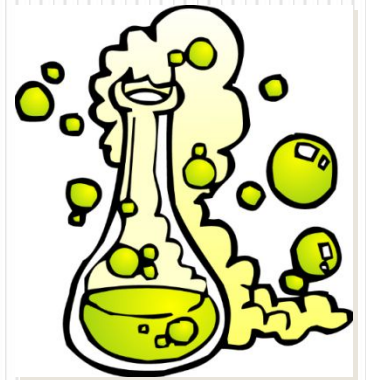


Introduction to Periodic Table

**A WAY OF ORGANIZING &
CLASSIFYING ELEMENTS**



Reading the Periodic Table

Periodic Table

- Group numbering is based on the new IUPAC system.
- Atomic weights are based on $^{12}\text{C} = 12$ and conform to the 1995 IUPAC reported values. Number in () indicates the isotope of longest half-life.

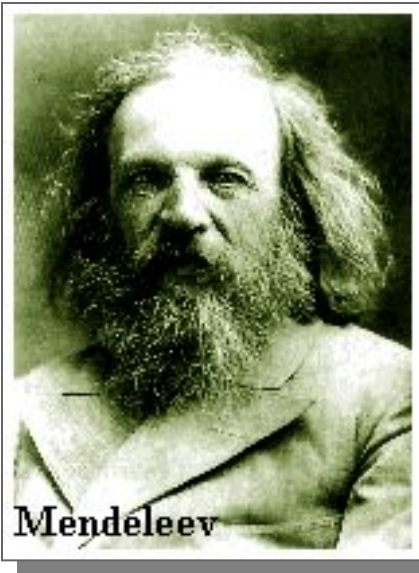
1 H 1.00794 Hydrogen																	18 He 4.002602 Helium
3 Li 6.941 Lithium	4 Be 9.012182 Beryllium											5 B 10.811 Boron	6 C 12.0107 Carbon	7 N 14.00674 Nitrogen	8 O 15.9994 Oxygen	9 F 18.9984032 Fluorine	10 Ne 20.1797 Neon
11 Na 22.989770 Sodium	12 Mg 24.305 Magnesium	3 Sc	4 Ti	5 V	6 Cr	7 Mn	8 Fe	9 Co	10 Ni	11 Cu	12 Zn	13 Al 26.981538 Aluminum	14 Si 28.0855 Silicon	15 P 30.973762 Phosphorus	16 S 32.066 Sulfur	17 Cl 35.4527 Chlorine	18 Ar 39.948 Argon
19 K 39.0983 Potassium	20 Ca 40.078 Calcium	21 Sc 44.955910 Scandium	22 Ti 47.867 Titanium	23 V 50.9415 Vanadium	24 Cr 51.9961 Chromium	25 Mn 54.938049 Manganese	26 Fe 55.845 Iron	27 Co 58.933200 Cobalt	28 Ni 58.6934 Nickel	29 Cu 63.546 Copper	30 Zn 65.39 Zinc	31 Ga 69.723 Gallium	32 Ge 72.64 Germanium	33 As 74.92160 Arsenic	34 Se 78.96 Selenium	35 Br 79.904 Bromine	36 Kr 83.80 Krypton
37 Rb 85.4678 Rubidium	38 Sr 87.62 Strontium	39 Y 88.90585 Yttrium	40 Zr 91.224 Zirconium	41 Nb 92.90638 Niobium	42 Mo 95.94 Molybdenum	43 Tc (98) Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.90550 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.8682 Silver	48 Cd 112.411 Cadmium	49 In 114.818 Indium	50 Sn 118.710 Tin	51 Sb 121.760 Antimony	52 Te 127.60 Tellurium	53 I 126.90447 Iodine	54 Xe 131.29 Xenon
55 Cs 132.90545 Cesium	56 Ba 137.327 Barium	Lanthanides	72 Hf 178.49 Hafnium	73 Ta 180.9479 Tantalum	74 W 183.84 Tungsten	75 Re 186.207 Rhenium	76 Os 190.23 Osmium	77 Ir 192.217 Iridium	78 Pt 195.078 Platinum	79 Au 196.96655 Gold	80 Hg 200.59 Mercury	81 Tl 204.3833 Thallium	82 Pb 207.2 Lead	83 Bi 208.98038 Bismuth	84 Po (209) Polonium	85 At (210) Astatine	86 Rn (222) Radon
87 Fr (223) Francium	88 Ra 226.025 Radium	Actinides	104 Rf (261) Rutherfordium	105 Db (262) Dubnium	106 Sg (263) Seaborgium	107 Bh (264) Bohrium	108 Hs (265) Hassium	109 Mt (268) Meitnerium	110 Ds (269) Darmstadtium	111 Rg (272) Roentgenium	112 Uub (277) Ununbium	113 Uut (285) Ununquadium	114 Uuq (285) Ununquadium	115 Uup (289) Ununpentium	116 Uuh (289) Ununhexium	117 Uus (293) Ununseptium	118 Uuo (293) Ununoctium
Lanthanides	57 La 138.9055 Lanthanum	58 Ce 140.116 Cerium	59 Pr 140.90765 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (145) Promethium	62 Sm 150.36 Samarium	63 Eu 151.964 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92534 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93032 Holmium	68 Er 167.26 Erbium	69 Tm 168.93421 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.967 Lutetium		
Actinides	89 Ac (227) Actinium	90 Th 232.0381 Thorium	91 Pa 231.03588 Protactinium	92 U 238.02891 Uranium	93 Np (237) Neptunium	94 Pu (244) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (247) Berkelium	98 Cf (251) Californium	99 Es (252) Einsteinium	100 Fm (257) Fermium	101 Md (258) Mendelevium	102 No (259) Nobelium	103 Lr (262) Lawrencium		

