Ministry of Higher Education & Scientific Research

Hilla University College

Criminal Evidence Department

Analytical Chemistry

First-year

Lecture Two

The Periodic Table of the Elements



Dr. Ammar M. Al

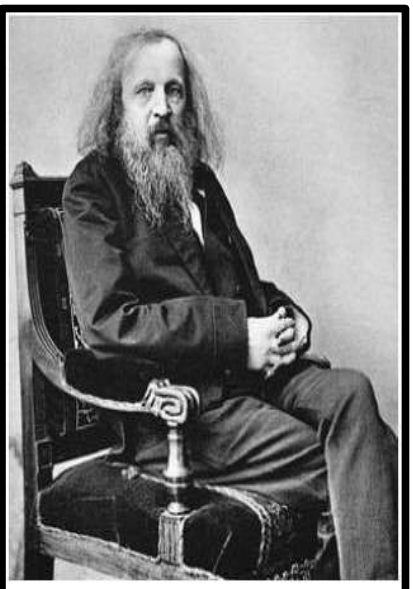


FIGURE 2.14 ▲
Dmitri Ivan 1 deleev (1834–1907)

In 1869 the Russian chemist Dmitri Mendeleev (1834–1907) and the German chemist J. Lothar Meyer (1830–1895), working independently, made similar discoveries.

They found that when they arranged the elements in order of **atomic mass**, they could place them in horizontal rows, one row under the other so that the elements in each **vertical column have similar properties**. A tabular arrangement of elements in rows and columns, highlighting the regular repetition of properties of the elements, is called a **periodic table.**

A **modern** version of the periodic table, with the elements **arranged by atomic number**.

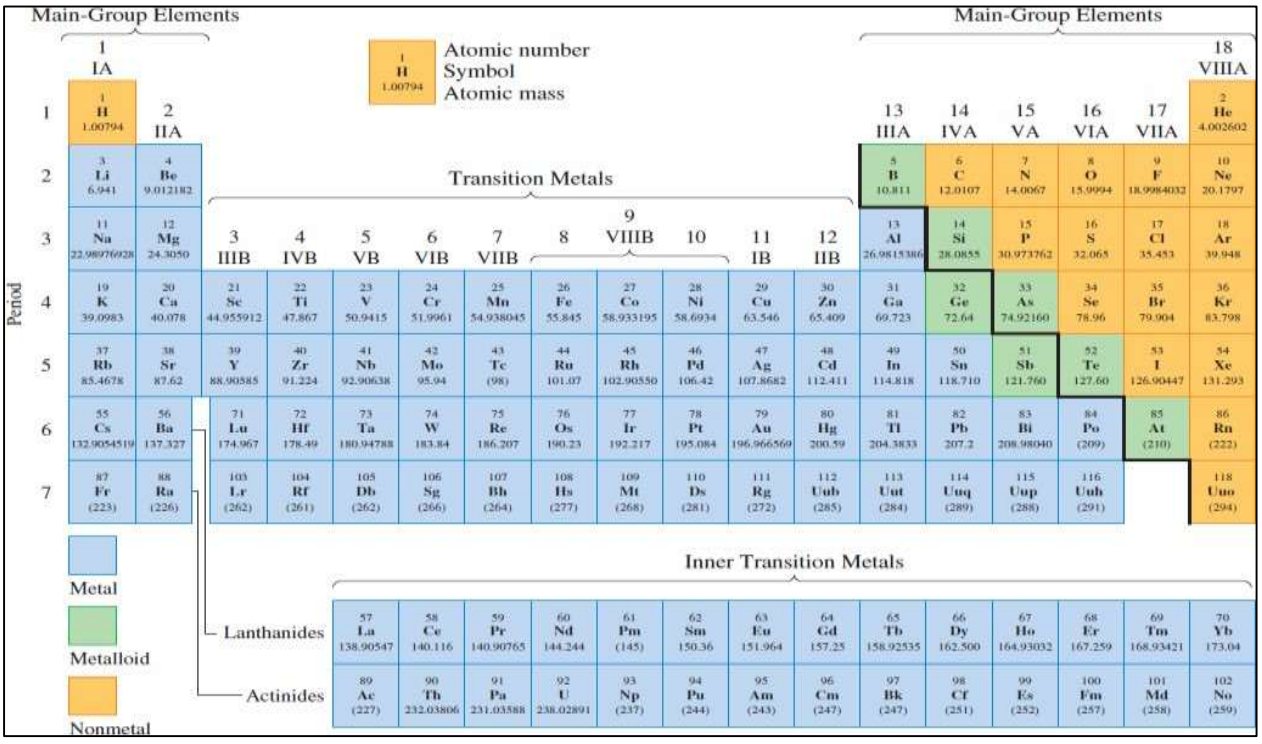


FIGURE 2
A modern form of the periodic table

Periods and Groups:

The basic structure of the periodic table is its division into **rows** and **columns**, or ***periods and groups.***

A period consists of the elements in any one *horizontal row* of the periodic table.

