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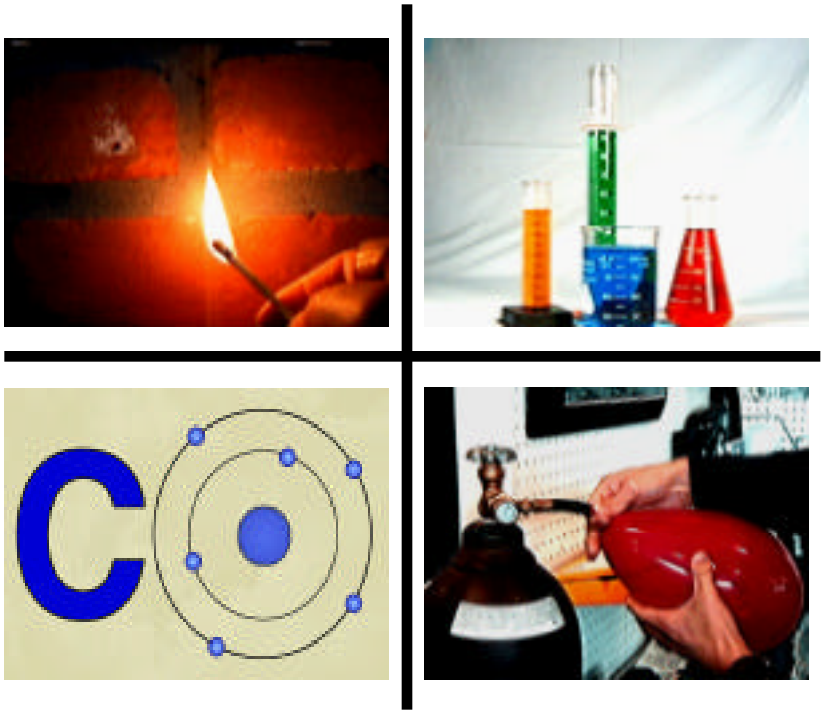
Atomic Structure and the Periodic Table



from the
Physical Science Series

Teacher's Guide

ATOMIC STRUCTURE AND THE PERIODIC TABLE

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Atomic Structure and the Periodic Table

Teacher's Guide
Table of Contents

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Atomic Structure and the Periodic Table
Teacher's Guide
Grades 5-8

Introduction

This video is geared towards students in grades 5 - 8. The goal of the program is to familiarize students with the principles of physical science, particularly the atomic structure and the Periodic Table. A detailed examination of the structure of the atom will expose students to subatomic particles, including protons, neutrons, and electrons. Students will be shown how to compute atomic numbers, and learn how isotopes relate to atomic number. They will address such topics as atomic mass and electron arrangement of different elements. This information will provide background for understanding the organization of the Periodic Table, as well as its major groups and families.

Links to Curriculum Standards

This video correlates to the following:

A. National Science Education Standards for Grades 5-8
   Physical Science (Content Standard B)
   Properties and Changes of Properties of Matter

B. Benchmark for Science Literacy (American Association for the Advancement of Science - Project 2061) - for Grades 6-8 - The Physical Setting: 4D The Structure of Matter

Summary of the Video

The video is vocabulary-rich and uses key terminology such as *atomic structure, subatomic particles, nucleus, protons, atomic mass units, neutron, atomic number, isotopes, electrons, electron cloud, metals, nonmetals,* and *metalloids*. Numerous colorful and easy-to-understand graphics greatly enhance student under-

standing of the key concepts involved with learning about atomic structure and the Periodic Table.

Pretest

An optional pretest is provided (**Blackline Master #1**) . This test will help you determine the level of student comprehension prior to participating in this lesson. An Answer Key appears on pages 6-11 of this Teachers Guide.

Video Quiz

The video concludes with a ten-question Video Quiz which may be used to gage student comprehension immediately after the presentation of the video. **Blackline Master #2: Video Quiz** provides students with a printed copy of the questions and a list from which to choose correct answers.

Instructional Notes

Before presenting this lesson to your students we suggest that you preview the video and review this guide, and the accompanying blackline master activities in order to familiarize yourself with their content.
As you review the materials presented in this guide, you may find it necessary to make some changes, additions, or deletions to meet the specific needs of your class. We encourage you to do so, for only by tailoring this program to your class will they obtain the maximum instructional benefits afforded by the materials.

