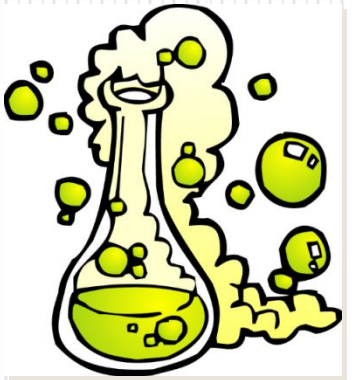
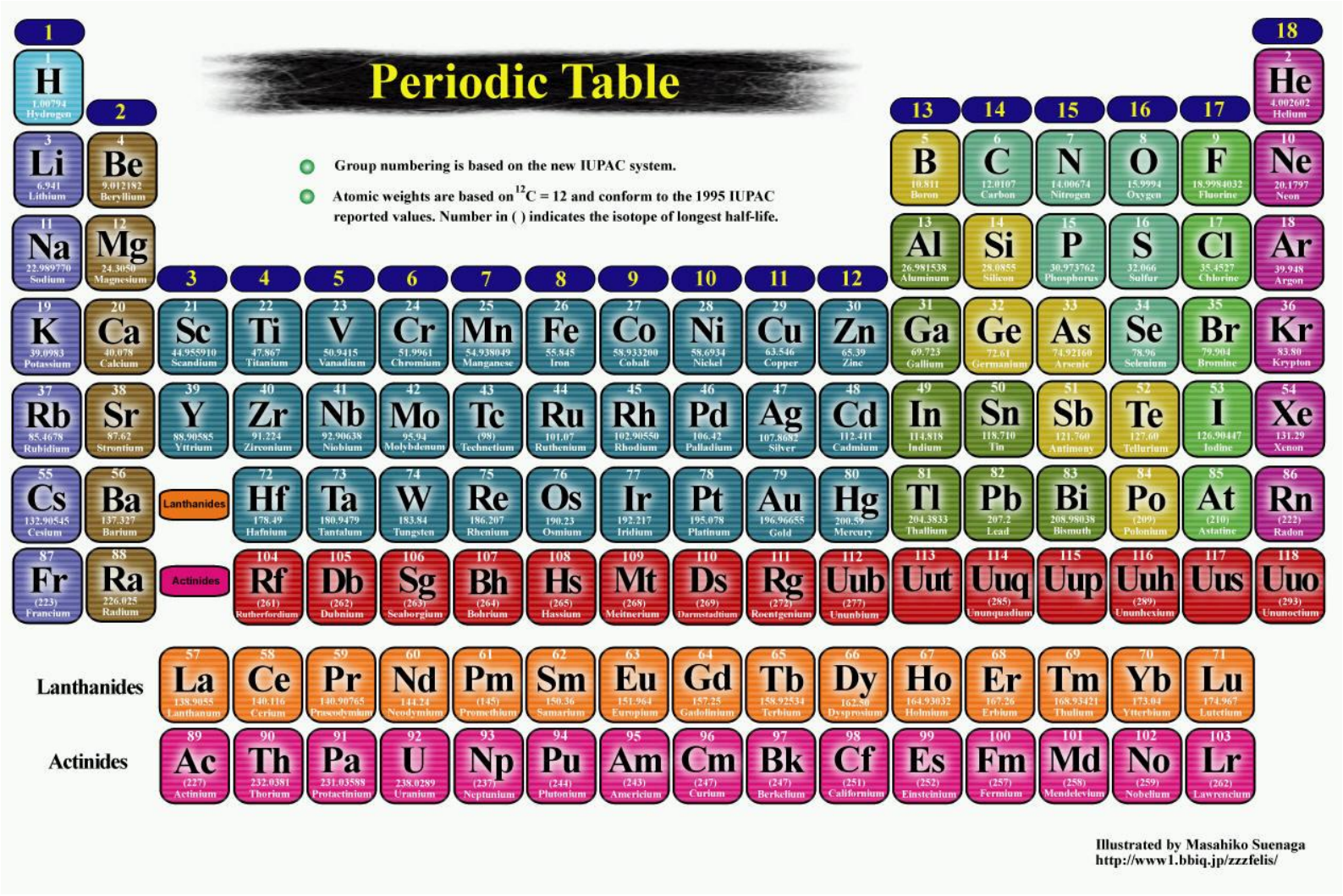
Introduction to Periodic Table

