# Chemistry: *Discussion Guide*

## Overview

Chemistry is central to many of the past century's technological advances. Bring chemistry out of the lab and into the future with this discussion guide and its related videos and activities.

Students will begin with a look at how silicon transistors revolutionized and miniaturized the computer industry. Then, they'll investigate how alloys made of aluminum and lithium have reshaped aircraft and space vehicles. Bill Nye profiles the important discoveries of plastics and fullerenes, introducing students to the science of nanotechnology. The guide ends with a look to the future and chemistry's potential to change the way we drive.

## Classroom Activities

1. Show the "Silicon: Computing Champion" segment from *The Periodic Table of the Elements: Metalloids* program.
    - **Discussion:** Ask: How common is silicon? *(It's the second most abundant element on the planet.)* What are some products that are made with silicon? *(Compounds of silicon and other elements are used to manufacture glass and to make soaps, adhesives, egg preservatives, lubricants, polishes, electrical insulators, cement, and solar cells. Very pure silicon is used to make semiconductors and microchips for electronic devices.)* What does it mean that silicon acts as a semiconductor? *(At high temperatures, atoms of semiconductors conduct electricity as if they were metals. But at lower temperatures, they act as insulators; stopping electric currents from flowing.)*
    - **Science Investigation:** In the video, students learn that the "invention of silicon transistors revolutionized and miniaturized the world of computers. Now binary switches could be microscopic, faster, and more reliable." Have students research and report on the independent and nearly simultaneous development of the integrated circuit by Robert Noyce and Jack Kilby. The following Web sites are good starting points:
        - http://www.computerhistory.org/VirtualVisibleStorage/artifact_main.php?tax_id=03.01.01.00#0
        - http://www.pbs.org/transistor/background1/events/icinv.html
        - http://www.pbs.org/newshour/bb/remember/jan-june05/kilby_6-22.html
        - http://inventors.about.com/library/weekly/aa080498.htm
        - http://nobelprize.org/physics/educational/integrated_circuit/history/
    - **Build a Silicon Wafer:** Working individually or in small groups, have students try their hand at a computerized jigsaw puzzle on the Intel Web site that challenges them to assemble a completed silicon wafer: http://www.intel.com/museum/exhibit/Santa_Clara/teach_learn/puzzles/puzzles.htm

2. Show the "Lithium: Aircraft Alloys" segment from *The Periodic Table of the Elements: Alkali Metals* program. (Access to *unitedstreaming* is required.)
    - **Discussion:** Ask: Why are aluminum-lithium alloys used in aircraft and space vehicles? *(Aluminum is light and resists corrosion well, but it is too weak and bendable by itself in many airplane parts. The chemical properties of lithium make it an excellent metal to add to aluminum. Since lithium is the lightest metallic element, its alloys are also very light compared to other alloys. But they are also very strong and resistant to fatigue. This combination of toughness and lightness make aluminum-lithium alloys a good match for aircraft.)*
    - **Brainstorming Activity:** Print copies of the following Web essay written by the U.S. Centennial of Flight Commission and distribute to students: http://www.centennialofflight.gov/essay/Evolution_of_Technology/composites/Tech40.htm.
    - Review the term *unobtainium* as a class. *(The term* unobtainium *is sometimes used to identify materials that are desired but not yet available.)* Working in small groups, have students brainstorm the properties of a material that would be even more useful to aircraft builders than the aluminum-lithium alloy. Ask for volunteers to share their group's list with the class. Review the ideas, making sure that students understand this unobtainium material would, at minimum, have the combination of toughness and lightness of aluminum-lithium and be inexpensive to manufacture.
    - **Science Investigation:** Ask students if they have ever heard of lithium-ion batteries. Chances are good that many will be familiar with these rechargeable batteries used by most of today's cell phones and laptop computers. Working individually or in small groups, have students research and report on the benefits and disadvantages of these batteries. The following Web sites are good starting points:
        - http://www.apple.com/batteries/
        - http://www.maxell.co.jp/e/products/industrial/battery/li_ion/
        - http://www.ipodbatteryfaq.com/

