Tie-Dye Designs

Introduction

Engage students with this fun tie-dying activity while teaching basic chemistry concepts.

Concepts

- Dyes
- pH
- Covalent bonding vs. adsorption

Materials

Sodium carbonate, anhydrous, $NaCO_3$, 500 g
Urea, 650 g
Water, tap, hot
Articles to tie-dye
Beakers, 1000-mL, one for each dye color
Binding materials
Dish soap, Joy® or Dawn®
Drop cloth, plastic
Gloves, latex
Grocery bags, plastic or resealable plastic bags
Newspaper
Pipets, jumbo
Plastic buckets, 5-gallon, 3
Reactive dyes of various colors, powder
Spray bottles, one for each dye color
Tongs

Safety Precautions

Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Wear old clothes and shoes. Do not let the students get sloppy with the dye solutions because dye stains skin, clothing and other materials. Wash hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Prepare urea solution by dissolving 650 g of urea in 8 L of water in a labeled 5-gallon bucket.
2. Prepare the dye solution by first making the dye powder into a uniform paste with a small amount of cold water in a 1000-mL beaker. Dilute to 1 L using urea solution. The color of the dye may be controlled by increasing or decreasing the amount of powered dye used to create the paste.
3. Prepare sodium carbonate solution by dissolving 250 g $NaCO_4$ in 8 L of water in each of two labeled 19-L buckets.
4. Prepare the items to be tie-dyed by pre-washing them in hot water with a detergent that does not contain phosphates or chlorines. Joy®, Dawn® and Ivory® are a few examples of phosphate- and chlorine-free detergents.
5. Dry items in clothes dryer set on hot to remove additional surface additives.
6. Soak the items to be tie-dyed in the sodium carbonate solution for a minimum of 20 minutes.
7. Wring the excess sodium carbonate out of the fabric.

Procedure

1. Work on newspapers or paper towels with a drop cloth on the floor.
2. Fold, twist, scrunch and tie with the binding items the items to create the desired pattern (see steps 3–5).
3. Patterns in which the dye is best applied using jumbo pipets or squeeze bottles include:

   a. **Spiral.** Lay the shirt flat on a flat surface, pinch the center of the item, and twist (see Figure 1). The twisting creates a flat disk shape that is secured by three rubber bands or string. Make sure the bands intersect in the center of the disk

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creating six equal sections, like spokes on a wheel (see Figure 2). Each section may be dyed a different color to create a rainbow pattern, if desired.

b. **Twist.** Grasp opposite corners of the item and twist each corner in opposite directions. The twist may be as loose or tight as desired. A loosely twisted item pattern will not be as dramatic as a tightly twisted item. Bind the item using rubber bands or string. Dye will not seep under the bindings if they are tight (see Figure 3).

c. **Rosettes.** Pinch small areas of the item and bind each using rubber bands. Create a row of rosettes by pinching small sections of the fabric across the entire item. Gather each pinched section into the opposite hand and tightly bind the entire row together (see Figure 4).

d. **Striped.** Fold the item accordion style and bind it every 2 or 3 inches. Each section may be dyed a different color or shades of color (see Figure 5).

e. **Sunburst.** Make a single large pinch in the center of the item and bind it tightly at the base. Dye the pinched section a different color from the remaining portion of the item.

f. **Heart or Other Bilateral Shape.** Fold the item in half. Draw a half of the shape along the folded edge of the item using a pencil. Baste along shape with thick nylon thread. Be careful to tie a secure starting knot. Pull the basting threads while pushing the fabric to create a gather. Tightly bind the fabric at the gather. Dye the inside of the shape a dark shade and the rest of the item a lighter or contrasting color.

4. Patterns in which the dye is best applied by soaking or dipping the fabric in the color.

   a. **Three-layered, Dip-dyed.** Soak the fabric in a plastic bucket of dye. Submerge the entire item in the desired color for 2 minutes, stirring constantly. Lift the top third of the item out of the dyebath. Gently move the rest of the fabric back and forth in the dyebath for 5–10 minutes. Lift the next third of the item out of the dyebath. Gently move the remaining fabric back and forth in the dyebath until the desired color has been reached (see Figure 6).

   b. **Multicolor Dip-dyed.** Soak the entire item in the lightest color desired first. Remove the item from the first dye and wring out the excess solution. Dip part of the item in a complementary color for 5–10 minutes. Repeat as desired (see Figure 6).

   c. **Two-way Striped Design.** Fold the item accordion style and bind it every 2–3 inches (see Figure 5). Tie dye by soaking the fabric for several minutes in the dye solution, stirring constantly. Remove the item and wring out the excess dye. Rinse the item in water until the water remains clear. Cut the bindings and refold the item accordion style, beginning from a different side. Rebind the fabric every 2–3 inches. Immerse the item in the same color for an additional 5–10 minutes, stirring constantly. Remove the item from the dye bath and wring excess solution out of the fabric.

