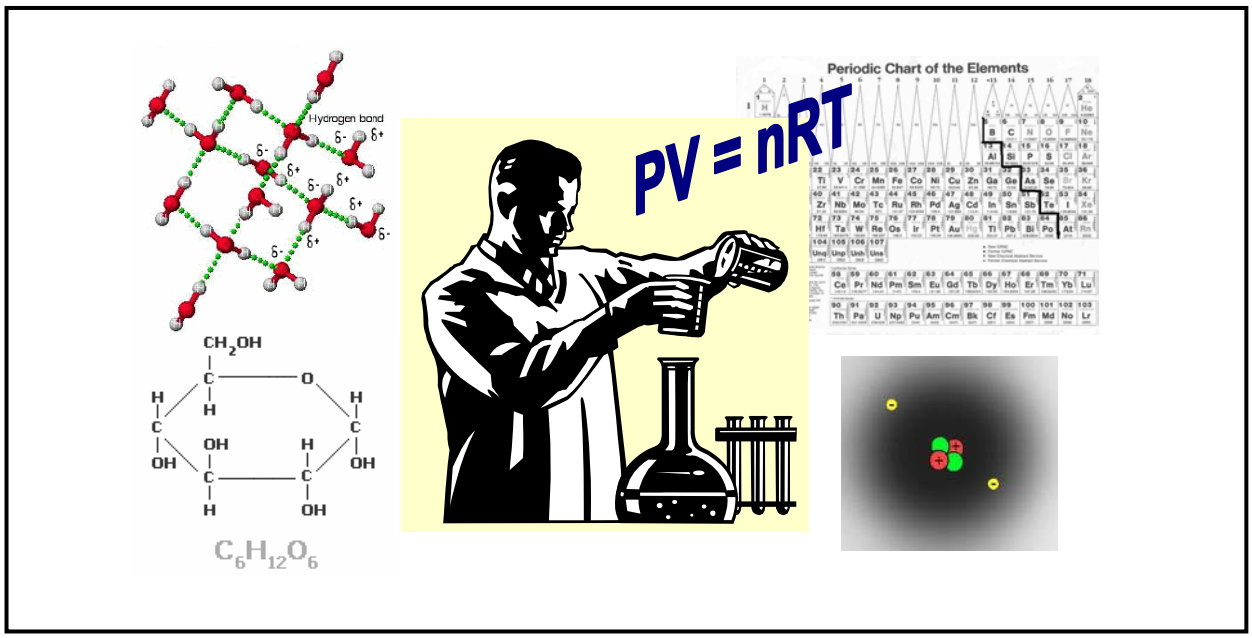
Project EASE

(Effective Alternative Secondary Education)

CHEMISTRY



MODULE 11

Atoms in the Periodic Table

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Module 11
Atoms in the Periodic Table

What this module is about

In chemistry, the generalization that there is a recurring pattern in the properties of the elements is explained through an organized table called the **PERIODIC TABLE. DMITRI MENDELEEV** organized the order of elements in the periodic table according to their atomic numbers. Later, great progress was made in explaining the periodic law in terms of the electronic structure of atoms and molecules.

As you study the features of the periodic table, the simplest question you must ask is "How are elements arranged?" Studying the chemistry of every element in the periodic table is not a simple thing to do.

By reading this module it would be a lot easier to understand how the elements are arranged. This module will help you fully understand the similarities and differences among atoms and why elements are grouped together in a table. This module also includes the historical background on how the Periodic Table was formed.

You will study the following lessons in this module:

- **Lesson 1 – The Periodic Table and the Symbols of Elements**
- **Lesson 2 – Properties of Elements in the Periodic Table**
- **Lesson 3 – The Electron Configuration and Order of Elements**
- **Lesson 4 – Importance of Some Elements in Industry**

What you are expected to learn

After going through the module, you are expected to:

1. name the elements given the chemical symbol;
2. state the basis of the arrangement of elements in the periodic table ;
3. use the periodic table to predict the properties of elements; and
4. be familiar with the properties of some elements and their uses in industry.

How to learn from this module

Here's a simple guide for you in going about the module:

1. Read and follow the instructions carefully.
2. Answer the pre-test in order to determine how much you know about the lessons in this module.
3. Check your answers with the given answer key at the end of this module.
4. Read each lesson and do the activities that are provided for you.
5. Perform all the activities diligently to help and guide you in understanding the topic.
6. Take the self-tests after each lesson to determine how much you understood the topic.
7. Answer the posttest to measure how much you have gained from the lessons.

Good luck and have fun!

What to do before (Pretest)

I. Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Among the scientists who were responsible for the development of the periodic table are: **I.** Dmitri Mendeleev **II.** Johann Dobereiner and **III.** John Newlands. Arrange their names in order of the history of the development of the periodic table.
   a. I , II, III
   b. II, III, I
   c. III, I, II
   d. III, II, I

2. Who was the scientist who arranged the elements according to groups of three?
   a. John Dalton
   b. Johann Wolfgang Dobereneir
   c. Dmitri Inovich Mendeleev
   d. John Alexander Newlands

3. All the elements belonging to Group II A have ___ electron(s) in its outermost shell.
   a. 1
   b. 2
   c. 3
   d. 4

4. The number of protons in an atom represents the
   a. ionization energy
   b. electronegativity
   c. atomic number
   d. atomic mass

5. Which of the following is an alkali metal?
    a. Ba
    b. Pb
    c. Li
    d. Fe

6. Which of the following decreases across a period on the periodic table?
    a. atomic radius
    b. ionization energy
    c. electron affinity
    d. electronegativity

7. Which of the following statements is **NOT** correct?
    a. Atoms become smaller as one moves down a group.
    b. Atoms become smaller as one moves to the right across a period.
    c. Atoms become larger when electrons are removed.
    d. The size of an atom is not a factor in arranging the elements in the periodic table.

8. Who was the scientist who arranged the elements in horizontal rows according to increasing atomic masses?
    a. John Dalton
    b. Johann Wolfgang Dobereneir
    c. Dmitri Inovich Mendeleev
    d. John Alexander Newlands

9. Which orbital is being filled in the lanthanide series of elements?
    a. 4f
    b. 4d
    c. 5f
    d. 5d

10. Which of the following sets is a set of all metals?
    a. S, Li, C
    b. He, Be, Ne
    c. K, Li, Na
    d. Ca, Cr, Co

11. Each vertical column of the periodic table is called
    a. a period
    b. a row
    c. a group
    d. none of these

12. What family of elements includes helium and neon?
    a. noble gases
    b. alkali metals
    c. halogens
    d. none of these

13. What family of elements includes fluorine and chlorine?
    a. noble gases
    b. alkali metals
    c. halogens
    d. none of these

14. How many electrons are there in an atom of an element in Period 4 group VII A?
    a. four
    b. five
    c. six
    d. seven

15. Which element reacts by gaining an electron?
    a. He
    b. Be
    c. F
    d. Na

II. Fill in the blank with the correct word(s).

1. The first scientist to arrange the elements in the periodic table by groups of eight (8) was _____.
2. The number of electrons distributed in each energy level of an atom is indicated by the _____.
3. Elements having some metallic and nonmetallic properties are called _____.
4. Elements belonging to Family VIII A are called _____.
5. In an electron configuration, the number **3** in $1s^2 2s^2 2p^6 3s^1$ represents the _____ in the periodic table.

