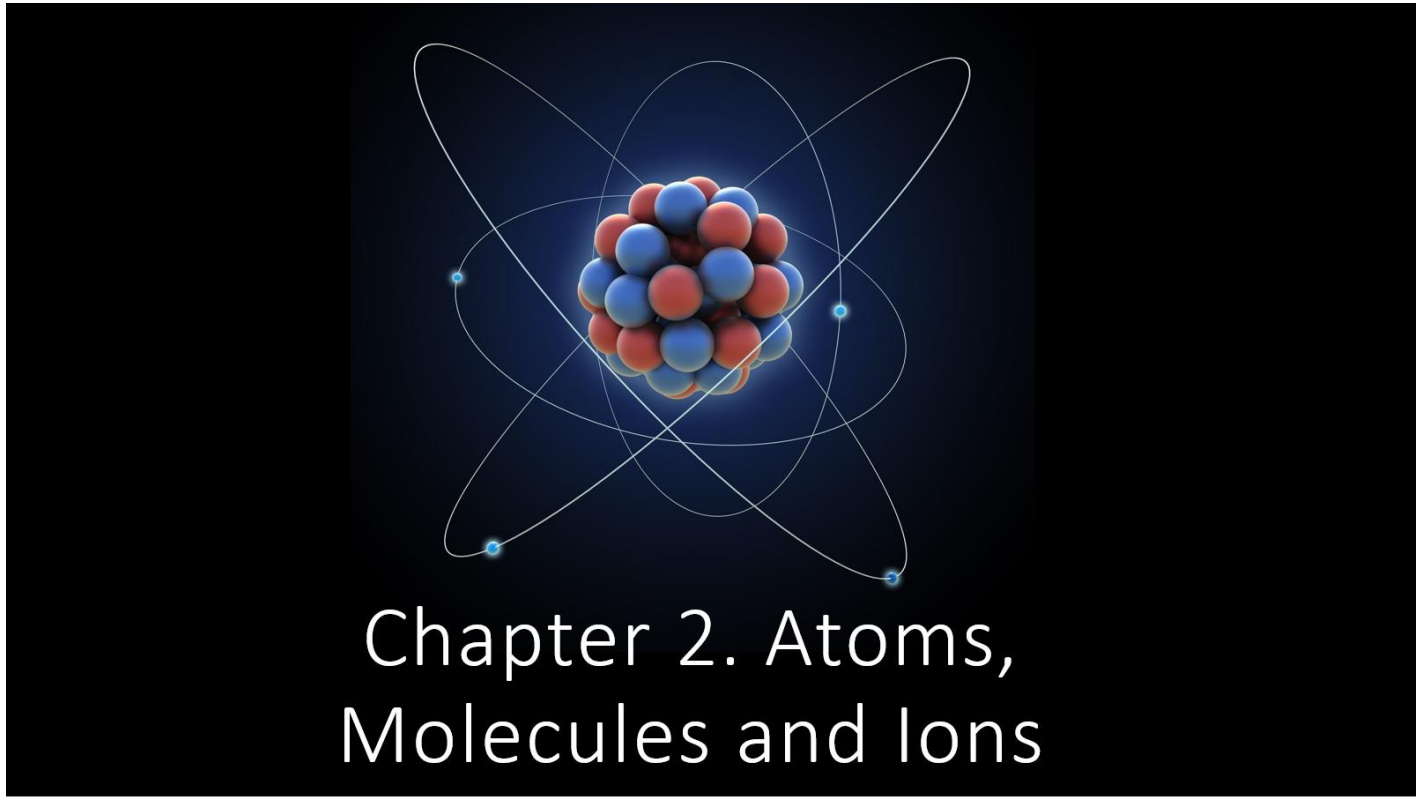


General Chemistry I, CHEM 103-002

Lecture 4: Chemical Formula, Periodic Table, Ionic and Molecular Compounds

September 9th 2026

HW#1 due today at 5pm

How to study for CHEM103

- Read book and solve on your own book examples.
- Come and participate in lecture.
- At the end of each book chapter, there are additional exercises with an answer key provided at the end of the book.
- Go over lecture slides and solve lecture problems.
- Break up and do homework over multiple days.
- Ask yourself if you are comfortable in achieving the learning objectives outlined?
- Go to office hours with your questions. Email to arrange an appointment for office hours if you can't make a specific office hours.

Office Hours: Tuesday 9:15-10:15am
(in Park 22) Thursday 9:15-10:15am
or by appointment (email me)
or email me with questions!

TA Hours w/Ramona: Wednesday 2:00-4:00pm in Park 252

Q-center: https://www.brynmawr.edu/inside/offices-services/q-center/q-center-schedule

Announcements

- Class TA Office Hours with Ramona: Wednesday 2PM-4PM in Park 252.

- Plan for this week CHEM 103:
- Complete Chapter 2
- Homework 2: Will be posted tomorrow (9/10) at 9am and due Wednesday (9/16) 5pm.
- Recitation Worksheet #2 for Friday recitation

- Recitation Period:
- Lowest score of all recitation worksheets will be dropped
- First 20 minutes we will spend solving altogether one problem.
- Last 20-30 minutes spend on completing on your own recitation worksheet with closed book. Bring calculator. Need to submit worksheet at the end of recitation period.

Learning Objectives for Chapter Units 2.3 – 2.6

- Calculate atomic weights of elements when given isotope distribution or mass spectrometry data. Solve problems involving isotope distribution and atomic masses.
- Write and interpret symbols that depict the atomic number, mass number, and charge of an atom or ion.
- Calculate average atomic mass and isotopic abundance.
- Explain the organization of elements in the periodic table.
- Understand the structure of the periodic table; be able to rapidly find relevant information in it. Use it confidently to 1) classify elements as metals, nonmetals or metalloids (semimetals) and 2) identify if an element belongs to a key group/region discussed in class (alkali metals, transition metals, halogens, noble gases…).
- Know that matter can be made up of single atoms (elements), molecules (elements and compounds) or networks/extended structures (elements and compounds).
- Name and write formulas of the seven diatomic elements.
- Use the periodic table to predict charges of ions from key groups (e.g., alkali metals).
- Name and write formulas of common monoatomic ions.
- Define ionic and molecular (covalent) compounds.
- Predict the type of compound formed from elements based on their location within the periodic table.
- Determine formulas for simple ionic compounds.

Reading from book pages 73-93.

