Higher Chemistry: Unit 4 - Researching Chemistry

Revision of Researching Chemistry & Chemical Analysis

Learning Outcomes

The lesson will help you revise the following topics

1. Common Chemical Apparatus
2. General Practical Techniques
3. Reporting Experimental Work
4. Chromatography (chemical analysis)

Success Criteria

You will have been successful in this lesson if you:

1. Read the summary given (do not copy these notes – you already have them)
2. Watch the links provided
3. Complete questions provided
4. EXTENSION: There is a further reading section to help you gain more depth of understanding for this section. There are also suggested questions for you to try from the blue book of revision questions.

If you have any questions about the content of this lesson, you should ask your class teacher either through your class MS team or via email. The teams will be monitored through the week and someone will get back to you as soon as they can.

Links to Prior Knowledge

You may wish to revise the following to help you understand this lesson:

Higher chemistry – Unit 4 Researching Chemistry

You may wish to have a copy of the data booklet handy for this lesson. Download or print a copy of the Higher Chemistry Data Booklet from MS Teams or the SQA website - https://www.sqa.org.uk/sqa/files_ccc/ChemistryDataBooklet_NewH_AH-Sep2016.pdf

Do not copy the notes below - these are a summary of the printed notes you already have for this unit. Have your Researching Chemistry Booklet open while you are completing this lesson - and highlight important parts.

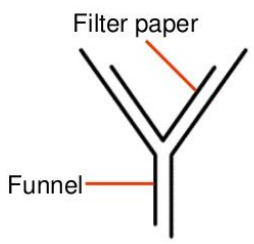
WATCH: Click on the link for a 9 minute recorded lesson for this topic:

Recorded Lesson from Ms Hastie

Researching Chemistry & Chromatography

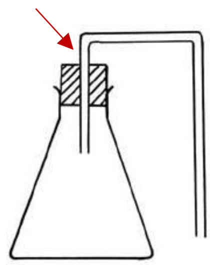
1. Common Chemical Apparatus

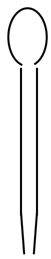
Below are some pieces of apparatus you may have seen in class. You need to be able to identify or draw these pieces of equipment, in addition to the more common chemical equipment like test tubes and beakers etc. (The full list is in your Researching chemistry booklet.)



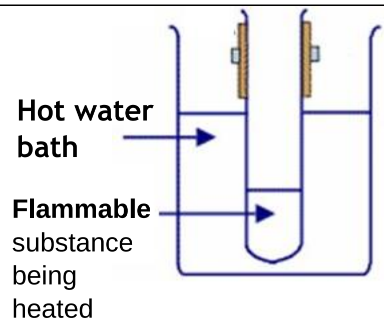
Filter funnel (+ paper)

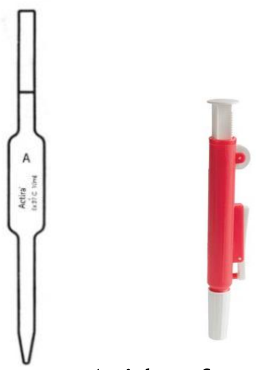
Delivery tube (Must be open)



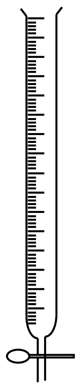


dropper

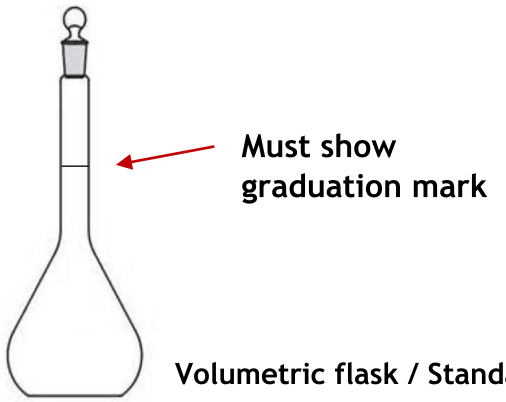




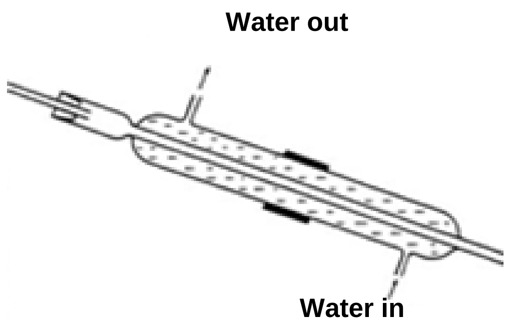
Pipette (with safety filler)



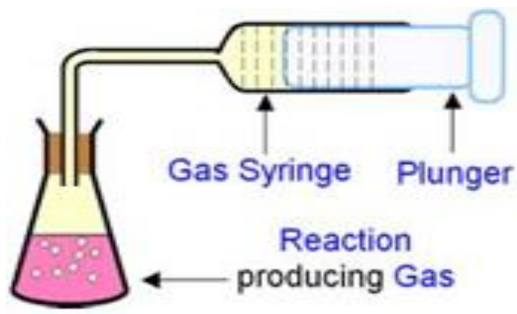
Burette



Volumetric flask / Standard flask



Condenser (cools gases back to liquid state)



Gas syringe

Drawing Sectional Diagrams

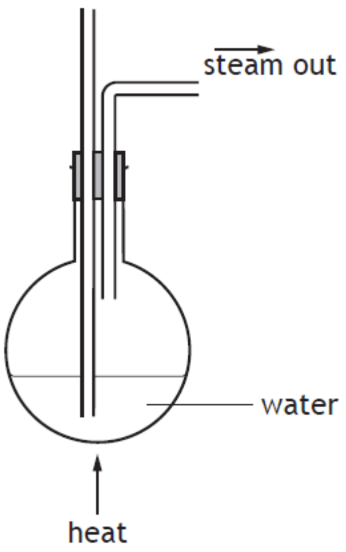
You should be able to draw labelled, sectional diagrams with common chemical apparatus. There is usually one question in each exam that describes an experimental set up and asks you to draw it.

