Colour and Chemistry: Applications in Daily Life

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Chemical Indicators

Any substance that gives a visible sign, usually by a **colour** change, of the presence or absence of a threshold concentration of a chemical species.

**Example:** Acid-Base Indicators Phenolphthalein

**Water to Wine**

Acidic: Colorless  Basic: Pink
**Acid, Base and pH in a nutshell**

**Acids**

**Bases**

**pH** is a measure of the concentration of $\text{H}^+$ ions in a solution.
Color and Molecular Structure

- Light delivers energy in little packets called photons.
- Different colors of light pack different amounts of energy in their photons.
- All materials absorb photons of some energy. But only substances that absorb photons of visible light will have color.
- Different molecules absorb different colors of light, depending on their electronic structure.
Mystery behind “Water to Wine”

In Base

Molecule flat: electron moves freely over most of molecular framework

In Acid

Molecule not flat: electron does not move freely and absorbs in the UV
Red Cabbage: Natural Indicator

Red Cabbage

Natural pH sensitive indicator

<table>
<thead>
<tr>
<th>pH</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>red</td>
</tr>
<tr>
<td>3.6</td>
<td>red-violet</td>
</tr>
<tr>
<td>5.9</td>
<td>violet</td>
</tr>
<tr>
<td>7.0</td>
<td>blue-violet</td>
</tr>
<tr>
<td>7.4</td>
<td>blue</td>
</tr>
<tr>
<td>9.8</td>
<td>blue-green</td>
</tr>
<tr>
<td>&gt; 12</td>
<td>green</td>
</tr>
</tbody>
</table>
Mood Lipsticks

**Product Description:** Colour changes instantly according to body chemistry - Long lasting 12 hour lip colour - Moisturizes and protects with ALOE VERA and antioxidants Vitamins A, C & E
Methylene Blue: Redox Indicator

Methylene Blue | Leucomethylene Blue

Reduction ⇄ Oxidation

Solution contain Glucose, Methylene Blue and Sodium Hydroxide

**Reaction 1**
Methylene Blue + Glucose → Leucomethylene Blue + Sodium Gluconate

**Reaction 2**
Leucomethylene Blue + O₂ → Methylene Blue + H₂O
Methylene Blue as Oxygen Indicator

- Presence of oxygen necessary for re-oxidation

- If vial is not opened after each experiment to let in sufficient oxygen, the re-oxidation to methylene blue does not work

- Can be used to determine the presence of oxygen in certain samples
Methylene Blue as indicator for testing milk quality

- Pasteurized (does not contain microorganisms)
- Unpasteurized (contain bacteria such as lactobacillus sp)

Pasteurized Milk + Methylene Blue → Remains Blue

Unpasteurized Milk + Methylene Blue → Slowly turns colorless
Indicators here, there, everywhere
Indicators to Detect Blood in Crime Scene

Haemoglobin + $\text{H}_2\text{O}_2$ \rightarrow $\frac{1}{2} \text{O}_2$

Reduced Phenolphthalein: Colorless
Oxidized Phenolphthalein in Base: Pink
The Composition of Paint

Paint is composed of colored pigment and a binder

Pigment: Colored powdered substance (minerals, inorganic salts, dyes)

Binder: Material that evenly disperses the pigment, adheres to surface when paint applied and then dries

Additives: Such as Glycerine for brushability, antioxidants to prevent paint spoliation

Paints are homogeneous mixtures, are uniform throughout
Brief but Colorful History of Paint

**Bison**

- Dated 35,000 years ago
- Painted in cave walls by the Cro-Magnon man, our Paleolithic ancestors
- Found in Lascaux, France

**Pigment**

**Binder**

Saliva and animal fat
Earth’s Natural Palette

Red

Hematite: Iron Oxide

Cinnabar: Contains mercury; toxic

Blue

Lazurite: Bright blue; very expensive

Azurite: Blue with green tinge; basic copper carbonate much cheaper; used by Michelangelo
Earth’s Natural Palette

Yellow and Orange
Orpiment and Realgar: used as late till 19th century when it was discovered to have arsenic. Van Gogh’s mental illness and Monet’s blindness were probably caused by it.

Green
Malachite is a copper compound and is possibly the oldest known green pigment used.
Inorganic Salts as Pigments

Colored Pigments can be formed by precipitation of aqueous ions in solution

Yellow lead chromate
\[
Pb(NO_3)_2 + Na_2CrO_4 \rightarrow PbCrO_4 + 2NaNO_3
\]

White zinc hydroxide
\[
Zn(NO_3)_2 + NaOH \rightarrow Zn(OH)_2 + 2NaNO_3
\]

Blue Copper Carbonate
\[
Cu(NO_3)_2 + Na_2CO_3 \rightarrow CuCO_3 + 2NaNO_3
\]
The Frescos

Michelangelo: Created the most influential works in Fresco in the western art history

Ceiling of Sistine Chapel, Vatican City

Creation of Adam
Painting of Fresco’s and Secco’s: Egg Tempera

• They were done mostly using egg tempera paint
• It contains a colored pigment and the yolk of an egg mixed with water
• The egg temperas were absorbed into freshly spread wet plaster and remained vibrant as long as the paint survived
• The paint became part of the plaster
Making Binder for Egg Tempera

The egg yolk will now be mixed with equal amount of water to make the binder
The pigment

Yellow lead chromate
\[ \text{Pb(NO}_3\text{)}_2 + \text{Na}_2\text{CrO}_4 \rightarrow \text{PbCrO}_4 + 2\text{NaNO}_3 \]

White zinc hydroxide
\[ \text{Zn(NO}_3\text{)}_2 + \text{NaOH} \rightarrow \text{Zn(OH)}_2 + 2\text{NaNO}_3 \]

Blue Copper Carbonate
\[ \text{Cu(NO}_3\text{)}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CuCO}_3 + 2\text{NaNO}_3 \]
Oil Paintings

*Oil Paints*, pigment combined with oil discovered in early 15\textsuperscript{th} century. Oil such as terpentine oil and linseed oil is the binder.

Sunrise- An impression by Monet  
Starry Nights by Van Gogh
Acrylic paints and other medium

Acrylic Paints

Poster Paint

Transparent Water Color
Art Restoration

• Great works of art are susceptible to effects of aging, temperature and humidity changes, and exposure to light-needs to be conserved

• Conservation involved cleaning the work, analyzing the work for damage, restoring the damaged areas and preserving the original

• Understanding the usage of pigments and binders over ages is utmost important to carry out proper restoration
Fun Activity for you

Create a pallet of natural paints. How?

Find colored rocks. Grind each rock with a mortar and pestle. Add a binder to the powdered rock. Binders can be egg yolk, starch or even glue. Now you have paints. Use these paints in a drawing. Try to identify an element or a combination of elements that produce certain colors.
Acknowledgement

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Reference- Chemical Curiosities: Spectacular Experiments and Inspired Quotes by H. W. Roesky