A WAY OF ORGANIZING & CLASSIFYING ELEMENTS

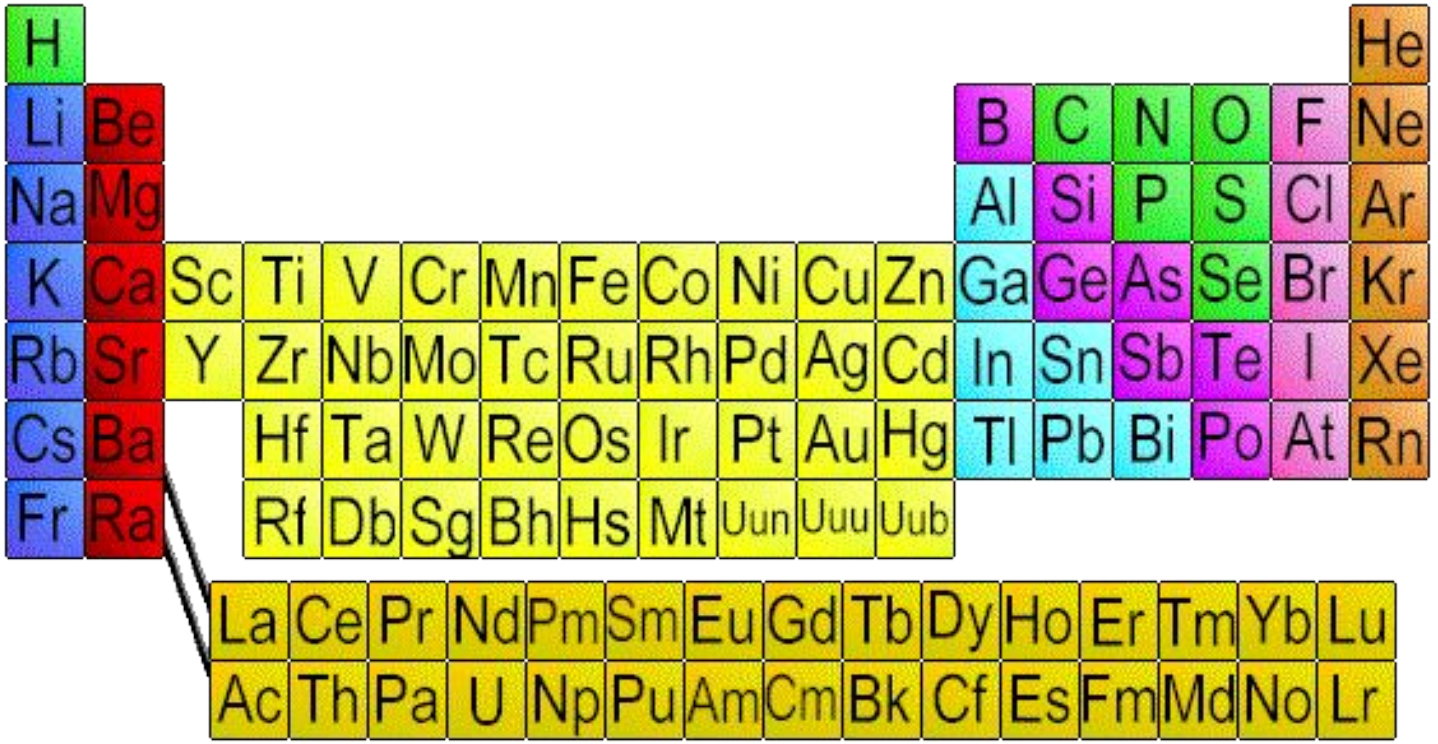


Reading the Periodic Table

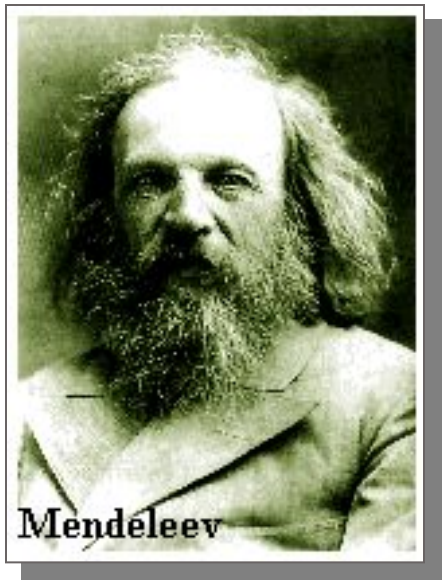


What is the Periodic Table?

- It is an **organizational system** for elements.