A group consists of the elements in any one *column* of the periodic table.

Under an international naming convention, the groups are numbered numerically from 1 to 18 from the leftmost column (the alkali metals) to the rightmost column (the noble gases).

Previously, they were known by roman numerals. In America, the roman numerals were followed by either an "A" if the group was in the s- or p- block, or a "B" if the group was in the d-block, e.g., the group 4 elements were group IVB, and the group 14 elements was group IVA.

groups some of names common	
Group	Name
1	alkali metals
2	alkaline earth metals
11	coinage metals
12	volatile metals (rarely used)
17	halogens
18	gases noble

Blocks

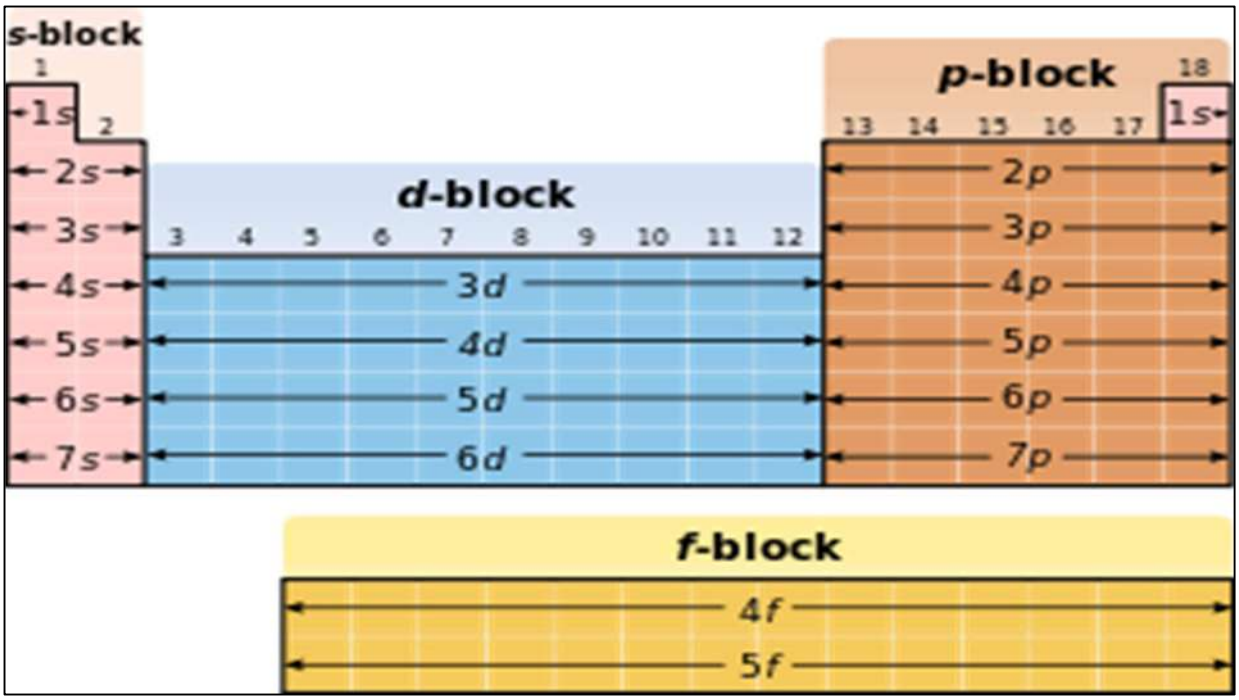
Because of the importance of the outermost electron shell, the different regions of the periodic table are sometimes referred to as blocks, named according to the subshell in which the "last" electron resides.

The s-block comprises the first two groups (alkali metals and alkaline earth metals) as well as hydrogen and helium.

The p-block comprises the last six groups which are groups 13 to 18 in IUPAC (3A to 8A in American) and contains, among other elements, all of the metalloids.

The d-block comprises groups 3 to 12 in IUPAC (or 3B to 2B in American group numbering) and contains all of the transition metals.

The f-block, usually offset below the rest of the periodic table, comprises the lanthanides and actinides.



