C8 Chemical Analysis

Revision Lesson

Title – C8 Chemical Analysis Monday, 25 September 2023

Do it now:

Describe the relationship between boiling point and chain length. Longer hydrocarbon = higher boiling point (stronger intermolecular forces)	State two equations for rate of reaction. Include units. Volume of gas ÷ time (cm^3/s) Mass of reactant ÷ time (g/s)	What apparatus can be used to measure rate of reaction? Gas syringe and stopwatch OR Mass balance and stopwatch
How can pure substances be distinguished from impure ones? By looking at their melting points.	Why are large hydrocarbons cracked? To make shorter AND MORE USEFUL alkanes (for fuel) and alkenes (for polymers)	What would happen to the yield of ammonia in the reaction below, if temperature was increased. NITROGEN + HYDROGEN $\rightleftharpoons^{exo}$ AMMONIA N_2 $3H_2$ $2NH_3$ Yield of ammonia would decrease, as equilibrium would shift to the left (the endothermic direction).

LO: Define pure substances

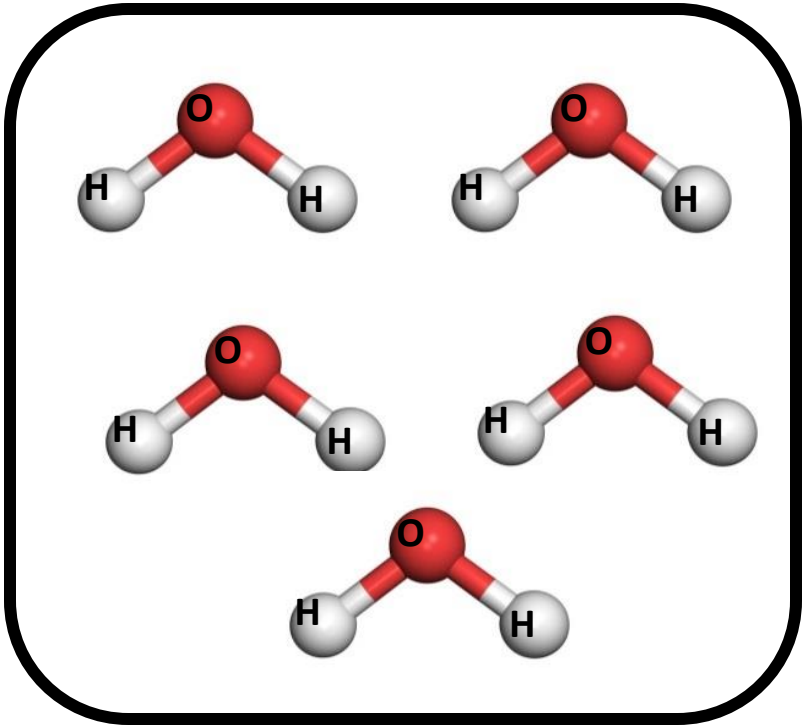
THINK PAIR SHARE

Which of these images show pure substances?

Challenge: *Explain your answers.*

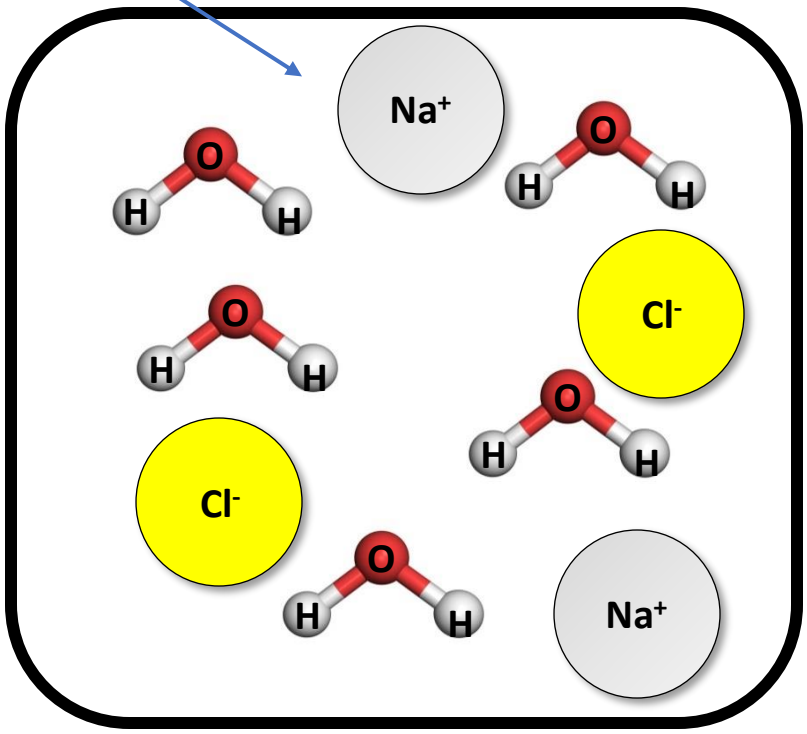
Explain the properties of small covalent compounds

This is what comes out of taps!



Pure water

No free moving charged particles, **cannot** conduct electricity!



Impure water

Free moving ions, **can** conduct electricity!

LO: Define pure substances

Key definition:

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

Gold is an element and can be pure, however gold jewellery usually contains a mixture of elements.

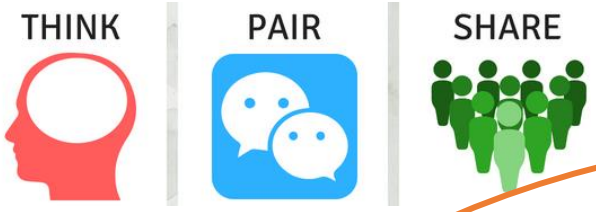
Pure gold is too soft!

Did you know?

The purest gold ever was produced in 1957 and was 999.999 on the fineness scale.

Gold purity is still often measured on the older carat scale, where 24 carat gold is pure gold.

LO: **Distinguish** pure and impure substances using MP and BP data



Adding salt makes the ice an ***IMPURE MIXTURE.***

This ***LOWERS THE MELTING POINT*** of the ice.

The ice freezes at a ***LOWER TEMPERATURE.***

Hint: *How does the ... **perties** of the ice?*

LO: Distinguish pure and impure substances using MP and BO data

Pure and impure substances

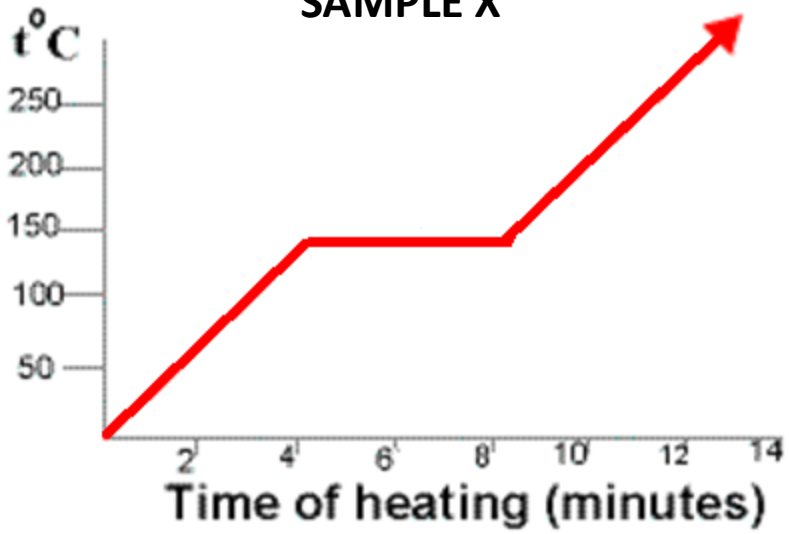
Pure substances melt and boil at specific temperatures.

If the substance is **pure**, the melting point will be specific temperature.

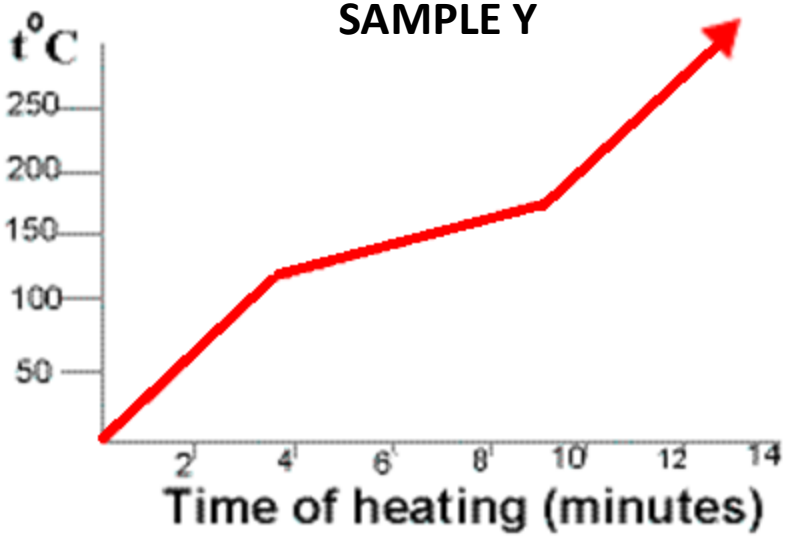
If the substance is **impure**, the melting point will be a **broad range** of temperatures.

LO: **Distinguish** pure and impure substances using MP and BP data

SAMPLE X



SAMPLE Y



What is the difference between these two graphs?

Which graph shows a pure sample?

Sample X is pure because the melting point is at a specific temperature.

Which graph shows an impure sample?

Sample Y is impure because there are a range of melting points

Identify formulations given appropriate information.

Key definition:

A formulation is a **mixture** of components which has been designed as a **useful** product.

Formulations are complex mixtures in which each chemical has a particular purpose, giving a product with the desired properties.

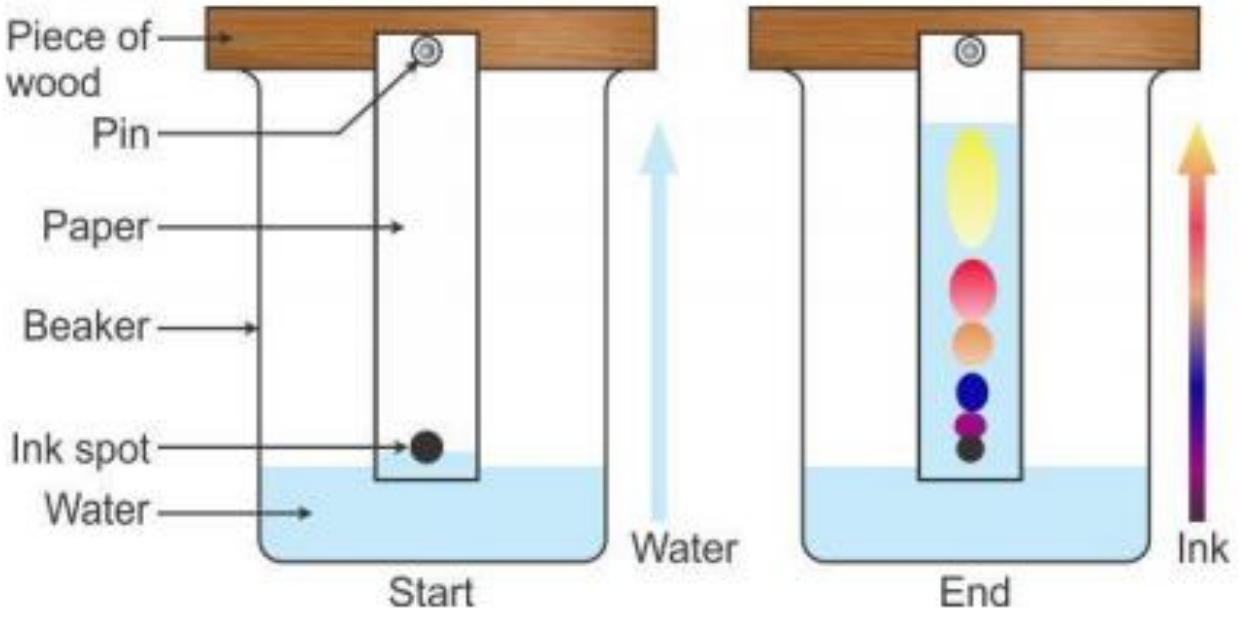
e.g. medicines, paints, cleaning agents, fertilisers, cosmetics

Describe what substances chromatography can separate

Key definition:

Chromatography is a method used for separating and identifying small quantities of chemicals in a mixture.