Example from 2015 Higher Paper:

Methyl cinnamate is a naturally occurring ester found in the essential oil extracted from the leaves of strawberry gum trees.

To extract the essential oil, steam is passed through shredded strawberry gum leaves. The steam and essential oil are then condensed and collected.

Complete the diagram to show an apparatus suitable for carrying out this extraction.

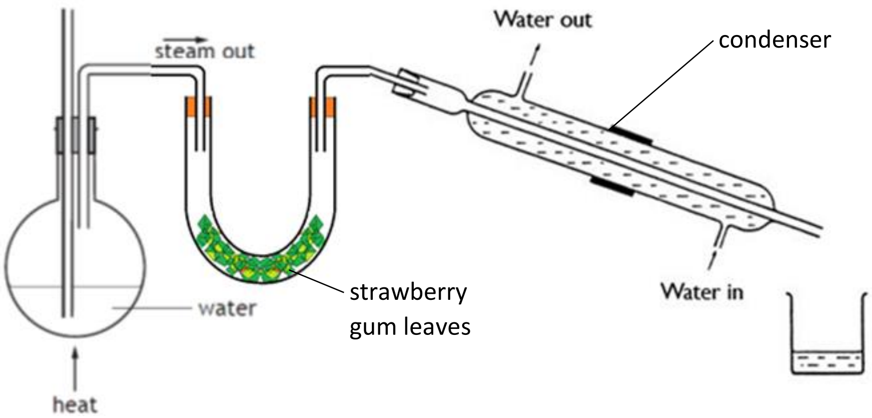


TASK:

Answer the question above by drawing the assembled apparatus in your jotter. The answer is given on the next page for you to compare… no peeking!

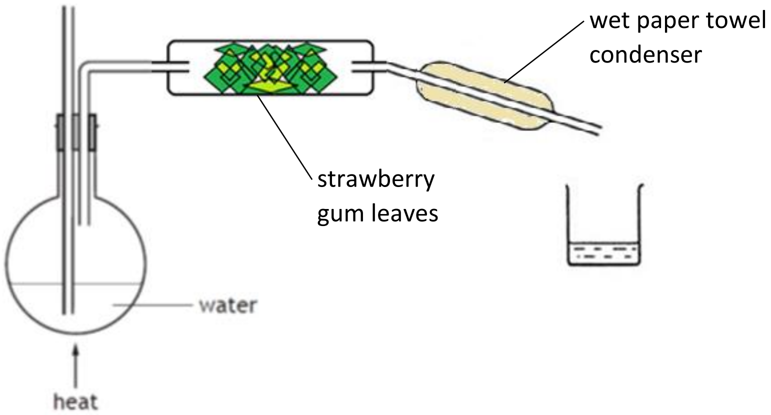
The marking scheme for this question states that:

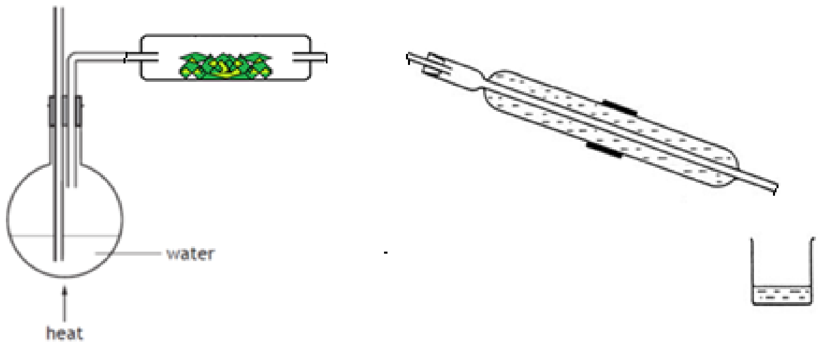
Question			Answer	Max Mark	Additional Guidance
3.	(a)	(i)	Workable apparatus for passing steam **through** strawberry gum leaves (1) Workable apparatus for condensing the steam and essential oil (1)	2	Treat both marks separately "Through" not "over" A closed system would not allow candidates to gain mark for condensation.



POINTS TO MAKE A GOOD DIAGRAM:

- The apparatus connects up
- It fulfils the instructions
- It is clearly labelled (in case your drawing skills aren't great)
- It is drawn neatly and size is proportional to the original



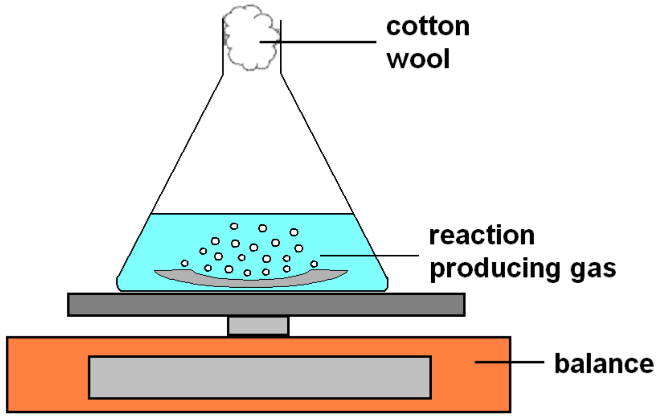


POINTS TO AVOID A BAD DIAGRAM:

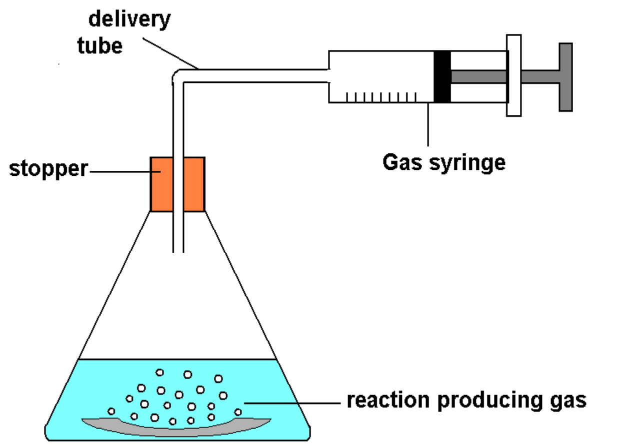
- **It does not fulfil the instructions** – the steam is passed OVER the gum leaves instead of THROUGH.
- **The ends of the apparatus are closed** – this means the gas CANNOT PASS THROUGH.
- **No labels** (the examiner cannot read your mind if your drawing isn't clear enough)
- **The apparatus doesn't join up**.

