Cambridge Assessment International Education

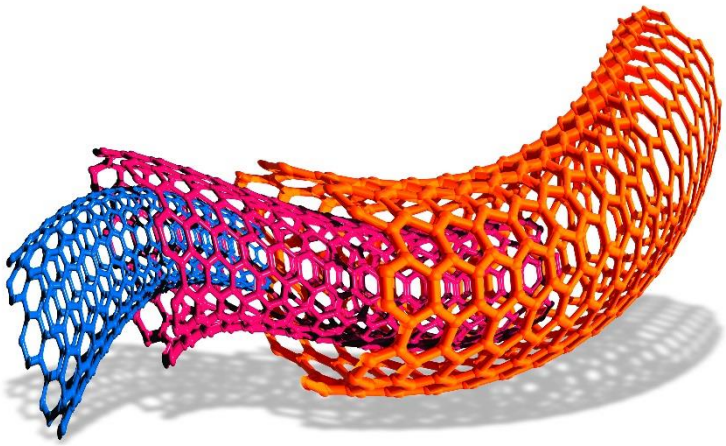
Skills Pack

The identification of unknown compounds **X** and **Y**

Cambridge IGCSE™

Co-ordinated Sciences 0654

This *Skills Pack* can also be used with the following syllabuses:
- Cambridge IGCSE™ (9–1) Chemistry **0971**
- Cambridge IGCSE™ Chemistry (US) **0439**
- Cambridge IGCSE™ Combined Science **0653**
- Cambridge IGCSE™ (9–1) Co-ordinated Sciences (Double Award) **0973**
- Cambridge IGCSE™ Physical Science **0652**
- Cambridge O Level Chemistry **5070**



Version 2.0

Cambridge Pathway

Contents

Icons used in this pack:

Briefing lesson

Lab option 1: *Run the experiment*

Lab option 2: *Virtual experiment*

Debriefing lesson

Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note

Our *Skills Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Skills Packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

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Lab lesson (1 hour*)	
Option 1: run the experiment	**Option 2: virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.

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Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases this also includes the opportunity to practise extended writing skills.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this *Skills Pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: **The identification of unknown compounds** X **and** Y

This *Skills Pack* focuses on qualitative analysis (the identification of ions and gases).

Qualitative analysis is commonly used to identify ionic substances by analysing their component anions and cations.

This experiment has links to the following syllabus content (see syllabus for detail):

- C8.4 Identification of ions and gases

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations**:

- make and record observations
- interpret and evaluate experimental observations.

Prior knowledge

Knowledge from the following syllabus topics is useful for this experiment.

- C3.4 Ions and ionic bonds
- C8.1 The characteristic properties of acids and bases
- C9.4 Transition elements

Going forward

The awareness and skill of making careful and accurate observations in this pack will assist learners in all areas of lab work. Learners could be encouraged to try to write balanced equations for some of the simpler chemical reactions that occur in this topic. Learners may be curious about any qualitative analysis tests for non-ionic compounds. Refer them to the bromine water test for unsaturation for alkenes. The chemical tests for water could also be discussed.

Briefing lesson: **What is qualitative analysis?**

Resources	• A range of white compounds (corn starch, sugar, baking powder, table salt) • Vinegar • Copper(II) sulfate pentahydrate (in a beaker) • Videos for qualitative analysis (cations, anions and flame tests) • Worksheets A and B
Learning objectives	By the end of the lesson: • ***all*** learners should be able to explain that specific chemical tests enable you to identify unknown substances and that there are specific tests for identifying anions and cations. • ***most*** learners should be able to highlight good lab technique and safety issues. • ***some*** learners should be able to explain that the basis of many of the tests used in qualitative analysis depends on the varying solubility of ionic substances.

Timings	Activity
15 min	**Starter/Introduction** Gather the learners around a demonstration bench to look at a number of white compounds (corn starch and sugar, baking powder and table salt). The demonstration details can be found in the Teachers' Notes section of the pack. The aim of this activity is to relate some everyday events and/or experiments, done in earlier years, to the idea of why we need to perform chemical tests to identify substances.
30 min	**Main lesson** The aim of this part of the lesson is to demonstrate the safety and good practice aspects of doing qualitative analysis. Hand out Worksheet A to each learner for reference and spend five minutes skimming through the main areas of the sheet – they will need to be familiar with this sheet when doing either of the lab lessons. Explain that each unknown substance they test will consist of anion tests and cation tests, which may include a flame test. In addition, alert them to the fact, that they will be analysing gases produced in certain reactions. Give learners Worksheet B and show the unedited versions of the qualitative analysis videos. Play each of the videos in full. Pause at relevant points so that your learners can answer the questions on the sheet. Also remind learners of the safety aspects associated with the tests as you go.
15 min	**Plenary** Show the learners a sample of copper(II) sulfate pentahydrate in a small beaker (or show an image of these blue crystals). • Ask the learners to tell you which ion is the cation and which ion is the anion. • Ask the learners to write down the chemical formula. • Using their qualitative analysis sheets, ask the learners which tests could be performed to show the presence of the cation and the anion. Explain that in future sessions they will be given unknown samples and they will have to carry out the various tests to confirm what their unknown samples are.

Lab lesson: **Option 1 – run the experiment**

Resources	• Teacher notes • *Teacher walkthrough* video • Worksheets A, C and D • Equipment as outlined in the notes
Learning objectives	By the end of the lesson: • ***all*** learners should be able to perform the relevant tests on the unknown compounds. • ***most*** learners should be able to identify compounds **X** and **Y**. • ***some*** learners will be able to evaluate and interpret their results.

Timings	Activity
10 min	**Starter/Introduction** Show the unknown mixture of compounds, **X** and **Y**. Tell learners that they need to find a way to separate **X** and **Y** before conducting qualitative tests on each substance. **Safety** Ensure that all learners are wearing fastened lab coats. Make sure that they wear goggles throughout and that learners with long hair tie it up safely. Remind learners about spillages. Circulate the classroom at all times during the experiment so that you can make sure that your learners are safe. Ask the learners a few warm-up questions: What type of chemical bonding do compounds **X** and **Y** have? Does the appearance of the compounds tell us anything about their identity?
30 min	**Main lesson** Learners should work in pairs. Learners should already have a copy of Worksheet A. Give each pair Worksheet C detailing the method for this experiment and Worksheet D to record their results. **Safety** Ideally, to minimise movement around the room, each pair of learners should have the chemical solutions placed in front of them. Additionally: 1. Each bench should have a small beaker labelled 'chemical waste' on it. The learners should be encouraged to use this for the disposal of solutions after each test. They should also be shown where the large bottle labelled 'chemical waste' is for the end of the lesson, into which they will empty the contents of their beakers. 2. Bunsen burners: indicate to the learners the position of the lit Bunsen burner and that they are burning with a yellow safety flame. Remind them that this must be changed to a blue flame when doing the test and then returned to a yellow safety flame afterwards. Compound **X** = NH_4Cl Compound **Y** = $CaSO_3$
5 min	Make sure that the learners tidy up after themselves, clean up any bench spills, empty the contents of their test-tubes and empty their 'chemical waste' into the main 'chemical waste' bottle. Finally, they should wash their hands.
15 min	**Plenary** Discuss each result with the learners using the answers for Worksheet D.

