Greatest Discoveries With Bill Nye: Chemistry
Teacher's Guide

Grade Level: 6–8	**Curriculum Focus:** Physical Science	**Lesson Duration:** Two class periods

Program Description

Oxygen and Atoms — Explore atomic and molecular structure and see how oxygen was first isolated. ***Chemical Structure and the Periodic Table of Elements —*** Examine the experiments that brought us the periodic table of the elements. ***Chemicals and Electricity —*** See how electrochemistry revealed the subatomic particles we know as electrons. ***Chemical Compounds and Radioactivity —***Explore the benefits of chemical compounds and radioactivity. ***Plastics and Fullerenes: The Future of Chemistry—*** See how plastics and nanotechnology are changing our world.

Discussion Questions

- What is the periodic table of the elements and how is it used?
- How do molecules bond with one another?
- What are the electrically charged parts of an atom?
- How has chemistry changed our world?

Video Index

Segment 1: Oxygen and Atoms (8 min.)

Description

See how Joseph Priestley and Antoine Lavoisier experimented with oxygen. Explore the work of other scientists who made important advances in atomic theory and molecular structure.

Pre-viewing question

Q: What do you know about oxygen?
A: Answers will vary.

Post-viewing question

Q: Describe Joseph Priestley's early experiments with gasses.
A: Priestley heated mercury with a magnifying glass; it began to change to metal and release a gas, which he captured. In 1774 he and French scientist Antoine Lavoisier successfully isolated the gas. By weighing the substances, Lavoisier was able to tell that a gas was isolated.

Segment 2: Chemical Structure (9 min.)

Description

Take a closer look at the experiments that led to the creation of the periodic table of the elements and learn how chemical bonds occur.

Pre-viewing question

Q: What chemical reactions you have observed?
A: Answers will vary.

Post-viewing question

Q: How did August Kekule's discovery about carbon change the science of chemistry?
A: August Kekule established a simple formula to represent how chemicals bonded. Benzene was the only chemical compound that did not fit the formula because its chain of carbon and hydrogen atoms required more combining power than the formula allowed. Kekule realized that its six carbon atoms formed a ring (not a chain), and each one had a hydrogen atom attached with alternating single and double bonds. Thanks to this discovery, chemists had a formula to explain how carbon combined with other molecules to form chemical compounds.

Segment 3: Chemicals and Electricity (8 min.)

Description

Electrochemistry helped scientists discover new elements and the electrically charged subatomic particles now known as electrons. Examine the contributions Humphry Davy, Robert Bunsen, and Joseph Thomson made to chemistry.

Pre-viewing question

Q: How can you tell which chemical elements are present in a burning substance?
A: The color of a flame indicates which elements are present. Shades of yellow indicate sodium, and green indicates copper.

Post-viewing question

Q: How did Joseph Thomson discover electrons?
A: Experimenting with the electrical part of atoms, Thomson hooked the ends of a glass tube to electrical sources, which created a stream of cathode rays. After exposing the stream of cathode rays to a magnet, it bent. Magnets can only affect matter, so he determined that the stream was composed of an electrically charged substance (radiant matter). Thomson had found the first subatomic particles: The ray was a stream of electrons.

Segment 4: Chemical Compounds and Radioactivity (6 min.)

Description

Thanks in part to Marie Curie's work we can understand the benefits and dangers of radioactivity. Explore the uses of chemical compounds and radioactivity in modern society.

Pre-viewing question

Q: Can you name some chemical compounds?
A: Answers will vary.

Post-viewing question
Q: What are the benefits of radioactivity?
A: The benefits of radioactivity include medical imaging, which is used to help find tumors; calculating the age of the Earth; powering spacecraft; and creating steady electrical current in some smoke alarms.

Segment 5: Plastics and Fullerenes (10 min.)

Description
Many plastic products are better and stronger than anything found in nature. Investigate nanotechnology, the future of chemistry, which is promising to produce even better artificial materials.

Pre-viewing question
Q: What would the world be like without plastics?
A: Answers will vary.

Post-viewing question
Q: How do you think nanotechnology will change our world?
A: Answers will vary.

Lesson Plan

Student Objectives

- Investigate the history and future of chemistry.
- Demonstrate an understanding of the importance of careful observation and experimentation.
- Experiment, observe, and record the properties of different chemical mixtures.

Materials

- *Greatest Discoveries With Bill Nye: Chemistry* program
- Cornstarch, about 2 ½ cups per student group
- Food coloring, approximately six to eight drops per student group
- Plastic baggies, two per student
- Plastic bowls or plates, two per student group
- Small paper cup, one per student group
- Coffee stir sticks (tongue depressors or Popsicle sticks), two per student group
- Water
- Wax paper
- White glue, about one cup per student group

- Borax solution (1 heaping teaspoon of Borax powder per cup of warm water; about 1 gallon for 50 students)
- Small scoop or dipper for the Borax solution
- Metric rulers, one per student group
- Measuring cup or 8-oz. beaker with milliliters marked, one per student group
- Science journals or paper
- Pencils and erasers
- Computer with Internet access (optional)

