IGCSE CHEMISTRY STUDY NOTES
UNIT 2 EXPERIMENTAL TECHNIQUES

UNIT 2

EXPERIMENTAL TECHNIQUES

2.2 PURITY

2.2.1 CRITERIA OF PURITY

• Demonstrate knowledge and understanding of paper chromatography • Interpret simple chromatograms	CORE	C
• Interpret simple chromatograms, including the use of R_f values • Outline how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents. (Knowledge of *specific* locating agents is not required.)	SUPPLEMENT	S
• Identify substances and assess their purity from melting point and boiling point information • Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs	CORE	C

ASSESSMENT 2.2.1

- **Paper Chromatography:**
  Chroma: Colour
  Graph: Picture
  an experimental technique used for separation and identification of components of a mixture
  for example: *mixture of dyes or inks*
- was earlier used for coloured mixtures only
- is now applied to colourless mixtures too
  for example: *mixture of amino acids or simple sugars*

PROCEDURE FOR CHROMATOGRAPHIC SEPARATION

Step 1:
Setting up the chromatographic chamber:
A beaker or gas jar is filled with a suitable solvent as shown in **diagram 1**.
The mouth of the chamber is covered (with a petri-dish) to prevent the solvent vapours from escaping. (This allows the chamber to get saturated with the solvent vapours.)

Step 2:
Preparing the Chromatography paper:
A horizontal line is drawn in pencil about 2–3 cm from the bottom of the chromatography paper strip.
It is called the start line or baseline or line of origin.

Step 3:
Spotting the sample
The mixture to be separated is spotted on the baseline using a capillary tube or a dropper with a fine bore.
The spotting is done 2–3 times on the same spot with drying in between.

DROPPER

Step 4:

Running the chromatogram

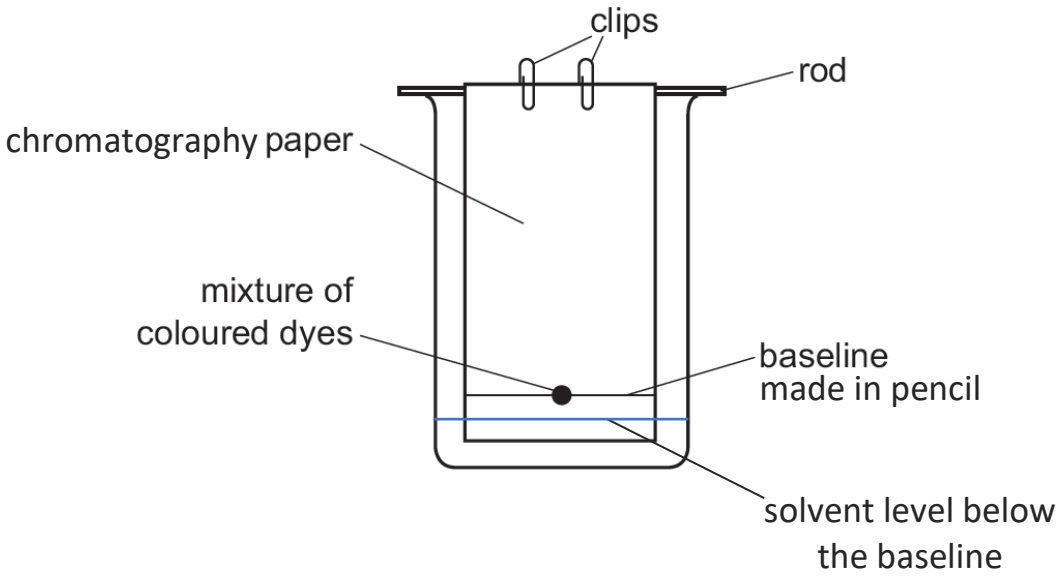
The chromatography paper is then suspended in the solvent from a rigid support such that the solvent level is below the baseline.

As the solvent moves up the paper, the sample is carried with it and begins to separate.

The separation is continued till the solvent reaches more than ¾ ths of the paper.

The chromatogram is removed from the chamber and air-dried.

