

Lesson 6: The Recurring (Periodic) Table of Elements (2 Days)

☐ Getting Started

One effective way to identify and to classify objects is by their function. For example, if I say "ball," there are a lot of ways to interpret that. If I say "a ball used for throwing sports," that is more specific. The function of the ball in a throwing sport eliminates some sports while including others. If I go on to say "a ball used in a popular North American throwing sport," football comes to mind. The throwing clue helps me classify which balls are the right ones to put in the group that I am developing. Another obvious sport is baseball. Although both balls are different, they are involved in sports that utilize throwing. There are also many other ways to classify any number of objects. The same can be said of classifying elements.

Classification systems are artificial. They do not neatly present themselves in the natural world, but all matter in the natural world has traits that make classification possible. One of the most famous classification systems is the periodic table of elements. The periodic table is a display of the chemical elements and is organized based on atomic numbers and electron configurations. **Electron configuration** is the distribution of electrons of an atom or molecule (or other physical structure) in atomic or molecular orbitals. Also utilized are chemical properties that are recurring or periodic. Elements are presented in order of increasing atomic number or number of protons and divided into three main groups: metals, nonmetals, and inert (or noble) gases.

In this lesson, the goal is to introduce you to the periodic table and to help you become familiar with how it is organized. As you proceed through the lesson, see if you can begin to make predictions based on the patterns found in the periodic table.

Stuff You Need

- *Eyewitness Chemistry* by Ann Newmark
- periodic table of elements (kit)

Ideas to Think About

- What makes one piece of matter different from another?
- What patterns can be observed in elements?

Things to Know

- **atomic mass:** the mass of an atom
- **electron configuration:** the distribution of electrons of an atom or molecule (or other physical structure) in atomic or molecular orbitals

- **metalloid:** a nonmetallic element that has properties between those of a metal and nonmetal; some are also called semiconductors

**Periodic Table**

www.beyondthepage.com/link/2877/

Read this webpage about how the periodic table is organized and then answer the questions in the "Reading and Questions" section.

☐ **Reading and Questions**

Read the "Periodic Table" webpage (link provided). Also review the periodic table image on pp. 22-23 in *Eyewitness Chemistry* and the images of the placement of metals and nonmetals found on pp. 25 and 26. Then answer these questions.

1. What are the horizontal rows on the periodic table called? What do elements on the same row have in common?

2. What are the vertical columns called?

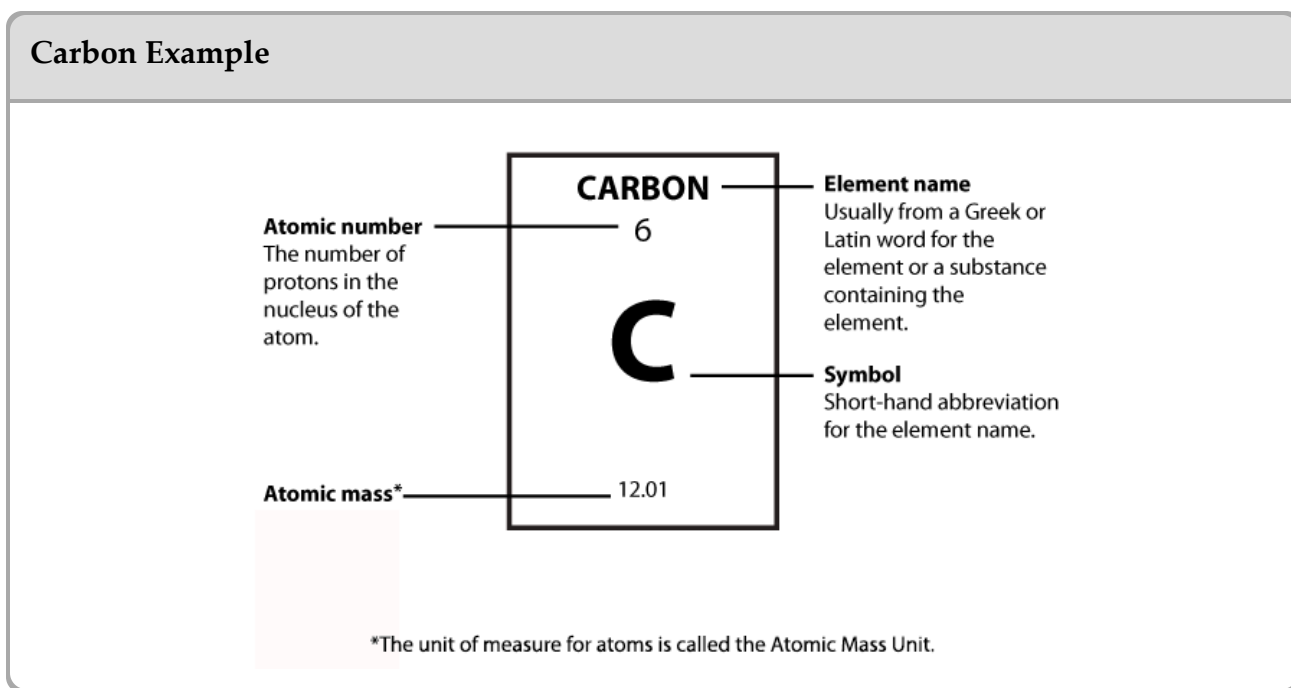
3. Where are metals and nonmetals generally located on the periodic table?