Key to answers on page 27.

Lesson 1. The Periodic Table and the Symbols of Elements

This lesson will show you how to read symbols of elements in the periodic table. It will also focus on the historical background of the development of the periodic table.

What you will do

Activity 1.1

Read the history of the development of the periodic table and answer the questions after the selection.

A. History of the Periodic Table

The early years of the 19th century witnessed a rapid development in chemistry. The art of distinguishing similarities and differences among atoms prompted scientists to devise a way of arranging the elements. Relationships were discerned more readily among the compounds than among the elements; thus, the classification of elements lagged many years behind the classification of compounds. In fact, no general agreement had been reached among chemists as to the classification of elements for nearly half a century after the systems of classification of compounds had been established.

It was in 1817 when **Johann Wolfgang Döbereiner** showed that the atomic weight of strontium lies midway between those of calcium and barium. Some years later he showed that other such **"triads"** exist (chlorine, bromine, and iodine [halogens] and lithium, sodium, and potassium [alkali metals]). He also showed that similar relationships extended further than the triads of elements, fluorine being added to the halogens, and magnesium to the

alkaline-earth metals. Oxygen, sulfur, selenium, and tellurium were classed as one family, and nitrogen, phosphorus, arsenic, antimony, and bismuth as another family of elements.

Attempts were later made to show that the atomic weights of the elements could be expressed by an arithmetic function. In 1863, A.E.B, De Chancourtois proposed a classification of the elements based on the new values of atomic weights given by Stanislao Cannizzaro's system of 1858. De Chancourtois plotted the atomic weights on the surface of a cylinder with a circumference of 16 units, corresponding to the approximate atomic weight of oxygen. The resulting helical curve brought closely related elements onto corresponding points above or below one another on the cylinder, and he suggested in consequence that "the properties of the elements are the properties of numbers," a remarkable prediction in the light of modern knowledge.

Another way of classifying the elements was later proposed by **John Alexander Reina Newlands** in 1864. He proposed that elements be classified in the order of increasing atomic weights, the elements being assigned ordinal numbers from one upward and divided into seven groups, with each group having properties closely related to the first seven of the elements then known: hydrogen, lithium, beryllium, boron, carbon, nitrogen, and oxygen. This relationship was termed the **law of octaves**, by analogy with the seven intervals of the musical scale.

As a result of an extensive correlation of the properties and the atomic weights of the elements in 1869, **Dmitri Inovich Mendeleev** proposed the **periodic law**, which states that "the elements arranged according to the magnitude of atomic masses show a periodic change of properties." Lothar Meyer had independently reached a similar conclusion, published after the appearance of Mendeleev's paper. He wrote down the properties and atomic weights of the elements on cards. There were only 63 **elements** known at the time. He arranged and rearranged the cards in columns. Eventually he realized that there was a repeating (or periodic) relationship between the properties of the elements and their atomic weights. When the elements are arranged in order of increasing atomic weights the properties of the elements were repeated very often. He understood the importance of this discovery.

What you will do

Selt-Test 1.1

Fill in the blanks with the word / words that best complete(s) the statements below:

1. The first scientist who arranged the elements into group of threes with the same properties was _____.

2. The arrangement of grouping elements by three's is called _____.

3. Elements were also grouped by eight. This was devised by _____.

4. Arranging the elements into groups of eight was termed as the Law of _____.

5. The modern periodic table was devised by _____.

Key to answers on page 27.

What you will do

Activity 1.2

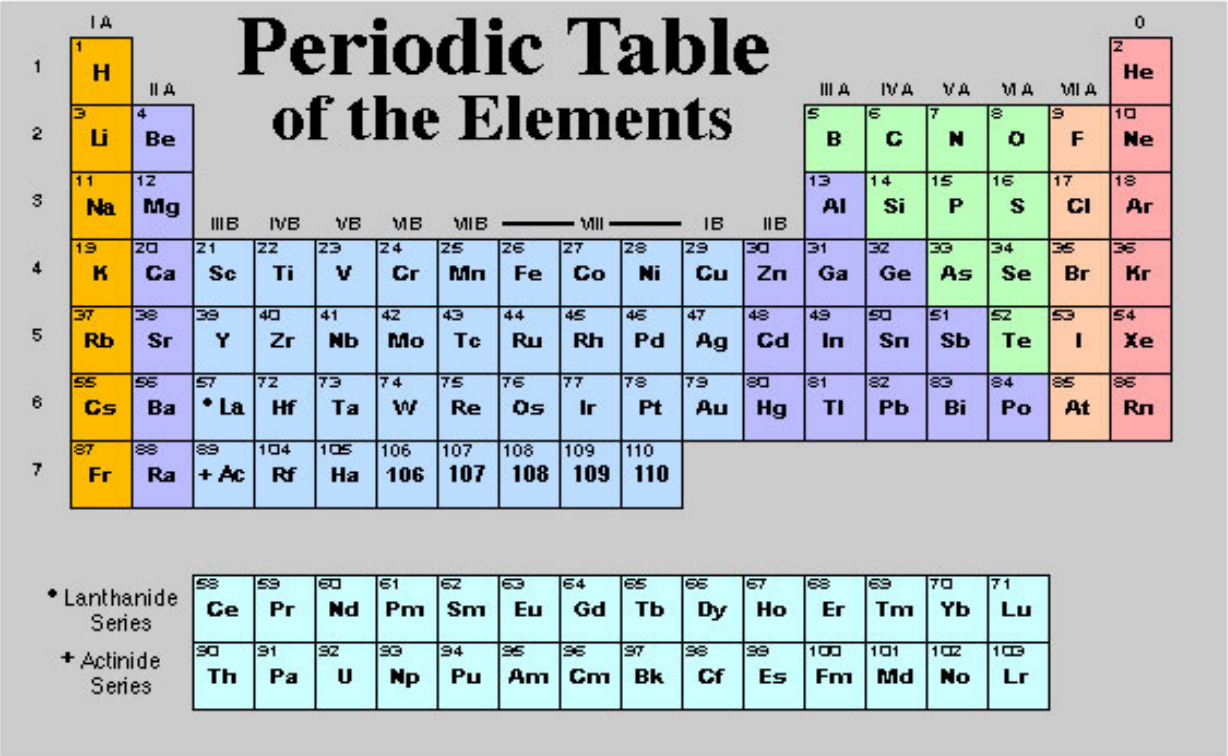
Below is Mendeleev's version of the periodic table:

The rows **1** to **7** are called **periods**. The columns **I A** on the left to **0** on the right are known as **groups**. Elements with similar properties fall into vertical columns (groups) and horizontal rows (periods), which form the table. Elements within the groups have similar valences. Mendeleev left spaces in his table for elements not yet discovered. He also predicted what properties these undiscovered elements would have. Between 1875 and 1886, the elements gallium, scandium and germanium were discovered. They all fitted into the positions predicted by Mendeleev. As a result, the periodic law gained universal acceptance.

