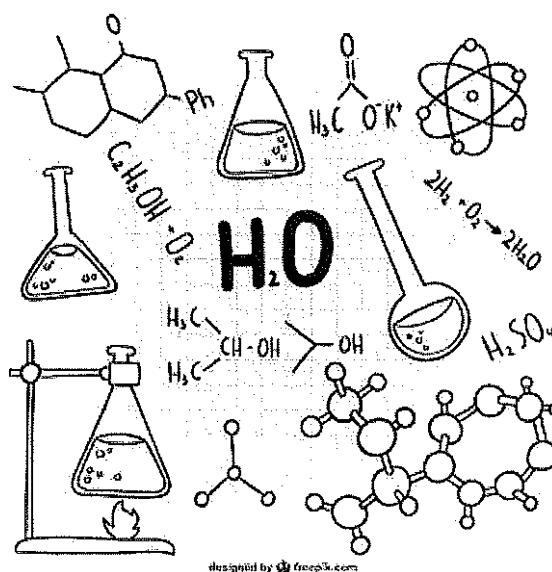


# A-level chemistry transition work



Chemistry is the science of matter and the fascinating changes it can undergo.

**Moving from GCSE chemistry to A level chemistry can be a daunting leap.** You'll be expected to remember a lot more facts, equations and definitions. You will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This transition work will allow you to pre-learn some useful definitions and help you to practise some of the maths skills you will need.

## Tasks

1. Learn the definitions for **Practical science key terms** (page 2) and **Atomic structure** (page 3). You will be assessed on these in September
2. Complete the practice questions in the **Maths skills** section (pages 4-12). You should write your answers next to each question.
3. Watch / read / do at least one of the further movie, book/article, research projects at the end of this pack

Have fun.

The Chemistry Department

**Teacher comments:**

*"...when I started doing chemistry, I did it the way I fished - for the excitement, the discovery, the adventure, for going after the most elusive catch imaginable in uncharted seas"*

K. Barry Sharpless

## Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Chemistry.

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

## Practical science key terms

|                                                                                                |                                                                                                                                                        |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| When is a measurement valid?                                                                   | when it measures what it is supposed to be measuring                                                                                                   |
| When is a result accurate?                                                                     | when it is close to the true value                                                                                                                     |
| What are precise results?                                                                      | when repeat measurements are consistent/agree closely with each other                                                                                  |
| What is repeatability?                                                                         | how precise repeated measurements are when they are taken by the <i>same</i> person, using the <i>same</i> equipment, under the <i>same</i> conditions |
| What is reproducibility?                                                                       | how precise repeated measurements are when they are taken by <i>different</i> people, using <i>different</i> equipment                                 |
| What is the uncertainty of a measurement?                                                      | the interval within which the true value is expected to lie                                                                                            |
| Define measurement error                                                                       | the difference between a measured value and the true value                                                                                             |
| What type of error is caused by results varying around the true value in an unpredictable way? | random error                                                                                                                                           |
| What is a systematic error?                                                                    | a consistent difference between the measured values and true values                                                                                    |
| What does zero error mean?                                                                     | a measuring instrument gives a false reading when the true value should be zero                                                                        |
| Which variable is changed or selected by the investigator?                                     | independent variable                                                                                                                                   |
| What is a dependent variable?                                                                  | a variable that is measured every time the independent variable is changed                                                                             |
| Define a fair test                                                                             | a test in which only the independent variable is allowed to affect the dependent variable                                                              |
| What are control variables?                                                                    | variables that should be kept constant to avoid them affecting the dependent variable                                                                  |

## Atoms, ions, and compounds

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

|                                                                          |                                                                                                                             |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| What does an atom consist of?                                            | a nucleus containing protons and neutrons, surrounded by electrons                                                          |
| What are the relative masses of a proton, neutron, and electron?         | 1, 1, and $\frac{1}{1836}$ respectively                                                                                     |
| What are the relative charges of a proton, neutron, and electron?        | +1, 0, and -1 respectively                                                                                                  |
| How do the number of protons and electrons differ in an atom?            | they are the same because atoms have neutral charge                                                                         |
| How does the number of protons differ between atoms of the same element? | it does not differ – all atoms of the same element have the same number of protons                                          |
| What force holds an atom nucleus together?                               | strong nuclear force                                                                                                        |
| What is the proton number / atomic number of an element?                 | the number of protons in the atom's nucleus of an element                                                                   |
| What is the mass number of an element?                                   | number of protons + number of neutrons                                                                                      |
| What is an isotope?                                                      | an atom with the same number of protons but different number of neutrons                                                    |
| What is the equation for relative isotopic mass?                         | relative isotopic mass = $\frac{\text{mass of an isotope}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$          |
| What is the equation for relative atomic mass ( $A_r$ )?                 | relative atomic mass = $\frac{\text{weighted mean mass of 1 atom}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$  |
| What is the equation for relative molecular mass ( $M_r$ )?              | relative molecular mass = $\frac{\text{average mass of 1 molecule}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$ |
| What is an ion?                                                          | an atom or group of atoms with a charge (a different number of electrons to protons)                                        |
| Define the term cation                                                   | a positive ion (atom with fewer electrons than protons)                                                                     |
| Define the term anion                                                    | a negative ion (atom with more electrons than protons)                                                                      |
| What is the function of a mass spectrometer?                             | it accurately determines the mass and abundance of separate atoms or molecules, to help us identify them                    |
| What is a mass spectrum?                                                 | the output from a mass spectrometer that shows the different isotopes that make up an element                               |
| What is a binary compound?                                               | a compound which contains only two elements                                                                                 |

## Maths skills

### 1 Core mathematical skills

A practical chemist must be proficient in standard form, significant figures, decimal places, SI units, and unit conversion.

