CHAPTER 8
PERIODIC TABLE

A. Introduction

If elements are listed according to their atomic number, then elements which have similar chemical and physical characteristic will be on the regular interval. This empirical observation is called periodic table which was presented first by Dmitry Mendeleyev.

Figure 8.1. Dmitry Mendeleyev

Elements which have similar characteristic are in group which presented in vertical column as follow:

- Group I consist of Hydrogen atom which added by alkali metal. Elemnt in this group are very reactive chemically and have valency of 1.
- Group VII consists of halogen, volatile, nonmetal which are active, have valency of 1 and combine to be diatomic in gas phase.
- Group VIII consist of nobble gas, This elements are not reactive, usually do not react with other elements to produce compound, and its atom does not combine to be molecule.

Horizontal row is called period. A cross at each period, it is occurred transition from active metal, rather active metal, active nonmetal, very active nonmetal, until nobble gas.

Transition elements are metal which have similar chemical characteristic. Five teen transition elements in 6 periods can not be differenced in characteristic and they are called lantanide. Similar group for metal which have near relation is actinide which in periode 7.

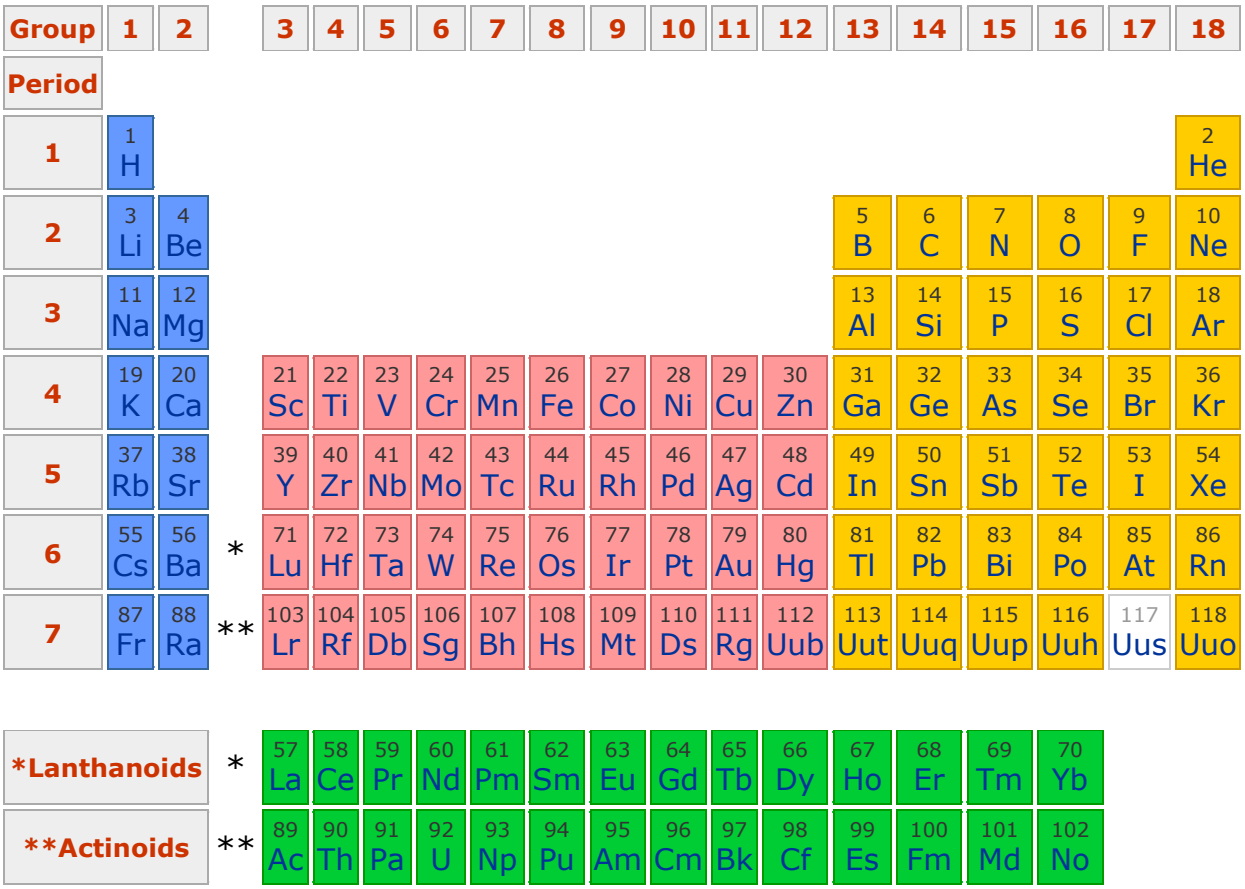


Figure 8.2. Periodic Table

B. Characteristic of Element

Two rules which can be applied to understand the chemical and physical characteristic of element are:

- Subshell which is fulfilled by electron is the most stable configuration.
- Subshell which is fulfilled by electrons does not give a contribution in chemical and physical behavior of atom.

Atomic Radius

Atomic radius is not an observable which has an axact certain value, because the size of atom is determined by density probability of electron..

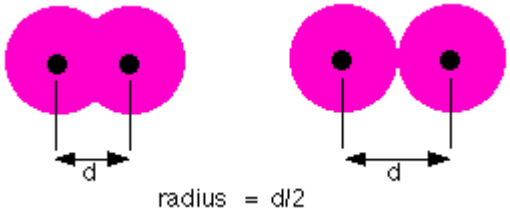


Figure 8.3. Measurement of Atomic Radius (1/2 diameter)

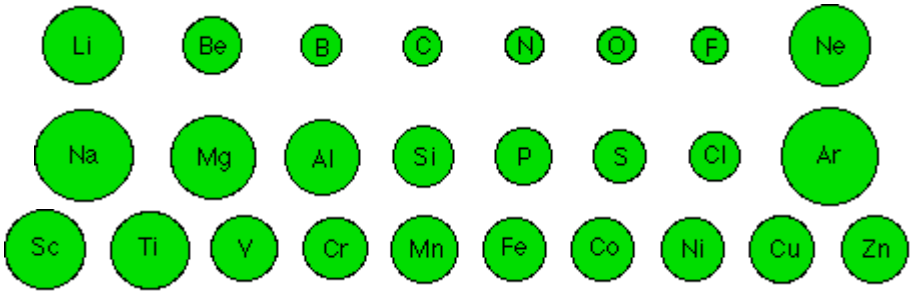


Figure 8.4. Comparison Atomic Diameter in Several Elements

Figure 8.5. Diameter of Ion

Ionization Energy

The minimum energy which required to release electron from atom is called ionization energy. For example the ionization energy of hydrogen atom is 3,6 eV. Helium atom has first ionization energy and second ionization energy 24,6 eV and 54,4 eV respectively. Table 8.1 followed present ionization energy of several element.

Table 8.1 Ionization Energy for Several Atoms

Atom	Ionization Energy (eV)
Hydrogen (H)	13,6
Helium (He)	24,59
Lithium (Li)	5,39
Berillium (Be)	9,32
Neon (Ne)	21,56
Natrium (Na)	5,14
Argon (Ar)	15,76
Kalium (K)	4,34
Cuprum (Cu)	7,72
Kripton (Kr)	14,00
Rubidium (Rb)	4,18

Aurum (Au)	9,22

In Figure 8.6 until 8.9 are presented ionization energy for several elements.