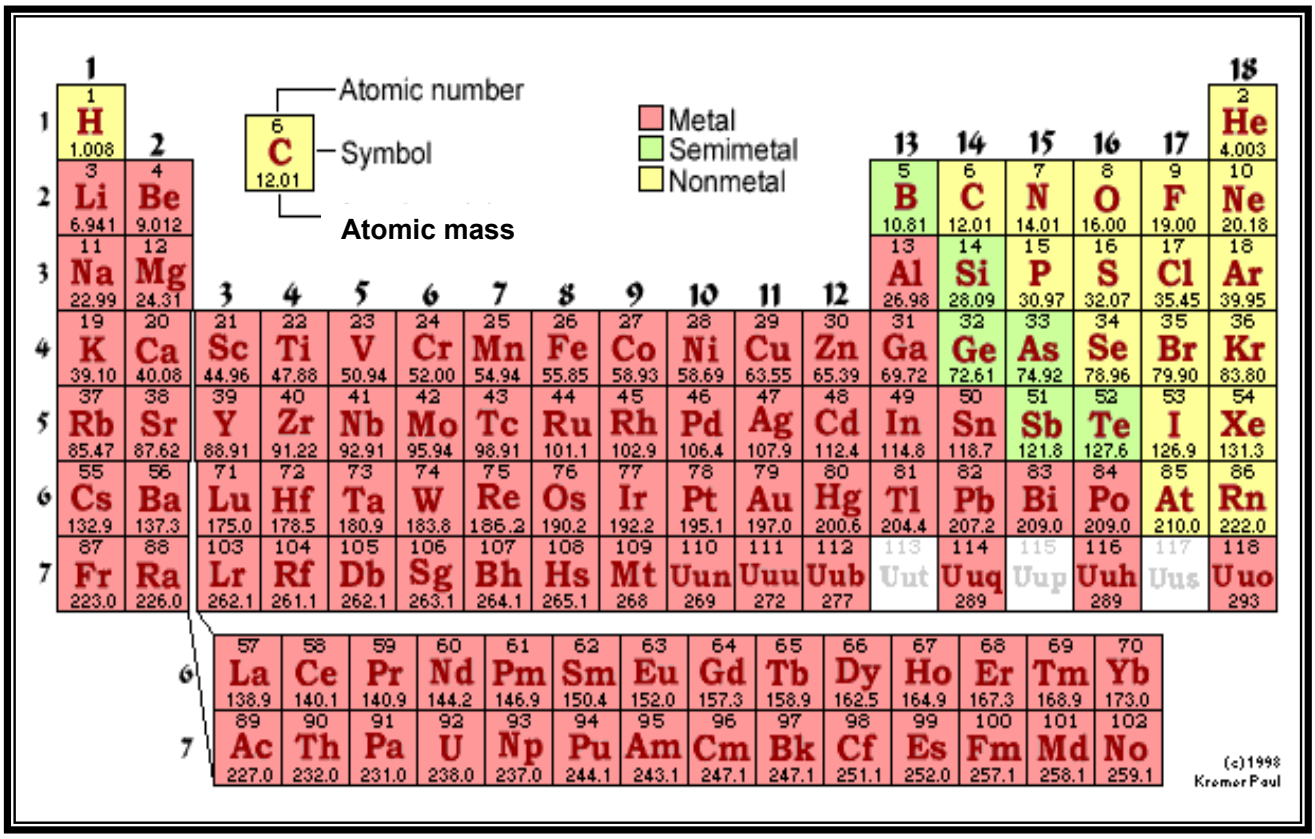
The elements in the same row have something in common. All of the elements in a **period** have the same number of electron **shells**. Both elements in the top row (the first period) have one shell for their electrons. All elements in the second period have two electron shells. The number of shells increases as you go down the table.

The columns in the table are called Groups. The elements in a group have the same number of electrons in their outer shell. So, all elements in Group I have one electron in their outer shells. The elements in Group II have two electrons in the outer shell.

Figure 1. Mendeleev's Version of the Periodic Table



Based from the periodic table of Mendeleev, below is the modern version:



Study the terms below for you to be familiar with the modern periodic table:

- **periodic table** - The periodic table is a chart of all the known elements in order of increasing atomic number. The table puts elements into groups with similar characteristics, allowing us to recognize trends over the whole array of elements.

- **atom** - An atom is the smallest unit of a substance that still has all the properties of that substance. In most cases, an atom consists of protons, neutrons, and electrons. The protons and neutrons are found in the center of the atom, called the atomic nucleus, and the electrons orbit or circle around the center of the nucleus in paths called orbitals.

- **atomic number** - The atomic number of an atom is equal to the number of protons that the atom contains. Atoms can have differing numbers of neutrons and electrons while still retaining the original characteristic properties of that atom. However, if an atom gains or loses a proton, in essence, it changes its atomic number and becomes an entirely new atom with new characteristics.

- **atomic weight/mass** - The atomic weight of an atom is a measure of how much mass an atom has. The atomic weight is calculated by adding the number of protons and neutrons together. Atomic masses are not listed as whole numbers on the periodic table because atoms can come in forms with different amounts of neutrons. The atomic weight reported for any particular element is an average weight of all the known forms of that element.

The Elements in the Periodic Table

A. How are elements named?

Chemists have developed a unique system of symbols and notation designed to simplify the writing of chemical symbols, formula, and reactions. This system also shows the mathematical relations of atoms and reacting chemicals, the way atoms are put together to form complex molecules, and the type of chemical bond between atoms.

The early alchemists used various symbols to represent the **92** natural elements they used, a custom that was continued into the 19th century. Jacob Berzelius of Sweden was the first to use letters to represent the elements. In most cases he was able to use the first letter of the name of the element as its symbol; **O** stood for **oxygen**, **C** for **carbon**, **H** for **hydrogen**, and so on. Two letters are used to distinguish between elements that have the same initial letter, e.g. **N** for **nitrogen**, **Ne** for **neon**, and **Ni** for **nickel**. Sometimes the symbol is derived from the Latin name of the element, e.g. **gold (*aurum*)** is **Au, iron (*ferrum*)** is **Fe,** and **lead (*plumbum*)** is **Pb**. Whenever two letters are used for an element, the first letter is capitalized but the second is not. Thus the element **cobalt, Co**, is distinguished from the compound **carbon monoxide, CO**.

Because of continued search for synthetic elements, aside from the 92 naturally - occurring elements there are man-made elements which were named by scientists as follows.

Element	Familiar Place or Name	Symbol of Element
Californium	California	Cf
Einsteinium	Albert Einstein	Es
Nobelium	Alfred Nobel (Nobel Prize)	No
Neptunium	Neptune	Ne
Plutonium	Pluto	Pu
Americium	America	Am
Berkelium	Berkeley, California	Bk
Curium	Marie and Pierre Curie	Cu
Francium	France	Fr
Scandium	Scandinavia	Sc
Polonium	Poland	Po
Tungsten	Wolfrom (Peter Woulf)	W

These elements are organized using the **periodic table**. *(Please refer to the modern version of the periodic table in inset.)* A periodic table is a classification and tabulation of the elements in the order of their atomic numbers and atomic masses that show the elements' chemical and physical properties.

