Forensic Detectives: Chemistry at Work: Teacher's Guide

Grade Level: 6-8	**Curriculum Focus:** Forensic Science	**Lesson Duration:** Four class periods

Program Description

From crime-scene clues to pyrotechnic beauty, there's wonder and power in the molecular makeup of substances. Segments cover methods of analysis, chemical reactions, the periodic table of the elements, and the significance of carbon. This presentation uses fascinating examples to reinforce the roles and importance of chemistry in today's world. This program includes one feature segment and three short segments.

Onscreen Questions

- What is the periodic table of elements?
- How do forensic detectives use chemistry to examine evidence?
- What is a chemical reaction?
- What are some uses of carbon??

Lesson Plan

Student Objectives

- Discuss the definition of chemistry and the different careers related to chemistry.
- Talk about how people use chemistry every day.
- Research one chemistry-related career for a class presentation.

Materials

- *Forensic Detectives: Chemistry at Work* video and VCR, or DVD and DVD player
- Computer with Internet access
- Poster board, markers, colored pencils, and other materials for student posters
- Paper and pencils

Procedures

1. After watching *Forensic Detectives: Chemistry at Work*, ask students how they would define chemistry. Help them create a simple definition, such as "Chemistry is the structure and properties of substances and how they react to one another." or "Chemistry is about what substances are made of and how they combine."
2. Next, ask students to describe careers that involve chemistry based on what they viewed. Discuss what the following careers have in common. (They all deal with substances, their properties, and how they react with each other.)
    - Chemists who study the properties and reactive qualities of elements
    - Forensic scientists who use chemical analysis to identify or match evidence from a crime scene
    - Pyrotechnicians who combine chemicals that produce fireworks displays
    - Scientists and engineers who develop new materials
3. Tell students that chemistry is involved in many careers because chemicals are the basis for many of the products we use every day, from drugs to synthetic fibers to perfume. Almost all new products, from NASA spaceflight materials to new bubble-gum flavors, depend on chemistry. Examples follow:
    - Chemical engineers use or make new chemicals to solve problems and find practical applications.
    - Materials scientists use chemicals to discover and create new materials with unusual properties, such as a strong lightweight metal or a plastic that can conduct electricity.
    - Pharmacists, doctors, and nurses use chemistry to understand how drugs interact with the human body.
    - Food scientists are involved in making new ingredients or use chemistry to test food for quality and safety.
    - Safety and health inspectors analyze the safety of different places, from restaurants to water treatment plants.
4. Share the following list of chemistry-related careers with the class:
    - Agricultural chemist
    - Chemist
    - Chemical engineer
    - Chemical salesperson
    - Chemistry teacher or college professor
    - Environmental chemist
    - Food and flavor chemist
    - Forensic chemist

- Geochemist (study chemicals in rocks)
- Hazardous materials expert
- Materials scientist
- Medicinal chemist
- Pulp and paper chemist
- Safety or health inspector
- Textile chemist
- Water chemist

5. Have students research a chemistry-related job. They may choose one listed above or another from their own research. Have them answer the following questions:

   General Questions

   - What is the purpose of this job?
   - What are some of its specific tasks?
   - What kind of education and experience is required?
   - In what kinds of places might people in this job work? (lab, outside, in an office, etc.)
   - In what types of companies do people with this job work?

   Personal Questions

   - What would you like about this job?
   - What wouldn't you like?
   - What would be most challenging?
   - Do you think this job is a good fit for you? Why or why not?

6. Share the following Web sites with the class. Give students at least one full class period to read about careers and select one to explore.

   - Chemical Careers (list of careers, background, quotes, general information)
     http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=vc2%5c3wk%5cwk3.html
   - A Day in the Life: Chemist
     http://www.princetonreview.com/cte/profiles/dayInLife.asp?careerID=34
   - A Day in the Life: Chemical Engineer
     http://www.princetonreview.com/cte/profiles/dayInLife.asp?careerID=33
   - What Do Chemical Engineers Do? (click "Job Descriptions")
     http://www.aiche.org/careers/overview.htm
   - Chemists and Materials Sciences
     http://www.bls.gov/oco/ocos049.htm

