The Periodic Table

Objectives

- Describe how Mendeleev arranged the elements in the periodic table
- Explain how the predictions Mendeleev made and the discovery on new elements demonstrated the usefulness of his periodic table

History on the Organization of Elements

- **Antoine Lavoiser**

  - organized known elements (very few) into metals, non metals, gases, and earths

- **Dmitri Mendeleev**

  - organization based on a popular card game solitaire
  - each card had the elements name, mass, and properties
  - lined up the cards in order of increasing mass, found a pattern
    - elements with similar properties were in the same column

Mendeleev

Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
H = 1							
Li = 7	Be = 9.4	B = 11	C = 12	N = 14	O = 16	F = 19	
Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 31	S = 32	Cl = 35.5	Fe = 56, Co = 59,
K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Ni = 59, Cu = 63.
(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	Ru = 104, Rh = 104,
Rb = 85	Sr = 87	Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Pd = 106, Ag = 108.
(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	I = 127	
Cs = 133	Ba = 137	Di = 138	Ce = 140	—	—	—	— — — —
(—)	—	—	—	—	—	—	
—	—	Er = 178	La = 180	Ta = 182	W = 184	—	Os = 195, Ir = 197,
							Pt = 198, Au = 199.
(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
—	—	—	Th = 231	—	U = 240		

- **Predictions**

  - could not make a complete table, only had 63 elements leaving many spaces between elements

  - used properties of other elements to predict undiscovered elements properties

Mendeleev

- **Evidence**

- named some of the missing elements, and predicted some of their properties
- as elements were found scientists were able to verify properties and even explain chemical behaviors of elements in groups

Periodic Law

- Medeleev's periodic table was completed before the discovery of protons.
- by looking at certain trends, among the elements a new organization was created
- **Periodic Law**

  - pattern of repeating properties displayed by elements in the periodic table

SO….the periodic table is now arranged by atomic number instead of atomic mass

Objectives

- Describe the arrangement of elements in the modern periodic table
- Understand the trends that established the modern periodic table
- Locate periods and groups in the period table

Valence Electrons

- **Definition**

  - an electron that is in the highest occupied energy level of an atom

  - determine the properties of elements

Valence Electrons Cont.

Remember your shells: 2e-,8e-,8e-,18e-,18e-,32e-

ex. Sodium Neon

** Group number or group number – 10**

Lewis Dot Structures

- electron dot diagram, where each dot represents a valence electron

  ex.

- Practice Problems

  Br K

  Be Al

Ions

- **Definition**

  - an atom or group of atoms that has a positive or negative charge

    ex. Cl^-, Ca^{2+}

- **Formation of Ions**

  - atom gains or loses electrons (protons electrons)
  - atom is no longer neutral
  - become a cation or an anion

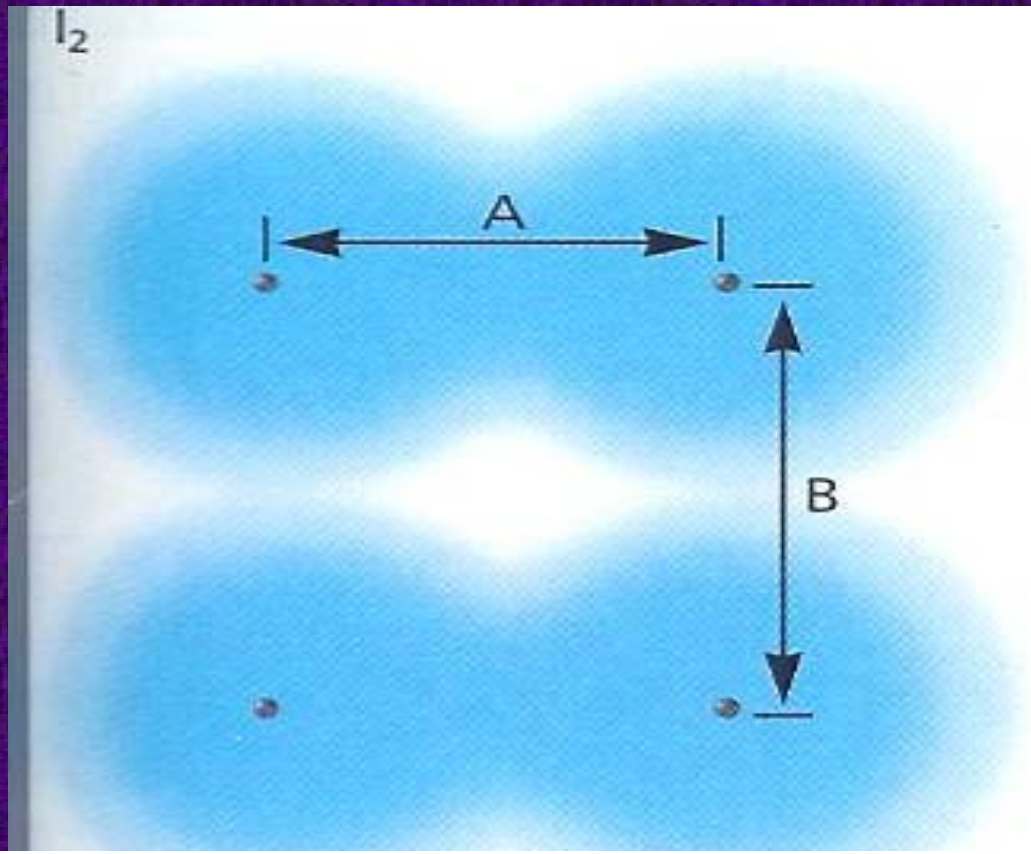
Ions Cont.

