

Chemical Pigments Experiment

A-level

Scheme of work unit: C2 Rocks and Metals

Intended learning: C2a Provide a visual aid to show pupils a chemical reaction and then get them to write out the reaction using word equations and represent the reaction by writing balanced equations using chemical symbols.

Introduction notes:

- A pigment is a small particle that does not dissolve in water.
- Pigments can be natural or man-made.
- Malachite Green is a chemical that is primarily used as a dye.
- When diluted, it can be used as a topical antiseptic or to treat parasites, fungal infections, and bacterial infections in fish and fish eggs. It is also used as a bacteriological stain.
- Prussian Blue is a dark blue pigment used in paints and formerly in blueprints.
- Despite being one of the oldest known synthetic compounds, the composition of Prussian Blue was uncertain until recently. The precise identification was complicated by 3 factors:
 - (i) Prussian Blue is extremely insoluble but also tends to form colloids (a suspension of particles in a liquid).
 - (ii) Traditional syntheses tend to afford impure compositions.
 - (iii) Even pure Prussian Blue is structurally complex, defying routine crystallographic analysis.
- The chemical formula of Prussian Blue is $\text{Fe}_7(\text{CN}_{18})(\text{H}_2\text{O})_x$

Resources required:

- Burettes
- Funnels
- Filter papers
- Watch glasses
- Conical flasks
- Iron(III) chloride – FeCl₃
- Potassium ferrocyanide – K₄[Fe(CN)₆]
- Copper sulfate – CuSO₄·5H₂O
- Sodium carbonate - Na₂CO₃
- Cobalt chloride – CoCl₂·6H₂O
- Sodium phosphate – Na₂HPO₄

Practical notes:

The chemicals should not be ingested. Cobalt chloride is a listed carcinogen by inhalation, and therefore this solution should be prepared in advance. Dissolving 6g CoCl₂·6H₂O per 250ml of water makes this. Gloves should be worn to prevent skin contact. Safety glasses and lab coats should be worn at all times.

Iron chloride – R22 38 41, S26 39

Potassium ferrocyanide – R32, S22 24/25

Prussian blue – S22 24/25

Copper sulfate – R22 36/28 50/53, S22 60 61

Sodium carbonate – R36, S22 26

Copper carbonate – R22 36/37/38, S26 36

Cobalt chloride – R49 22 42/43 50/53, S53 22 45 60 61

Disodium hydrogen phosphate –

Cobalt phosphate – R22 36/37/38 40 42/43, S26 36

Answers:

1. Pigment is a solid substance with does not dissolve in water (or vehicle)
2. Iron, cobalt and copper metals cause the colours. Potassium and sodium are present as well.
3. **Prussian Blue:** $3K_4[Fe(CN)_6] + 4FeCl_3 \rightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$
Malachite Green: $2CuSO_4 \cdot 5H_2O + Na_2CO_3 \rightarrow Cu_2CO_3(OH)_2 + 2NaSO_4 + 3H_2O + H_2$
Cobalt Violet: $3CoCl_2 \cdot 6H_2O + 2Na_2HPO_4 \rightarrow Co_3(PO_4)_2 + 4NaCl + 2HCl + 6H_2O$
4. The two liquids react to form an insoluble product.
5. Iron chloride = 0.154 mol dm⁻³. Potassium ferri cyanide = 0.0814 mol dm⁻³.
Copper sulphate = 0.0917 mol dm⁻³. Sodium carbonate = 0.208 mol dm⁻³.
Disodium hydrogen phosphate = 0.1549 mol dm⁻³.