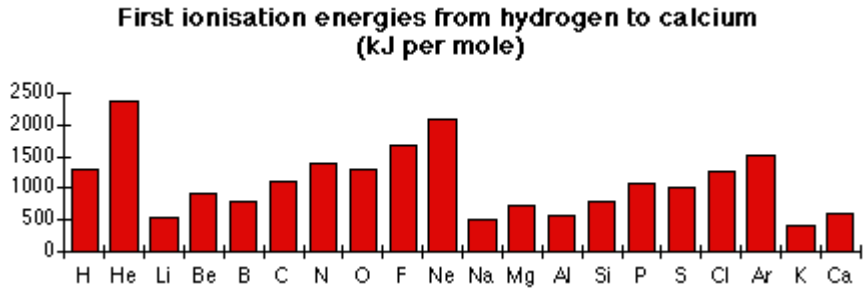


Figure 8.6. First Ionization Energy from Hydrogen until Calcium

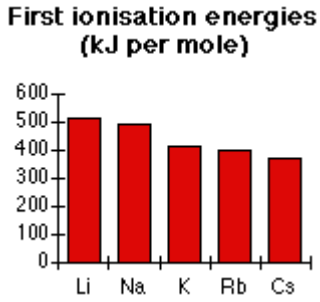
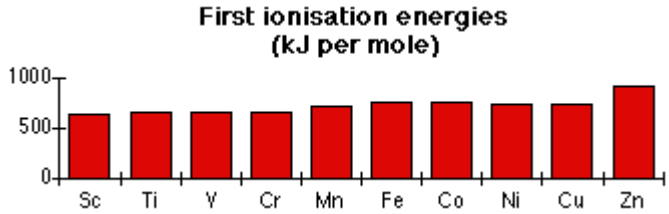


Figure 8.7.Energi ionisasi Pertama Unsur-Unsur Group I



Gambar 8.8. First Ionization Energy of Transition Elements

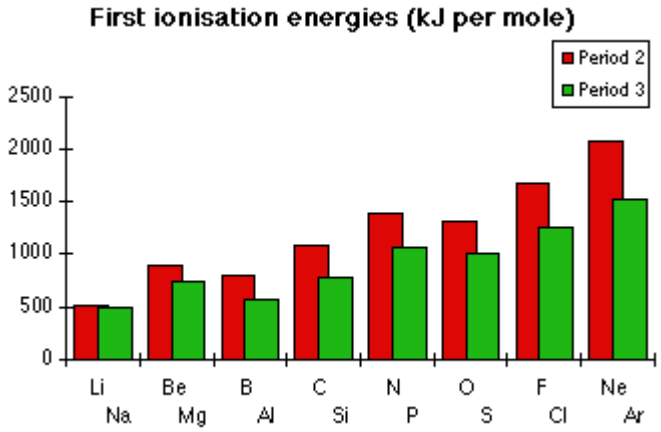


Figure 8.9. Fisrs Ionization Energy of Elements in Period 2 dan Period 3

Electric Resistivity

Material which has length of L, surface area of A, resistivity of ρ, will have electric resistance R:

$$R = \rho \frac{L}{A} \tag{8.1}$$

Resistivity ρ is a characteristic of material. Unit of resistivity Ωcm. Good conductor has small resistivity, for example cuprum has resistivity of $1{,}7.10^{-6}$ Ωcm. Bad conductor (example: Sulfur) has large resistivity of 2.10^{17} Ωcm. In atomic view, electric current depend on electron flow. The electric current also depend on the ability of electron to move from atom to other atom. Electron in state of *s* ($l = 0$) is easier to move than electron which has higher state of *l*.

Magnetic Suceptibility (χ)

If material is placed in magnetic field with m,agnetic induction of B, then the material will be induced to be magnet with magnetization of M which its value is proportional with B.

$$\mu_o M = \chi B \tag{8.2}$$

Material with susceptibility of $\chi > 0$ is called paramagnetic material, for $\chi < 0$ diamagnetic material, while for ferromagnetic material χ is not defined. According to the atomic theory, magnetism of material depend on spin quantum number s and orbital quantum number *l*, because the value of spin magnetic moment μ_s and orbital magnetic moment μ_l are proportional with s and *l*. Spin magnetic moment μ_s and orbital magnetic moment μ_l cause paramagnetic suceptibility in all atoms.

C. Nobble Gas

Nobble gas placed in the last column in periodic table. Nobble gas is difficult to react and produce compound because its subshell is fulfilled of electrons. In room temperature, nobble gas is monoatomic and has a very low boiling poit of -200 ^{o}C, also has a very large of ionization energy.

D. Elements of subshell p

Halogen element (F, Cl, Br, I, At) are elements which leak of one electron to form closed shell and have electron configuration of np^5. This elements are very reactive to react to form compound. Halogen elements have the smallest radius in elements of subshell *p*.