What is the Periodic Table?

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

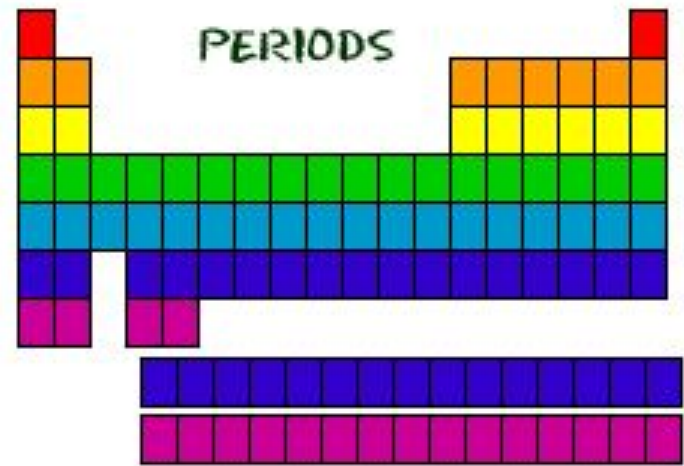
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub						
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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



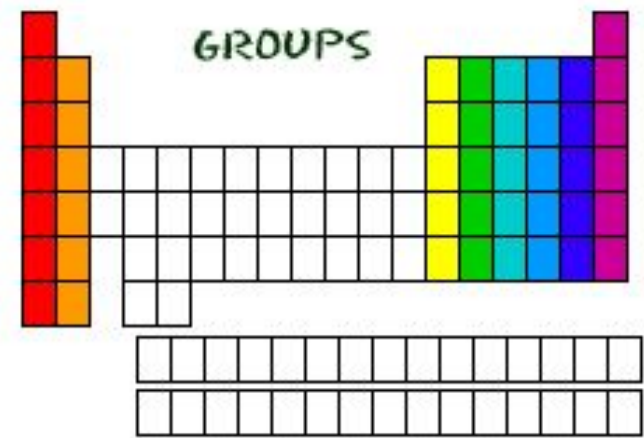
- The **horizontal rows** of the periodic table are called *periods*.
- Elements in a period are not similar in properties.
- All of the elements in a period have the *same number of atomic orbitals* 軌道.
- Every element in the top row (**the first period**) has one orbital for its electrons. All of the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

19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
39.10	40.08	44.96	47.87	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.41	69.72	72.64	74.92	78.96	79.90	83.80

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?