Activities☐ **Activity 1: Organization of the Periodic Table**

In this first activity, you will be introduced to some basic information about the elements found on the periodic table. You will be looking at atomic number, atomic mass, and electron configuration (specifically the number of electrons on the outer shell). You will then complete a couple of activities that will help reinforce your

understanding. NOTE: A full-color copy of the periodic table has been included with this unit. You should have it handy to refer to as needed.

Consider the "Carbon Example" graphic. The atomic number, which represents the number of protons in the element, is at the top of the information square. The name of the element is above the atomic number. The atomic mass of the element is at the bottom. In between each number is the shorthand abbreviation or symbol for each element.



Keep in mind the following information about the parts of the atom:

- A proton is a positively charged particle in the nucleus of the atom. The number of protons in an atom's nucleus is its atomic number.
- An electron is a negatively charged particle surrounding the nucleus of the atom.
- The number of electrons surrounding the nucleus of an atom is equal to the number of protons in the atom.
- A neutron is a particle in the nucleus that has about the same mass as a proton but has no charge. For the atoms of the first 20 elements, the number of neutrons is either equal to or slightly greater than the number of protons.

Using the information provided, complete the "Organization of the Periodic Table" page by filling in the missing information for each element in the table. After you complete the table, use the information to fill in the five blocks at the bottom of the page. Refer to the "Carbon Example" graphic as needed.

☐ Activity 2: Periodic Table and Atomic Structure

In this activity, think back to the beginning of the unit when you worked on atomic structure and learned about the number of electrons on the outer shells of each element.

On the "Periodic Table and Atomic Structure" page, you will write the number of electrons present for each shell that is used. For example, helium has two electrons. They fill the first shell, so you will write "2" in the "n=1" column. If helium had three electrons, you would write 2 for the first shell and 1 for the second shell.

As you recall, each atom has orbitals (also called shells). In the list below and on the activity page, "n" represents which orbital is represented. The label n=1 represents the orbital closest to the nucleus; n=2 equals the orbital that is second closest, etc. Each orbital can hold a maximum number of electrons:

- 1st orbital (n=1) -- maximum number of electrons is 2
- 2nd orbital (n=2) -- maximum number of electrons is 8
- 3rd orbital (n=3) -- maximum number of electrons is 18*
- 4th orbital (n=4) -- maximum number of electrons is 32 (although the maximum number we will work with in this unit is 8)

* Although the third shell can eventually hold up to 18 electrons, the fourth shell begins filling before the third shell is completely filled. For the first 20 elements, you can treat the third shell as holding 8 electrons before the fourth shell begins to fill. In later chemistry courses, you will learn why this happens and how the remaining spaces in the third shell are filled.

Use the information about each orbital to complete the activity page. Remember that the number of electrons is equal to the number of protons. Once one orbital is full (has its maximum number of electrons), start filling the next orbital (the exception being the third shell — once it contains 8 electrons, you start filling the 4th orbital).

Hold on to your activity sheets. You will use them in other parts of the lesson, and you will use information from the table for your final activity.

Day 2

☐ Activity 3: Seeing Patterns in the Periodic Table

In this activity, you will be introduced to more key ideas associated with the periodic table. You will be challenged to make a connection between the information provided and the table that you completed in Activity 2. To help you with this

material, considering reviewing p. 12 of *Atoms*. Pay attention to the term **metalloid** (an element that has properties of both a metal and nonmetal).

Nonmetals that are Gases

Inert gases and other nonmetals are found on the right side of the periodic table. Inert gases have an outer shell that is full.

- Using the table completed in Activity 2, what elements are inert gases?
- What trends do you notice with regards to the outer shells of gases?

Metals

Metals are located on the left side and middle of the periodic table. The seven metalloids are located between the metals and nonmetals. What differences do you see between the outer shells of metals and nonmetals?

