Periodic Table of the Elements
Noble Gases
Teacher's Guide

Grade Level: 9–12	**Curriculum Focus**: Physical Science	**Lesson Duration:** Two class periods

Program Description

From Times Square to Las Vegas, everyone knows the allure of the bright neon lights. Take a broader view of the noble gases by looking at their applications in photography and electronics.

Lesson Summary

Students identify the noble gases on the periodic table of the elements and discuss their key characteristics. Then they research how neon signs are made and how different noble gases produce different colors when an electric current is applied. The final product is a design for a neon sign and an explanation of how it is made.

Onscreen Questions

Part 1, "Exploring the Noble Gases," "Helium: Rocket Fuel," "Neon: Fabulous Fluorescence," and "Krypton: Faster than a Speeding Bullet"

- What properties do the noble gases share?
- How do neon and other noble gases produce light?

Part 2, "Understanding the Universe"

- What are the most common elements in stars?
- What evidence supports the Big Bang theory?

Lesson Plan

Student Objectives

- Identify the noble gases on the periodic table of the elements and describe two characteristics of this group.

- Design a neon sign and explain how it is made, identifying which noble gas produces each color.

Materials

- *Noble Gases* program
- Computer with Internet access
- Copy of the Periodic Table of Elements
- Sheets of white paper
- Markers and colored pencils

Procedures

1. Begin the lesson by asking students to write on a piece of scrap paper where they have seen neon signs and whether they think these signs are effective. Then ask them to put the piece of paper away until the end of the lesson.
2. Direct students' attention to the periodic table of the elements in a book or on a class chart. Point out the noble gases. As a class, make a list of the elements in this group, where on the periodic table they are located, and two characteristics of this group. The chart will include the following information.

   Elements in the Noble Gases Group

   - Helium
   - Neon
   - Argon
   - Krypton
   - Xenon
   - Radon

   Group on the Periodic Table

   - Group 18

   Characteristics of the Group

   - Stable and inert, or nonreactive
   - Colorless
   - Odorless

3. Point out to students that even though the noble gases are colorless, some of them, including neon, argon, and xenon, are used to make neon signs found in many different places. Explain to students that they will be learning how colorless gases are used to make these colorful signs. Then they will design their own signs and write a description explaining how their signs are made.
4. Ask students to begin their research about how noble gases are used to make neon signs by watching two segments from the program *Noble Gases*—"Exploring the Noble Gases" and "Neon: Fabulous Fluorescence." Ask students to pay close attention to how different colors are produced from the noble gases.
5. After students have finished watching the segments, give them time in class to design an interesting neon sign and to research how these signs are made. The Web sides listed below have useful information on this topic.
   http://www.chemicalelements.com/groups/noblegases.html
   http://science.howstuffworks.com/question293.htm
   http://inventors.about.com/library/weekly/aa980107.htm
   http://collections.ic.gc.ca/neon/neonscience/neon.html
6. For your information, here is a brief description of how neon signs are made.
   - Hollow glass tubes of varying lengths are used to make the different shapes seen in neon signs. The glass is heated on burners that use a combination of a gas and forced air. Four burners are used during this process. Specialized burners produce different shapes. For example, fishtail burners produce angles, and ribbon burners produce curves. Hand torches also are used.
   - To produce color, the gases must be put into the tube. A vacuum is created in the tube, and then as the tube cools, the gases are pumped in from a large tank. Once the gases are in the tube, an electrical current is applied, which excites the atoms and causes them to emit light.
   - Different gases produce different colors. Neon glows bright red. A mixture of argon and small particles of mercury emits a bluish color. Coating the glass with phosphor and then adding argon results in yellow and some shades of white.
   - An artist often creates a sign simply by bending the tubes. Sometimes, however, the artist uses a pattern in creating the design. Then glass is bent over a fire-resistant pattern laid over the burners.
7. During the next class period, give students a little more time to complete their signs and descriptions. Then ask for volunteers to share their signs. Make sure students explain how to create the signs and their colors.
8. Conclude the lesson by asking students to revisit the notes they recorded at the beginning of he lesson. Now that students know more about neon signs, is there anything they would add to their initial ideas? What do students think can be done to make neon signs even more effective?