Metals, Nonmetals, and Metalloids

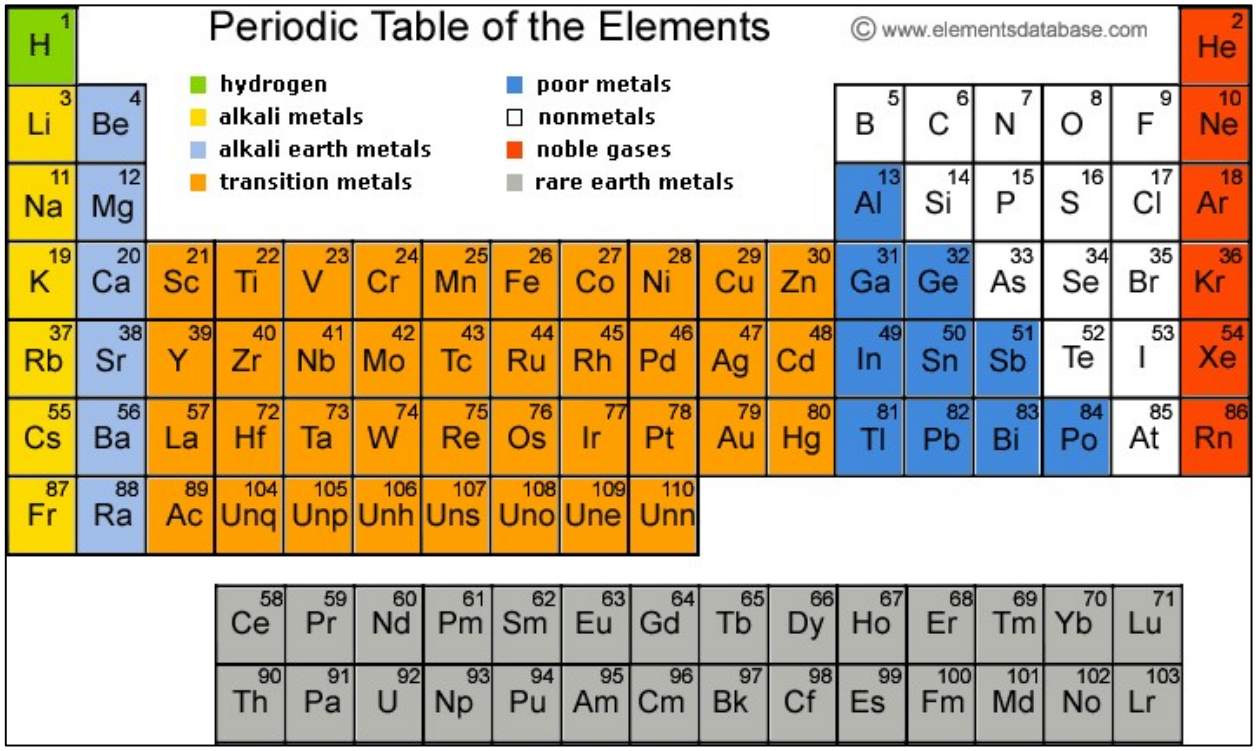
The elements of the periodic table in Figure 2 are divided by a heavy 'staircase' line into metals on the left and nonmetals on the right.

A metal is a substance or mixture that has a characteristic luster, or shine, and is generally a good conductor of heat and electricity. Except for mercury, the metallic elements are solids at room temperature (about 20°C). They are more or less malleable (can be hammered into sheets) and ductile (can be drawn into wire).

A nonmetal is an element that does not exhibit the characteristics of a metal. Most of the nonmetals are gases (for example, chlorine and oxygen) or solids (for example,

phosphorus and sulfur). The solid nonmetals are usually hard, brittle substances. Bromine is the only liquid nonmetal.

Most of the elements bordering the staircase line in the periodic table (Figure 2) are metalloids or semimetals. **A metalloid, or semimetal**, has both metallic and nonmetallic properties. These elements, such as silicon (Si) and germanium (Ge), are usually good semiconductors—elements that, when pure, are poor conductors of electricity at room temperature but become moderately good conductors at higher temperatures.