#### 1.1 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  $A \times 10^x$  where  $A$  is a number from 1 to 10 and  $x$  is the number of places you move the decimal place.

For example, to express a large number such as  $50\,000 \text{ mol dm}^{-3}$  in standard form,  $A = 5$  and  $x = 4$  as there are four numbers after the initial 5.

Therefore, it would be written as  $5 \times 10^4 \text{ mol dm}^{-3}$ .

To give a small number such as  $0.000\,02 \text{ Nm}^2$  in standard form,  $A = 2$  and there are five numbers before it so  $x = -5$ .

So it is written as  $2 \times 10^{-5} \text{ Nm}^2$ .

#### Practice questions

- Change the following values to standard form.
  - boiling point of sodium chloride:  $1413^\circ\text{C}$
  - largest nanoparticles:  $0.0\,001 \times 10^{-3} \text{ m}$
  - number of atoms in 1 mol of water:  $1806 \times 10^{21}$
- Change the following values to ordinary numbers.
  - $5.5 \times 10^{-6}$
  - $2.9 \times 10^2$
  - $1.115 \times 10^4$
  - $1.412 \times 10^{-3}$
  - $7.2 \times 10^1$

#### 1.2 Significant figures and decimal places

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, 0.000 434 56 is 0.000 435 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, 0.003 018 is 0.003 02 to three significant figures.

Sometimes numbers are expressed to a number of decimal places. The decimal point is a place holder and the number of digits afterwards is the number of decimal places.

For example, the mathematical number pi is 3 to zero decimal places, 3.1 to one decimal place, 3.14 to two decimal places, and 3.142 to three decimal places.

**Practice questions**

- 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 0.043 19 (2 s.f.)    d 7 999 032 (1 s.f.)
- 4 Use the equation:  
 number of molecules = number of moles  $\times 6.02 \times 10^{23}$  molecules per mole  
 to calculate the number of molecules in 0.5 moles of oxygen. Write your answer in standard form to 3 s.f.
- 5 Give the following values in the stated number of decimal places (d.p.).  
 a 4.763 (1 d.p.)    b 0.543 (2 d.p.)    c 1.005 (2 d.p.)    d 1.9996 (3 d.p.)

**1.3 Converting units**

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units.

If you convert between units and round numbers properly it allows quoted measurements to be understood within the scale of the observations.

| Multiplication factor | Prefix | Symbol |
|-----------------------|--------|--------|
| $10^9$                | giga   | G      |
| $10^6$                | mega   | M      |
| $10^3$                | kilo   | k      |
| $10^{-2}$             | centi  | c      |
| $10^{-3}$             | milli  | m      |
| $10^{-6}$             | micro  | $\mu$  |
| $10^{-9}$             | nano   | n      |

Unit conversions are common. For instance, you could be converting an enthalpy change of  $488\,889\text{ J mol}^{-1}$  into  $\text{kJ mol}^{-1}$ . A kilo is  $10^3$  so you need to divide by this number or move the decimal point three places to the left.

$$488\,889 \div 10^3 \text{ kJ mol}^{-1} = 488.889 \text{ kJ mol}^{-1}$$

Converting from  $\text{mJ mol}^{-1}$  to  $\text{kJ mol}^{-1}$ , you need to go from  $10^3$  to  $10^{-3}$ , or move the decimal point six places to the left.

$$333 \text{ mJ mol}^{-1} \text{ is } 0.000\,333 \text{ kJ mol}^{-1}$$

If you want to convert from  $333 \text{ mJ mol}^{-1}$  to  $\text{nJ mol}^{-1}$ , you would have to go from  $10^{-9}$  to  $10^{-3}$ , or move the decimal point six places to the right.

$$333 \text{ mJ mol}^{-1} \text{ is } 333\,000\,000 \text{ nJ mol}^{-1}$$

**Practice question**

- 6 Calculate the following unit conversions.
- a  $300\text{ }\mu\text{m}$  to m  
 b 5 MJ to mJ  
 c 10 GW to kW

## 2 Balancing chemical equations

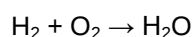
### 2.1 Conservation of mass

When new substances are made during chemical reactions, atoms are not created or destroyed – they just become rearranged in new ways. So, there is always the same number of each type of atom before and after the reaction, and the total mass before the reaction is the same as the total mass after the reaction. This is known as the conservation of mass.

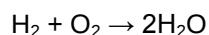
You need to be able to use the principle of conservation of mass to write formulae, and balanced chemical equations and half equations.

### 2.2 Balancing an equation

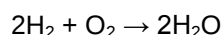
The equation below shows the correct formulae but it is not balanced.



While there are two hydrogen atoms on both sides of the equation, there is only one oxygen atom on the right-hand side of the equation against two oxygen atoms on the left-hand side. Therefore, a two must be placed before the  $\text{H}_2\text{O}$ .



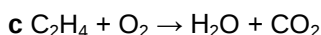
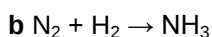
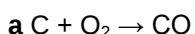
Now the oxygen atoms are balanced but the hydrogen atoms are no longer balanced. A two must be placed in front of the  $\text{H}_2$ .



The number of hydrogen and oxygen atoms is the same on both sides, so the equation is balanced.

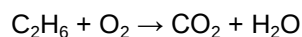
### Practice question

1 Balance the following equations.

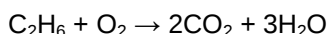


### 2.3 Balancing an equation with fractions

To balance the equation below:

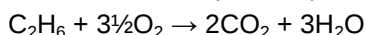


- Place a two before the  $\text{CO}_2$  to balance the carbon atoms.
- Place a three in front of the  $\text{H}_2\text{O}$  to balance the hydrogen atoms.

