# Leaf chromatography

This investigation is part of the **Nuffield practical collection**, developed by the Nuffield Foundation and the Royal Society of Chemistry. Delve into a wide range of chemical concepts and processes with this collection of over 200 step-by-step practicals: rsc.li/43bjGql

## Learning objectives

1. Carry out paper chromatography to find the pigments present in leaves and calculate their $R_f$ values.
2. Identify stationary and mobile phases in paper chromatography.
3. Describe what the chromatogram can tell us about substances.
4. Explain why water is not always used as the solvent in chromatography.

During the practical activity, learners will build understanding of how paper chromatography experiments are carried out. Use questioning while setting up the practical and analysing the results to develop your learners' understanding of stationary and mobile phases, as well as what chromatograms can tell us about relative solubilities of pigments and relative attractions towards the chromatography paper.

You may wish to set up an example chromatogram where water is used to clearly illustrate learning objective 4.

## Scaffolding

Integrated practical instructions are included in the PowerPoint for the practical activity and are available to download from rsc.li/49nMlMP

Two versions of the worksheet are included: a scaffolded (✪✪) and an unscaffolded (✪) version. Questions in the scaffolded worksheet provide more prompts about correct use of keywords and structuring answers, whereas the unscaffolded worksheet provides less guidance.

Teachers may decide to remove the results table and guidance for how to calculate $R_f$ values to provide further challenge for learners.

## Technician notes

Read our standard health and safety guidance and carry out a risk assessment before running any live practical (rsc.li/3zyJLkx).

You can make the capillary tubing from lengths of ordinary glass tubing (diameter: 3–4 mm) using a Bunsen burner fitted with a flame-spreading ('fish-tail') jet.

A variety of leaves can be used. The best results are obtained from trees or bushes with dark green leaves, e.g. holly.

Use teat pipettes that do not allow squirting, e.g. those fitted to dropper bottles of universal indicator.

The spot on the chromatography paper should be as small and as concentrated as possible. Encourage learners to be patient and to wait until each application is dry before adding the next.

At least three spots should be obtained and one of these should be yellow due to carotenes.

The extent to which any particular component moves up the paper is dependent not only on its solubility in propanone but also on its attraction for the cellulose in the chromatography paper. The yellow carotene spot (with a higher $R_f$ value) tends to move up the paper the furthest.

## Equipment

*Apparatus (per group)*

- Safety glasses
- Pestle and mortar
- Chromatography paper
- Beaker, 100 $cm^3$
- Small capillary tube
- Pencil
- Ruler
- Cut-up leaves (or leaves and scissors)

*Chemicals (per group)*

- Propanone (HIGHLY FLAMMABLE, IRRITANT) (approx. 10 $cm^3$ per group)

- Sand

## Preparation

- Approximately 10 $cm^3$ of propanone per group is required. See CLEAPSS Hazcard HC085A, refer to SSERC or contact your local safety advisory body.
- For disposal, dilute in water to below 1M (~ 5 % v/v) and pour down a foul-water drain.

- Propanone, $CH_3COCH_3$ (l), (HIGHLY FLAMMABLE, IRRITANT) – The vapour of propanone is HIGHLY FLAMMABLE. Do not have any source of ignition nearby.

- A lid should be used during this experiment if it is not possible to provide fume hood use. An upturned watch glass works well.
- Beware of sharp edges when using capillary tubes.

## Answers

1. Stationary phase = chromatography paper
   Mobile phase = propanone
2. Water is not used in this experiment as the dyes are **not soluble** in water and would therefore not move up the chromatography paper.
3. Pencil must be used for all markings as it is **insoluble** in the solvent. Pen is soluble and would also travel up the chromatography paper and interfere with results.
4. View alongside student results. Students should identify the pigment which has travelled the greatest distance – this is the **most soluble** pigment.
5. View alongside student results. If **more than one spot** is produced, the pigment is a mixture. Pure substances produce only one spot during chromatography.
6. 

(a) Spot 1 did not travel up the chromatography paper because it was insoluble in the solvent used.
(b) Spots 2, 3 and 4 travel different distances because they have different solubilities in the solvent and different attractions for the paper.
Because Spot 4 travelled the furthest, it has the highest solubility and the lowest attraction to the paper.
Spot 2 has the lowest solubility (apart from spot 1 which is insoluble) and the highest attraction to the paper.

7. *Unscaffolded:*
   Any two conclusions from:
   Drink A contains EXBERRY®, but Drink B does not.
   Drink A contains three different colourings, one of which is EXBERRY®.
   Drink B contains two different colourings.
   EXBERRY® was the most soluble colouring.
   Drinks A and B contain only one common ingredient.

   *Scaffolded:*

(a) Only Drink A contains EXBERRY® colouring.
(b) Drink A contains the most colourings – two spots are produced.
(c) Drinks A and B contain only one common ingredient. This is not EXBERRY®. They produced a spot with a common Rf value.
(d) EXBERRY® was the most soluble colouring in the solvent.