

Teacher and Technician Sheet

Students carrying out this practical will:

- Learn and use key words, such as **insoluble**, **stabilised**, **pigment**, **vehicle**, **acidity**, **humectants**, **opacity**, **permanence** and **tack**.
- Make inks from tea and discuss whether different types of tea produce different colours of ink.
- Observe the effects of adding a stabiliser (arabic gum) to tea and determining its purpose.
- Analyse the similarities and difference between brown and herbal tea ink when exposed to light (over a period of time).

Introduction:

(The topic could start with a group discussion during which teachers introduce the following ideas, especially the words in bold.)

The earliest writing inks were black and were developed around 2500 BCE (Before Common Era similar to BC). Later brown ink was made using oak galls.

The black material was an **insoluble** substance called carbon found as soot or finely ground charcoal. If you put this carbon in water it does not mix very well. To help it mix, the mixture of water and carbon is **stabilised** with a gum such as gum arabic or a protein such as egg white.

Modern ink is more complicated. It contains many ingredients. The coloured substance is the **pigment** and the liquid is known as the '**vehicle**'. Modern inks include substances that keep the **acidity** around neutral. These are known as pH modifiers. There are **humectants** that slow down the drying, resins to help binding and flow, defoamer/antifoaming agents to control the foaming of the ink, wetting agents to control surface properties, biocides to stop the growth of fungi and bacteria, and thickeners to control ink application.

Making an ink, similar to the early inks, can be carried out by pupils using household materials. To do this they can use chemicals extracted from teas. Black tea is best but if the pupils use herbal or green teas they can investigate other coloured inks.

The pigment is what gives the ink its colour and depth known as the **opacity**. However, when the inks are exposed to long periods of sunlight, especially bright sun, or strong heat the colour of the ink will change over time or fade this is known as the **permanence** of colour. Another important thing with an ink is the stickiness or flow known as **tack**. Too sticky and the ink will not flow with the nib onto the paper.

(This practical can be done with pupils working as individuals or in groups of two. Groups of two allows for good discussion between the pupils. Teachers can use the questions set as the stimulus for discussion and the answers can be used as a group report.)



Curriculum range:

This practical is suitable for all pupils as part of a general introduction to coloured substances. It links with:

- setting up simple practical enquiries, comparative and fair tests;
- reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions;
- using straightforward scientific evidence to answer questions or to support their findings;
- compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency;
- know that some materials will dissolve in liquid to form a solution;
- build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials.

Hazard warnings:

Safe for pupils to carry out however CARE needs to be taken since the pupils will need to use hot water. If behaviour is an issue then the teacher or technician can prepare the tea solution beforehand. Pupils would then start at step 3.

When carrying out step 3 if pupils use their hands or fingers there is the possibility of them getting stained fingers or hands so plastic gloves should be worn. There is also some controversy over the use of gum Arabic since it has been identified as a possible low level skin irritant and a skin/respiratory sensitizer. The danger may lie in continued use and the risk in this case is low but to be safe it is recommended that gloves be worn.

Equipment:

For each pupil or pairs:

- 4 teaspoons of loose tea or (3) 4–5 teabags (of each brown, green and herbal tea)
- 1 teaspoon gum arabic 'crystals' or 3 teaspoons of gum arabic liquid
- 1 cup
- 1 spoon
- 1 fine sieve
- 1/2 cup near boiling water
- 1 screw top bottle or container to store the ink in



Access to:

Disposable plastic cups

Disposable plastic spoons

Hot water

Paper towelling

Plastic straws

Scissors

A4 paper

Disposable plastic gloves

Bottle or container to store ink

Technical notes:

Different sized straws could be provided for students to test their writing with different sized nibs.

Using gum arabic liquid rather than the powder ensures that it mixes in well.

Craft glue also works reasonably well as an alternative to gum arabic.

Results:

Using 2–3 teaspoons of gum arabic or glue in half a cup of 'ink' (tea solution) makes writing easier than when using no stabiliser.

A similar result can be obtained using craft glue instead of gum arabic, with the exception that the ink with gum arabic as the stabiliser is glossier when dry.

The method supplied results in a good colour from brown, green and herbal tea with the colours being noticeably different.

Herbal tea produces the palest ink and the resulting colour depends on the type of herbal tea used.

It is noticeably easier to write with the ink containing a stabiliser such as gum arabic than without a stabiliser.

Without a stabiliser it is difficult to write letters clearly, the liquid spreads and splatters, the letters have to be rewritten frequently.

With a stabiliser added it is much easier to write letters clearly and the ink sets on the paper with a gloss.



Leaving the paper out in the light or kept in the dark did not yield any difference in results over a week. The papers should then perhaps be left out in the light or dark for a longer period of time (or in brighter light).

The equipment needed for this practical is readily available and the learning objectives are achievable within the lesson time.

The hazards are minimal assuming the expected level of behaviour from students.