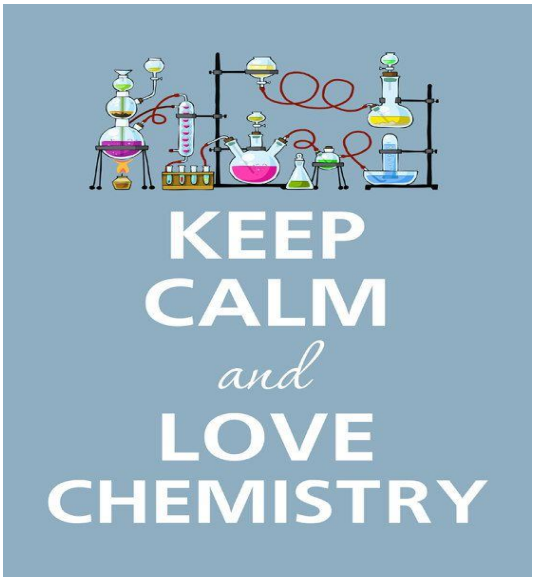
Corby Technical School
A Level Chemistry
Transition Booklet

This booklet is designed to prepare you for the Chemistry A level course and to bridge the gap and extend into A-Level.

What is included:

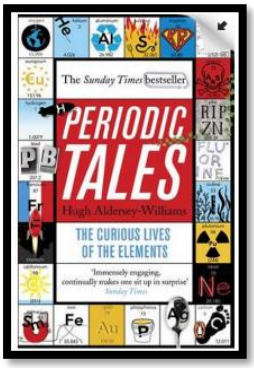
- Book recommendations
- Movie recommendations
- Guidance on how to make notes
- Research activities
- **5 Week Transition Classes (topics and practice)**
- Ideas for day trips
- Science on social media
- Science Websites
- Science things to do



Contact Details:
Miss. Coulson
ccoulsonl@corbytechnicalschool.org

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 Biology



Periodic Tales: The Curious Lives of the Elements Hugh Aldersey-Williams

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.

ISBN-10: 0141041455

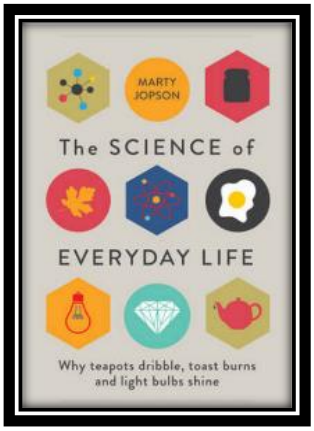
http://bit.ly/pixlchembook1

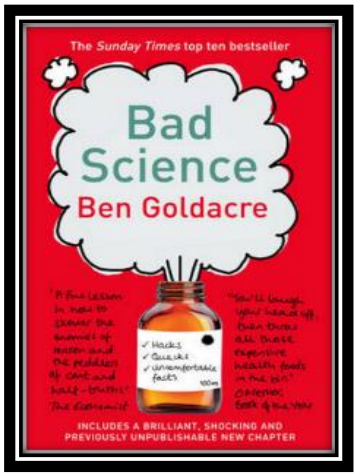
The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine (Hardback) Marty Jopson

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

ISBN-10: 1782434186

http://bit.ly/pixlchembook2





Bad Science Ben Goldacre

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 'sciency'.

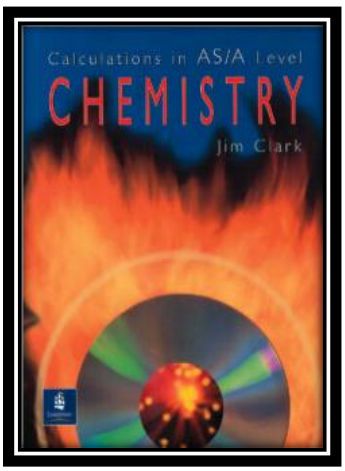
ISBN-10: 000728487X

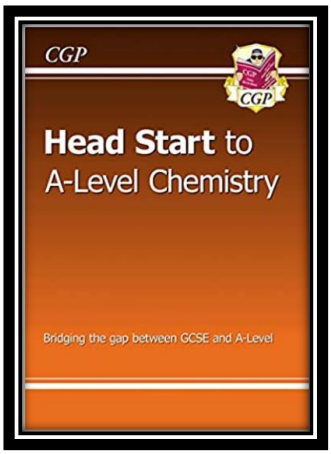
http://bit.ly/pixlchembook3

Calculations in AS/A Level Chemistry (Paperback) Jim Clark

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 website.

ISBN-10: 0582411270
http://bit.ly/pixlchembook4



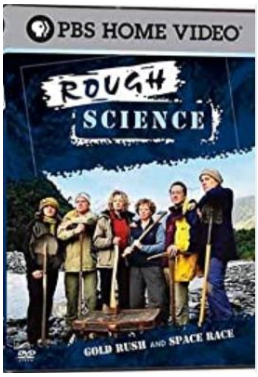


Head Start to A-Level Chemistry - CGP
This fantastic Head Start book from CGP is the ideal way to bridge the gap between GCSE and A-Level Chemistry. It recaps all the crucial topics you'll need to remember from GCSE, with crystal-clear study notes and examples, plus practice questions to test your understanding.

ISBN-10: 1782942807

Videos to Watch Online

Everyone loves a good story and everyone loves some great science.



Rough Science – The Open University (34 episodes available)

Real scientists are 'stranded' on an island and are given scientific problems to solve using only what they can find on the island.
Great fun if you like to see how science is used in solving problems.
There are six series in total
http://bit.ly/pixlchemvid1a
http://www.dailymotion.com/playlist/x2igjq_Rough-Science_rough-science-full-series/1#video=xxw6pr
or
http://bit.ly/pixlchemvid1b
https://www.youtube.com/watch?v=lUoDWAt259I

A Thread of Quicksilver – The Open University (34 episodes available)

A brilliant history of the most mysterious of elements – mercury. This program shows you how a single substance led to empires and war, as well as showing you come of the cooler properties of mercury.

https://www.youtube.com/watch?v=t46lvTxHHTA

10 weird and wonderful chemical reactions

10 good demonstration reactions, can you work out the chemistry of …. any… of them?

http://bit.ly/pixlchemvid3

https://www.youtube.com/watch?v=0Bt6RPP2ANI

There are some great TV series and box sets available too, you might want to check out: Blue Planet, Planet Earth, Frozen Planet.

