

## Discussion and Notes

*If using the notes for training, keep a copy of these safety training notes and a signed attendance sheet to verify regular safety training. Regulatory inspectors will usually request proof of safety training.*

*For more information about Green Chemistry, visit the EPA website at [www.epa.gov](http://www.epa.gov) and search Green Chemistry.*

## Greening the Science Lab

For over 40 years, Flinn Scientific has embraced a consistent philosophy regarding the use of chemicals in science labs: “Chemicals in any form can be safely stored, handled or used if the physical, chemical, and hazardous properties are fully understood and the necessary precautions, including the use of proper safeguards and personal protective equipment, are observed.” We still believe this philosophy is appropriate, perhaps more so today as the list of banned or restricted lab chemicals in various states continues to grow.

With negative attention focused on “problem” chemicals, the idea of “green chemistry” may seem like an oxymoron. Green chemistry, however, is real, and it carries a positive message about chemistry and science. The *Green Chemistry Program* was initiated by the U.S. Environmental Protection Agency in the 1990s. The program calls for the design of chemical products and processes that will reduce or eliminate the generation of hazardous substances. How can instructors and schools benefit from the principles of green chemistry and the knowledge gained through its success?

### Basic Principles of Green Chemistry

Green chemistry presents a wonderful opportunity for science instructors to increase safety, improve science education, and impart the values and benefits of science to the next generation. The basic principles of green chemistry as they relate to science labs include the following:

- ◆ Design lab activities to avoid generating hazardous by-products that require waste disposal.
- ◆ Substitute less hazardous and less toxic chemicals in chemical reactions or lab tests.
- ◆ Perform lab activities on a small-scale or microscale level to reduce the amounts of chemicals used.

### Reviewing Lab Activities

To implement green chemistry, science instructors need to know what chemicals are being used in lab activities. This requires two things: an accurate inventory of chemicals, and a list of chemicals used in experiments and demonstrations in science courses. After compiling the list of chemicals they actually use, most departments find that many chemicals in their inventory are not needed. In reviewing current lab activities, carefully compare the hazards of chemicals versus the learning goals and objectives. Many science departments use lead nitrate, for example, to precipitate lead iodide and demonstrate crystal formation. No doubt it is a beautiful demonstration. However, is the need for licensed hazardous waste disposal of the heavy metals used in this demonstration justified in terms of the learning goals? Mixing copper chloride and sodium phosphate solutions gives a turquoise solid. It may not be quite as pretty, but it teaches the same thing, and it is “greener” and safer.

### Advantages of Microscale Labs

The advantages of microscale lab activities are well known: the labs are faster, students and staff are exposed to lower concentrations of possibly hazardous chemicals (especially for volatile substances), departments save money in the cost of chemicals, glassware, and equipment, staff spend less time setting up and cleaning up, and the amount of waste generated is greatly reduced. Many common lab activities can be microscaled simply by combining drops of liquids in a well plate instead of mixing milliliters of liquid in a beaker.

## Discussion and Notes

*Set up regular meetings to discuss some of the “not so green” lab activities and share ideas for possible alternatives. Don’t think that just because you don’t have time to review every single lab, you shouldn’t do anything. Remember, a journey of a thousand miles begins with a single step.*

## Color the Curriculum Green!

- ◆ Incorporate treatment of by-products from chemical reactions into lab procedures—neutralize acids, reduce halogens, precipitate silver ions.
- ◆ Purchase digital thermometers—they are safer and more precise.
- ◆ Use lower concentrations or less hazardous forms of chemicals.
  - Always work with the lowest concentration possible of strong acids.
  - Substitute solutions for pure solids. The LD<sub>50</sub> of copper(II) chloride is 140 mg/kg—extremely toxic. Using 1 M CuCl<sub>2</sub> solution reduces the hazard almost tenfold!
  - Avoid finely divided metals. Granular zinc is safer than zinc dust; magnesium ribbon is safer than magnesium powder.
- ◆ Substitute a propylene glycol-based preservative such as Formalternate® for formaldehyde in dissection activities.
- ◆ For the synthesis of a coordination compound, use iron instead of nickel or cobalt salts.
- ◆ Incorporate applications-oriented experiments into the curriculum: acid–base titrations of fruit juices, redox reactions using Vitamin C, paper chromatography of amino acids, etc.
- ◆ Teach fundamental principles in environmental science: determine the alkalinity or buffer capacity of water by acid–base titration; use the Winkler method to measure dissolved oxygen concentrations in water; simulate the production and properties of acid rain; investigate the specific heat values of sand, soil, and water and their influence on climate.

Green chemistry does NOT mean doing fewer labs, “dumbing down” the course, or teaching less science. In fact, green chemistry may be a very effective teaching tool. With the increasing emphasis on inquiry-based labs, challenge students to review an existing lab and use the principles of green chemistry to modify or improve it. By empowering and exciting the next generation of scientists, you will be making a positive contribution to the environment and to science education.

## Flinn Online Laboratory Safety Course — It’s Free!

*“The online safety course is truly a terrific service that Flinn offers, and I greatly appreciate it!”*

That’s just one of the many comments we have received from instructors who have completed the comprehensive [Flinn Scientific Laboratory Safety Course](#). Visit the Flinn website today to get started.

## Thank You for Your Support

Please continue to support our efforts to improve safety in science labs by ordering your science supplies and laboratory chemicals from Flinn Scientific.

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