Teacher notes

Watch the *Teacher Walkthrough video* for unknown compounds **X** and **Y** and read these notes.

Briefing lesson method

Corn starch and sugar:

1. Place a spatula full of each of the white powders into two separate small beakers. Tell the learners that one of them is corn starch and that the other is sugar. Ask the learners to tell you which is sugar and which is corn starch. How do they know this?
2. Remind the learners of the test for starch with iodine solution and the test for sugar with Benedict's solution. Ask the learners if they can remember the outcomes for the tests – if not, remind them using a video.

Baking powder and table salt:

1. Add a little vinegar to both substances and note the outcome.
2. Get the learners to identify the baking powder (it fizzes and bubbles).
3. Discuss with learners how they know that the other sample is table salt.
4. Lead them to the idea that a negative test does not mean that the sample is table salt and that a huge number of chemicals look just the same.
5. Make sure that you have a discussion about safety and that under no circumstances should learners taste the powders.

For the main practical lesson, each pair will require:

- a stoppered vial (or test-tube) containing the following compounds mixed in distilled water:
  - ammonium chloride (1 g, this is compound '**X**')
  - calcium sulfite (1 g, this is compound '**Y**')
- a test-tube rack and access to clean and dry test-tubes
- a filter funnel and filter papers
- a conical flask (100 cm^3)
- access to small, clean, dry spatulas
- distilled water (bottle)
- a loop of flame test wire attached to a suitable rod
- a Bunsen burner
- dilute hydrochloric acid [0.5 mol/dm^3]
- hydrochloric acid [5 mol/dm^3]
- fresh saturated limewater solution
- dilute nitric acid solution [0.5 mol/dm^3]
- silver nitrate solution
- barium nitrate solution
- a small piece of aluminium foil
- a strip of red litmus paper
- acidified potassium manganate(VII) solution
- some strips of filter paper
- sodium hydroxide solution [1 mol/dm^3]
- aqueous ammonia solution [1 mol/dm^3]

Each bench should have a beaker labelled 'chemical waste' on it so that learners do not tip chemicals down the sink. Even though the quantities of waste should be minimal, it is good practice to encourage environmental awareness.

Additionally, a large bottle (in a central location) labelled 'chemical waste' should be made known to the learners so that at the end of the experiment, before they wash their hands and take their lab coats off, they tip the contents of their beakers into it.

Safety

The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.
It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
Ammonium chloride	 GHS07 (*moderate hazard* **MH**)	**In the eye:** flood the eye with gently-running tap water for at least 10 min. See a doctor. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throate and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash off the skin with plenty of water. **Spilt on the floor, bench, etc.:** Brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse it well.
Calcium sulfite	 GHS08 (*health hazard* **HH**)	**In the eye:** Flood the eye with gently-running tap water for 10 min. See a doctor if pain persists. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** brush compound off contaminated clothing. Rinse clothing or the skin as necessary **Spilt on the floor, bench, etc.:** brush up compound spills, trying to avoid raising dust, then wipe with a damp cloth.
Dilute hydrochloric acid [0.5 mol/dm^3]	 GHS07 (*moderate hazard* **MH**) (below a concentration of 2.7 mol/dm^3)	**In the eye:** flood the eye with gently-running tap water for 10 min. See a doctor. **Vapour breathed in:** remove to fresh air. Call a doctor if breathing becomes difficult. **Swallowed:** do no more than wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing, then drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** for release of gas, consider the need to evacuate the lab and open all windows. For large spills, and especially for (moderately) concentrated acid, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water. Wipe up small amounts with a damp cloth and rinse it well.
Concentrated hydrochloric acid [2 mol/dm^3]		**In the eye:** flood the eye with gently-running tap water for 10 min. See a doctor. **Vapour breathed in:** Remove to fresh air. Call a doctor if breathing becomes difficult. **Swallowed:** wash out the mouth with water. Do not induce

Substance	Hazard	First aid
	GHS05 (*corrosive* **C**)  GHS07 (*moderate hazard* **MH**)	vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Then drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** for release of gas, consider the need to evacuate the lab and open all windows. For large spills, and especially for (moderately) concentrated acid, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water. Wipe up small amounts with a damp cloth and rinse it well.
Dilute nitric acid [0.5 mol/dm^3]	 GHS05 (*corrosive* **C**)	**In the eye:** flood the eye with gently-running tap water for 10 min. See a doctor. **Fumes breathed in:** remove the casualty to fresh air. Keep them warm. If more than a 'sniff' is inhaled, see a doctor even if no symptoms are apparent. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** quickly use a dry cloth or paper towel to wipe as much liquid off the skin as possible. Then drench with plenty of water. If a large area is affected or blistering occurs, see a doctor. Remove contaminated clothing and rinse it well. **Spilt on the floor, bench, etc.:** wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated acid, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise with sodium carbonate. Rinse with plenty of water.
Silver nitrate solution	 GHS09 (*hazardous to the aquatic environment* **N**)	**In the eye:** Flood the eye with gently-running tap water for at least 10 min. See a doctor. **Swallowed:** Do no more than wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing**: Remove contaminated clothing and rinse it. Wash off the skin with plenty of water. If the silver nitrate produces more than small burns, see a doctor **Spilt on the floor, bench, etc.:** Wear eye protection and gloves. Scoop up the solid. Rinse the area with water and wipe up, rinsing repeatedly. Rinse the mop or cloth thoroughly.
Barium nitrate solution	LOW HAZARD	**In the eye:** flood the eye with gently-running tap water for at least 10 min. See a doctor. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** brush off any compound. Remove contaminated clothing. Drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor. Rinse contaminated clothing with water. **Spilt on the floor, bench, etc.:** scoop up any compound. Rinse the area with water, diluting greatly. Solutions should be treated with mineral absorbent (e.g. cat litter).

