AQA Chemistry Unit 12

Chemical Analysis

Crompton House Chemistry

I am able to:

		Learn it	Revise it
1	I can identify pure substances and mixtures from data about melting and boiling points		
2	I can describe chromatography and calculate Rf values		
3	I can explain how to test for the prescence of hydrogen, oxygen, carbon dioxide and chlorine		
Chemistry Only			
4	*I can identify some metal ions from the results of flame tests*		
5	*I can describe how sodium hydroxide solution can be used to identify some metal ions and write equations*		
6	*I can describe how to identify carbonates using limewater*		
7	*I can describe how to identify negative ions, including halide ions using silver nitrate and sulfate ions using barium chloride*		
8	I can state the advantages of using instrumental methods to identify elements and compounds compared to chemical tests		
9	I can describe how to use flame emission spectroscopy to identify metal ions		

DODDLE QUIZZES

AQA Pure Substances and Formulations _____%

AQA Chromatography _____%

AQA Chromatography (Practical) _____%

AQA Identifying Gases _____%

TRIPLE

AQA Identifying Ions (Practical) _____%

AQA Analysing Substances _____%

Kerboodle Extension Quizzes

Positive Points/postcards for completion

COMBINED	C10 Homework: Chemical Analysis	_____%
	C10 Progress quiz: Chemical Analysis	_____%
	C10 Checkpoint quiz: Chemical Analysis	_____%
TRIPLE	*C12 Homework: Chemical analysis 1*	_____%
	C12 Homework: Chemical analysis 2	_____%
	C12 Progress quiz: Chemical analysis 1	_____%
	C12 Progress quiz: Chemical analysis 2	_____%
	C12 Checkpoint quiz: Chemical analysis	_____%

Self-Reflection

WWW:

EBI:

Checked by Teacher:

Date:

Chapter 12: Chemical analysis

Knowledge organiser

Pure and impure

In chemistry, a **pure** substance contains a single element or compound that is not mixed with any other substance.

Pure substances melt and boil at specific temperatures.

An **impure** substance contains more than one type of element of compound in a **mixture**.

Impure substances melt and boil at a range of temperatures.

Formulations

Formulations are examples of mixtures. They have many different components (substances that make them up) in very specific proportions (amounts compared to each other).

Scientists spend a lot of time trying to get the right components in the right proportions to make the most useful product.

Formulations include fuels, cleaning agents, paints, alloys, fertilisers, and foods.

Chromatography

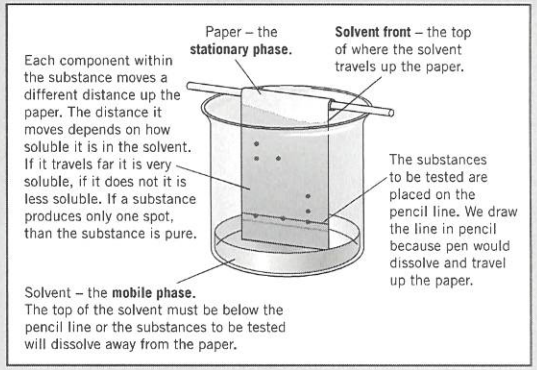
Chromatography is a method to separate different components in a mixture. It is set up as shown here, with a piece of paper in a beaker containing a small amount of solvent.

The **R_f value** is a ratio of how far up the paper a certain spot moves compared to how far the **solvent** has travelled.

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

It will always be a number between 0 and 1.

The R_f value depends on the solvent and the temperature, and different substances will have different R_f values. The R_f values for particular solvents can be used to identify a substance.



Testing gases

Common gases can be identified using the follow tests:

Gas	What you do	What you observe if gas is present
hydrogen	hold a lighted splint near the gas	hear a squeaky pop
oxygen	hold a glowing splint near the gas	splint re-lights
carbon dioxide	bubble the gas through limewater	the limewater turns milky (cloudy white)
chlorine	hold a piece of damp litmus near the gas	bleaches the litmus white

Testing for cations

Metal ions always have a positive charge (i.e., they are cations). Sodium hydroxide solution can be used to identify some metal ions.

