to overcome, and there are many such attractions in the giant lattice structure

b. Good conductors of electricity - due to the delocalised electrons, which are able to move freely through the structure and carry charge

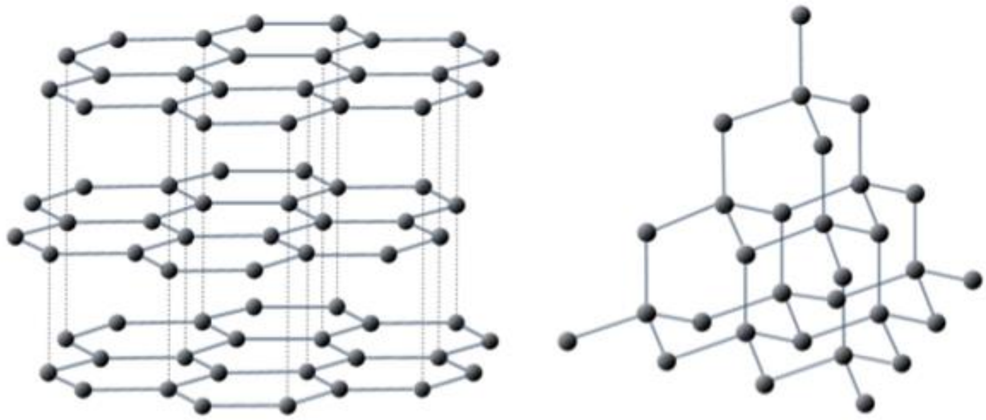
c. Alloys are harder than pure metals - due to the mixture of elements in an alloy having different sized atoms, which disrupts the ordered layers of atoms in the structure. This means that the layers cannot slide over each other

6. Compare the structures and properties of diamond and graphite

Diamond and graphite are both giant covalent lattices made from carbon atoms. Each carbon atom in diamond is bonded to 4 others, whereas in graphite, each atom is bonded to 3 others. Both structures contain large numbers of strong covalent bonds that require a lot of energy to break, so both substances have high melting points.

Graphite has a structure made up of layers with weak forces between them, meaning the layers can slide over each other. This makes graphite soft and slippery. Diamond, however, has no layers; its structure is extremely hard.

Graphite contains delocalised electrons which move through the structure, so graphite is a good conductor of electricity. Diamond has no delocalised electrons and therefore cannot conduct electricity.



Graphite (solid lines are strong covalent bonds, dotted lines are weak inter-layer bonds) | Diamond (all bonds are strong covalent bonds)

e. Mathematical skills.

1. Change the following values to standard form.

a. boiling point of sodium chloride: 1413 °C → 1.413×10^3

b. largest nanoparticles: 0.0001×10^{-3} m → 1×10^{-7}

c. number of atoms in 1 mol of water: 1806×10^{21} → 1.806×10^{24}

2. Change the following values to ordinary numbers.

a. 5.5×10^{-6} → 0.0000055 b. 2.9×10^{2} → 290 c. 1.115×10^{4} → 11,150

d. 1.412×10^{-3} → 0.001412 e. 7.2×10^{1} → 72

3. Give the following values in the stated number of significant figures (s.f.).

a. 36.937 (3 s.f.) → 36.9 b. 258 (2 s.f.) → 260

c. 0.04319 (2 s.f.) → 0.043 d. 7,999,032 (1 s.f.) → 8,000,000

4. Rearrange the equation c = n/V to make:

a. n the subject of the equation c = n/V → n = c x V

b. V the subject of the equation c = n/V → n = c x V → V = n/c

5. Rearrange the equation PV = nRT to make:

a. n the subject of the equation PV = nRT → n = PV/RT

b. T the subject of the equation PV = nRT → T = PV/nR

6. Answer these questions about percentages:

a. 62% of 128 = 79.36

b. 45% of a number is 18. The original number is 40

c. A chemical reaction has a percentage yield of 84% and produces 3.68g of the product. What mass of the product could be made if the reaction had a yield of 100%?
4.38g (3 s.f.)

7. Using the graph above, calculate the rate of reaction when the concentration of A is 0.5 moldm^{-3}.

Rate of reaction = 1.25/65 = 0.0192 (3 s.f.)

Appendix II: Periodic Table GCSE

AQA

The Periodic Table of Elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	[285] **Cn** copernicium 112	[286] **Nh** nihonium 113	[289] **Fl** flerovium 114	[289] **Mc** moscovium 115	[293] **Lv** livermorium 116	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.