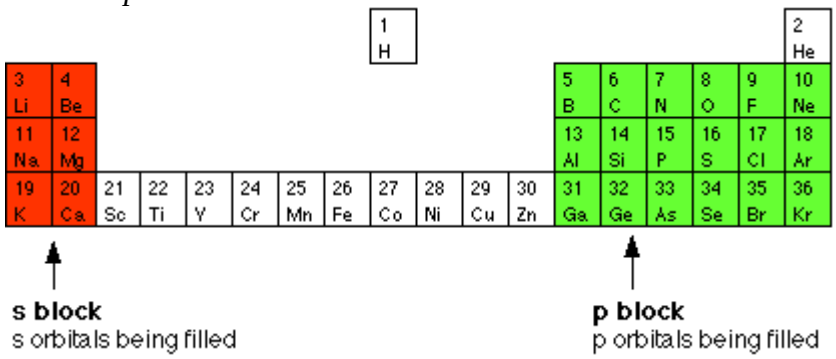


Figure 8.10. Elements of Subshell s and Subshell p

E. Elements of Subshell s

This elements is called alkali element, have electron configuration of ns^1 and for earth alkali elements have electron configuration of ns^2. The alkali element are reactive enough because they have the electron configuration ns^1, also earth alkali element are reactive enough too. These elements are good conductor and paramagnetic.

F. Transition Metal

Three series Sc until Zn, Y until Cd, and Lu until Hg are called transition metal. The behavior of transition elements are determined by the outer electron. Chemical characteristic of transition metal are relative the same. It is shown by the change of radius and ionization energy is relative small.

Electric resistivity of transition metal show two interesting characteristic: the first, the sharp increasing in the mid series, and the second, the sharp decreasing in the edge of metal series of Cu, Ag, and Au. Transition metal has a large conductivity and small susceptibility.

Transition metal has the same magnetic susceptibility. Electron which has large angular momentum contributes in feromagnetic behavior of Fe, Nil, and Co. While Cu and Zn have a diamagnetic behavior because subshell d is fulfilled by electrons.

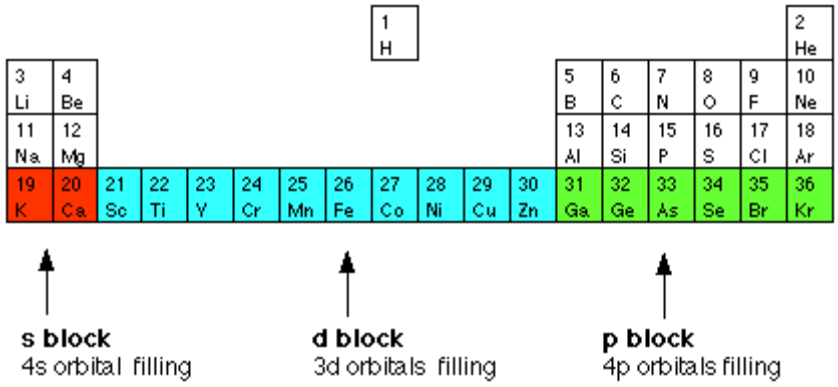


Figure 8.11. Elements of Orbital s, p, and d

G. Lanthanide (Rare Earth Element)

This elements have subshell of 4f fulfilled with electrons. Paramagnetic susceptibility of lanthanide elements are larger than paramagnetic susceptibility of transition metal. Ferromagnetic behavior of lanthanide is larger than iron group. In general, people say that if Fe is made to be magnet, the magnetization is more permanent than other elements. The fact that intensity magnetic field of Fe magnet is about 28 tesla while holmium (lanthanide element if it made magnet, it can have intensity of magnetic field about 800 tesla (about 30 times of the magnetization of iron). In room temperature, lanthanide elements do not show ferromagnetic behavior. If the lanthanide elements is made cold, the ferromagnetic behavior will arise. For example holmium will show the ferromagnetic behavior in the temperature of 20 ^{o}K.

H. Actinide

Elements of actinide series should be have the same behavior with lanthanide elements. Most of actinide elements are radioactive (for example uranium). The artificial element which available are limited then it is difficult to study the macroscopic behavior of the elements.

I. Reference

Clark, J. 2005. *Ionisation Energy; Atomic and Ionic Radius*. http:// www.chemguide.co.uk/book, html# top.

Haryono. 1990. *Kamus Penemu*. Jakarta: PT Gramedia.

Winter, M. 2007. *The Periodic Table*. http://www.webelement.com

Yusman Wiyatmo. 2008. *Fisika Atom dalam Perspektif Klasik, Semiklasik, dan Kuantum.* Yogyakarta: Pustaka Pelajar.