Other Common Chemical Apparatus Set ups

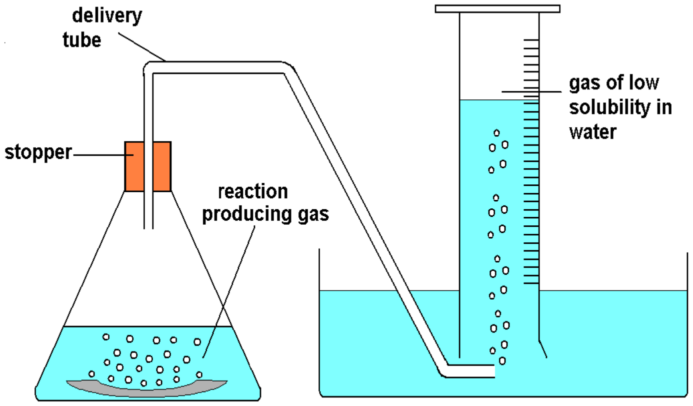
You do not need to be able to draw these set ups from memory, but it is a good idea to practice drawing them. Practicing drawing these set ups will help when you are asked to draw an unknown experiment in a test. (A full list of these experiments with descriptions can be found in your **Researching Chemistry Booklet**)



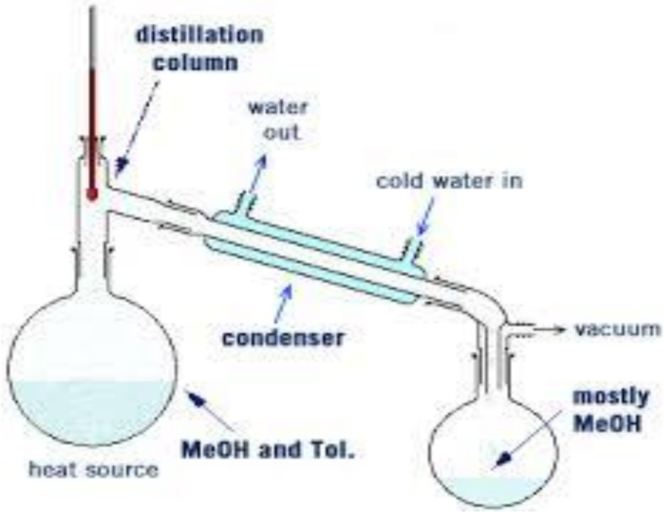
Measuring mass loss in an experiment



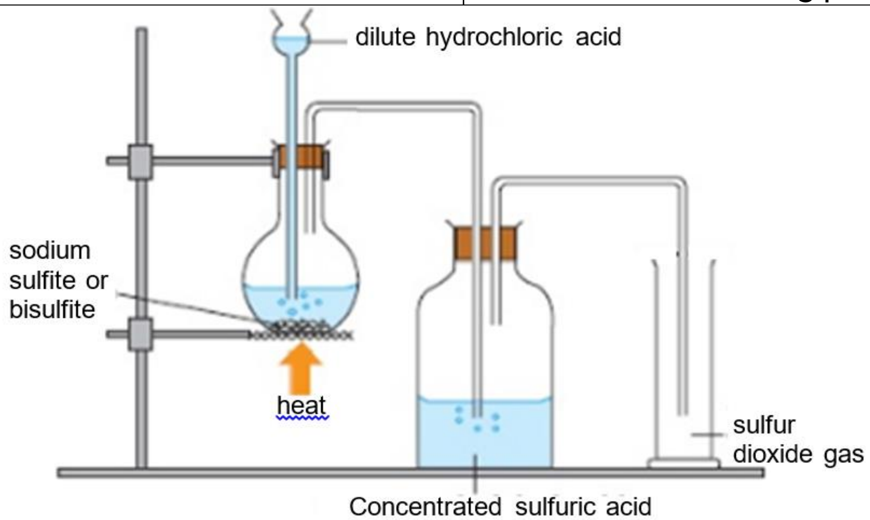
Collecting and measuring a water soluble gas



Collecting and measuring a gas that is insoluble in water



Distillation to separate liquids with different boiling points



Bubbling through a liquid to an then collecting by upward displacement of air

2. General Practical Techniques

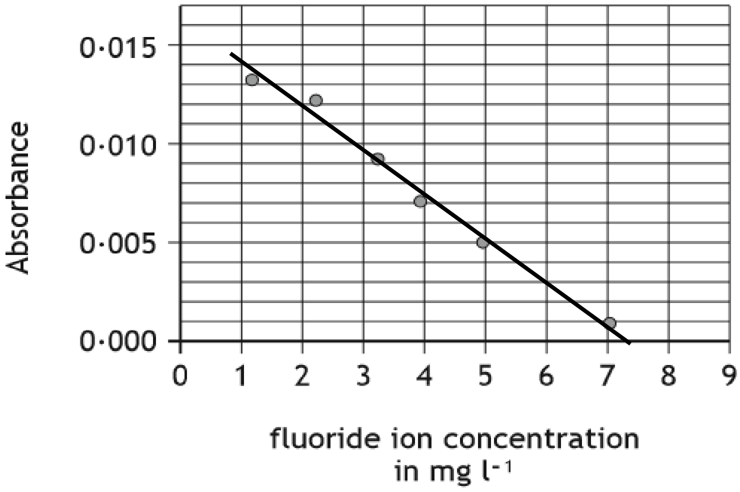
There are a number of practical techniques that you should be familiar with and should have seen throughout the higher course. Due to restrictions and school closures, it is likely that you may have missed some of these techniques or they may have been shown to you has demonstrations by your teacher. The videos below give demonstrations of some of these techniques. (A full list of techniques are given in you Researching Chemistry Booklet).