As the **solvent** rises up the paper it **dissolves** the sample mixture, which will then **travel** up the paper. **More soluble** compounds will travel **further up** the filter paper than less soluble compounds.



Describe what substances chromatography can separate

Identifying additives in food

Forensic science

Detecting explosives in airports

Uses of chromatography

Test water samples for pollution

Detecting pesticides / insecticides

Identifying drugs and alcohol

Describe what substances chromatography can separate

Chromatography in forensics

August 2002

Holly Wells and **Jessica Chapman** (two 10 year old girls)

Ian Huntley – charged with two counts of murder and sentenced to life imprisonment

The burnt and cut clothes were found in a bin.

Forensic scientists found fibres from their t-shirts in Ian Huntleys home and car.

The components of the red fibre dye from the footballs shirts matched with the separate component dyes from the fibres obtained as evidence.

Explain how to set up a chromatography practical

Chromatography – Required practical

Task: Use the video and the pictures on your method sheet to write a step by step method for chromatography.

https://www.youtube.com/watch?v=pnTGNAfu6GE

Play up to 7 minutes only!

Challenge:
Explain why the pencil line must be drawn in pencil.

Super challenge: *Why is a lid sometimes used?*

Chromatography method

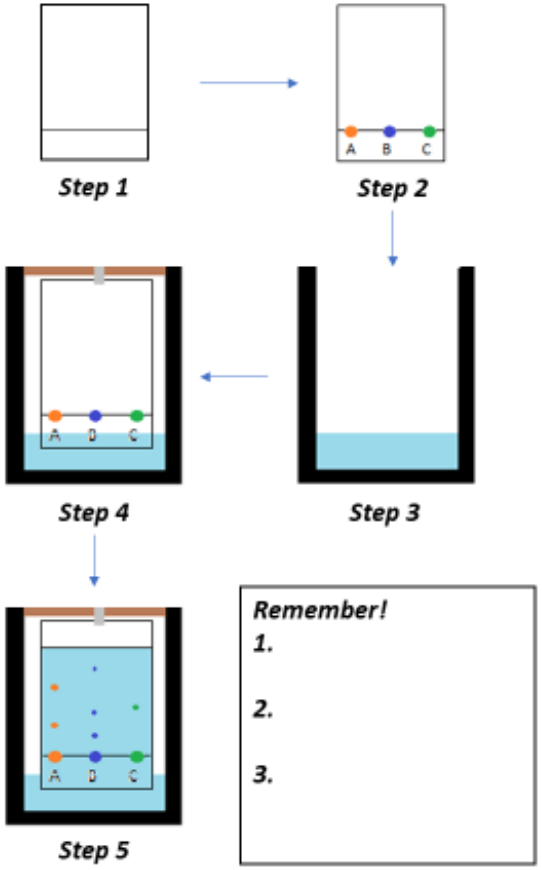
Step 1:

Step 2:

Step 3:

Step 4:

Step 5:



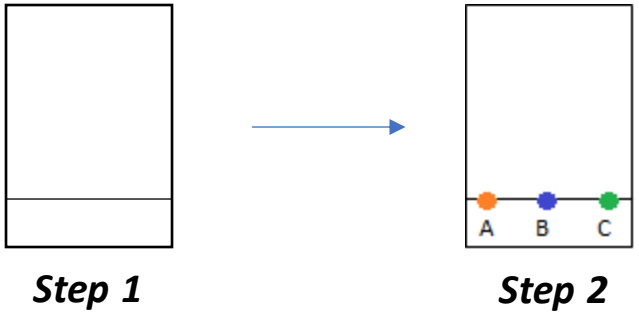
Step 1: Draw a pencil line 2cm from the bottom of a piece of chromatography paper.

Step 2: Place a dot of each ink sample on the pencil line and label the samples in pencil.

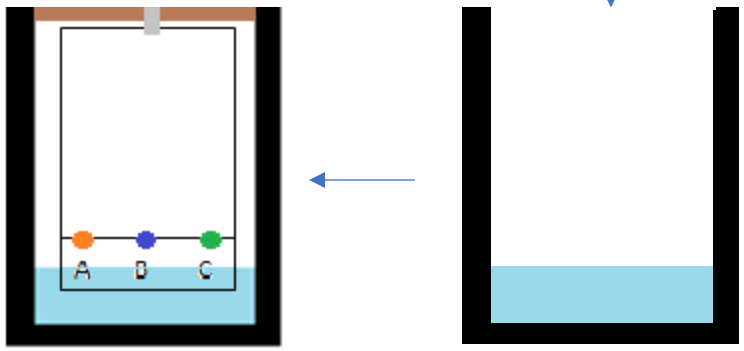
Step 3: Place 1cm of solvent into a beaker.

Step 4: Secure the chromatography paper to a rod and place the end of the paper into the solvent. Make sure the solvent level is **below** the pencil line.

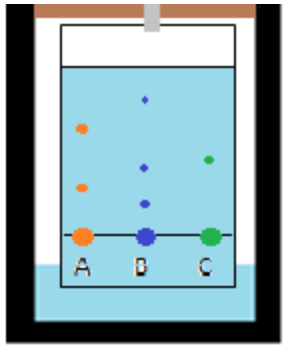
Step 5: Wait until the solvent has risen to about 1cm from the top of the paper. Draw a pencil line to show the solvent front and leave to dry.



Step 1 ***Step 2***



Step 4 ***Step 3***



Step 5

Remember!

1. Line must be drawn in pencil.
2. Solvent must be below pencil line.
3. A lid may be used to stop the solvent evaporating.

DECODE IT NOW

Word:

Stationary (tier 2)

Define it:

Not moving or not changing.

Write a sentence of your own that uses the word **stationary.**

Write your own definition of the word **stationary.**

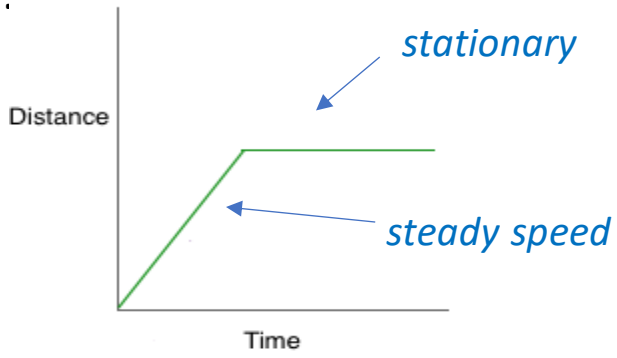
Which subjects or topics will this word be relevant to?

Link it (similar words):

Still, unmoving, motionless

Digging Deeper:

In physics, a stationary object can be shown on a distance time graph by a horizontal line:



Use it:

A car collided with a stationary vehicle.

Deconstruct it (root word):

From Latin word '*statio*' meaning '*standing*'.

DECODE IT NOW

Word:

Mobile (tier 2)

Define it:

Able to move freely or easily.

Write a sentence of your own that uses the word **mobile.**

Write your own definition of the word **mobile.**

Which subjects or topics will this word be relevant to?

Link it (similar words):

Moving, in motion, active

Digging Deeper:

The term ***mobile phones*** comes from the fact that the user can move around whilst using the phone.

Before the invention of mobile phones, telephones were connected to a phone line at the wall.

Use it:

He has broken his ankle so he is not very mobile.

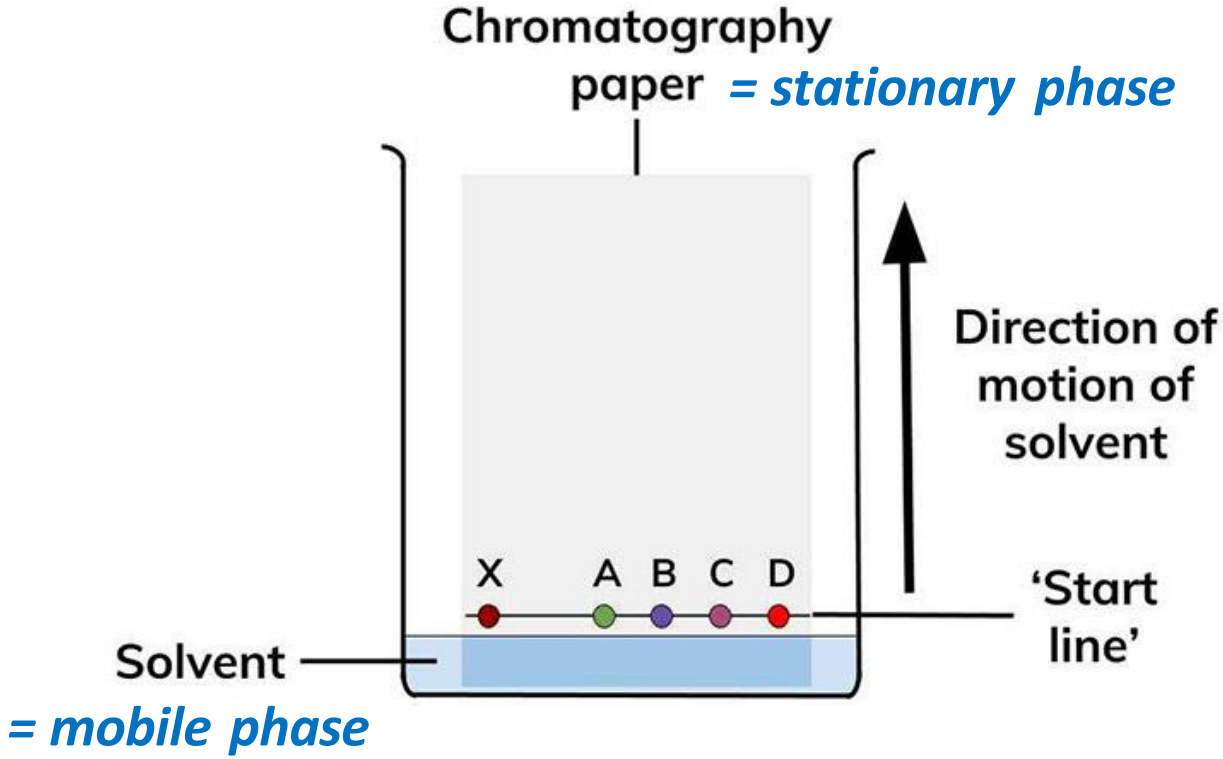
Deconstruct it (root word):

From Latin word '*mobilis*' meaning '*to move*'.