B. How are elements grouped?

Take note of the color-coding in the periodic table. Elements are grouped according to metals, nonmetals and metalloids. **Metals** are solid, malleable, ductile and good conductors of heat. They also possess luster. The only liquid metal is mercury, (***Hg***). **Nonmetals** can be solids, liquids or gases. The only liquid nonmetal is bromine, (***Br***). In between metals and nonmetals that lie along either side of the zigzag line of the periodic table are the **metalloids**. Some of these elements like boron (***B***) and silicon (***Si***) are used as semiconductors.

C. How are elements classified?

Elements are classified based on their positions or locations in the periodic table.

Group I A - The Alkali Metals

Group 1 elements are soft silvery metals. They react strongly with water. The further down the group you go, the more violent this reaction is. These alkali metals are usually stored under oil to protect them from moisture and oxygen. They all have one electron in their outer shells. In a chemical reaction an alkali metal atom loses this single electron. It achieves the stable electron structure of the noble gases.

Group II A – The Alkaline Earth Metals

This group consists of all metals that occur naturally in compound form. They are obtained from mineral ores and form alkaline solutions. These are less reactive than alkali metals.

Group III A – The Aluminum Group

The elements in this group are fairly reactive. The group is composed of four metals and one metalloid which is boron.

Group IV A – The Carbon Group

This group is composed of elements having varied properties because their metallic property increases from top to bottom meaning the top line, which is carbon, is a nonmetal while silicon and germanium are metalloids, and tin and lead are metals.

Group V A – The Nitrogen Group

Like the elements in group IV A, this group also consists of metals, nonmetal and metalloids.

Group VI A – The Oxygen Group

This group is called the oxygen group since oxygen is the top line element. It is composed of three nonmetals, namely, oxygen, sulfur and selenium, one metalloid, (tellurium) and one metal (polonium)

Group VII A – The Halogens

This group is composed of entirely nonmetals. The term “halogens” comes from the Greek word *hals* which means salt and *genes* which means forming. Halogens group are called “*salt formers”*.

Group VIII A – The Noble Gases

This group is composed of stable gases otherwise known as the non-reactive or inert elements.

The transition elements

The elements in the middle of the table are called transition elements. They are all metals and so they are also called transition metals.

The system of grouping elements over A and B groups was devised by the **International Union of Applied and Pure Chemistry (IUPAC)** to eliminate confusion.

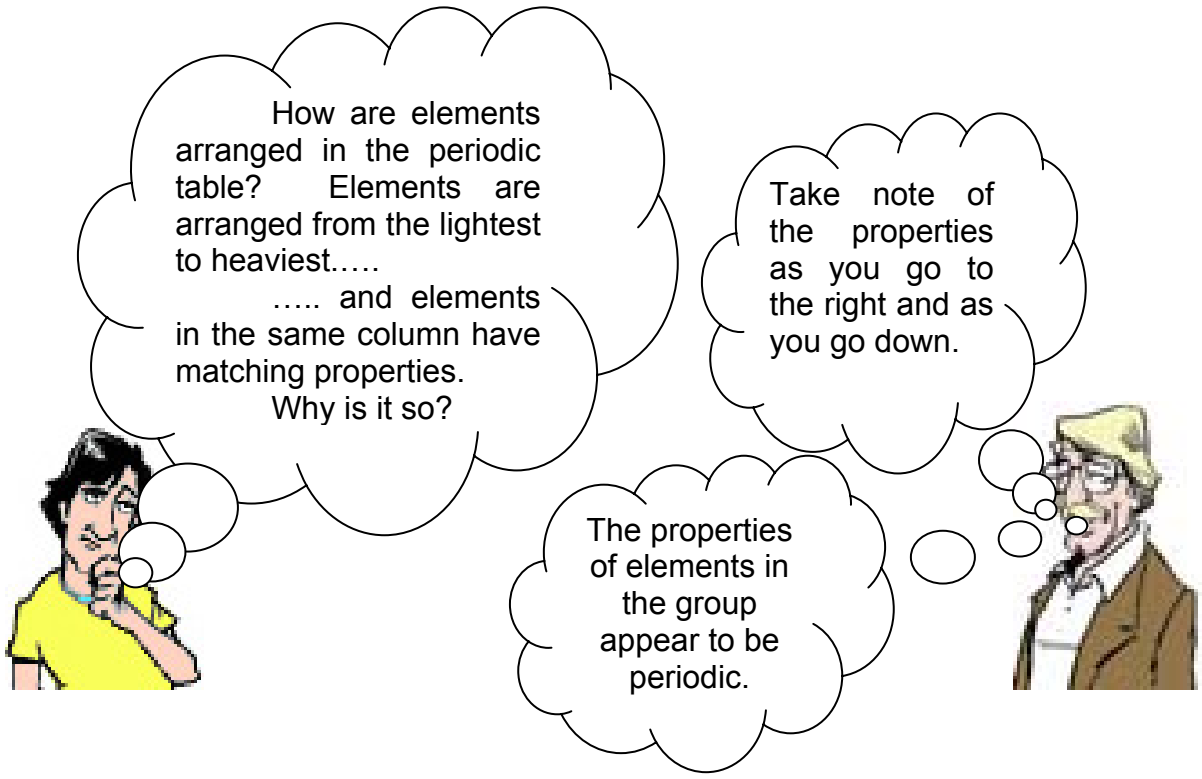
Lesson 2. Properties of Elements in the Periodic Table