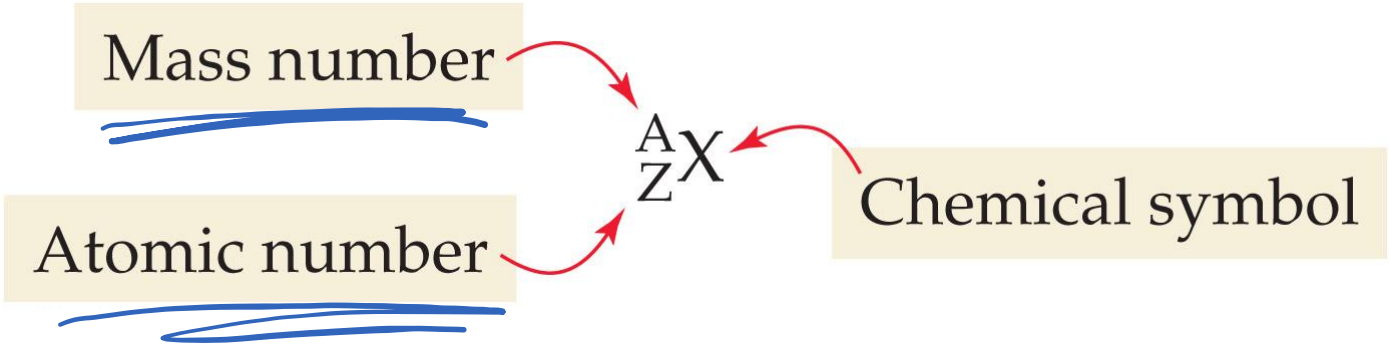
Chapter Unit 2.3

Atomic Structure, Symbolism and Isotopes

Isotopes: When the Number of Neutrons Varies

- All atoms of a given element have the same number of protons.
- They do not necessarily have the same number of neutrons.
- Atoms with the same number of protons but different numbers of neutrons are called **isotopes.**
- All elements have their own unique percent **natural abundance** of isotopes.

Isotope Symbol Notation



Isotopes of Neon: $^{20}_{10}Ne$ $^{21}_{10}Ne$ $^{22}_{10}Ne$

mass number differs

protons

Mass number (A) = # protons + # neutrons

A = Z + # neutrons

Participation Questions

1. How many protons and neutrons are in this isotope of Uranium? $^{238}_{92}U$

2. If an atom has a mass number of 32 and has 17 neutrons, it is an isotope of which element?

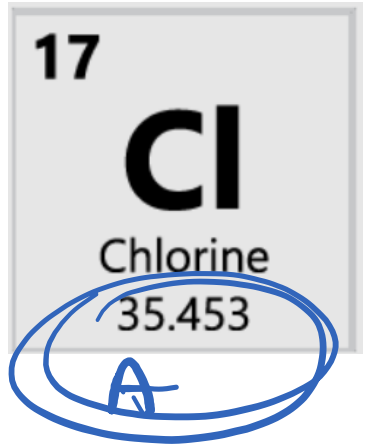
3. What is unique for each element?

4. What are the atomic number, mass number, and symbols for the chlorine isotope with 18 neutrons?

https://docs.google.com/forms/d/e/1FAIpQLSfxgeXLY0WCnx2nsFg0-XBYdBVzkUOLEzNL0Efjvov509VPyQ/viewform?usp=publish-editor

Atomic Mass

Atomic mass: mass of element listed in periodic table



Atomic mass on periodic table is a weighted average

based on the natural abundance of each **isotope!**

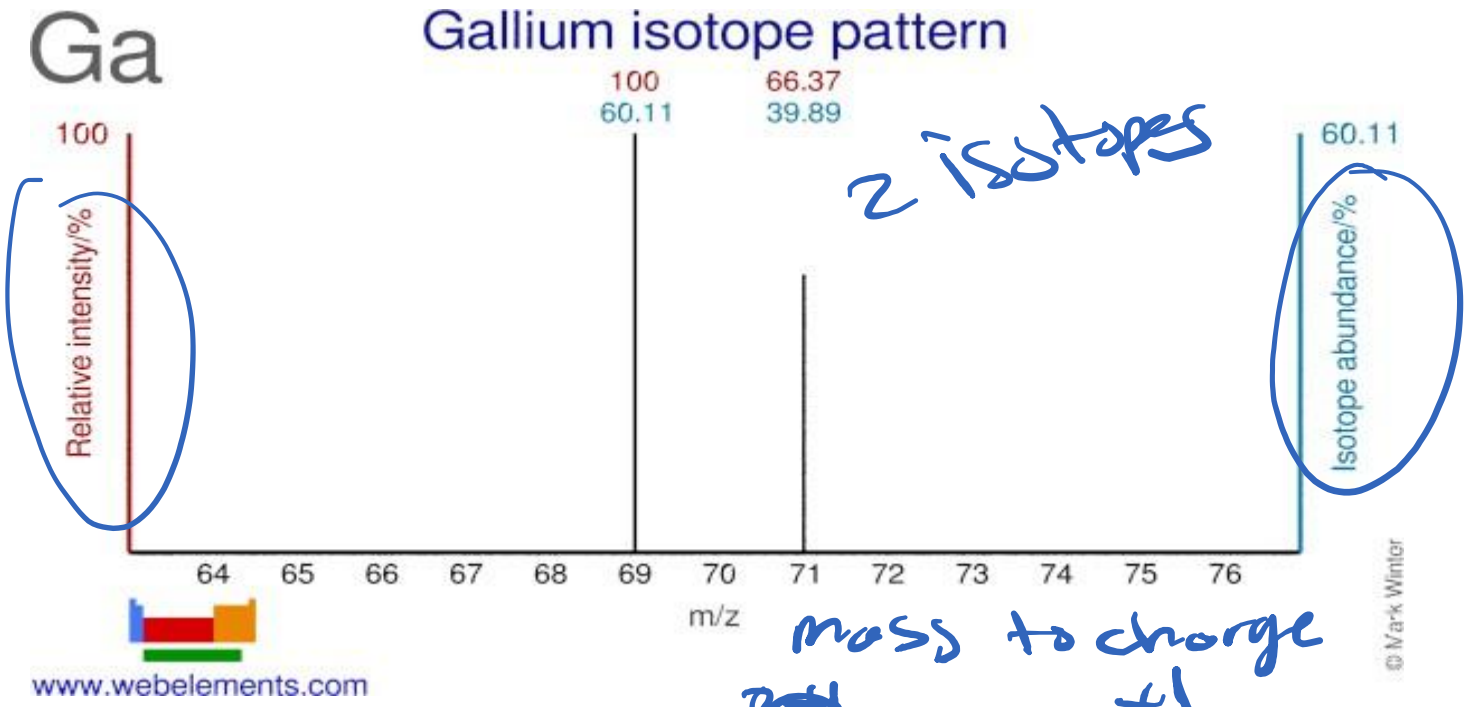
	# protons	# neutrons	Mass Number (A)	Mass (amu)	Percent Abundance
Cl-35	17	18	35	34.45 amu	75.77%
Cl-37	17	20	37	36.97 amu	24.23%