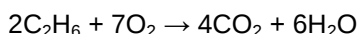


There are now four oxygen atoms in the carbon dioxide molecules plus three oxygen atoms in the water molecules, giving a total of seven oxygen atoms on the product side.

- To balance the equation, place three and a half in front of the  $\text{O}_2$ .

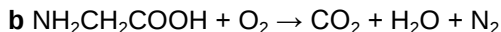
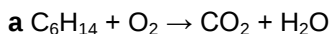
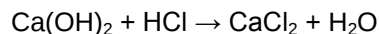


- Finally, multiply the equation by 2 to get whole numbers.



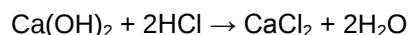
**Practice question**

2 Balance the equations below.

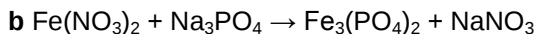
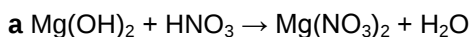
**2.4 Balancing an equation with brackets**

Here the brackets around the hydroxide ( $\text{OH}^-$ ) group show that the  $\text{Ca}(\text{OH})_2$  unit contains one calcium atom, two oxygen atoms, and two hydrogen atoms.

To balance the equation, place a two before the HCl and another before the  $\text{H}_2\text{O}$ .

**Practice question**

3 Balance the equations below.

**3 Rearranging equations and calculating concentrations****3.1 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 ( $M$ ):

$$n = \frac{m}{M}$$

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 ( $n$ ):

$$M = \frac{m}{n}$$

**Practice questions**

1 Rearrange the equation  $c = \frac{n}{V}$  to make:

a  $n$  the subject of the equation

b  $V$  the subject of the equation.

2 Rearrange the equation  $PV = nRT$  to make:

a  $n$  the subject of the equation

**b**  $T$  the subject of the equation.

### 3.2 Calculating concentration

The concentration of a solution (a solute dissolved in a solvent) is a way of saying how much solute, in moles, is dissolved in 1 dm<sup>3</sup> or 1 litre of solution.

Concentration is usually measured using units of mol dm<sup>-3</sup>. (It can also be measured in g dm<sup>-3</sup>.)

The concentration of the amount of substance dissolved in a given volume of a solution is given by the equation:

$$c = \frac{n}{V}$$

where  $n$  is the amount of substance in moles,  $c$  is the concentration, and  $V$  is the volume in dm<sup>3</sup>.

The equation can be rearranged to calculate:

- the amount of substance  $n$ , in moles, from a known volume and concentration of solution
- the volume  $V$  of a solution from a known amount of substance, in moles, and the concentration of the solution.

### Practice questions

- 3 Calculate the concentration, in mol dm<sup>-3</sup>, of a solution formed when 0.2 moles of a solute is dissolved in 50 cm<sup>3</sup> of solution.
- 4 Calculate the concentration, in mol dm<sup>-3</sup>, of a solution formed when 0.05 moles of a solute is dissolved in 2.0 dm<sup>3</sup> of solution.
- 5 Calculate the number of moles of NaOH in an aqueous solution of 36 cm<sup>3</sup> of 0.1 mol dm<sup>-3</sup>.

## 4 Molar calculations

### 4.1 Calculating masses and gas volumes

The balanced equation for a reaction shows how many moles of each reactant and product are involved in a chemical reaction.

If the amount, in moles, of one of the reactants or products is known, the number of moles of any other reactants or products can be calculated.

The number of moles ( $n$ ), the mass of the substance ( $m$ ), and the molar mass ( $M$ ) are linked by:

$$n = \frac{m}{M}$$

**Note:** The molar mass of a substance is the mass per mole of the substance. For CaCO<sub>3</sub>, for example, the atomic mass of calcium is 40.1, carbon is 12, and oxygen is 16. So the molar mass of CaCO<sub>3</sub> is:

40.1 + 12 + (16 × 3) = 100.1. The units are g mol<sup>-1</sup>.

Look at this worked example. A student heated 2.50 g of calcium carbonate, which decomposed as shown in the equation:



The molar mass of calcium carbonate is  $100.1 \text{ g mol}^{-1}$ .

- a Calculate the amount, in moles, of calcium carbonate that decomposes.

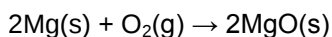
$$n = \frac{m}{M} = 2.50/100.1 = 0.025 \text{ mol}$$

- b Calculate the amount, in moles, of carbon dioxide that forms.

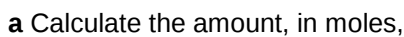
From the balanced equation, the number of moles of calcium carbonate = number of moles of carbon dioxide = 0.025 mol

### Practice questions

- 1 In a reaction, 0.486 g of magnesium was added to oxygen to produce magnesium oxide.



- a Calculate the amount, in moles, of magnesium that reacted.  
b Calculate the amount, in moles, of magnesium oxide made.  
c Calculate the mass, in grams, of magnesium oxide made.
- 2 Oscar heated 4.25 g of sodium nitrate. The equation for the decomposition of sodium nitrate is:



- a Calculate the amount, in moles, of sodium nitrate that reacted.  
b Calculate the amount, in moles, of oxygen made.

- 3 0.500 kg of magnesium carbonate decomposes on heating to form magnesium oxide and carbon dioxide. Give your answers to 3 significant figures.