Substance	Hazard	First aid
Sodium hydroxide solution [1 mol/dm^3]	 GHS05 (*corrosive* **C**)	**In the eye:** flood the eye with gently-running tap water for at least 20 min. See a doctor. If a visit to hospital is necessary, continue washing the eye during the journey in an ambulance. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** wipe up small amounts with a damp cloth and rinse it well. For larger amounts, and especially for (moderately) concentrated solutions, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise with citric acid. Rinse with water.
Ammonia solution [1 mol/dm^3]	 GHS05 (*corrosive* **C**)  GHS07 (*moderate hazard* **MH**)  GHS09 (*hazardous to the aquatic environment* **N**)	**In the eye:** flood the eye with gently-running tap water for at least 20 min (for alkalis). See a doctor. If it is necessary to go to hospital, continue washing the eye during the journey in an ambulance. **Vapour breathed in:** remove the casualty to fresh air. Call a doctor if breathing becomes difficult. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing. Drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** consider the need to evacuate the lab and open windows if large amounts are spilt and especially for (moderately) concentrated solutions. Cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise with citric acid. Rinse with plenty of water. Wipe up small amounts with a damp cloth and rinse.
Potassium manganate (VII) solution	 GHS07 (*moderate hazard* **MH**)	**In the eye:** flood the eye with gently-running tap water for at least 20 min. See a doctor. **Swallowed:** wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** Remove contaminated clothing and rinse it. Wash off the skin with plenty of water. (Manganate(VII) will give permanent stains to clothing and the skin.) If skin contamination is more than small, see a doctor. **Spilt on the floor, bench, etc.:** Wear eye protection and gloves. Scoop up the solid. Rinse the area with water and wipe up, rinsing repeatedly. (Manganate(VII) will give permanent stains.) Rinse the mop or cloth thoroughly.
	Burns	Flood burnt area with water for at least 10 min. For serious injuries see a doctor.

Teacher method

This is your version of the method for this experiment.

Do not share this method with learners. Give them Worksheet C and Worksheet D.

Before you begin
Plan how you will group your learners during the lab session.

Think about:

- the number of pairs of learners you will need to cater for
- the amount of equipment/chemicals required
- where the chemicals will be placed in the lab
- the waste protocol for the lab
- the appropriate risk assessments and ensure they have been carried out.

Experiment
Circulate during the practical in case learners encounter any difficulties.

Steps	Notes
1. Check that learners have all the chemicals they need in front of them.	*If this is not possible because of space in the lab, set the chemicals out safely for easy access.*
2. Check that the learners have Worksheet A, Worksheet C and Worksheet D.	*Here is where you can ask:* *1. What type of chemical bonding do compounds **X** and **Y** have?* *2. Does the appearance of the compounds tell us anything about their identity?*
3. Show the mixture of compounds '**X**' and '**Y**' that have been mixed with distilled water in one vial.	
4. Before they start, warn the learners about safety and good practice for this experiment.	*Always monitor learners doing the flame tests. Check that they use the blue flame for the test and return the Bunsen burner back to the safety flame afterwards.*

5. Check that the learners perform the filtration stage safely and correctly. You may need to remind the learners how important it is to wash the residue with a small amount of distilled water.

You may need to remind the learners how important it is to wash the residue with a small amount of distilled water.

6. In this experiment the learners have a free choice as to the tests they can perform in order to reveal the identy of '**X**' and '**Y**'.

Check that each pair has a definitive plan for how they wish to test the unknown mixture.

Be mindful of the time available and be ready to guide learners towards some tests and away from others.

Clean-up

After the practical learners should:

- empty their chemical waste into the main chemical waste bottle in a central location
- tidy up their work space and put things away as instructed
- ensure any spillages have been mopped up
- wash their hands with soap and water.

Details of the tests

Here are the details of how to carry out each of the tests for the anions, cations and flame tests used in qualitative analysis. Before allowing your learners to do these tests, familiarise yourself with them.

Anions

1. Test for carbonate ions in solution:

(a) Add dilute hydrochloric acid (1 cm^3).

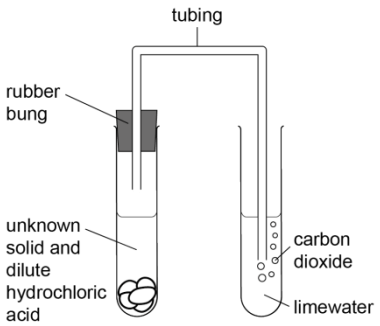
(b) If effervescence/fizzing/bubbles are observed, the gas should be tested with limewater solution to confirm that it is carbon dioxide.

(c) To test with limewater, you will require two test-tubes, a rubber bung and some tubing.

(d) Set-up the apparatus as shown below:

Safety

Ensure learners use a light twisting action to place the bung in the mouth of the test-tube so that the gas cannot escape. Tell them to not press too hard as the glass tubing is easily broken.



(e) The limewater will go cloudy as the CO_2 is bubbled through it.

2. Test for chloride/bromide/iodide ions in solution:

(a) Acidify a solution containing the chloride/bromide/iodide ions (1 cm^3) by adding dilute nitric acid (5 drops).

(b) Add aqueous silver nitrate solution (10 drops) and shake gently.

(i) If chloride ions are present, a white precipitate will form.

(ii) If bromide ions are present, a cream precipitate will form.

(iii) If iodide ions are present, a yellow precipitate will form.

Note: this is a very sensitive test and deionised water should be used.

3. Test for nitrate ions in solution:

Safety

Do this test in the fume cupboard.

(a) Add dilute sodium hydroxide solution (10 drops) to a solution containing nitrate ions (1 cm^3) and gently shake the mixture.

(b) Add a small piece of aluminium foil to the tube.

(c) Heat the tube gently for a few seconds only, ensuring that the mouth of the test-tube is facing away from yourself (and the learners). Then remove from the source of heat. Nothing much may appear to happen initially, but once the reaction starts it is very exothermic and can occasionally cause the contents of the tube to erupt out.

(d) After gentle heating, the aluminium will be seen to be reacting vigorously and there is therefore no need for further heating.

(e) At this point you should cautiously test for the presence of ammonia gas by placing a piece of damp red litmus paper close to the mouth of the test-tube.
A common cause of error is the learner touching the litmus paper against the inside of the test-tube making contact with the sodium hydroxide. This should be avoided, since it gives a false result.

4. Test for sulfate ions in solution:

(a) Acidify a solution containing the sulfate ions (1 cm^3) by adding dilute nitric acid (5 drops).

(b) Add aqueous barium nitrate solution (10 drops) and shake gently.

(c) If sulfate ions are present, a white precipitate will form.

