## Objectives

**C2.7** Explain the experimental techniques for separation of mixtures by:

(e) paper chromatography.

**C2.9** Describe paper chromatography as the separation of mixtures of soluble substances by running a solvent (mobile phase) through the mixture on the paper (the paper contains the stationary phase), which causes the substances to move at different rates over the paper.

**C2.10** Interpret a paper chromatogram:

(a) to distinguish between pure and impure substances

(b) to identify substances by comparison with known substances

(c) to identify substances by calculation and use of Rf values.

**C2.11** *Investigate the composition of inks using simple distillation and paper chromatography*.

### Maths requirements

**1c** Use ratios, fractions and percentages.

**3a** Understand and use the symbols: =, <, <<, >>, >, ∝ and ~.

**3c** Substitute numerical values into algebraic equations using appropriate units for physical quantities.

**4a** Translate information between graphical and numeric form.

## Learning outcomes

5th **SC2.7** Describe how some mixtures can be separated by chromatography.

6th **SC2.9** Draw and interpret diagrams showing how chromatography is done.

6th **SC2.9** Explain how substances can be separated by chromatography.

5th **SC2.10** Identify pure substances and mixtures on chromatograms.

5th **SC2.10** Identify substances that are identical on chromatograms.

6th **SC2.10** Calculate $R_f$ values and use them to identify substances.

# Exploring

## 1. Chromatography of ink – Core practical

This practical forms part of the core practical requirement of the specification. It is supported by the information in the Student Book *SC2c Paper chromatography*. Students' sheet CP1a(Investigating composition of Ink) provides instructions to help students to compare the mixtures of dyes in the inks used in black marker pens or felt-tip pens. Have a selection of pens available, labelled with letters for ease of identification. These should be tested before the lesson to ensure that they do contain different mixtures of dyes. One set of pens will be sufficient for the whole class. Alternatively bottles of black inks from different manufacturers could be used instead of pens.

This is a relatively simple procedure, similar to chromatography investigations that students will have done during KS3 work. The second side of the worksheet contains two separate sheets that can be used to help students plan a further investigation. The first suggests investigating the mixtures of dyes in inks other than black, or looking at mixtures in 'permanent' inks. Students will need to use solvents other than water for this.

The second sheet uses a crime scenario, asking students to test different pens to see if one of them could have been used to write a 'poison pen' letter. Have a selection of pens available, and also a pre-prepared chromatogram made from one of them, with the final solvent level marked to allow students to make $R_f$ calculations from it. This is the chromatogram supposedly made using ink extracted from the letter. Also have available a short paragraph of text describing how the chromatogram was made. You could follow this up by discussing whether or not identifying the type of pen used for writing the letter actually proves that the suspect

from whose home the pen was taken was the writer (no – because many other people own a similar pen; or the pen could have been left in their home by someone else).

### ⚠ Safety

The solvent suggested for biro ink is flammable and harmful – ensure there are no naked flames in the lab.

***Support:*** The further investigation looking at the range of dyes in different coloured pens is the most suitable for students working at this level. Help them to write a simple plan for their investigation, and check that their apparatus is set up correctly to obtain suitable chromatograms.

***Stretch:*** If doing the 'Poison Pen' activity, some of the pens provided could contain water-soluble inks and some could contain permanent inks – this will allow rapid elimination of some of them. In addition, students could be provided with several types of chromatography paper, so they will need to find out the type of paper used in the pre-prepared chromatogram and use that type so that they can compare $R_f$ values.

**Expected results**

Black inks usually include black dyes and blue dyes, and sometimes other colours as well. The results of the other investigations will depend on the pens available.

**Course resources**

**Chem Students' sheet CP1a**

**Equipment**

250 $cm^3$ beaker, chromatography paper cut to fit the beaker used and stapled to a splint or attached to a pencil or glass rod using paper clips, four different black felt pens or water-soluble marker pens labelled A–D

For the chromatography investigations: selection of different coloured marker pens or felt-tip pens, selection of pens with 'permanent' (non-water-soluble) inks, solvent that will dissolve the permanent ink (for biro ink a mixture of butan-1-ol, ethanol, water (3:1:1 by volume) is suitable; and the addition of a few drops of 880-ammonia may produce a better chromatogram). For other permanent inks try ethanol, propanone or propan-2-ol, but test them before the lesson to see if they work with the pens to be used.

For the 'Poison Pen' investigation: selection of four or more pens of one colour (blue or black) with different combinations of dyes, labelled Suspect 1, Suspect 2 etc, pre-prepared chromatogram made using one of the pens using the same paper that students will use, suitable solvent (see above) if the pens to be tested have permanent inks.