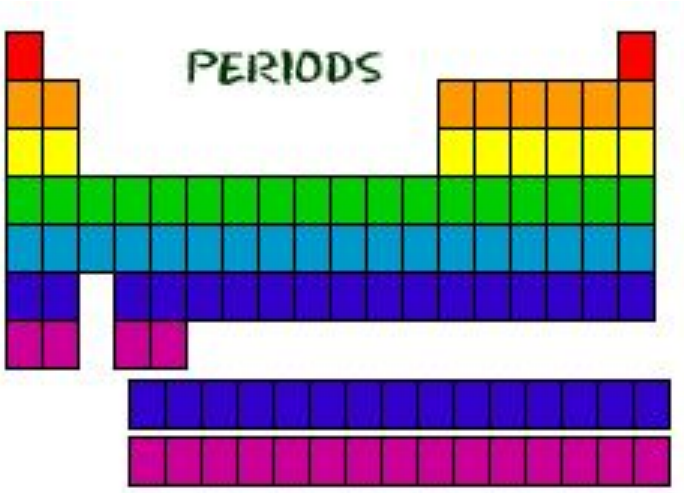


Who created it?



- The quest for a systematic arrangement of the elements started with the discovery of individual elements.
- By 1860 about 60 elements were known and a method was needed for organization.
- In 1869, Russian chemist Dimitri Mendeleev proposed **arranging elements by atomic weights and properties**.
- The table contained gaps but Mendeleev predicted the discovery of new elements.

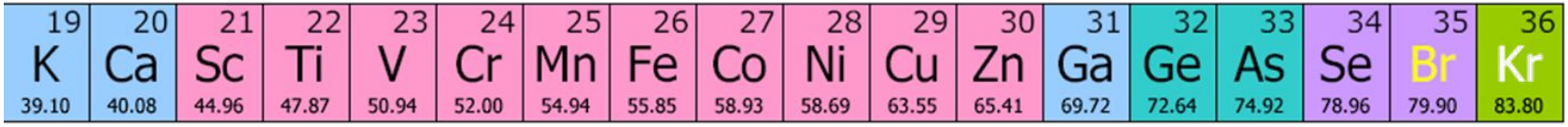
Periods = Rows 一排



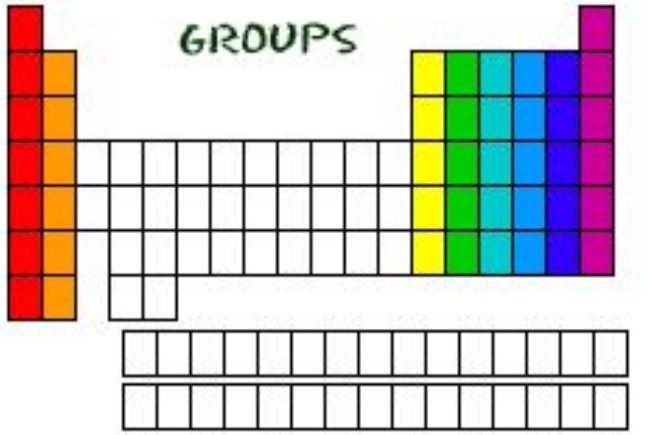
- The **horizontal rows** of the periodic table are called ***periods***.
- Elements in a period are not similar in properties.
- All of the elements in a period have the ***same number of atomic orbitals*** 軌道.
- Every element in the top row (**the first period**) has one orbital for its electrons. All of the elements in the second row (**the second period**) have two orbitals for their electrons. It goes down the periodic table like that.

Periods = Rows

- **Atomic mass increases** from left to right across a period.
- **Metals are on the left.**
- **Non-metals are on the right.**
- The **first element** in a period is usually an **active metal**, and the **last element** in a period is always an **inactive gas**.