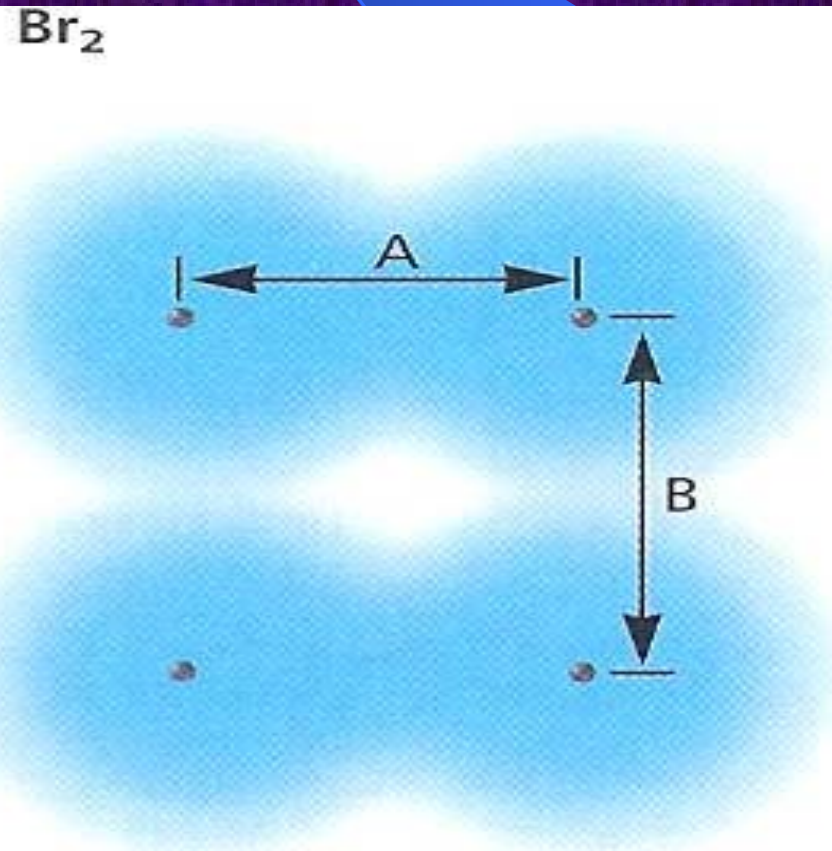
- cation (+): lost electrons
  - now name of atom + *ion* : sodium *ion*
- anion (-): gained electrons
  - now ends in *ide*: Chlor*ide*

Organizing the Elements Cont.