Demo Link	Brief Description
Weighing By Difference	Used to accurately find the mass of a transferred solid 1. Place a beaker on a balance and measure out a mass of solid. 2. Record the mass of the beaker and the solid. *(TOTAL MASS)* 3. Transfer the solid to a second container - to use for your experiment. 4. Reweigh the now 'empty' beaker and any leftover solid. *(LEFTOVER MASS)* **5.** The accurate mass of solid transferred is the ***difference*** **between the two recorded masses.** ***MASS USED = TOTAL MASS - LEFTOVER MASS***
	Can be determined experimentally and calculated using, $E_h = cm\Delta T$ *then scaling up to* ***one mole of the alcohol****.* where **E_h** = the heat energy released (in kJ or kJ mol^{-1}) **c** = the specific heat capacity of water. It is a constant, 4.18 kJ kg^{-1} $^{\circ}C^{-1}$ **m** = the mass of water (in kg) ($100cm^3$ = 0.1kg) **ΔT** = the change in temperature (˚C). Experimental values are always lower than Data Booklet values to due to heat loss to the surroundings, incomplete combustion and alcohol mass lost through evaporation.

Preparation of a standard solution	A **standard solution** is one of accurately known concentration 1. The weighed sample is dissolved in a small volume of (deionised) water in a beaker and the solution transferred to a standard flask. 2. The beaker is rinsed and the rinsings are also poured into the standard flask. 3. The flask is made up to the mark adding the last few drops of water using a dropping pipette. 4. The flask is stoppered and inverted several times to ensure thorough mixing of the solution.
Titration	Used to find the concentration of an unknown solution 1. A burette is rinsed then filled with standard solution to the zero mark 2. A pipette is rinsed then filled with solution of unknown concentration up to the graduation mark and then emptied into a conical flask 3. The conical flask is placed on a white tile and an indicator is added (potassium permanganate is self-indicating) 4. The solution in the burette is added to the conical flask until the indicator changes. (the end point) 5. The volume used is recorded and the process is repeated until titre results are within 0.02cm^3 (concordant) 6. Average of concordant results are used to calculate unknown concentration.
Distillation	Used to separate a mixture of liquids with different points. 1. Liquid mixture is heated just above the boiling point of one of the liquids. 2. Gas travels through the condenser, cooling to a liquid. 3. Separated liquid is collected in a beaker

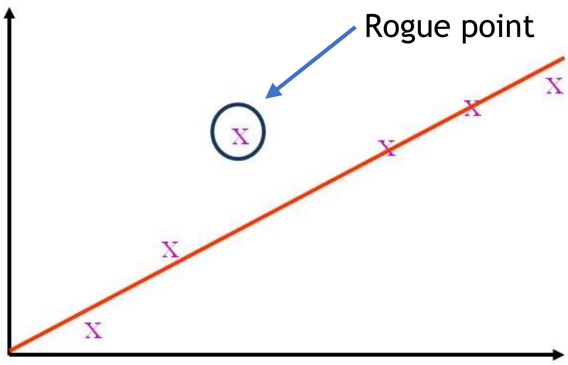
3. Reporting Experimental Work

You should be able to process experimental results by:

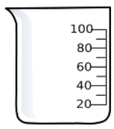


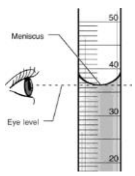
- Drawing graphs and sketching **lines or curves of <u>best fit</u>**.

- **Calculating averages** (means) for experiments e.g. from concordant results.



- **Identifying and eliminating rogue points** from the analysis of results.





- Describing the relative **accuracy of apparatus:**
  Know that **beakers** and **measuring cylinders** are only used for <u>rough</u> measurements. **Burettes, pipettes and volumetric/standard flasks** are used for <u>accurate</u> measurements.

- Appreciating that when a measurement has been repeated, any variations in the value obtained give an indication of the **reproducibility** of the technique.

	Experiment 1 (mg/100 cm^3)	*Experiment 2* (mg/100 cm^3)	*Experiment 3* (mg/100 cm^3)
Student A	30·0	29·0	28·0
Student B	26·4	26·6	26·8
Student C	26·9	27·0	26·9

Most reproducible

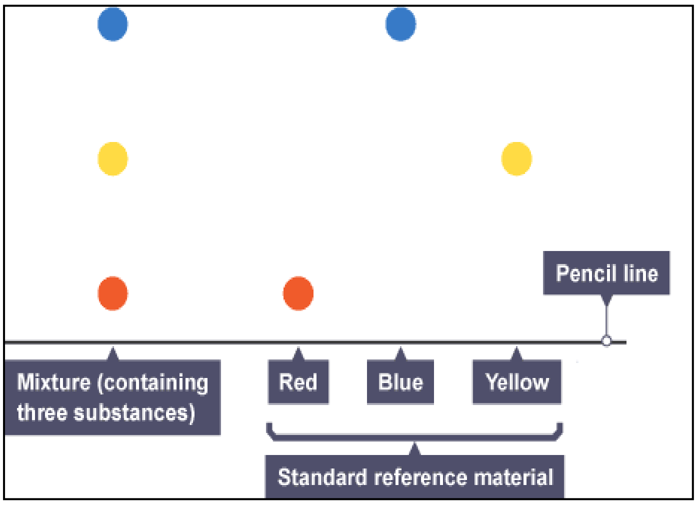
4. Chromatography

Chromatography is a separation technique that uses difference in the **polarity and molecular size to separate the components present within a mixture**. Below are two examples of how we use chromatography.