It is also suggested that the video presentation take place before the entire group under your supervision. The lesson activities grow out of the context of the video, therefore, the presentation should be a common experience for all students.

Student Preparation

You may want students to look up the vocabulary words addressed in the video. Have them write down the definitions, and review their spelling and pronunciations. Terms such as *atomic structure, subatomic particles, nucleus, protons, atomic mass units, neutron, atomic number, isotopes, electrons, electron cloud, metals, nonmetals,* and *metalloids* may be unfamiliar to students, and studying them before viewing the video will enhance student understanding.

Introducing the Video

You can introduce the video by asking students to write down as many elements they can name. After students have made their list of elements, compile a class list on the board. Next ask students how they would organize these elements in a logical manner. Discuss how they would organize the elements in a chart. Ideas might include by looks, by weight, by density, or perhaps even by atomic structure. Next, explain to students that scientists have struggled with same issue for hundreds of years, until they developed a logical way to organize elements in a chart called the Modern Periodic Table.

Student Objectives

After viewing the video and completing the lessons and activities, students should be able to do the following:

- Define and identify the parts of the atom.
- Define the terms *electron, proton, neutron, electron cloud, nucleus, isotope, metals, nonmetals,* and *metalloids.*
- Describe the organization of the Modern Periodic Table.
- Differentiate between groups and periods on the Periodic Table.
- Interpret information provided on the Periodic Table pertaining to atomic mass and atomic number.
- Describe general characteristics of groups on the Modern Periodic Table.

View the Video

This video is approximately eighteen minutes in length.

FOLLOW-UP ACTIVITIES

Discussion Questions

Following the video, students may have additional questions. Allow time for students to air their questions. Avoid answering the students' questions directly. Ask them additional questions leading them to the answers on their own, or encourage other students in the class to answer questions.

There are numerous issues which may warrant further questions. As a class you may want to discuss the following: these questions appear on **Blackline Master #3: Discussion Questions**, and may be distributed prior to class discussion. Answers to these questions appear in the Answer Key on pages __ of this guide.

1. Name the parts of an atom.
2. Provide examples of elements and their atomic number.
3. Provide an example of an isotope.
4. Provide examples of elements and their chemical symbols.
5. What are some of the characteristics of metals.
6. Describe how the Periodic Table is arranged.

Blackline Masters

The following Blackline Master activity sheets are included with this guide. You may replicate and distribute them as needed. An Answer Key appears on pages 6-11 of this guide.

(1.) **Blackline Master #1: Pre-Test** is to be given to your students prior to viewing the video to assess their prior

knowledge of the topic.

(2.) **Blackline Master #2** is the sheet corresponding to the **Video Quiz** questions found at the end of the video. You may want to stop the video before the Quiz in order to distribute this sheet. Students should select the answers from the list at the bottom of the page. Review the questions and answers as a group, or collect the Quizzes for grading; they will help you determine student comprehension immediately following the video but before executing the Follow-up Activities.

(3.) **Blackline Master #3: Discussion Questions** corresponds with the questions presented in the previous section, and may be distributed prior to class discussion.

(4.) **Blackline Master #4: Word Search** is a vocabulary exercise. Once the words have been located on the grid, students should write their own definitions of each term on the sheet. Discuss their definitions, correcting any misconceptions.

(5.) **Blackline Master #5** is an **Internet Lesson** which helps students to understand atomic structure and the Periodic Table.

(6.) **Blacklines Master #6: Navigating the Modern Periodic Table** and **#7: Themes on the Periodic Table** are worksheets for the students to complete in class to further stress the concepts of atomic structure and the Periodic Table.

(7.) **Blackline Masters #8a-8b: Post-Test** is to be given to your students after viewing the video and completing the accompanying exercise to assess their knowledge of the topic. Questions are weighted to reflect difficulty of answers. Total point value is 100.