Procedures

1. Use *Greatest Discoveries With Bill Nye: Chemistry* to explore the history and importance of chemistry. Once you have watched the program, talk about the periodic table of the elements and the important discoveries shown in the program. What do we know about the elements now? How do elements bond? What is a chemical compound? What is a polymer? What are the uses of plastics? Why are plastics important? What are some compounds and mixtures used in daily life?
2. Talk about the importance of experimentation in science. Where would chemistry be without the discoveries and inventions featured? What might have happened if the chemists highlighted in the program had not carefully observed and recorded their experiments? Tell students they are going to conduct their own chemistry experiments to create two brand new substances. Like the chemists that have come before them, tell students that they will need to carefully record the steps they take to create their substances as well as their observations about the properties of the substances as they work with them. And finally, when they are satisfied with their products, they will need to brainstorm a name for their new mixtures and uses for these substances.
3. Divide the class into pairs or groups of three. Before beginning the experiments, remind students to never eat or taste any substances in science class unless they are directed to do so by a teacher.
4. First have students make "oobleck." Remind them that this is just a working name and that once their product is finished they will need a new name for it. Give each student group the following:
    - 2 ½ cups cornstarch
    - 2 cups water
    - food coloring
    - wax paper
    - plastic bowl
    - stirrers
    - plastic baggies

5. Instruct students to put the cornstarch in the bowl and add about one cup of water, mixing with a stirrer as they pour. Each time they add a new ingredient to their mixture, have them stop and observe the changes in properties. What does the mixture look like? How does it feel? How does it smell? Tell them to record their actions and observations in their science journals or on a piece of paper.
6. Have students add more water slowly if the mixture seems too dry and won't stick together. It should not be too dry, but too much water could make it too runny. Students may pour the mixture onto the wax paper and mix it with their fingers if they are having trouble mixing it in the bowl.
7. Tell students to add food coloring to their mixture. Once they are satisfied with the substance, have them put it on the wax paper (if it is not already there) and play with it. Have them discuss their substance with their lab partners. What does it look like? How does it feel? Can it stretch, bounce, or move in any other way? How can it be used? Give students time to observe the properties of their new substance. Once they have thought of a name and uses for it, ask them to divide it into the plastic baggies (one for each student) and set it aside. Make sure the groups have recorded the name and uses of their new substance.
8. Next have students make "ectoplasmic residue." Give student groups the following materials:
    - white glue
    - food coloring
    - water
    - stirrers
    - plastic bowl
    - small paper cup
    - wax paper
    - measuring cup or beaker
    - metric ruler
9. Have students use their metric ruler to measure two centimeters up from the bottom of the small paper cup. Have them make a line on the inside and outside of the cup, clearly marking two centimeters. Next, have them fill the cup to the line with white glue and then pour the white glue into their mixing bowl.
10. Have students measure out 14 ml. of water and add that to the glue, stirring well and observing and recording any changes. Then have them add 16 ml. of the Borax solution, stirring well and observing and recording any changes.
11. The residue should be forming a slimy blob, but if it's too runny, students may add a few more drops of the Borax solution. If it is too sticky, they may add a little more water. Once they have a blob that's not too runny or sticky, have them add food coloring and put it on the wax paper. What does it look like? How does it feel? What happens when it's pounded with a fist? Does it break apart easily? How is it similar to or different from the first substance? Have students

record their observations about this substance and compare it to the first one. Next, have them name this product and devise uses for it. They will divide it into two bags and take it home.

12. When the investigations are complete, give students time to sell their new substances to the rest of the class. Give each group a several minutes to talk about their product and how it could be used.
13. If time allows, have students go online and learn more about chemistry, compounds, and mixtures from the following Web sites:
    - http://library.thinkquest.org/3659/
    - http://www.mcps.org/bhs/classes/dana/Matter.html
    - http://www.webelements.com/index.html

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- **3 points:** Students were highly engaged in class discussions; were highly focused and engaged during the investigations; enthusiastically participated in successful lab experiments and presentations; made careful observations of their experiments; and demonstrated a solid understanding of the importance of experimentation and observation in chemistry.
- **2 points:** Students were engaged in class discussions; were focused and engaged during the investigations; participated in somewhat successful lab experiments and presentations; made good observations of their experiments; and demonstrated a basic understanding of the importance of experimentation and observation in chemistry.
- **1 point:** Students participated minimally in class discussions; were unfocused and not engaged during the investigations; minimally participated in lab experiments and presentations; made incoherent or incomplete observations of their experiments; and were unable to demonstrate an understanding of the importance of experimentation and observation in chemistry.

Vocabulary

chemistry

Definition: The science of the composition, structure, properties, and reactions of matter, especially of atomic and molecular systems

Context: The science of chemistry has yielded great discoveries that are useful and helpful to humankind.

compound

Definition: A pure substance composed of more than one element

Context: Kekule's discovery provided an underlying formula to explain how carbon combined with other molecules would form a world of chemical compounds.

element

Definition: A pure substance composed of only one type of atom

Context: Modern scientists changed the way we would learn about and understand the elements.

molecules

Definition: The smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms; a group of like or different atoms held together by chemical forces

Context: The gasses were made of multiple atoms, which came to be known as molecules.

polymers

Definition: Molecules composed of repeated subunits

Context: We have science making polymers, nylon, rayon, plexiglass—the structural materials of our civilization.

substance

Definition: A material that has mass and occupies space; matter

Context: Scientists have looked for substances that emitted strange and sometimes valuable forms of radiation.

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 lesson plan addresses the following science standards:

- Science as Inquiry: Understanding about scientific inquiry
- Physical Science: Chemical reactions; Transfer of energy; Structure of atoms; Structure and properties of matter; Interactions of energy and matter
- Science and Technology: Understanding about science and technology
- History and Nature of Science: History of science; Historical perspectives; Science as a human endeavor

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 scientific principles related to electricity; Understands the sources and properties of energy
- Science—Nature of Science: Understands the nature of scientific knowledge; Understands the nature of scientific inquiry
- Language Arts—Viewing: Uses viewing skills and strategies to understand and interpret visual media
- Language Arts—Writing: Uses the general skills and strategies of the writing process
- Historical Understanding—Understands the historical perspective
- Technology—Understands the relationships among science, technology, society, and the individual; Understands the nature and uses of different forms of technology

---

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

---