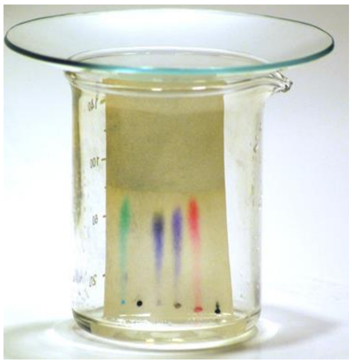
You are not required to describe any specific chromatographic method or experiment.

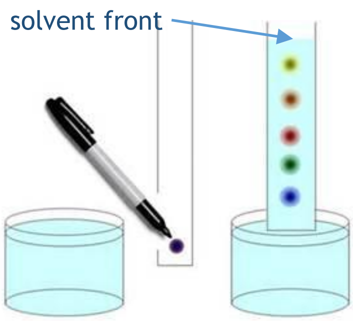
Paper Chromatography and **Thin Layer Chromatography (TLC)**

- Mixtures are separated by travelling with a solvent across paper or a TLC plate
- Separated substances are identified by comparing with pure samples.



In the paper chromatography across, the dye in the ink stains have dissolved in the solvent that is travelling up the paper.





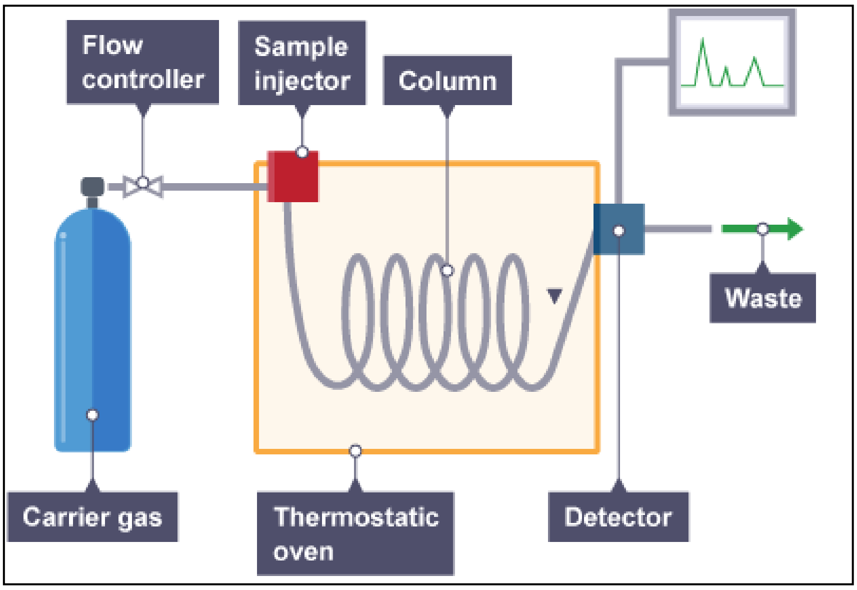
On closer inspection, the diagram on the left shows that the dye is a mixture, and some molecules have travelled further than others. In this type of chromatography, molecules travel further because:

1. They are able to dissolve in the solvent that is travelling through. (LIKE DISSOLVES LIKE)
2. They are smaller in molecular size.

A calculation using the distanced travelled compared with how far the solvent has travelled (the solvent front) produces a number called the retention factor, **R_f**, can be used to identify the compounds within a mixture.

Gas Chromatography

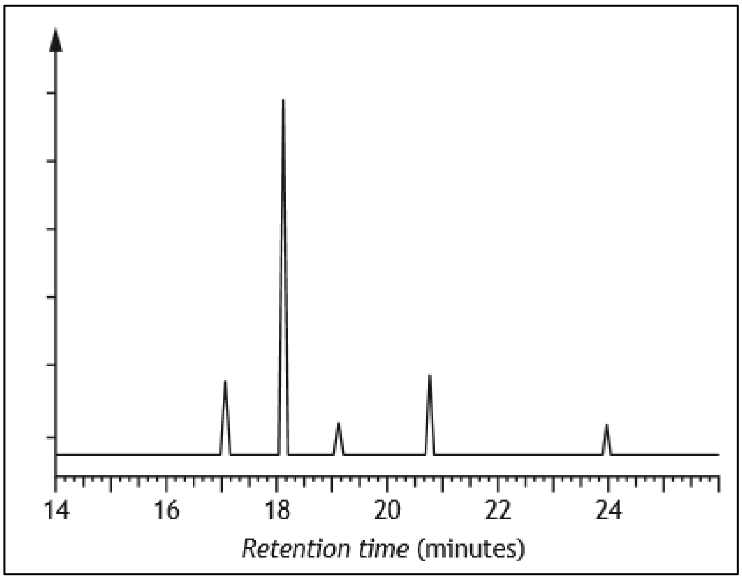
- Mixtures are pushed through long tube (column) containing a solvent by an inert gas.
- **Noble gases e.g. helium** are often used because they are **inert (unreactive).**



The results of gas chromatography experiment are displayed on a **chromatogram** (example shown).

Three main pieces of information can be gathered from a gas chromatogram:

1. The number of compounds in the mixture - represented by the number of peaks.
2. Quantity of each compound present - represented by the height of the peak (higher = greater quantity).
3. The retention time - How long it takes them to be pushed through the column - indicated by the position of the peak.



