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**Date:** *12/2/11*

**Introduction**

Many paints, dyes, inks and other colourings are a mixture of substances that have different colours. One method of separating these substances, and hence the colours, is by using a process called chromatography.

There are a range of chromatography techniques, including liquid, thin-layer, gas and paper. In paper chromatography, a liquid soaks through the paper carrying the mixture with it. Some substances are carried faster than others and, in this way, separation results.

When performing paper chromatography experiments, it is important to understand that there are two key components, the water (the mobile phase) and the paper (the stationary phase). Through capillary action, water moves up the paper, and the substances in the ink adhere to the water in different ways, and so, travel differing distances up the paper. When comparing inks, it is also important that many of the variables in the experiment are controlled ie the type of paper used, the amount of ink and the time in the water.

Through this technique, scientists are able to identify the chemical composition of unknown substances, as well as to identify the amount of a substance that is present. Forensic scientists can use the technique to match, say, the ink found at a crime scene to physical evidence found with the suspect.

**Research Question**

To investigate how substances, and hence colours, in water-based inks can be separated using paper chromatography.

**Hypothesis**

If water-based inks consist of primary colours, then these colours will be revealed using paper chromatography because different substances in the ink that contain these colours will adhere, or be attracted to, water in different ways.

**Materials**

* Minimum 250ml beaker
* 4 pieces of chromatography paper strips – approximately 10cm lengths x 3cm wide
* 4 water-based ink marker pens
* Small strips of tape
* Pencil or rod

Water-based ink mark or line.

* Water

**Variables**

*Independant* – (those that are changed) – ink being tested

*Dependant* – (those that are measured or observed) – colour separation

*Controlled* – (those that are constant in each test) – temperature of the water, source of the water, amount of water, time in the water, approximate amount of ink, the type of chromatography paper, distance of the ink line above the water.

**Method**

1. Cut pieces of chromatography paper approximately 10cm by 3cm.
2. Draw a line 2 cm from the end of the paper using a water-based marker pen
3. Pour tap water into the beaker to a minimum depth of 2cm.
4. Place the chromatography paper such that the end of the paper, with the ink line, just dips into the water. Ensure the ink line does not touch the water.
5. Using tape, attach the blank end of the paper to a pencil such that the paper ‘hangs’ from the pencil.
6. Place the pencil across the diameter of the rim of the beaker.
7. Leave the paper to stand until the water has risen almost to the end, near the pencil.
8. Remove paper to dry. Repeat with remaining inks, using a new strip of paper for each test.

**Results**

|  |  |
| --- | --- |
| **Water-Based Ink Colour** | **Observed Separated Colours** |
| 1. **Green**
 | Green, blue, yellow |
| 1. **Brown**
 | Brown, orange, blue, yellow |
| 1. **Orange**
 | Red, yellow, orange |
| 1. **Red**
 | Yellow, variations of shades of red |

**Discussion**

The results show that non-primary water-based inks separated to include some primary colours. Obvious exceptions were colours that were primary to begin with, for example, red. It would be expected that were the test conducted with other primary colours ie blue and yellow, that the result would be varying shades of the primary colour appearing on the chromatography paper. However, depending on the shade of the primary colour tested, other colours may be present.

It is interesting to note that, from the results listed, green did not completely separate into blue and yellow, but retained a large proportion of the original green tint. It would be expected also, that given more time in the water, or a greater distance to travel up the paper, enhanced separation would be visible. Another unexpected result was the appearance of yellow when testing red. A possible reason for this could be that as this was the last of the four tests, there was some contamination of the water from the previous test (Orange). Further investigation would need to occur in order to verify or check.

Future tests could also include the same colour, but from differing brands of marker pen. It would also be worthwhile in the future testing the same inks using perhaps a different chromatography method, to confirm results, or to judge which method produced the clearest results.

**Conclusion**

Colours in non-primary coloured water-based inks can be separated successfully using paper chromatography. The separated colours revealed tend to be primary colours – blue, yellow, red – although due to the constraints and materials used in this experiment, some of the original colour remained also. Primary coloured water-based inks tended to merely lighten.