1. Explain the relative size of subatomic particles using the following analogy: if an atom was the size of a huge football stadium, the nucleus of the atom would be the size of an orange on the field and electrons would only be the size of flies buzzing all the way up near the top of the stadium!
2. Discuss with students that while there are 92 naturally occurring elements, scientists have used the Periodic Table to predict the properties of synthetic elements and have discovered methods to synthesize many more.

Follow-up Activities

- Assemble a large number of styrofoam balls, connectable building blocks, clay, straws, sticks, toothpicks and gumdrops and challenge students to create three-dimensional models of atoms of specific elements using the Internet, textbooks and the Periodic Table as references.
- Ask your students to research different points in the history of the development of atomic theory, from the beliefs of ancient Greeks like Democritus and Aristotle, to the observations of scientists like John Dalton and Antoine Lavoisier, to the breakthroughs of scientists like Lise Meitner, Erwin Schrödinger, Neils Bohr and Albert Einstein, who were involved in the study of nuclear science and the creation of atomic models.

Internet Resources

Periodically, Internet Resources are updated on our web site at www.LibraryVideo.com

- **www.miamisci.org/af/sln/index.html**
  The Atoms Family site presented by the Miami Museum of Science contains a number of fun, hands-on activities that are an excellent way to learn about the principles of atoms and matter.
- **www.lbl.gov/abc**
  These pages provide a brief introduction to nuclear structure by the Nuclear Science Education Committee from the Lawrence Berkeley National Laboratory.
- **www.chem4kids.com/atoms/index.html**
  These pages from Rader's Chem4Kids kid-friendly Web site present atomic and molecular structure, chemical bonds and phases of matter.
- **library.thinkquest.org/3659/atommole/atoms.html**
  This CHEMystery site is a student-developed set of pages that gives an understandable and concise overview of atomic theory.

TEACHER'S GUIDE

Suggested Print Resources

- Barron, Rachel Stiffler. *Lise Meitner: Discoverer of Nuclear Fission*. Morgan Reynolds, Greensboro, NC; 2000.
- Gallant, Roy A. *The Ever-Changing Atom*. Benchmark Books, New York, NY; 2000.
- MacLeod, Elizabeth. *Albert Einstein: A Questioning Life*. Kids Can Press, Tonawanda, NY; 2003.
- Miller, Ron. *The Elements*. Lerner Publishing Group, Minneapolis, MN; 2004.

TEACHER'S GUIDE CONSULTANT

Conrad M. Follmer

25 years as a K-5 Science & Math Coordinator for a Pennsylvania public school system, currently an independent consultant to elementary schools.

TITLES

- **ATOMS & MOLECULES**
- **CHANGES IN PROPERTIES OF MATTER**
- **CHARACTERISTICS OF WAVES**
- **ELECTRICITY**
- **ELEMENTS, COMPOUNDS & MIXTURES**
- **FLIGHT**
- **FORCES**
- **FRICTION**
- **GRAVITY**
- **LIGHT**
- **MAGNETISM**
- **MOTION & BALANCE**
- **THE PERIODIC TABLE**
- **PROPERTIES OF MATTER**
- **SIMPLE MACHINES**
- **SOUND**

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TEACHER'S GUIDE

PHYSICAL SCIENCE IN ACTION™

Atoms & Molecules

Grades 5–8

Students in grade 5-8 classrooms possess a wide range of background knowledge. Student response to this video program is sure to be varied, so the teachers at these grades need all the help they can get! This guide has been designed to help the 5-8 science teacher by providing a brief synopsis of the program, previewing and follow-up questions, activities, vocabulary and additional resources.

Before Viewing: Extensive research tells how important it is for the teacher to discover what the students know — or think they know — about a topic, before actually starting a new unit. Therefore, after prompting discussion with the pre-viewing questions, lead your class to create a "Everything We Think We Know About…" list. You may also wish to preview key vocabulary words, and have students raise additional questions they hope will be answered.

After Viewing: Have your students share video excerpts that fascinated or surprised them, then challenge your students to prove or disprove the accuracy of the facts they put on their "Everything We Think We Know About…" list. Discuss what else they learned and use the follow-up questions and activities to inspire further discussion. Encourage students to research the topic further with the Internet and reading resources provided.

SCHLESSINGER SCIENCE LIBRARY

Program Summary

Everything in our world, from a puppy to a shooting star, is made of atoms and groups of atoms called molecules. Atoms themselves are made of subatomic particles called electrons, protons and neutrons. The nucleus of every atom is made of a certain number of protons and neutrons and orbiting this nucleus are smaller particles called electrons. These particles each have an electric charge and, just as with magnets, opposite charges attract and likes repel. Protons have a positive charge and neutrons have no charge, so the nucleus has a total positive charge. Since electrons have a negative charge, they are attracted to the nucleus. This is called electromagnetic force. The powerful force that keeps protons and neutrons together in the nucleus of an atom is nuclear force. This force is the strongest force known! The incredible power of nuclear force is released as energy when the nucleus is forced to split apart.