- **Atomic Radii:**

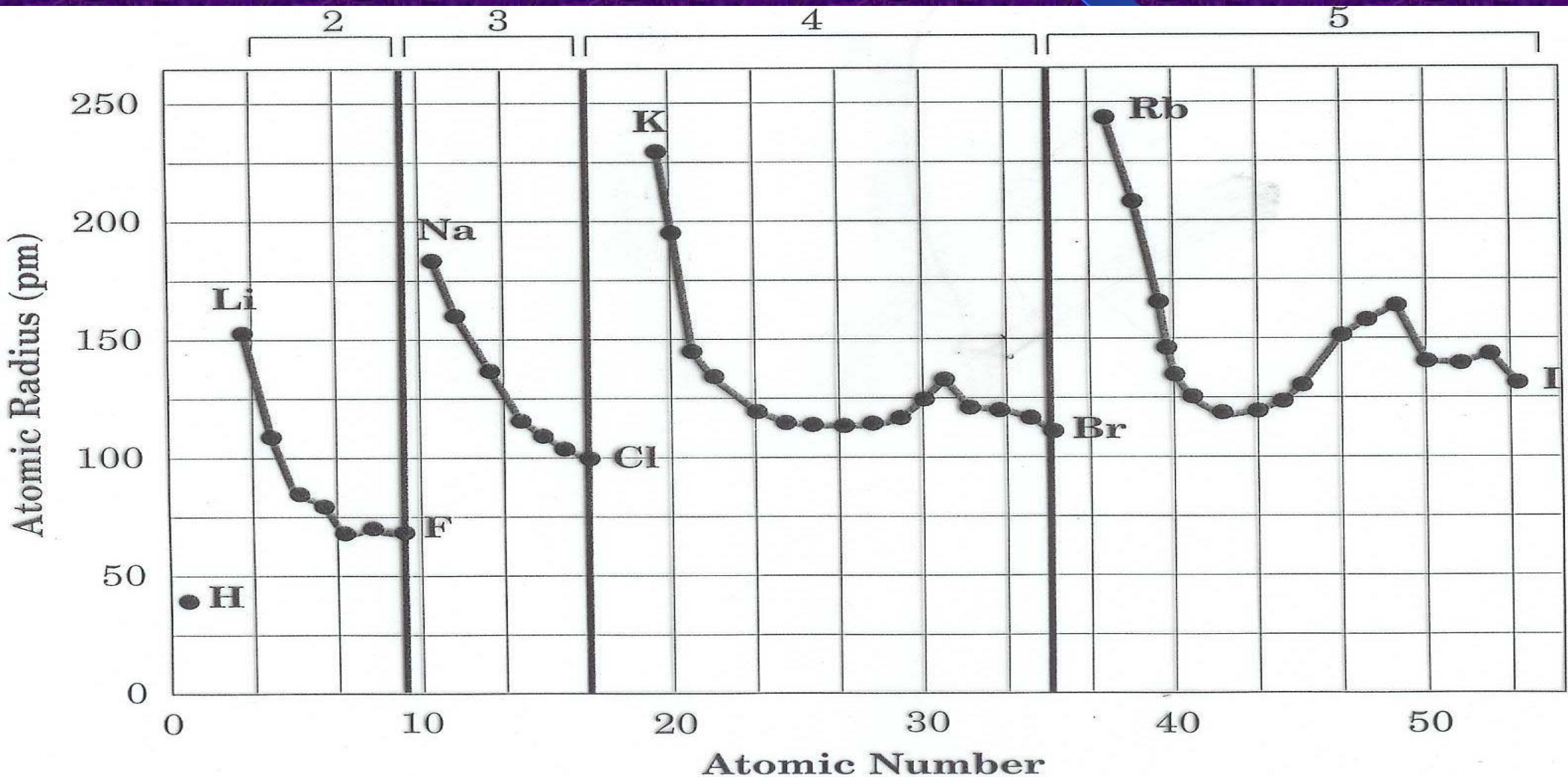
  - half the distance between the nuclei of the same atoms bonded together