Use the tables from Activity 2 to help you fill in the "Seeing Patterns in the Periodic Table" activity page. Based on the information, guess whether the element is a metal or nonmetal. Use your copy of the periodic table to check your answers. **NOTE:** When considering whether or not an element is a metal or nonmetal, keep in mind that the number of electrons on the outer shell is crucial. You will find that elements with generally less than four electrons on the outermost shell tend to be metals while those that are four or greater tend to be nonmetals.

Activity 4: Comparing and Contrasting Metals and Nonmetals

In this activity you will choose two of the elements from Activity 3. One of the elements should be a metal and one should be a nonmetal. Using what you have learned about the properties of matter, create a visual aid that will help someone recognize the recurring (periodic) trends found in the periodic table of elements by using the two elements you have chosen. You will want to use the vocabulary you have learned in this lesson and previous ones. Here are some basic hints to help:

- List the similarities between the two elements (for example, atomic structures all have the same particles)
- List the differences between the two (number of atomic particles, electrons on the outer shell, properties, etc.)
- Consider some of the key differences between the properties of metals and nonmetals.
- Your visual aid should show the similarities and differences between the two elements. Ideas include a Venn diagram or a table. Whichever design you choose, include the general location of the elements on the periodic table.

- Once you have completed this section of the activity, show how these trends are common on the periodic table. For example, show where the different types of elements are located.

Optional:

If time permits, create an atomic model drawing to show differences in the outermost shells of the two types of elements.

Wrapping Up

In the two days of this lesson you have made a connection between the atomic structure of each element and patterns that are emerging that lead to recognized differences between nonmetals and metals. As you work on the final project for this unit (which will be a more detailed look at the periodic table and the elements that are all around you at home) keep in mind that these patterns are consistent no matter how much or how little of an element is present. You can count on the fact that carbon (atomic number 6) will in its natural form not have more than four electrons on its outer shell. You can be confident that potassium (K, Atomic number 19) will always be a metal and that its outermost shell will have one electron on its outermost shell.

These last two lessons have been a challenge. Go back and look at them if you are not sure about any concepts. Make sure that you understand that different shells have different numbers of electrons. Make sure that you understand the differences between nonmetals and metals.

ORGANIZATION OF THE PERIODIC TABLE

Complete the table and then fill out atomic cards for the elements.

ELEMENT NAME	ATOMIC NUMBER	ATOMIC MASS	NUMBER OF PROTONS	NUMBER OF ELECTRONS
Hydrogen (H)	1	1.01		
Helium (He)	2	4.00		
Boron (B)		10.81	5	
Oxygen (O)		16.00		8
Magnesium (Mg)	12	24.31		

of protons _____
of electrons _____

of protons _____
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of electrons _____

PERIODIC TABLE AND ATOMIC STRUCTURE

Left Side of Periodic Table		Electron Shells			
		n = 1	n = 2	n = 3	n = 4
Element	Atomic Number				
Hydrogen	1				1
Lithium	3				3
Sodium	11				11
Potassium	19				19
Beryllium	4				4
Magnesium	12				12
Calcium	20				20
Right Side of Periodic Table		Electron Shells			
		n = 1	n = 2	n = 3	n = 4
Element	Atomic Number				
Oxygen	8				8
Sulfur	16				16
Fluorine	9				9
Helium	2				2
Chlorine	17				17
Neon	10				10
Argon	18				18

Seeing Patterns in the Periodic Table

Element Name	Atomic Symbol	Atomic Number	Outermost Electrons	Metal or Nonmetal
Carbon	C			
Magnesium	Mg			
Phosphorous	P			
Sulfur	S			
Calcium	Ca			
Nitrogen	N			
Potassium	K			

Lesson 6: The Recurring (Periodic) Table of Elements (2 Days)

Getting Started

✿ Ideas to Think About

- What makes one piece of matter different from another?
- What patterns can be observed in elements?

📖 Things to Know

- **atomic mass:** the mass of an atom
- **electron configuration:** the distribution of electrons of an atom or molecule (or other physical structure) in atomic or molecular orbitals
- **metalloid:** a nonmetallic element that has properties between those of a metal and nonmetal; some are also called semiconductors

⦿ Skills

- Understand the structure, classifications, and physical properties of matter. (S)
- Recognize that all matter is made up of atoms. (S)
- Know that atoms of the same element are all alike but are different from the atoms of other elements. (S)
- Explain how the periodic table is a model for classifying elements and identifying the properties of elements. (S)
- Recognize the basis for the organization of the periodic table. (S)
- Know that the properties of the elements reflect the structure of atoms. (S)
- Know how to identify metals and nonmetals. (S)
- Know how to use the periodic table to identify elements. (S)

Introducing the Lesson

On Day 1 of this lesson, your child will learn basic information about the organization of the periodic table including atomic number, atomic mass, number of protons, and number of electrons. She will also be challenged to complete a table that represents the electron configuration of different elements.