Extended Learning Activities

1. Observation Skills - Assign the students a task of trying to identify elements in their daily surroundings at home, school, and in other locations. After this is completed, compile a class list of all the elements that students have observed.
2. Creative Writing - Have students write a short story about future elements that might be added to the Periodic Table. What are the names of these new elements and why was that name chosen? How was it discovered and what are its uses and properties?
3. Career Connection - Have each student interview a person in his or her community who works with the Periodic Table and its elements, such as pharmacists, engineers, farmers, chemists, physicists, landscapers, and medical technologists , as well as many others. Each student should then report to the class on what he or she discovered, during a two-minute public speaking presentation.
4. History of Science - Have students research and write five-page papers on the major figures in developing the modern Periodic Table, such as Dmitri Mendeleev or Henry Moseley

Answer Key

Blackline Master #1: Pre-Test

1. F
2. T
3. T
4. F
5. F
6. T
7. T
8. T
9. F
10. T

Blackline Master #2: Video Quiz

1. structure
2. nucleus
3. protons
4. neutral
5. isotopes
6. electrons
7. mass
8. structure
9. metals
10. reactive

Blackline Master #3: Discussion Questions

1. Protons, neutrons, and electrons
2. Carbon 6, Copper 20, Silicon 14
3. Carbon - 14
4. Oxygen O, Hydrogen H, Calcium Ca
5. Metal elements have metal-like properties and are malleable, good conductors of electricity, and are highly dense.
6. The Periodic Table is organized via Periodic Law, which states that both chemical and physical properties of elements are periodic functions of their atomic structure. It is arranged using chemical symbols and atomic numbers.

Blackline Master #4: Word Search

Vocabulary Definitions:

atomic mass units - unit used to measure the mass of subatomic particles

atomic number - the number of protons in an atom

atomic structure - arrangement and number of smaller particles of an atom

electron cloud - space in which fast moving electrons are likely to be found

electrons - small, fast-moving negatively-charged electrons orbiting nucleus

families - columns of elements in the Periodic Table

isotopes - atoms of the same element with different numbers of neutrons

metalloids -an element that has properties of both metals and nonmetals

metals - elements which are good conductors of electricity, are malleable, and are shiny

neutron - neutral-charged subatomic particle

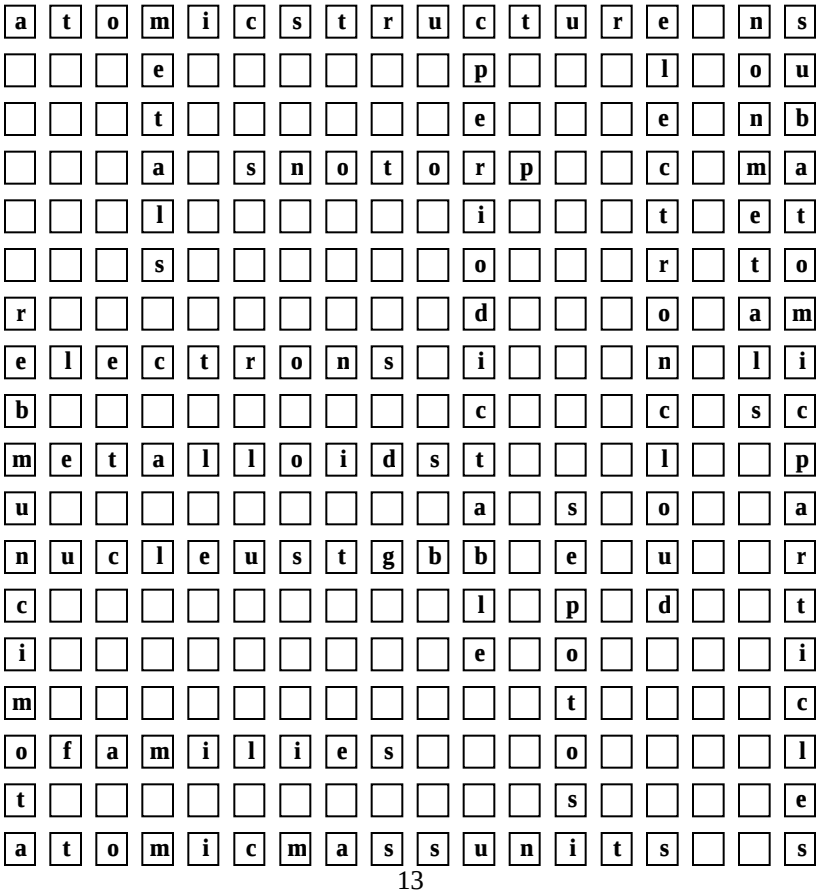
nonmetals - elements that are poor conductors of electricity, are brittle, and have low melting points