Atomic mass = (75.77% x 34.45 amu) + (24.23% x 36.97 amu)

A — abundance (percent) — amu of specific isotope

= (0.7577 x 34.45 amu) + (0.2423 x 36.97 amu) = 35.45 amu

Example element mass spectrum: gallium (Ga)



Charge for in mass spectra our class will be +1

1. What stable isotopes of Gallium can we derive from the given mass spectrum?
2. State what are the number of protons, electrons, and neutrons in each of them.

https://docs.google.com/forms/d/e/1FAIpQLScLIi3-NmHHyGEOXQc8Ya6HW6YAWMJV-TtLnOdKg87iNscSaw/viewform?usp=header

Practice problem

What are the percent natural abundances of the two naturally occurring isotopes of boron, ^{10}B and ^{11}B? These isotopes have masses of 10.012937 u and 11.009305 u, respectively.

wt% of $^{10}B = X$, $^{11}B = 1 - X$, $A = 10.811$ amu (from periodic table)

$(X)(10.012937\text{ amu}) + (1-X)(11.009305\text{amu}) = 10.811\text{ amu}$

$(10.012937\text{ amu})X + 11.009305\text{amu} - (11.009305\text{amu})(X) = 10.811\text{ amu}$

$11.009305\text{amu} - 10.811\text{amu} = (11.009305\text{ amu})X - (10.012937\text{amu})X$

(11.009305amu: 1 2 3 4 5 6; 10.811amu: 1 2 3; 11.009305 amu: 1 2 3 4 5 6 DP; 10.012937amu: 1 2 3 4 5 6 DP; millionth place)

$0.198395\text{amu} = (0.996368\text{amu})X \Rightarrow$

$X = 0.199$

$X = 19.9\%\ ^{10}B$ so $^{11}B = 1 - X$ $^{11}B = 0.801 \Rightarrow 80.1\%$

Chapter Unit 2.4

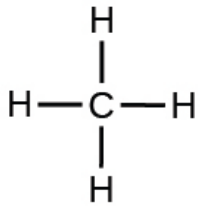
Chemical Formula

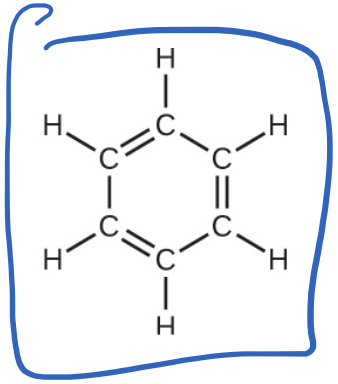
Chemical Formula

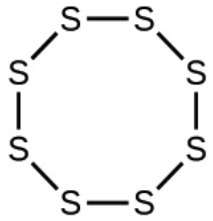
- Molecular Formula

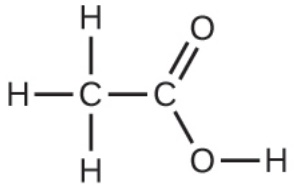
CH_4, C_6H_6, S_8, $C_2H_4O_2$

- Structural Formula









- Empirical Formula

ratio of all types of atoms to each.
Not actual # of atoms

MF	EF
C_6H_6	CH
$C_6H_{12}O_6$	CH_2O

Chemical Formula

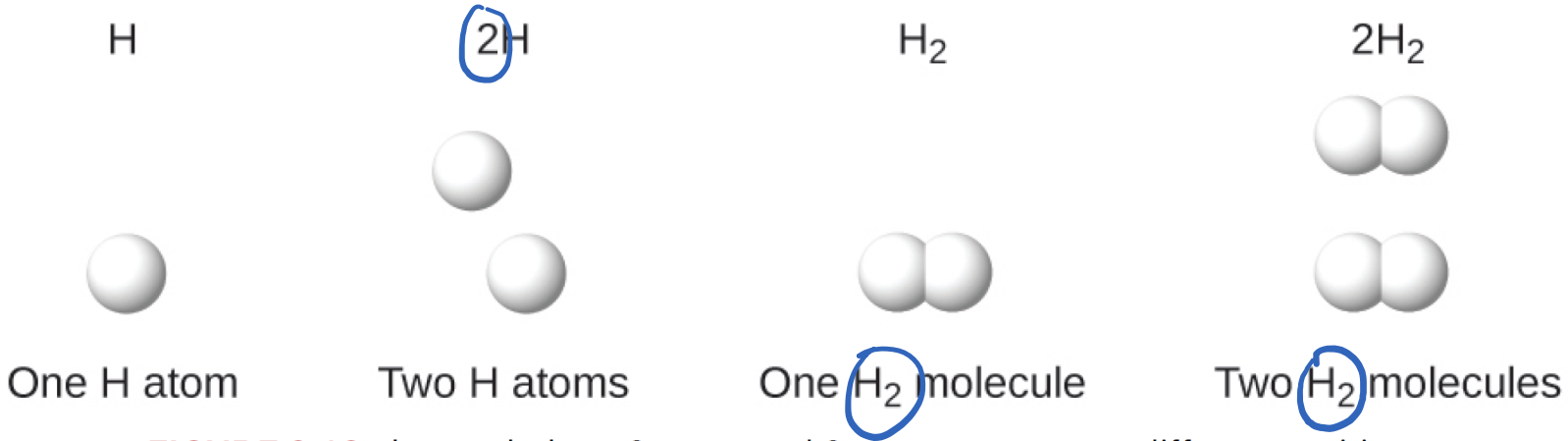
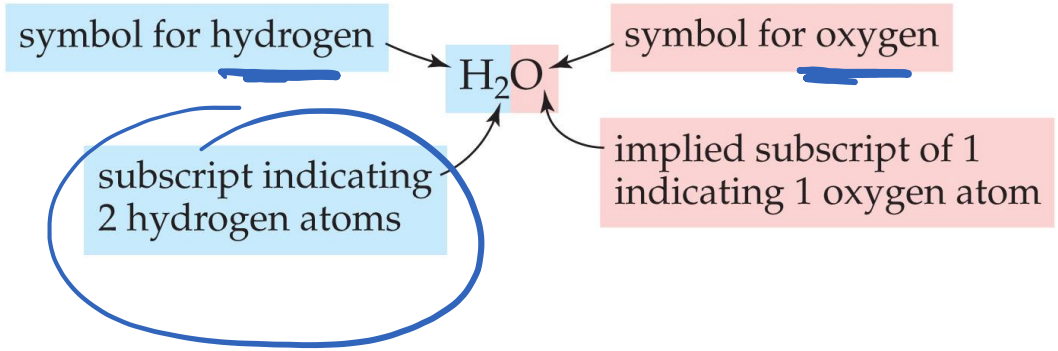


FIGURE 2.18 The symbols H, 2H, H_2, and $2H_2$ represent very different entities.