Molecules will travel faster though the column (lower retention time) if they:

1. Are smaller in molecular size.
2. Do not interact with the substance they are travelling through in the column. (ie they have a different type of intermolecular bonding and do not form bonds with the liquid in the column)

Learning Outcomes

You should have now revised:

1. Common Chemical Apparatus
2. General Practical Techniques
3. Reporting Experimental Work
4. Chromatography

Further Reading

To learn more about proteins, try the following online resources:

Scholar: Log in through GLOW

Higher Chemistry → Researching Chemistry

Read through the exercises and **TRY THE END TOPIC TESTS**

Evans2 chem web: https://www.evans2chemweb.co.uk/login/index.php#

Username: snhs password: giffnock

Select any teacher → revision material → CfE Higher→ Unit 4 - Researching Chemistry

Read through Common Chemical Apparatus, General Practical Techniques, Reporting Experimental Work

ANSWERS TO EXERCISES WILL BE POSTED ON WEDNESDAY FOR YOU TO CHECK YOUR WORK

EXTENSION WORK

Use the online learning link above if you would like to extend your knowledge on this topic. For more practise questions, use your Revision Questions for Higher Chemistry "Blue book":

Chromatography page 114 Q1-4

Practical Skills (i) page 116 Q1-6

Practical Skills (ii) page 119 Q1-5

HOMEWORK IS DIFFERENT THIS WEEK!!

This week's homework will be **SELF-ASSESSED.**

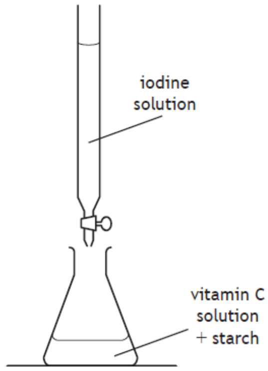
You should now complete "Practical Techniques & Chemical Analysis Revision Questions" below in your homework jotter, or the back of your class jotter if you don't have your homework jotter at home with you.

The answers to this homework will be posted on Wednesday. You should mark **your own work and make the necessary corrections.**

Take a picture of your **marked answers and corrections** and submit them to your class teacher by **1pm on Friday 5th March.** Your teacher will let you know how to submit this.

A copy of the homework is on the next pages.

Practical Techniques & Chemical Analysis Revision Questions



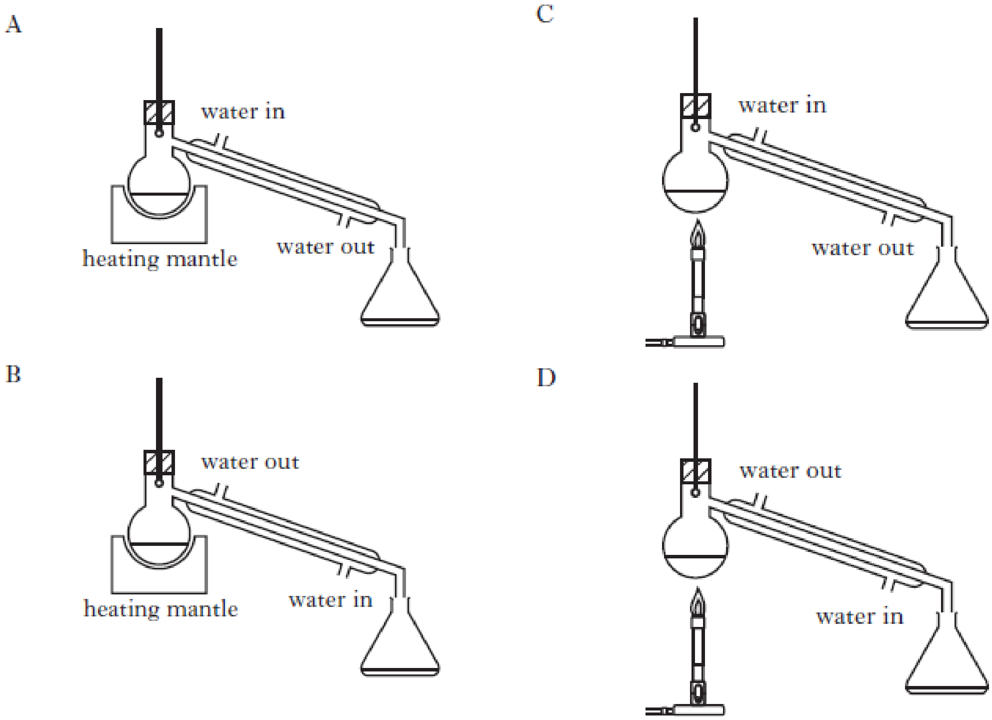
1. A student was carrying out a titration to establish the concentration of vitamin C using iodine solution. Which of the following would help the student achieve a precise end-point?

A Placing a white tile underneath the conical flask
B Using the bottom of the meniscus when reading the burette
C Repeating titrations
D Carrying out a rough titration first

2. A 0·10 mol l^{-1} solution could be prepared most accurately from a 1·0 mol l^{-1} solution using

A a 1 cm^3 dropping pipette and a 10 cm^3 measuring cylinder
B a 10 cm^3 measuring cylinder and a 100 cm^3 volumetric flask
C a 25 cm^3 pipette and a 250 cm^3 volumetric flask
D a 50 cm^3 burette and a 500 cm^3 measuring cylinder.

3. Which of the following diagrams shows the correct set up for the separation of ethanol from ethanoic acid?



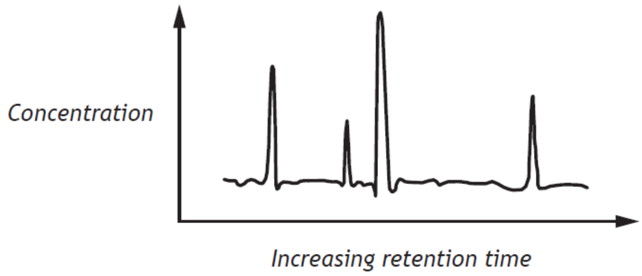
4. The alcohol content of wine was analysed by four students. Each student carried out the experiment three times.