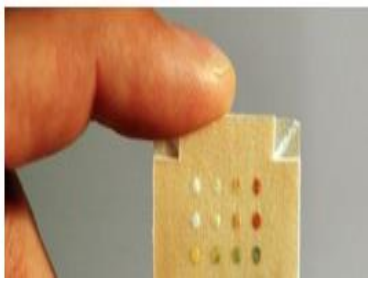
Movie Recommendations

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:

The incredible chemistry powering your smartphone
Available at :
https://www.ted.com/talks/cathy_mulzer_the_incredible_chemistry_powering_your_smartphone
Ever wondered how your smartphone works? Cathy Mulzer, reveals how almost every component of our high-powered devices exists thanks to chemists -- and not the Silicon Valley entrepreneurs that come to most people's minds.

The Chemistry of Cookies
Available at :
https://www.ted.com/talks/stephanie_warren_the_chemistry_of_cookies
Stephanie Warren explains via basic chemistry principles how the dough spreads out, at what temperature we can kill salmonella, and why that intoxicating smell wafting from your oven indicates that the cookies are ready for eating.

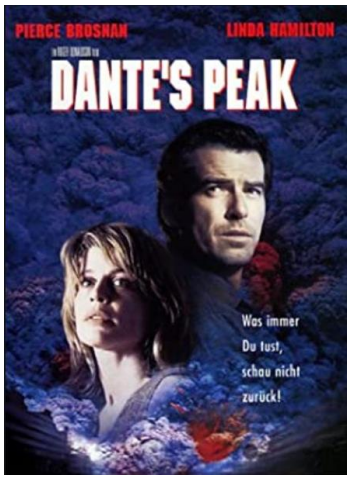
A lab the size of a postage stamp
Available at :
https://www.ted.com/talks/george_whitesides_a_lab_the_size_of_a_postage_stamp
Traditional lab tests for disease diagnosis can be too expensive and cumbersome for the regions most in need. George Whitesides' ingenious answer is a foolproof tool that can be manufactured at virtually zero cost.



Award-winning teenage science in action
Available at :
https://www.ted.com/talks/lauren_hodge_shree_bose_naomi_shah_award_winning_teenage_science_in_action
In 2011 three young women swept the top prizes of the first Google Science Fair. Lauren Hodge, Shree Bose and Naomi Shah describe their extraordinary projects -- and their route to a passion for science.

Chemistry in Full Length Feature Movies

Everyone loves a good story and everyone loves some great science.



Dantes Peak 19974: Volcano Disaster Movie

Use the link to look at the Science of acids and how this links to the movie.
http://www.open.edu/openlearn/science-maths-technology/science/chemistry/dantes-peak

http://www.flickclip.com/flicks/dantespeak1.html

http://www.flickclip.com/flicks/dantespeak5.html

Fantastic 4 2005 & 2015

Michio Kaku explains the "real" science behind fantastic four

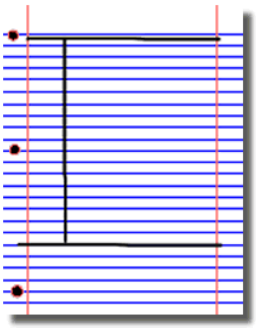
http://nerdist.com/michio-kaku-explains-the-real-science-behind-fantastic-four/

http://www.flickclip.com/flicks/fantastic4.html

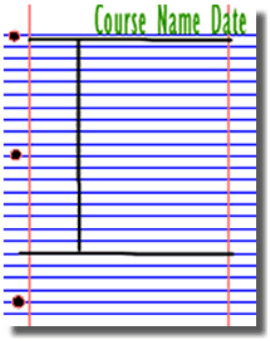
Research activities

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

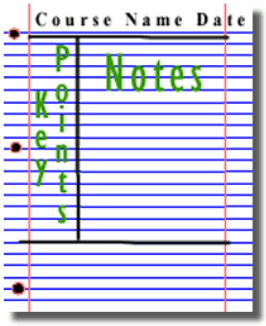
1. Divide your page into three sections like this



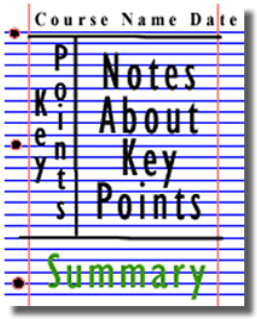
2. Write the name, date and topic at the top of the page



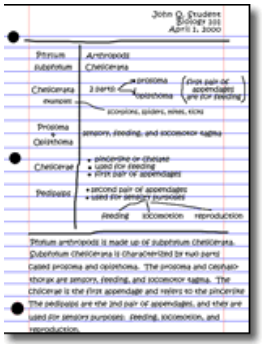
3. Use the large box to make notes. Leave a space between separate idea. Abbreviate where possible.



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

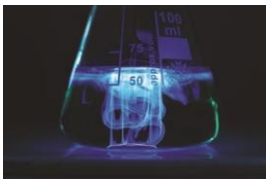
Research activities

Use your online searching abilities to see if you can find out as much about the topic as you can. Remember it you are a prospective A level chemist, you should aim to push **your** knowledge. Some starting points for your research have been provided to support.

You can make a 1-page summary for each one you research using Cornell notes:
http://coe.jmu.edu/learningtoolbox/cornellnotes.html

Task 1: The chemistry of fireworks
What are the component parts of fireworks? What chemical compounds cause fireworks to explode? What chemical compounds are responsible for the colour of fireworks?