- a Calculate the amount, in moles, of magnesium carbonate used.  
b Calculate the amount, in moles, of carbon dioxide produced.

## 5 Percentage yields and percentage errors

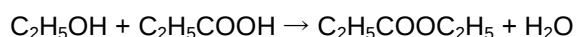
### 5.1 Calculating percentage yield

Chemists often find that an experiment makes a smaller amount of product than expected. They can predict the amount of product made in a reaction by calculating the percentage yield.

The percentage yield links the actual amount of product made, in moles, and the theoretical yield, in moles:

$$\text{percentage yield} = \frac{\text{actual amount (in moles) of product}}{\text{theoretical amount (in moles) of product}} \times 100$$

Look at this worked example. A student added ethanol to propanoic acid to make the ester, ethyl propanoate, and water.



The experiment has a theoretical yield of 5.00 g.

The actual yield is 4.50 g.

The molar mass of  $\text{C}_2\text{H}_5\text{COOC}_2\text{H}_5 = 102.0 \text{ g mol}^{-1}$

Calculate the percentage yield of the reaction.

Actual amount of ethyl propanoate:  $n = \frac{m}{M} = 4.5/102 = 0.0441 \text{ mol}$

Theoretical amount of ethyl propanoate:  $n = \frac{m}{M} = 5.0/102 = 0.0490 \text{ mol}$

percentage yield =  $(0.0441/0.0490) \times 100\% = 90\%$

### Practice questions

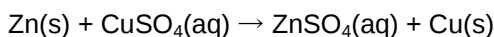
- 1 Calculate the percentage yield of a reaction with a theoretical yield of 4.75 moles of product and an actual yield of 3.19 moles of product. Give your answer to 3 significant figures.
- 2 Calculate the percentage yield of a reaction with a theoretical yield of 12.00 moles of product and an actual yield of 6.25 moles of product. Give your answer to 3 significant figures.

### 5.3 Calculating percentage error in apparatus

The percentage error of a measurement is calculated from the maximum error for the piece of apparatus being used and the value measured:

$$\text{percentage error} = \frac{\text{maximum error}}{\text{measured value}} \times 100\%$$

Look at this worked example. In an experiment to measure temperature changes, an excess of zinc powder was added to  $50 \text{ cm}^3$  of copper(II) sulfate solution to produce zinc sulfate and copper.



The measuring cylinder used to measure the copper(II) sulfate solution has a maximum error of  $\pm 2 \text{ cm}^3$ .

- a** Calculate the percentage error.

$$\text{percentage error} = (2/50) \times 100\% = 4\%$$

- b** A thermometer has a maximum error of  $\pm 0.05 \text{ }^\circ\text{C}$ .

Calculate the percentage error when the thermometer is used to record a temperature rise of  $3.9 \text{ }^\circ\text{C}$ . Give your answer to 3 significant figures.

$$\text{percentage error} = (2 \times 0.05)/3.9 \times 100\% = 2.56\%$$

(Notice that two measurements of temperature are required to calculate the temperature change so the maximum error is doubled.)

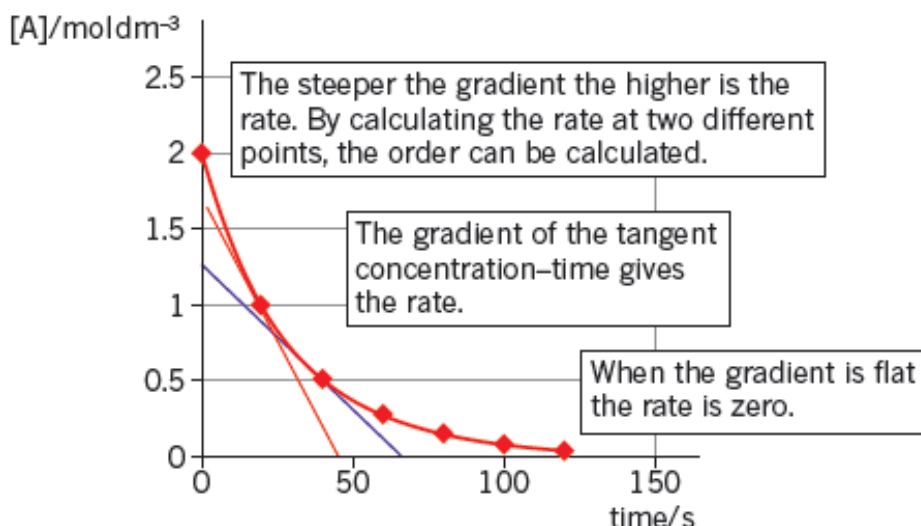
### Practice questions

- 3 A gas syringe has a maximum error of  $\pm 0.5 \text{ cm}^3$ . Calculate the maximum percentage error when recording these values. Give your answers to 3 significant figures.  
**a**  $21.0 \text{ cm}^3$       **b**  $43.0 \text{ cm}^3$
- 4 A thermometer has a maximum error of  $\pm 0.5 \text{ }^\circ\text{C}$ . Calculate the maximum percentage error when recording these temperature rises. Give your answers to 3 significant figures.  
**a**  $12.0 \text{ }^\circ\text{C}$       **b**  $37.6 \text{ }^\circ\text{C}$

## 6 Graphs and tangents

### 6.1 Deducing reaction rates

To investigate the reaction rate during a reaction, you can measure the volume of the product formed, such as a gas, or the colour change to work out the concentration of a reactant during the experiment. By measuring this concentration at repeated intervals, you can plot a concentration–time graph.



**Note:** When a chemical is listed in square brackets, it just means ‘the concentration of’ that chemical. For example,  $[O_2]$  is just shorthand for the concentration of oxygen molecules.