Describe the stationary and mobile phases in chromatography

Key definition:

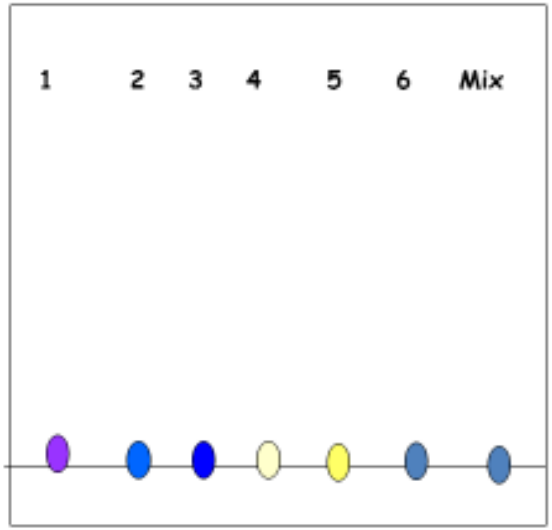
In chromatography, the **mobile** phase (the moving phase) is the ***solvent***. The **stationary** phase (the phase that does not move) is the ***chromatography paper***.



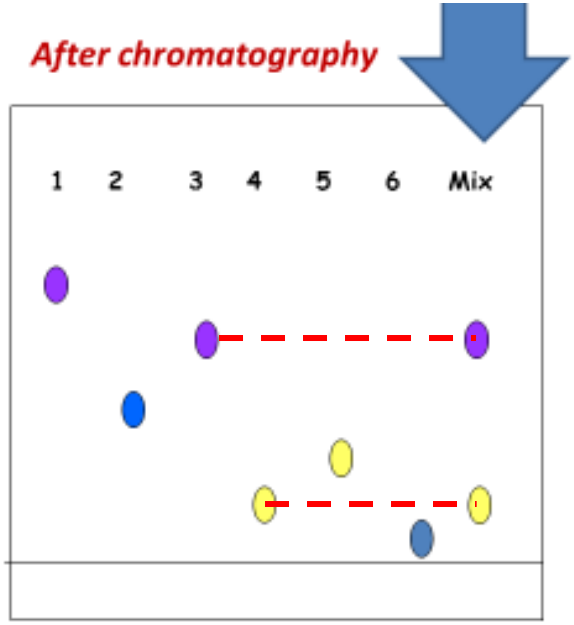
Think of your chromatograms as a dot to dot…

If there are dots of the same colour, which have travelled the **same distance**, they will be the **same substance:**

Spots of ink before chromatography



After chromatography

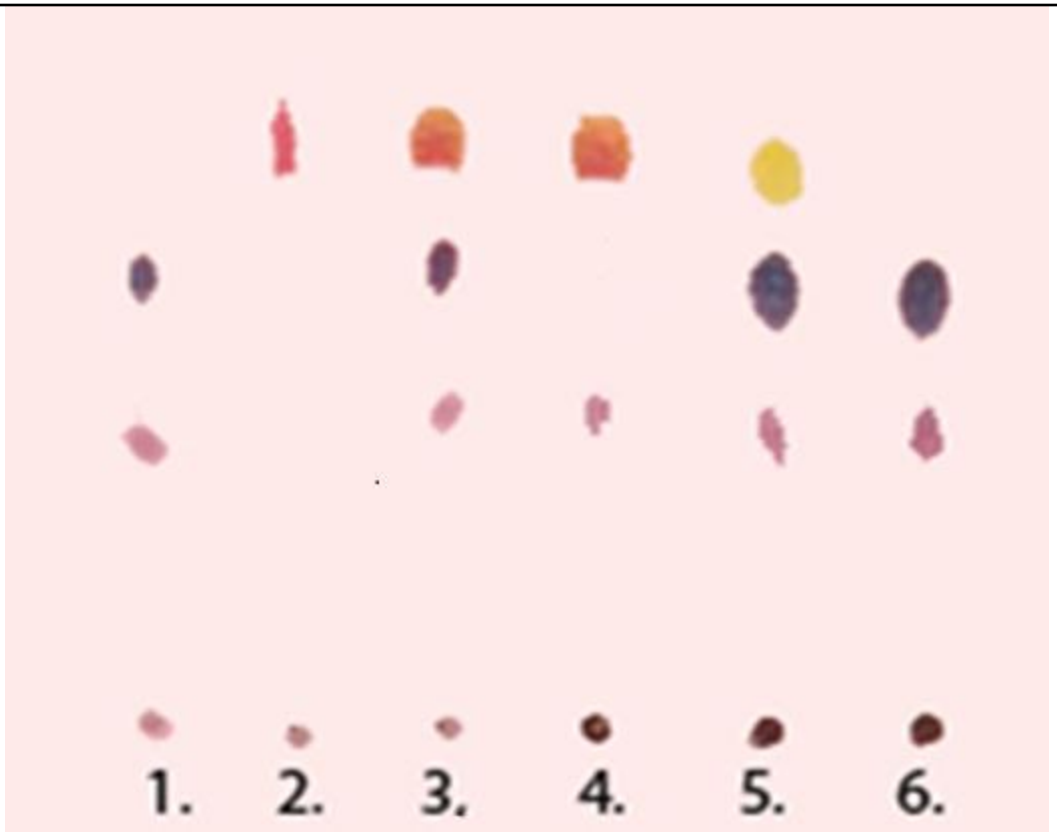


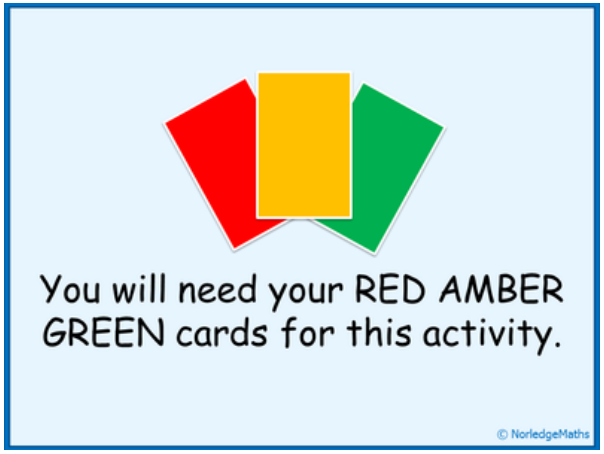
Which dyes does the 'mix' contain?

The mix contains ink 3 and ink 4.

Challenge: *Ink 1, 2, 3, 4, 5, 6 are all pure substances as they only contain one dot (showing only one substance)*

Which of the two inks contain exactly the same chemicals?



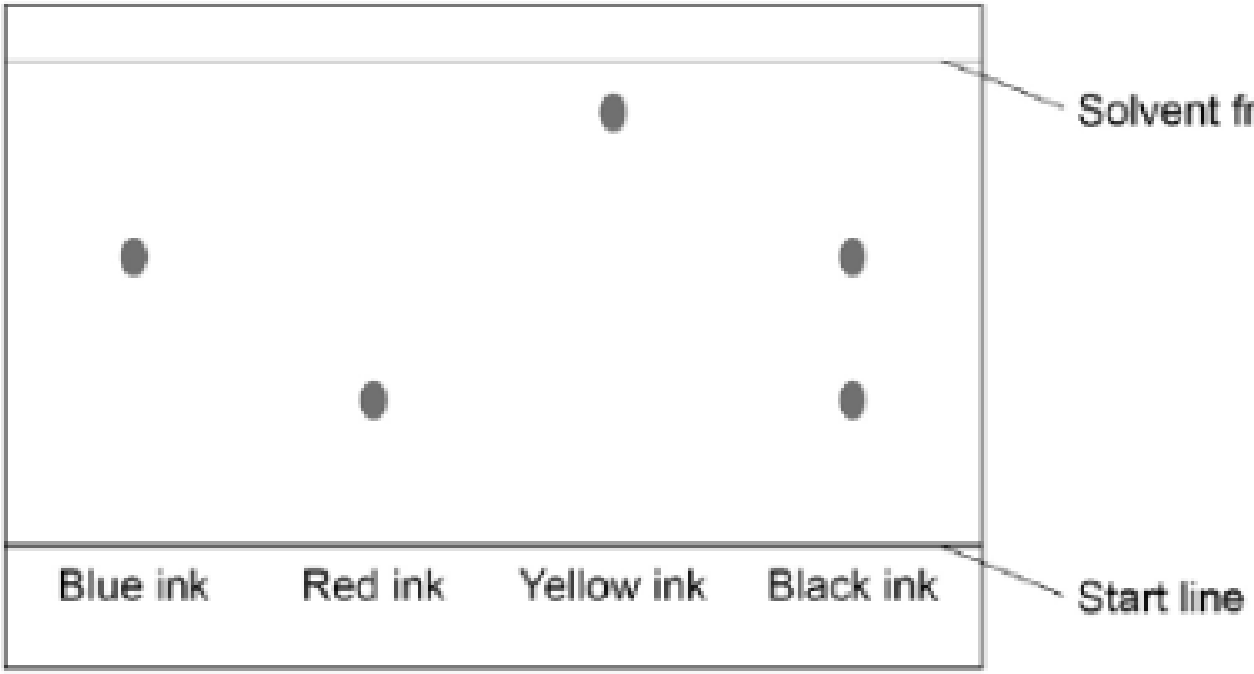


a) 1 and 6

b) 3 and 4

c) 5 and 6

Analyse chromatograms to identify unknown substances



What colours are in the black ink?

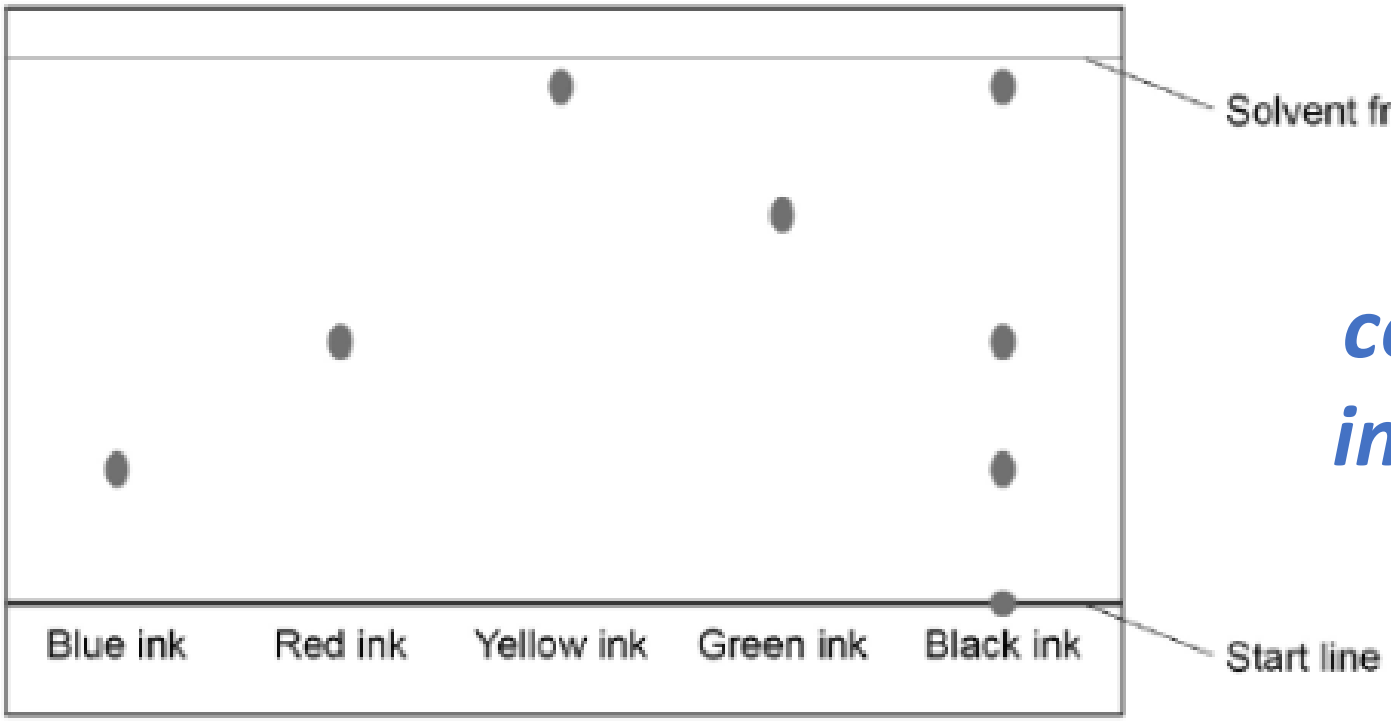
You will need your RED AMBER GREEN cards for this activity.

