Searching For an Organizing Principle

- Chlorine, bromine, and iodine have very similar chemical properties.

Chlorine	Bromine	Iodine
35.453 amu	79.904 amu	126.90 amu

The Periodic Law

- In the modern periodic table, elements are arranged in order of increasing atomic number.

1	1 H																																2 He
2	3 Li	4 Be																							5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg																							13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca															21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr															39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub		114 Uuq				

The Periodic Law

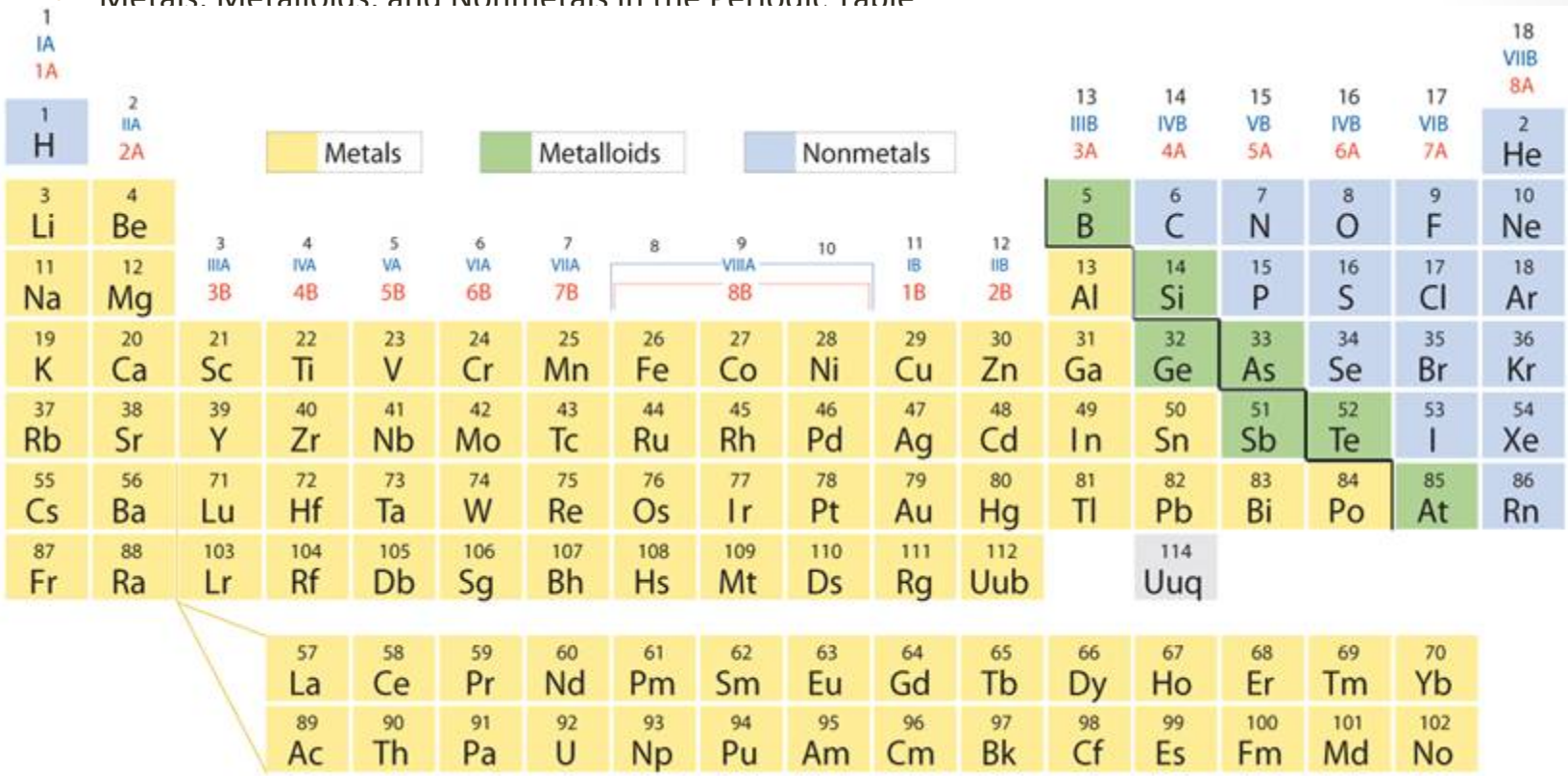
- The **periodic law:** When elements are arranged in order of increasing atomic number, there is a periodic repetition of their physical and chemical properties.
  - The properties of the elements within a period change as you move across a period from left to right.
  - The pattern of properties within a period repeats as you move from one period to the next.