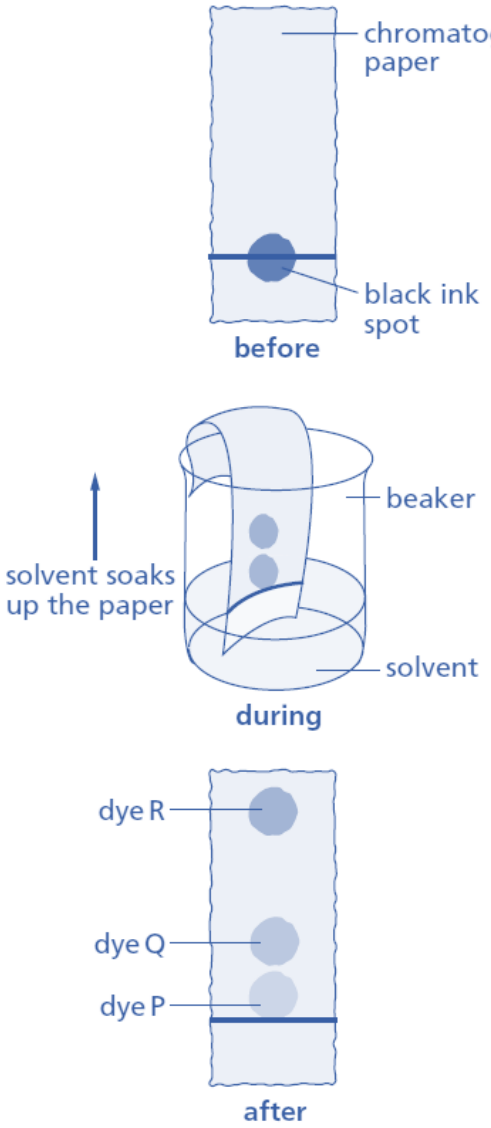
Diagram 1



Clips are used to hold the paper in position to maintain the solvent level below the baseline.

C

Chromatographic separation of black ink



3 spots → 3 dyes

The black ink separates into three dyes: P, Q and R.

WORKING PRINCIPLE (why does separation occur?)

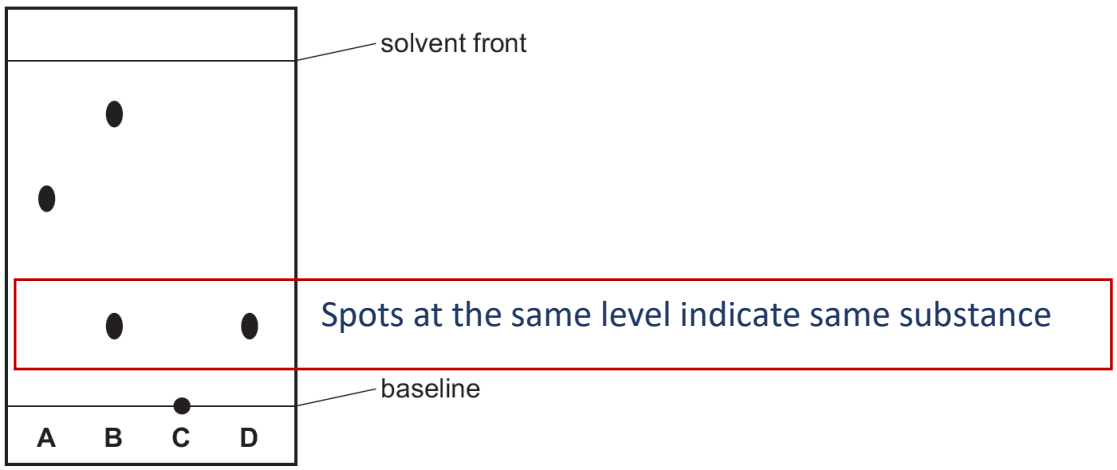
Separation occurs because the substances have **different solubilities** in the solvent and are **adsorbed*** to different degrees by the chromatography paper. As a result, they are separated gradually as the solvent moves up the paper.

***ADSORB**

C

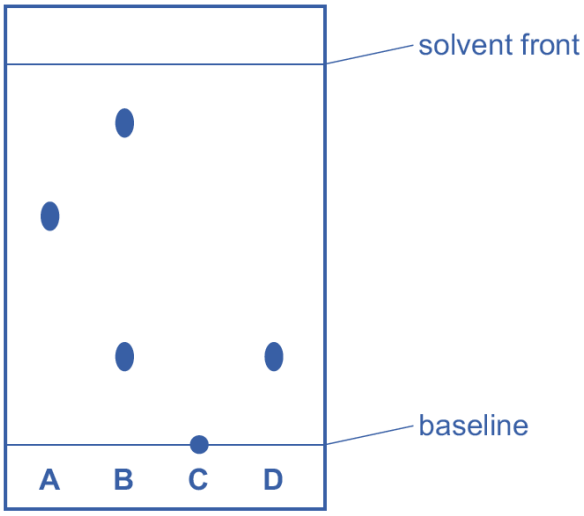
INTERPRETING SIMPLE CHROMATOGRAMS

- 1 spot after separation → the substance spotted is a single substance (pure), not a mixture
- More than 1 spot after separation → the substance spotted is a mixture (impure)
- Number of spots → number of components in the mixture
- Spot doesn't move from baseline → sample insoluble in the chosen solvent, no separation occurs



QUESTION

The diagram shows the chromatogram obtained from four dyes, **A**, **B**, **C,** and **D**.