Cation	Positive result
aluminium ions, Al^{3+}	on slow addition of excess sodium hydroxide solution, white **precipitate** forms that eventually dissolves again with excess sodium hydroxide
calcium ions, Ca^{2+}	on addition of excess sodium hydroxide solution, white precipitate that does not dissolve
magnesium ions, Mg^{2+}	on addition of excess sodium hydroxide solution, white precipitate that does not dissolve
copper(II) ions, Cu^{2+}	forms a blue precipitate
iron(II) ions, Fe^{2+}	forms a green precipitate
iron(III) ions, Fe^{3+}	forms a brown precipitate

Flame tests

Substances containing metals can produce a coloured light in a flame. This can be used to identify the metal. However, if there is more than one metal in the substance then this method will not work, as the colours mix and intense colours mask more subtle colours.

Metal	Flame colour
lithium	crimson
sodium	yellow
potassium	lilac
calcium	orange-red
copper	green

Testing for anions

Anion	Test	Positive result
carbonate, CO_3^{2-}	add dilute acid	carbon dioxide gas formed which can be test for with limewater
chloride, Cl^-	add silver nitrate solution in the presence of nitric acid	white precipitate formed
bromide, Br^-	add silver nitrate solution in the presence of nitric acid	cream precipitate formed
iodide, I^-	add silver nitrate solution in the presence of nitric acid	yellow precipitate formed
sulfate, SO_4^{2-}	add barium chloride solution in the presence of hydrochloric acid	white precipitate formed

Instrumental methods

Instrumental analysis involves using complex scientific equipment to test substances.

Instrumental methods are rapid and accurate. They are also sensitive, which means they can give results even with very small amounts of substance.

Flame emission spectroscopy

Flame emission spectroscopy is a type of instrumental analysis similar to a **flame test**.

The sample solution is put into a flame and the light given off is passed through a spectroscope. Instead of a human observing a colour, the instrument tells you exactly which wavelength of light is being given off as a line spectrum. You can then compare the spectrum to a reference to establish the identity of your sample. You can also measure the concentration of the substance in your sample solution.

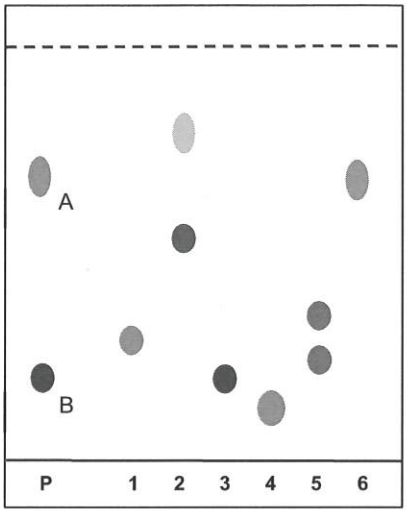
Key terms

Make sure you can write a definition for these key terms.

chromatography, flame emission spectroscopy, flame test, formulation, impure, instrumental analysis, mobile phase, precipitate, pure, R_f value, solvent, solvent front, stationary phase

CHROMATOGRAPHY (A)

Substance P was analysed by paper chromatography using ethanol as solvent.



a Explain why spot A moves further up the paper than spot B.

.....

.....

.....

.....

.....

b Calculate the R_f values for spots A and B. Give your answers to 2 significant figures.

Spot A..... spot B.....

....

....

....

c Which of substances 1-6 are in mixture P? .....

d What is the solvent front? .....

.....

.....

.....

e The starting line is drawn with the graphite in a pencil. Why is this a suitable substance for the line?

.....

.....

.....

.....