	Experiment 1 (%)	Experiment 2 (%)	Experiment 3 (%)
Student A	10.0	9.0	8.0
Student B	6.4	6.6	6.8
Student C	6.5	6.6	6.6
Student D	9.0	8.5	9.6

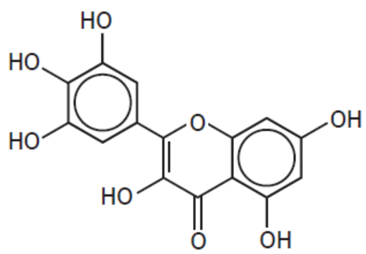
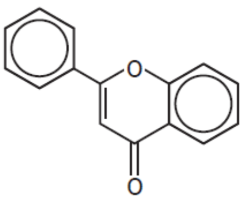
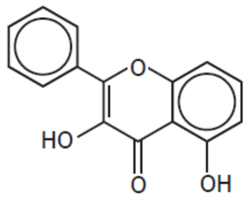
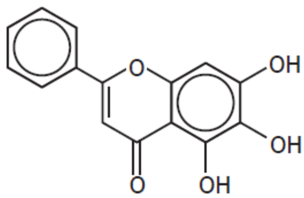
The most reproducible results were obtained by

A Student A
B Student B
C Student C
D Student D.

5. A chemist analysed a mixture of four dyes **A**, **B**, **C** and **D** using gas-liquid chromatography. In this technique, compounds are separated depending on their polarity, with the most polar having the longest retention times. The chromatogram obtained is shown below.



Which of the following compounds was present in greatest concentration?

Dye	Structure
A	
B	
C	
D	

6. The correct method of filling a 20 cm^3 pipette is to draw the liquid into the pipette

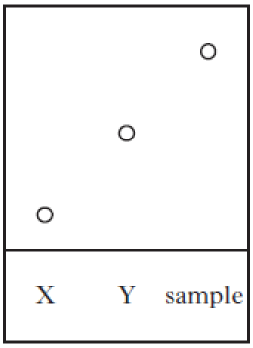
A doing it slowly at the end, until the top of the meniscus touches the mark
B doing it slowly at the end, until the bottom of the meniscus touches the mark
C to above the mark and then release liquid from the pipette until the top of the meniscus touches the mark
D to above the mark and then release liquid from the pipette until the bottom of the meniscus touches the mark.

7. An organic chemist is attempting to synthesise a fragrance compound by the following chemical reaction.

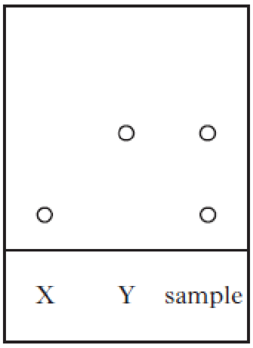
compound **X** + compound **Y** → fragrance compound

After one hour, a sample is removed and compared with pure samples of compounds **X** and **Y** using thin-layer chromatography. Which of the following chromatograms shows that the reaction has produced a pure sample of the fragrance compound?

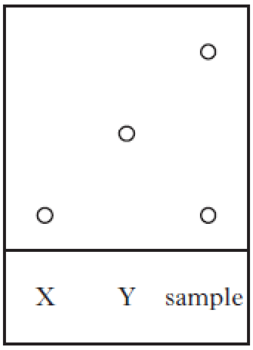
A



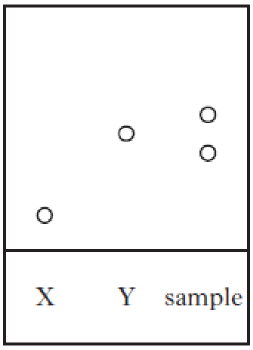
B



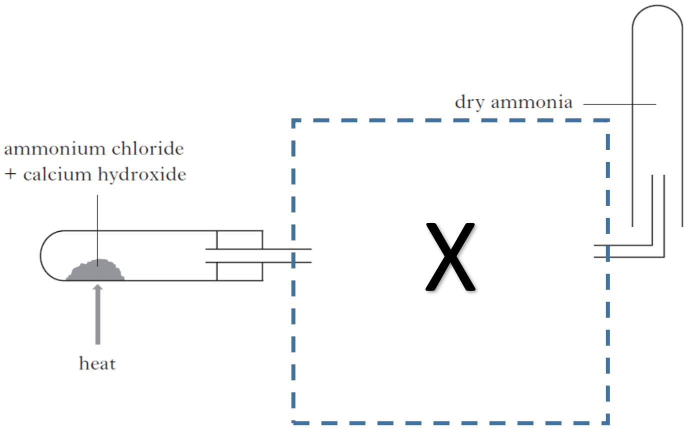
C



D

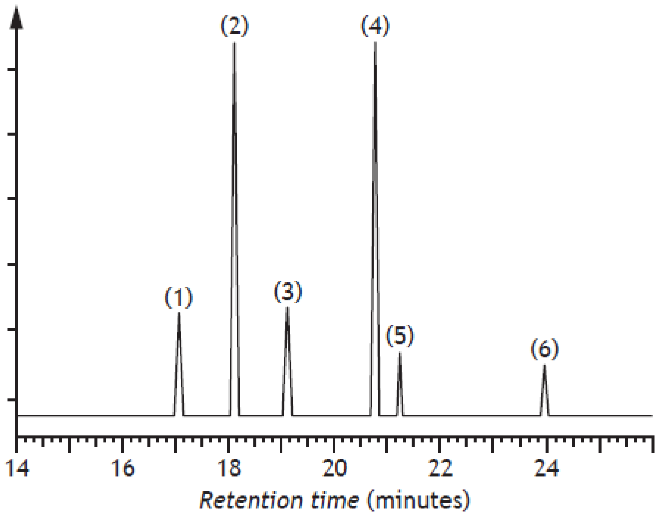


8. A small sample of ammonia can be prepared in the laboratory by heating a mixture of ammonium chloride and calcium hydroxide. The ammonia is dried by passing it through small lumps of calcium oxide and collected by the downward displacement of air. Draw suitable apparatus at point "X" to complete the diagram to show how ammonia gas can be dried before collection.
(You do not need to re-draw the two test tubes shown) **(1)**



9. Essential oils from the lavender plant are used in aromatherapy. Gas chromatography can be used to separate and identify the organic compounds in lavender oils.

