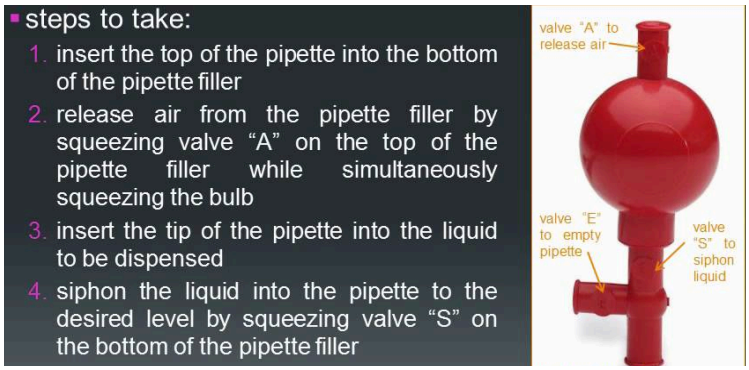
Ma x Va = Mb x Vb
When heating solid, always test for co2 and look out for water droplets

Procedure

1. Gentle heating: half air-hole open, move boiling tube; strong heating: full air-hole open, stay above flame

Titration

1. Rinse burette and filter funnel
    a. Use tap water (fill up to ½) with a closed tap, then open tap and release some water to wash the tip, then flip it over and twirl to pour out the rest of the solution from top of the burette
    b. Repeat with deionised water and relevant solution
    c. Repeat procedure with filter funnel
    d. Then fill up the burette with the relevant solution with a filter funnel. give a strong jerk to release air bubbles. Record the reading on burette
2. Rinse conical flask
    a. Rinse with tap water and deionised water
    b. DO NOT use relevant solution
3. Rinse pipette
    a. Fill up a beaker with tap water. Use tap water (fill up to ⅓ with pipette filler) and swirl to wash the bulb, then pour out
    b. Repeat with deionised water and relevant solution
    c. Suck up relevant solution with pipette filler and empty into conical flask, tap twice gently to ensure all the solution has gone into conical flask



- Burette readings

Titration number	1	2	3
Final burette reading/cm3	2dp	2dp	2dp
Initial burette reading/cm3	2dp	2dp	2dp
Volume of X used/ cm3	2dp	2dp	2dp
Best titration results (✓)			

Graph

- Scale: 2, 5, 10
- Origin must label
- Best fit line: must past through at least 1, don't have to be equal points out, sometimes must pass through origin
- MUST EXTRAPOLATE

Source of error and ways to improve

- Water might have evaporated from the solution, increasing its concentration. This can be improved by covering the petri dish
- Heat may be lost to the surroundings. This can be improved by adding lid, changing to styrofoam cup, wrapping test tube with towel, or any heat insulator
- For mixing liquids: use a burette to measure the volume as burette is a precise apparatus for measuring volume of solution compared to measuring cylinder
- For collecting hydrogen: test tube of hydrogen may have been contaminated with air that was present in the flask before the experiment started, hence test tube of gas collected is impure oxygen
- For crystallisation: it does not give a 100% yield of crystals, some of the salt still remains dissolved in the water so the mass of crystals obtained is less than what it should have been
- For evaporation to dryness: some of the salt formed may be lost due to “sputtering”
- For paper chromatography: it was difficult to determine the centre of the red dye due to odd shape, hence distance travelled by red dye measured may be higher than expected, Rf value calculated may be higher
- For heating in crucible to find empirical formula: some of the ash (MgO) may be lost to the surroundings, thus affecting the mass of the crucible and lid after weighing it. This is because the lid is often lifted to allow the introduction of air. The ash, being a fine and light particle, might easily be lost to the surroundings. This can be improved by opening the lid slightly and hovering above the crucible so that enough oxygen can enter, instead of lifting the lid completely.
- Heat in solution may not be distributed evenly. Some parts may have higher temperatures than other parts. This can be improved by stirring mixture before taking temperature to ensure heat produced is distributed evenly around the solution
- For titration with unknown concentration, the impurities inside sodium hydroxide might react with the hydrochloric acid and this will result in higher volume of hydrochloric acid recorded. The percentage purity would have been higher than the expected percentage purity. expt 3.6 (T) titration.pdf
- It is difficult to compare colour of solution with universal indicator scale, resulting in inaccurate pH measurements
- The reaction between metal and acid is exothermic, the heat produced might raise the temperature of the solution, leading to a faster rate of reaction. This can be improved by using a thermostatically controlled water bath