5. Test for sulfite ions in solution:

This test must be conducted carefully in a fume cupboard. If no fume cupboard is available, then use the video to show this test.

Safety

Sulfur dioxide is a pungent, toxic gas, and is particularly harmful to people with respiratory problems. Therefore, learners with such conditions should take extra care and not stand right next to the fume cupboard or smell the contents of the test-tube themselves.

(a) Add a small volume of hydrochloric acid to the test sample and shake gently.

(b) Warm gently and remove from the source of heat.

(c) Immediately test for the presence of sulfur dioxide gas using potassium manganate(VII) solution.

(d) Place a drop of acidified potassium manganate(VII) solution onto a strip of filter paper.

(e) If sulfur dioxide gas is present, the purple-stained filter paper will become colourless.

Cations

1. Adding aqueous sodium hydroxide:

(a) Make a solution of the unknown and put 1 cm^3 (max.) into a test-tube.

(b) Add 1 cm^3 (max.) sodium hydroxide solution and shake carefully.

(c) Record the appearance of any precipitate formed.

(d) Continue to add sodium hydroxide solution and shake – is the precipitate soluble or insoluble in excess?

2. Adding aqueous ammonia:

(a) Make a solution of the unknown and put 1 cm^3 (max.) into a test-tube.

(b) Add 1 cm^3 (max.) ammonia solution and shake carefully.

(c) Record the appearance of any precipitate formed.

(d) Continue to add ammonia solution and shake – is the precipitate soluble or insoluble in excess?

3. Test for ammonium ions in solution:

(a) Add sodium hydroxide solution (1 cm^3).

(b) Warm the mixture gently in a Bunsen flame and then remove from the heat.

(c) Moisten a piece of red litmus paper and hold it near the mouth of the test-tube. If the paper turns blue, this indicates that ammonia gas is present which confirms the presence of ammonium ions.

A common cause of error is the learner touching the litmus paper against the inside of the test-tube making contact with the sodium hydroxide. This should be avoided, since it gives a false result.

4. Flame tests

(a) Dip the flame test wire into a test-tube containing a small amount of hydrochloric acid [5 mol/dm^3].

(b) Heat the wire for a few seconds in the blue flame of the Bunsen burner.

(c) Dip the wire into a solution of the test substance.

(d) Observe and record the flame colour.

(e) If multiple-flame tests are being performed make sure that the wire is cleaned by dipping it into the hydrochloric acid and heating in the blue flame, repeating this process until there is no positive flame test colour.

Lab lesson: **Option 2 – virtual experiment**

Resources	• *Virtual experiment* video for unknown **X** and **Y** • Worksheets A, C and D
Learning objectives	By the end of the lesson: • ***all*** learners should be able to make relevant observations based on the tests on the unknown compounds. • ***most*** learners should be able to identify compounds **X** and **Y**. • ***some*** learners will be able to evaluate and interpret their results.

Timings	Activity
10 min	**Starter/Introduction** Gather the learners around the screen and ensure they have the relevant worksheets (Worksheet A, Worksheet C and Worksheet D). Introduce the virtual practical. Tell the learners they will try to find out the cations and anions present in two compounds, **X** and **Y**. Show them the start of the *Virtual Experiment video* which shows a vial containing a white solid in a clear liquid. Pause the video and ask learners what they observe about the mixture. Tell learners that in order to perform qualitative analysis tests on the two compounds they will need to separate the mixture. Ask them to draw an equipment set-up on Worksheet D as to how they would do that – then play the video to see if they are correct.
20 min	**Main lesson** **Tests on soluble compound X** Focus on the tests and the observations at this stage. Allow the learners to work out what each observation or observations indicate. (a) (b) Discuss the significance of neither substance being coloured. It is also important to emphasise which substance is soluble and which is insoluble in water. Discuss the filtration process and the need to wash the residue with a small volume of distilled water. Tell the learners that the filtrate is now ready to be divided into portions ready for subsequent tests. (c) Show the addition of a few drops of dilute nitric acid, followed by aqueous barium nitrate solution. Even though the test is negative for sulfate ions, learners should be discouraged from writing 'nothing'. (d) Next show the addition of a few drops of dilute nitric acid, followed by silver nitrate solution. Learners will observe a white precipitate being formed, which confirms the presence of a chloride. (e) Learners will observe that when ammonia solution is added to a small volume of solution **X**, no precipitate is formed. (f) To the final portion of the solution **X**, aqueous sodium hydroxide is added and the contents of the test-tube heated gently. Discuss with the learners that a pungent-smelling gas is produced, but should not be relied on as a definitive test. A piece of damp red litmus paper turning blue indicates ammonia gas. Learners should now be able to decide what compound **X** is. *Continues on next page …*

Timings	Activity
	Compound **X** is NH_4Cl. Weaker learners may need help with writing down the chemical formula. **Tests on insoluble compound Y** Again, focus on the execution of the tests and the observations. (a) Show hydrochloric acid being added to the solid sample **Y**. It dissolves in the acid before decomposing on heating. Explain that one of the decomposition products is sulfur dioxide gas and show the decolourisation test that confirms its presence. (b) and (c) Show the addition of aqueous sodium hydroxide to the sample producing a white precipitate. Ask learners which possible cations this could indicate. Then show the flame test, explaining that a brick-red flame colour suggests the presence of calcium ions. Discuss how the two tests together point strongly to the presence of calcium being present in the sample. Learners should now be able to decide what compound **Y** is. Compound **Y** is $CaSO_3$. Weaker learners may need help with writing down the chemical formula.
	**Plenary** Discuss each result with the learners using the suggested answers for Worksheet D.

Debriefing lesson: **Language of observation**

Resources	• Worksheets E, F and G
Learning objectives	By the end of the lesson: • ***all*** learners should be able to construct simple sentences to describe qualitative analysis observations. • ***most*** learners should be able to do the above, plus use chemically appropriate vocabulary. • ***some*** learners will be able to evaluate the quality of the observations made and be able to suggest improvements.

Timings	Activity
10 min	**Starter/Introduction** Using Worksheet E, ask learners to improve the observation statements for some flame test examples. Ask learners if each of the statements is factually accurate, what's missing, and get them to re-write new statements for each.
20 min	**Main lesson** Ask learners to work in pairs for this exercise. Hand out Worksheet F to learners, which involve observations in qualitative analysis. Explain to the learners that they have to answer the questions in the same tenses. Show learners examples of the different tenses being used on the worksheet: past, present, future and also explain that they will work on comparing observations too and why that might be useful in chemistry.
15 min	Once complete, get learners to swap their sheets with another learner pair and get the learners to give feedback on the answers. Learners can use the answers to Worksheet F as a guide. If needed, the relevant sections of the videos can be played to remind the learners of the tests.
15 min	**Plenary** Hand out Worksheet G and ask learners to complete it. Working individually, learners need to identify and correct the mistakes in the sentences provided. Each question details the number of mistakes to correct.