a) Red

b) Blue and yellow

c) Red and blue

Analyse chromatograms to identify unknown substances



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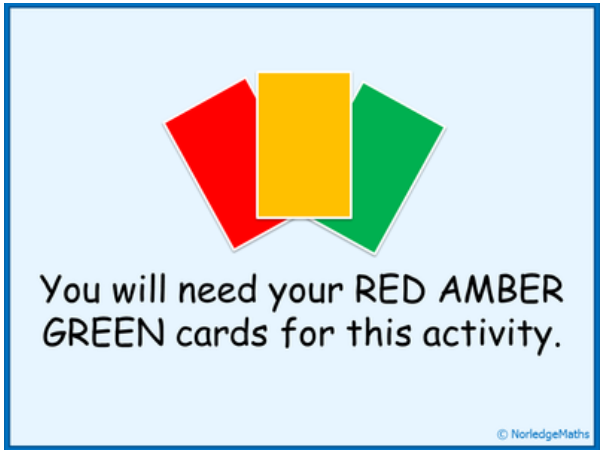
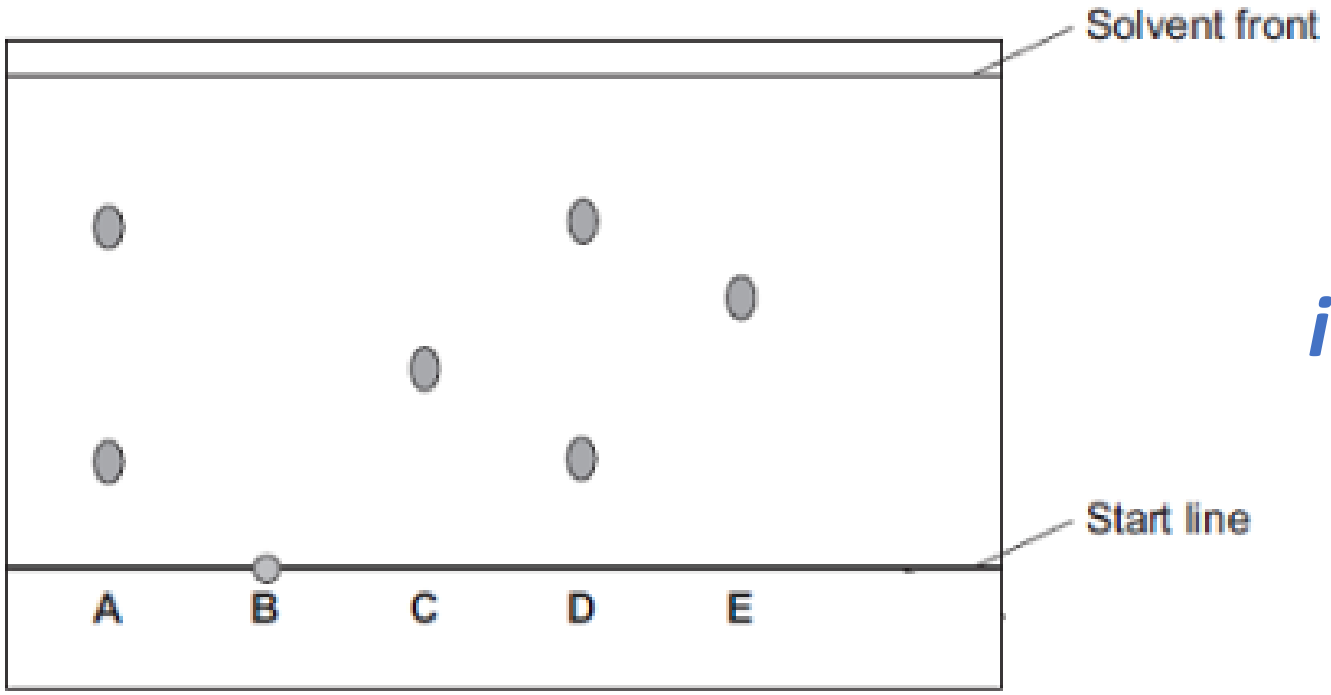


a) Red and blue

b) Blue and yellow

c) Blue, red and yellow

Analyse chromatograms to identify unknown substances



Which two inks are the same?

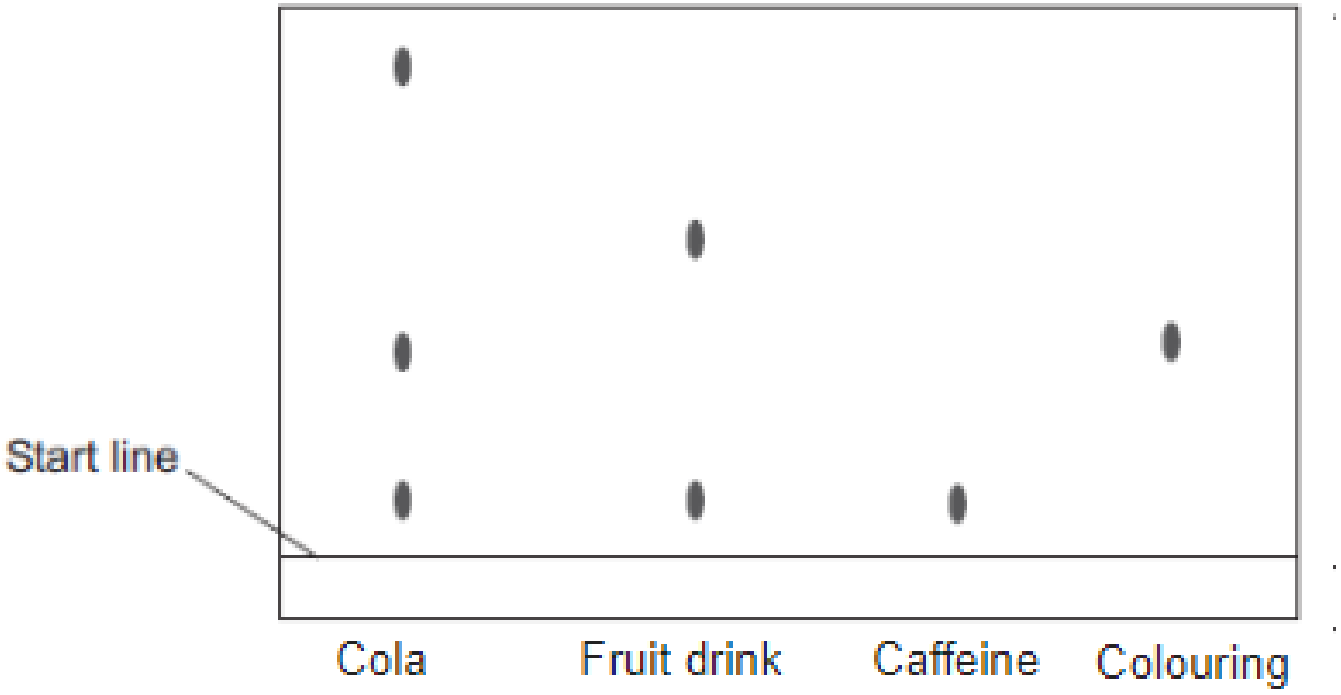
You will need your RED AMBER GREEN cards for this activity.

a) C and E

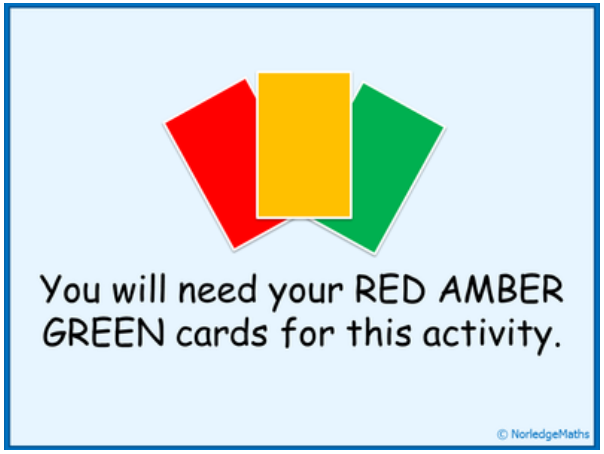
b) A and D

c) A, D and E

Analyse chromatograms to identify unknown substances



What substances are present in cola?

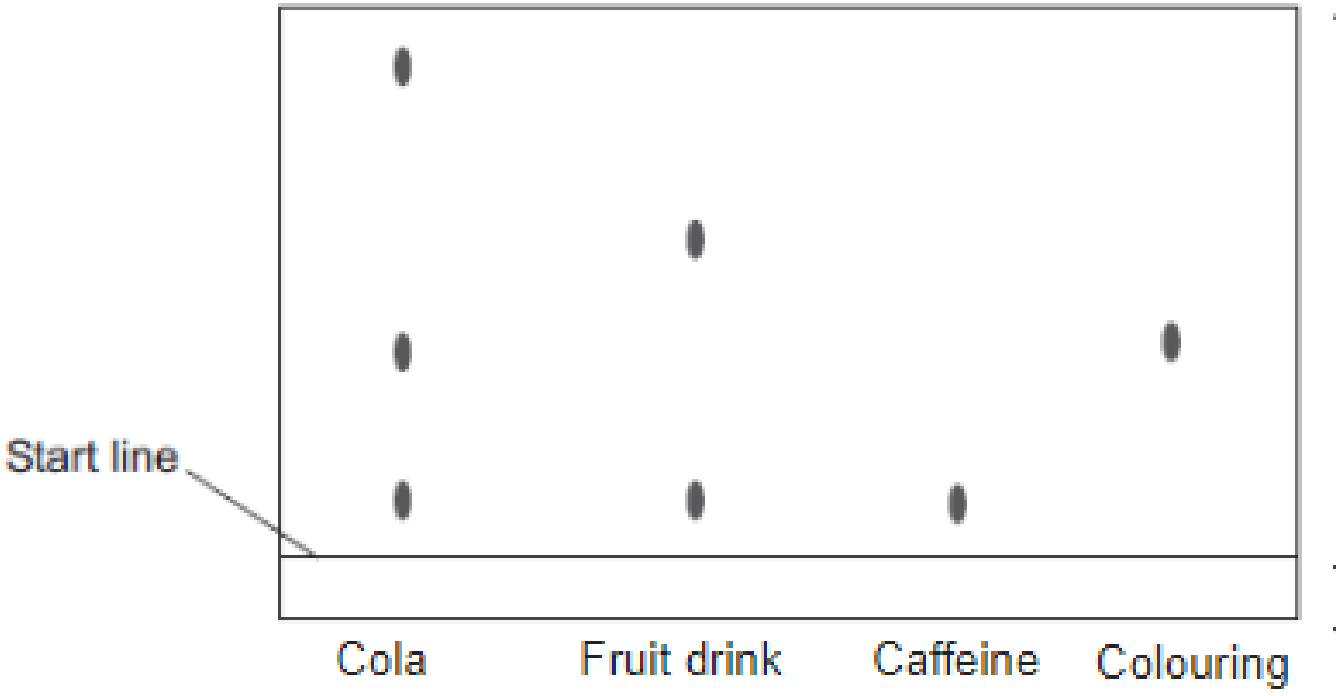


a) Caffeine

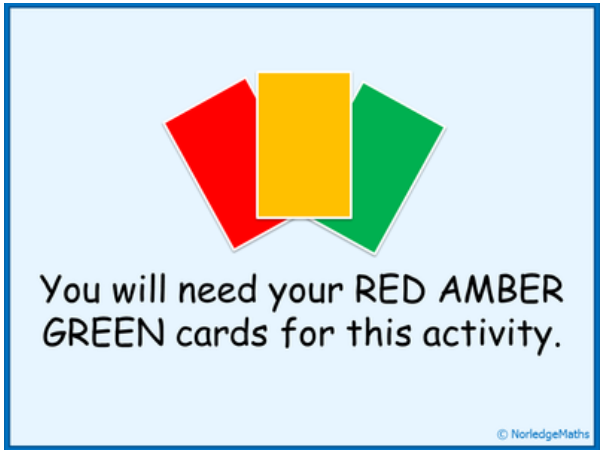
b) Colouring

c) Both

Analyse chromatograms to identify unknown substances



What substances are present in fruit drink?