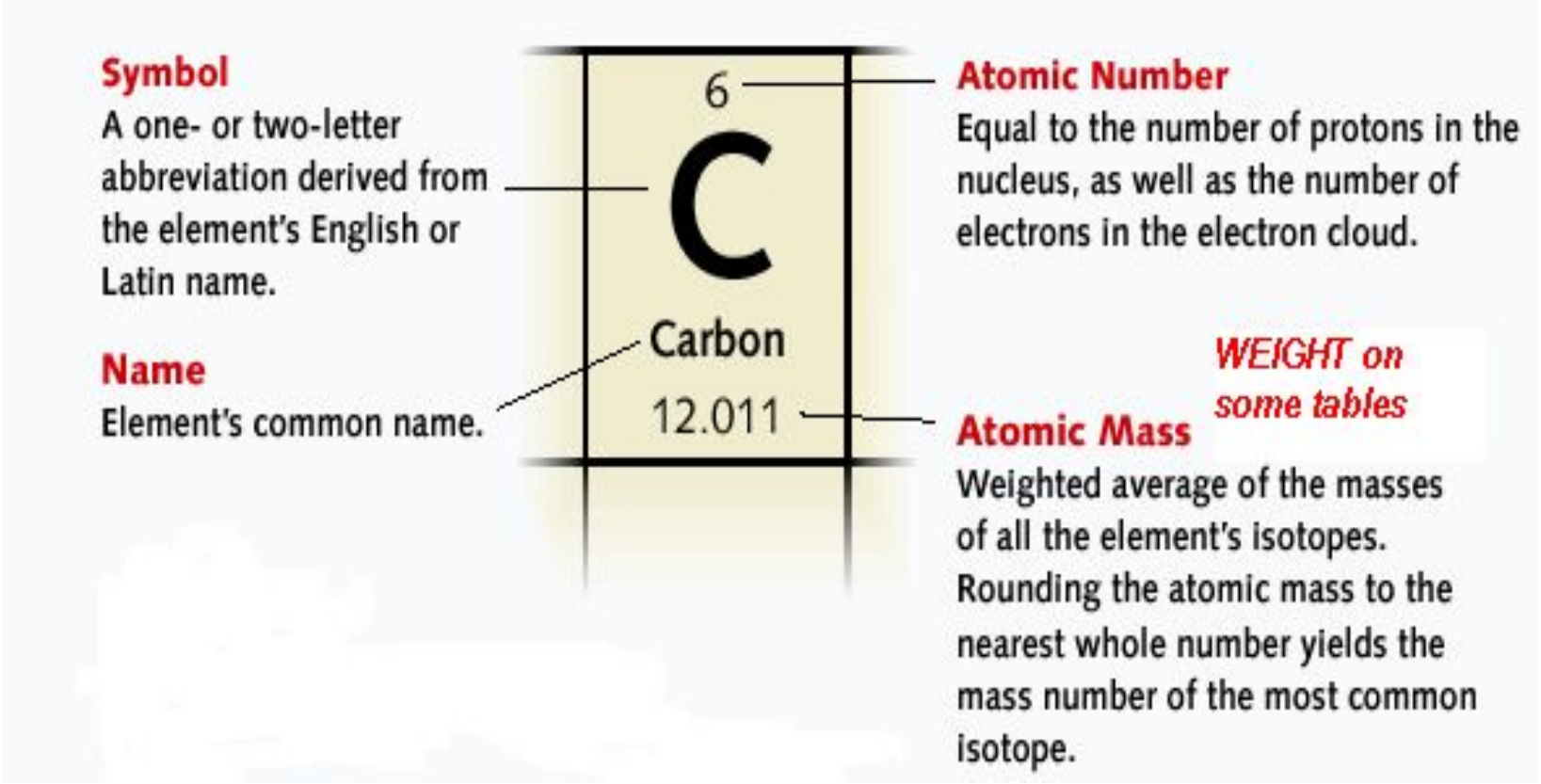


Groups = Columns縱列



- The **vertical columns** of the periodic table are called ***groups***.
- Elements in the same group have ***similar characteristics or properties***.
- The elements in a group have the ***same number of electrons in their outer orbital.*** Those outer electrons are also called ***valence electrons*** 價電子.
- Every element in the first column (**group 1**) has one electron in its outer shell. Every element on the second column (**group 2**) has two electrons in the outer shell. As you keep counting the columns, you'll know how many electrons are in the outer shell.
- **Atomic mass increases from top to bottom across a**

What do all the numbers mean?