Assessment

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

- 3 points: Students identified all the noble gases on the periodic table of the elements and accurately described several characteristics of these elements; developed a highly creative design for their neon sign; and demonstrated a clear understanding of how signs are made and how the noble gases are used to produce different colors.
- 2 points: Students identified most of the noble gases on the periodic table of the elements and satisfactorily described at least two characteristics of these elements; developed a satisfactory design for their neon sign; and demonstrated a satisfactory understanding of how signs are made and how the noble gases are used to produce different colors.
- 1 point: Students had difficulty identifying the noble gases on the periodic table of the elements and could not describe any characteristics of these elements; did not complete a design for their neon sign; and demonstrated a weak understanding of how signs are made and how the noble gases are used to produce different colors.

Vocabulary

argon

Definition: A noble gas that, when mixed with phosphor and stimulated by an electric current, produces a yellow color

Context: Because argon produces an interesting color when mixed with another material, it is often used in brightly colored signs.

neon

Definition: A noble gas that glows bright red when its atoms are stimulated by an electric current

Context: The British chemist Sir William Ramsay discovered neon at the end of the 19th century, but it wasn't until 1910 that the Frenchman Georges Claude figured out how to produce neon lighting.

neon signs

Definition: Brightly colored signs produced by pumping neon and other noble gases through a vacuum tube and applying electricity

Context: Part of the glamour of Las Vegas comes from the many neon signs that call attention to hotels and restaurants.

noble gases

Definition: The elements in Group 18 of the Periodic Table that are odorless, colorless, and not very reactive

Context: Unlike the nonmetals, which are quite common, the noble gases are found only in small amounts on Earth.

periodic table of the elements

Definition: An organization of Earth's elements arranged according to atomic number, or the number of protons an element's nucleus contains

Context: The six elements found in Group 18 of the periodic table of the elements are helium, neon, argon, krypton, xenon, and radon; together, these are referred to as the noble gases.

Academic Standards

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:

- Physical Sciences: Understands the structure and property of matter
- Language Arts—Viewing: Uses viewing skills and strategies to understand and interpret visual media
- Visual Arts—Understands the visual arts in relation to history and cultures

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 national standards:

- Physical Science: Chemical reactions
- Physical Science: Structure and properties of matter

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

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 sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. 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. Exploring the Noble Gases (5 min.)
Examine the key properties and uses of the noble gases, the most stable group of elements on the periodic table.

II. Helium: Rocket Fuel (7 min.)
Less dense than the air we breathe, helium is a stable gas that plays an important role in helping the space shuttle explore outer space.

III. Neon: Fabulous Florescence (6 min.)
Combined with electricity, the normally colorless and inert neon gives Las Vegas its round-the-clock glow. Learn about the chemistry of neon lights.

IV. Krypton: Faster Than a Speeding Bullet (6 min.)
High-speed photography captures ordinary actions in exquisite detail. Learn the properties and uses of krypton and discover the role it plays in photographs.

V. Understanding Our Universe (22 min.)
Learn some of the most important discoveries in astronomy and how the noble gases contribute to the formation of stars and the universe.

Curriculum Units

1. Key Properties of the Noble Gases
Pre-viewing question
Q: What do you know about the noble gases?
A: Answers will vary.

Post-viewing question
Q: Why is it difficult for the noble gases to form compounds?
A: The noble gases, which reside in group 18, have a full valence shell; because they need no electrons to be stable, they rarely react with other elements. Just the heavier noble gases form compounds and then only in the lab.

2. Properties and Uses of Helium
Pre-viewing question
Q: What are some uses of helium?
A: Answers may include filling party and scientific balloons and blimps. Combined with oxygen, helium goes into scuba divers' tanks.

Post-viewing question
Q: Compare the density of helium and the density of air.
A: Helium is very light, about seven times less dense than air.

3. Helium Fuels Space Travel
Pre-viewing question
Q: What happens in the launching of a space shuttle?
A: Answers will vary.