- Chemical Engineers
  http://www.bls.gov/oco/ocos029.htm
- Chemical and Engineering News: Career & Employment News (from flavor and fragrance chemists to those who discover and develop drugs)
  http://pubs.acs.org/cen/html/career.html
- Adventures of Meg A. Mole, Future Scientist (Featured chemists make household products and NASA insulation)
  http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=kids%5cmeg_index.html
- Science & Technology: Cool Tech Jobs (See Cosmetic Chemist and Forensic Scientist)
  http://www.girlpower.gov/girlarea/sciencetech/jobs/index.htm
- Science Knows No Boundaries (see Chemist and Food Scientist)
  http://www.ars.usda.gov/is/kids/scientists/scientistsframe2.htm
- Going Places with Chemistry (biographies of female scientists)
  http://www.chemheritage.org/women_chemistry/career/career.html
- BLS Career Information: Jobs for People Who Like Science (Chemist, Pharmacist)
  http://stats.bls.gov/k12/html/edu_sci.htm
- GetTech Careers
  http://www.gettech.org/txt/category2_txt.asp?cat=5
- Cool Tech Jobs: Cosmetic Chemist
  http://www.girlpower.gov/girlarea/sciencetech/jobs/cosmeticchemist.htm
- Career Zone: Chemists (click "Similar Jobs" for more)
  http://nycareerzone.org/graphic/profile.jsp;jsessionid=819311053448876046?onetsoc=19-2031.00

7. Give students a full class period to complete their research. As homework, have them create a poster entitled "If I were a..." about the profession they chose. The poster should include answers to the general questions in step 5.
8. Over the next few days, have students present their posters to the class. In their presentations, they should share answers to the personal questions above. Ask students to discuss each career after a presentation, citing something that surprised them about the job.

Assessment

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

- **3 points:** Students recalled several chemistry-related careers from the program; created a thorough poster that answered all research questions; made a clear presentation with thoughtful answers to the personal questions.
- **2 points:** Students recalled one or two chemistry-related careers from the program; created a satisfactory poster that answered most research questions; made an adequate presentation with thoughtful answers to at least one personal question.

- **1 point:** Students recalled no chemistry-related careers from the program; created an incomplete or sloppy poster that answered few or no research questions; made an unclear presentation without answering any personal questions.

Vocabulary

chemistry

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

Context: Detectives often use chemistry in their work, such as when they analyze residue from guns and determine the blood types at crime scenes.

engineer

Definition: One who applies science to the design and development of buildings, machines, and other products

Context: Chemical engineers use chemistry to solve problems and create new products.

forensic science

Definition: The study of evidence discovered at a crime scene and used in a court of law

Context: Forensic science encompasses fingerprint and handwriting analysis, as well as close scrutiny of fibers, hair, and other evidence found at the scene of a crime.

materials science

Definition: The study of the characteristics and uses of the various materials, such as metals, ceramics, and plastics, that are employed in science and technology

Context: Those who work in materials science work to develop new materials with unusual properties, such as a plastic that can conduct electricity.

Academic Standards

National Academy of Sciences

The National Science Education Standards provide guidelines for teaching science as well as a coherent vision of what it means to be scientifically literate for students in grades K-12. To view the standards, visit http://books.nap.edu.

This lesson plan addresses the following science standards:

- Science as Inquiry: Understandings about scientific inquiry
- Physical Science: Properties and changes of properties in matter
- Science in Personal and Social Perspectives: Science and technology in society
- History and Nature of Science: 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/.

This lesson plan addresses the following national standards:

- Science—Physical Sciences: Understands the structure and properties of matter
- Language Arts—Viewing: Uses viewing skills and strategies to understand and interpret visual media; Reading: Uses reading skills and strategies to understand and interpret a variety of informational texts
- Technology— Understands the relationships among science, technology, society, and the individual

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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

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DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How To Use the DVD

The DVD starting screen has the following options:

Play Video—This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into four parts (see below), indicated by video thumbnail icons. Watching all parts in sequence is similar to watching the video from start to finish. Brief descriptions and total running times are noted for each part. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

Curriculum Units—These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total

running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

***Standards Link*—**Selecting this option displays a single screen that lists the national academic standards the video addresses.

***Teacher Resources*—**This screen gives the technical support number and Web site address.

Video Index

I. The Periodic Table of Elements (9 min.)

The periodic table is the backbone of chemistry. Take a closer look at its groups and periods—and what they tell us about elements.

II. Clues from Chemistry (22 min.)

From pinpointing grains of sand to sniffing out accelerant, forensic investigators use chemical clues to unravel unsolved mysteries.

III. Chemical Display (6 min.)

Fireworks light up the night with their extraordinary colors and patterns. Explore the chemistry behind pyrotechnics.

IV. Carbon Copies (9 min.)

Carbon, the element most important to life on Earth, can take many forms. Discover the new uses scientists are exploring for this industrious element.