Chromatogram 1 - Lavender oil **A**



Peak	*Component*	*Component peak area*
1	1,8-cineole	7432
2	linalool	31 909
3	camphor	7518
4	linalyl acetate	27 504
5	geranyl acetate	3585
6	farnesene	1362
	Total peak area =	79 310

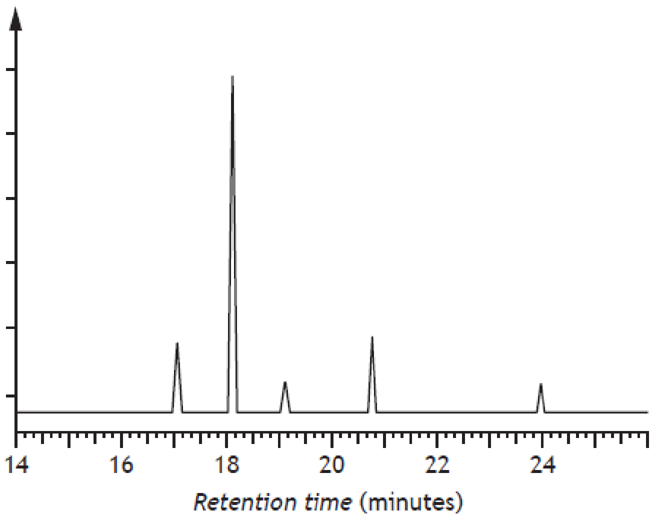
(a) The relative concentration of each component can be calculated using the following formula.

$$\text{Relative concentration} = \frac{\text{Component peak area}}{\text{Total peak area}} \text{ x } 100\ (\%)$$

Calculate the relative concentration of linalool in lavender oil **A**. **(1)**

Different varieties of lavender oils have different compositions.

Chromatogram 2 – Lavender oil **B**

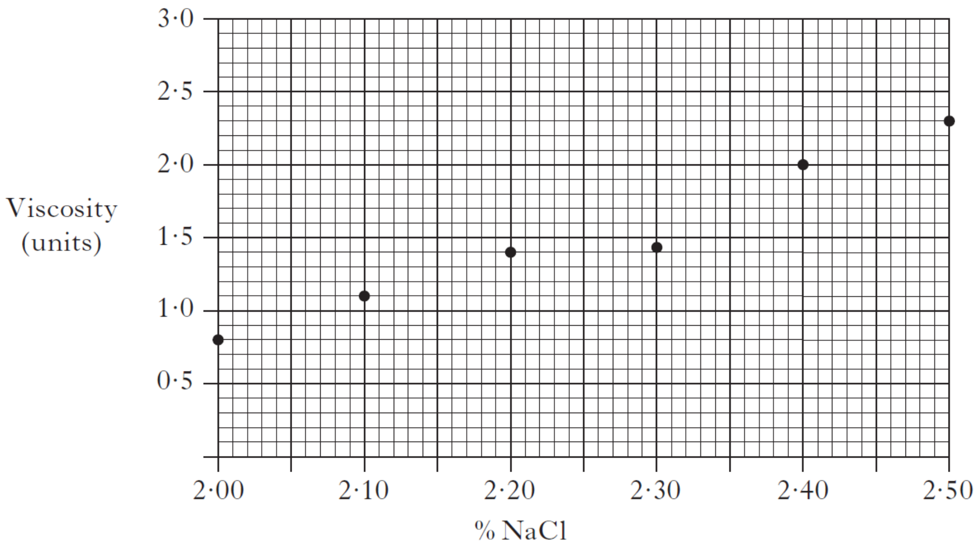


(b) Identify the component found in lavender oil **A** that is missing from lavender oil **B**. **(1)**

(c) The gas used to carry the perfume sample along the chromatography column is helium. Suggest why helium is used. **(1)**

(d) Apart from the polarity of the molecules, what else would affect the retention time of molecules during gas chromatography? **(1)**

10. Sodium chloride is added during manufacture to increase the viscosity of handwashes. In an investigation to measure the effect of sodium chloride on the viscosity of handwash, the following results were obtained.



(a) Use the graph to calculate the mass of sodium chloride, in grams, that should be added to 1 litre of handwash to give a viscosity of 1·5 viscosity units.
(Take the mass of 1 cm^3 of handwash to be 1·1 g) **(2)**

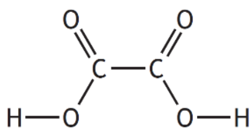
(b) As part of the above process, a standard solution of sodium chloride was made to add to the handwash. What is meant by the term **standard solution**? **(1)**

(c) Saline solution is a mixture of sodium chloride in water and has a number of uses in medicine. To make a 1% solution of saline, 1 g of sodium chloride is dissolved in 100cm^3 of water.

Calculate the number of moles of sodium chloride present a 500cm^3 bottle of 0.9% saline solution. **(2)**

11. The leaves of the rhubarb plant are considered poisonous because they contain high levels of oxalic acid.

Oxalic acid is a white, water-soluble solid. It is a dicarboxylic acid that has the structural formula shown.



Oxalic acid reacts with bases to form salts.

It can also be oxidised by strong oxidising agents to form carbon dioxide gas.

The oxidation equation for oxalic acid is shown.

$$H_2C_2O_4 \rightarrow 2CO_2 + 2e^- + 2H^+$$

Using your knowledge of chemistry, comment on how the mass of oxalic acid in a rhubarb leaf could be determined. **(3)**

Total = 20