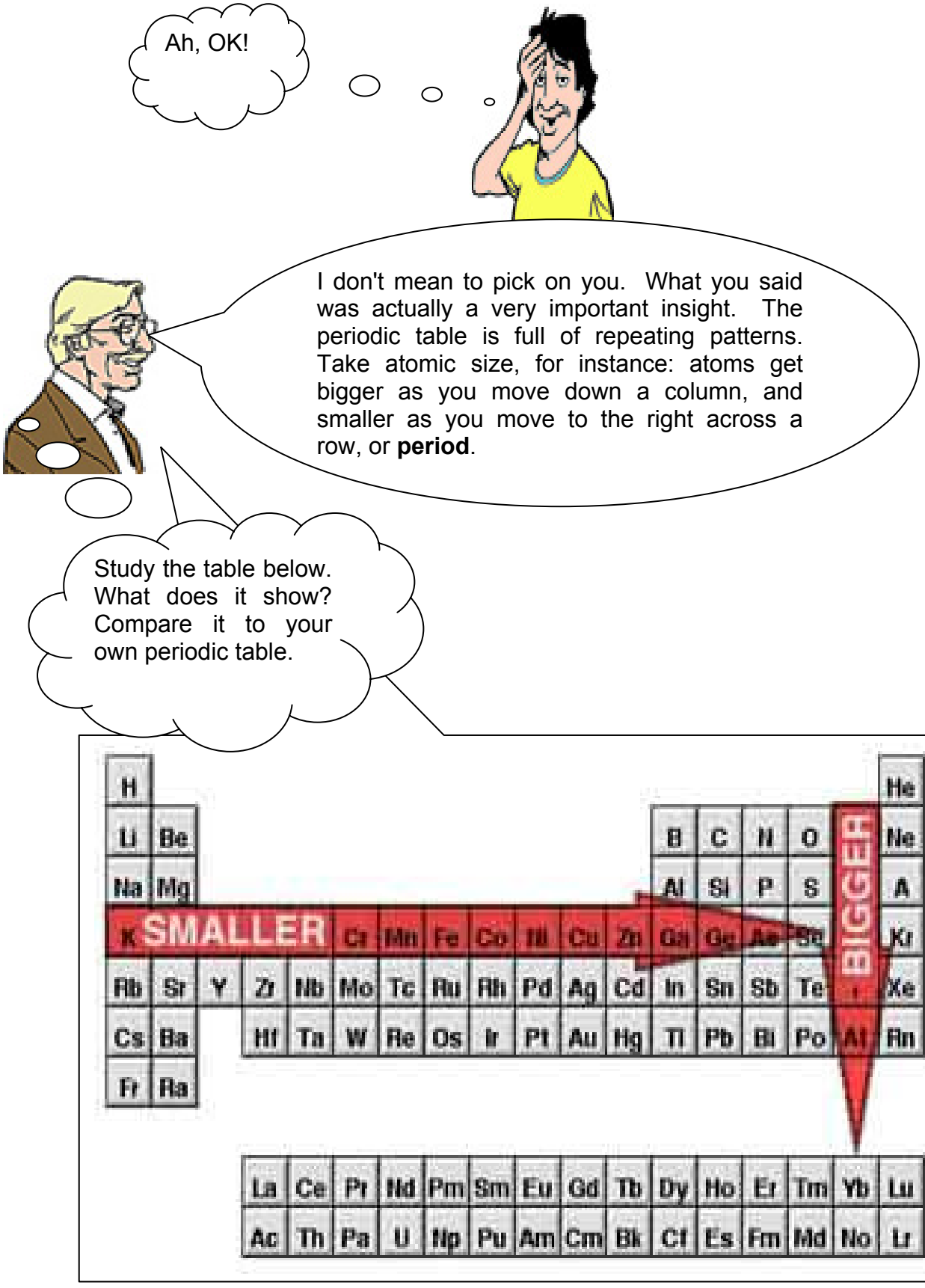
This lesson will focus on the arrangement of the elements in the periodic table based on their properties.

What you will do

Activity 2.1

Read the comic strips below. You will need your own periodic table for this activity:




Ah, OK!
I don't mean to pick on you. What you said was actually a very important insight. The periodic table is full of repeating patterns. Take atomic size, for instance: atoms get bigger as you move down a column, and smaller as you move to the right across a row, or **period**.
Study the table below. What does it show? Compare it to your own periodic table.
SMALLER
BIGGER

That's so weird! I thought atoms got bigger as they got heavier; why do they get *smaller* as you move to the right?

Now, I know. **The atomic size becomes smaller as I go from left to right, and becomes bigger as I go from top to bottom.** OK!

What about its atomic structure?

That's another thing. We'll talk about that when we go to the next lesson. For the mean time, let's summarize what you've learned in this lesson.

Two distinct trends are noticeable in the atomic size or atomic radius of the periodic table:

1. Atoms get larger going down a group (vertical arrangement or column); and
2. Atoms get smaller moving from left to right across each period (horizontal arrangement of elements).

What about ionization energy?
electronegativity?
electron affinity?

OK, that's a nice question! First, I would like you to know the meaning of these terms. ***Ionization energy*** is the energy required to remove the outer electron from an isolated atom. ***Electron affinity*** is the energy released when a neutral atom gains an extra electron to form a negatively-charged ion. ***Electronegativity*** is the electron attracting ability of an atom.

Examine your periodic table. It will tell you that the ionization energy for that element is quite small. It wouldn't take much to send that one solitary electron sailing off into dizzying freedom--and *that* sort of thing, electrons leaving their home atoms, leads directly to chemical reactions. What does it tell you? The atomic radius is affected by the ionization energy, electronegativity and electron affinity. As you go across from left to right, ionization energy, electronegativity and electron affinity increase, thus the atomic radius decreases. From top to bottom, ionization energy, electronegativity and electron affinity decreases, thus the atomic radius increases.

What you will do

Self-Test 2.1

1. Arrange the following elements according to decreasing atomic radius:
   a. As, P, Sb, N
   b. Sb, As, P, N
   c. As, N, P, Sb
   d. N, P, As, Sb

2. Which of the following decreases as you go from left to right?
   a. atomic radius
   b. ionization energy
   c. electron affinity
   d. electronegativity

3. Which of the following groups is a set of metals?
   a. Group VII A
   b. Group IV A
   c. Group II A
   d. Transition elements

4. Electron affinities of elements generally become smaller as we move from:
   a. top to bottom
   b. bottom to top
   c. left to right
   d. diagonally

5. The ability of an element to attract an electron from another atom is called:
   a. electronegativity
   b. electron affinity
   c. ionization energy
   d. metallic property

Key to answers on page 27.

Lesson 3. Electron Configuration and Order of Elements

The electrons in the highest energy level of an atom are called valence electrons. This lesson will discuss how these electrons are distributed around their orbital.

What you will do

Activity 3.1

Read this comic strip and find out more about the arrangement of elements in the periodic table.

After Mendeleev's time, scientists discovered what you already know: an atom consists of a positively charged nucleus, made of neutrons and protons, and electrons moving around it. This is shown by **electron configuration.**

"Electron configuration"? I'm not sure if I understand what that means. How do I go about it? Does it have something to do with the **"s p d f"** ?

Yes; **Electron configuration** *shows how the electrons are arranged in the selected element*. I'd be happy to explain how the electrons organize themselves. OK, examine the chart below.

s																	s
s	s											p	p	p	p	p	p
s	s											p	p	p	p	p	p
s	s	d	d	d	d	d	d	d	d	d	d	p	p	p	p	p	p
s	s	d	d	d	d	d	d	d	d	d	d	p	p	p	p	p	p
s	s	d	d	d	d	d	d	d	d	d	d	p	p	p	p	p	p
s	s																
		f	f	f	f	f	f	f	f	f	f	f	f	f	f		
		f	f	f	f	f	f	f	f	f	f	f	f	f	f		

It says that groups IA and IIA belong to the ***s*** block; groups IIIA to VIIIA belong to the ***p*** block; the transition metals to the ***d*** block and the lanthanides and actinides to the ***f*** block.