Worksheets and answers

	Worksheets	Answers
For use in the *Briefing lesson*:		
A: Notes for use in qualitative analysis	**20–21**	**—**
B: Performing qualitative analysis tests	**22–23**	**32–33**
For use in *Lab lesson: Option 1*:		
A: Notes for use in qualitative analysis	**20–21**	**—**
C: Method	**24–25**	**—**
D: Results	**26–27**	**34–35**
For use in *Lab lesson: Option 2*:		
A: Notes for use in qualitative analysis	**20–21**	**—**
C: Method	**24–25**	**—**
D: Results	**26–27**	**34–35**
For use in the *Debriefing lesson*:		
E: Flame test observations	**28**	**36**
F: Language focus	**29–30**	**37–38**
G: Correct the mistakes	**31**	**39**

Worksheet A: **Notes for use in qualitative analysis**

Tests 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.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream 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, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests 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., or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper (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
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Worksheet A: **Notes for use in qualitative analysis**

Tests for gases

gas	test and result
ammonia (NH_3)	turns damp, red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame test for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

Solubility rules

These are a guide to help you appreciate qualitative analysis more fully.

Ion [solubility in water]	Exceptions
All nitrates (NO_3^-) are soluble	None
All halides (Cl^-, Br^- and I^-) are soluble	Silver (Ag^+) and lead (Pb^{2+})
All sulfates (SO_4^{2-}) are soluble	Lead (Pb^{2+}), barium (Ba^{2+}) and calcium (Ca^{2+})
All carbonates (CO_3^{2-}) are insoluble	Sodium (Na^+), potassium (K^+) and ammonium (NH_4^+)

Worksheet B: **Performing qualitative analysis tests**

Answer these questions which are based on the qualitative analysis tests you have just seen in the video(s).

Test for carbonate anion

(a) What do you observe when dilute hydrochloric acid is added to a carbonate?

……

(b) Which reagent is used for testing the gas produced and what is the result?

……

……

(c) Explain why it is very important to keep the stopper kept on a freshly made up bottle of limewater.

……

……

Test for halide anion (chloride, bromide and iodide)

(a) What is the name of the reagent used to test for the presence of halide ions?

……

(b) Define the term precipitate.

……

……

(c) Why is it very important to use distilled water in the test for chloride ions?

……

……

Test for sulfite anion

(a) Which gas is produced during a positive test for a sulfite?

……

(b) What safety precautions need to be taken when performing this test?

……

……

Worksheet B: **Performing qualitative analysis tests**

Test for chromium(III) cation

(a) What does 'in excess' mean?

……

……

(b) What are the main differences in the results obtained when using aqueous sodium hydroxide, compared with using aqueous ammonia?

……

……

……

Test for aluminium cation

(a) What is the result obtained, when a small amount of aqueous sodium hydroxide is added to aqueous aluminium ions?

……

……

(b) What happens when you add an excess of this reagent?

……

……

(c) How is the result of this test different to that obtained with aqueous ammonia?

……

……

Flame tests

(a) What do you need in order to perform a typical flame test?

……

……

(b) What safety precautions should be taken?

……

……

……

Worksheet C: **Method**

This sheet is to support you in understanding the tests used to identify your unknown substances

Anions

1. Test for carbonate

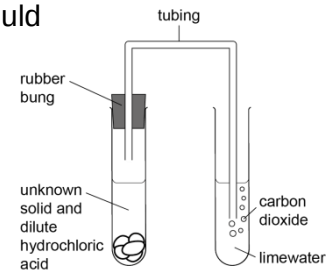
(a) Add dilute hydrochloric acid (1 cm^3) to your unknown compound.

(b) If effervescence/fizzing/bubbles are observed, the gas should be tested with limewater solution. This will confirm the presence of carbon dioxide.

(c) To test with limewater, you will require two test-tubes, a rubber bung and some tubing.

(d) The set-up of the apparatus is shown opposite:

(e) The limewater will go cloudy as the carbon dioxide is bubbled through it.



Safety

Use a light twisting action to place the bung in the mouth of the test-tube so that the gas cannot escape. Be careful not to press too hard, or you might break the glass. Ask your teacher for help if you are unsure.

2. Test for chloride/bromide/iodide

(a) Acidify a solution of your unknown (1 cm^3) by adding dilute nitric acid (5 drops).

(b) Add aqueous silver nitrate solution (10 drops) and shake gently.

(i) If chloride ions are present, a white precipitate will form.

(ii) If bromide ions are present, a cream precipitate will form.

(iii) If iodide ions are present, a yellow precipitate will form.

Note: this is a very sensitive test and deionised water should be used.

3. Test for nitrate **(do this test in a fume cupboard)**

(a) Add dilute sodium hydroxide solution (10 drops) to a solution of your unknown (1 cm^3) and gently shake the mixture.

(b) Add a small piece of aluminium foil to the tube.

(c) Heat the tube gently for a few seconds only, ensuring that the mouth of the test-tube is facing away from yourself. Then remove from the source of heat.

(d) After gentle heating, the aluminium will be seen to be reacting vigorously and there is therefore no need for further heating.

(e) At this point you should cautiously test for the presence of ammonia gas by placing a piece of damp red litmus paper close to the mouth of the test-tube.
Make sure you don't touch the inside of the test-tube with the litmus paper!

4. Test for sulfate

(a) Acidify a solution containing your unknown (1 cm^3) by adding dilute nitric acid (5 drops).

(b) Add aqueous barium nitrate solution (10 drops) and shake gently.

(c) If sulfate ions are present, a white precipitate will form.

Worksheet C: **Method**

5. Test for sulfite **(always do this test in a fume cupboard)**

(a) Add a small volume of hydrochloric acid to your unknown in a test-tube and shake gently.
(b) Warm gently and remove from the source of heat.
(c) Immediately test for the presence of sulfur dioxide gas.
(d) Place a drop of acidified potassium(VII) manganate solution onto a strip of filter paper and place in the neck of the test-tube.
(e) If sulfur dioxide gas is present, the purple-stained filter paper will become colourless.

Cations

1. Adding aqueous sodium hydroxide:

(a) Make a solution of the unknown and put 1 cm^3 (max.) into a test-tube.
(b) Add 1 cm^3 (max.) sodium hydroxide solution and shake carefully.
(c) Record the appearance of any precipitate formed.
(d) Continue to add sodium hydroxide solution and shake – is the precipitate soluble or insoluble in excess?