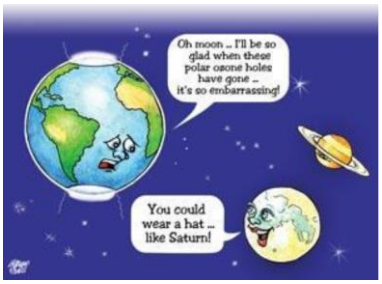
Task 2: Why is copper sulfate blue?
Copper compounds like many of the transition metal compounds have got vivid and distinctive colours – but why?



Task 3: Aspirin
What was the history of the discovery of aspirin, how do we manufacture aspirin in modern chemical process?

Task 4: The hole in the ozone layer

Why did we get a hole in the ozone layer? What chemicals were responsible for it? Why were we producing so many of these chemicals? What is the chemistry behind the ozone destruction?



Task 5: ITO and the future of touch screen devices

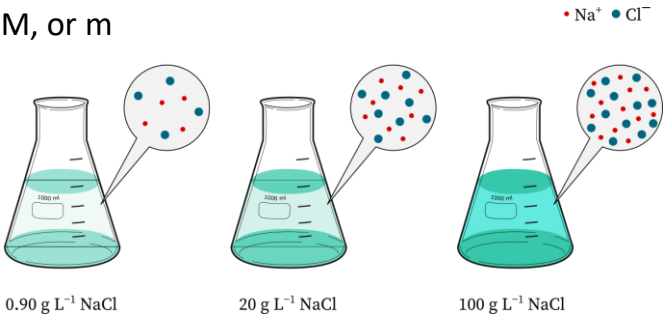
ITO – indium tin oxide is the main component of touch screen in phones and tablets. The element indium is a rare element and we are rapidly running out of it. Chemists are desperately trying to find a more readily available replacement for it. What advances have chemists made in finding a replacement for it?

Week 1: Dilutions, Standard Solutions, Concentration Calculations

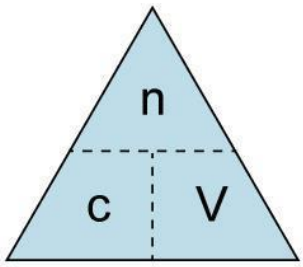
In chemistry, **concentration** refers to the amount of a substance in a defined space. Another definition is that concentration is the ratio of solute in a solution to either solvent or total solution.

Concentration is usually expressed in terms of mass per unit volume. However, the solute concentration may also be expressed in moles or units of volume. Instead of volume, concentration may be per unit mass. While usually applied to chemical solutions, concentration may be calculated for any mixture.

Unit Examples of Concentration: g/cm^3, M, or m



Concentration Calculations



$$Concentration = \frac{moles}{volume}$$

1. Calculate the number of moles in the following.
   a) 2 dm^3 of 0.05 mol dm-3 HCl
   b) 50 litres of 5 mol dm^{-3} H_2SO_4
   c) 10 cm^3 of 0.25 mol dm^{-3} KOH

2) Calculate the concentration of the following in both mol dm-3 and g dm-3
   a) 0.400 moles of HCl in 2.00 litres of solution
   b) 12.5 moles of H_2SO_4 in 5.00 dm^3 of solution
   c) 1.05 g of NaOH in 500 cm^3 of solution

3) Calculate the volume of each solution that contains the following number of moles.
   a) 0.00500 moles of NaOH from 0.100 mol dm^{-3} solution
   b) 1.00 x 10^{-5} moles of HCl from 0.0100 mol dm^{-3} solution

Week 1: Dilutions, Standard Solutions, Concentration Calculations

Standard Solution

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Errors in the diagram:

Practice before Master Class: http://chemcollective.org/activities/vlab/67

Week 1: Dilutions, Standard Solutions, Concentration Calculations

Dilutions

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Errors in Diagram:

Dilution Calculations $M_1V_1 = M_2V_2$

1. If 45 mL of water are added to 250 mL of a 0.75 M K2SO4 solution, what will the molarity of the diluted solution be?
2. If water is added to 175 mL of a 0.45 M KOH solution until the volume is 250 mL, what will the molarity of the diluted solution be?
3. How much 0.075 M NaCl solution can be made by diluting 450 mL of 9.0 M NaCl?
4. If 550 mL of a 3.50 M KCl solution are set aside and allowed to evaporate until the volume of the solution is 275 mL, what will the molarity of the solution be?
5. How much water would need to be added to 750 mL of a 2.8 M HCl solution to make a 1.0 M solution?

Week 2: Moles Calculation; Titration's & Titration Calculations

A mole is simply a unit of measurement. Units are invented when existing units are inadequate. Chemical reactions often take place at levels where using grams wouldn't make sense, yet using absolute numbers of atoms/molecules/ions would be confusing, too.

Like all units, a mole has to be based on something reproducible. A mole is the quantity of anything that has the same number of particles found in 12.000 grams of carbon-12. That number of particles is Avogadro's Number, which is roughly 6.02×10^{23}.1 A mole of carbon atoms is 6.02×10^{23} carbon atoms. A mole of chemistry teachers is 6.02×10^{23} chemistry teachers. It's a lot easier to write the word 'mole' than to write '6.02×10^{23}' anytime you want to refer to a large number of things. Basically, that's why this particular unit was invented.

Why don't we simply stick with units like grams (and nanograms and kilograms, etc.)? The answer is that moles give us a consistent method to convert between atoms/molecules and grams. It's simply a convenient unit to use when performing calculations. You may not find it too convenient when you are first learning how to use it, but once you become familiar with it, a mole will be as normal a unit as, say, a dozen or a byte.