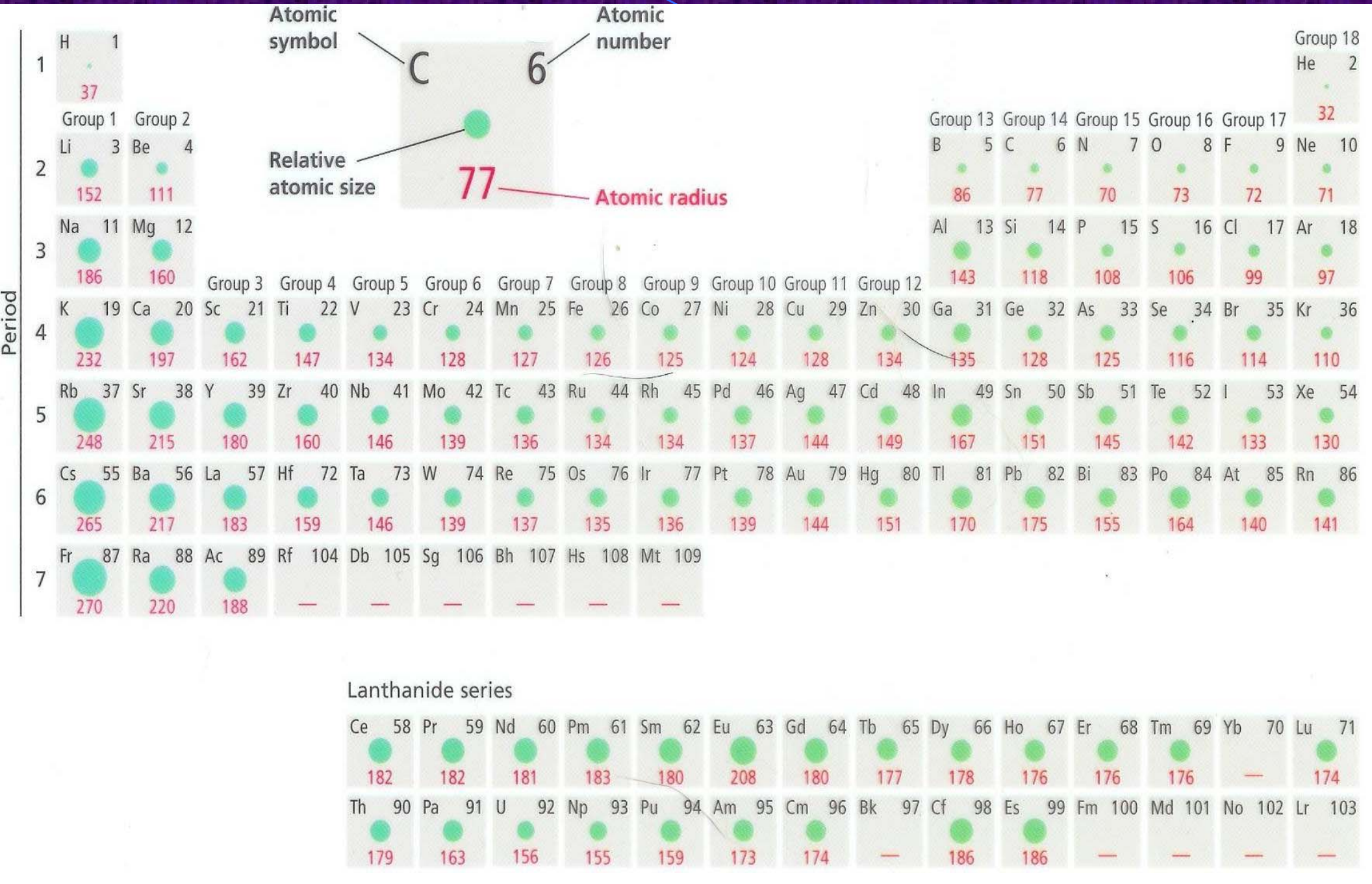


Trends of the Atomic Radii

- at certain intervals, atomic radii is dramatically <u>greater</u> than that of the previous element



Trends of the Atomic Radii



Organizing the Elements Cont.