On Day 2, your child will be challenged to see patterns in the periodic table. She will be introduced to the different forms of the elements and be asked to complete a table based on certain patterns that she should be starting to recognize. Day 2 may be a brief activity and can be used to start reviewing for the test on this unit.

Reading and Questions

1. What are the horizontal rows on the periodic table called? What do elements on the same row have in common?

A row is called a period. All elements in a period have the same number of orbitals (orbits along which electrons travel).

2. What are the vertical columns called?

Groups

3. Where are metals and nonmetals generally located on the periodic table?

The nonmetals are on the upper right. Metals are in the left and center as well as very bottom.

Activities

Activity 1: Organization of the Periodic Table

Your child should fill out the chart provided with the following answers:

Element Name	Atomic Number	Atomic Mass	Number of Protons	Number of Electrons
Hydrogen (H)	1	1.01	1	1
Helium (He)	2	4.00	2	2
Boron (B)	5	10.81	5	5
Oxygen (O)	8	16.00	8	8
Magnesium (Mg)	12	24.31	12	12

Activity 2: Periodic Table and Atomic Structure

Periodic Table and Atomic Structure - Left Side of Periodic Table - Answer Key:

Left Side of Periodic Table		Electron Shells				
		n = 1	n = 2	n = 3	n = 4	
Element	Atomic Number					Total
Hydrogen	1	1				1
Lithium	3	2	1			3
Sodium	11	2	8	1		11
Potassium	19	2	8	8	1	19
Beryllium	4	2	2			4
Magnesium	12	2	8	2		12
Calcium	20	2	8	8	2	20

Periodic Table and Atomic Structure - Right Side of Periodic Table - Answer Key:

RightSide of Periodic Table		Electron Shells				
		n = 1	n = 2	n = 3	n = 4	
Element	Atomic Number					Total
Oxygen	8	2	6			8
Sulfur	16	2	8	6		16
Fluorine	9	2	7			9
Helium	2	2				2
Chlorine	17	2	8	7		17
Neon	10	2	8			10
Argon	18	2	8	8		18

Day 2

Activity 3: Seeing Patterns in the Periodic Table

Your child should complete the table and make use of the periodic table included with this unit to check the final column (metal or nonmetal) once she has completed the table.

Answer Key - Seeing Patterns in the Periodic Table

<i>Element Name</i>	<i>Atomic Symbol</i>	<i>Atomic Number</i>	<i>Outermost Electrons</i>	<i>Metal or Nonmetal</i>
Carbon	C	6	4	Nonmetal
Magnesium	Mg	12	2	Metal
Phosphorus	P	15	5	Nonmetal
Sulfur	S	16	6	Nonmetal
Calcium	Ca	20	2	Metal
Nitrogen	N	7	5	Nonmetal
Potassium	K	19	1	Metal

In this activity, your child will choose one metal and one nonmetal from Activity 3 and create a visual aid that shows some similarities and differences between the two elements. She can use a Venn diagram or other graphic to compare and contrast the two. She should also include some key differences between the properties of metals and nonmetals, such as ductility, malleability, solubility, and conductivity. She will need to focus on the number of electrons on the outermost shell. Your child should be able to point out that metals are typically center and left of center of the periodic table, while nonmetals are mostly on the far right. Refer to the answer key for Activity 3 for details about the elements your child chose.

Wrapping Up

Questions to Discuss

- Using the table completed in Activity 2, what elements are inert gases? How do you know? (Helium, neon, argon; because the outermost shells of each one is full.)
- What trends do you notice with regards to the outer shells of nonmetals? (Nonmetals tend to have shells that are full -- as with inert or noble gases -- or almost full.)
- What differences do you see between the outer shells of metals and nonmetals? (Metals tend to have fewer electrons on their outermost shells; metals tend to have less than 4, and nonmetals tend to have 4 or more.)

Things to Review

- Understand that all matter is made up of atoms and that atoms of the same element are all alike.
- Know that atoms of one element are different from the atoms of other elements at the most basic level.
- The periodic table is a way to classify elements based on their properties.
- Recognize that the organization of the periodic table is based on the atomic structure of the atoms of each element.
- General trends on the periodic table include that nonmetals tend to have more electrons on their outermost shells, and metals tend to have fewer electrons on their outermost shells.