- Magnesium ribbon floats on the surface and is not completely submerged in the acid during the reaction, leading to a longer time recorded. This can be improved by using a glass rod to fully submerge the magnesium ribbon
- Difficulty in reading the meniscus of potassium manganate due to it being a dark liquid, resulting in inaccurate reading of the titre volume. This can be improved by taking reading of the burette using the top of the meniscus instead
- Last resort: human reaction time in starting and stopping the stopwatch. This can be improved by taking multiple readings and finding the average
- Involving heat: use burette to measure volume of reactants, use a data logger with temperature probe to measure temperature

Qns

- Why is magnesium ribbon cleaned before the experiment
    - Ans: to make sure there are no impurities on the surface of the magnesium ribbon that would tamper with the results
- Why is the lid necessary? (for heating in crucible)
    - Ans: it is to prevent some of the magnesium oxide powder from escaping into the surroundings, delivering inconsistent results
- Why should the lid be lifted occasionally
    - Ans: it is to allow the introduction of oxygen so the experiment can be carried out as combustion requires oxygen
- Why is conical flask used instead of beaker for titration
    - The sloping sides of a conical flask prevents loss of reactant due to splashing during swirling which could lead to inaccurate titration results
- Explain why a pipette and burette are used instead of a measuring cylinder
    - Pipette and burette are very precise apparatus used for measuring volume of solutions. This will reduce the percentage error as much as possible.
- Explain why during titration it is not necessary to dry the conical flask before adding the alkali
    - The water present will not change the number of moles of reactant added into the conical flask. Hence the titre value will not be affected
- Explain why the conical flask is not rinsed with the solution that it contains
    - Rinsing the conical flask with the solution will cause the volume of reactant to be higher than 25.0cm3. The volume of acid recorded will then be higher than expected
- Another student carries out this titration but average volume of B added was slightly higher than it should be, explain why this error is unlikely to change the calculated whole number value of x [2024 o levels qn1cii]
    - As the average volume of B is slightly larger than it should be, number of moles of B will be higher so the mass of $C_2H_2O_4$ will be higher and mass of water in 1dm3 will be smaller. Mole ratio of $C_2H_2O_4$:H_2O will be changed from 1:2.26 to 1:2.00 based on decrease in mass of water. As x is a whole number, the value of x will still round to 2 and the error is unlikely to change the calculated whole number value of x.

- State and explain whether heating your sample of cuso4xh2o for a third time would give a more accurate value for x (20221bii)
    - To ensure all the water of crystallisation is driven off, giving a more accurate value for x. This is because after the second heating, there were still some blue solid in the middle of the boiling tube, which means not all the water of crystallisation is driven out.
- A student heated the sample strongly causing it to decompose to give black solid and so2. State and explain the effect on x
    - The calculated value of x will be larger than expected. This is because the total mass lost from the original example of A will be larger due to both water and so2 being driven off. n
- Why was nitric acid used rather than hydrochloric or sulfuric acid (2019 q2g)
    - To ensure that no chloride or sulfate ions are formed, which will affect the results of the anion test
- Suggest why heating the sample once for 3 minutes may not give an accurate value for the percentage by mass of sodium hydrogencarbonate in R (2019 q2ci)
    - Time is too short for all the sodium hydrogencarbonate to decompose on heating. This can be improved by reheating and reweighing the contents when it is cool until mass of test tubes and its content remains constant
- state which reactant is limiting reactant, explain your answer using observations from the experiment [2024 o level 2aii]
    - Magnesium is the limiting reactant as all the magnesium reacts with the acid. Where there is no more grey piece of magnesium, gas bubbles stopped forming
- describe how rate of reaction changes during the reaction [2024 qn2ciii]
    - The rate of reaction is faster at the start, then the rate of reaction gradually slows down until a constant volume of gas is produced. The reaction stopped when t=80s. At this point, the reaction stopped and the gradient was 0. The gradient is positive and steep at the start and the gradient is less steep as the time proceeds. Eventually the gradient is 0 which shows that the reaction has ended. [must give general statement then explain in detail]
- Explain why water was added to each reaction mixture 2023 1civ
    - Water was added such that the total volume of mixture would be kept constant at 11.0cm3. Concentration of B would then be directly proportional to the volume of B added