Metals, Nonmetals, and Metalloids

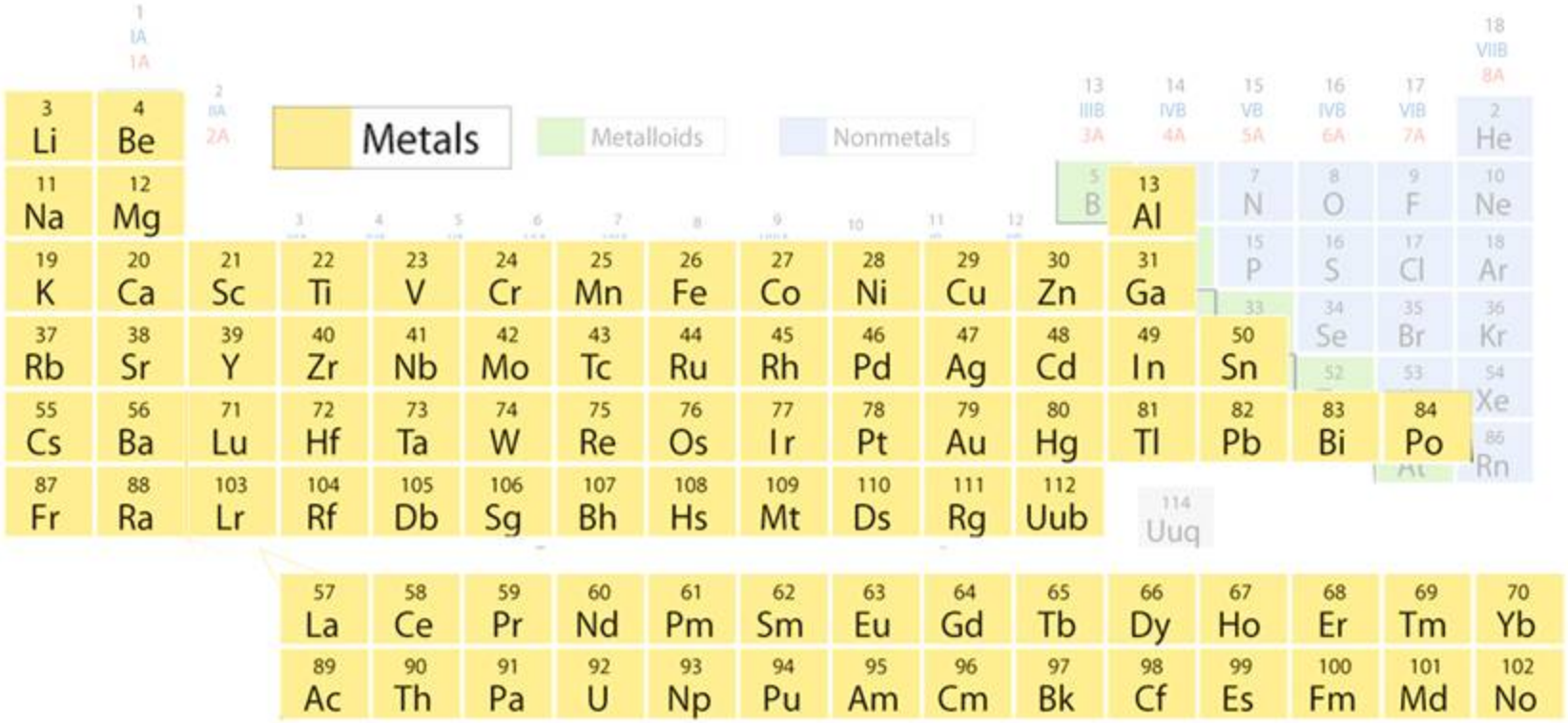
- Three broad classes of elements are metals, nonmetals, and metalloids.
- Across a period, the properties of elements become less metallic and more nonmetallic.