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  $1.0 \text{ mol dm}^{-3}$ , the tangent intercepts the y-axis at 1.75 and the x-axis at 48.

The gradient is  $\frac{-1.75}{48} = -0.0365$  (3 s.f.).

So the rate is  $0.0365 \text{ mol dm}^{-3} \text{ s}^{-1}$ .

### Practice question

- Using the graph above, calculate the rate of reaction when the concentration of A halves again to  $0.5 \text{ mol dm}^{-3}$ .

### 6.2 Deducing the half-life of a reactant

In chemistry, half-life can also be used to describe the decrease in concentration of a reactant in a reaction. In other words, the half-life of a reactant is the time taken for the concentration of the reactant to fall by half.

**Practice question**

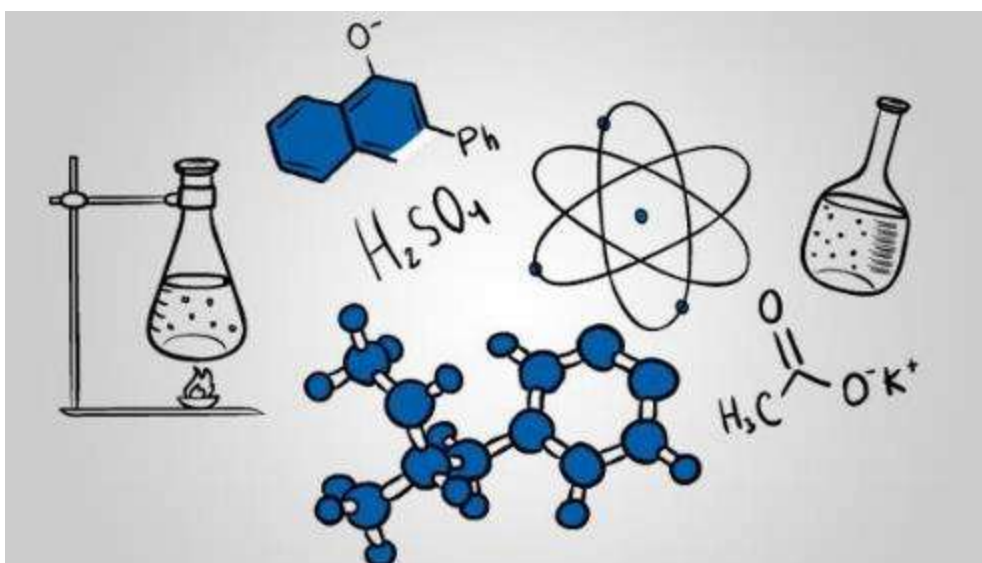
- 2 The table below shows the change in concentration of bromine during the course of a reaction.

| Time / s | [Br <sub>2</sub> ] / mol dm <sup>-3</sup> |
|----------|-------------------------------------------|
| 0        | 0.0100                                    |
| 60       | 0.0090                                    |
| 120      | 0.0066                                    |
| 180      | 0.0053                                    |
| 240      | 0.0044                                    |
| 360      | 0.0028                                    |

- a** Plot a concentration–time graph for the data in the table.  
**b** Calculate the rate of decrease of Br<sub>2</sub> concentration by drawing tangents.  
**c** Find the half-life at two points and deduce the order of the reaction.

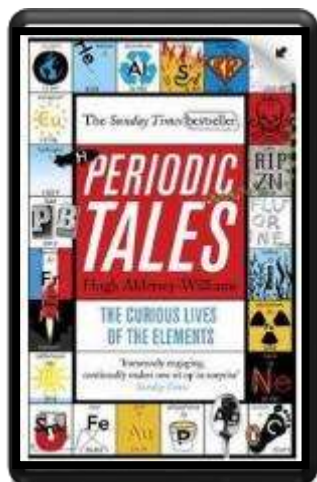
# So you are considering A level Chemistry?

This pack contains loads of further reading and research projects to prepare you to start A level in Chemistry in September. It is aimed to be used after you complete your GCSE, throughout the remainder of the summer term and over the summer holidays to ensure you are ready to start your course in September.



## Book Recommendations

Kick back this summer with a good read. The books below are all popular science books and great for extending your understanding of chemistry

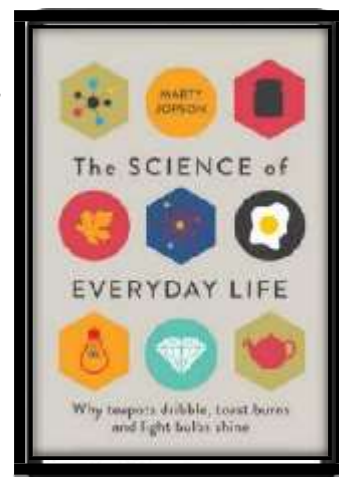


### Periodic Tales: The Curious Lives of the Elements

This book covers the chemical elements, where they come from and how they are used. There are loads of fascinating insights into uses for chemicals you would have never even thought about.

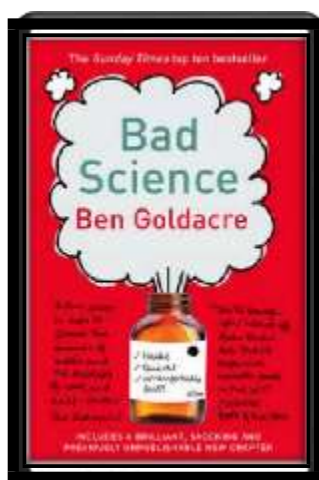
### The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine

The title says it all really, lots of interesting stuff about the things around your home!



