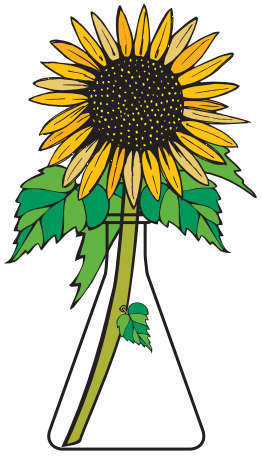
# Color the Curriculum Green

## Greening the School Science Lab



Green Chemistry does NOT mean doing fewer labs or teaching less science! In fact, the opposite is true. By practicing green chemistry, not just in chemistry classes but all across the science curriculum, you will be able to teach the same concepts and accomplish the same learning goals. More importantly, you will feel better knowing that you're making a positive contribution to the environment and to science education by empowering and exciting the next generation of scientists.

Try the following suggestions to help you get started on the path to greener science labs in your school.

- Incorporate disposal treatment into the lab procedure—neutralize acid products with sodium carbonate, reduce halogen waste with sodium thiosulfate, precipitate silver ions with sodium chloride, etc.
- Purchase digital thermometers—they are safer and more precise than spirit-filled glass thermometers.
- Use lower concentrations or less hazardous forms of chemicals whenever possible.
  - —Use ethyl alcohol with a pinch of sodium chloride for laboratory burners. Do not use methyl alcohol.
  - —Always work with the lowest concentration possible of strong acids. If a procedure calls for 3 *M* hydrochloric acid, try 1 or 2 *M* HCl. Copper wire requires concentrated nitric acid to dissolve, but copper foil will dissolve in 6 *M* $HNO_3$.
  - —Substitute solutions for pure solids whenever possible. The $LD_{50}$ of copper(II) chloride is 140 mg/kg—extremely toxic. Using 1 *M* $CuCl_2$ solution reduces the toxicity hazard almost tenfold! There is also a reduced risk of exposure to toxic fumes or dust when working with solutions.
  - —Avoid finely divided forms of metals. Granular zinc is safer than zinc dust; magnesium ribbon is safer than magnesium powder. Finally divided metals may be both a reactivity or flammability hazard (Zn, Mg) and an inhalation hazard (Pb, Cr, etc).
  - —Sodium chlorate is more stable than potassium chlorate for small-scale oxygen generation.
  - —Ammonium chloride is less hazardous than ammonium nitrate for endothermic solution experiments.
  - —Prepare bromine solutions in water ("bromine water").
  - —Use hexanes rather than diethyl ether for extraction procedures.
- Perform a modern variation of the classic Boyle's law experiment using a syringe in a special pressurized soda bottle—get rid of the mercury-filled column. Flinn offers "Boyle's Law in a Bottle" Student Laboratory Kit (Catalog No. AP6855), an environmentally friendly Boyle's law experiment.
- To determine molar volume, generate hydrogen gas (from magnesium and hydrochloric acid) instead of oxygen, which requires dangerous potassium chlorate.
- Use sodium hypochlorite rather than sodium dichromate as an oxidizing agent (the latter is a carcinogen).
- Substitute a propylene glycol–based preservative such as Formalternate® for formaldehyde in dissection activities.
- For the synthesis of a coordination compound, use an iron compound instead of nickel or cobalt.
- Incorporate applications-oriented lab activities into the curriculum wherever possible to make the experiments more interesting to students while at the same time reducing the use of hazardous chemicals. Examples include acid–base titrations of fruit juices, redox reactions using Vitamin C as a reducing agent, paper chromatography of food dyes, and the preparation of biodiesel.
- Teach fundamental principles in environmental chemistry and biology.



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—Determine the alkalinity or buffer capacity of water by acid–base titration.

—Use the Winkler method to measure dissolved oxygen concentrations in water as a function of nutrient levels, such as nitrate and phosphate ions.

—Compare the ability of soil verses sand to bind nutrients and exchange ions using ionic indicator dyes.

—Simulate the production and the properties of acid rain.

—Investigate how the specific heat of geological materials such as sand, soil, and water influence climate.

- Look for lab activities to teach recent advances in science and technology. These include building a solar cell, preparing and testing biodiesel fuel made from vegetable oil, and demonstrating the properties of "colloidal gold" nanoparticles.
- Carry out all lab activities on a microscale level. The advantages are many—the labs are faster, so students can do more trials and gather more data; students and teachers are exposed to lower concentrations of possibly hazardous chemicals (especially for volatile substances); departments save money in the cost of chemicals, glassware, and equipment; teachers spend less time setting up and cleaning up; and the amount of waste generated is greatly reduced. Many common lab activities can be reduced to the microscale level simply by combining drops of liquids in a well plate instead of mixing milliliters of liquid in a beaker.

## Materials for *Color the Curriculum Green* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|---|---|
| AP6855 | Boyle's Law in a Bottle—Student Laboratory Kit |
| AP6916 | Build a Solar Cell Kit |
| AP7154 | Preparation and Properties of Biodiesel Fuel—Student Laboratory Kit |
| AP7117 | Ruby-Red Colloidal Gold Nanotechnology Demonstration Kit |
| FB1883 | Specific Heat and Climate Laboratory Kit |

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