Symbol

A one- or two-letter abbreviation derived from the element's English or Latin name.

Name

Element's common name.

6
C
Carbon
12.011

Atomic Number

Equal to the number of protons in the nucleus, as well as the number of electrons in the electron cloud.

Atomic Mass

Weighted average of the masses of all the element's isotopes. Rounding the atomic mass to the nearest whole number yields the mass number of the most common isotope.

WEIGHT on some tables

MAIN-GROUP ELEMENTS

MAIN-GROUP ELEMENTS

Metals (main-group)
 Metals (transition)
 Metals (inner-transition)
 Metalloids
 Nonmetals

Period	1	TRANSITION ELEMENTS															VIIIA (18)		
	1	IA (1) 1 H 1.008											IIA (2) 2 He 4.003						
	2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
	3	11 Na 22.99	12 Mg 24.31	IIIB (3)	IVB (4)	VB (5)	VIB (6)	VII B (7)	VIII B (8) (9) (10)		IB (11)	IIB (12)	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95	
	4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
	5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
	6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (263)	105 Db (262)	106 Sg (266)	107 Bh (267)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 (285)	113 (284)	114 (289)	115 (289)	116 (292)			

INNER-TRANSITION ELEMENTS

6	Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
7	Actinides	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

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

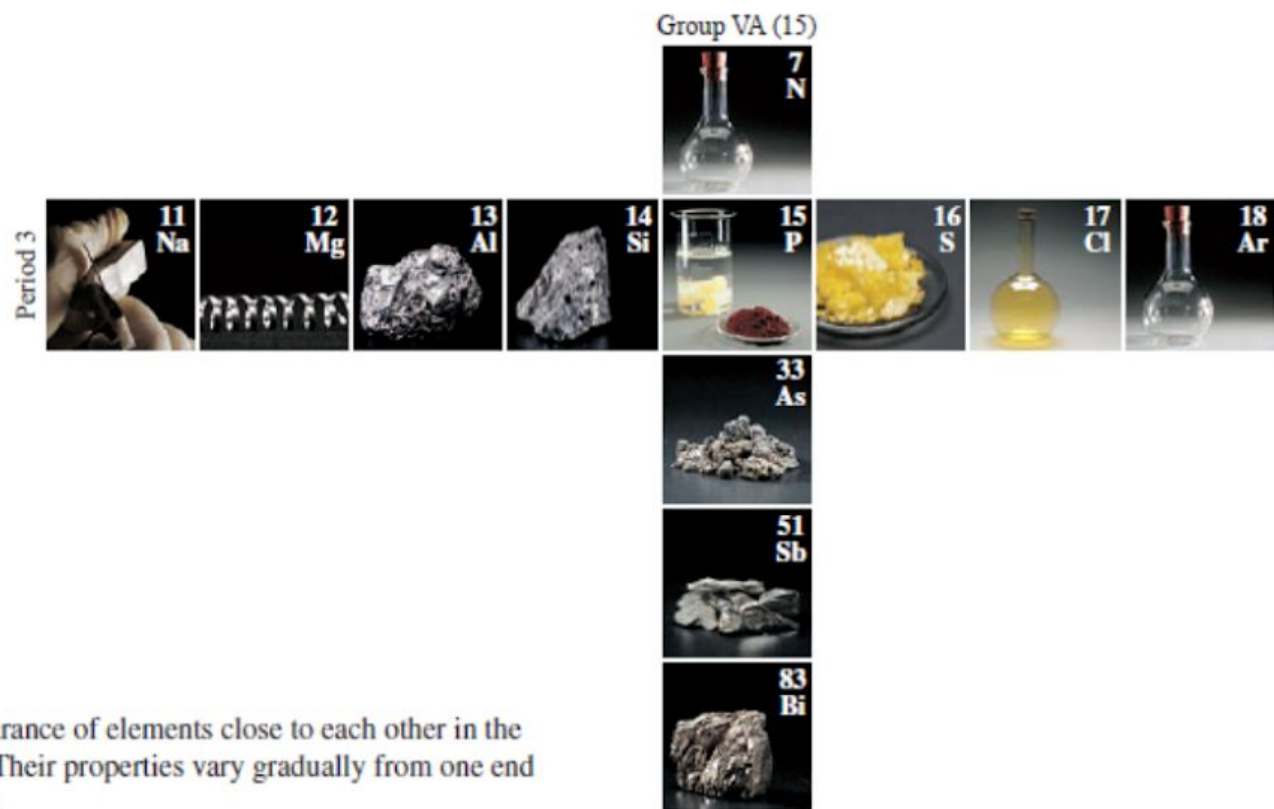