- **Ionization energy:**

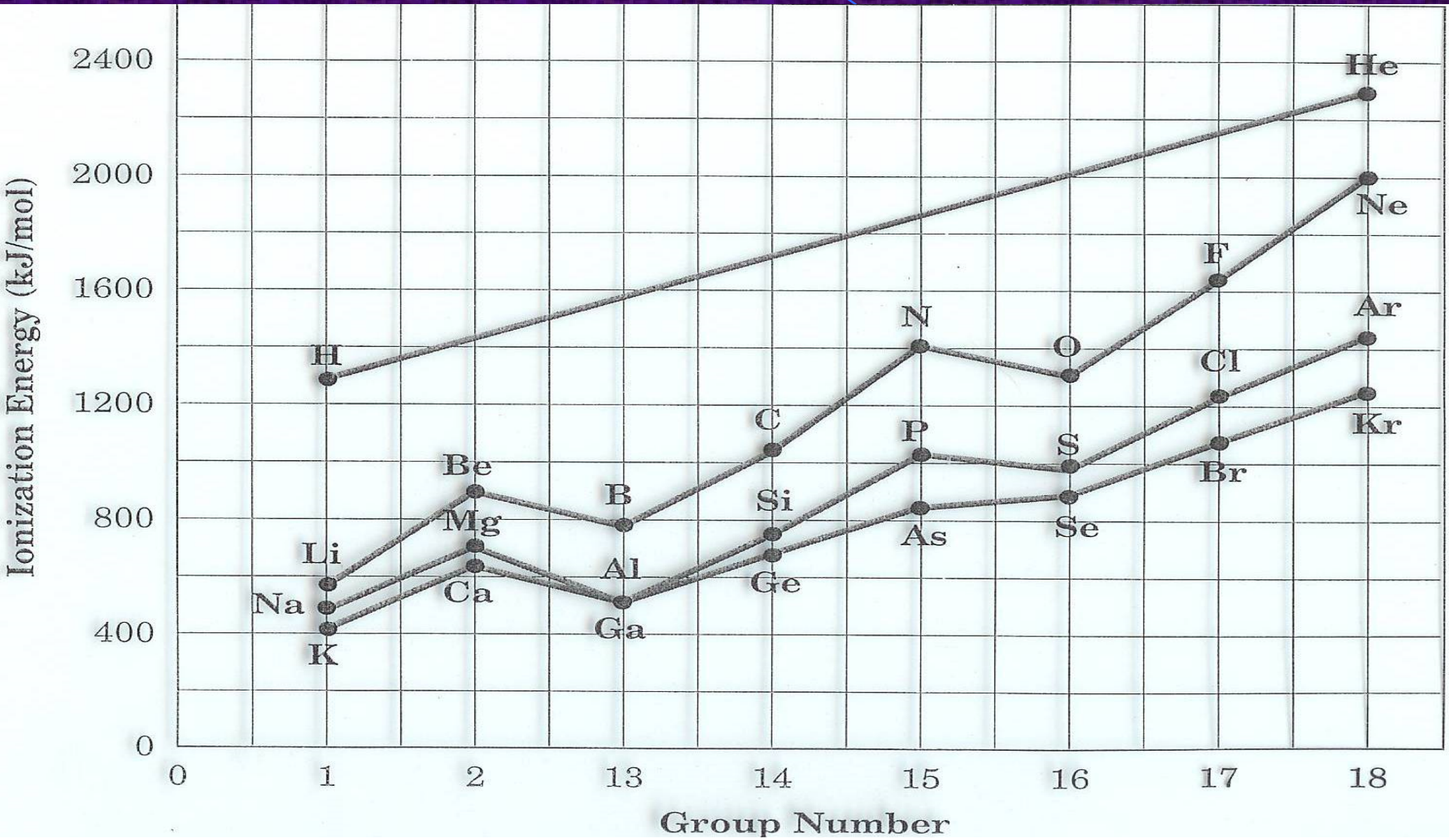
  - amount of energy required to pull an electron away from an atom to form a positively charged ion