Gas tests

1. Hydrogen [acid + metal]
    a. Place a lighted splint at the mouth of the test tube
    b. Observations
        i. Effervescence is observed
        ii. Gas is colourless and odourless
        iii. Gas given off extinguishes the lighted splint with a pop sound
        iv. Hydrogen gas is given off
2. Carbon dioxide [acid with carbonate]

    a. Bubble the gas into limewater
        i. Remember to add limewater into test tube and prepare delivery tube
    b. Observations
        i. Effervescence is observed
        ii. Gas is colourless and odourless
        iii. Gas given off produces white precipitate in limewater
        iv. Carbon dioxide gas is given off
3. Oxygen [decomposition of h2o2 with catalyst manganese oxide (iv) MnO2]
    a. Insert a glowing splint into the test tube
    b. Observations
        i. Effervescence is seen
        ii. Gas is colourless and odourless
        iii. Gas given off relights a glowing splint
        iv. Oxygen gas is given off
4. Chlorine [sodium chlorate NaClO3 + hydrochloric acid
a. Hold a piece of damp blue litmus paper over the mouth of the test tube
b. Observations
    i. Effervescence is seen
    ii. Gas is greenish yellow and pungent
    iii. Gas given off turns damp blue litmus red then bleaches it
    iv. Chlorine gas is given off

4. Ammonia [strong heating of ammonium salt in a dry test tube]
    a. Hold a piece of damp red litmus paper over the mouth of the test tube
    b. Observations
        i. Gas is colourless and pungent
        ii. Gas given off turns damp red litmus paper blue
        iii. NO EFFERVESCENCE because ammonia is normally obtained from heating of dry ammonium salt

5. Sulfur dioxide [solid sodium sulfite + hydrochloric acid and warm]
    a. Dip a piece of filter paper into acidified potassium manganate. Hold this piece of filter paper at the mouth of the test tube
        i. Effervescence is seen
        ii. Gas is colourless and pungent
        iii. Gas evolved decolourises purple solution of acidified potassium manganate
        iv. Sulfur dioxide gas is evolved

purity/titration calculations

expt 3.6 (T) titration.pdf

Expt 3.7 (T) Prepare CuSO4 2024.pdf

Ver2_Expt 3.9(T)_Calculate water of crystallisation.pdf

Precision

Instrument	Values can be recorded to the nearest …	Examples
Burette	0.05 cm^3	25.00 cm^3, 10.05 cm^3
Pipette		25.0 cm^3, 20.0 cm^3
Measuring cylinder	0.5 cm^3	14.0 cm^3, 14.5 cm^3
Electronic balance (Copy completely)	0.1 g	150.0 g, 151.8 g
	0.01 g	131.00 g, 189.30 g
Ruler	0.1 cm	11.0 cm, 15.8 cm
Thermometer	0.5 °C	40.0 °C , 40.5 °C
Stopwatch	1s	23 s, 50s

Test for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

Test for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt.
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
lead(II) (Pb^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., soluble in excess giving a colourless solution

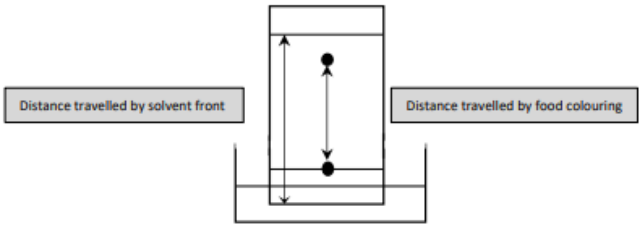
Planning

- State dependent, independent and constant variables
- Write out procedures
- State how to change variable
- Make conclusion

Example 1:

Some soft drinks contain food colourings. Food colourings contains a mixture of different coloured compounds.
E numbers are used to identify compounds added to foods.
E110 is Sunset Yellow and is one of the compounds in a liquid food colouring.