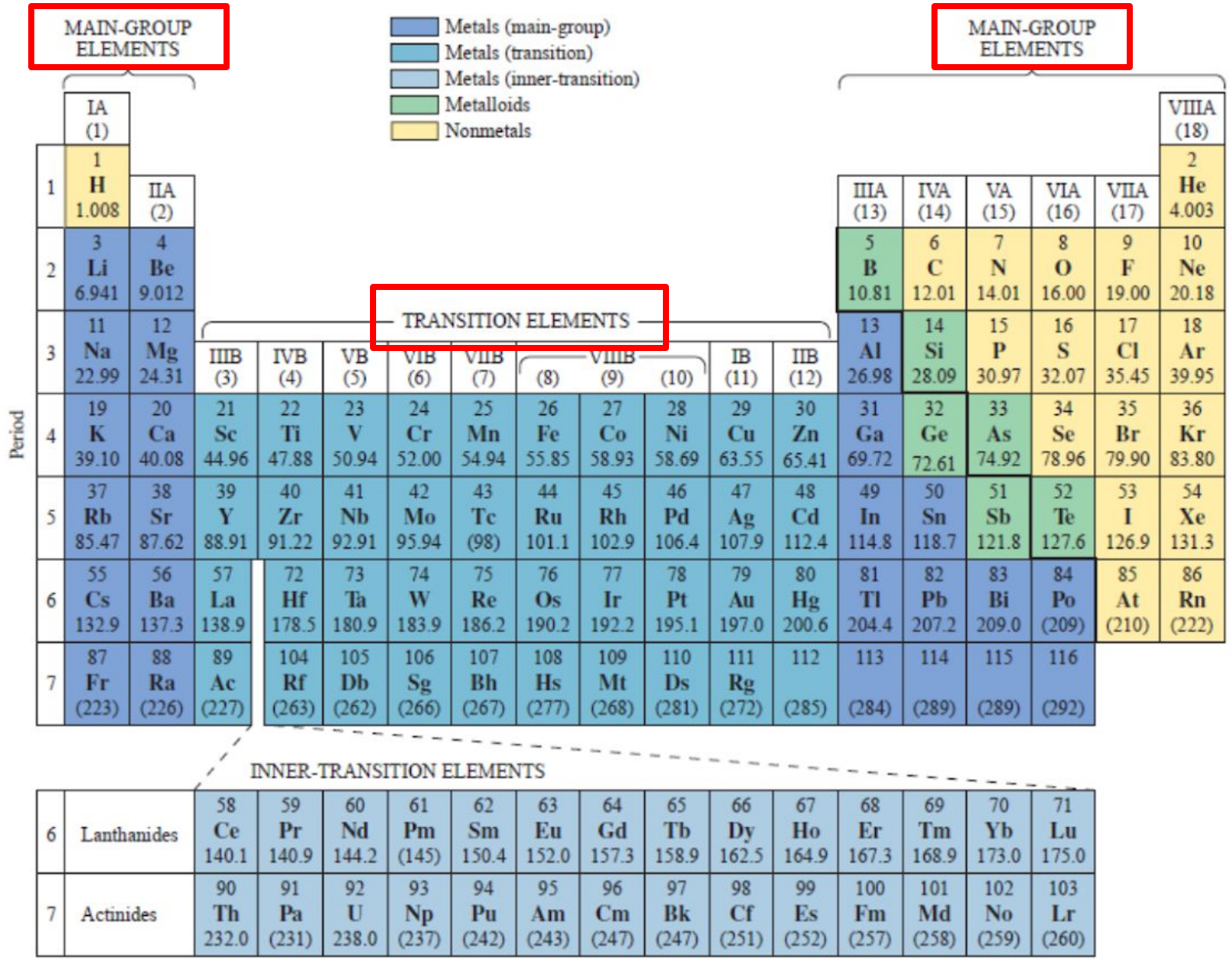


FIGURE 2.18 The periodic table helps us to classify elements in a variety of ways.