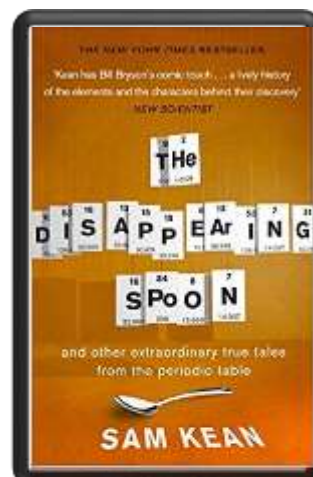
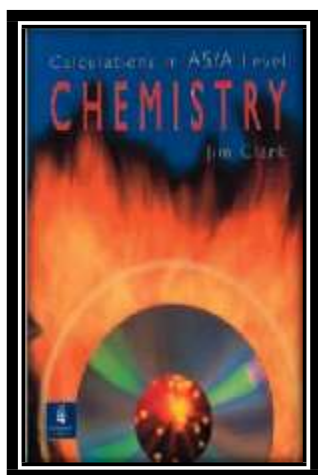
### Bad Science

Here Ben Goldacre takes apart anyone who published bad / misleading or dodgy science – this book will make you think about everything the advertising industry tries to sell you by making it sound 'sciencey'.



### Calculations in AS/A Level Chemistry

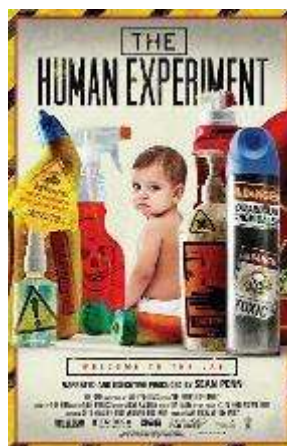
If you struggle with the calculations side of chemistry, this is the book for you. Covers all the possible calculations you are ever likely to come across. Brought to you by the same guy who wrote the excellent [chemguide.co.uk](http://chemguide.co.uk) website.



One of our crowning scientific achievements is also a treasure trove of passion, adventure, betrayal and obsession. **The Disappearing Spoon** follows the elements, their parts in human history, finance, mythology, conflict, the arts, medicine and the lives of the (frequently) mad scientists who discovered them.

## Movie Recommendations

Everyone loves a good story and everyone loves some great science. Here are some of the picks of the best films based on real life scientists and discoveries. You won't find Jurassic Park on this list! We've looked back over the last 50 years to give you our top 5 films you might not have seen before. Great watching for a rainy day.



### The Human Experiment (2013)

A documentary that explores chemicals found in everyday household products.

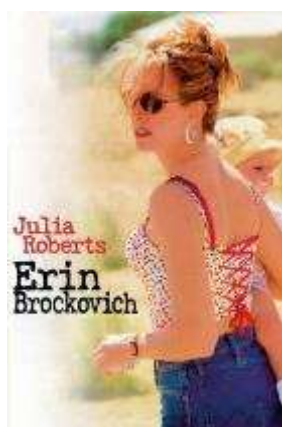
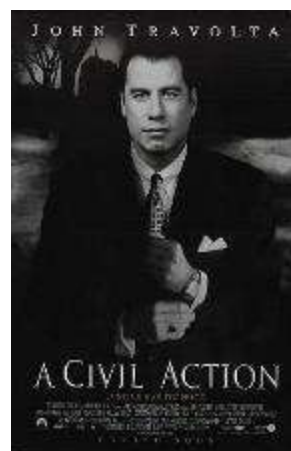
### An Inconvenient Truth (2006)

Al Gore, former presidential candidate campaigns to raise public awareness of the dangers of global warming and calls for immediate action to curb its destructive effects on the environment. (See also: An Inconvenient Sequel, 2017)



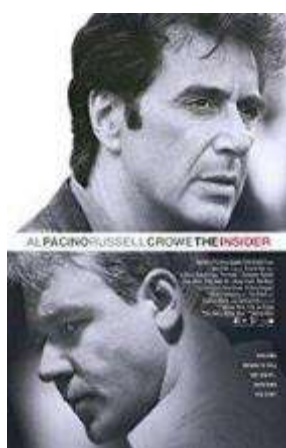
### A Civil Action (1998)

A tenacious lawyer takes on a case involving a major company responsible for causing several people to be diagnosed with leukemia due to the town's water supply being contaminated, at the risk of bankrupting his firm and career.



### Erin Brockovich (2000)

Based on a true story. An unemployed single mother becomes a legal assistant and almost single-handedly brings down a California power company accused of polluting a city's water supply.



### The Insider (1999)

A research chemist comes under personal and professional attack when he decides to appear in a "60 Minutes" expose on Big Tobacco.

## Movie Recommendations

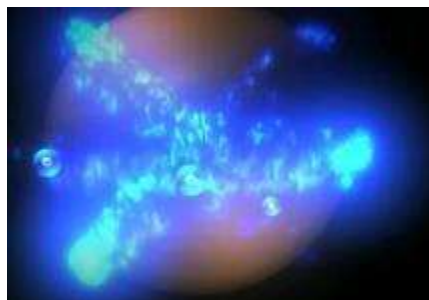
If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

### Play with Smart Materials

Available at :

[https://www.ted.com/talks/catarina\\_mota\\_play\\_with\\_smart\\_materials](https://www.ted.com/talks/catarina_mota_play_with_smart_materials)

Ink that conducts electricity; a window that turns from clear to opaque at the flip of a switch; a jelly that makes music. All this stuff exists, it's time to play with it. A tour of surprising and cool new materials.