Chemical/Molecular Formula

Indicate the ratio of each element in the compound

Ratio is always the same for a given compound



Example: H_2O

H = symbol for hydrogen; subscript 2 means 2 H atoms

O = symbol for oxygen; implied subscript 1 means 1 O atom

Table Sugar: $C_{12}H_{22}O_{11}$

12 C atoms, 22 H atoms, 11 O atoms in every molecule

Ratio 12:22:11

Chapter Unit 2.5

The Periodic Table

Periodic Table

Organized by Dmitri Mendeleev (1869)

When elements are arranged in order of increasing mass, certain sets of properties recur periodically. Left spaces for then undiscovered elements; predicted their properties

1 H	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	19 K	20 Ca

Arranged elements in rows so vertical columns share similar properties.

1 H							2 He
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca						

Periodic Law: It’s all about the protons and electrons (electron configuration)

The **periodic law**, is as follows: the properties of the elements are periodic functions of their atomic numbers.

Protons: Identity

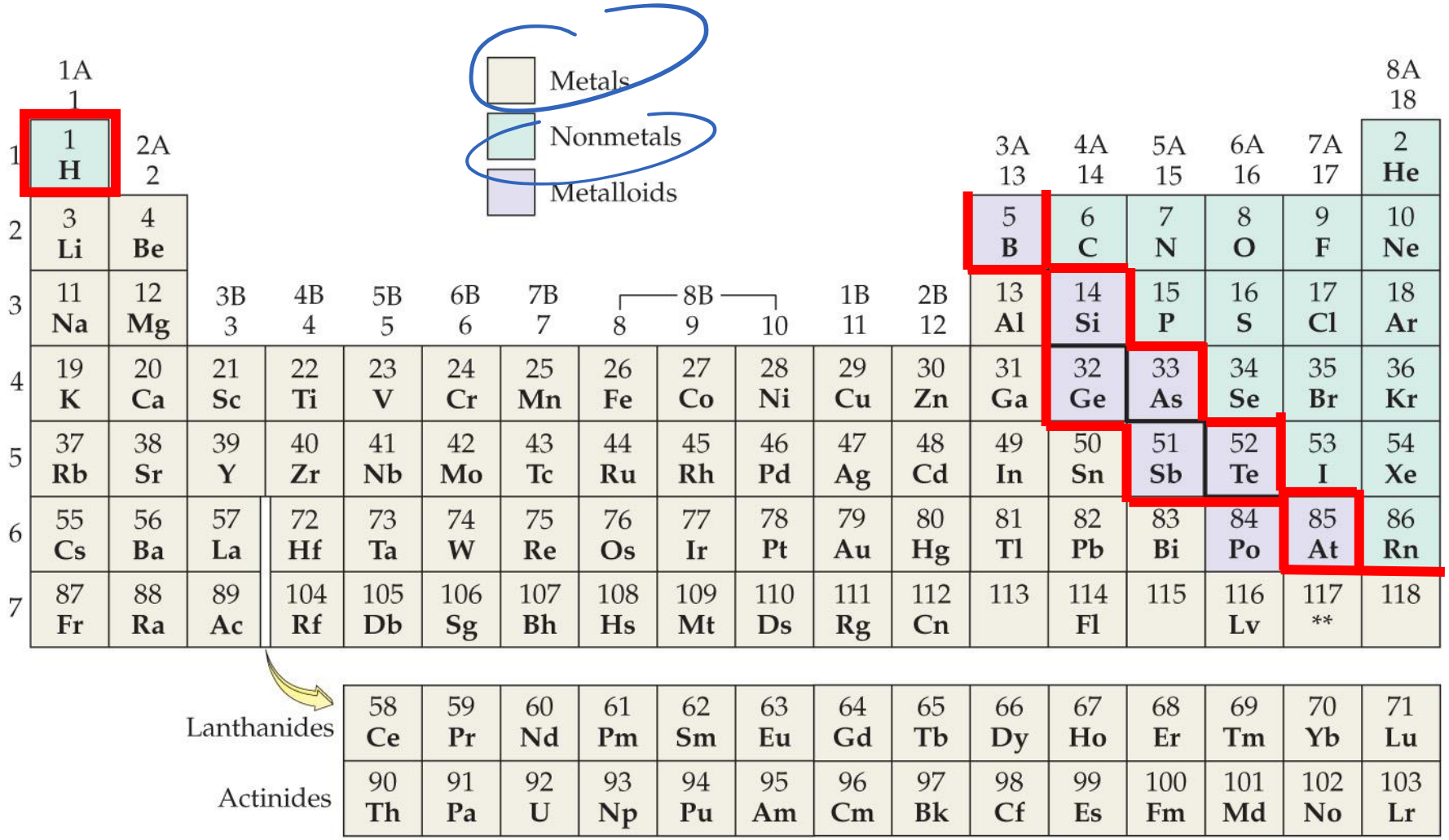
- Defines the Element
- Sets the Sequence
- Anchors the Electrons

Electrons: Periodicity

- Drives Chemical Reactions
- Creates the "Periodicity"

If protons are the foundation and address of a house, electrons are the architecture and the people living inside—they determine what the house actually looks like and how it interacts with the neighborhood.

Locating Metals, Nonmetals, Metalloids



Metals	**Nonmetals**
Electrical - Conductive	Electrical - Insulator
Thermal - Conductive	Thermal - Insulator
Metallic gray luster	No luster
Most are solids**	All phases
Malleable - sheets	Brittle
Ductile – wires	Nonductile
Tend to form (+) ions	Tend to form (-) ions, but (+) ions are not uncommon.