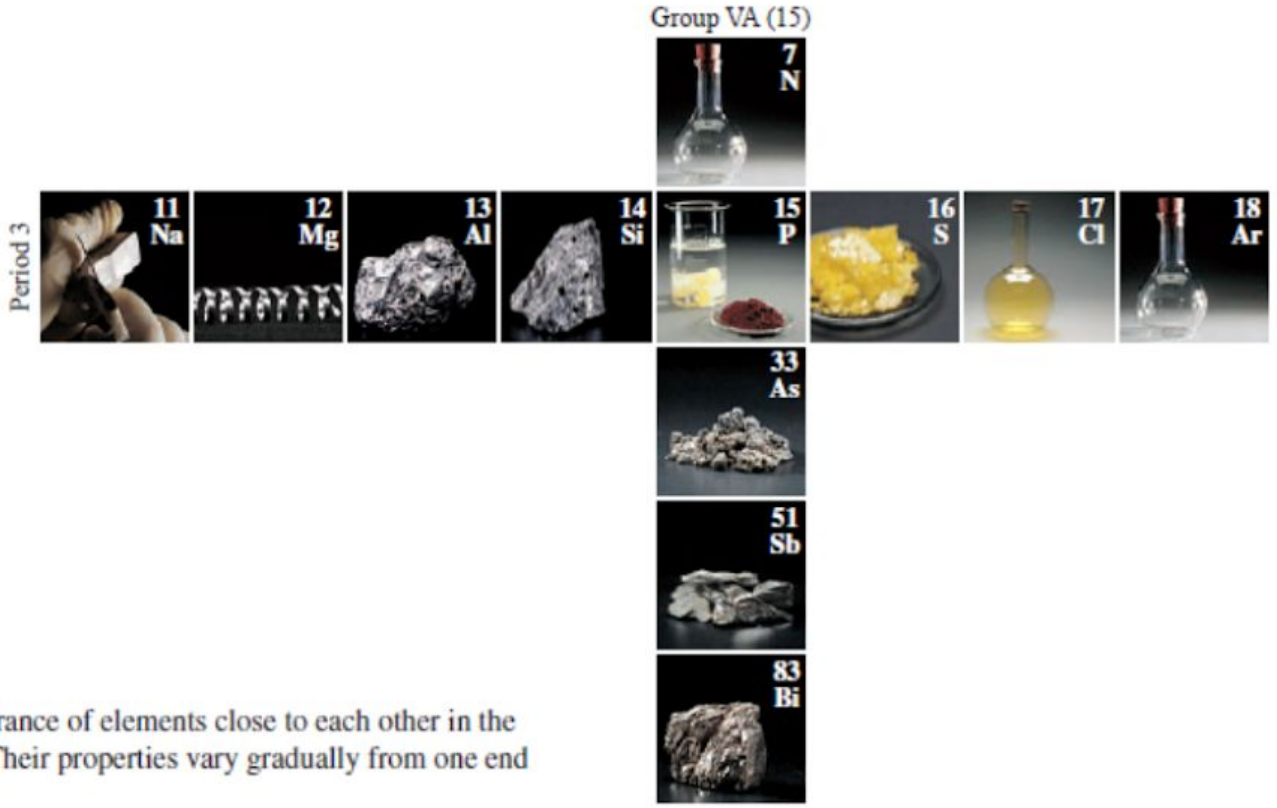
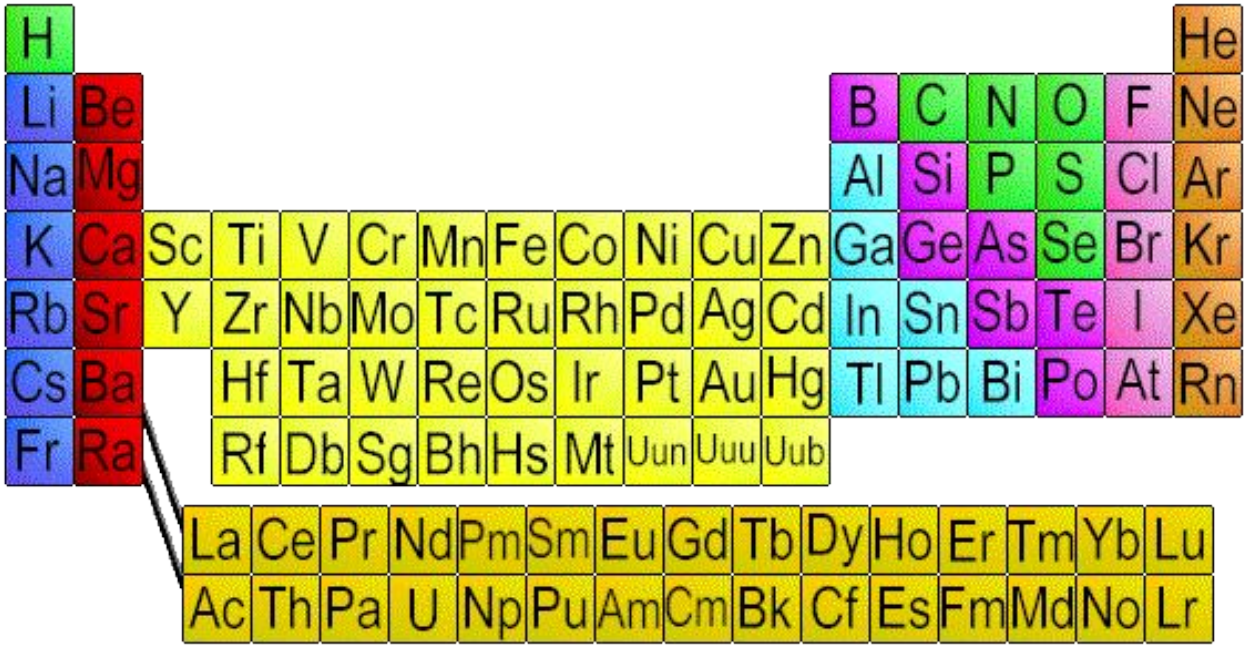
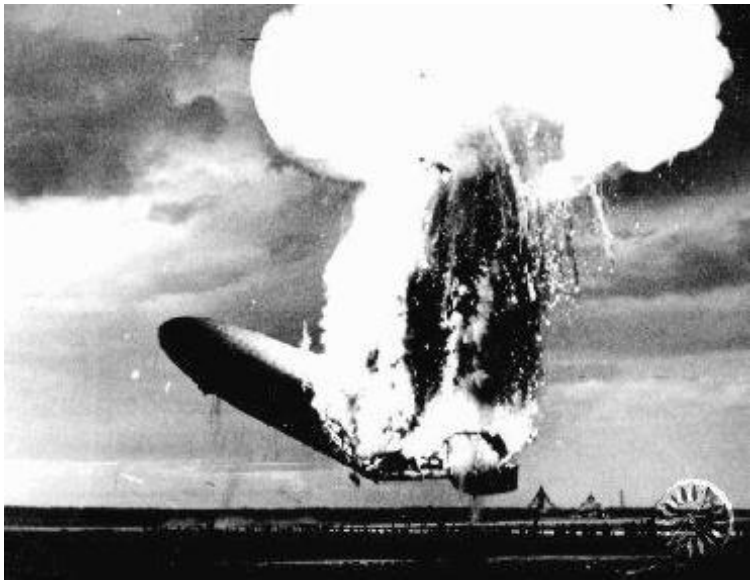


FIGURE 2.19 The physical appearance of elements close to each other in the same group or period are similar. Their properties vary gradually from one end of the group or period to the other.