    - generally increases with increasing atomic number

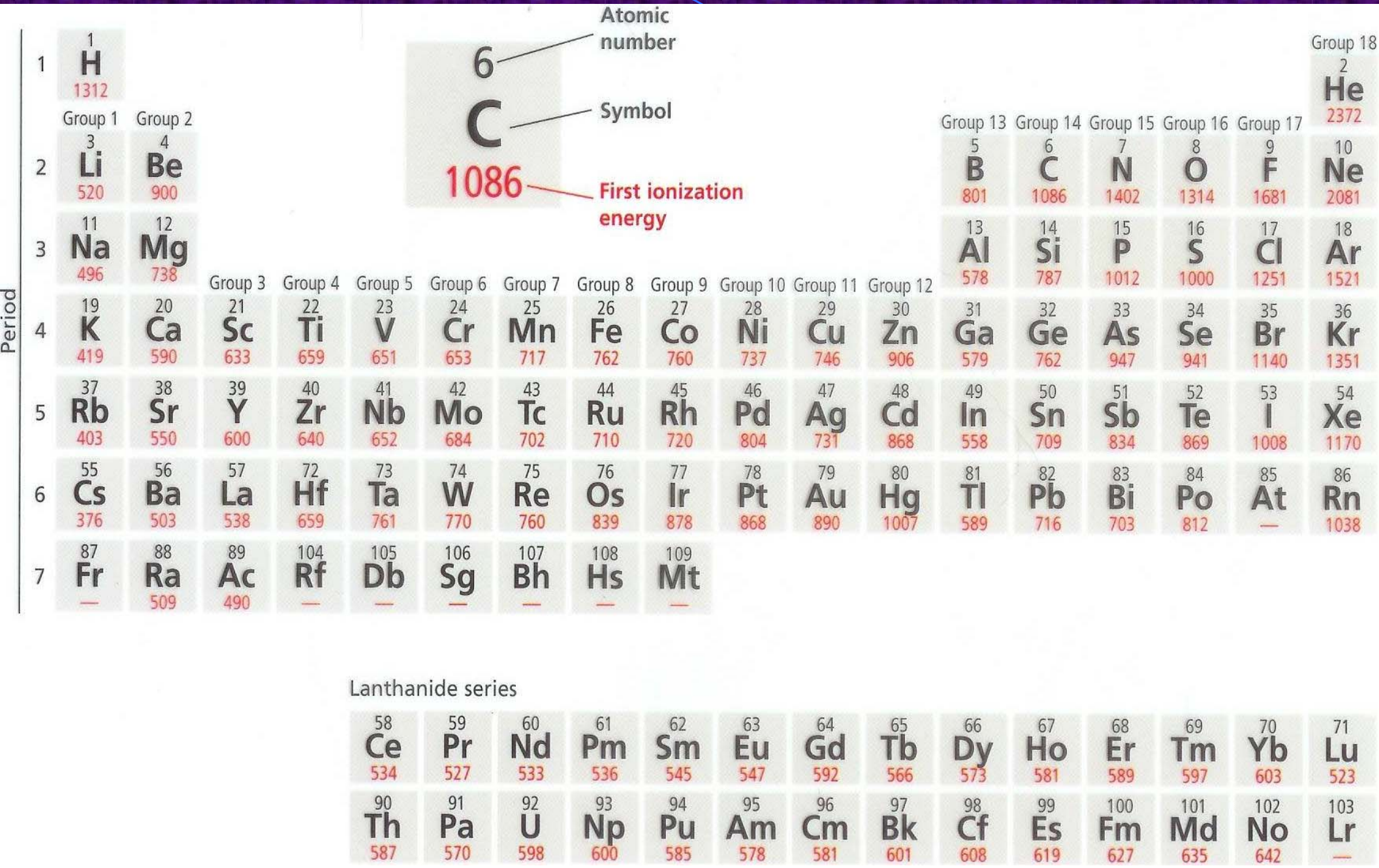
    - at some points, when atomic number increases there is a dramatic decrease