nucleus - center or core of atom that contains protons and neutrons

Periodic Table - chart that organizes all known elements according to atomic number

protons - positively charged subatomic particles located in the nucleus of an atom

subatomic particles - smaller particles that make up the atom, including protons, neutrons, and electrons



Blackline Master #5: Internet Lesson

1. Atomic number is equal to the amount of electrons which is also equal to the amount of protons in the element.
2. It is a symbol that represents either the name of the element or the Latin name of the element.
3. The atomic weight is the weight of the element. It can be used to find the number of neutrons in an element by using the equation: Atomic Weight -
Atomic Number = Number of Neutrons.
4. Alkali Metals, Transitional Metals, Other Metals, Halogens, Alkali Earth Metals, Rare Earth Metals. Nonmetals, and Noble Gases.
5. International Union of Pure and Applied Chemistry
6. Element 106 - seaburgium
7. Neptunium (Np) and Plutonium (Pu)
8. Rutherfordium (Rf), Dubnium (Db), Seaborgium (Sg). Bohrium, (Bh) and Hassium (Hs)

Blackline Master #6: Navigating the Modern Periodic Table

1. 7
2. 18
3. The elements in the first group are called the alkali metals. The elements in the second group are called the alkaline earth metals. Elements in these groups are very reactive, and combine easily with other elements.
4. The elements in group 8 are the noble gases. These elements are very stable, and do not react readily with other elements.
5. a. The “8” is the atomic number.
   b. The number 15.999 is the atomic mass (weight) signifying the number of protons and neutrons.
6. a. Ca
   b. 20
   c. 40.08
7. a. Cu
   b. 29
   c. 63.546

8. a. 7
   b. 7 electrons
   c. 7 protons

Blackline Master #7: Themes on the Periodic Table

1. 18
2. There are 109 elements, although this number may vary slightly, depending on the individual Periodic Table.
3. 7
4. Elements on the Periodic Table are organized according to their atomic number.
5. The elements at the bottom of the Table are placed there to make the Table shorter and easier to read. The elements in these two rows are called the "rare earth metals." The first row is called the "lanthanoid series," and is made up of soft metals with high conductivity. The second row is referred to as the "actinoid series;" these elements are radioactive.
6. The staircase line divides the metals, on the left, from the nonmentals, on the right.
7. a. The metalloids are located along the bold staircase.
   b. Examples of metalloids include aluminum and boron.
   c. A metalloid is an elements that has properties common to both metals and nonmetals.
8. As you go from left to right along the periods, the atomic number increases, the elements become larger, and the elements become less metal-like.
9. The alkaline metals hold one valence electron. They tend to bond easily with other atoms, and are very reactive.
10. a. Transition metals have low numbers of valence electrons and bond easily. They are good conductors of electricity.
    b. Iron is used in making steel. Gold and silver are used to make jewelry. Mercury is used in thermometers.
11. a. carbon
    b. Carbon is an element found in thousands of compounds, and is found in foods we eat. Silicon is a very abundant

element in the earth's crust and is used in making computer chips. Tin is used in making all kinds of metal alloys.
12. a. Noble gases have their outer energy level filled to capacity with electrons. They do not readily form bonds with other atoms and are very stable.
b. Helium is used to fill balloons. Neon is used to make the red coloring in neon signs.

Blackline Masters #8a-8b: Post- Test

1. structure
2. nucleus
3. protons
4. positive
5. isotopes
6. cloud
7. symbols
8. groups
9. nonmetals
10. reactive
11. True
12. False
13. False
14. True
15. True
16. a.
17. d.
18. b.
19. a.
20. b.

Script of Narration

Atomic Structure and the Periodic Table

What makes one substance different from another? What makes the glass in these goblets different from the diamond in this ring?