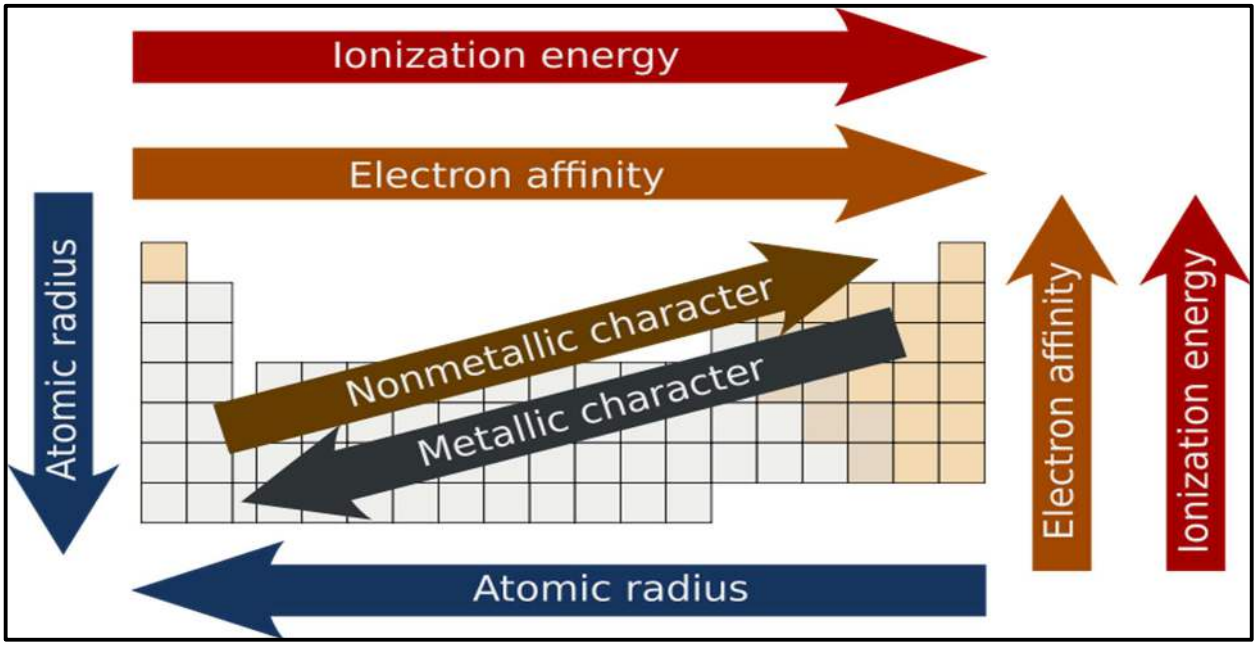
E*xercise 2and 3 By referring to the periodic table (Figure 2 or inside front cover), identify the group and period to which each of the following elements belongs. Then decide whether the element is a metal, nonmetal, or metalloid.*
a. Se b. Cs c. Fe d. Cu e. Br

Periodic table trends.

The electron configuration of electrons orbiting neutral atoms shows a recurring pattern or periodicity.

The electrons occupy a series of electron shells (numbered shell 1, shell 2, and so on).

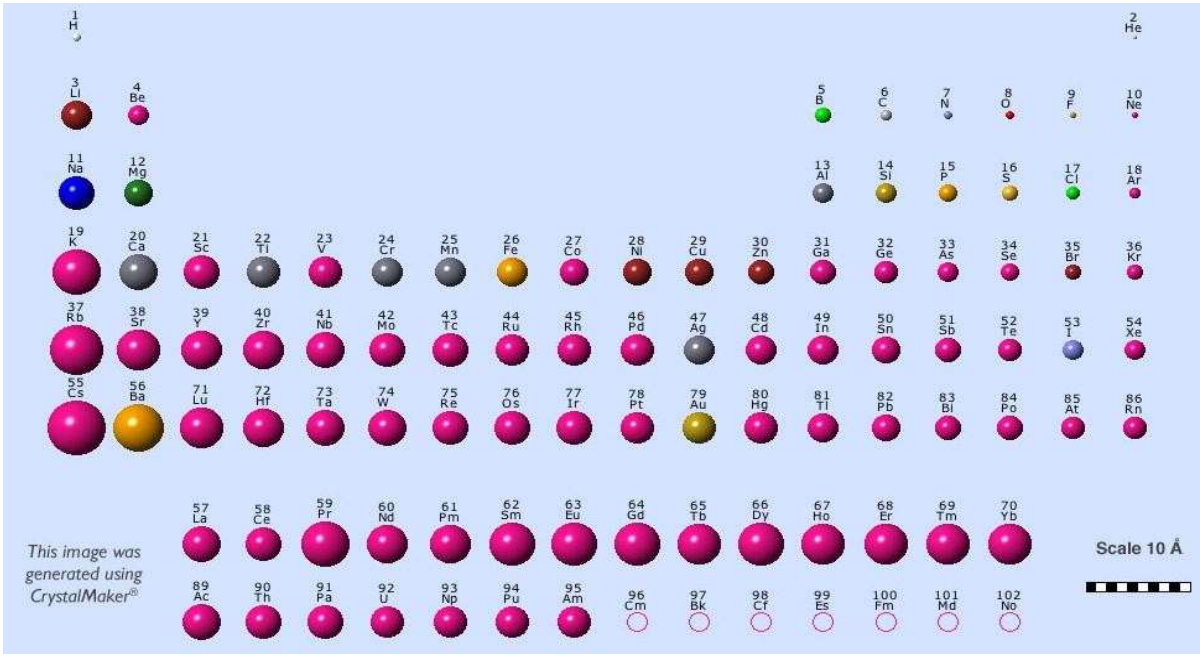
Each shell consists of one or more subshells (named s, p, d, f and g). As atomic number increases, electrons progressively fill these shells and subshells.