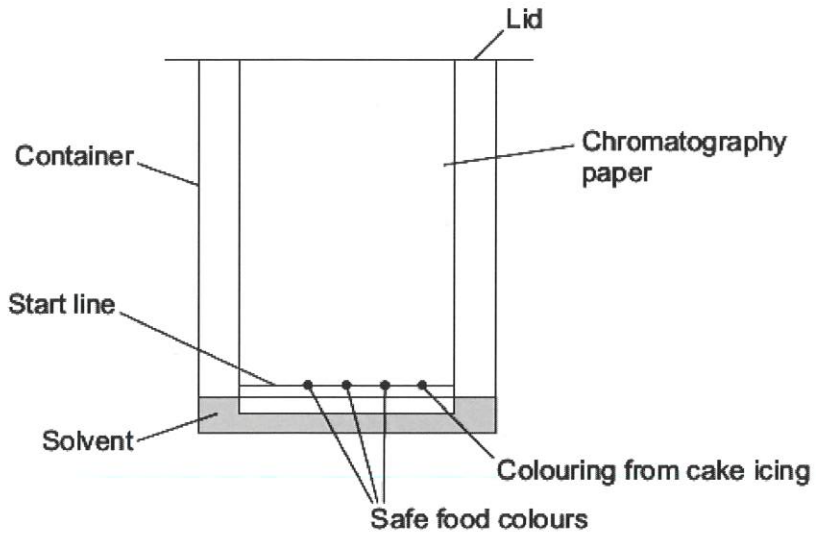
Exam Questions

Q1. Icing on cakes is tested to check that safe colours were used when they were made.

By Megan Chromik [CC-BY-SA-2.0], via Wikimedia Commons

Paper chromatography is one method of testing which colours are in cake icing.

(a) The diagram shows an experiment a student did.



(i) Suggest why there is a lid on the container.

_____

_____

(1)

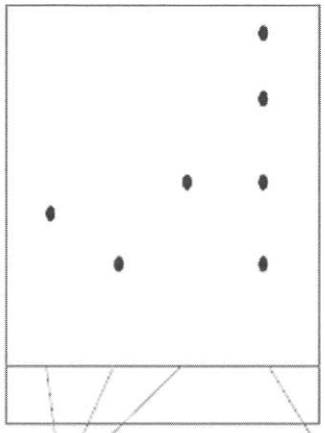
(ii) The start line should be drawn in pencil **not** in ink.
Suggest why.

_____

_____

(1)

(b) The diagram shows the results of the paper chromatography experiment.



Safe food colours Colouring from cake icing

(i) How many different food colours were used in the colouring from the cake icing?

_____

(1)

(ii) Is the cake icing safe to eat?

Give a reason for your answer.

_____

_____

(1)

(c) Gas chromatography linked to mass spectroscopy is an example of an instrumental method. This method was used on a mixture of solvents.

(i) Give **two** advantages of gas chromatography compared with paper chromatography.

_____

_____

_____

_____

(2)

(ii) What does gas chromatography do to the mixture of solvents?

_____

_____

(1)

(iii) What information does mass spectroscopy give?

_____

_____

(1)

(Total 8 marks)

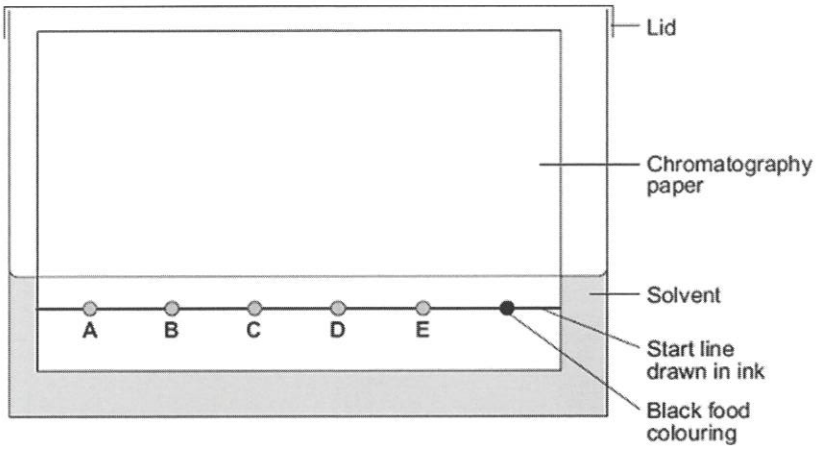
Q2. Chromatography can be used to separate components of a mixture.

(a) A student used paper chromatography to analyse a black food colouring.

The student placed spots of known food colours, **A**, **B**, **C**, **D** and **E**, and the black food colouring on a sheet of chromatography paper.

The student set up the apparatus as shown in **Diagram 1**.