They are both clear, sparkling solids. But diamonds are one of the hardest materials on earth and are even used to make saws which can cut rock, and glass is fragile and is easily broken. The difference lies in the types of atoms that make them up. What makes atoms different from each other?

We are going to take a look inside atoms and examine their atomic structure. Atomic structure refers to the arrangement and number of smaller particles of an atom. These smaller particles that make up atoms, or subatomic particles, include protons, neutrons, and electrons. Let us consider each subatomic particle separately.

This is an atom of carbon, a substance found in charcoal and diamonds. The nucleus is the center or core of the atom. It is where 99.9 % of an atom's weight is located. The nucleus contains protons, as seen here in red, and neutrons seen here in green.

Protons are positively charged particles, symbolized here by a "plus" sign. All protons are the same, no matter what type of atom they are in.

The weight of subatomic particles is measured in units called *atomic mass unit*s. A proton weighs one atomic mass unit. There are millions and millions of protons in a single drop of water.

The other subatomic particles located in the nucleus are *neutrons.* A neutron is a neutrally-charged particle. The do not have a charge. Neutrons also have an atomic mass of about one atomic mass unit.

While the nucleus contains most of the mass of an atom it takes up only 1/100,000th of an atom's space, equivalent in ratio to this ball in this meadow.

While all atoms have a nucleus, what is it that makes them different? The answer lies in their number of protons. The *atomic number* is the number of protons in an atom. For example, the element carbon, which

is what makes up the graphite in this pencil, has an atomic number of "6." It has six protons. All atoms of carbon have the same atomic number of "6." The atomic number also equals the number of electrons. Therefore, carbon also has six electrons, seen here in red. Copper, a different element, has an atomic number of "20."

It is useful to know the combined number of protons and neutrons in an atom. The atomic mass, also known as the *atomic weight* or *mass number*, is the sum weight of the protons and neutrons in an atom.

Let's take the element silicon, symbolized by the letters "Si." Silicon is a major element that makes up the sand on this beach. Silicon has fourteen protons and fourteen neutrons that add up to an atomic weight of 28 atomic mass units.

While most types of carbon, such as that in these trees, have six protons, the number of neutrons may vary. *Isotopes* are atoms of the same element

with different numbers of neutrons. For example, carbon can have an atomic mass of 12 or 14. Carbon with an atomic mass of 12, seen here with six red protons and six blue neutrons is referred to as "carbon - 12." But carbon can also have an atomic mass of 14, called "carbon-14," seen here with six red protons and eight blue neutrons. Carbon-14 in nature is unstable, and gradually deteriorates. With specialized equipment scientists can estimate the age of objects, such as this bone, by measuring the degradation of carbon-14. Because most elements have more than one isotope, each element has an average atomic mass calculated from the average mass of its isotopes.

The fast-moving particles around the nucleus are electrons. *Electrons* are negatively charged particles. They are a fraction of the size of protons or neutrons. To help you visualize this size difference, if this ball were a neutron, then this pea would be an electron. An electron weighs just .0006 atomic mass units. Because electrons weigh so little, their weight is not even considered in calculating an atom's atomic mass. The electrons move very quickly, perhaps as quickly as a billion times a second around the nucleus, forming what is called an *electron cloud.* The electron cloud is the space in which the extremely fast-moving

electrons are likely to be found.

As scientists learned more about elements and atoms, they developed a way to organize them in a logical manner. They created a chart to organize elements by their atomic structure that is referred to as the "Modern Periodic Table." The Modern Periodic Table represents a remarkable scientific endeavor. It takes thousands of seemingly unrelated pieces of information and fits them together in a logical format. This organization is dictated by the Periodic Law which states that both chemical and physical properties of elements are periodic functions of their atomic numbers. The position of elements on the Periodic Table is dictated by the number of protons, or their atomic number. Notice how the top number, the atomic number increases from left to right. The elements on the Periodic Table are represented by their chemical symbols. A chemical symbol is an abbreviated way of symbolizing an element

with one or two letters For example, the element oxygen, found in the air we breathe, is symbolized by the letter "O" on the Periodic Table. Oxygen, along with hydrogen is a fuel commonly used in rockets. Hydrogen is symbolized by the letter "H," found in the upper left portion of the chart.