Other than periods and groups, the table is divided into families



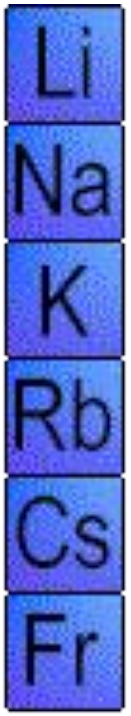
Hydrogen



- **Hydrogen belongs to a family of its own.**
- **Hydrogen is a diatomic (H_2), reactive gas.**
- Hydrogen was involved in the explosion of the Hindenberg.
- Hydrogen is promising as an alternative fuel source for automobiles.

Alkali metals

- 1st column on the periodic table (**Group 1**) not including hydrogen.
- **Their low ionization energies (the amount of energy required to remove an electron) result in their metallic properties and high reactivities.** They are very reactive metals that do not occur freely in nature.
- An alkali metal can easily lose its valence electron to form the univalent cation.
- Alkali metals have **low electronegativities (**describes the tendency of an atom to attract electrons towards itself**)**.
- **Softer** than most other metals, soft enough to cu with a butter knife!!!
- Good conductors of heat and electricity.
- Can explode if they are exposed to water.



Alkaline earth metals

- Second column on the periodic table (**Group 2**).
- They are **very reactive metals**, which are always **combined with nonmetals in nature**.
- Alkaline earths have **low electronegativities**.
- The alkaline earths have **two electrons in the outer shell**.
- The two valence electrons are not tightly bound to the nucleus, so the alkaline earths readily lose the electrons to form divalent cations.
- Several of these elements are important mineral nutrients, such as Mg and Ca.

Transition metals

- The **transition elements are located in groups IB to VIIIB of the periodic table**.
- **These elements are very hard, with high melting points and boiling points**.
- Moving from left to right across the periodic table, the five *d* orbitals become more filled. The *d* electrons are loosely bound, which contributes to the **high electrical conductivity of the transition elements**.
- They exhibit a wide range of positively charged forms. Allow them to form many different ionic and partially ionic compounds.

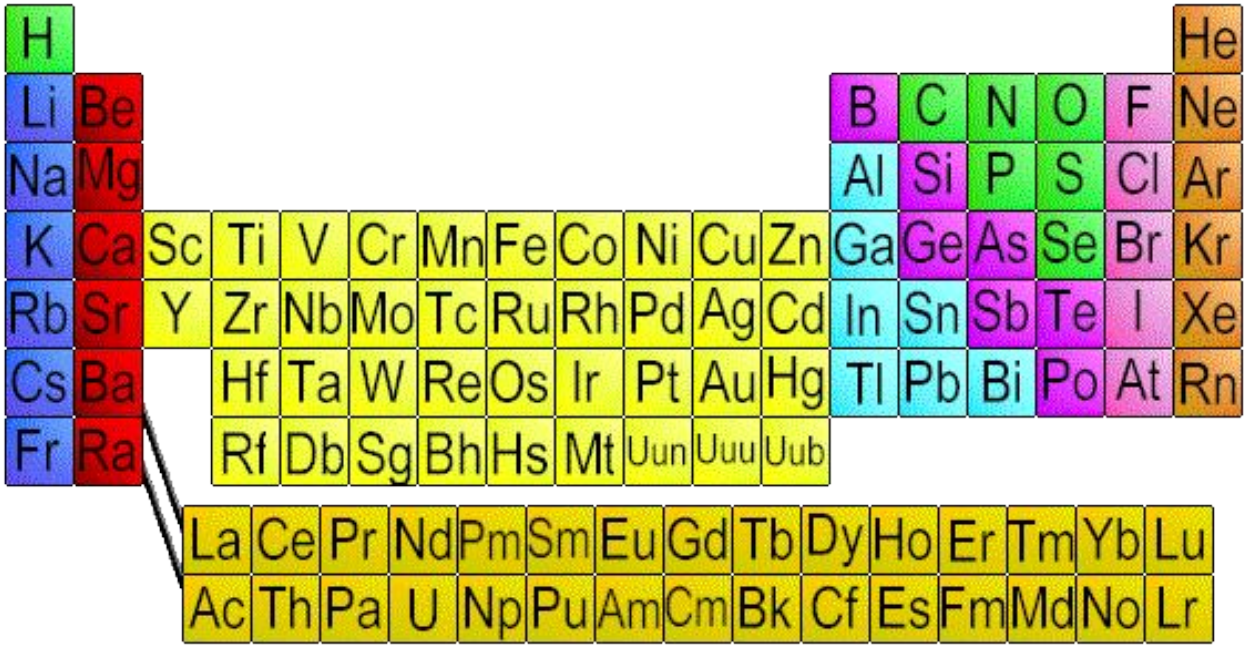
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub

Rare earth elements

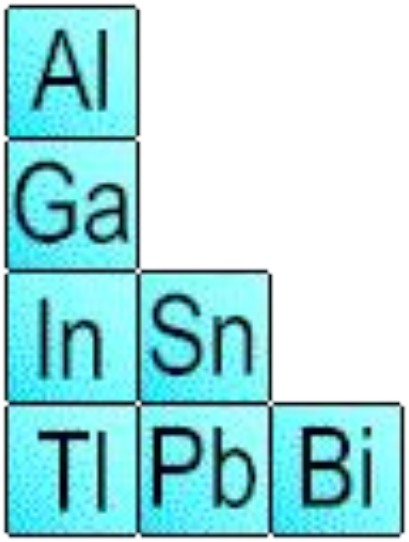
- The **rare earth metals are found in group 3 of the periodic table, and the 6th (5*d* electronic configuration) and 7th (5*f* electronic configuration) periods**.
- There are **two blocks of rare earths**, the **lanthanide series and the actinide series**.
- The rare earths are silver, silvery-white, or gray metals.
- **The metals have high electrical conductivity.**
- Many are man-made.

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Other than periods and groups, the table is divided into families



Other metals



- They are usually in form of solid and have a high density.

Metalloids準金屬

- **The electronegativities and ionization energies of the metalloids are between those of the metals and nonmetals, so the metalloids exhibit characteristics of both classes.**
- Their reactivity depends on properties of other elements in reaction.
- The intermediate conductivity of metalloids means they tend to make good semiconductors.

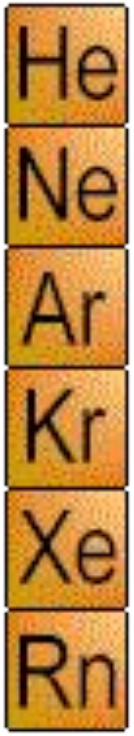
Non-Metals

- The nonmetals are **located on the upper right side** of the periodic table.
- **Nonmetals have high ionization energies and electronegativities**.
- **They are generally poor conductors of heat and electricity**.
- **Most nonmetals have the ability to gain electrons easily.**

Halogens

- The halogens are located in **Group VIIA** of the periodic table, and are a particular class of **nonmetals**.
- These **reactive** nonmetals **have seven valence electrons**.
- Halogens range from solid (I_2) to liquid (Br_2) to gaseous (F_2 and Cl_2) at room temperature.
- **The halogens have very high electronegativities. Fluorine has the highest electronegativity of all elements.**
- The halogens are particularly reactive with the alkali metals and alkaline earths, forming stable ionic crystals.

Noble Gases



- The noble gases, also known as the inert gases, are **located in Group VIII** of the periodic table.
- The noble gases are **relatively nonreactive**. This is because **they have a complete valence shell. They have little tendency to gain or lose electrons.**
- The noble gases **have high ionization energies and negligible electronegativities**.
- The noble gases have low boiling points and are all gases at room temperature.

EXAMPLE 2.9 Classification of Elements

Classify each of the following elements by group number, group name (if applicable), and period, and as a metal, nonmetal, or metalloid.

(a) sodium (b) silicon (c) bromine (d) copper

Solution:

(a) Na is in group IA (1), the alkali metal group, and in period 3, and is a metal.
(b) Si is in group IVA (14) and in period 3, and is a metalloid.
(c) Br is in group VIIA (17), the halogen group, and in period 4, and is a nonmetal.
(d) Cu is in group IB (11), a transition metal group, and in period 4, and is a metal.

EXAMPLE 2.10 Predicting Charges on Ions

Write the symbol for the ion that each of the following elements is predicted to form.

(a) magnesium (b) bromine (c) nitrogen

Solution:

These ions can be predicted by their positions in the periodic table.

(a) Magnesium is in group IIA (2), so it will lose two electrons to form Mg^{2+}, giving it the same number of electrons as neon.

(b) Bromine is in group VIIA (17), so it will gain one electron to form Br^{-}, giving it the same number of electrons as krypton.

(c) Nitrogen is in group VA (15), so it will gain three electrons to form N^{3-}, giving it the same number of electrons as neon.

Fun time~

Periodic Table Song

http://www.youtube.com/watch?v=zUDDiWtFtEM