Teacher and Technician Sheet

Students carrying out this practical will:

- Learn about the general make up of paints and use key terms such as **pigment, binder, extender, tempera, lake pigment** and **precipitation.**
- Prepare egg tempera paint and lake pigment egg tempera paint.
- Observe, and compare and contrast various aspects of the two paints, including, how easy are the paints to use, how do they look, and how have the paints changed over time?

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

All around us is colour. Humans have tried to use colour to create images and one of the oldest substances used to make this colour is paint. From cave paints to modern ones, the general formula has stayed the same but to understand paint we need to know what it is made of.

Paint is a mixture consisting of:

- A **pigment** (a material that reflects a colour off of the surface it coats). A pigment can be any coloured material such as a mineral. Pigments can be made from a natural dye material from a plant like tea.
- The pigment is mixed with a glue substance or **binder,** often in water or oil.
- There is often another liquid, such as water mixed in to make the paint flow easier or make it easier to use and this is called an **extender**.

One theory about the paints used by the cave painters was that the pigments were local coloured rocks mixed with a binder such as salvia, plant sap or egg yolk. It is likely that the cave painters used all three named binders, sometimes together with a single pigment.

Simple paint using a water soluble binder is known as **tempera** paint and this style dominated for many centuries until **oil** paint was developed.

The coloured material or pigment needs to be extracted. For a mineral paint this can be done by collecting soils or rocks, grinding and separating the coloured material. This is then mixed with binder and extender to make the **tempera** paint

For a plant dye, the coloured substance can be separated by absorbing the coloured material on to a white material, or by precipitating the soluble dye using a metallic salt. The resulting pigment is called a **lake pigment**. This can be mixed with the binder and extender to make **tempera** paint.

The **precipitation** method using metallic salts is generally not appropriate for younger pupils but one can achieve the same effect by using simple kitchen materials like tea and egg shells. Some people have also used coffee successfully.

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Making the ground egg shell can take a bit of time even when using a pestle and mortar so this part could be carried out as a teacher demonstration. The students could be provided with a pot of calcium carbonate instead.

The process in the following practical was used for centuries to make paints.

(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:
Upper primary age students and up. 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; and
- build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials.

Hazard warnings:
Raw eggs can carry bacteria so with younger pupils use plastic gloves and they must wash their hands when they have finished.

The chalks are mainly calcium sulfate with a safe dye. Egg shells are largely calcium carbonate and are considered generally safe if clean.

Wear safety glasses to protect eyes from any raised dust particles.

Discourage students from putting anything in their mouths.

Craft / paper glue (egg alternative) is safe.

Calcium carbonate is **LOW HAZARD**

Equipment:
(For Teacher Demo)

- Pestle and mortar (or tile/saucer and spoon)
- Disposable plastic cup
- 1 egg

For each pupil or pairs:

- 1 egg (or pot of craft glue)1 pot of calcium carbonate (if using instead of egg shell)
- 5 paper or plastic cups
- 1 metal ruler or metal spatula
- Access to 1 box of mixed coloured chalks
- 1 saucer or tile
- 2 tea bags
- 2 disposable plastic spoons
- 1 eye dropper (or disposable plastic pipettes)
- 2 cotton buds
- 2 paper towels and filter papers
- 1 egg yolk separator
- 2 fine paint brushes
- 1 sheet of A4 white paper
- 1 pair of disposable plastic gloves each
- Access to (hand) hot water
- Safety spectacles

Technical notes:
The teacher could demonstrate making the powdered egg shell and provide pots of calcium carbonate (**low hazard**), which could be labelled as 'egg shell powder' for the students.

If pestle and mortars are not available then it may be worth investing in a small one for the teacher to use (they can be purchased for less than £3 from some suppliers).

Everything involving the eggs could be carried out by the teacher with the students observing. This will allow them to see the texture and colours of the egg shell and egg white and yolk, but without any of the health concerns that may be an issue with grinding egg shells and allergies, etc.

Very similar results can be achieved in this experiment whether using craft glue or egg yolk.

Hand hot water from the hot tap can be used to brew the tea and should present no hazard.

Results:
It takes about a few minutes to produce ground egg shell using a pestle and mortar, so the teacher should start by using the bowl and spoon and then move on to 'one made earlier', which could be a pot of calcium carbonate labelled as 'egg shell powder'.

Alternatively, the calcium carbonate connection could be clearly explained and leave everything labelled as calcium carbonate rather than egg shell powder.

One egg shell provides approximately one teaspoon of ground egg shell.

A metal ruler (utensil) works best to scrape the chalk but a small plastic ruler can work as well and they are usually more readily available.

The results are comparable between the egg shell and the calcium carbonate and the students will still gain an understanding of the process of creating the tempura paint.

The difference between using ground egg shell and calcium carbonate is the coarseness of the powder. The egg shell can still be relatively gritty compared to the fineness of calcium carbonate powder.

The results are also very similar whether using egg yolk or craft glue.

The egg yolk / coloured chalk mixture results in a slightly different colour than the glue / coloured chalk mixture due to the yellow of the egg yolk, but the gloss on the dried paint is very similar.

The egg shell and tea mixture creates a brownish / pink paint paste while the calcium carbonate and tea mixture creates a pale brown to dark cream paint paste.

It's best to use a couple of teabags in hand hot water for the time specified to get a good colour.

Using egg white instead of egg yolk results in a transparent paler coloured paint.

This result will not be observed if craft glue is used as an egg substitute.

Overall, the egg yolk paint mixture results in a higher glaze.

The glue is a good substitute for egg yolk.

Calcium carbonate powder can be used for powdered egg shell.

Egg white doesn't mix as easily with the powder as the egg yolk or glue and is more transparent when dry than egg yolk or glue.

If necessary this practical could be adapted to use substitutes in the ways outlined above.

The equipment needed is readily available and the learning objectives are achievable.

The drying time needed can be less than originally stated but it may need more than one lesson to cover the practical.

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