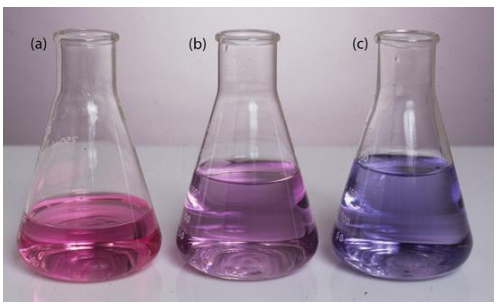
Calculations

$$Moles = \frac{mass}{volume}$$

$$Moles = Concentration\ x\ Volume$$

Titrations

A **titration** is a laboratory technique used to precisely measure molar concentration of an unknown solution using a known solution. The basic process involves adding a **standard solution** of one reagent to a known amount of the unknown solution of a different reagent. For instance, you might add a standard base solution to an mystery acid solution. As the addition takes place, the two reagents in the solutions, in this the acid and base, react. You also add an **indicator**, which is a molecule that changes color when the original reagent (the acid in the mystery solution, say) is completely consumed by reaction with the standard solution reagent. If you know exactly how much standard was added before the color change, you can calculate how many moles of the unknown were present at the beginning, and thus the concentration of the unknown.



Week 2: Moles Calculation; Titration's & Titration Calculations

Titration Calculations

1. Balance the equation
2. Moles of known compound.
3. Ratio of known to unknown compound
4. Unknown value using the new known mole value.

Example: 25 cm^3 of a solution of 0.1 $moldm^{-3}$ NaOH reacts with 50 cm^3 of a solution of hydrochloric acid. What is the concentration of the **acid**?

$$NaOH + HCl \rightarrow NaCl + H_2O$$

$V = 25cm^3 = 0.025dm^3$ $C = 0.1\ mol/dm^3$ $n = c \times v$ $n = 0.1 \times 0.025$ $n = 0.00025\ mol$	Ratio NaOH : HCl 1:1 Therefore we have 0.00025mol of HCl	$V = 50cm^3 = 0.050dm^3$ $n = 0.00025\ mol$ $c = n \times v$ $c = 0.00025/0.050$ $c = 0.005\ mol/dm^3$

Practice

25.0 cm^3 of a 0.10 $moldm^{-3}$ solution of sodium hydroxide was titrated against a solution of hydrochloric acid of unknown concentration. 27.3 cm^3 of the acid was required. What was the concentration of the acid?

25 cm^3 of a solution of sodium hydroxide reacts with 15 cm^3 of 0.1 mol/dm^3 HCl. What is the molar concentration of the sodium hydroxide solution?

22.5 cm^3 of sodium hydroxide solution reacted with 25.0 cm^3 of 0.100 mol/dm^3 hydrochloric acid. $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O$ Calculate the concentration of the sodium hydroxide solution in mol/dm^3. Give your answer to 3 significant figures.

25.0 cm^3 of 0.200 mol/dm^3 sodium hydroxide solution reacted with 28.7 cm^3 sulfuric acid. Calculate the concentration of the sulfuric acid in mol/dm^3. Give your answer to 3 significant figures. $2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

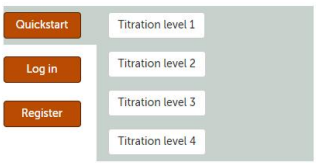
25.0 cm^3 of 0.150 mol/dm^3 sodium hydroxide reacted with 30.3 cm^3 of a solution of ethanoic acid. $CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$ Calculate the concentration of the ethanoic acid in mol/dm^3. Give your answer to 3 significant figures

Week 2: Moles Calculation; Titration's & Titration Calculations

Titration Practical:

Quick Start: Experiment 1: https://virtual.edu.rsc.org/titration/experiment/2

As you work through the method, please write a method which you could follow in week 5 of the transition lessons, where we will complete a titration to identify concentration of vitamin C in fruit juices.



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Additional Support:

https://www.youtube.com/watch?v=RI14t0R1wMY

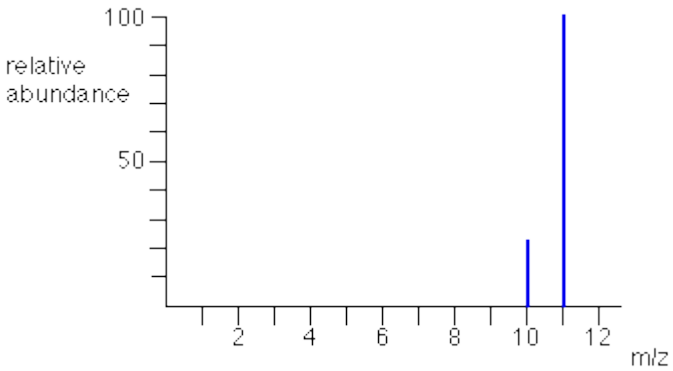
https://www.youtube.com/watch?v=YqfvRBJ-iPg

Week 3: Mass Spectrum

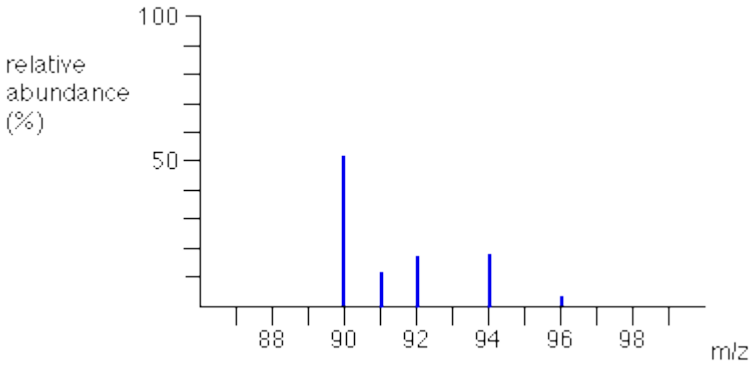
The mass spectrum of monatomic elements

Monatomic elements include all those except for things like chlorine, Cl_2, with molecules containing more than one atom.

The mass spectrum for boron



The mass spectrum for zirconium



The number of isotopes

The 5 peaks in the mass spectrum shows that there are 5 isotopes of zirconium - with relative isotopic masses of 90, 91, 92, 94 and 96 on the ^{12}C scale.

The abundance of the isotopes

This time, the relative abundances are given as percentages. Again you can find these relative abundances by measuring the lines on the stick diagram.