(a) Give **one** conclusion that can be drawn about dye **B**.

Solution:

Dye B is a mixture of two dyes. One of the two is dye D.

(b) Suggest why dye **C** remained on the baseline.

Solution:

Dye C is insoluble in the solvent used.

R_f VALUES

(R_f: Retardation factor)

Solute front

- distance travelled by solute (spot) on the chromatogram
- measured from baseline to centre of spot (using a ruler)

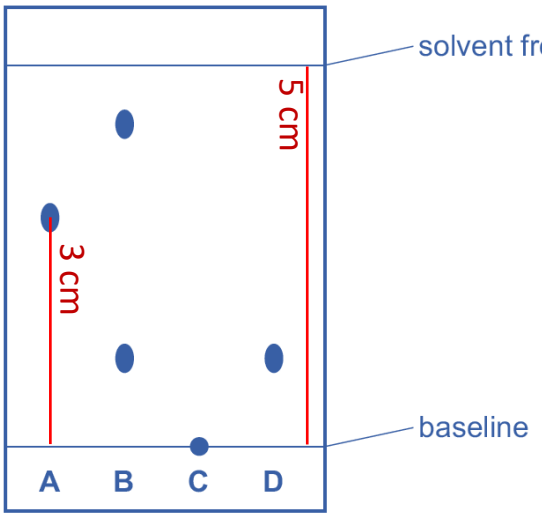
Solvent front

- distance travelled by solvent on the chromatogram
- measured from baseline

$$R_f = \frac{\text{solute front}}{\text{solvent front}}$$

R_f values are used for identification of solutes by comparison with R_f values of known solutes obtained under **identical experimental conditions**.

QUESTION



R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by the compound}}{\text{distance travelled by the solvent}}$$

Calculate the R_f value of dye A.

Solution:

Solute front = 3 cm

Solvent front = 5 cm

R_f value of dye A = $\frac{3}{5}$ = 0.6

S

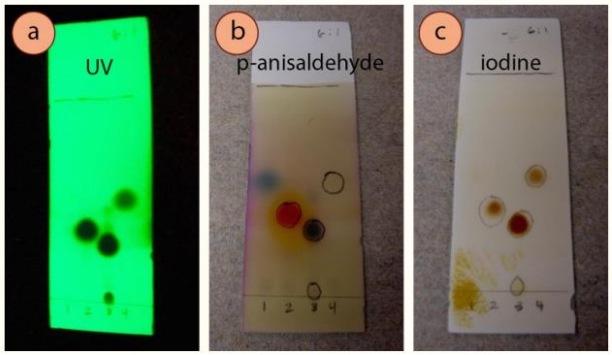
LOCATING AGENTS

Chromatography techniques can be applied to **colourless substances** by exposing chromatograms to substances called locating agents.

Locating agents are chemical reagents that react with the separated (colourless) spots to form a coloured product.
The spots become visible upon exposure to the locating agent.
Their R_f values can then be calculated.

In some cases, the position of the substances on the chromatogram may be located using ultraviolet light.

Spots made visible using UV light (a) and locating agents (b and c)



Note:
Knowledge of *specific* locating agents is not required.

QUESTION

A student carried out paper chromatography on a mixture of amino acids.
The student sprayed the dried chromatogram with a locating agent.
What is the function of the locating agent?

Solution:

Amino acids are colourless.
The locating agent formed coloured spots with the amino acids making them visible.

A pure substance has a unique melting point / boiling point.

For example, the melting point of pure water (ice) is 0°C and the boiling point is 100°C.

The presence of impurities –

- lowers the melting point
- increases the boiling point

The melting point of impure water (ice) < 0°C and the boiling point > 100°C.

The purity of a substance can therefore be assessed by determination of its melting point / boiling point.

For example, to test is a water sample is pure, determine its boiling point.
If impure, it will boil over a range of temperatures higher than 100°C.
If pure, it will boil at a fixed temperature, that is, 100°C.

Purity of substances is of utmost importance in everyday life, particularly when it is to do with **foodstuffs** and **medicines**.
Presence of impurities in food and medicines may adversely affect the normal functioning of body and result in undesirable side-effects.

ASSESSMENT 2.2.1