L27935 Simple Chromatography Kit NFU 1240

Background

Chromatography is a method used for separating mixtures by passing it through a medium in which the constituents move at a different rate. The word 'chromatography' comes from the Greek words *khroma*, meaning colour, and *graphia*, meaning writing. The history of chromatography is somewhat contentious, however, the first use of true chromatography is usually attributed to a Russian-Italian botanist called Mikhail Tsvet for his work around the turn of the twentieth century. He first printed the term in 1906 whilst describing how he separated some different colours he found in plants.

There are a variety of types of chromatography, including thin-layer, gas, and liquid chromatography. This kit covers simple paper chromatography.

Investigation

This kit provides equipment for a simple experiment on an ink mixture.

Equipment per student/group:

- One plastic tube and lid
- One glass rod
- One dropper
- Access to water
- Access to the ink mixture
- Strip of chromatography paper approximately 10cm long.
- Pencil
- Ruler

The ink and water represent minimal hazards to the students. However, it would be good practice to provide the students with safety goggles or spectacles.

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Method

1. Take your ruler and the piece of chromatography paper and measure 2cm up from one of the ends. Use your pencil to draw a line across the paper. Put a cross on the middle of the line. (You may want the student to write their name, in pencil, on the other end for ease of identification later.)

2. Using the dropper put 1cm depth of water in the tube.

3. Touch your glass rod into the surface of the ink mixture. Gently transfer the drop on the end to the cross on the chromatography paper. (It is a common mistake to use the dropper to do this but this puts too much ink on the paper.)

4. When the drop has dried put another drop onto the same place, when this has dried put this end of the paper into the tube until the end of the paper just goes into the water. Do not let the coloured mark go into the water and don't let the paper touch the sides.

5. Now put the lid on the tube so that it holds the paper in place.

6. Watch what happens as the water creeps up the paper. (The ink should start to separate out into its different pigments.)

7. When the water gets to within 1cm of the top remove the paper and allow the paper to dry.

Scientific explanation

The simplest explanation is to say that those pigments that dissolve better in water travel further than those that only dissolve a little, however the reality is much more complicated. The pigments are adsorbed onto the paper (adsorption is a surface phenomenon involving the penetration of one substance onto the bulk of another, which is different to absorption). As water passes over those substances that are weakly adsorbed (by the paper), they are carried further than those that are strongly adsorbed.

However, in paper chromatography the situation is further complicated as the paper consists of many cellulose fibres which adsorb a percentage of water. It is the partition of the components of the mixture, between this water (in the cellulose of the paper) and the water flowing over the paper that actually brings about the separation.

Follow on activities

Food dyes - It is possible to do a similar experiment with food-dyes.
Sugar coated sweets used to produce some very colourful results but food substances now rarely contain more than one or two pigments. It is important to trial these experiments before doing them with your class to make sure you get suitable results. Dampening the sweet with a drop of water and then rubbing it on the paper is usually enough to transfer the dye. You may want to ask the children why they think food colourings have changed in this way. (Science has improved sufficiently to produce single pigment colours where a blend was required before, and concern over food additives in the late 1980's led many manufacturers to reduce the numbers of colours they were putting in food.)

Inks - felt-tip pens can produce interesting results, but even the cheapest of these are now often made from a single pigment so you may need to trial the experiment several times before you find the right

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colours (improvements in science again). A crime scene using four different inks, one of which has been used to create a forgery is often very motivational.
Indicators - Universal Indicator pH 1-14 contains a range of dyes, not all of which are visible at pH7 (neutral water). Interesting results can be obtained using acidified and alkaline solvents. Please take appropriate safety precautions including wearing goggles when handling chemicals and carry out the experiment in a glass test-tube.

Plant materials - Plant material often produces good results, but requires the use of organic solvents rather than water. A simple method is to grind red and blue flowers in a pestle and mortar with a very small amount of ethanol. (It is important to keep the quantity of ethanol small, as you will need a concentrated solution.) This experiment often produces better results if the solvent for producing the chromatogram is changed from water to a mixture of 60% butan-1-ol (flammable and toxic), 15% ethanoic acid (corrosive and flammable) and water 25%.
Note: If you are changing the solvent please carry out the experiment in a glass beaker or test-tube rather than the tube included in this kit, as the solvent may damage the tube. Please take appropriate safety precautions when handling chemicals.

Alternative methods

The particular method of chromatography that you have just used is 'ascending paper chromatography'. Another technique called 'simple radial chromatography' can be achieved by placing a dot of ink in the centre of a round filter paper, then resting the filter paper on the top of a beaker. Use the dropper to drip water very slowly on to the centre over the ink.

It is possible, but more difficult, to do 'descending paper chromatography':

1. Use approximately 15cm of the paper provided in the kit and draw pencil lines across one side at 2cm, 4cms and 6cms from one end. Fold the paper on the 2cm and 4cm line; place the dot of ink on the centre of the 6cm line.

2. Place the plastic tube inside a beaker and lie the glass rod across the top of the beaker. Put the bent end of the paper in the tube so that the 2cm fold is at the top and the 4cm fold takes the paper over the glass rod. (You may need to fix the paper in the top of the tube with a paper clip but do not attach anything to the glass rod, just let the paper fall over it.) Depending on the size of your beaker you may want to shorten the long end so that it does not rest on the bottom.

3. Use the dropper to carefully fill the tube with water. Stop the experiment before the water reaches the bottom of the paper. (An improved result may be obtained in an enclosed container where the air is saturated with water vapour.)

Students may want to investigate the advantages and disadvantages of the different methods.

Taking it further

A good 'modern' example of a different type of chromatography is electrophoresis. Electrophoresis apparatus can be used to demonstrate how scientists are able to:

- Produce a 'DNA fingerprint' from evidence found at scenes of crimes
- Prove paternity
- Determining if a person may be carrying a genetically inherited disease
- Explore evolutionary history with genetic evidence

The method can be easily demonstrated with a glass slide, a low voltage power pack with wires and crocodile clips, chromatography paper, a weak salt solution and a concentrated potassium manganate (VII) solution.

1. Soak the paper in the salt solution and place on the glass slide; fix in place using the crocodile clips on the wires.

2. Put a drop of the potassium manganate (VII) solution in the middle of the paper and apply 1 to 2 volts.

The manganate ion is coloured and negatively charged and will slowly spread out in the direction of the positive terminal. The potassium ion will move towards the negative terminal however it is colourless so this will not be seen.

Please ensure that you take suitable safety precautions, including goggles.

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