2. Adding aqueous ammonia:

(a) Make a solution of the unknown and put 1 cm^3 (max.) into a test-tube.
(b) Add 1 cm^3 (max.) ammonia solution and shake carefully.
(c) Record the appearance of any precipitate formed.
(d) Continue to add ammonia solution and shake – is the precipitate soluble or insoluble in excess?

3. Test for ammonium

(a) Make a solution of the unknown and put 1 cm^3 (max.) into a test-tube.
(b) Add sodium hydroxide solution (1 cm^3) to the unknown solution.
(c) Warm the mixture gently in a Bunsen flame and then remove from the heat.
(d) Moisten a piece of red litmus paper and hold it near the mouth of the test-tube. If the paper turns blue, this indicates that ammonia gas is present which confirms the presence of ammonium ions. Make sure you don't touch the inside of the test-tube with the litmus paper!

Flame tests

(a) Dip the flame test wire into a test-tube containing a small amount of hydrochloric acid [5 mol/dm^3].
(b) Heat the wire for a few seconds in the blue flame of the Bunsen burner.
(c) Dip the wire into a solution of the unknown.
(d) Place the wire in the centre of the flame.
(e) Observe and record the flame colour.

Worksheet D: **Results**

You have been provided with two compounds, labelled **X** and **Y**.

Carry out the following tests on the compounds, entering your results and conclusions in the table.

Tests of sample X	
tests	**observations**
(a) Describe the appearance of the **X** and **Y** mixture	…….
(b) How would you separate **X** and **Y** so that you can test both of them individually? Draw your equipment set-up and check your method and equipment required with your teacher before proceeding.	
<u>Tests on the solution of **X**</u> **(c)** To the first portion, acidify with dilute nitric acid (2 drops) and add 5 drops of barium nitrate.	…….
(d) To the second portion, acidify with dilute nitric acid (2 drops) and add 5 drops of silver nitrate solution.	…….
(e) To the third portion, add aqueous ammonia solution (10 drops)	…….
(f) To the final portion, add aqueous sodium hydroxide solution (10 drops). Gently warm the contents of the test-tube, testing any gases produced.	……. …….
• Write down the name and formula of the cation and anion that you have identified above: ○ cation: …… anion: …….. • Name of compound **X**: …….. • Chemical formula of compound **X**: ……	

Worksheet D: **Results**

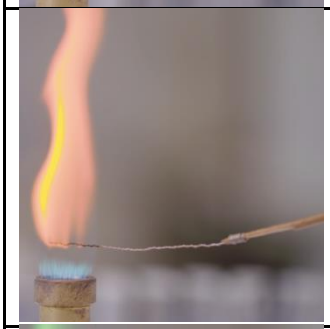
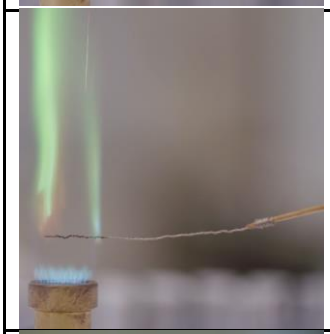
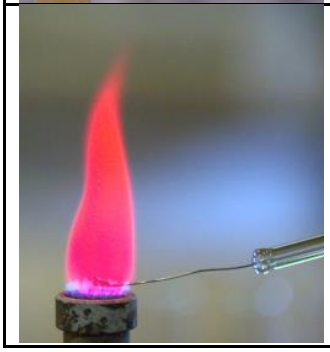
Tests on sample Y	
tests	**observations**
Tests on the insoluble solid **Y** **(a)** To the contents of a test-tube containing compound **Y**, add a large excess of aqueous sodium hydroxide solution.	…… ……
(b) Perform a flame test on a small amount of **Y**. To do this, dip a clean flame test wire into the concentrated hydrochloric acid solution and then into solid **Y**. Hold the wire into the blue Bunsen flame. Observe and record any flame colour produced.	……
(c) Add dilute hydrochloric acid (1 cm^3) and warm the contents of the test-tube gently. **Do this test in a fume cupboard.** Test any gases produced. Keep the contents of this tube for the next test.	…… ……

- Write down the name and formula of the cation and anion that you have identified above:
    - cation: …… anion: ……
- Name of compound **Y**: ……
- Chemical formula of compound **Y**: ……

Worksheet E: **Flame test observations**

Look at the observation statements next to the flame colours.

Can you improve them in order to make them better observation statements?

Observation	Statement	Improved statement
	This is sodium.	
	Purple flame means K.	
	A brick-red flame colour was observed. This means that the lithium ion is present.	
	Cu.	
	Red/lithium.	

Worksheet F: **Language focus**

Each question below concerns observations in qualitative analysis.

Ensure that you answer each pair of questions using the same tense as in the question given.

Past tense

1. What happened when a strip of filter paper, acidified with potassium manganate(VII) solution, was placed close to the top of a test-tube producing sulfur dioxide gas?

……

……

2. What happened when an aqueous solution of sodium hydroxide, was added to a solution containing chromium(III) ions?

……

……

Present tense

1. What happens when a few drops of aqueous silver nitrate are added to an acidified solution of sodium bromide?

……

……

2. What do you observe when a sample containing sodium ions is burning in a blue Bunsen flame?

……

……

Worksheet F: **Language focus**

Future tense

1. What will happen when an excess of aqueous ammonia is added to a precipitate of copper(II) ions?

……

……

2. A test-tube contains a small piece of aluminium and a solution containing nitrate ions and aqueous sodium hydroxide. What will happen when it is gently heated?

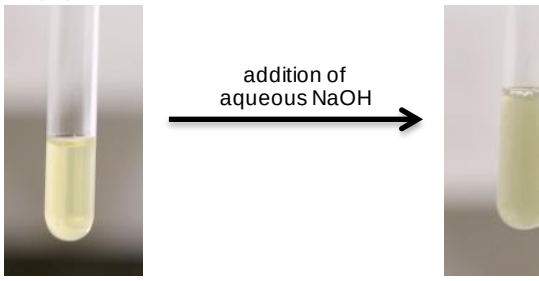
……

……

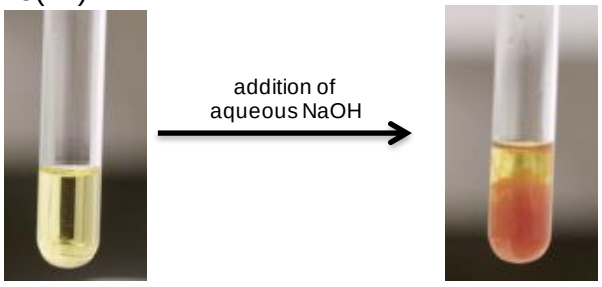
Comparing

Look at the images below for the reactions of Fe(II) and Fe(III) ions with aqueous sodium hydroxide.