In this case, the 5 isotopes (with their relative percentage abundances) are:

zirconium-90	51.5
zirconium-91	11.2
zirconium-92	17.1
zirconium-94	17.4
zirconium-96	2.8

Week 3: Mass Spectrum

Independent Questions:

1. Mass spectra enable you to find relative abundances of the isotopes of a particular element.

a) What are isotopes? ……

b) Define relative atomic mass. ……

c) The mass spectrum of strontium contains the following lines for 1+ ions:

m/z	% abundance
84	0.56
86	9.86
87	7.00
88	82.58

Calculate the relative atomic mass of strontium:

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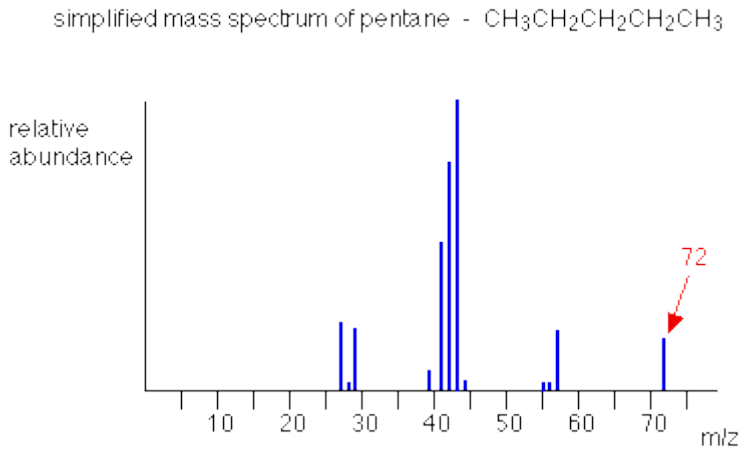
Week 3: Mass Spectrum

Using the molecular ion to find the relative formula mass
In the mass spectrum, the heaviest ion (the one with the greatest m/z value) is likely to be the molecular ion. A few compounds have mass spectra which don't contain a molecular ion peak, because all the molecular ions break into fragments.

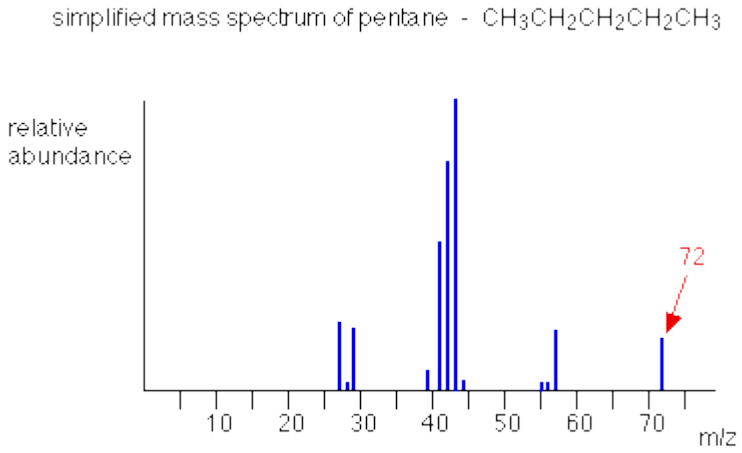
For example, in the mass spectrum of pentane, the heaviest ion has an m/z value of 72.



Because the largest m/z value is 72, that represents the largest ion going through the mass spectrometer - and you can reasonably assume that this is the molecular ion. The relative formula mass of the compound is therefore 72.

Week 3: Mass Spectrum

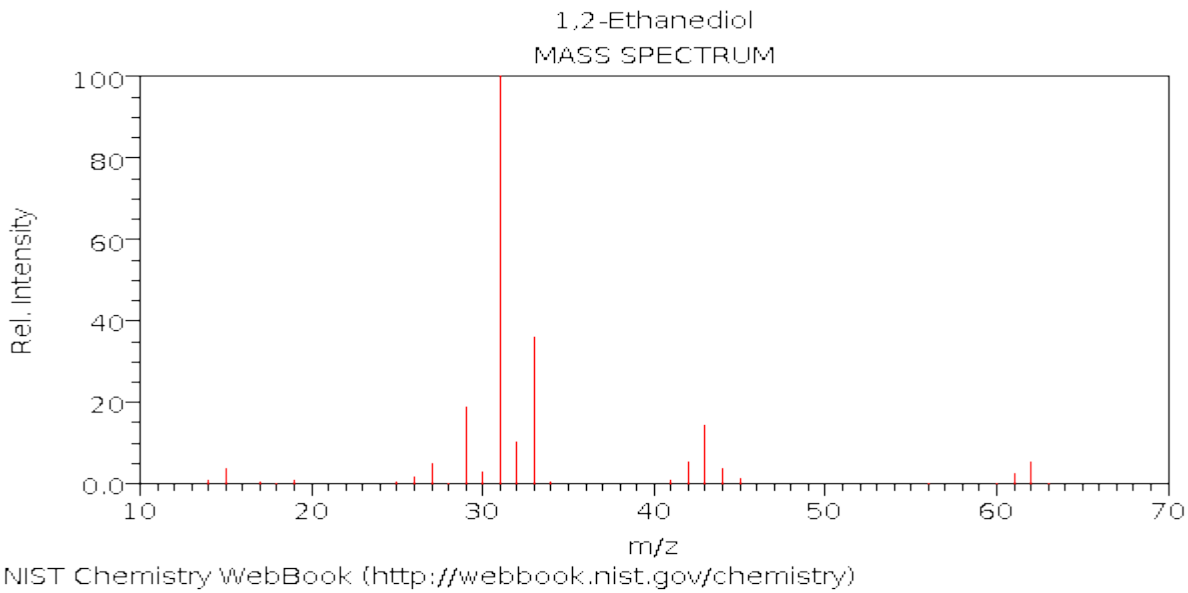
Fragmentation: This is when the compound will break 1 bond forming ions. These ions will produce peaks in the mass spectrum and can be used to try and figure out an unknown compound.