5. Spray bottles or squirt bottles filled with dye and sprayed at various low angles on loosely folded fabric create very interesting patterns. Stencils, leaves, and plastic shapes can be placed on an item that when spray-dyed create unique effects.

6. Once the tie-dying is complete, wrap the tie-dyed item in dry newspaper and place it into the plastic grocery bag. Allow it to set 2 to 24 hours.

7. Remove each item from its plastic bag and rinse in warm water (75–90 °F). Carefully, cut the ties and rinse again. Change the water and continue to rinse until the water remains clear. *Note:* Do not dye or rinse items in plastic or fiberglass sinks—they will be stained by the dyes.

8. Set the dye(s) by washing the items in a washing machine set on hot. Add 2 tablespoons of the pre-wash detergent such as Joy®, Dawn® or Ivory®. Wash no more than 10, like-colored items together in the washing machine. Dry the items in a dryer using the hot setting. After the dye has been set, the fabric should be colorfast.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The waste solutions may be disposed of according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Process: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties of matter, chemical reactions, motions

Tips

- Articles to tie-dye may include T-shirts, lab coats, socks, pillowcases, jeans, handkerchiefs, camisoles, tennis shoes. 100% cotton tie-dyes best but any blend that is at least 60% cotton will work.
- Binding materials may include rubber bands, cord, plastic wrap, fishing line or string to tie the items.
- Wear gloves or use tongs when handling wet material.
- When dyeing with two or more colors, use adjacent primary or secondary colors from a color wheel to create comple mentary colors where the two dyes run together.
- Display a color wheel prior to beginning the dyeing process and discuss primary, and secondary color concepts. This will help eliminate mud-colored items.
- This is an excellent cross-curriculum activity that an art teacher would enjoy too.
- Make the tied areas very snug so that no dye will stain the fabric under the binding.
- Create a lighter shade of a color by diluting the dye with the urea solution before pipeting it onto the item.
- Combine dyeing techniques. For example, dip-dye an item in a light color. Remove the item and wring out the excess solution. Next, create a series of rosettes in a complementary, dark color.
- Use different materials to bind areas of the fabric. For example, thick rubber bands in the center and fishing line on the outer portions of the item.
- Carefully melt paraffin wax or crayons and paint a design or write messages on the fabric. Allow the wax to cool before dyeing. The wax will resist the dye and the wax area will remain dye-free. Remove the wax before machine washing the fabric. Place newspaper on top of and underneath the waxed fabric and iron with a medium hot iron. Change the paper frequently to remove all wax. Crayons will leave some color behind adding dimension to the project.
- Set up separate folding stations and dyeing stations around the room to help contain any mess.
- Copy tie-dye figure sheet and place at folding station for student reference.
- Clean sinks and containers immediately after dyeing.
- If students wear uniforms, have them bring in a large, old T-shirt to wear over their uniform while tie-dying.
- Have students bring in usable but stained white T-shirts to tie-dye as part of a “reduce, reuse, recycle” program, or as part of an Earth Day activity.
- Have students create holiday shirts the day before vacation: for example, orange/black for Halloween, orange/brown/yel low for Thanksgiving, red/green/black for Kwanza, red/green for Christmas, blue/white for Chanukah, etc.
- Create school-colored shirts at the beginning of Spirit Week or Homecoming Week and have everyone wear their creation on Pride Day.
- Consult *Chem Fax!* publication number 10553 for specific instructions about making tie-dye solutions.

Materials for *Tie-Dye Designs* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP9073	Tie-Dye Lab Coat Kit
AP8700	Tie-Dyeing—Chemistry Fun Activity Kit
AP8701	Pipets, Jumbo, Beral-type, 15 mL capacity, pkg/70
AP8702	Urea, 650 g
S0052	Sodium Carbonate, 500 g
AP8704	Reactive Dye, Yellow, 45 g
AP8705	Reactive Dye, Red, 45 g
AP8706	Reactive Dye, Blue, 45 g
AP8707	Reactive Dye, Green, 45 g
AP8882	Reactive Dye, Royal Purple, 45 g
AP8883	Reactive Dye, Orange, 45 g
AP8884	Reactive Dye, Hot Pink, 45 g
AP8885	Reactive Dye, Turquoise, 45 g
AP8886	Reactive Dye, Sky Blue, 45 g
AP8887	Reactive Dye, Black, 45 g
AP8928	Rainbow Tie-Dye Book