Curriculum Units

1. A Jeweler's Dream

Pre-viewing question
Q: Why is gold so highly prized?
A: Answers will vary.

Post-viewing question
Q: What makes gold an ideal metal for jewelry?
A: Its physical properties: Gold has a low melting point, it doesn't react with oxygen (tarnish), and as a fairly soft metal, it's easy to craft.

2. Looking at the Elements

Pre-viewing question
Q: What's the most important element in the world?
A: Answers will vary.

Post-viewing question
Q: How is the periodic table arranged?
A: The horizontal rows of elements, called periods, are organized by the electrons in their atoms. As you move left to right within a period, the properties of the elements gradually change. The vertical

columns of elements are called groups. The elements in each group have similar chemical properties.

3. Atoms and Elements

Pre-viewing question
Q: What known element is the most reactive?
A: Answers will vary.

Post-viewing question
Q: What is the makeup of an atom?
A: All atoms have the same make-up—electrons surrounding a central nucleus, which is composed of particles called protons and neutrons. Electrons carry a negative electrical charge. Protons are positively charged. Neutrons have a neutral charge.

4. Mysterious Balloons

Pre-viewing question
Q: What's the most unusual object you've seen in the sky?
A: Answers will vary.

Post-viewing question
Q: Why did the military suppress news about the balloons?
A: Answers will vary.

5. Balloon Bomb Science

Pre-viewing question
Q: Who would you guess was sending the balloon bombs?
A: Answers will vary.

Post-viewing question
Q: How did the balloon bombs work?
A: When released, the balloons floated upward. As the sun heated a balloon, it would expand and rise. But if it expanded too much, it could burst, so a valve opened that would release excess pressure. As night fell and a balloon cooled, it would descend. But if it dropped too much, it could crash. To prevent this, an altimeter closed a switch that ignited a charge. The blast released a pair of sandbags, lightening the load and sending the balloon back up. When all the sand bags had been released, a final charge would release the bomb.

6. Stopping the Bombs

Pre-viewing question
Q: What can you tell by looking at grains of sand?
A: Answers will vary.

Post-viewing question
Q: How did the sand in the balloon bombs help geologists locate their origin?
A: The sand lacked coral fragments and granite, one of the most common rock types on Earth. It had high concentrations of rare volcanic minerals and microscopic plant and animal fossils. The

absence of coral ruled out all beaches south of the 35th parallel; coral is almost always found in the warm waters that wash these beaches. The absence of granite eliminated other beaches. The volcanic minerals led the geologists to the peninsula east of Tokyo, and the microscopic fossils to Ichinomiya/Sendai.

7. Investigating Arson

Pre-viewing question
Q: Why do people commit arson?
A: Answers will vary.

Post-viewing question
Q: What are the drawbacks of using animals for arson investigations?
A: Answers will vary.

8. Dog Senses

Pre-viewing question
Q: What is a dog's most important sense?
A: Answers will vary.

Post-viewing question
Q: What can we learn about human olfaction by studying animal olfaction?
A: Answers will vary.

9. Fire in the Air

Pre-viewing question
Q: What are the dangers of fireworks?
A: Answers will vary.

Post-viewing question
Q: What are the main ingredients in firework stars?
A: An oxidizing agent, fuel, and chemicals that provide color. In most stars, the main fuel is the powdered form of the metal aluminum. Chemicals that add colored flames include strontium (red), barium (green), and copper (blue).

10. Explosions of Light and Color

Pre-viewing question
Q: Are fireworks difficult to make?
A: Answers will vary.

Post-viewing question
Q: What are the four parts of an aerial shell?
A: They are: 1) the lift charge, a packet of black powder taped to the bottom of the aerial shell that provides the energy needed to propel the shell into the air; 2) the star bundle; 3) the bursting charge, which bursts the aerial shells open, ignites the stars, and pushes them outward in a pattern; and 4) the fuse, which provides the activation energy for the shell.

11. Collecting Hydrocarbons

Pre-viewing question
Q: What are the pros and cons of drilling for oil?
A: Answers will vary.

Post-viewing question
Q: Where does hydrocarbon come from?
A: It's produced from crude oil, found deep within Earth's crust. To obtain hydrocarbons, oil companies drill into the layers of rock.

12. Forms of Carbon

Pre-viewing question
Q: In what form is carbon most valuable?
A: Answers will vary.

Post-viewing question
Q: Why makes diamonds strong and stable?
A: Their carbon atoms are arranged in a crystal structure—each carbon atom is bonded to four others. Diamonds do not easily react with other chemicals.