Fe(II)



Fe(III)



Compare what is happening when aqueous sodium hydroxide is added to these test-tubes.

……

……

Worksheet G: **Correct the mistakes**

Correct the sentences below in the spaces provided.

The number of mistakes is shown in brackets.

1. When a percipitate is formed in qualitative analysis, it indicates that the substance is soluble in water. (*two mistakes to correct*)

……

……

……

2. A wooden splint is ignited using a Bunsen burner. It is brought next to the mouth of a test-tube containing oxygen which causes it to 'pop'. (*one mistake to correct*)

……

……

……

3. A test-tube containing aqueous iron(II) ions produces a red-brown precipitate when a small volume of aqueous sodium hydroxide is added. The precipitate dissolves in excess aqueous sodium hydroxide to give a red-brown solution. (*two mistakes to correct*)

……

……

……

4. A yellow solution is produce when aqueous silver nitrate is added to an acidified solution of bromide ions. (*three mistakes to correct*)

……

……

……

5. Ammonium gas changes red litmus paper blue. (*two mistakes to correct*)

……

……

……

Worksheet B: **Answers**

Answer these questions which are based on the qualitative analysis tests you have just seen in the video(s).

Test for carbonate anion

(a) What do you observe when dilute hydrochloric acid is added to a carbonate?

effervescence / bubbling / fizzing

(b) Which reagent is used for testing the gas produced and what is the result?

Limewater solution; the solution will turn cloudy/milky in the presence of carbon dioxide

(c) Explain why it is very important to keep the stopper kept on a freshly made up bottle of lime water.

So the carbon dioxide in the air does not turn the limewater solution cloudy/milky

Test for halide anion (chloride, bromide and iodide)

(a) What is the name of the reagent used to test for the presence of halide ions?

Silver nitrate solution

(b) Explain the term precipitate.

A precipitate is formed when two solutions react together producing a solid substance that may or may not be dissolved in excess.

(c) Why is it very important to use distilled water in the test for chloride ions?

The test for chloride is a very sensitive test and as tap water contains chloride ions, these will cause a precipitate to form and give a false result.

Test for sulfite anion

(a) Which gas is produced during a positive test for a sulfite?

sulfur dioxide (SO_2) gas

(b) What safety precautions need to be taken when performing this test?

The test must be done in a fume cupboard as sulfur dioxide is a toxic gas.

Worksheet B: **Answers**

Test for chromium(III) cation

(a) What does 'in excess' mean?

In excess means adding much more of one reagent than is needed for complete reaction

(b) What are the main differences in the results obtained when using aqueous sodium hydroxide, compared with using aqueous ammonia?

One difference is in the solubility of the precipitate. With ammonia solution, the precipitate is insoluble in excess. Additionally, the colour of the precipitate is a grey-green colour compared to the green colour obtained with sodium hydroxide solution.

Test for aluminium cation

(a) What is the result obtained when a small amount of aqueous sodium hydroxide is added to aqueous aluminium ions?

A white precipitate is formed

(b) What happens when you add an excess of this reagent?

The precipitate dissolves to produce a colourless solution

(c) How is the result of this test different to that obtained with aqueous ammonia?

The precipitate formed is insoluble in excess reagent

Flame tests

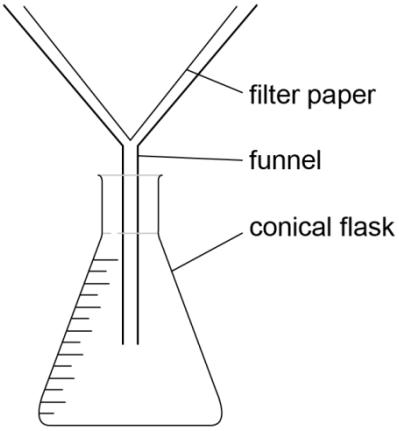
(a) What do you need in order to perform a typical flame test?

The most important piece of equipment is a flame test wire made from an inert material that does not produce a flame colour itself. You also need concentrated hydrochloric acid to clean the wire in between tests and a Bunsen burner.

(b) What safety precautions should be taken?

Between the tests, and after use, the Bunsen burner should be left on a yellow safety flame. Long hair should be tied up and a lab coat and safety goggles must be worn. Care should be taken when using concentrated hydrochloric acid so that it does not splash.

Worksheet D: **Answers**

Tests of sample X	
tests	**observations**
(a) Describe the appearance of the **X** and **Y** mixture.	*The mixture is a colourless liquid with a white solid in it.*
(b) How would you separate **X** and **Y** so that you can test both of them individually? Draw your equipment set-up and check your method and equipment required with your teacher before proceeding.	*You need to filter the mixture using filter paper, a funnel and a conical flask.* 
<u>Tests on the solution of **X**</u> **(c)** To the first portion, acidify with dilute nitric acid (2 drops) and add 5 drops of barium nitrate.	*No precipitate was observed.*
(d) To the second portion, acidify with dilute nitric acid (2 drops) and add 5 drops of silver nitrate solution.	*A white precipitate formed.*
(e) To the third portion, add aqueous ammonia solution (10 drops)	*No precipitate was observed.*
(f) To the final portion, add aqueous sodium hydroxide solution (10 drops). Gently warm the contents of the test-tube, testing any gases produced.	*No precipitate was observed.* *A pungent smelling gas was observed, which turned damp red litmus paper blue.*

- Write down the name and formula of the cation and anion that you have identified above:
  - cation: *ammonium* NH_4^+ anion: *chloride* Cl^-
- Name of compound **X**: *ammonium chloride*
- Chemical formula of compound **X**: NH_4Cl