Outline a method you could use to determine whether a sample of this food colouring contains E110.
You are provided with only a liquid sample of this food colouring.



1. Add a drop of food colouring on the start line of the chromatogram.
2. Put the paper chromatogram in a beaker of water, as shown in the diagram.
3. Record the distance travelled by the solvent front and the distance travelled by the food sample.
4. Calculate the Rf value by taking (distance travelled by food colouring)/(distance travelled by solvent front).
5. Compare the Rf value calculated with the Rf value of E110. If the Rf value if the same, the food sample contains E110.

Example 2:

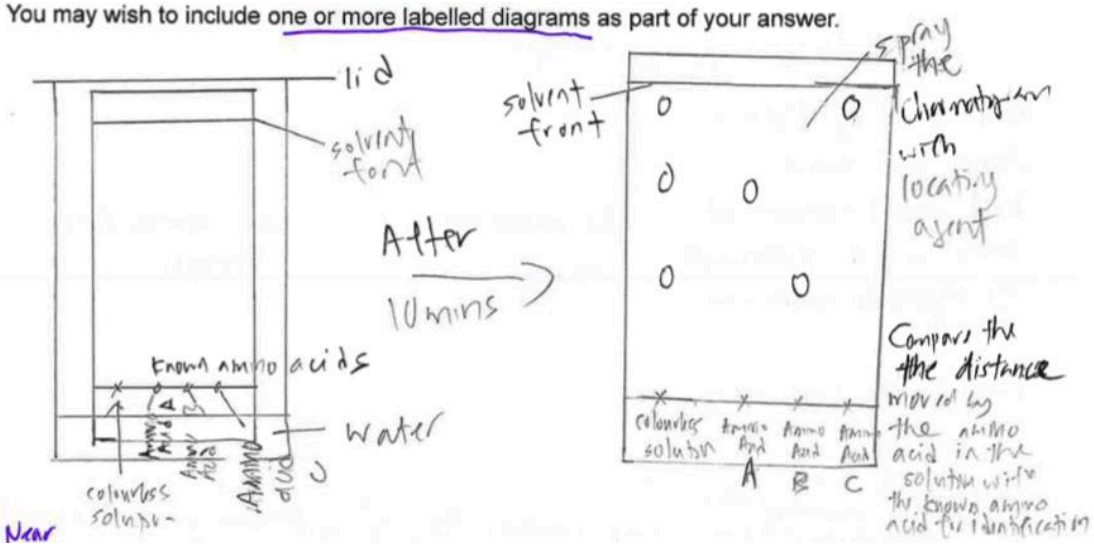
Hydrated copper (II) sulfate crystals molecular formula can be represented as $CuSO_{4.x}H_2O$.
The water of crystallization can be driven off by gentle heating.
You are provided with 1g of hydrated copper(II)sulfate. Suggest how you would determine the value of x in $CuSO_{4.x}H_2O$.

1. Heat the 1g of hydrated copper (II) sulfate crystals gently in a boiling tube.
2. Weigh the hydrated copper (II) sulfate every 5 minutes after cooling, until the weight is constant with a mass balance until the crystals turn from blue to white.
3. Record the final mass of copper (II) sulfate.
4. To find the mass of water, take initial mass of copper (II) sulfate – final mass of copper (II) sulfate.
5. Mass of copper (II) sulfate in 1g = mass of copper (II) sulfate = 1 – mass of water.
6. Number of moles of water = mass of water ÷ Mr of water
7. Final mass of crystals ÷ by the Mr of copper (II) sulfate.
8. Compare the mole ratio.
9. X = (number of moles of water) / (number of moles of copper (II) sulfate)

2024 q3

A food supplement powder states that it contains 3 different amino acids. A sample of the food supplement dissolves in water to form a colourless solution. Describe a chromatography experiment to identify the 3 amino acids present in the food supplement.