Metals, Nonmetals, and Metalloids

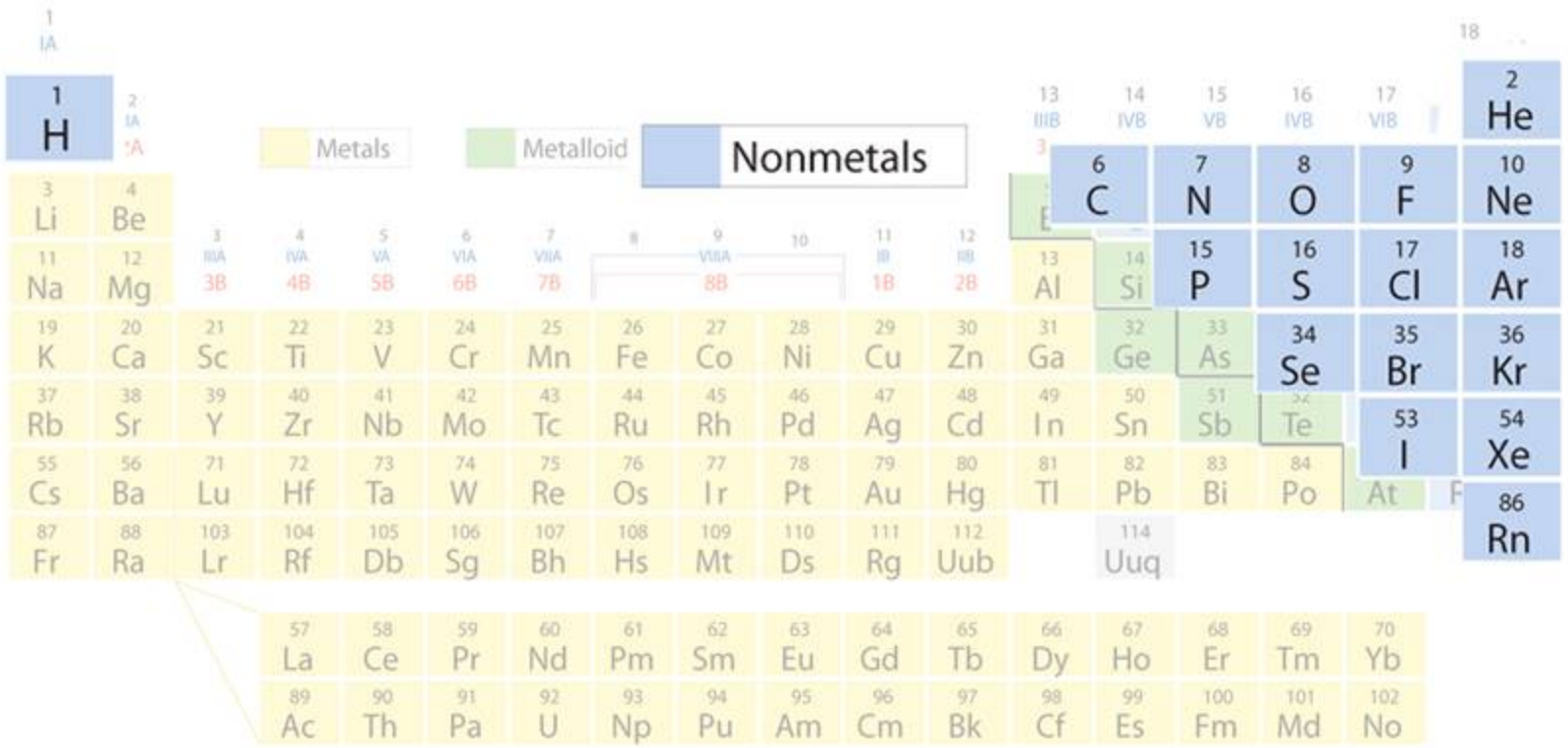
- Metals, Metalloids, and Nonmetals in the Periodic Table



