Paints and Pigments Experiment

Scheme of work unit: **C2** Rocks and Metals

Intended learning: **C2a** Learn the difference between pigments & dyes.
The nature of thermochromic pigments.
The nature of photochromic pigments.
The nature of phosphorescent pigments

Introduction notes:

- A **pigment** is a material that changes the colour of light it reflects as the result of selective colour absorption. This physical process differs from fluorescence, phosphorescence, and other forms of luminescence, in which the material itself emits light. Many materials selectively absorb certain wavelengths of light. Materials that humans have chosen and developed for use as pigments usually have special properties that make them ideal for colouring other materials.
- A distinction is usually made between a pigment, which is insoluble in the vehicle, and a dye, which is either a liquid, or is soluble in its vehicle. A colourant can be both a pigment and a dye depending on the vehicle it is used in.
- A **dye** can generally be described as a coloured substance that has an affinity to the substrate to which it is being applied. The dye is generally applied in an aqueous solution, and may require a mordant to improve the fastness of the dye on the fiber.
- A **mordant** is a substance used to set dyes on fabrics by forming an insoluble compound with the dye. It may be used for dyeing fabrics, or for intensifying stains in cell or tissue preparations. A mordant is either inherently colloidal or produces colloids and can be either acidic or alkaline.
- Mordants include tannic acid, alum, chrome alum, sodium chloride, and certain salts of aluminum, chromium, copper, iron, iodine, potassium, sodium, and tin.
- Thermochromic paint is a relatively recent development in the area of colour-changing pigments. It involves the use of liquid crystal or leuco dye technology. After absorbing a certain amount of light or heat, the crystallic or molecular structure of the pigment reversibly changes in such a way that it absorbs and emits light at a different wavelength than at lower temperatures. Thermochromic paints are seen quite often as a coating on coffee mugs, whereby once hot coffee is poured into the mugs, the thermochromic paint absorbs the heat and becomes coloured or transparent, therefore changing the appearance of the mug.
- A **leuco dye** is a dye whose molecules can acquire two forms, one of which is colourless.
- Reversible photochromics work by changing their chemical structure after absorbing UV light, usually from the sun or a UV light. The UV light causes the photochromics to absorb colour (like a dye), and then change back to clear when the UV source is removed. They can cycle thousands of times depending upon the application. They can also change from one colour to a different colour by combination with a permanent pigment.
- One of the most famous reversible photochromic applications is colour changing lenses for sunglasses, as found in Transitions eye-glasses. Reversible photochromics are also found in novelty applications such as toys, cosmetics, and industrial applications.

- Phosphorescence is a process in which energy absorbed by a substance is released relatively slowly in the form of light. This is in some cases the mechanism used for "glow-in-the-dark" materials which are "charged" by exposure to light.

Resources:

Pigment/Dye Experiment:

- Sample of pigment (e.g. charcoal, white chalk powder)
- Samples of a dye
- Samples of natural pigments (e.g. berries that are crushed)
- Transparent containers (e.g. plastic cups)
- White cotton fabric
- Water
- Place in front of the pupils, examples of two dyes and two pigments.

Thermochromic Experiment:

- Examples of thermochromic items (e.g. a mug painted in thermochromic paint, thermochromic paper).
- Thermochromic pigment
- Acrylic base
- Powder paints
- Water
- Sample containers

Photochromic Experiment:

- Photochromic beads
- UV lamp/torch

Phosphorescent Experiment:

- Card
- Phosphorescent paint

Further Work:

Investigate phosphorescent pigments and also photochromic pigments. Understand the chemical changes that occur within these pigments so that we see a colour change/glow-in-the-dark effect. Suggest practical uses of these types of pigments.

Answers:

- The dyes dissolve and the pigments do not.
- Pigments will not stain clothes (normally). Before synthetic dyes people used nautral dyes such as indigo, madder and henna.
- The synthetic dye will work the best because it is purer and at higher concentration than the natural dye.

- The mug changes colour
- Frying pans, babies bottles, autoclaves.
- Binder = acrylic base, solvent = water.