What structures could have produced the m/z peak at 43; 29; 57; 56; 55. Draw them below:

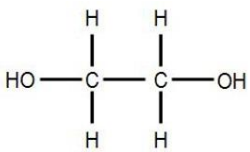
Week 3: Mass Spectrum

Independent Work/Home Work



Using the above spectrum:

1. What is the formula mass? ……
2. 1,2 – Ethanediol has the following structure:



What structure causes the m/z peak at 61?

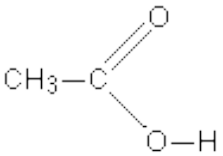
What is the structure causes the m/z peak at 29?

What causes the m/z peak at 33?

Week 4: Identification of Unknown using IR Spectrum

Ethanoic acid

Ethanoic acid has the structure:

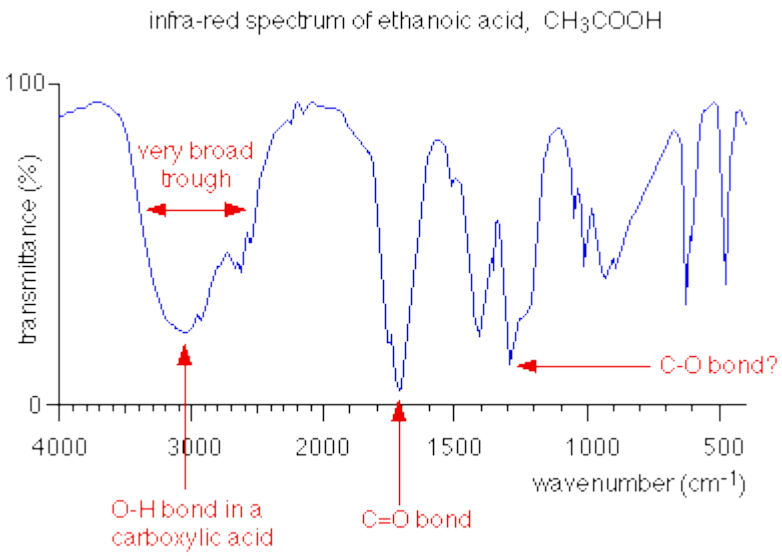


You will see that it contains the following bonds:

- carbon-oxygen double, C=O
- carbon-oxygen single, C-O
- oxygen-hydrogen, O-H
- carbon-hydrogen, C-H
- carbon-carbon single, C-C

The carbon-carbon bond has absorptions which occur over a wide range of wavenumbers in the fingerprint region - that makes it very difficult to pick out on an infra-red spectrum.

The carbon-oxygen single bond also has an absorbtion in the fingerprint region, varying between 1000 and 1300 cm^{-1} depending on the molecule it is in. You have to be very wary about picking out a particular trough as being due to a C-O bond.

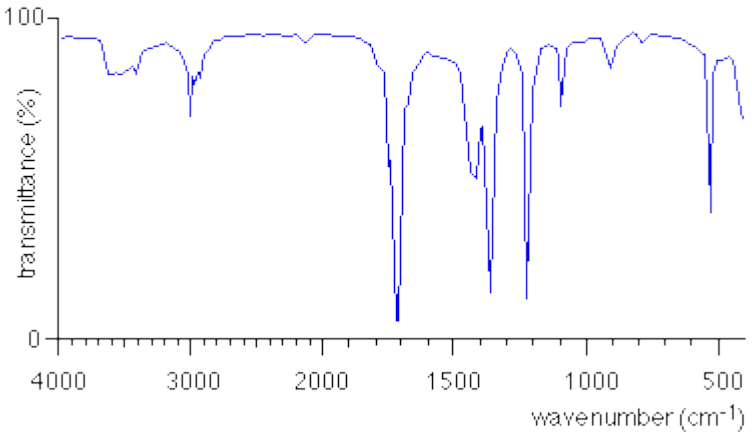


The possible absorption due to the C-O single bond is queried because it lies in the fingerprint region. You couldn't be sure that this trough wasn't caused by something else.

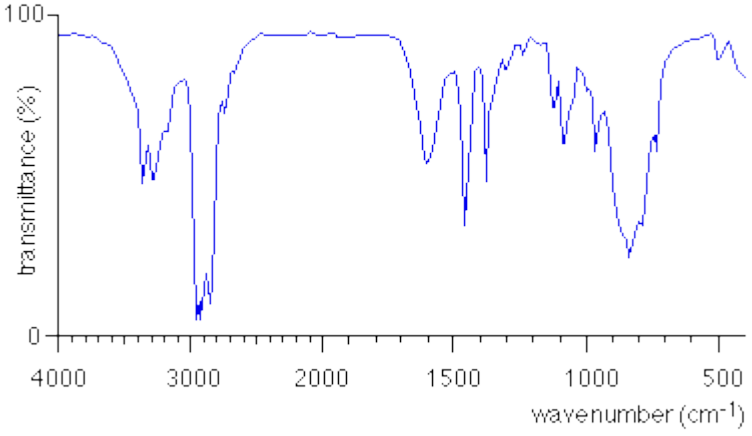
Week 4: Identification of Unknown using IR Spectrum