Diagram 1



The student made **two** errors in setting up the apparatus.
Identify the **two** errors and describe the problem each error would cause.

_____

_____

_____

_____

_____

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_____

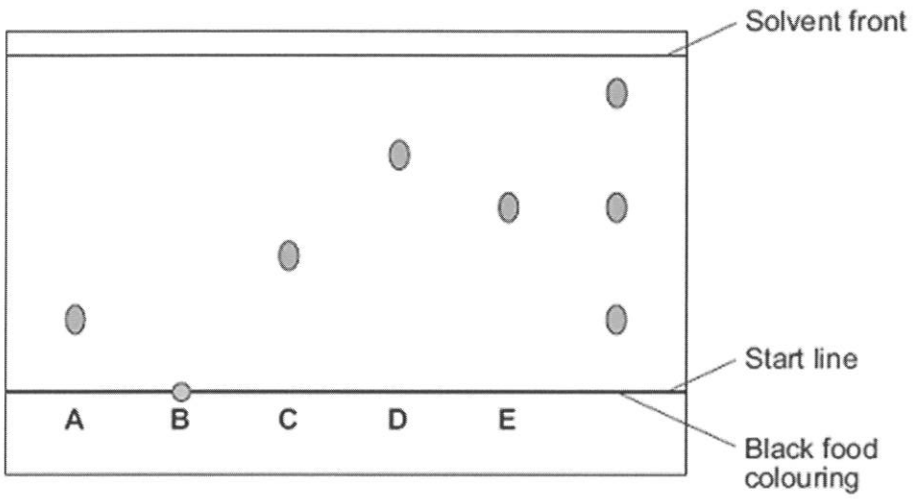
_____

(4)

(b) A different student set up the apparatus without making any errors.

The chromatogram in **Diagram 2** shows the student's results.

Diagram 2



(i) What do the results tell you about the composition of the black food colouring?

_____

_____

_____

(2)

(ii) Use **Diagram 2** to complete **Table 1**.

Table 1

	Distance in mm
Distance from start line to solvent front	_____
Distance moved by food colour **C**	_____

(2)

(iii) Use your answers in part **(b) (ii)** to calculate the R_f value for food colour **C**.

_____

_____

R_f value = _____

(1)

(c) **Table 2** gives the results of chromatography experiments that were carried out on some known food colours, using the same solvent as the students.

Table 2

Name of food colour	Distance from start line to solvent front in mm	Distance moved by food colour in mm	R_f value
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

Which of the food colours in **Table 2** could be food colour **C** from the chromatogram?

Give the reason for your answer.

_____

_____

_____

_____

(2)

(d) Two types of chromatography are gas chromatography and paper chromatography.

Give **one** advantage of gas chromatography compared with paper chromatography.

_____

_____

(1)

(Total 12 marks)

TRIPLE ONLY QUESTION

Q3. This question is about chemical analysis.

A student tested copper sulfate solution and calcium iodide solution using flame tests.

This is the method used.

1. Dip a metal wire in copper sulfate solution.
2. Put the metal wire in a blue Bunsen burner flame.
3. Record the flame colour produced.
4. Repeat steps 1 to 3 using the same metal wire but using calcium iodide solution.

(a) What flame colour is produced by copper sulfate solution?

_____

_____

(1)

(b) Calcium compounds produce an orange-red flame colour.

The student left out an important step before reusing the metal wire.

The student's method did **not** produce a distinct orange-red flame colour using calcium iodide solution.

Explain why.

_____

_____

_____

_____

(2)

(c) The student added sodium hydroxide solution to:

- copper sulfate solution
- calcium iodide solution.

Give the results of the tests.

Copper sulfate solution _____

_____

Calcium iodide solution _____

_____

(2)

(d) To test for sulfate ions the student added dilute hydrochloric acid to copper sulfate solution.

Name the solution that would show the presence of sulfate ions when added to this mixture.

_____

(1)

(e) To test for iodide ions the student added dilute nitric acid to calcium iodide solution.

Name the solution that would show the presence of iodide ions when added to this mixture.

Give the result of the test.

Solution _____

Result _____

_____

(2)

(Total 8 marks)