Metals, Nonmetals, and Metalloids

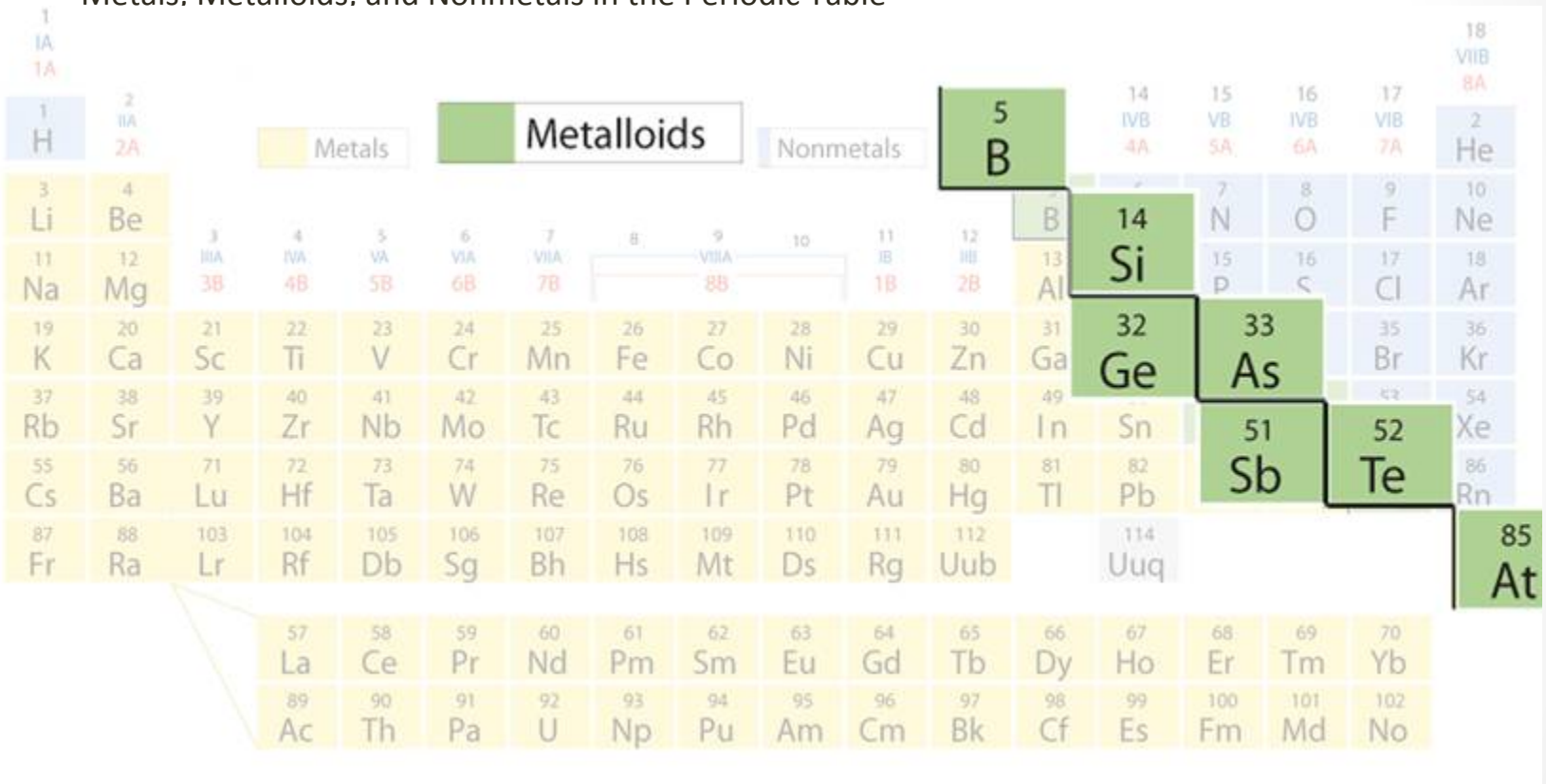


Metals, Nonmetals, and Metalloids



Metals, Nonmetals, and Metalloids

- Metals, Metalloids, and Nonmetals in the Periodic Table



Metals, Nonmetals, and Metalloids

- Metals
  - **Metals** are good conductors of heat and electric current.
    - 80% of elements are metals.
    - Metals have a high luster, are ductile, and are malleable.

Metals, Nonmetals, and Metalloids

Metals, Nonmetals, and Metalloids

- Nonmetals
  - In general, **nonmetals** are poor conductors of heat and electric current.
    - Most nonmetals are gases at room temperature.
    - A few nonmetals are solids, such as sulfur and phosphorus.
    - One nonmetal, bromine, is a dark-red liquid.