Since the properties of an element are mostly determined by its electron configuration, the properties of the elements likewise show recurring patterns or periodic behavior, some examples of which are shown in the diagram on the left.

Such as Atomic radii, Ionization energy, Electronegativity, acidity and basicity and metallic character.

Radii Atomic



Atomic radii vary in a predictable and explainable manner across the periodic table. For instance, the radii generally decrease along each period of the table, from the alkali metals to the noble gases; and increase down each group.

The radius increases sharply between the noble gas at the end of each period and the alkali metal at the beginning of the next period.

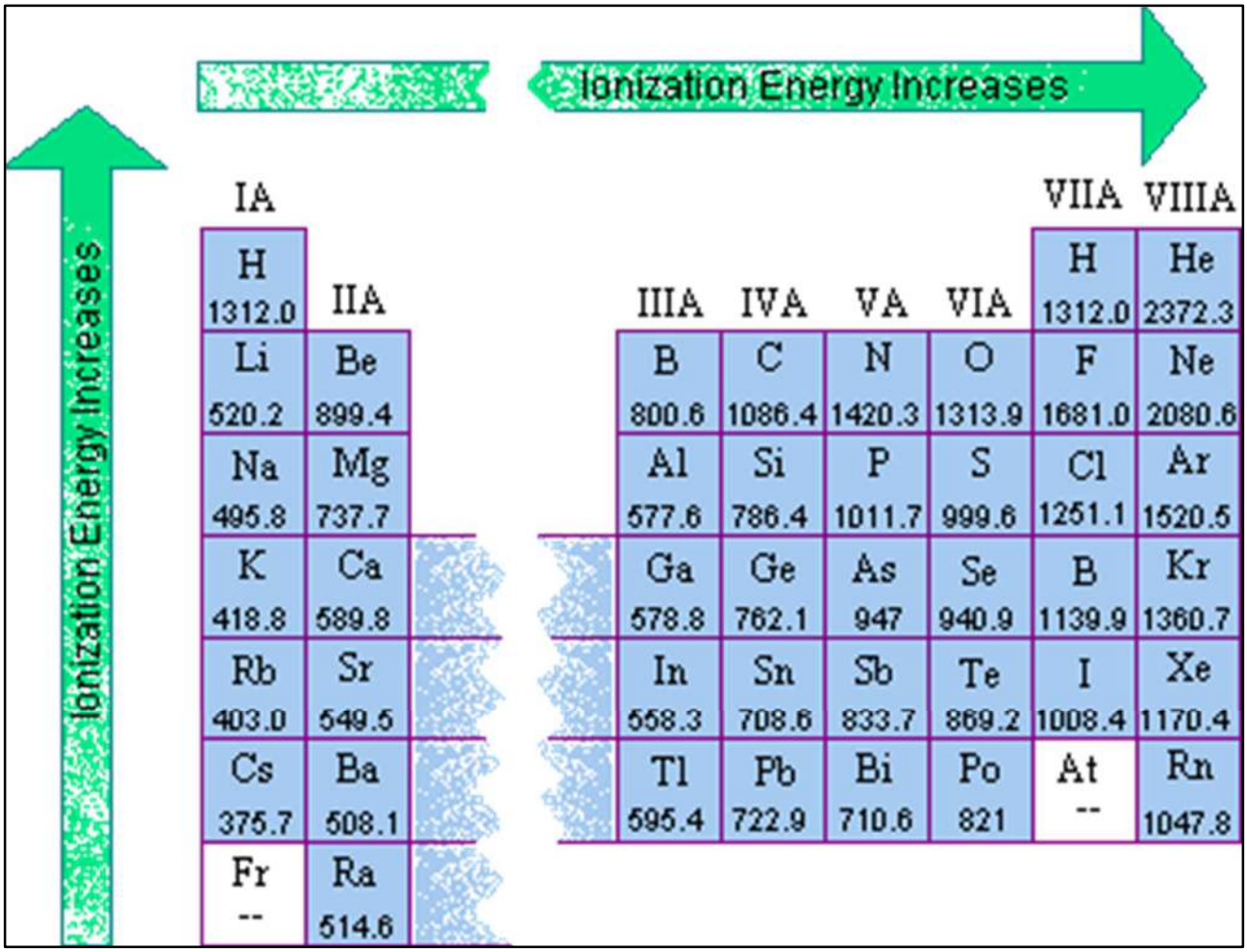
Ionization energy

The first ionization energy is the energy it takes to remove one electron from an atom,

$$Na_{(g)} + \text{energy} \rightarrow Na^{+}_{(g)} + e^{-}$$

The second ionization energy is the energy it takes to remove a second electron from the atom, and so on.

$$Na^{+}_{(g)} + \text{energy} \rightarrow Na^{2+}_{(g)} + e^{-}$$



Two trends are apparent from these data.