Locating Main Families of the Periodic Table

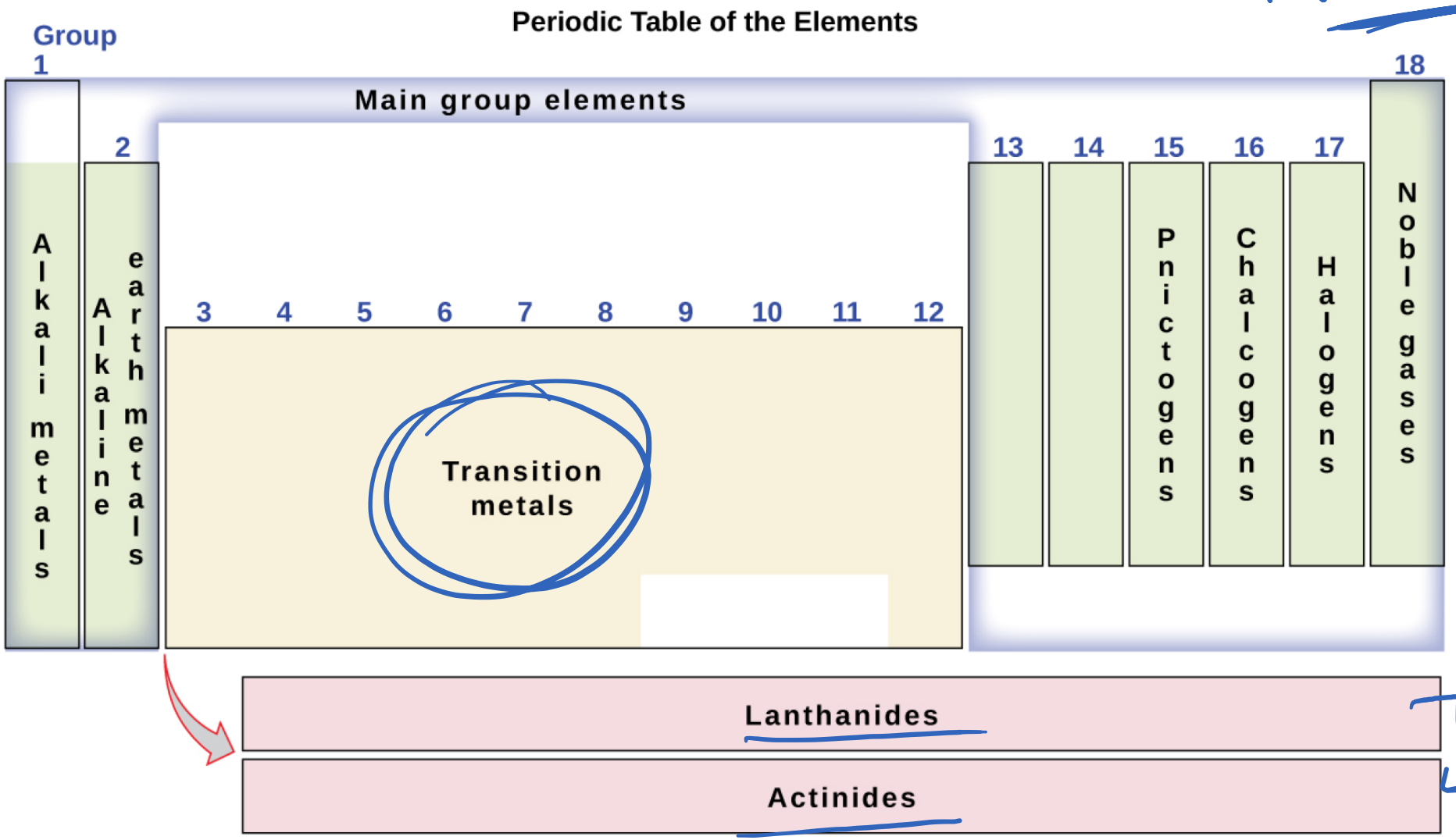
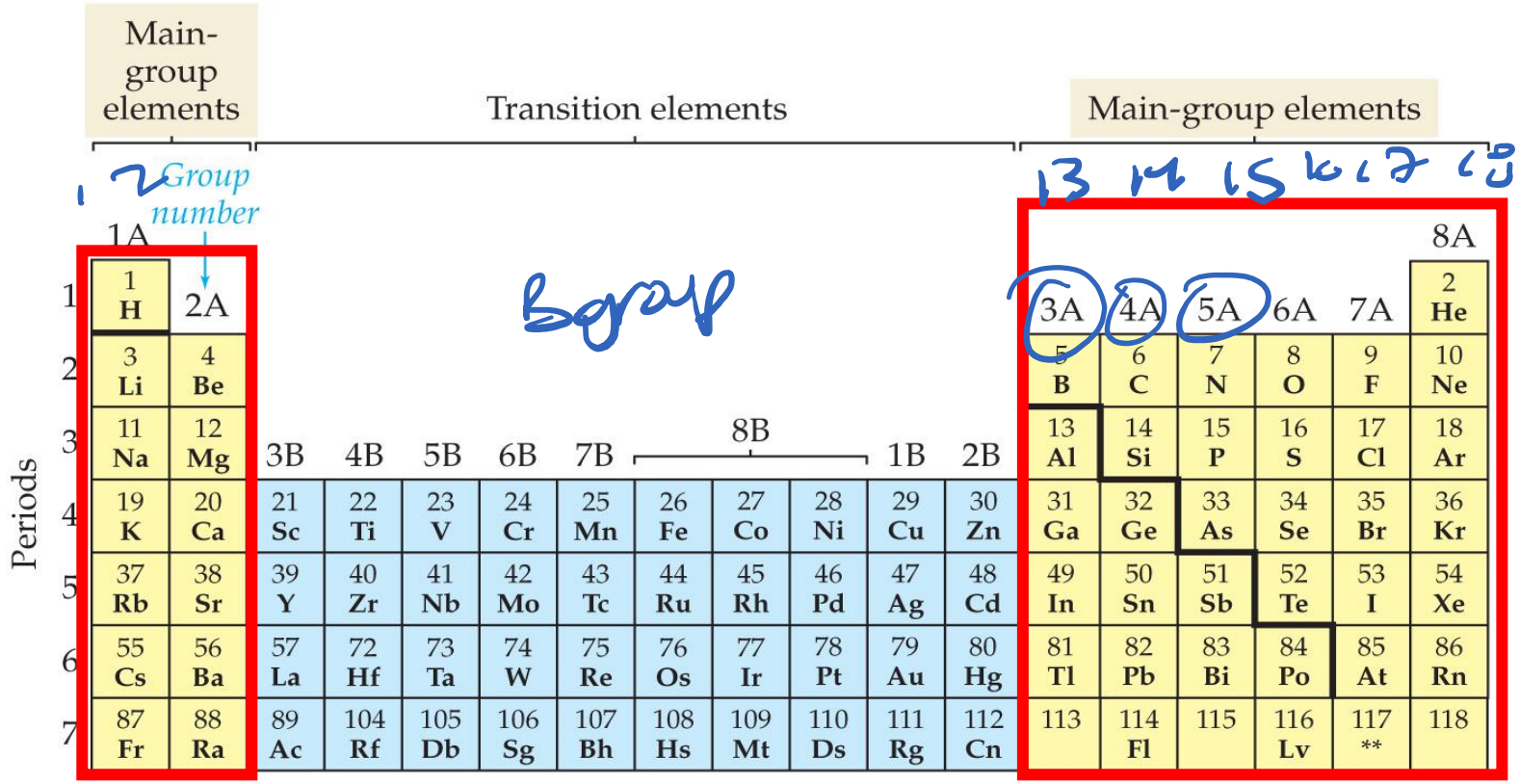


FIGURE 2.27 The periodic table organizes elements with similar properties into groups.