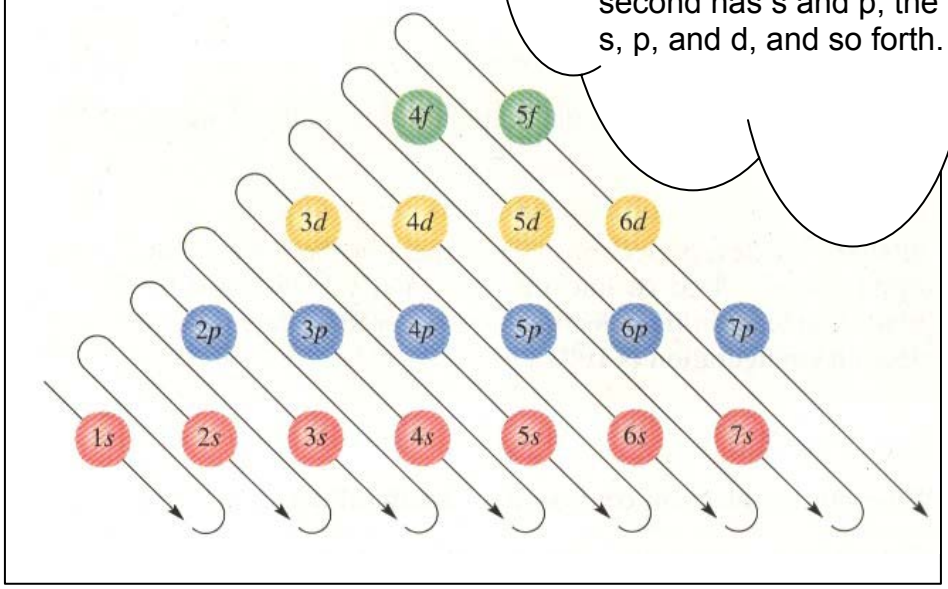
s – sharp	**2** electrons to fill
p – principal	**6** electrons to fill
d – diffuse	**10** electrons to fill
f – fundamental	**14** electrons to fill

In determining the total number of electrons in an energy level use the formula **number of electrons = $2n^2$** where n is the number of energy level; so for the first energy level there are 2 ;
2^{nd} = 8 = (2+6); 3^{rd} = 18 = (2 + 6 = 10);
4^{th} = 32 = (2 + 6 + 10 + 14)

But, how will I do it? Can you give me a pattern to make it easier and faster?

Very easy! Just follow the arrows.

The **s, p, d and f** are called **sublevels**; they are smaller "subdivisions" of energy within the primary levels. You refer to different energy levels using a number for the primary level plus a letter for the sublevel; for example, you might speak of an electron in a "3p" **state** or **orbital**. Each primary level has one more sublevel than the one below: the first primary level has only s orbitals, the second has s and p, the third s, p, and d, and so forth.



Below are samples of electron configuration of some elements:

Elements	Atomic Number	Electron Configuration	Period	Group
Hydrogen, H	1	$1s^1$	1	I A
Lithium, Li	3	$1s^2 2s^1$	2	I A
Berylium, Be	4	$1s^2 2s^2$	2	II A
Carbon, C	6	$1s^2 2s^2 2p^2$	2	IV A
Nitrogen, N	7	$1s^2 2s^2 2p^3$	2	V A
Aluminum, Al	13	$1s^2 2s^2 2p^6 3s^2 3p^1$	3	III A
Sulfur, S	16	$1s^2 2s^2 2p^6 3s^2 3p^4$	3	VI A
Potassium, K	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$	4	I A
Bromine, Br	35	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$	4	VII A
Dysprosium, Dy	66	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{10}$	6	II B

Analysis of the Table:

Take note of the coefficient of the last energy level. Notice also the exponent or the number on the superscript of the letter of the last energy level.

*The **coefficient** represents the **series or the period** of the element and the **superscript or the exponent** represents the **number of electrons** in the outermost energy level or simply the valence electrons. It is also the **Family or the Group Number** of the element.*

What you will do

Self-Test 3.1

Fill up the columns:

1. Write the electron configuration.
2. Identify the period and group number without looking at your periodic table.

Elements	Atomic Number	Electron Configuration	Period	Group
Magnesium	12			
Chromium	24			
Silicon	14			
Galium	31			
Krypton	36			
Rubidium	37			
Silver	47			
Antimony	51			
Iodine	53			
Barium	56			

Key to answers on page 28.

Lesson 4. Importance of Some Elements in the Human Body

This lesson tackles the different uses of elements in the periodic table. Some of these elements are essential to our lives, in industry and in modern technologies.

Group I A – The Alkali Metals

Group 1A elements are soft silvery metals. They are highly reactive with water and melt at low temperature. Because of their reactivity, they are never found free in nature. Compounds of these elements like sodium chloride or table salt is a fundamental part of the diet; potassium compounds are important nutrients for plants. Potassium nitrate, KNO_3, commonly known as *salitre,* is used in making tocino.

Group II A – The Alkaline Earth Metals

This group consists of all metals that occur naturally in compound form. They are obtained from mineral ores and form alkaline solutions. These are less reactive than alkali metals. Magnesium (Mg) and calcium (Ca) are the most abundant elements in the earth's crust. Calcium is one of the important elements in teeth and bones. Radium, the heaviest alkaline metal, is used for cancer treatment.

Group III A – The Aluminum Group

The elements in this group are fairly reactive. The group is composed of four metals and one metalloid, which is boron. Aluminum is a metal abundantly found in the earth's crust. It is used as a raw material for kitchenware due to its low density

property. Others, such as gallium is used as semiconducting material in the form of gallium arsenide.

Group IV A – The Carbon Group

This group is composed of elements having varied properties because their metallic property increases from top to bottom meaning the top line which is carbon, is a non-metal, silicon and germanium are metalloids while tin and lead are metals. Carbon is the major constituent of most chemical compounds. Tin alloys are used in making weapons, cutting utensils and for canning of foods. Lead is an additive for paint and for plumbing purposes.

Group V A – The Nitrogen Group

Like the elements in group IV A, this group also consists of metals, a nonmetal and metalloids. Nitrogen gas makes up three-fourths of the earth's atmosphere. This gas is useful in preparing ammonia and fertilizers.

Group VI A – The Oxygen Group

The elements in this group like the sulfur and selenium are essential components in the human diet.

Group VII A – The Halogens

Fluorine is a major component of the chlorofluorocarbons (CFCs) that are used as aerosols and refrigerants. Chlorine is used as bleaching agent. Bromine, known to us as the only liquid metal, is used in the manufacture of photographic films and dyes, while an isotope of iodine, iodine 131, is used in thyroid gland treatment. Iodine is also used in the preparation of iodized salt that refreshes and prevents memory gap.

Group VIII A – The Noble Gases

The element helium is used for balloon inflating since it is very light. Argon and neon are used as advertising lights.

The transition elements

These elements are lanthanides compounds that are used as "green TV" or colored picture tube. Uranium isotopes are used as fuel for nuclear reactors. Americium is used as "smoke detector'.

What you will do

Self-Test 4.1

Match Column A with Column B.

ELEMENT	USE(S)
1. americium	a. used as constituent of “green TV”
2. iodine 131	b. heaviest metal used for cancer treatment
3. potassium compound	c. ¾ of the earth’s atmosphere
4. calcium compound	d. used in aerosols
5. nitrogen	e. raw material for kitchen wares
6. magnesium	f. an element from group IIA found in the earth’s crust
7. neon	g. advertising lights
8. lanthanide metals	h. used as preservative
9. aluminum	i. used as smoke detector
10. radium	j. used for thyroid gland treatment

Key to answers on page 28.