Worksheet D: **Answers**

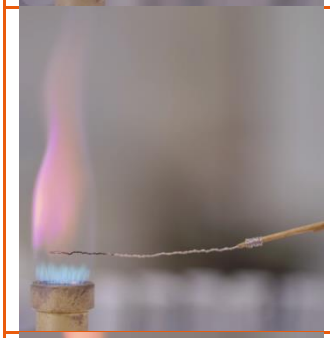
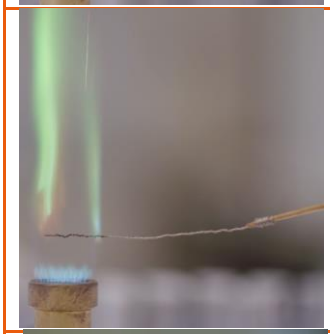
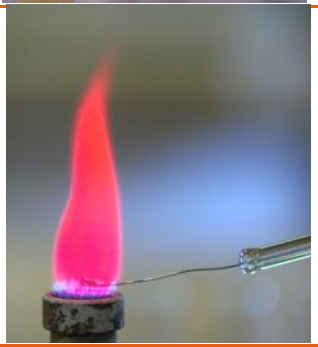
Tests on sample Y	
tests	**observations**
Tests on the insoluble solid **Y** **(a)** To the contents of test-tube containing compound **Y**, add a large excess of aqueous sodium hydroxide solution.	A white precipitate formed.
(b) Perform a flame test on a small amount of **Y**. To do this, dip a clean flame test wire into the concentrated hydrochloric acid solution and then into solid **Y**. Hold the wire into the blue Bunsen flame. Observe and record any flame colour produced.	A brick-red flame was observed.
(c) Add dilute hydrochloric acid (1 cm^3) and warm the contents of the test-tube gently. **Do this test in a fume cupboard.** Test any gases produced. Keep the contents of this tube for the next test.	A piece of filter paper soaked in acidified potassium manganate(VII) solution changed from purple to colourless.

- Write down the name and formula of the cation and anion that you have identified above:
  - cation: calcium Ca^{2+} anion: sulfite SO_3^{2-}
- Name of compound **Y**: calcium sulfite
- Chemical formula of compound **Y**: $CaSO_3$

Worksheet E: **Answers**

Look at the observation statements next to the flame colours.

Can you improve them in order to make them better observation statements?

Observation	Statement	Improved statement
	This is sodium.	An orange/yellow flame was observed. This means that the sodium ion is present.
	Purple flame means K.	A lilac flame was observed. This means that the potassium ion is present.
	A brick-red flame colour was observed. This means that the lithium ion is present.	A brick-red flame colour was observed. This means that the calcium ion is present.
	Cu.	A green flame was observed. This means that the copper ion is present.
	Red/lithium.	A red flame was observed. This means that the lithium ion is present.

Worksheet F: **Answers**

Each question below concerns observations in qualitative analysis.

Ensure that you answer each pair of questions using the same tense as in the question given.

Past tense

1. What happened when a strip of filter paper, acidified with potassium manganate(VII) solution, was placed close to the top of a test-tube producing sulfur dioxide gas?

The purple coloured strip of filter paper went colourless/became colourless.

2. What happened when an aqueous solution of sodium hydroxide was added to a solution containing chromium(III) ions.

A green precipitate formed.

Present tense

1. What happens when a few drops of aqueous silver nitrate are added to an acidified solution of sodium bromide?

A cream coloured precipitate (of silver bromide) is formed.

2. What do you observe when a sample containing sodium ions is burning in a blue Bunsen flame?

An intense yellow flame is observed.

Worksheet F: **Answers**

Future tense

1. What will happen when an excess of aqueous ammonia is added to a precipitate of copper(II) ions?

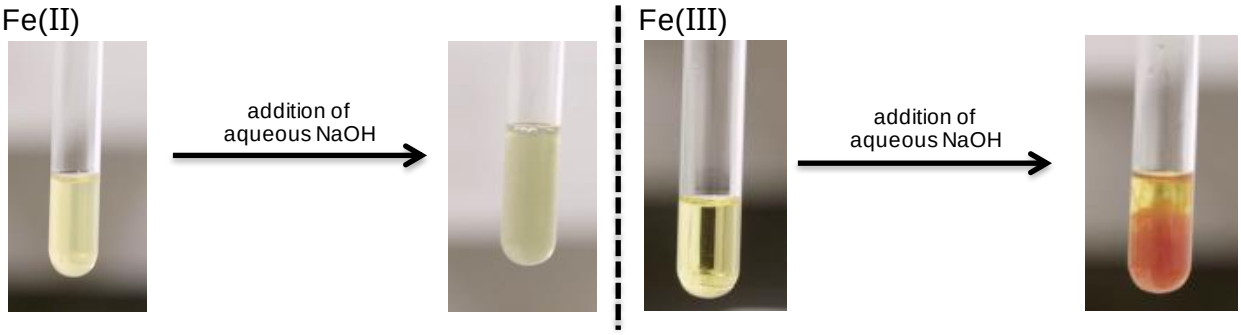
A deep blue solution will be formed.

2. A test-tube contains a small piece of aluminium and a solution containing nitrate ions and aqueous sodium hydroxide. What will happen when it is gently heated?

Vigorous effervescence will occur/bubbling will occur/it will fizz.

Comparing

Look at the images below for the reactions of Fe(II) and Fe(III) ions with aqueous sodium hydroxide.



Compare what is happening when aqueous sodium hydroxide is added to these test-tubes.

In both test-tubes precipitates are formed. However, in test-tube 1, the precipitate is green whereas the precipitate in test-tube 2 is red-brown.

Worksheet G: **Answers**

Correct the sentences below in the spaces provided.

The number of mistakes is shown in brackets.

1. When a percipitate is formed in qualitative analysis, it indicates that the substance is soluble in water. (*two mistakes to correct*)

   When a precipitate is formed in qualitative analysis, it indicates that the substance is insoluble in water.

2. A wooden splint is ignited using a Bunsen burner. It is brought next to the mouth of a test-tube containing oxygen, which causes it to 'pop'. (*one mistake to correct*)

   A wooden splint is ignited using a Bunsen burner. It is brought next to the mouth of a test-tube containing hydrogen, which causes it to 'pop'.

3. A test-tube containing aqueous iron(II) ions produces a red-brown precipitate when a small volume of aqueous sodium hydroxide is added. The precipitate dissolves in excess aqueous sodium hydroxide to give a red-brown solution. (*two mistakes to correct*)

   A test-tube containing aqueous iron(II) ions produces a green precipitate when a small volume of aqueous sodium hydroxide is added. The precipitate is insoluble in excess sodium hydroxide.

   Or

   A test-tube containing aqueous iron(III) ions produces a red-brown precipitate when a small volume of aqueous sodium hydroxide is added. The precipitate is insoluble in excess sodium hydroxide.

4. A yellow solution is produce when aqueous silver nitrate is added to an acidified solution of bromide ions. (*three mistakes to correct*)

   A yellow precipitate is produced when aqueous silver nitrate is added to an acidified solution of iodide ions.

5. Ammonium gas changes red litmus paper blue. (*two mistakes to correct*)

   Ammonia gas changes damp red litmus paper blue.

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