Teacher and Technician Sheet

In this practical students will:

- Learn how verdigris copper is produced, using key terms such as **alloys, redox reactions, oxidation states, corroded** and **verdigris.**
- Observe and analyse differences between copper coins which have been exposed to different experimental conditions.
- Identify whether the changes seen are because of a chemical or physical change, using their scientific understanding to explain their prediction.

Introduction for teachers:

(This topic could start with a group discussion about metals and the way they change when they corrode. During which the teachers introduce the following ideas, especially the words in bold.)

Copper and copper **alloys** like bronze will corrode with long exposure to the air. When it corrodes the copper takes on a blue-green colour. Corrosion is the **oxidation** of copper; a chemical reaction between copper and oxygen in which copper oxide can be produced.

The Greeks and Romans deliberately **corroded** copper to make a pigment called **verdigris**. Pliny the Elder (23-79 CE) recorded a recipe for the making of verdigris in his *Natural History*.

Because verdigris is made through a natural process and the environmental conditions can vary, the verdigris salts will have different hues of green and bluish green. These colours can be due to different chemical composition and crystalline structure.

(This investigation can be carried out by pairs of students and they could be asked to prepare an article for a science magazine on the production of verdigris.)

Curriculum range:

This is a good practical for upper secondary students. Younger pupils can carry out the experiment for experience, but the chemistry could be too difficult for the majority of the younger pupils. The aim is to gain some understanding of the way artists used scientific methods to make pigments. It links with:

- setting up simple practical enquiries, comparative and fair tests;
- reporting on findings from enquiries and observations, including oral and written explanations, displays or presentations of results and conclusions;
- using straightforward scientific evidence to answer questions or to support their findings;

- building a more systematic understanding of the chemistry of paint by exploring the way coloured materials can be used to make a paint;
- asking questions and developing a line of enquiry based on observations of the real world, alongside prior knowledge and experience;
- using appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety;
- making and recording observations using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements;
- presenting observations using appropriate methods;
- interpreting observations and identifying patterns using those observations to draw conclusions;
- presenting reasoned explanations, including explaining data in relation to predictions and hypotheses; and
- learning about the concept of oxidation.

Hazard warnings:

Ethanoic acid is an acid and so it is advisable to take care when handling it. (Low hazard at 1 M. IRRITANT at 2 M it is similar to household vinegar at this molarity.)

Plastic gloves and safety glasses would be advised. If spilt wash away with plenty of water.

Equipment:

- 2 beakers (250 cm^3)
- Sodium chloride (24 g)
- Spatula
- Weighing boat or gallipot
- Balance
- Stirring rod
- 1 M ethanoic acid or white wine vinegar (100 cm^3)
- 1 M citric acid (100cm^3) IRRITANT

- 1 measuring cylinder (100 cm^3)
- 6 new copper coins
- Paper towels
- Stop clock
- Pen

Technical notes:

The coins need to have a high quantity of copper in them so if copper based coins are not available use disks of copper. (Use the newest coins available to give a good comparison in the results). Since the modern British coins have a reduced copper content if you can get them then old pre-decimal coinage would be good.)

Results:

The coins that have been rinsed off in water and dried (A) look shiny, not green.

The unwashed coins (B) will start to turn green.

Going further:

Instead of ethanoic acid try using citric acid (2-hydroxypropane-1,2,3-tricarboxylic acid). This should make the citrate salt and this will have a different colour green.