      ex. Li, Na, K, Rb, Cs, Fr

Trends of Ionization Energy



Trends of Ionization Energy



Organizing the Elements Cont.

* Because other properties of the elements follow the same pattern, it is natural to group the elements according to these intervals

Organizing the Elements Cont.

- each row is commonly referred to as a period

- there are 7 periods
- each period is placed on top of each other, giving rise to columns, known as a group

Organizing the Elements Cont.

- slight modifications of He; nothing in common with the 2nd elements of the other periods

  - Helium moves right until it is aligned with other similar elements such as Ne, Ar, and other noble gasses

  - 2nd period we slide B through Ne

  - 3rd period we slide Al through Ar

Results of Organization

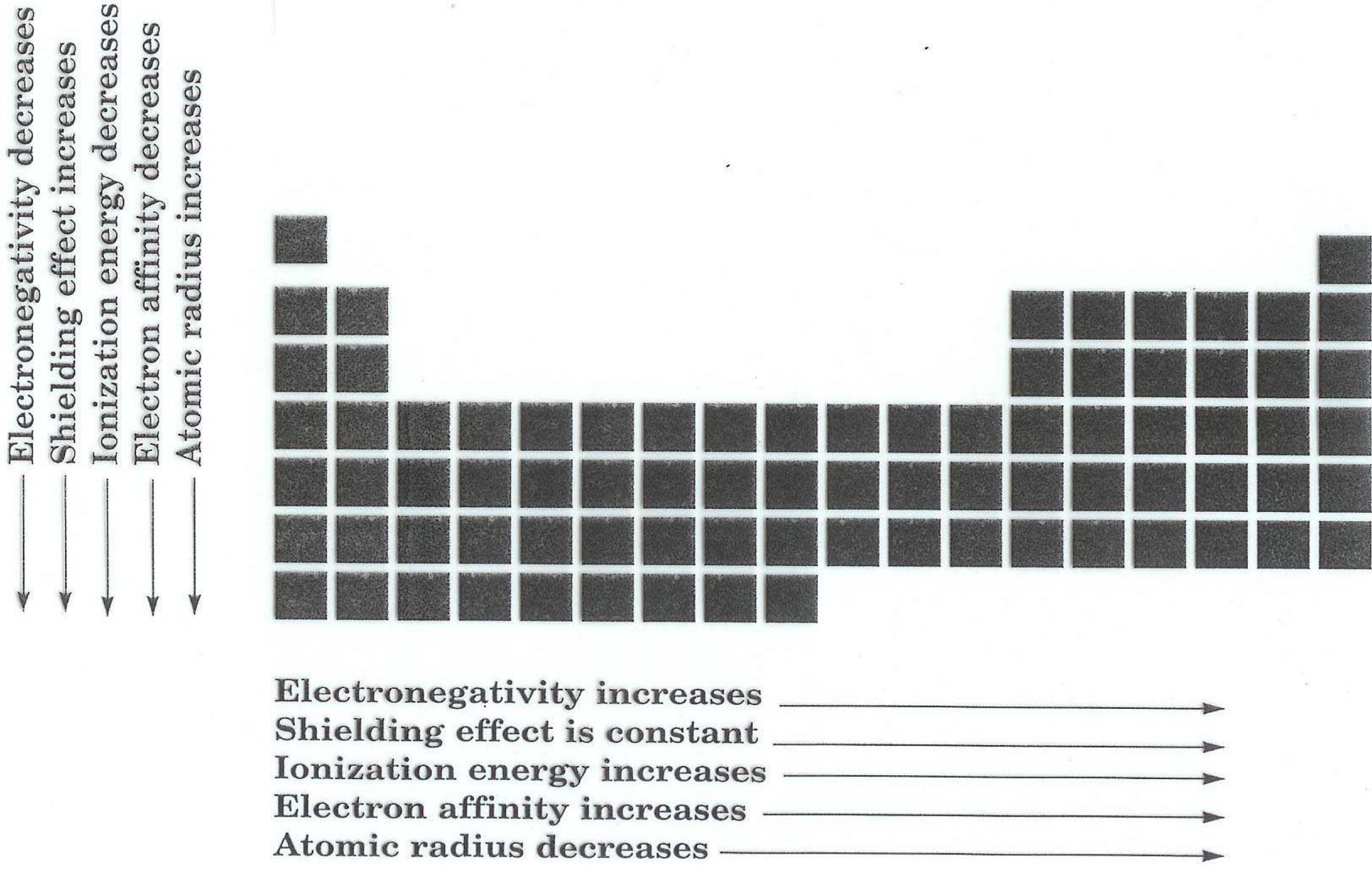
7 periods (Across)