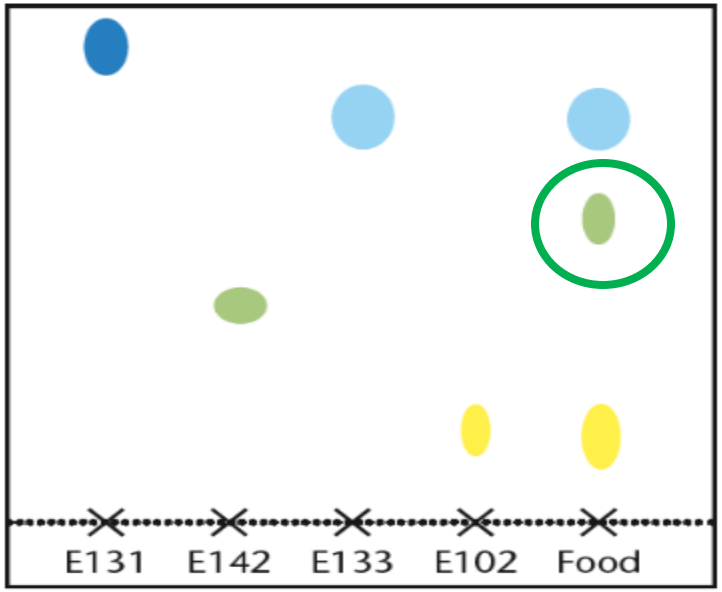


a) Caffeine

b) Colouring

c) Both

Analyse chromatograms to identify unknown substances



The sample of food contains E102, E133 and one unknown substance.

E131, E142, E133 and E102 are pure substances. The food sample is a mixture.

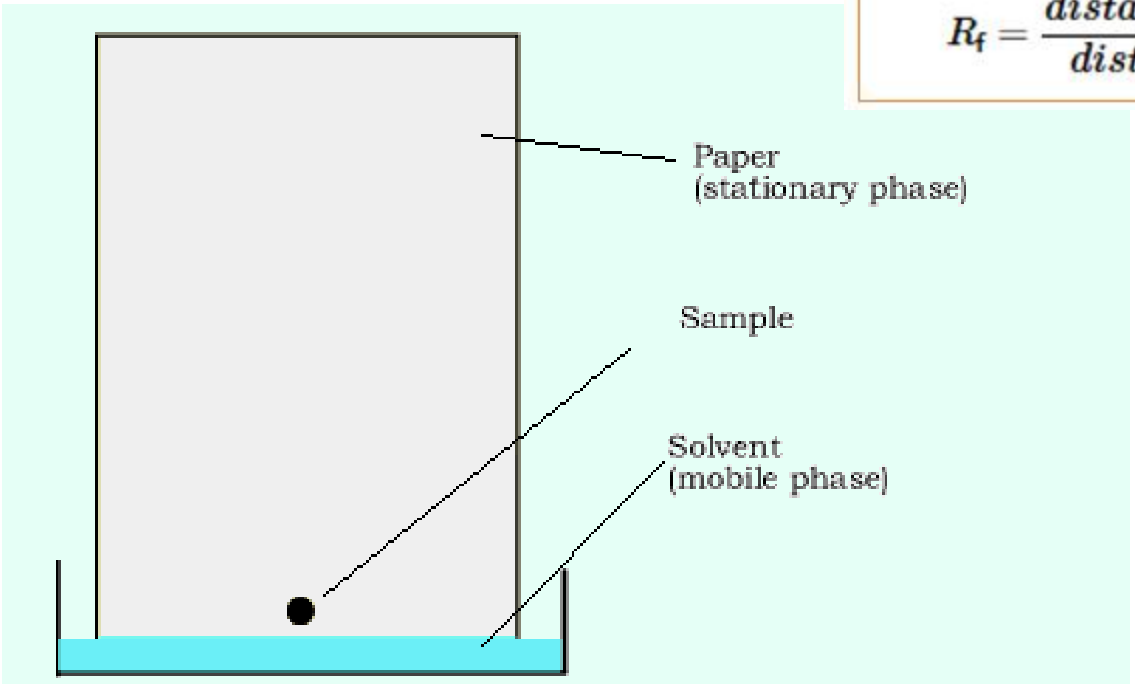
We cannot say for sure that the food sample is safe because it contains an unknown substance (shown by the green dot). This unknown substance may not be suitable for human consumption.

Measuring R_f values

You can use your chromatogram to calculate Rf values for each substance (or 'dot') in a sample.

If two substances (or 'dots') have the same Rf values, they must be the same substance!

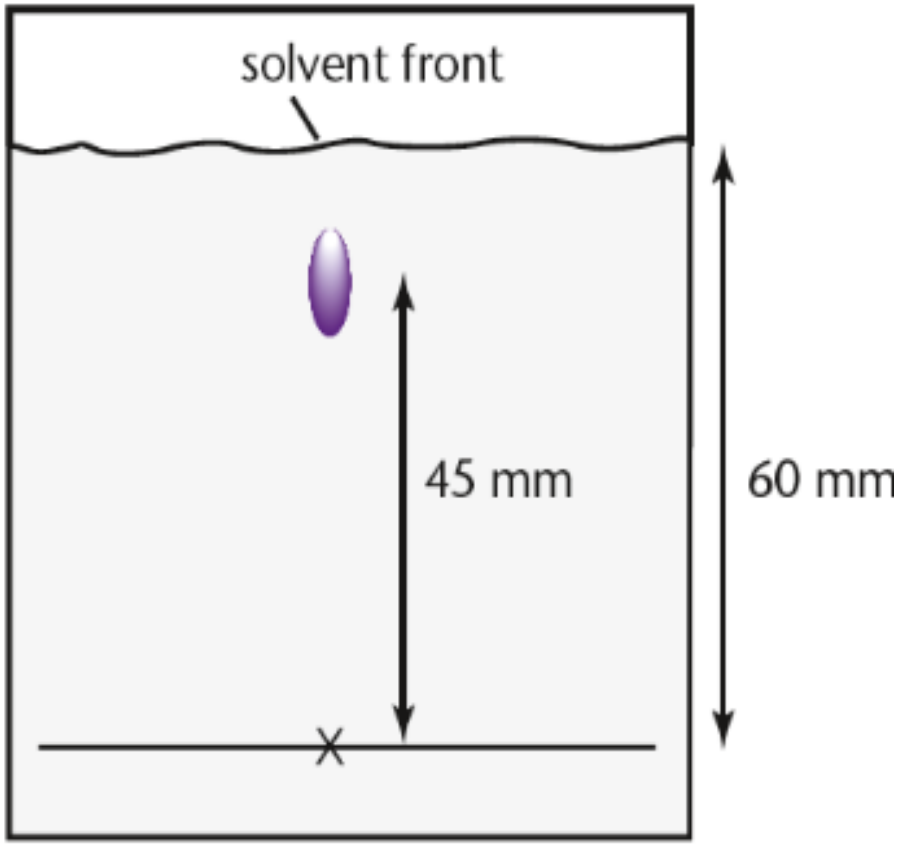
$$R_f = \frac{distance\ moved\ by\ substance}{distance\ moved\ by\ solvent}$$



Challenge: *Why are Rf values* ***always*** *lower than 1?*

Measuring R_f values:

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



Exam practice:

Calculate the Rf value of the sample shown in the chromatogram.

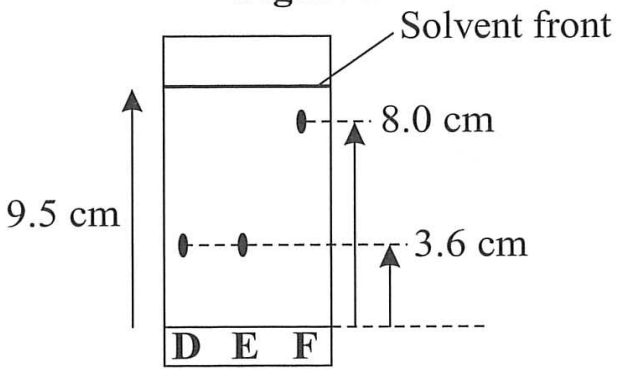
Rf value = 45 ÷ 60

= ***0.75***

1 Paper chromatograms were produced for three dyes, **D**, **E** and **F**, using a variety of solvents. The chromatogram produced using ethanol as a solvent is shown in **Figure 1**.

Grade 6-7

Figure 1



1.1 Calculate the R_f values for **E** and **F** in ethanol, using the chromatogram shown in **Figure 1**.

[4]

1.2 Why do the substances travel different distances?

.....

.....

[1]

1.3 In all solvents, each dye only has one spot.
What does this imply about the composition of the dyes?

.....