### Just how small is an atom?

Available at :

[https://www.ted.com/talks/just\\_how\\_small\\_is\\_an\\_atom](https://www.ted.com/talks/just_how_small_is_an_atom)

Just how small are atoms? Really, really, really small. This fast-paced animation from TED-Ed uses metaphors (imagine a blueberry the size of a football stadium!) to give a visceral sense of just how small atoms are.

### Battling Bad Science

Available at :

[https://www.ted.com/talks/ben\\_goldacre\\_battling\\_bad\\_science#t-44279](https://www.ted.com/talks/ben_goldacre_battling_bad_science#t-44279)

Every day there are news reports of new health advice, but how can you know if they're right? Doctor and epidemiologist Ben Goldacre shows us, at high speed, the ways evidence can be distorted, from the blindingly obvious nutrition claims to the very subtle tricks of the pharmaceutical industry.



### How Spectroscopy Could Reveal Alien Life

Available at :

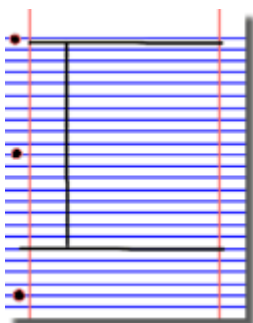
[https://www.ted.com/talks/garik\\_israelian\\_what\\_s\\_inside\\_a\\_star](https://www.ted.com/talks/garik_israelian_what_s_inside_a_star)

Garik Israelian is a spectroscopist, studying the spectrum emitted by a star to figure out what it's made of and how it might behave. It's a rare and accessible look at this discipline, which may be coming close to finding a planet friendly to life.

## Research Activities

Research, reading and note making are essential skills for A level chemistry study. For the following tasks you can produce 'Cornell Notes' to summarise your reading.

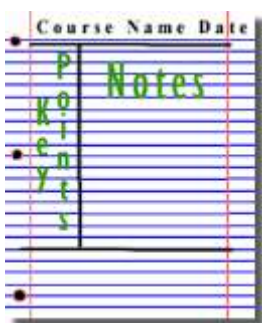
1. Divide your page into three sections like this



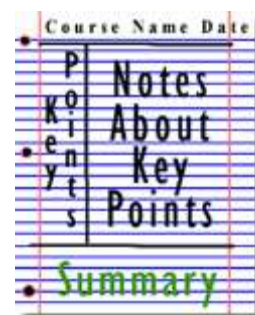
2. Write the name, date and topic at the top of the page



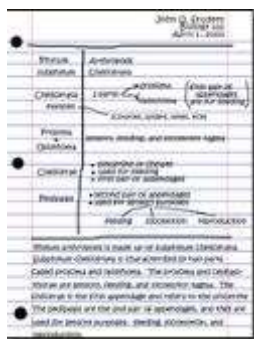
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



4. Review and identify the key points in the left hand box



5. Write a summary of the main ideas in the bottom space



Images taken from <http://coe.jmu.edu/learningtoolbox/cornellnotes.html>

## Research Activities

Our friends at the University of Birmingham have produced a brilliant online project investigating toxicology! Check out <https://chembam.com/home-learning/toxicology/>



The other activities are all from CATALYST magazine, and are great way of exploring how research is conducted. Do all of them, or pick the most interesting-sounding ones. It's up to you!

### Topic 1: Using Plastics in the Body

Available at:

<https://www.stem.org.uk/resources/elibrary/resource/382317/using-plastics-body>

This Catalyst article looks at how scientists are learning to use polymers for many medical applications, including implants, bone repairs and reduction in infections.



### Topic 2: Catching a Cheat

Available at:

<https://www.stem.org.uk/system/files/elibrary-resources/2017/03/Catching%20a%20cheat.pdf>

This Catalyst article looks at analytical chemists who are involved in many kinds of testing, including drug testing to catch cheats in sport.



### Topic 3: Diamond: More than just a gemstone

Available at:

<https://www.stem.org.uk/system/files/elibrary-resources/2017/02/Diamond%20more%20than%20just%20a%20gemstone.pdf>

This Catalyst article looks at diamond and graphite which are allotropes of carbon. Their properties, which depend on the bonding between the carbon atoms, are also examined.



#### Topic 4: The Bizarre World of High Pressure Chemistry

Available at:

### Research Activities

[https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27\\_1\\_the\\_bizarre\\_world\\_of\\_high\\_pressure\\_chemistry.pdf](https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_the_bizarre_world_of_high_pressure_chemistry.pdf)

This Catalyst article investigates high pressure chemistry and discovers that, when put under extreme pressure, the properties of a material may change dramatically.



club  
lence

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#### Topic 5: Microplastics and the Oceans

Available at:

[https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27\\_1\\_microplastics\\_%20and\\_the\\_oceans.pdf](https://www.stem.org.uk/system/files/elibrary-resources/2016/11/Catalyst27_1_microplastics_%20and_the_oceans.pdf)

This Catalyst article looks at microplastics.

Microplastics are tiny particles of polymer used in many products. They have been found to be an environmental pollutant especially in oceans.



Many of these science centres and museums also have online exhibitions! Check them out!