FIGURE 2.19 The physical appearance of elements close to each other in the same group or period are similar. Their properties vary gradually from one end of the group or period to the other.

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

H																			He
Li	Be											B	C	N	O	F		Ne	
Na	Mg											Al	Si	P	S	Cl		Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		Rn	
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub								
			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	



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 cut 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 VIIB 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.

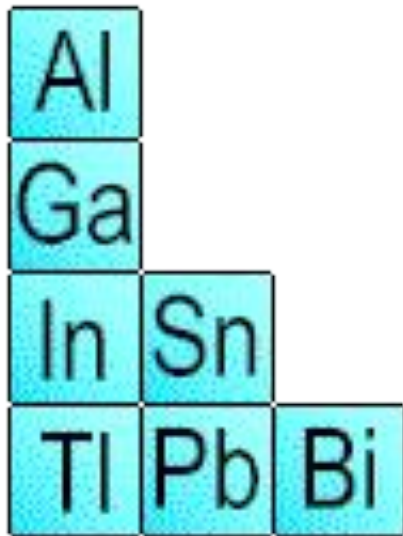
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

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

H																			He
Li	Be											B	C	N	O	F		Ne	
Na	Mg											Al	Si	P	S	Cl		Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		Rn	
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub								
			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	

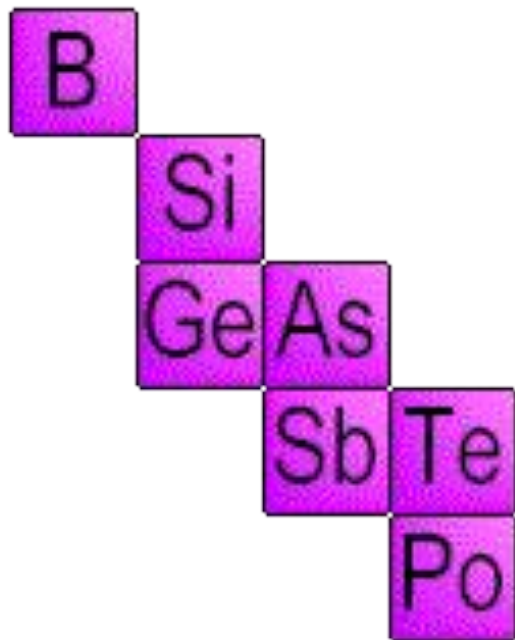


Other metals



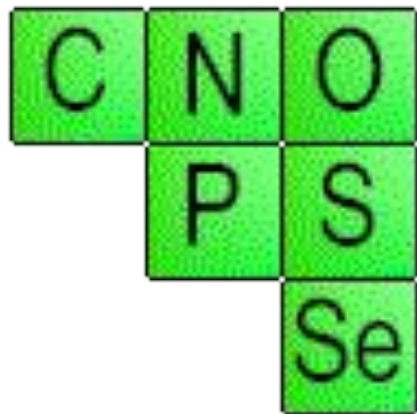
- They are usually in form of solid and have a high density.

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



F
Cl
Br
I
At

- 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 Mg²⁺, 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 N³⁻, giving it the same number of electrons as neon.

Fun time~

Periodic Table

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