Propanone

infra-red spectrum of propanone, $CH_3C(=O)CH_3$



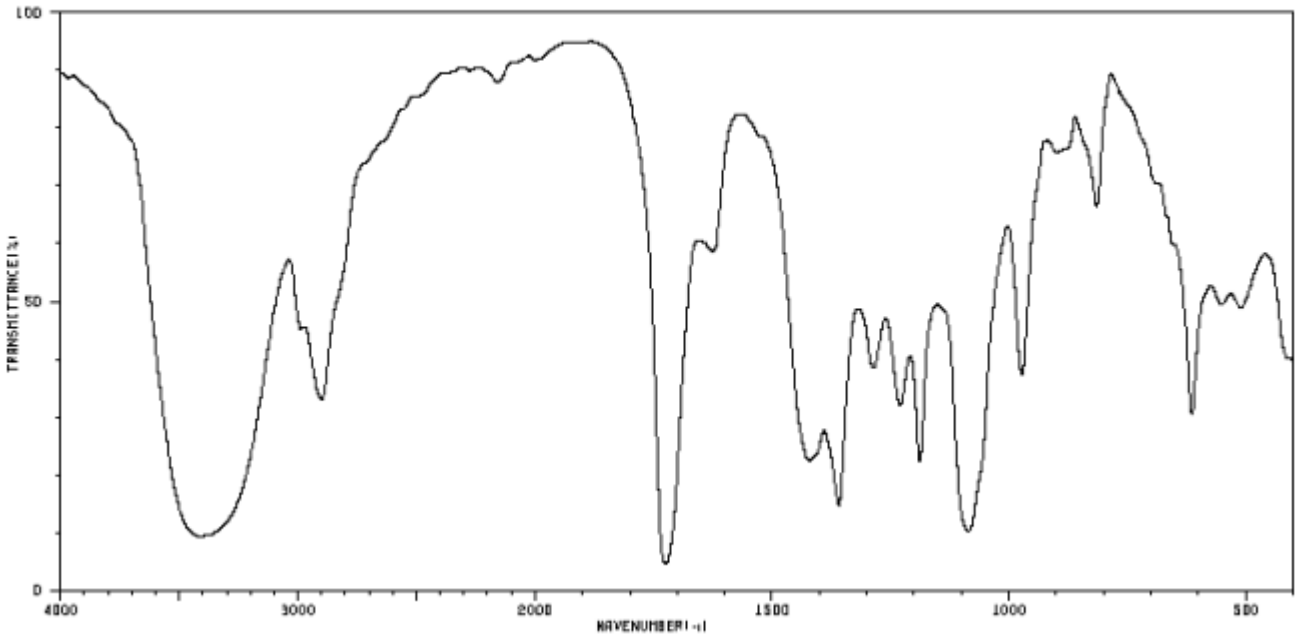
infra-red spectrum of 1-aminobutane, $CH_3CH_2CH_2CH_2NH_2$



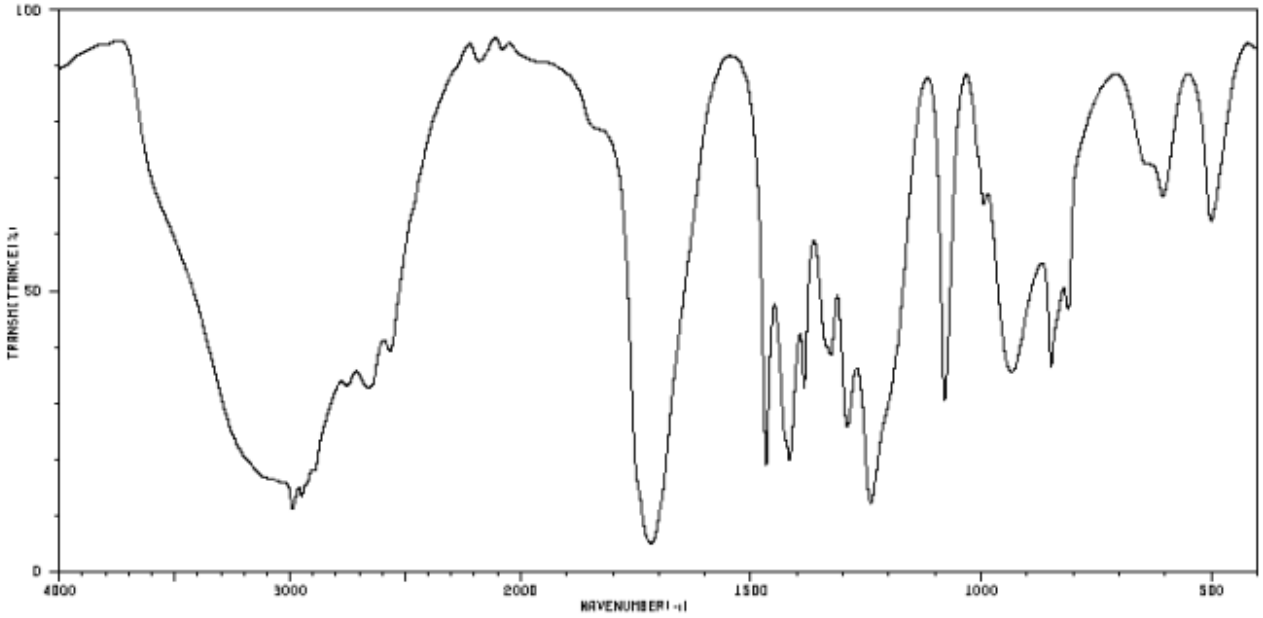
Bond	Wavenumber / cm^{-1}
C-O	1000 - 1300
C=O	1680 - 1750
C-H	2850 - 2960
O-H (acids)	2500 - 3300
O-H (alcohols)	3200 - 3500

Week 4: Identification of Unknown using IR Spectrum

Spectrum 2:



Spectrum 3:



Week 4: Identification of Unknown using IR Spectrum

Using the following structures link the structure to the IR Spectrum. Provide some reasoning for your choices.

