Chemical Pigments Experiment

Key Stage 4

Introduction

A pigment is a small particle that does not dissolve in water. The light from the sun gets selectively absorbed by the pigment, and the colour reflected is the colour we see. This physical process differs from fluorescence, phosphorescence, and other forms of luminescence, in which the material itself emits 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 pigment must have a high tinting strength relative to the materials it colours. It must be stable in solid form at ambient temperatures.

For industrial applications, as well as in the arts, permanence and stability are desirable properties. Pigments that are not permanent are called fugitive. Fugitive pigments fade over time, or with exposure to light, while some eventually blacken.

Pigments are used for colouring paint, ink, plastic, fabric, cosmetics, food and other materials. Most pigments used in manufacturing and the visual arts are dry colourants, usually ground into a fine powder. This powder is added to a vehicle (or matrix), a relatively neutral or colourless material that acts as a binder.

A distinction is usually made between a pigment, which is insoluble in the solvent, and a dye, which is either a liquid, or is soluble in its solvent. A colourant can be both a pigment and a dye depending on the vehicle it is used in. In some cases, a pigment can be manufactured from a dye by precipitating a soluble dye with a metallic salt. The resulting pigment is called a lake pigment.

In this practical experiment, you will be making three different chemical pigments, Prussian Blue, Malachite Green and Cobalt Violet.

Practical

- Iron(III) chloride – $FeCl_3$
- Potassium ferrocyanide – $K_4[Fe(CN)_6]$
- Copper sulfate – $CuSO_4.5H_2O$
- Sodium carbonate - Na_2CO_3
- Cobalt chloride solution – $CoCl_2.6H_2O$
- Disodium hydrogen phosphate – Na_2HPO_4

Making the solutions:

- Prussian Blue – Dissolve 2.5g $FeCl_3$ in 100ml of water. Dissolve 3g $K_4[Fe(CN)_6]$ in 100ml of water.
- Malachite Green – Dissolve 2.2g $CuSO_4.5H_2O$ in 100ml of water. Dissolve 2.2g Na_2CO_3 in 100 ml of water.
- Cobalt Violet –Dissolve 2.2g of Na_2HPO_4 in 100ml of water.

Prussian Blue:

Transfer approximately 50ml of potassium ferrocyanide to a beaker from the volumetric flask.
Fill the burette carefully with iron chloride. Then add 50ml of iron chloride to the beaker containing the potassium ferrocyanide. Observe what happens.
Flute a piece of filter paper so that it fits into the funnel. Put the funnel into the conical flask.
Pour the solution into the funnel slowly.
If there is any pigment left at the bottom of the flask, use a little water and swirl around flask. Filter this solution too.
Leave the pigment to dry.

Malachite Green:

Transfer approximately 50ml of sodium carbonate to a beaker from the volumetric flask.
Fill the burette carefully with copper sulfate. Then add 50ml of copper sulfate to the beaker containing the sodium carbonate. Observe what happens.
Filter and dry by the same method as for Prussian Blue.

Cobalt Violet:

Transfer approximately 20ml of disodium hydrogen phosphate to a beaker from the volumetric flask.
Fill the burette carefully with cobalt chloride. Then add 20ml of cobalt chloride to the beaker containing the disodium hydrogen phosphate. Observe what happens.
Filter and dry by the same method as for Prussian Blue.

Questions

1. In the pigments, it is usually the type of metal that makes them coloured. Name the metals present in the 3 pigments you have made

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2. What did you observe when mixing the two solutions to make Malachite Green?

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3. What was this effect caused by?

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4. Write balanced equations for the formation of Prussian Blue, Malachite Green and Cobalt Violet:

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