1- Generally, the first ionization energy increases as we go from left to right across a row of the periodic table.

2- The first ionization energy decreases as we go down a column of the periodic table

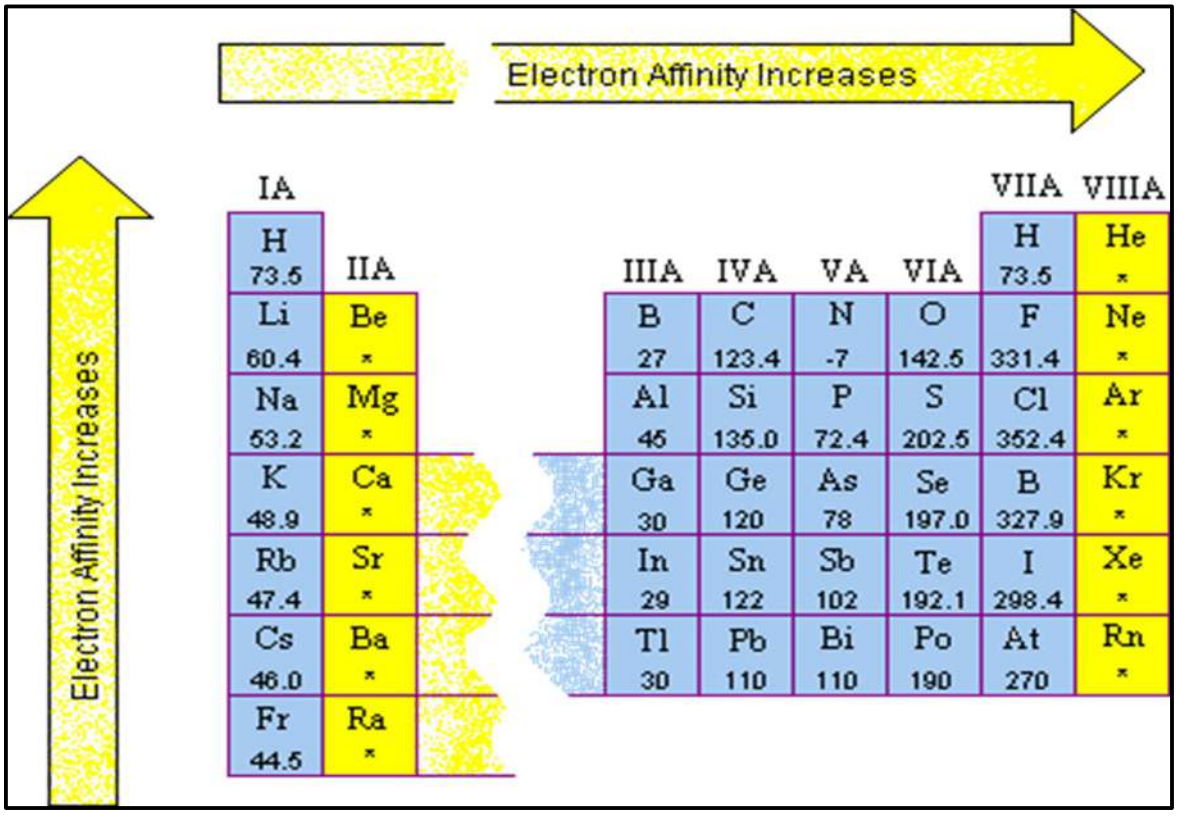
First, Second, Third, and Fourth Ionization Energies of Sodium, Magnesium, and Aluminum (kJ/mol)

	1st IE	2nd IE	3rd IE	4th IE
Na	495.8	4562.4	6912	9543
Mg	737.7	1450.6	7732.6	10,540
Al	577.6	1816.6	2744.7	11,577