Let's take a look at another element - calcium. Calcium is an element found in the human body and in the bones of other animals. Calcium is also common in rocks such as limestone and marble seen here. It is located here on the Periodic Table. The chemical symbol for calcium is "Ca."

On top of the chemical symbol is the atomic number. The atomic number of calcium is 20. Remember that the atomic number is equal to the number of protons. Here you can see 20 protons with a positive charge in the nucleus. Below the chemical symbol for calcium is the atomic mass. Here you can see that the atomic mass of calcium is 40.08 atomic mass units.

You will notice that the Periodic Table is organized in a grid with rows and columns. There are 18 columns, called *groups* or *families*. These groups, or families, have elements that possess many similar

chemical and physical characteristics that we will explore later. The rows in the Periodic Table are called *periods*. Unlike the elements in families, the elements in periods do not have a great deal in common. But by looking at elements across the periods we notice some interesting patterns. There are seven periods or rows. Notice that a portion of Rows 6 and 7 has been removed. These periods are still part of the Periodic Table, but have been moved to make the table shorter and easier to read.

As you go from left to right in the Periodic Table, one obvious trait stands out - the atomic numbers increase in regular intervals. For example, you see how the atomic number increases, starting with silicon, with an atomic number of 14, then phosphorus, with an atomic number of 15, then sulfur, with an atomic number of 16, and so on.

Of the 109 known elements, the vast majority are metals. These are highlighted on the Periodic Table in green. While you may think of objects such as silverware, pans, and wires as metals, other elements such as calcium and sodium are also metals. Elements toward the middle and left such as mercury, are also metals, having metal-like properties such as shininess, as seen in this aluminum foil, and are malleable, the ability to be shaped. Metals are also good conductors of electricity such as that found in this electric fence. Generally speaking, metals also have a high density, as is this case with this piece of rapidly sinking lead. Magnesium, a metal commonly used to make airplanes is in a specific family of metals called the *alkaline earth metals* , highlighted here in blue on the Periodic Table. The alkaline earth metals are a highly reactive group. For example, magnesium seen here brightly reacts when burned.

Within the metals are the transition metals, seen here in green. They are less reactive than the first two groups of metals. There are many commonly used metals in the transition metals, including iron, used in making machinery and bridges, copper, used in wire and pipes, and tungsten, used in light bulbs. These shiny metals tend to be good conductors of electricity Transition metals such as iron, zinc, and co-

balt are also used to make colorful paints.

The elements to the right of the staircase-like line in the Periodic Table are called the nonmetals. The nonmetals tend to have opposite properties from the metals. These elements tend to have a dull luster, and are brittle, such as this sulfur. They have low densities and melt at lower temperatures. The do not conduct electricity well. One such family of nonmetals are the N*oble Gases*, highlighted here in light red. These elements are found in small amounts as gases in the earth's atmosphere. Argon is the most common of the noble gases, and makes up about one percent of the earth's atmosphere. Many signs are made with inert gases, such as this neon-filled sign.

The elements highlighted in orange just to the right and left of the staircase line are called *metalloids* because they have properties of both and metals and nonmentals. Metalloids are solids that conduct heat and electricity better than nonmetals but not as well as metals. Silicon is one such metalloid that is used in computers. It is valued in computers because it is a semiconductor, meaning it is somewhere between a conductor and an insulator of electricity.

We have explored just a small amount of the information found on the Periodic Table. Next time you get a chance spend some time exploring the Periodic Table. You will be surprised at the amount of interesting facts you will learn.

Fill in the correct when you hear this tone. Good luck and let's get started.

1. Atomic _____ refers to the arrangement and number of smaller particles in an atom.
2. The _____ is the center or core of an atom.
3. _____ are positively charged particles located in the nucleus.
4. Neutrons have a _____ charge.
5. _____ are atoms of the same element with different numbers of neutrons.
6. _____ are subatomic particles with a negative charge.
7. The sum weight of protons and neutrons in an atom is its atomic _____.

8. Elements in the Periodic Table are ordered according to their atomic _____.

9. _____ are the most common elements on the periodic table.

10. Elements in the family called the alkaline earth metals are very _____.

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