[1]

1.4 State which of the dyes could be the same.

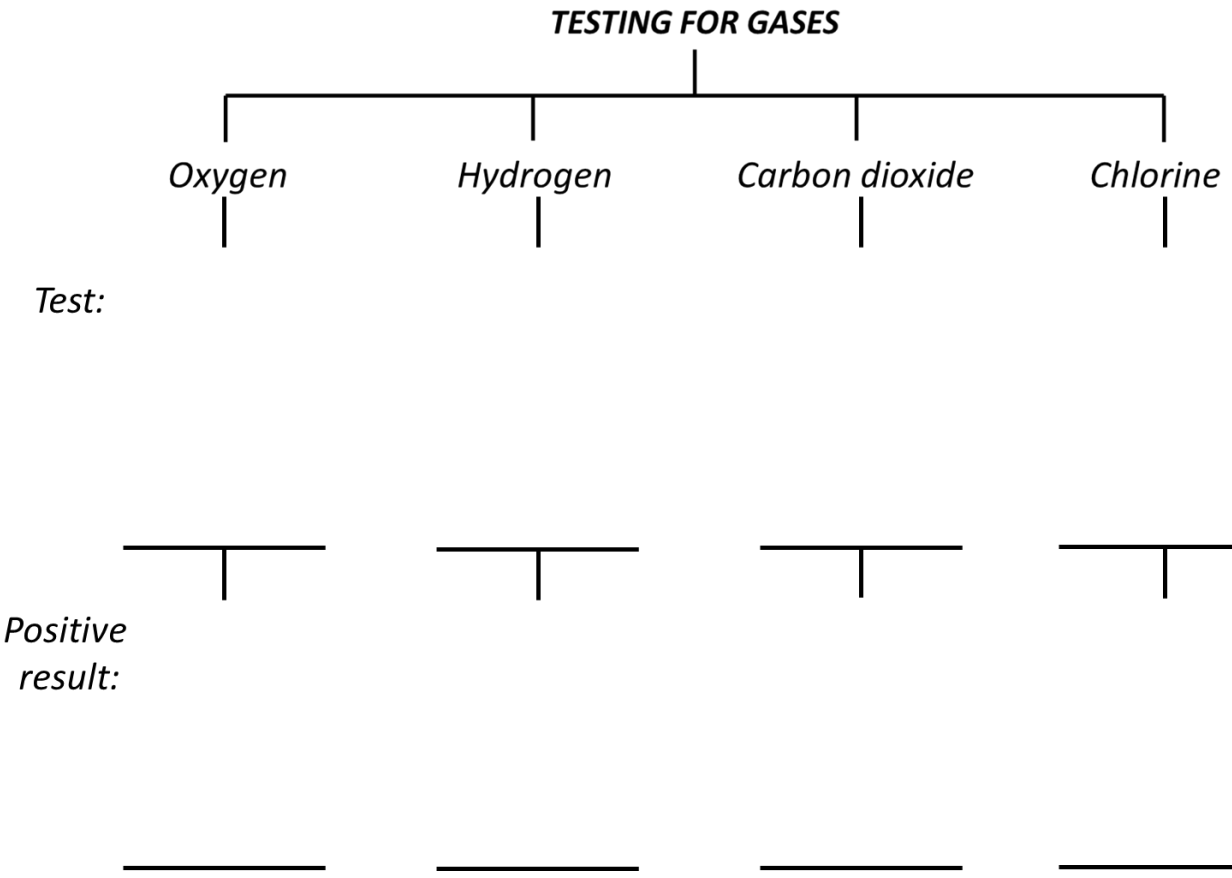
.....

[1]

LO: Describe the tests for four common gases

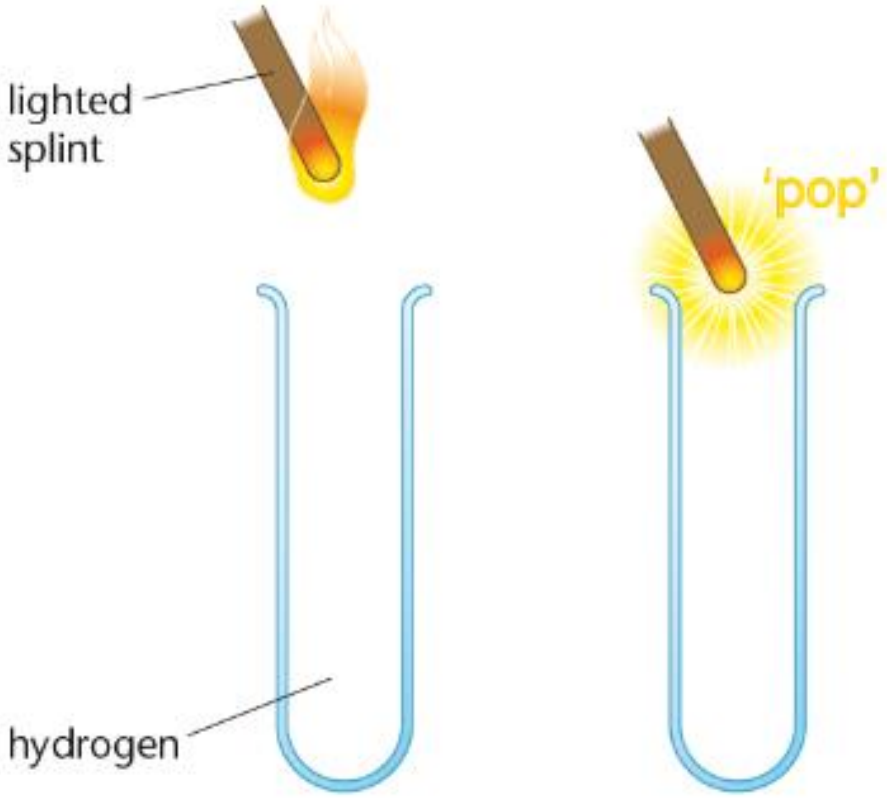
Task: Complete the mind map to show the tests for each of the gases.

https://www.youtube.com/watch?v=P_gPlbExHv0



Challenge:
Write word equations for each of the reactions in the gas tests.

Testing for hydrogen



Squeaky pop test

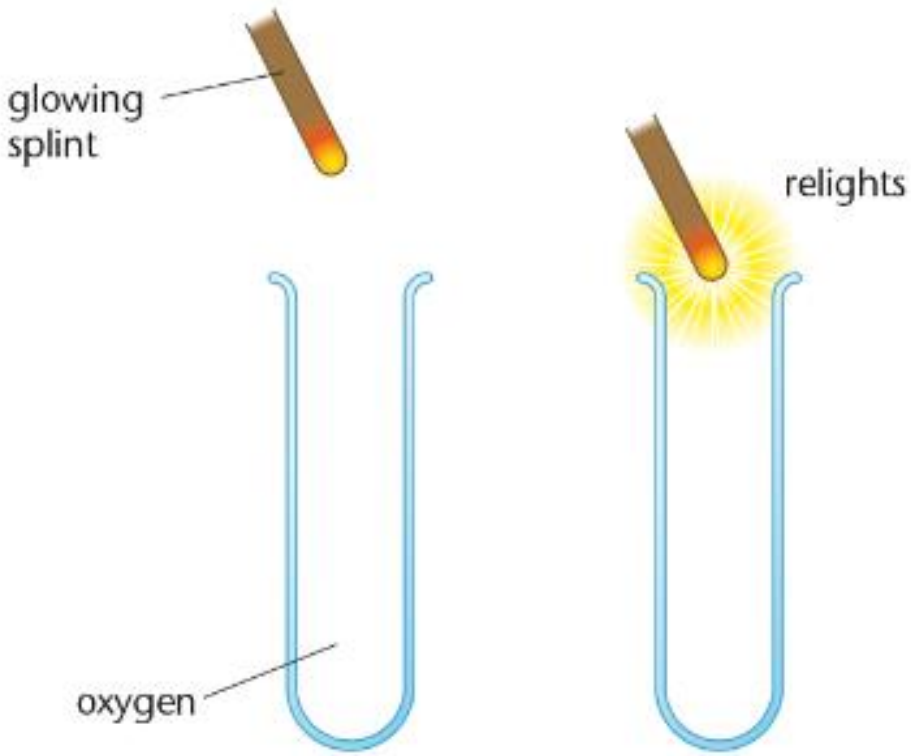
A lighted splint is placed into a boiling tube full of gas.

If hydrogen is present, the hydrogen will make a squeaky pop sound.

Testing for oxygen

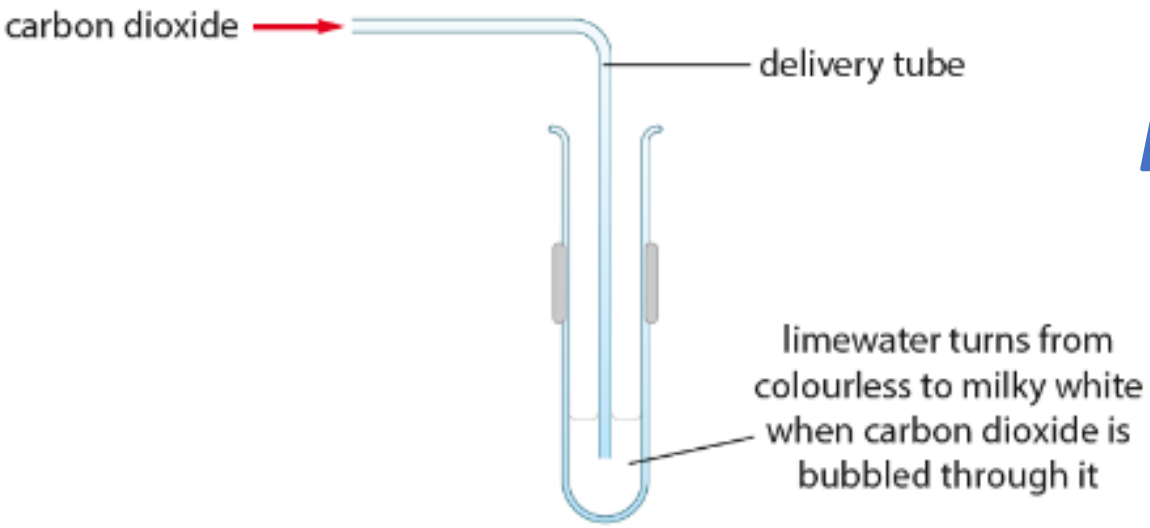
A glowing splint (a splint that has recently been blown out) is placed into a boiling tube full of gas.

If oxygen is present, the splint will relight.



Glowing splint test

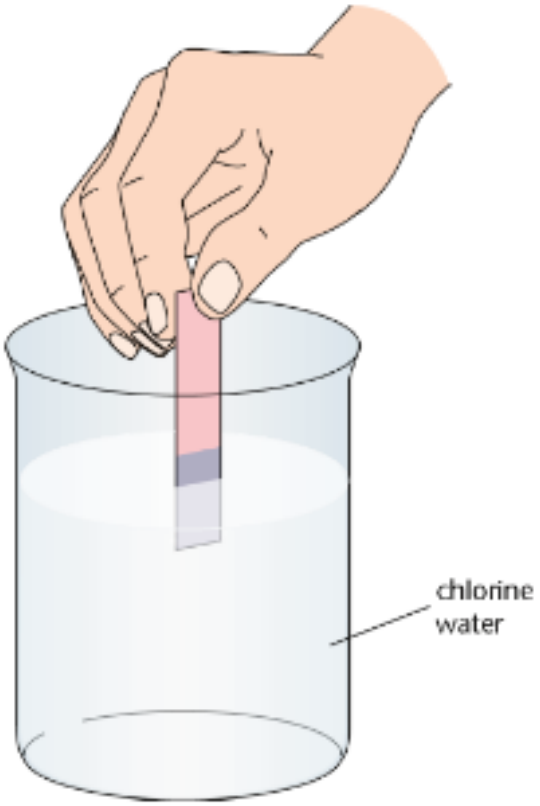
Testing for carbon dioxide



Limewater test

A gas is bubbled through limewater (calcium hydroxide solution). If carbon dioxide is present, the limewater will turn from colourless to milky white.

Testing for chlorine



Litmus paper test

Damp litmus paper is placed into a liquid.

If chlorine is present in the liquid, the litmus paper will be bleached a white colour.

LO: Describe the tests for four common gases

Self assessment:

TESTING FOR GASES

	Oxygen	Hydrogen	Carbon dioxide	Chlorine
Test:	Place a ***glowing splint*** in the tube of gas.	Place a ***lit splint*** in the tube of gas.	Bubble the gas through ***limewater***.	Hold a sample of ***damp litmus paper*** in the gas.
Positive result:	The glowing splint will ***relight***.	There will be a ***'squeaky pop'***.	The limewater will go ***cloudy/milky.***	The damp litmus paper will be ***bleached***.

Exam practice

Complete your exam style questions!

Challenge: *Explain why using a glowing splint to test for oxygen gas works. Use scientific concepts to help you with your answer.*

Maths challenge!

(i) Which result is anomalous?
Give a reason for your choice.

(ii) Calculate the mean volume of hydrogen collected in one minute.

(iii) Give a reason why the experiment should be repeated several times.