Let’s Summarize

A. Development of the Periodic Table

1. **Johann Wolfgang Dobereiner** classified elements in sets of three. He called it the “**law of triads**”
2. **John Alexander Reina Newlands** arranged the elements according to increasing atomic mass and suggested that every eighth element has similar properties. He called his law the “**law of octaves**”.
3. **Dmitri Inovich Mendeleev** devised the first periodic table, which he used to predict three new elements. He proposed the ”**periodic law**” which states that when elements are arranged in order of increasing atomic number, their properties show periodic pattern.

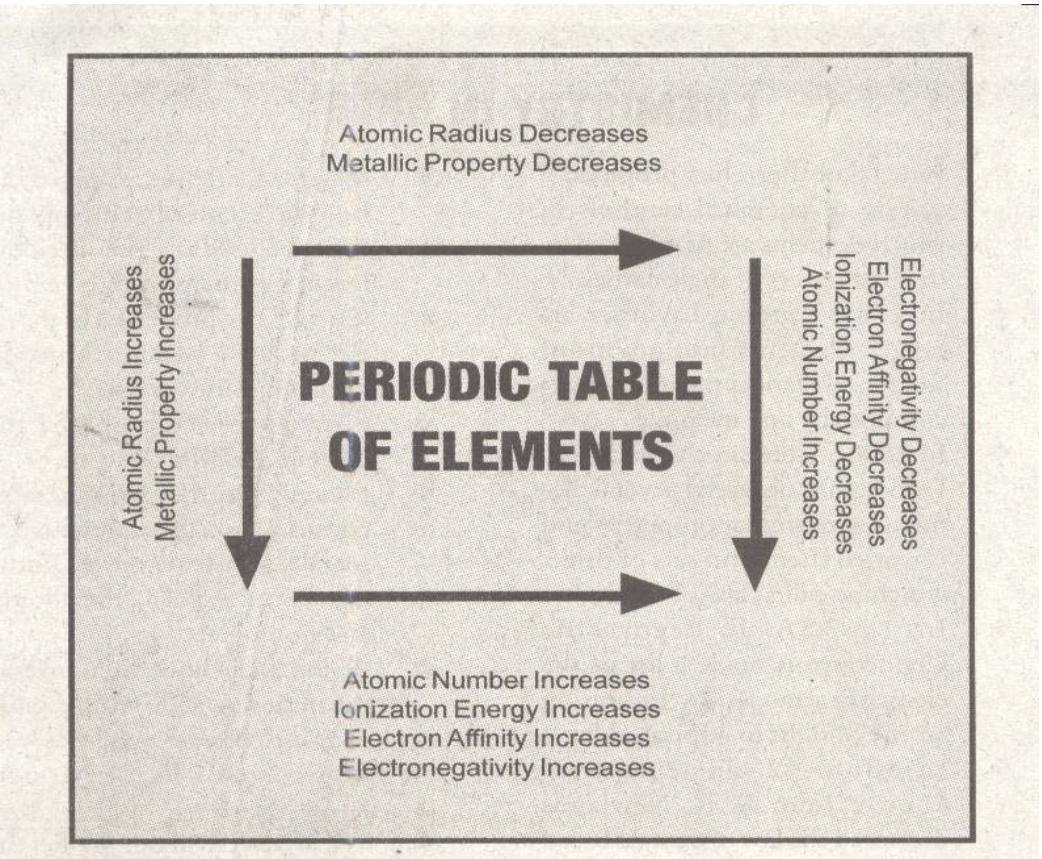
B. The Periodic Table and the Elements

1. The periodic table is composed of 7 rows or periods and 18 major groups or columns. Elements in a group have similar properties particularly those elements in four of the groups: Group IA – The alkali metals; Group II A - the alkaline earth metals; Group VII A – the halogens and Group VIII A – the noble gases.

2. The elements are given symbols devised by John Jacob Berzelius. An element is named after its discoverer, place of discovery, first letter of the name of the element, first and the second letter for those having the same first letter and some are after their Latin names. The elements are grouped into Group A and B Group by the INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY (**IUPAC**).
3. Elements in the periodic table are also grouped according to metals, non-metals and metalloids. **Metals** are lustrous, malleable and ductile. They are good conductors of heat. Metals are found on the left side of the periodic table. **Nonmetals** have a diverse set of properties. They are found on the upper right side of the periodic table. **Metalloids** or semimetals possess the properties of both the metals and the non-metals.

C. Periodic Trends

1. A periodic trend is a property that changes as you move across a period or down a group of the periodic table.



1. Atomic radius increases as you move down a group and decreases as you move across.
2. Ionization energy is the energy needed to remove an electron to form a positive ion.

3. Electron affinity is the energy change that occurs when an atom gains an electron to form a negative ion.
4. An element's electronegativity reflects its attraction for electrons in a chemical bond.

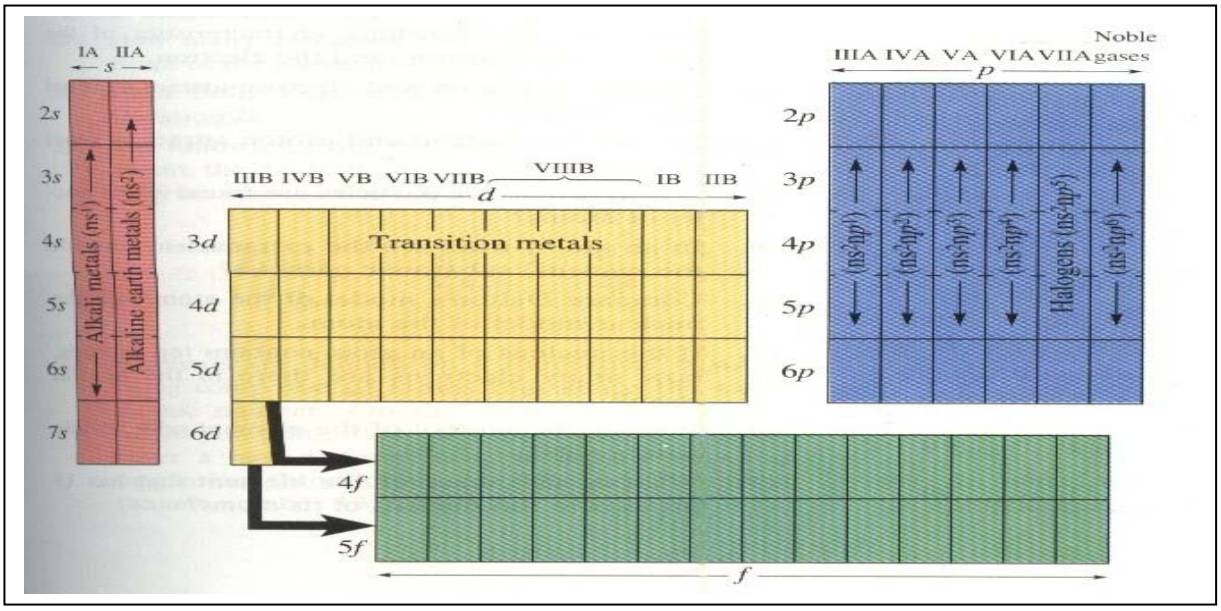
D. Electron Configuration and Order Among Elements