Main Group Elements and Transition Elements

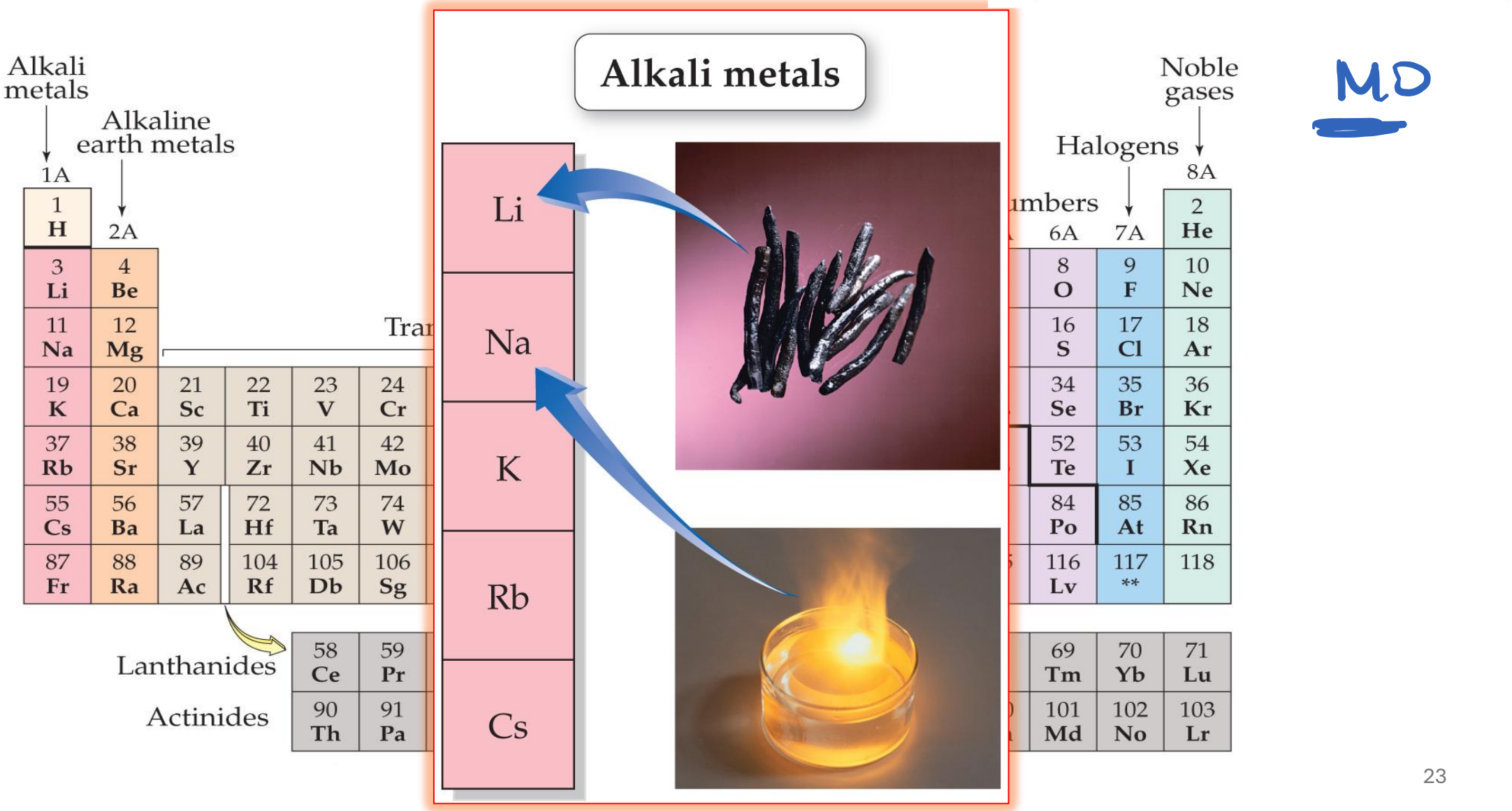


For main group elements, properties can generally be predicted based on the element's position.

Groups 1A Alkali Metals

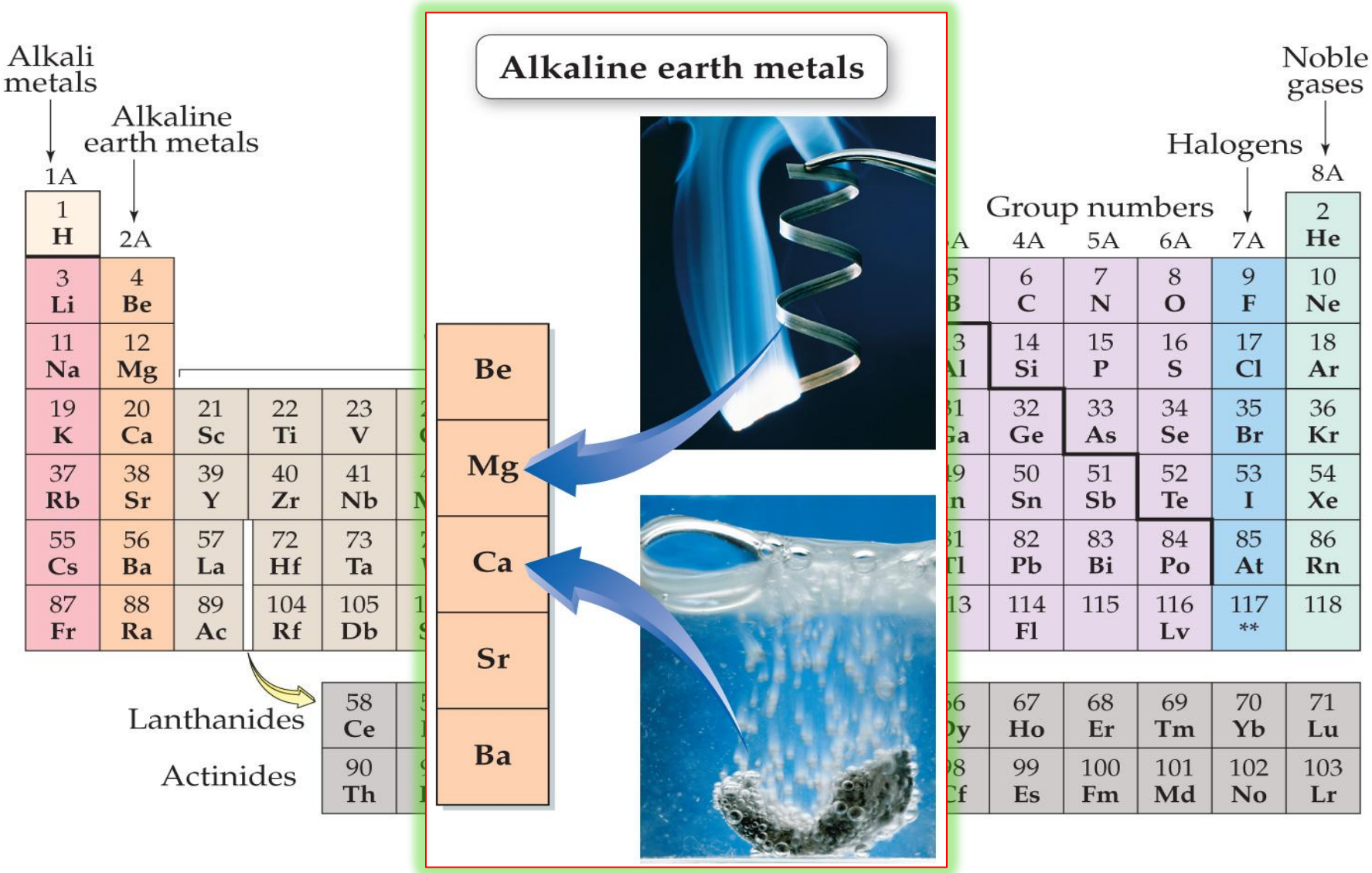
- When burned in air, alkali metals form either the oxide, peroxide, or superoxide as the principal product, depending on the size of the cation.