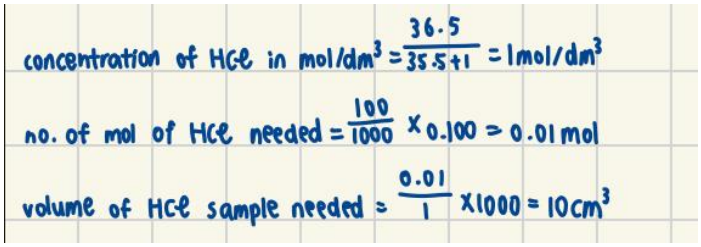
You may wish to include one or more labelled diagrams as part of your answer.



1. Near the end of the chromatography paper, draw a line in pencil 2cm away from the end of the paper
2. place a spot of colourless solution on the start line
3. pour water into the beaker to a depth of 1cm below the start line
4. place the chromatography paper in the beaker and ensure that the spot of colourless solution is above the water level
5. allow the separation to take place in 10. Minutes and remove the paper from the beaker. Allow it to rest for 2 minutes and draw the solvent front using a pencil
6. as the dissolved amino acids are colourless, a locating agent is sprayed on the chromatography paper so that the chemicals will react with the colourless substance to form coloured spots
7. measure the distance moved by the solvent front and the unknown amino acid from the start line.
8. Calculate the Rf value = distance amino acid moved/ distance solvent front. Compare the Rf value with other known amino acids to identify the unknowns

2021 qn3

A student is provided with a solution of hydrochloric acid that contains 36.5g/dm3 of acid. Outline what the student should do to prepare 100cm3 of 0.100mol/dm3 of hydrochloride acid from the solution provided.



1. Measure out 10cm3 of 1mol/dm3 of HCl using a burette and place in into a beaker
2. using a burette, add 90cm3 of distilled water into the beaker, which gives 100cm3 of 0.100mol/dm3 of HCl

2 A solder is an alloy made of a mixture of zinc and aluminium.

You are provided with a powdered sample of the solder, 1.00 mol/dm3 sulfuric acid and 1.00 mol/dm3 aqueous ammonia.
Outline a method by which the percentage by mass of **aluminium** in the solder can be determined.
You may assume that all the apparatus normally found in a school laboratory are available. **No other reagents** should be used aside from the ones provided.

In your method, you should note any assumptions that you make, include the measurements you would take and explain how you would use your results to determine the percentage by mass of aluminium in the solder.

[Ar: H, 1; N, 14; O, 16; Al, 27; S, 32]

- Measure a fixed mass, m_1 g, of the powdered solder using an electronic balance.
- Place the powdered solder into a beaker.
- Add excess sulfuric acid to the beaker and stir the mixture using a glass rod.
- After the reaction is complete / no more effervescence and no solid remaining, add excess aqueous ammonia to the solution.
- A precipitate of aluminium hydroxide is formed.
- Filter the mixture using a filter funnel and filter paper. The residue is aluminium hydroxide.
- Wash / rinse the residue with deionised water and dry with sheets of filter paper.
- Measure the mass of the residue, m_2 g, using an electronic balance.

= To find percentage by mass of aluminium in the solder:
No. of moles of aluminium hydroxide = m_2 / Mr of $Al(OH)_3$ = m_2 / 78 = y mol

Mole ratio of $Al(OH)_3$: Al = 1 : 1

No. of moles of aluminium = y mol

Mass of aluminium = y x A_r of Al = 27y g

% by mass of Al = $(27y / m_1) \times 100\%$

Assumption:
1) The solder does not contain any other metals that can form metal ions which form precipitates with excess aqueous ammonia.
2) The solder does not contain any solid impurities that do not react with dilute sulfuric acid.

https://document.grail.moe/3a751398e9ce44c7b9d8e37877c4bc37.pdf (sample qns for planning with ms)

https://document.grail.moe/ffa7628a23ce4cffb4e9e6ae1b8e59db.pdf (idk was too lazy to look)