Post-viewing question
Q: How does helium help a space shuttle leave Earth's atmosphere?
A: A space shuttle's OMS, or orbital maneuvering system, which places the shuttle into orbit, requires helium to operate. To ignite the OMS, helium gas is released through a series of valves and tubes, releasing the fuel and oxidizers. Because it has a full valence shell, there is no danger of helium reacting with the fuel or the oxidizer and creating possible hazards for the shuttle crew or a possible loss of fuel.

4. Properties and Uses of Neon
Pre-viewing question
Q: What do you know about the element neon?
A: Answers will vary.

Post-viewing question
Q: Describe an atom of neon in its most common form.
A: In its most common form, the nucleus of a neon atom contains 10 positively charged protons and 10 uncharged neutrons. Neon has 10 negatively charged electrons to balance its 10 protons. These electrons are found in two orbital shells surrounding the nucleus. Its valence shell is complete, so neon is extremely stable and nonreactive.

5. The Lights of Las Vegas
Pre-viewing question
Q: What do you know about the signs in Las Vegas?
A: Answers will vary.

Post-viewing question
Q: What gives neon lights their different colors?
A: The wavelength of the light energy released when electricity runs through a neon-filled tube determines the color of the florescence. While brightly lit signs are commonly called neon lights, it takes other gases individually and collectively to achieve more than 150 different colors. Neon produces a familiar reddish glow, krypton glows silvery white, and xenon glows green-blue.

6. Properties and Uses of Krypton
Pre-viewing question
Q: What are some stable elements?
A: Answers will vary.

Post-viewing question
Q: What are some common uses of krypton?
A: Krypton is used for lighting for high-speed photography, and luminous signs that glow with a greenish-yellow light. Some florescent light bulbs have a mixture of krypton and argon gases. In 1960 the length of a meter was defined by the orange-red spectral line of an isotope of krypton. Recently a helium-neon laser replaced krypton as the standard length of a meter.

7. Krypton and High-Speed Photography
Pre-viewing question
Q: What is an advantage of using high-speed photography?
A: Answers will vary.

Post-viewing question
Q: Why are krypton lights used in creating high-speed photographs?
A: Krypton lights can produce the enormous amount of light necessary to keep the exposure on a photographic subject. Several krypton light sources together provide enough light for high-speed filming. The element's brightness and extremely fast response to an electrical current make it invaluable for quality high-speed photography.

8. Early Astronomers
Pre-viewing question
Q: What do you know about the field of astronomy?
A: Answers will vary.

Post-viewing question
Q: How was helium discovered?
A: While studying the outermost layer of the sun during a total solar eclipse in 1868, French astronomer Pierre Jules Caesar Janssen noticed an unusual yellow line in its spectrum. The English astronomer Sir Norman Lockyer realized that the line could not be produced by any known element, and he hypothesized that a new element—later called helium—was responsible for the yellow emission.

9. An Expanding Universe
Pre-viewing question
Q: Why do you know about the big bang theory?
A: Answers will vary.

Post-viewing question
Q: How old is our universe according to the big bang theory?
A: Astronomers have determined that the big bang that created the universe took place 15 to 20 billion years ago.

10. Images From Space
Pre-viewing question
Q: What interesting things have you seen in the night sky?
A: Answers will vary.

Post-viewing question
Q: Do you think new evidence will cause scientists to drastically revise the big bang theory? Explain your answer.
A: Answers will vary.

11. Radio Astronomy: Static From Space
Pre-viewing question
Q: What do you think are the most important discoveries in astronomy?

A: Answers will vary.

Post-viewing question
Q: Describe the events that led to astronomer George Smoot's discovery.
A: Announced in 1992, George Smoot's discovery was evidence of subtle variations in the energy left over from the universe's creation. He searched for irregularities in the background radiation to show that the big bang had been uneven. Before this discovery, astronomers thought the universe was expanding uniformly and that the only motion we should see is Earth going around the sun and the sun going around the galaxy. When they began to see that the largest motion of all was galaxy itself, the only conclusion they could reach was that something was causing the galaxy to move. What they determined is that a large group of galaxies must be nearby, which did not fit with the energy of the big bang being evenly spread.

12. Black Holes and Stars
Pre-viewing question
Q: What would you like to know about our universe?
A: Answers will vary.

Post-viewing question
Q: Where might the matter inside a black hole go?
A: Answers will vary.