- Atomic Radius decreases
- Ionization energy increase
- Electron Affinity increases

18 Groups (Down)

- Atomic Radius increases
- Ionization energy decreases
- Electron affinity decreases
- Elements have similar chemical and physical properties
- # of valence electrons are the same

Organizing the Elements Cont.

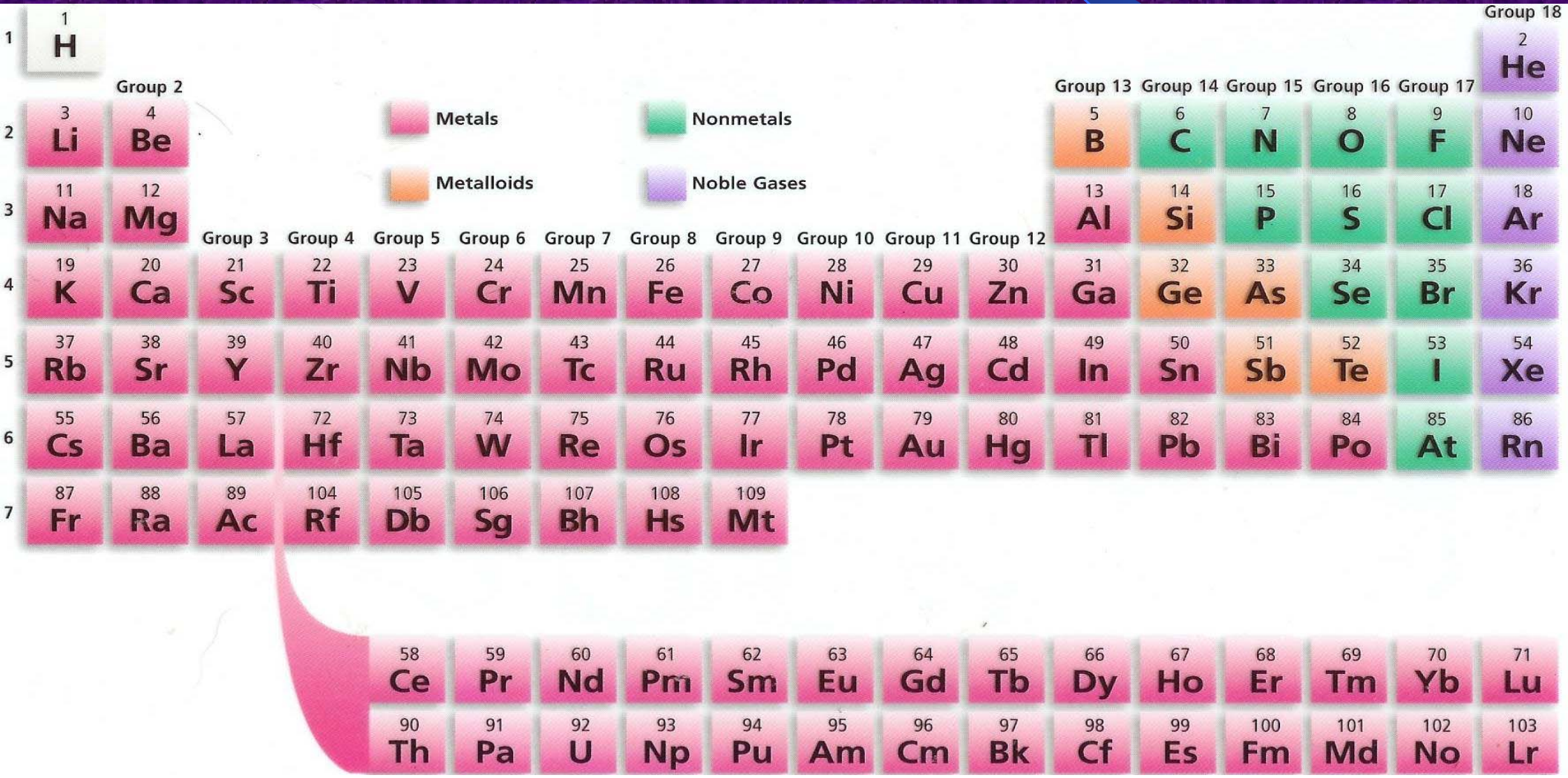


Objectives

- **Identify general properties of the metals, non metals, and metalloids.**
- **Describe how properties of elements change across a period in the periodic table**

How are Elements Classified?

- **Three Regions**
  - metals, and nonmetals, and metalloids



Metals

- **Metals**

  - include group 1 -12 and some elements from 13 - 16

  - most known elements

  - good conductors of electricity/heat

  - solid at room temperature, except mercury

    ex. Na, Ag, Pb

Non Metals

- **Definition**

  - elements that are poor conductors of electricity/heat

  - low boiling points, SO…most are gases at room temperature

  - varying chemical properties

    ex. He, F, P

Metalloids

- **Definition**

  - elements with properties that fall between those of metals and non metals

    - chemical properties will vary, usually most like the region they are closer to

      ex. As: closer to non metal most of it's property will resemble that

Families of the Periodic Table

- **Families/Groups**
  - Alkali metals
  - Alkali Earth metals
  - Boron Family
  - Carbon Family
  - Nitrogen Family
  - Oxygen
  - Transition Metals
  - Halogens
  - Noble Gases

Alkali Metals

- **Definition**

  - highly reactive metallic elements in group 1

  - react with water to form hydrogen and alkaline solutions; burn in air

  - al-quili means wood ashes

  - term dates back to ancient times; people discovered that wood ashes mix with water to produce slippery solutions that can remove grease

  - one outer electron, by losing this electron they become a cation, and become stable

Alkali Metals Cont.

- soft metals; can be cut with a knife
- shiny, but dull quickly due to oxygen and water in air
- good conductors
- gaseous states at high temperatures become plasmas

ex. Na, Cs, Rb

Alkali-Earth Metals

- **Definition**

  - group 2 elements

  - comes from idea of "Earth", materials unable to light on fire

  - reactive metallic elements with two electrons in the outermost energy level

  - harder, denser, stronger and have higher melting points, lower reactivity than alkali

    ex. Be, Ca, Mg

Transition Metals

- **Lanthanides**

  - shiny, metallic transition metals (58 – 71) in which electrons are added to 4f orbitals

  - located at the bottom of the periodic table for convenience

- **Actinides**

  - shiny metallic transition metals (90 – 103) in which electrons are added to 5f orbitals

  - located at the bottom of the periodic table for convenience

  - radioactive

Halogens

- **Definition**

  - nonmetallic elements in group 17, that have 7 electrons in the outer most energy level and combines with many metals to form salts

  - term comes from Greek means "*salt former*"

    Salt: a compound composed of positive and negative ions arranged in a regular 3D pattern

  - most reactive group of nonmetals

  - varying physical properties, similar chemical properties

Noble Gas

- **Definition**

  - elements in group 18 that are characterized by low reactivity

  - term comes from noble people, did not associate with anyone other then their kind

  - characterized by an octet of electrons in the outermost energy level; (happy)

    - exception of helium

  - very stable, (unreactive)

  - colorless, odorless

  - practical applications: balloons, illumination

Hydrogen

- most common element in the universe
- behaves unlike any other element due to its structure of 1 p 1 e
- react with numerous elements
- component of all hydrocarbons, and molecules that are essential to life; fats, proteins, carbohydrates
- practical uses

  ex. ammonia, fertilizers