Experiment	Volume of hydrogen collected in one minute in cm^3
1	49
2	50
3	35
4	48

5.8.1 Purity, formulations and chromatography

5.8.1.1 Pure substances

Content
In chemistry, a pure substance is a single element or compound, not mixed with any other substance. Pure elements and compounds melt and boil at specific temperatures. Melting point and boiling point data can be used to distinguish pure substances from mixtures. In everyday language, a pure substance can mean a substance that has had nothing added to it, so it is unadulterated and in its natural state, eg pure milk. Students should be able to use melting point and boiling point data to distinguish pure from impure substances.

Red	Amber	Green

5.8.1.2 Formulations

Content
A formulation is a mixture that has been designed as a useful product. Many products are complex mixtures in which each chemical has a particular purpose. Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties. Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods. Students should be able to identify formulations given appropriate information. Students do not need to know the names of components in proprietary products.

Red	Amber	Green

5.8.1.3 Chromatography

Content	Key opportunities for skills development
Chromatography can be used to separate mixtures and can give information to help identify substances. Chromatography involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases. The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent can be expressed as its R_f value: $R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$ Different compounds have different R_f values in different solvents, which can be used to help identify the compounds. The compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents. Students should be able to: • explain how paper chromatography separates mixtures • suggest how chromatographic methods can be used for distinguishing pure substances from impure substances • interpret chromatograms and determine R_f values from chromatograms	WS 2.2, 3.1, 2, 3 MS 1a Recognise and use expressions in decimal form. MS 1c Use ratios, fractions and percentages. MS 1d Make estimates of the results of simple calculations.
• provide answers to an appropriate number of significant figures.	MS 2a

Required practical activity 12: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate R_f values.

AT skills covered by this practical activity: chemistry AT 1 and 4

Red	Amber	Green

5.8.2 Identification of common gases

5.8.2.1 Test for hydrogen

Content
The test for hydrogen uses a burning splint held at the open end of a test tube of the gas. Hydrogen burns rapidly with a pop sound.

5.8.2.2 Test for oxygen

Content	K s
The test for oxygen uses a glowing splint inserted into a test tube of the gas. The splint relights in oxygen.	

5.8.2.3 Test for carbon dioxide

Content	K s
The test for carbon dioxide uses an aqueous solution of calcium hydroxide (lime water). When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).	

5.8.2.4 Test for chlorine

Content	K s
The test for chlorine uses litmus paper. When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white.	

Red	Amber	Green

Complete the practice paper questions!

Revision lesson link:

GCSE Science Revision Chemistry "Required Practical 6: Chromatography" – YouTube

GCSE Science Chemistry (9-1) - Tests for Gases – YouTube

Formulations - Chemical analysis - (CCEA) - GCSE Chemistry (Single Science) Revision - CCEA - BBC Bitesize

15 Minute ILT Task:

5.8.1.1 Pure substances	1. In chemistry, what is a pure substance? 2. How can you test the purity of a sample? 3. What effect would impurities have in a samples melting and boiling point?
5.8.1.2 Formulations	1. What are formulations? 2. List some examples of formulations. 3. What components make up the formulation, paint? 4. Describe the importance of formulations in the pharmaceutical industry.
5.8.1.3 Chromatography	1. What is chromatography? 2. Describe the two phases in chromatography? 3. What is the stationary phase and the mobile phase in paper chromatography? 4. In paper chromatography what does the amount of time the molecules spend in each phase depend on? 5. What is the result of a chromatography experiment called? 6. What is meant by the Rf value? 7. State the formula used to calculate Rf values. 8. Describe how chromatography can be carried out to see if a certain substance is present in a mixture?

Title – C8 Chemical Analysis Monday, 25 September 2023

Do it now:

Describe the relationship between boiling point and chain length.	State two equations for rate of reaction. Include units.	What apparatus can be used to measure rate of reaction?
How can pure substances be distinguished from impure ones?	Why are large hydrocarbons cracked?	What would happen to the yield of ammonia in the reaction below, if temperature was increased. NITROGEN + HYDROGEN $\overset{exo}{\rightleftharpoons}$ AMMONIA N_2 $3H_2$ $2NH_3$

LO: Define pure substances

Key definition:

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

Gold is an element and can be pure, however gold jewellery usually contains a mixture of elements.

Pure gold is too soft!

Did you know?

The purest gold ever was produced in 1957 and was 999.999 on the fineness scale.

Gold purity is still often measured on the older carat scale, where 24 carat gold is pure gold.

LO: Distinguish pure and impure substances using MP and BO data

Pure and impure substances

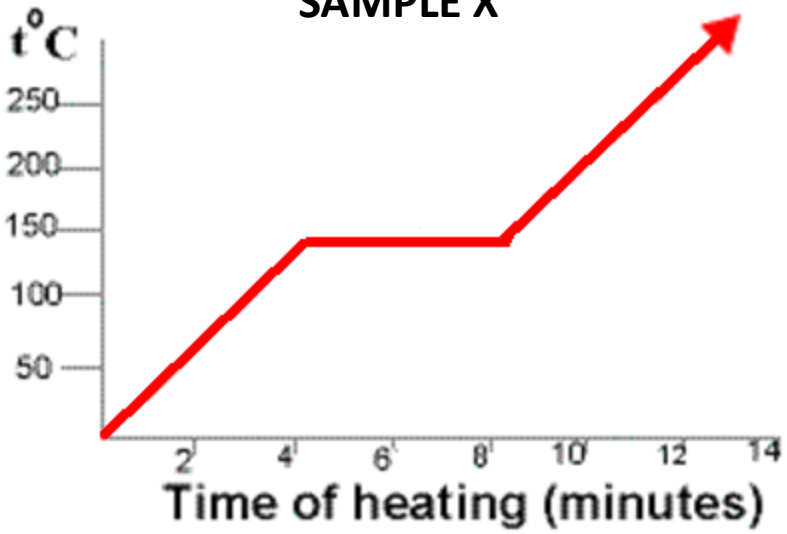
Pure substances melt and boil at specific temperatures.

If the substance is **pure**, the melting point will be specific temperature.

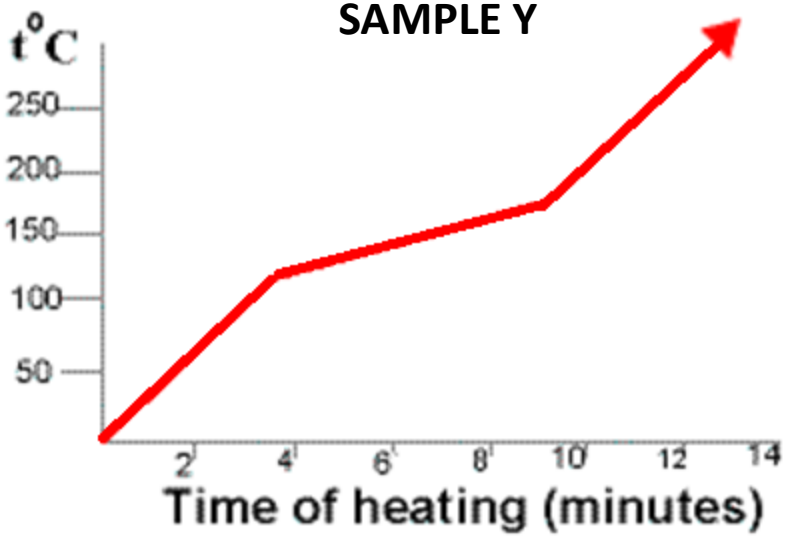
If the substance is **impure**, the melting point will be a **broad range** of temperatures.

LO: **Distinguish** pure and impure substances using MP and BP data

SAMPLE X



SAMPLE Y



What is the difference between these two graphs?

Which graph shows a pure sample?

Which graph shows an impure sample?

Identify formulations given appropriate information.

Key definition:

A formulation is a **mixture** of components which has been designed as a **useful** product.

Formulations are complex mixtures in which each chemical has a particular purpose, giving a product with the desired properties.

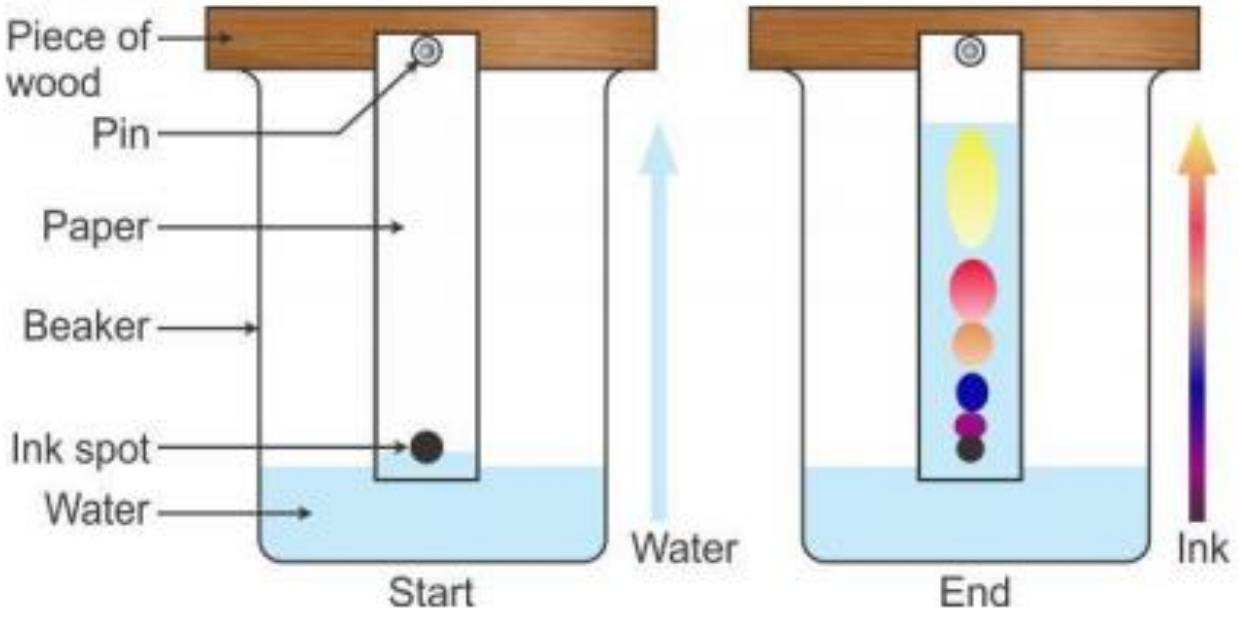
e.g. medicines, paints, cleaning agents, fertilisers, cosmetics

Describe what substances chromatography can separate

Key definition:

Chromatography is a method used for separating and identifying small quantities of chemicals in a mixture.

As the **solvent** rises up the paper it **dissolves** the sample mixture, which will then **travel** up the paper. **More soluble** compounds will travel **further up** the filter paper than less soluble compounds.



Describe what substances chromatography can separate

Identifying additives in food

Forensic science

Detecting explosives in airports

Uses of chromatography

Test water samples for pollution

Detecting pesticides / insecticides

Identifying drugs and alcohol

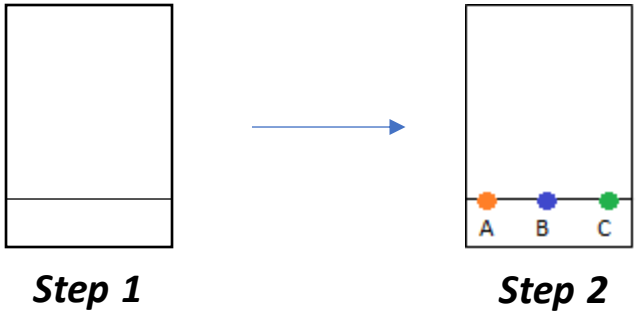
Step 1: Draw a pencil line 2cm from the bottom of a piece of chromatography paper.