Metals, Nonmetals, and Metalloids

- Metalloids
  - A **metalloid** generally has properties that are similar to those of metals and nonmetals.
  - The behavior of a metalloid can be controlled by changing conditions.

Metals, Nonmetals, and Metalloids

- If a small amount of boron is mixed with silicon, the mixture is a good conductor of electric current. Silicon can be cut into wafers, and used to make computer chips.

Write labels on your blank periodic table

- The Group 1A metals are called **alkali metals.** (not hydrogen)
- The Group 2A elements are called **alkaline earth metals.**
- The nonmetals of Group 7A are called **halogens.**

Representative Elements

- Alkali Metals
- Alkaline Earth Metals
- Other Metals
- Metalloids
- Nonmetals
- Noble Gases

Transition Elements

- Transition Metals
- Inner transition metals

14 — Atomic number
Si — Element symbol
Silicon — Element name
* 28.086 — Average atomic mass
2 8 4 — Electrons in each energy level

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.0079																	2 He Helium 4.0026
3 Li Lithium 6.941	4 Be Beryllium 9.0122											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.179
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.08	21 Sc Scandium 44.956	22 Ti Titanium 47.90	23 V Vanadium 50.941	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.933	28 Ni Nickel 58.71	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.22	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.4	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.69	51 Sb Antimony 121.75	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.30
55 Cs Cesium 132.91	56 Ba Barium 137.33	71 Lu Lutetium 174.97	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.09	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.37	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (264)	108 Hs Hassium (265)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (269)	111 Rg Roentgenium (272)	112 *Uub Ununbium (277)		114 *Uuq Ununquadium				

Elements 104–114 are the transactinide elements.

*Name not officially assigned.

Lanthanide Series

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La Lanthanum 138.91	Ce Cerium 140.12	Pr Praseodymium 140.91	Nd Neodymium 144.24	Pm Promethium (145)	Sm Samarium 150.4	Eu Europium 151.96	Gd Gadolinium 157.25	Tb Terbium 158.93	Dy Dysprosium 162.50	Ho Holmium 164.93	Er Erbium 167.26	Tm Thulium 168.93	Yb Ytterbium 173.04

Actinide Series

89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac Actinium (227)	Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium (237)	Pu Plutonium (244)	Am Americium (243)	Cm Curium (247)	Bk Berkelium (247)	Cf Californium (251)	Es Einsteinium (252)	Fm Fermium (257)	Md Mendelevium (258)	No Nobelium (259)

Electron Configurations in Groups

- Elements can be sorted groups based on their electron configurations.
- Elements within a group end with the same suborbital configuration. For representative elements, the principle energy level is the same number as the period.

Electron Configurations in Groups

- The Representative Elements
  - Elements in groups 1A through 7A are often referred to as **representative elements** because they display a wide range of physical and chemical properties.
    - The *s* and *p* sublevels of the highest occupied energy level are not filled.
    - The group number equals the number of electrons in the highest occupied energy level.

Electron Configurations in Groups

- The Noble Gases
  - The **noble gases** are the elements in Group 8A of the periodic table. The electron configurations for the first four noble gases in Group 8A are listed below.

Helium (He)	$1s^2$
Neon (Ne)	$1s^2 2s^2 2p^6$
Argon (Ar)	$1s^2 2s^2 2p^6 3s^2 3p^6$
Krypton (Kr)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

Electron Configurations in Groups

- In atoms of the Group 1A elements below, there is only one electron in the highest occupied energy level.

Lithium (Li)	$1s^2 2s^1$
Sodium (Na)	$1s^2 2s^2 2p^6 3s^1$
Potassium (K)	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

Alkali Metals have similar properties

- Alkali metals and water

Electron Configurations in Groups

- In atoms of the Group 4A elements below, there are four electrons in the highest occupied energy level.

Carbon (C)	$1s^2 2s^2 2p^2$
Silicon (Si)	$1s^2 2s^2 2p^6 3s^2 3p^2$
Germanium (Ge)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$

Transition Elements

- In atoms of a **transition metal**, the highest occupied *s* sublevel and a nearby *d* sublevel contain electrons.
- In atoms of an **inner transition metal**, the highest occupied *s* sublevel and a nearby *f* sublevel generally contain electrons.

Transition Elements

- Blocks of Elements