Glasgow Science  
Centre - Glasgow

Dundee Science  
Centre - Dundee

W5 - Belfast

Colour Experience -  
Bradford

Catalyst Discovery  
Centre - Widnes

Black Country Living  
Museum - Dudley

Cambridge Science  
Centre - Cambridge

Think-tank -  
Birmingham

The Whipple  
Museum -  
Cambridge

National Museum -  
Cardiff

The Faraday Museum  
- London

Bristol Science  
Centre - Bristol

Circle the correct answers in this section

1 Which row shows the atomic structure of an atom of the  $^{19}\text{F}$  isotope?

|   | protons | neutrons | electrons |
|---|---------|----------|-----------|
| A | 9       | 9        | 10        |
| B | 9       | 10       | 9         |
| C | 10      | 9        | 10        |
| D | 10      | 10       | 9         |

[1]

2 Which row shows the numbers of neutrons and electrons in an  $^{56}\text{Fe}^{3+}$  ion?

|   | neutrons | electrons |
|---|----------|-----------|
| A | 26       | 27        |
| B | 29.8     | 56        |
| C | 30       | 23        |
| D | 33       | 20        |

[1]

3 What is the total number of electrons in a nitrate ion,  $\text{NO}_3^-$ ?

- A 32                      B 33  
C 47                      D 64

[1]

4 Calcium hydroxide contains  $\text{Ca}^{2+}$  and  $\text{OH}^-$  ions.

What is the formula of calcium hydroxide?

- A  $\text{CaOH}$                       B  $\text{CaOH}_2$   
C  $\text{Ca}_2\text{OH}$                       D  $\text{Ca}(\text{OH})_2$

[1]

5 The mass of an object measured on a 4 decimal place balance is 7.0855 g

What is this mass to 3 significant figures?

- A 7.09 g                      B 7.19 g  
C 7.085 g                      D 7.086 g

[1]

**OCR Chemistry A**

**6** Rearrange  $PV = nRT$  to make  $n$  the subject.

**A**  $n = \frac{RV}{PT}$

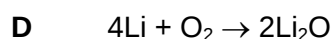
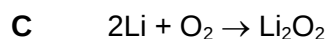
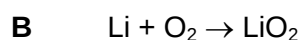
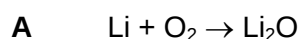
**B**  $n = \frac{PV}{RT}$

**C**  $n = \frac{RT}{PV}$

**D**  $n = \frac{1}{RTPV}$

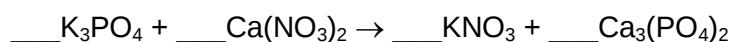
[1]

**7** Lithium reacts with oxygen to form lithium oxide,  $\text{Li}_2\text{O}$   
Which equation is correct for this reaction?



[1]

**8** Balance the equation below.



[2]

**9** What is the relative formula mass of  $\text{NH}_4\text{NO}_3$ ?

**A** 42.0

**B** 56.0

**C** 66.0

**D** 80.0

[1]

**10** How many moles of  $\text{CO}_2$  are there in 22 g of  $\text{CO}_2$ ?

**A** 0.25

**B** 0.5

**C** 2

**D** 4

[1]

## OCR Chemistry A

Tick the boxes next to the correct answers in this section

- 11 Sodium carbonate contains sodium ions and carbonate ions.

Which statement(s) is/are correct?

The formula of sodium carbonate is  $\text{NaCO}_3$ .

☐

The relative formula mass of sodium carbonate is 106.

☐

A carbonate ion has the formula  $\text{CO}_3^{2-}$ .

☐

A sodium ion contains one electron in its outer shell.

☐

[1]

- 12 A sample of copper contains two isotopes,  $^{63}\text{Cu}$  and  $^{65}\text{Cu}$ .  
The relative atomic mass of copper is 63.5.

Which statement(s) is/are correct? Tick **two** boxes

$^{65}\text{Cu}$  has two more neutrons than  $^{63}\text{Cu}$

☐

$^{65}\text{Cu}$  has two more protons than  $^{63}\text{Cu}$

☐

$^{63}\text{Cu}$  and  $^{65}\text{Cu}$  contain the same number of electrons

☐

$^{65}\text{Cu}$  has two more electrons than  $^{63}\text{Cu}$

☐

[1]

- 14 Which statement describes the structure of an atom?

a sphere of positive charge with electrons embedded in it

☐

a nucleus of protons and neutrons, orbited by electrons

☐

a solid sphere that cannot be divided into smaller parts

☐

protons and electrons in a nucleus, surrounded by neutrons

☐

[1]

# OCR Chemistry A

**15** Which force holds an atom's nucleus together?

electrostatic force

☐

electromagnetic force

☐

strong nuclear force

☐

weak intermolecular interactions

☐

[1]

**16** What type of error is caused by results varying around the true value in an unpredictable way?

measurement error

☐

systematic error

☐

random error

☐

zero error

☐

[1]

**Answer the questions in the spaces provided in this section**

**17** Describe what it means when results are described as:

**accurate:** .....

.....

**precise:** .....

..... [2]

**18** This question is about atoms, isotopes and ions.

**a i** Complete the table below to show the properties of the particles.

| Particle | Relative mass | Relative charge |
|----------|---------------|-----------------|
| proton   |               |                 |
| neutron  |               |                 |
| electron |               |                 |

[3]

- ii Complete the table for an atom and an ion of two **different** elements.

| Element | Mass number | Protons | Neutrons | Charge | Electron configuration |
|---------|-------------|---------|----------|--------|------------------------|
|         |             | 11      | 13       | 0      |                        |
|         | 34          |         |          | 2–     | 2.8.8                  |

[2]

- (b) State the similarities and differences between isotopes of the **same** element.

Similarities.....

.....

Differences.....

..... [2]

- (c) An isotope of an element **X** contains 56 protons and 56 neutrons.

Identify element **X** and write down the mass number and atomic number of this isotope of **X**.

element **X** = .....

Atomic number: .....

Mass number: ..... [3]

- 19** Describe the function of a mass spectrometer.

.....

.....

..... [2]

**Total = 30 marks**