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

Tie-Dye Figure Sheet

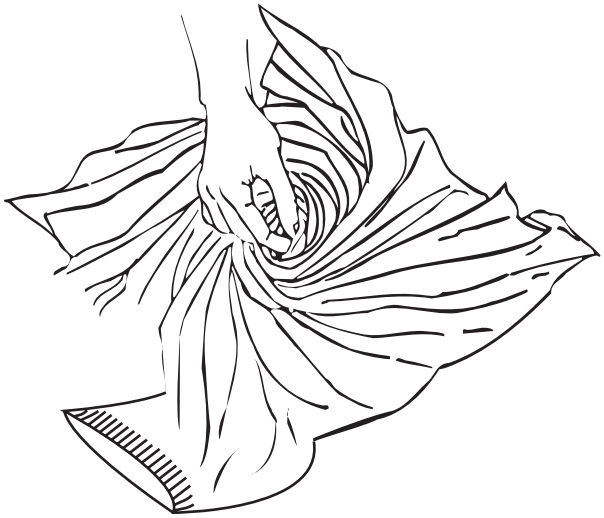

Figure 1.

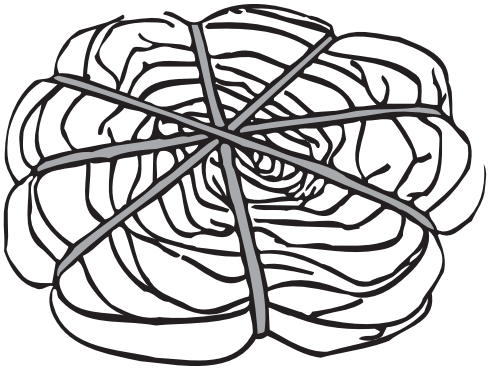

Figure 2.

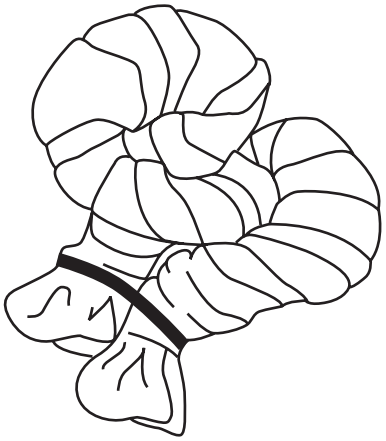

Figure 3.

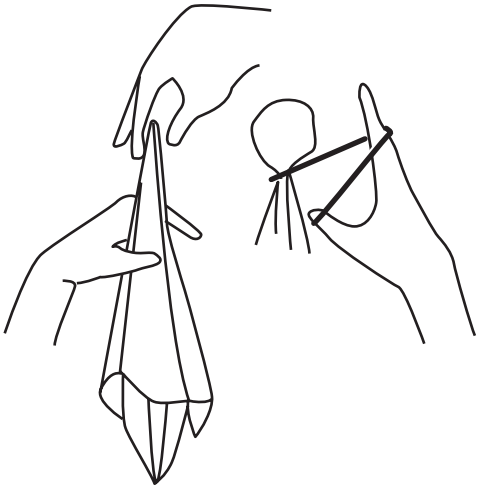

Figure 4.

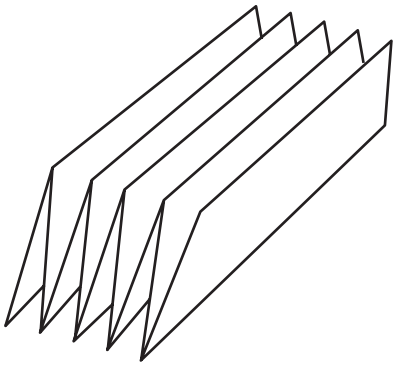

Figure 5.

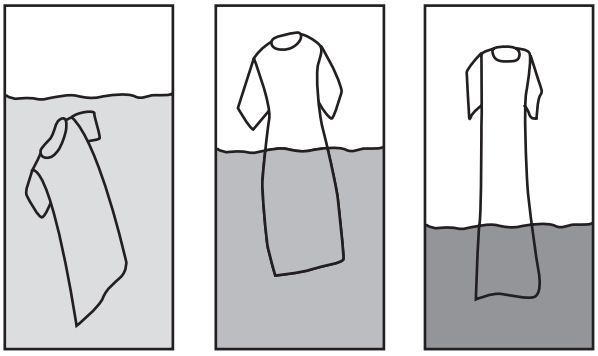

Figure 6.