If everything is made of atoms and their subatomic particles, why doesn't everything look alike? The answer to this question can be found by studying the properties of elements. Atoms with identical properties and a specific number of protons in their nuclei are called elements. For example, every atom of the element sulfur in the universe has 16 protons and possesses identical properties. Scientists have discovered over 100 different elements and grouped them according to their properties in the Periodic Table of Elements. The atomic number of each element is the number of protons found in the nucleus of atoms comprising that element, and the atomic mass of an element is found by adding the number of protons and neutrons found in atoms of that element. The 20 million different substances in the world come from combinations of two or more of these elements in a process known as chemical bonding. When elements bond or combine, the result is a compound. All of the molecules of a compound are the same, just as all of the atoms of a single element are the same. For example, when two atoms of hydrogen bond with one atom of oxygen, the result is one molecule of the compound known as water. Because the hydrogen and oxygen atoms in a molecule of water share their electrons, this type of bond is a covalent bond. However, when the atoms of elements give up or gain electrons to create a compound, the bond is an ionic bond. Losing an electron creates a positive electrical charge, making a positive ion, while gaining an electron creates a negative ion. In summary, chemical bonds are created when atoms lose, gain or share electrons.

Vocabulary

The following words are included for teacher reference or for use with students. They are listed in the order in which they appear in the video.

atoms — The small particles that make up matter, consisting of a nucleus containing protons and neutrons surrounded by orbiting electrons.

subatomic particles — The small parts that comprise an atom: protons, neutrons and electrons.

nucleus — The center of every atom, containing positively charged protons and neutrally charged neutrons. The number of protons in a given nucleus distinguishes one element from another.

Democritus — (460 — 370 BCE) A Greek philosopher who theorized that all matter could be reduced to particles that could not be divided, which he described as "atomos."

(Continued)

proton — A subatomic particle located in the nucleus of an atom that carries a positive charge.

neutron — A subatomic particle with a neutral charge located in the nucleus of an atom.

electron — The negatively charged particles that orbit the nucleus of every atom.

electromagnetic force — The attraction or repulsion between charged particles. Electromagnetic force holds negatively charged electrons to the positively charged nuclei of atoms.

nuclear force — The strongest force known, responsible for the joining of subatomic particles within an atom.

elements — Unique pure substances that are comprised of atoms having the same properties and the same number of protons. Everything in the universe is made of some combination of approximately 100 elements.

Periodic Table of Elements — The scientific chart that contains an arrangement of all known elements into a particular order based upon the number of protons and other properties of each element.

atomic number — The number of protons in an atom. All the atoms of an element have the same atomic number.

atomic mass — The average mass of an atom of an element found by adding the number of protons and neutrons in an atom.

chemical bond — Interaction among atoms that occurs when electrons are shared or transferred.

compounds — Substances formed by the joining of elements through chemical bonding. Every molecule of a compound is the same.

covalent bond — The type of chemical interaction in which atoms share electrons.

ionic bond — The type of chemical interaction in which atoms lose or gain electrons, creating either negative or positive ions.

ion — An atom or group of atoms that carries an electric charge as a result of having lost or gained one or more electrons.

Pre-viewing Discussion

Before students generate their list of "Everything We Think We Know About…" for this topic, stimulate and focus their thinking by raising these questions so that their list will better reflect the key ideas in this show:

1. What is matter?
2. What is the difference between an atom and a molecule?
3. How are substances formed?

After the class has completed their "Everything We Think We Know About…" list, ask them what other questions they have that they hope will be answered during this program. Have students listen closely to learn if everything on their class list is accurate and to hear if any of their own questions are answered.

Focus Questions

1. What is the smallest particle of matter?
2. What are the subatomic particles that make up atoms?
3. Can you describe a typical model of an atom?
4. What did the ancient Greek philosopher Democritus believe about matter? Was his theory widely accepted during his lifetime?
5. What do magnets and subatomic particles have in common?
6. What are the electric charges of subatomic particles?
7. How does electromagnetic force hold subatomic particles together?
8. If like charges repel, how does the positively charged nucleus of an atom stay together?
9. What is nuclear force?
10. What makes one atom different from another?
11. What are some characteristics of sulfur?
12. Approximately how many elements can be found in nature?
13. What is the Periodic Table of Elements?
14. What does an element's atomic number tell about that element?
15. What are some examples of properties of elements?
16. What does an element's atomic mass tell about the atoms that make up that element?
17. If there are only a little over 100 elements, how can there be over 20 million different substances in the world?
18. How do atoms join together to make different substances?
19. What is the relationship between atoms and elements?
20. What is the relationship between compounds and molecules?
21. What is a covalent bond?
22. What is an example of a molecule created by a covalent bond?
23. What is an ionic bond?
24. What is an example of a compound created by an ionic bond?
25. What are the phases of matter?
26. How does the vibration of atoms relate to phases of matter?

Follow-up Discussion

Research indicates that students will retain their previous misconceptions about a topic, in preference to new information, until they actively recognize and correct their own errors. Therefore, it is important to have your students re-examine the facts/beliefs they put on their "Everything We Think We Know About…" list. It might also be helpful to review the list by marking each entry with a "+" or "-" to show which facts were correct and which were incorrect.

Discussions that ensue from thought-provoking questions provide a good way to assess the overall depth of student understanding. The following are some suggested discussion questions.

(Continued)