Bond	Wavenumber / cm^{-1}
C-O	1000 - 1300
C=O	1680 - 1750
C-H	2850 - 2960
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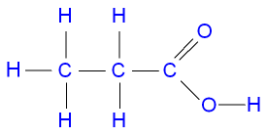
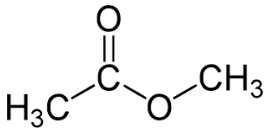
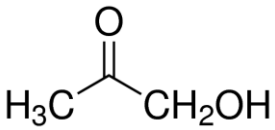
propanoic acid:



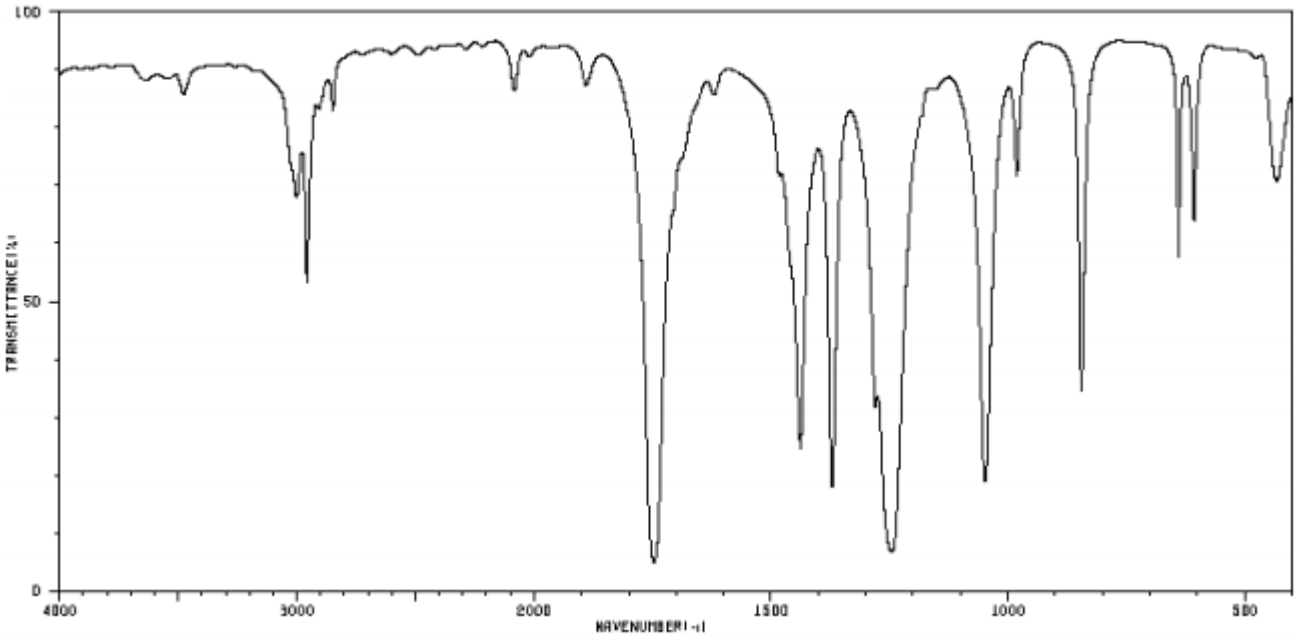
methyl ethanoate:



hydroxypropanone:

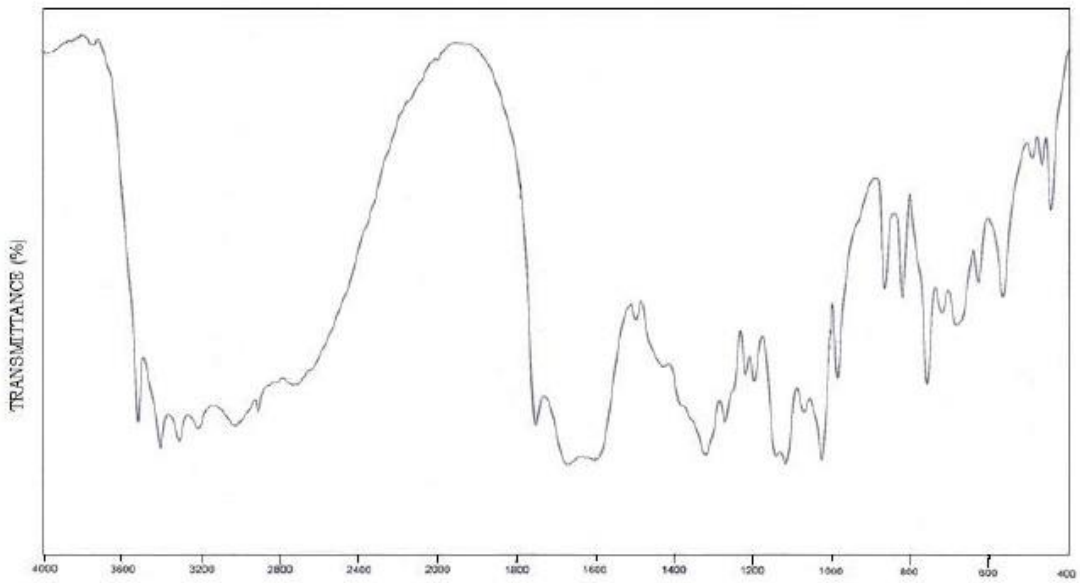


Spectrum 1:



Week 5: Vitamin C Identification & Titration

Practical: https://www.canterbury.ac.nz/media/documents/science-outreach/vitaminc_iodine.pdf



Bond	Wavenumber / cm^{-1}
C-O	1000 - 1300
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Places to visit

1. Go outdoors!
   Have you actually spent any time observing the geology of the area you live in? What rocks or minerals are found in your area? Does your area have a history of extracting minerals? If so what were they, what were they used for, how did they obtain them? Are there any working or remains of mineral extraction industries?

2. Are there any chemical or chemistry based businesses in your area? A big ask, but one that could be really beneficial to you, write them a letter explaining that you are taking A level chemistry and you want to see how chemistry is used in industry and you would like to visit / have some work experience. You never know this could lead to great things!!!!

3. Science museums.
   You could visit your nearest science museum. They often have special exhibitions that may be of interest to you.
   https://en.wikipedia.org/wiki/List_of_science_museums#United_Kingdom

   or

https://www.sciencemuseum.org.uk/virtual-tour-science-museum

5. Somerset Earth Science Centre:

   http://www.earthsciencecentre.org.uk

6. The UK Association for Science and Discovery Centres (ASDC)

   This association brings together over 60 major science engagement organisations in the UK.

   http://sciencecentres.org.uk/centres/weblinks.php