1. The distribution of electrons among the orbitals of an atom is its **electron configuration.**
2. **s** – sharp **2** electrons to fill
   p – principal **6** electrons to fill
   d – diffuse **10** electrons to fill
   f – fundamental **14** electrons to fill

   Total number of electrons in an energy level can be found by the formula
   number of electrons = $2n^2$

   Where **n** is the number of energy level;
   1st energy level there are 2 ;
   2nd = 8 = (2+6)
   3rd = 18 = (2 + 6 = 10); 4th = 32 = (2 + 6 + 10 + 14)

3. The **s, p, d, and f** are called **sublevels**; they are smaller "subdivisions" of energy within the primary levels. You refer to different energy levels using a number for the primary level plus a letter for the sublevel; for example, you might speak of an electron in a "3p" **state** or **orbital**. Each primary level has one more sublevel than the one below: the first primary level has only s orbitals, the second has s and p, the third s, p, and d, and so forth.



Posttest

I. Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. The lowest sublevel in each principal energy level is the
   a. s b. p c. d d. f

2. Which among the elements is an alkali metal?
   a. boron
   b. magnesium
   c. sodium
   d. oxygen

3. Elements in the 4f series are called:
   a. alkali metals
   b. alkaline earth metals
   c. actinides
   d. lanthanides

4. What is the most abundant element in the universe?
   a. oxygen
   b. carbon
   c. silicon
   d. aluminum

5. Which transition metal is the best conductor of electricity?
   a. copper
   b. silver
   c. chromium
   d. iron

6. Which of these metals are soft enough to be cut by a knife?
   a. alkaline metals
   b. alkali metal
   c. transition metals
   d. all of these

7. Among the groups in the periodic table, which set of elements are the least reactive?
   a. Lanthanides
   b. actinides
   c. Halogens
   d. Inert gases

8. The scientist who grouped the elements into sets of three is
   a. Mendeleev
   b. Newlands
   c. Dobereiner
   d. Moseley

9. As you move from left to right of the periodic table, the elements

a. increase in atomic radius
b. increase ionization energy
c. decrease in electron affinity
d. have no periodic trends

10. The energy change when an electron is added is called:
a. ionization energy
b. electronegativity
c. electron affinity
d. reactivity

11. How many elements are in the second period of the periodic table?
    a. 2 b. 4 c. 6 d. 8

12. How many electrons do the elements belonging to Group IIIA have in their outermost shell?
    a. 1 b. 2 c. 3 d. 4

13. Which orbital is being filled in the actinides series of elements?
    a. 4f b. 4d c. 5f d. 5d

14. Who stated the "law of Octaves'?
    a. Johann Wolfgang Dobereneir
    b. Dmitri Inovich Mendeleev
    c. John Alexander Newlands
    d. John Dalton

15. In electron configuration, what does the number before the sub-energy level represent?
    a. Period
    b. Group
    c. total number of electrons
    d. number of outermost electrons

II. Matching Type: Match Column A with Column B

COLUMN A	COLUMN B
1. halogens group	a. electron configuration
2. noble gases	b. B Group
3. alkali metals	c. Group I – A
4. carbon group	d. Group II – A
5. alkaline earth metals	e. Group III – A
6. transition metals	f. Group IV A
7. aluminum group	g. Group V A
8. oxygen group	h. Group VI A
9. Nitrogen group	i. Group VII A
10. electron distribution	j. Group VIII A

III. Complete the Table below. (Don't look at your periodic table)

Elements	Atomic Number	Electron Configuration	Period	Group
1. Sodium, Na	11			
2. Titanium, Ti	22			
3. Phosphorus,P	15			
4. Fluorine, F	9			
5. Chlorine, Cl	17			

Key to answers on page 28.

Key to Answers

Pretest

I. Multiple Choice

1. b
2. a
3. b
4. c
5. c
6. a
7. a
8. b
9. c
10. c
11. c
12. a
13. c
14. d
15. d

II. Fill in the Blanks

1. John Newlands
2. electron configuration
3. metalloids
4. inert gases or noble elements
5. series or period number

Lesson 1

Self-Test 1.1

1. Johann Wolfgang Dobereiner
2. Triads
3. Alexander Reina Newlands
4. Octaves
5. Dmitri Mendeleev

Lesson 2

Self-Test 2.1

1. b
2. a
3. c
4. a
5. a

Lesson 3

Self-Test 3.1

Elements	Atomic Number	Electron Configuration	Period	Group
Magnesium	12	$1s^2 2s^2 2p^6 3s^2$	3	II A
Chromium	24	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$	4	VI B
Silicon	14	$1s^2 2s^2 2p^6 3s^2 3p^2$	3	IV A
Galium	31	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$	4	V A
Krypton	36	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$	4	VIII A
Rubidium	37	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$	1	I A
Silver	47	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10}$	5	I B
Antimony	51	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^3$	5	V A
Iodine	53	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10} 5p^1$	5	VII A
Barium	56	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^{10} 5p^6 6s^2$	6	II A

Lesson 4

Self-Test 4.1

ELEMENT	USE(S)
1. americium	i. used as smoke detector
2. iodine 131	j. used for thyroid gland treatment
3. potassium compound	h. used as preservative
4. calcium compound	d. used in gypsum making
5. nitrogen	c. ¾ of the earth's atmosphere
6. magnesium	f. an element from group IIA found in the earth's crust
7. neon	g. advertising lights
8. lanthanide metals	a. used as constituent of "green TV"
9. aluminum	e. raw material for kitchen wares
10. radium	b. heaviest metal used for cancer treatment

Posttest

I. Multiple Choice

1. a
2. b
3. d
4. d
5. b
6. a
7. d
8. c
9. b
10. b
11. d
12. c
13. c
14. c
15. a

II. Matching Type

COLUMN A	COLUMN B
1. halogens group	i. Group VII A
2. noble gases	j. Group VIII A
3. alkali metals	c. Group I – A
4. carbon group	f. Group IV A
5. alkaline earth metals	d. Group II – A
6. transition metals	b. B Group
7. aluminum group	e. Group III – A
8. oxygen group	h. Group VI A
9. nitrogen group	g. Group V A
10. electron distribution	a. electron configuration

III. Complete the Table below:

Elements	Atomic Number	Electron Configuration	Period	Group
1. Sodium, Na	11	$1s^2 2s^2 2p^6 3s^1$	3	I A
2. Titanium, Ti	22	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$	4	IV B
3. Phosphorus,P	15	$1s^2 2s^2 2p^6 3s^2 3p^2$	3	V A
4. Fluorine, F	9	$1s^2 2s^2 2p^5$	2	VII A
5. Chlorine, Cl	17	$1s^2 2s^2 2p^6 3s^2 3p^5$	3	VII A

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