$M + O_2 \rightarrow$	Li_2O	Na_2O_2	KO_2	RbO_2	CsO_2
Anion	oxide	peroxide	superoxide	superoxide	superoxide

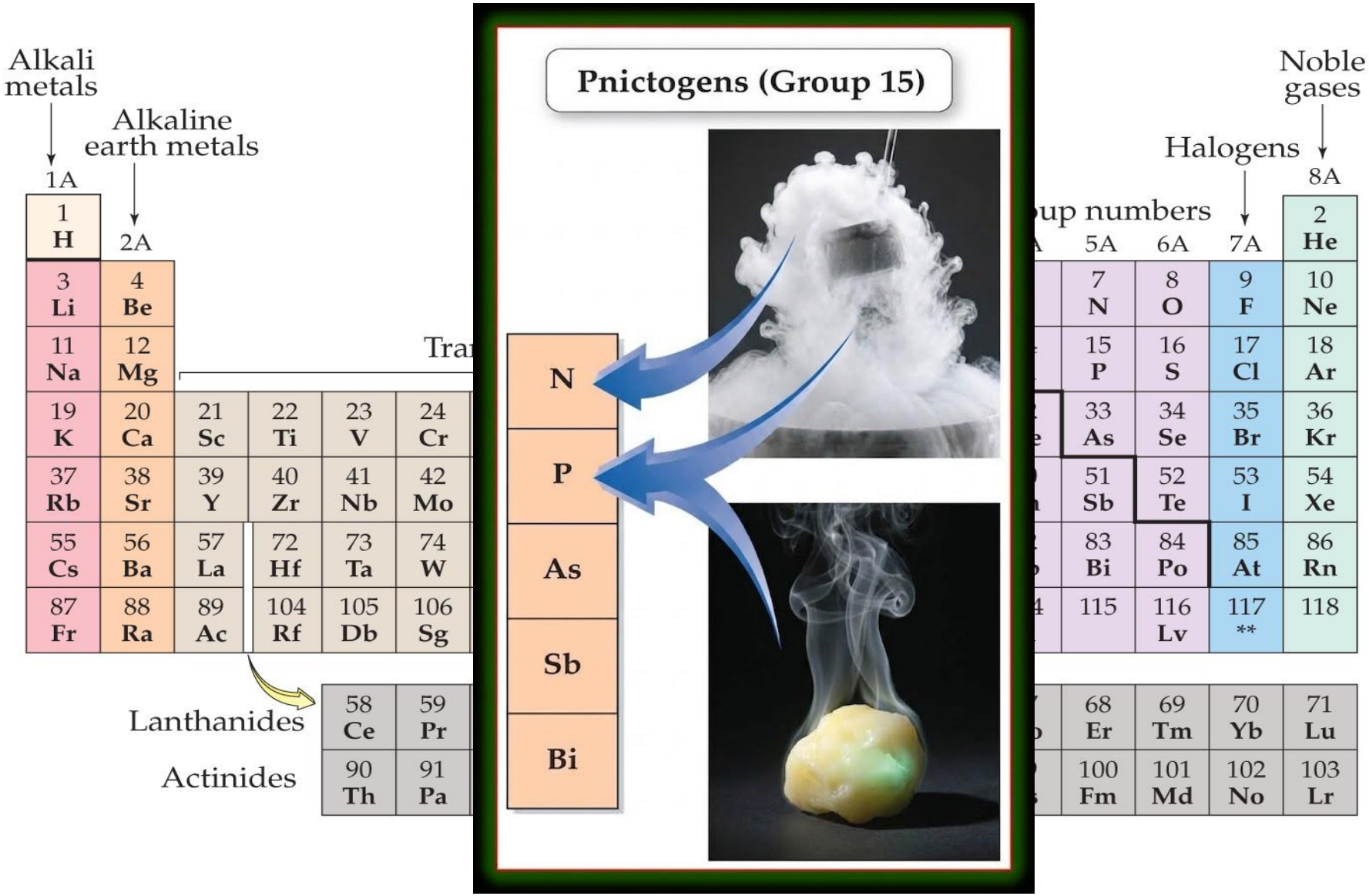


MD

Groups 2A Alkaline Earth

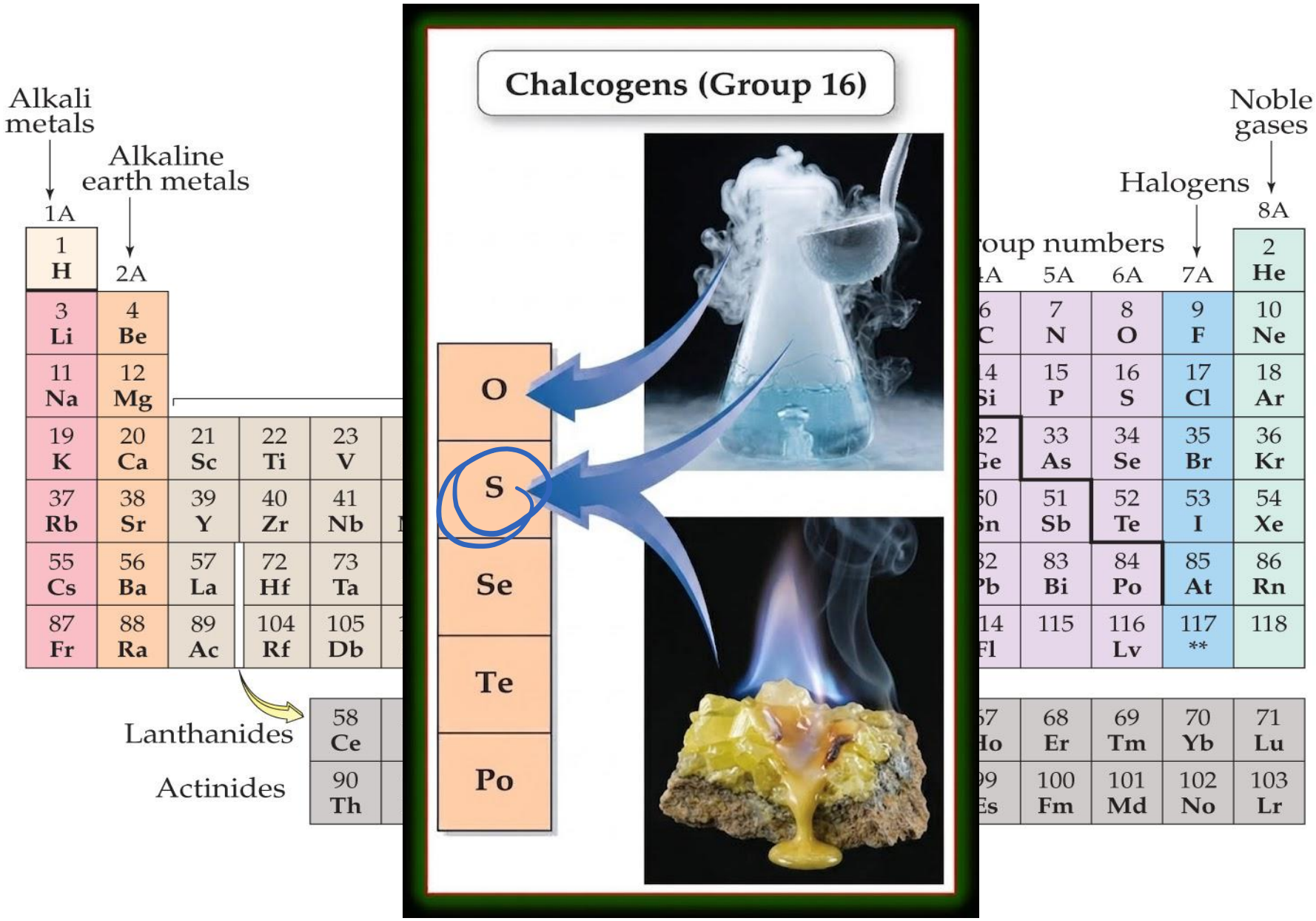


Groups 5A Pnictogen



The group 15 elements, known as pnictogens (from Greek *pnigein*, meaning "to choke"). This refers to the asphyxiating properties of pure