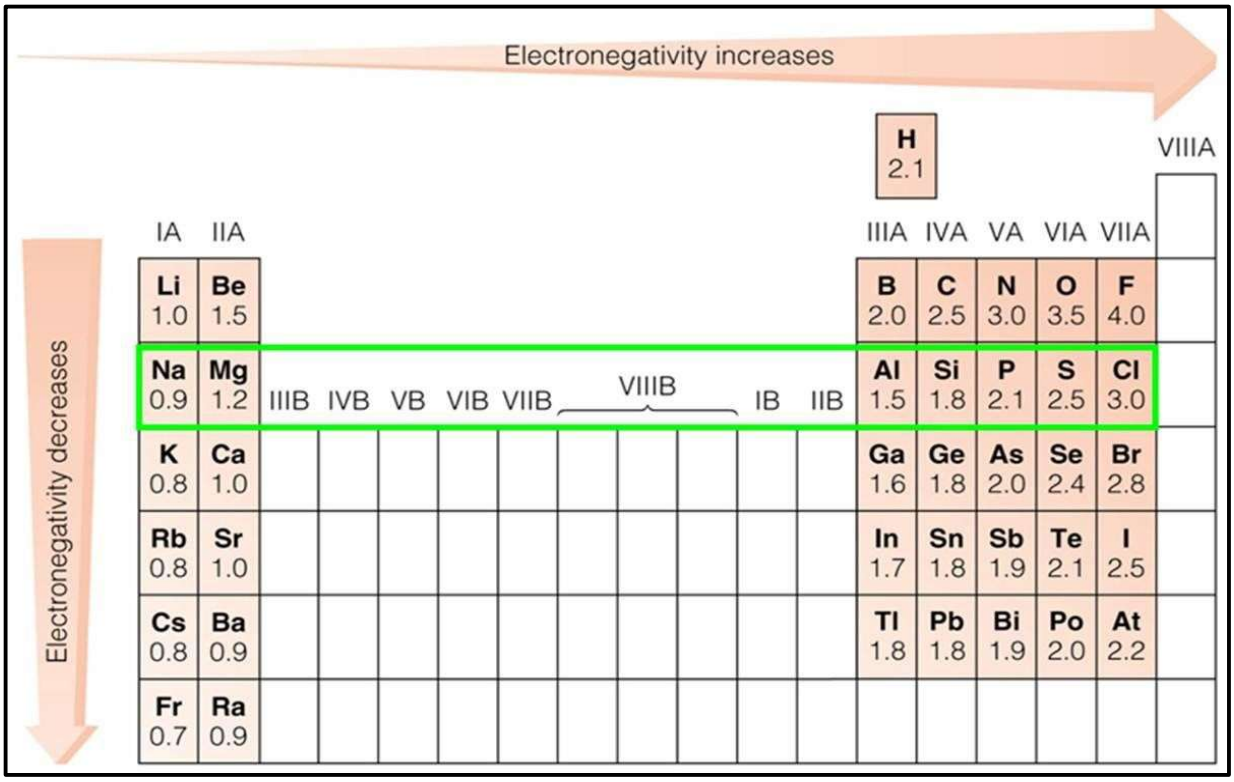
Electronegativity

Electronegativity is the tendency of an atom to attract electrons.

An atom's electronegativity is affected by both its atomic number and the distance between the valence electrons and the nucleus.



The higher its electronegativity, the more an element attracts electrons. Electronegativity generally increases on passing from left to right along a period, and decreases on descending a group. Hence, fluorine is the most electronegative of the elements while Caesium is the least, at least of those elements for which substantial data is available.



Electron affinity

The electron affinity of an atom is the amount of energy released when an electron is added to a neutral atom to form a negative ion. Generally, nonmetals have more positive electron affinity values than metals. Chlorine most strongly attracts an extra electron.

Electron affinity generally increases across a period. This is caused by the filling of the valence shell of the atom; a group 17 atom releases more energy than a group 1 atom on gaining an electron because it obtains a filled valence shell and is therefore more stable. A trend of decreasing electron affinity going down groups would be expected.

Metallic character

The lower the values of ionization energy, electronegativity and electron affinity the more metallic character the element has. Conversely, nonmetallic character increases with higher values of these properties. The metallic character tends to decrease going

across a period and tends to increase going down a group. Thus, the most metallic elements (such as Caesium and francium) are found at the bottom left of traditional periodic tables and the most nonmetallic elements (oxygen, fluorine, chlorine) at the top right.

Self-Assessment and Review Questions

1- Identify periods and groups on the periodic table.

2- Find the main-group and transition elements on the periodic table.

3- Locate the alkali metal and halogen groups on the periodic table.

4- Recognize the portions of the periodic table that contain the metals, nonmetals, and metalloids (semimetals).

5- What is the name of the element in Group IVA and Period 5?

6- Cite some properties that are characteristic of a metal.

7- Identify the group and period for each of the following.

8- Refer to the periodic table (Figure 2). Label each as a metal, nonmetal, or metalloid.

a. C b. Po c. Cr d. Mg e. B .

9- Refer to the periodic table (Figure 2 or inside front cover) and obtain the group and period for each of the following elements. Also determine whether the element is a metal, nonmetal, or metalloid.

a. S b. Fe c. Ba d. Cu e. Ne

10- Refer to the periodic table (Figure 1) and answer the following questions.

a- What Group VIA element is a metalloid?

b- What is the Group IIIA element in Period 3?