Step 2: Place a dot of each ink sample on the pencil line and label the samples in pencil.

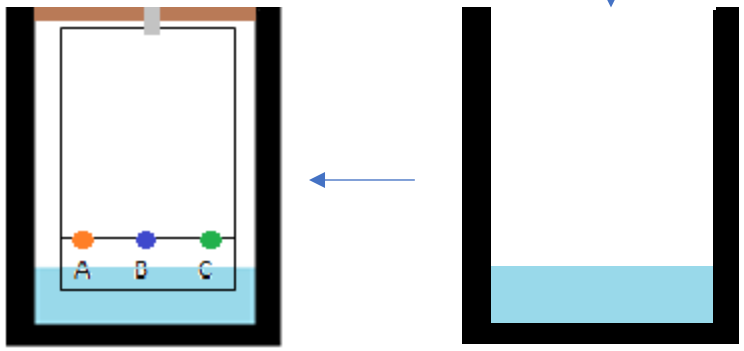
Step 3: Place 1cm of solvent into a beaker.

Step 4: Secure the chromatography paper to a rod and place the end of the paper into the solvent. Make sure the solvent level is **below** the pencil line.

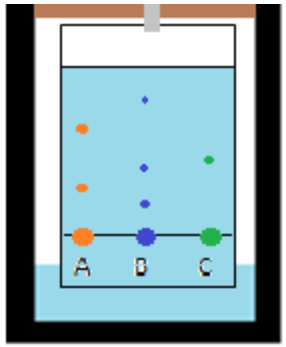
Step 5: Wait until the solvent has risen to about 1cm from the top of the paper. Draw a pencil line to show the solvent front and leave to dry.



Step 1 ***Step 2***



Step 4 ***Step 3***



Step 5

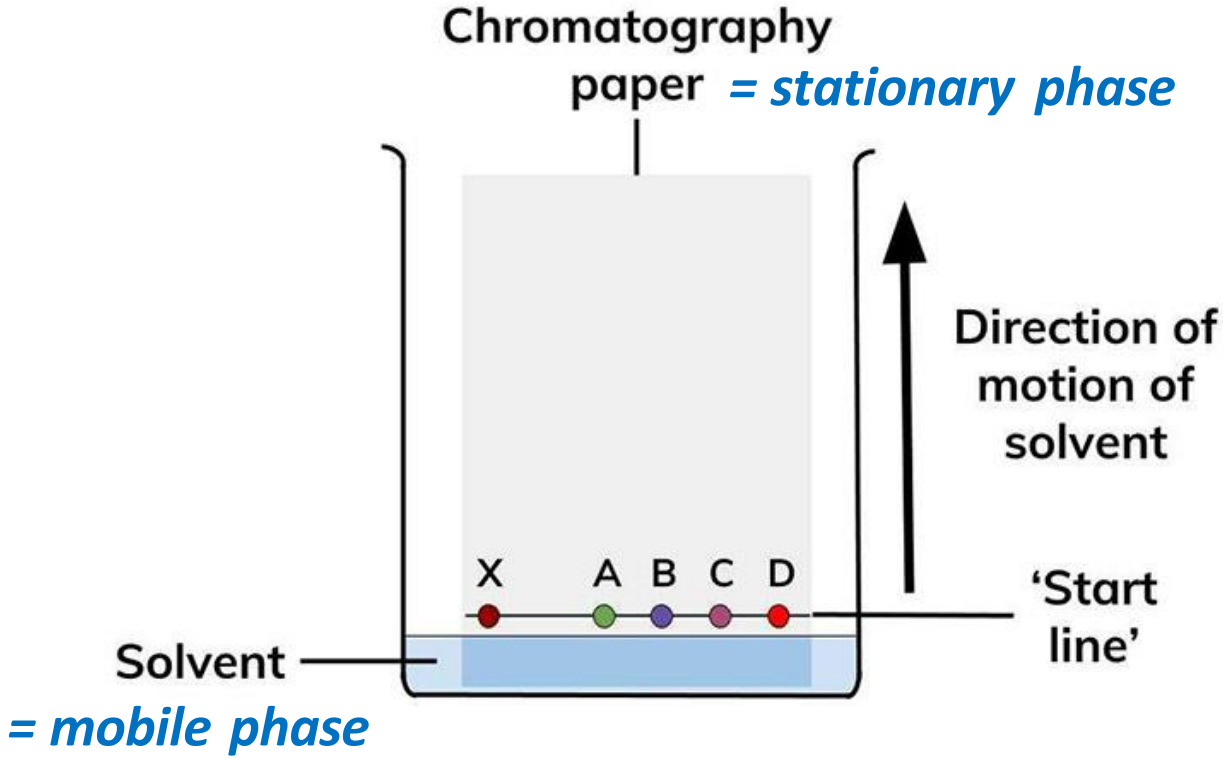
Remember!

1. Line must be drawn in pencil.
2. Solvent must be below pencil line.
3. A lid may be used to stop the solvent evaporating.

Describe the stationary and mobile phases in chromatography

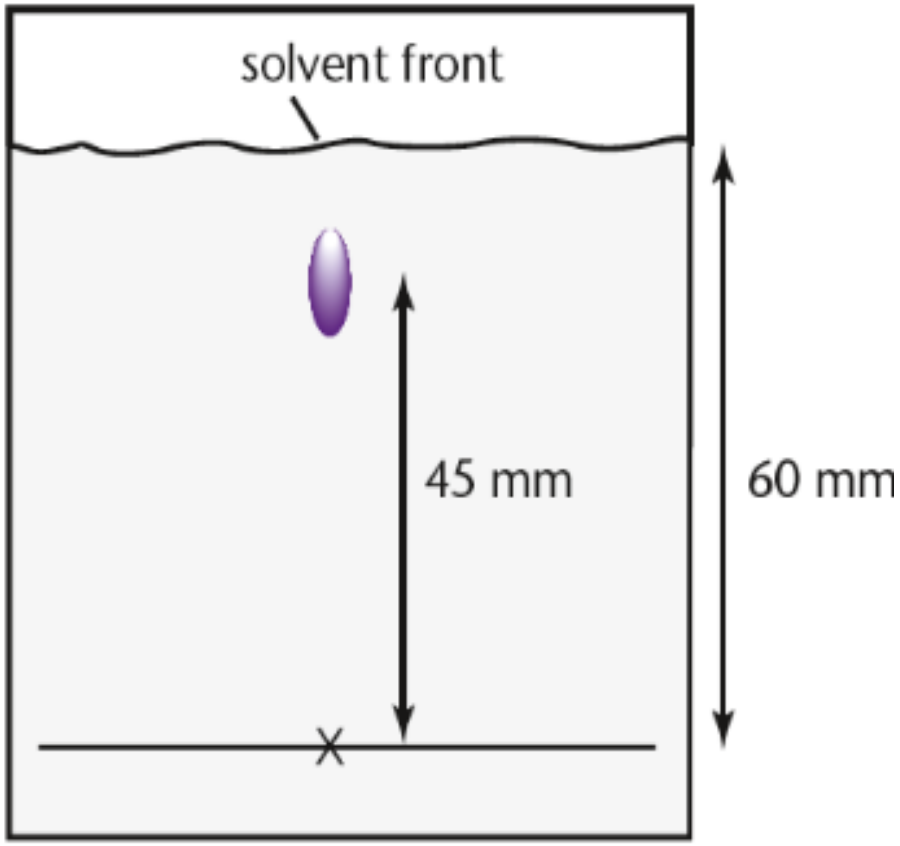
Key definition:

In chromatography, the **mobile** phase (the moving phase) is the ***solvent***. The **stationary** phase (the phase that does not move) is the ***chromatography paper***.



Measuring R_f values:

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



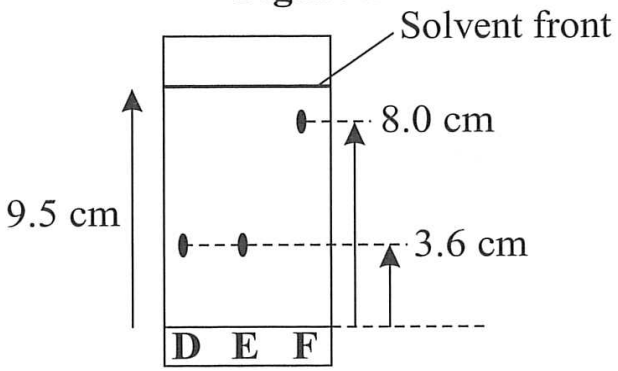
Exam practice:

Calculate the Rf value of the sample shown in the chromatogram.

1 Paper chromatograms were produced for three dyes, **D**, **E** and **F**, using a variety of solvents. The chromatogram produced using ethanol as a solvent is shown in **Figure 1**.

Grade 6-7

Figure 1



1.1 Calculate the R_f values for **E** and **F** in ethanol, using the chromatogram shown in **Figure 1**.

[4]

1.2 Why do the substances travel different distances?

.....

.....

[1]

1.3 In all solvents, each dye only has one spot.
What does this imply about the composition of the dyes?

.....

[1]

1.4 State which of the dyes could be the same.

.....

[1]

5.8.1 Purity, formulations and chromatography

5.8.1.1 Pure substances

Content
In chemistry, a pure substance is a single element or compound, not mixed with any other substance. Pure elements and compounds melt and boil at specific temperatures. Melting point and boiling point data can be used to distinguish pure substances from mixtures. In everyday language, a pure substance can mean a substance that has had nothing added to it, so it is unadulterated and in its natural state, eg pure milk. Students should be able to use melting point and boiling point data to distinguish pure from impure substances.

Red	Amber	Green

5.8.1.2 Formulations

Content
A formulation is a mixture that has been designed as a useful product. Many products are complex mixtures in which each chemical has a particular purpose. Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties. Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods. Students should be able to identify formulations given appropriate information. Students do not need to know the names of components in proprietary products.

Red	Amber	Green

5.8.1.3 Chromatography

Content	Key opportunities for skills development
Chromatography can be used to separate mixtures and can give information to help identify substances. Chromatography involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases. The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent can be expressed as its R_f value: $R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$ Different compounds have different R_f values in different solvents, which can be used to help identify the compounds. The compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents. Students should be able to: • explain how paper chromatography separates mixtures • suggest how chromatographic methods can be used for distinguishing pure substances from impure substances • interpret chromatograms and determine R_f values from chromatograms	WS 2.2, 3.1, 2, 3 MS 1a Recognise and use expressions in decimal form. MS 1c Use ratios, fractions and percentages. MS 1d Make estimates of the results of simple calculations.
• provide answers to an appropriate number of significant figures.	MS 2a

Required practical activity 12: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate R_f values.

AT skills covered by this practical activity: chemistry AT 1 and 4

Red	Amber	Green

5.8.2 Identification of common gases

5.8.2.1 Test for hydrogen

Content
The test for hydrogen uses a burning splint held at the open end of a test tube of the gas. Hydrogen burns rapidly with a pop sound.

5.8.2.2 Test for oxygen

Content	K s
The test for oxygen uses a glowing splint inserted into a test tube of the gas. The splint relights in oxygen.	

5.8.2.3 Test for carbon dioxide

Content	K s
The test for carbon dioxide uses an aqueous solution of calcium hydroxide (lime water). When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).	

5.8.2.4 Test for chlorine

Content	K s
The test for chlorine uses litmus paper. When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white.	

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15 Minute ILT Task:

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