Not your Mother's Tie Dye

What You Can Teach With Tie Dye

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Colour Theory:

The primary pigments are yellow, cyan [turquoise for the dye], and magenta [use fuchsia dye]. Challenge students to produce other colours from these dyes.

Yellow reflects green and red light, magenta reflects red and blue light, so the combination of magenta and yellow gives red, more yellow gives orange.

Cyan reflects green and blue light, so cyan and yellow gives a green colour, the shade of green will depend on the amounts of cyan and yellow combined.

Magenta and cyan mixed should give blue shades, more magenta gives violets and purples.

It can be done with great difficulty and patience, but a combination of yellow, magenta and cyan can produce black. Most often a very dark violet is produced.

Use the mixed colours to produce rainbow coloured "T" shirts.

NOTE: Vis–a-Vis black markers are black with a mixture of yellow, cyan and magenta inks. These inks can be separated out using chromatography. Use water for water soluble inks and 70% isopropanol for the permanent markers.

Molecular energy transition calculations:

Just as energy levels occur in atoms and calculations for electron transitions are done with the Bohr hydrogen atom, students can calculate the molecular electron transition from the colours. If a dye, e.g. azobenzene is orange, blue light of 450 nm wavelength is absorbed. The energy of the transition is given by:

$E = hc/l = 6.626 \times 10^{-34}$ J.s x 3.00 x 10^{17} nm/s /450 nm = 4.42×10^{-17} J.

Chromophores:

Dyes are coloured because they have groups of atoms known as chromophores. These are groups of atoms with alternating double and single bonds. The double bonded groups include alkenes, C=C, ketones and aldehydes, C=O, and C=N groups as well as benzene rings. Dyeing can thus be included in an organic chemistry unit.

The Chemistry of Dying:

The direct or Procion dyes used have a chlorine atom which reacts with a hydroxyl group [OH] on the cloth to produce HClO, hypochlorous acid, and the dye now bonds to the cloth, an example of a double displacement reaction.

dye-Cl + cloth-OH → HClO + cloth-dye

The sodium carbonate that the cloth is soaked in before dying will neutralize the acid, and to open the cloth fibres [alcohols are acidic so a base will do this.] for better dye absorption.

Silk is a polyamide, which is basic. Soaking in vinegar, which is acidic, opens the silk fibres up so more dye will adhere. The dye reacts at the amide centre. Note that silk and cotton will give slightly different colours when the dye is on.

Urea is added to the dye water to improve the solubility of the dye in the water.

Because water is full of –OH groups the dye will react with water, hence the dyes must be used once dissolved, they will not store in solution. The ludigol added will help preserve the dye in solution for a little bit longer.

Add sodium sulfate to the dye water to brighten the dyes.

Tie Dye Project: Instructions to Students

Date to begin: _____

Prior to Day One:

1. Obtain a white cotton garment, for example a white cotton “T” shirt.

2. Wash the shirt or garment before bringing it to school.
3. Determine a colour scheme and design for the garment before bringing it into school. Look at the possibilities on the attached sheets.

Day One:

4. At school day one the garment will be prepared by washing it in dish soap to remove the ultra-violet dye from laundry detergent or the sizing on a new garment. Both of these will interfere with the absorption of the dye.
5. The garment will be rinsed and then soaked in the sodium carbonate solution to open the fabric to absorb the dyes.
6. The dye displaces hydroxyl groups on the fabric and takes their place. Chloride combines with the hydroxyl to form an acid. The sodium carbonate in the fabric will neutralize the acid protecting the fabric.
7. The garment will be rung out as much as possible over the tub of solution.
8. The folding twisting etc. of the garment and the fastening with elastics will take place on a clean bench or desk.
9. Store the garment in a zip lock bag labeled with your name.

Day Two:

10. Place a newspaper section on a desk or bench. Cover the newspaper with white paper towel. Place the garment on the white paper towel.
11. Obtain the first colour in a plastic beaker and apply it to the desired section of the garment with the medicine dropper. [One colour at a time please.]
12. Wear rubber gloves [size required? are you allergic to latex?] to keep your hands from being dyed. Wash dye off the gloves often to keep the dye off parts of the garment you want a different colour.
13. The dyes will be dark to start with. If you want a lighter shade dilute the dye with “dye water”. You may mix dyes to obtain additional colours.
14. Keep the medicine dropper on the fabric and without bubbles to avoid spatters.
15. Open folds to dye inside them, or do not open folds if you want more white showing.
16. Do one colour at a time.
17. When one side of the garment is finished, flip it over onto fresh white paper towel and continue with the dying on the fresh side as before.
18. On completion of dyeing protect the garment with fresh white paper towel and place it in a zip lock bag. Seal the bag.
19. Take the garment home. Follow the washing instructions given.
20. During down time complete the reading about dyes and answer the questions that go along with the reading.