3. Show the "Plastics and Fullerenes: The Future of Chemistry" segment from the *Greatest Discoveries with Bill Nye: Chemistry* program. (Access to *unitedstreaming* is required.)
    - **Discussion:** Ask: When was the first plastic created? *(In the 1860s by a printer and amateur chemist named John Hyatt.)* What next step in the discovery process did Leo Baekeland take? *(He made the polymer Bakelite, the world's first truly synthetic plastic.)* What is a buckyball? *(A molecule with 60 carbon atoms that is especially stable.)* What are fullerenes?*(A new class of large all-carbon molecules.)* What is a carbon nanotube? *(Also known as a buckytube, it is a fullerene made of hollow molecules of pure carbon that form a seamless hollow tube.)*
    - **Writing Activity:** Have students write a one-page essay in which they explain in their own words what plastics are and why their discovery was important enough to make Bill Nye's list of 100 Greatest Discoveries. While this information can be gathered from the segment, you may want to have students conduct additional research before writing their essays. If so, point them to this American Plastics Council site: http://www.americanplasticscouncil.org/s_apc/sec.asp?CID=290&DID=886
    - **Related Viewing:** Have students learn more about carbon nanotubes. Show the "Pure Carbon: The Science of Nanotubes" segment of *Science Investigations Physical Science: Investigating Chemical Reactions.* (Access to *unitedstreaming* is required.) The segment looks at how this form of pure carbon could be the basis of a bold new engineering plan for Tokyo Bay in Japan and might lead to a new generation of computer chips with transistors smaller than those etched in silicon.

4. Show the "No Need to Refuel" segment from *The Periodic Table of the Elements: The Other Metals* program. (Access to *unitedstreaming* is required.)
    - **Discussion:** Ask: Why are graphite nanofibers important? *(This material can soak up hydrogen to produce a very high density system contained in a very small volume.)* What important property did the researchers discover about graphite nanofibers? *(You can manipulate the behavior of the metal particles in such a way that they create honeycomb structures which are ideally suited for the storage of hydrogen. They give the following example: "If we put hydrogen at high pressure, we'll be able to drive approximately one mile. If, on the other hand, we fill the canister with graphite nanofibers, we can now store sufficient hydrogen to be able to drive 25 miles with exactly the same volume canister.")*
    - **Fuel Cell Activity:** Print copies of the "Boosting Fuel Cells" article on the Science News for Kids Web site and distribute to students: http://www.sciencenewsforkids.org/articles/20050615/Feature1.asp. As a class, review Megan Burger's investigation of fuel-cell technology. Divide the class into small groups and send them to the following two Web sites to learn more about how fuel cells work. Challenge the groups to create a print or television ad that explains why fuel cell research should be supported.
        - http://www.science.howstuffworks.com/fuel-cell.htm
        - http://www.americanhistory.si.edu/fuelcells/basics.htm
    - **Nano Exploration:** Have students learn more about the science of nanotechnology by investigating the NanoKids project at Rice University. A kid-friendly article can be found on the Science News for Kids site: http://www.sciencenewsforkids.org/articles/20040609/Feature1.asp. Then, have students visit the Rice University site, where they can meet the NanoKids, explore the nanometer scale, and even join a Scholar's Club that allows them to become part of the nanoscale science and technology research team, reviewing animation models and trying out new educational games: http://cohesion.rice.edu/naturalsciences/nanokids/.

## Academic Standards

**National Academy of Sciences**
The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.

This discussion guide addresses the following national standards:

- Physical Science: Structure of atoms; Structure and properties of matter; Chemical reactions
- Science and Technology: Understandings about science and technology

**Mid-continent Research for Education and Learning (McREL)**
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science
    - Physical Sciences: Understands the structure and properties of matter; Understands the sources and properties of energy
    - Nature of Science: Understands the nature of scientific knowledge; Understands the scientific enterprise

- Language Arts
  - Writing: Uses grammatical and mechanical conventions in written compositions; Gathers and uses information for research purposes
  - Viewing: Uses viewing skills and strategies to understand and interpret visual media