11- Refer to the periodic table (Figure 2. or inside front cover) and answer the following questions.

a- What Group VA element is a metal?

b- What is the Group IIA element in Period 3?

12- Give one example (atomic symbol and name) for each of the following.

a- a main-group (representative) element in the second period.

b- an alkali metals.

c- a transition element in the fourth period.

d- a lanthanide element.

13- Give one example (atomic symbol and name) for each of the following.

a- a transition element in the fifth period.

b- a halogen.

c- a main-group (representative) element in the second period.

d- an actinide element

14- ……..1st chemist to arrange newly found elements into a table form/usable manner.

15- Elements arranged according to…….

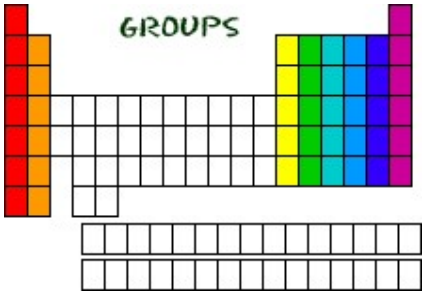
16- Resulted in……. or periodic intervals being……..

17- How the modern day periodic table is arranged?

18- As you move across a row or period, you add 1 proton to the nucleus, and 1 electron to the valence shell (√ or×).

19- The maximum number of valence electrons any element can have is eight (√ or×).

20- Put the blocks, periodic tends. Name of group 1, 2, 17, 18.



21- The chemical properties of an element are based on what?

22- Which of the groups are considered families? Give the group numbers and the names of the families.

23- Which group contains elements that do not typically react with other elements? Give the group number and the name.

24- Explain why elements in the group named above is not reactive.

25- Which group contains the most active metals? Give the group number and the name.

26- Which group contains the most active nonmetals? Give the group number and the name.

27- Which element is part of Group I, but is not an Alkali Metal?

28- Which groups form colored ions in solution? Give both the group numbers and the name.

29- Which group contains the second most active metals? Give both the group number and the name.

30- Which groups contain the most unpredictable metals? Give both the group numbers and the name.

31- Which type of element is located below or to the left of the staircase? What is the exception?

32- Which type of element is located above or to the right of the staircase?

33- Which type of element is located on the staircase? What are the exceptions?

34- Which of the following is NOT a property of a metal?

a.) Shiny; has luster b.) Malleable c.) Ductile d.) Brittle e.) Good conductor.

35- A sample of an element is shiny, is a good electrical conductor, and does not shatter when hit with a hammer. What type of element is it? (Circle one) METAL/NONMETAL/METALLOID.

36- A sample of an element is dull, does not conduct electricity, and shatters upon being hit with a hammer. What type of element is it? (Circle one) METAL/NONMETAL/METALLOID.

37- A sample of an element is shiny, does conduct electricity, and shatters upon being hit with a hammer. What type of element is it? (Circle one) METAL/NONMETAL/METALLOID.

38- What do metals have that allows them to conduct heat and electricity so well?

39- Shielding increases as the number ofincreases.

40- Who wins the ―tug of war‖ between protons and electrons and why?

41- What happens to atomic radius as you move across a period (from left to right)?

42- Explain your answer to #2 in terms of nuclear charge and number of principal energy levels.

43- What happens to atomic radius as you move down a group?

44- Explain your answer to #4 in terms of nuclear charge and number of principal energy levels.

45- Is the ionic radius of a metal larger or smaller than its atomic radius?

46- Explain your answer to #6 in terms of protons and electrons.

47- Is the ionic radius of a nonmetal larger or smaller than its atomic radius?

48- Explain your answer to #8 in terms of protons and electrons.

49- Which ion has the same electron configuration as an atom of He?

a. Ca^{2+} b. H^{-} c. O^{2-} d. Na^{+}.

50- Which of the following does not have a noble gas configuration?

a. Ar b. Na^{+} c. Mg^{2+} d. S

You should now be able to…

- Describe the origin of the periodic table State the modern periodic law.
- Key‖ the periodic table according to metals vs. nonmetals.
- Explain how an element's electron configuration is related to the element's placement within a period and a group on the periodic table'.
- Identify and state the properties of the following groups in the periodic table:
  - a- Alkali metals
  - b- Alkaline earth metals
  - c- Halogens
  - d- Noble Gases
  - e- Transition metals
- State the trends of the following properties within periods and groups of elements including:
  - a- Ionization energy
  - b- Electronegativity
  - c- Atomic Radius
  - d- Chemical Reactivity
  - e- Metallic/Nonmetallic character