nitrogen gas, which is the first element in the group, and to the poisonous, choking nature of some compounds formed by other elements in the group, such as arsenic.

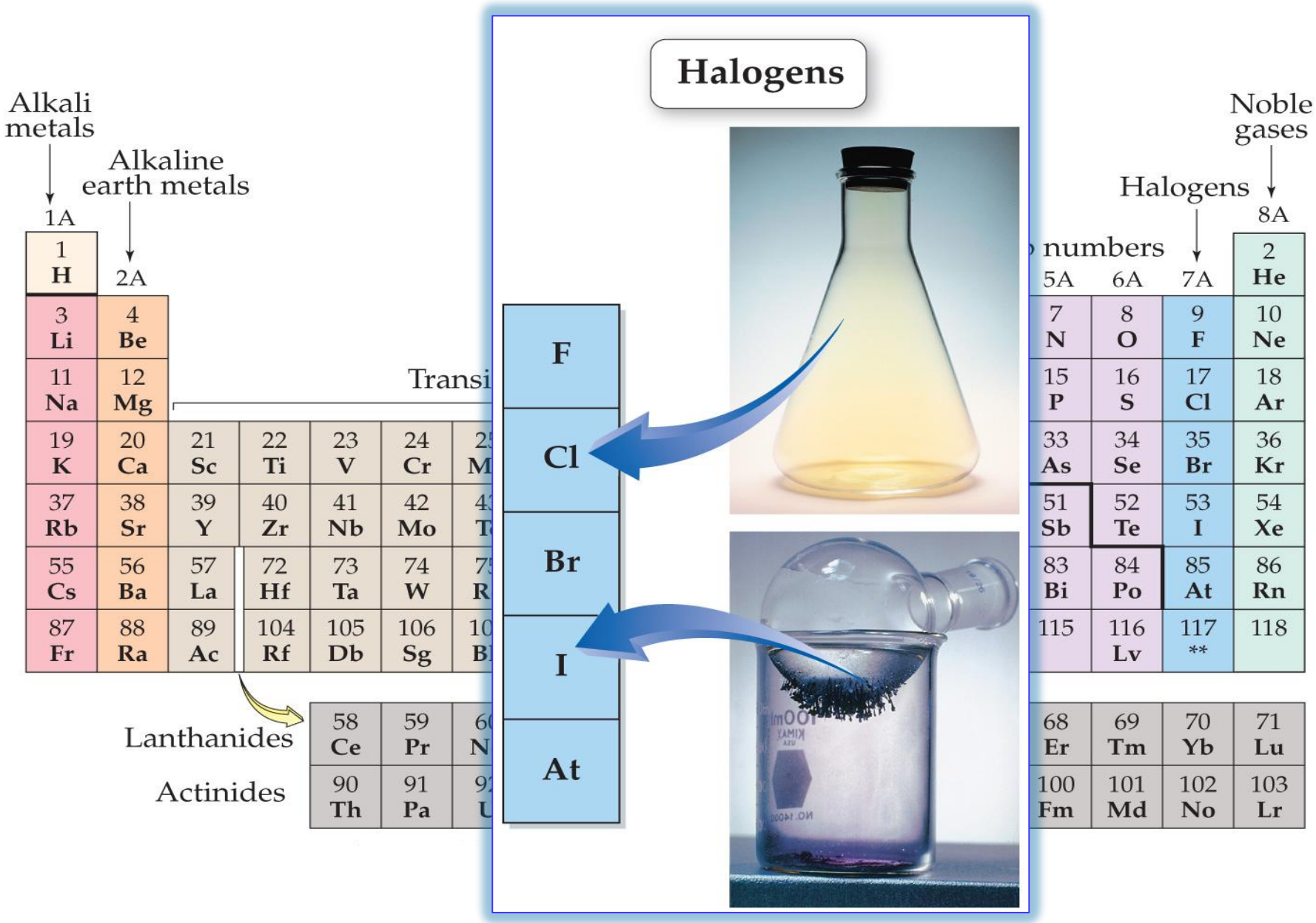
Groups 6A Chalcogen



The Group 16 elements are named chalcogen from the Greek, meaning "ore-forming," as these elements readily combine with metals to form ores in nature.

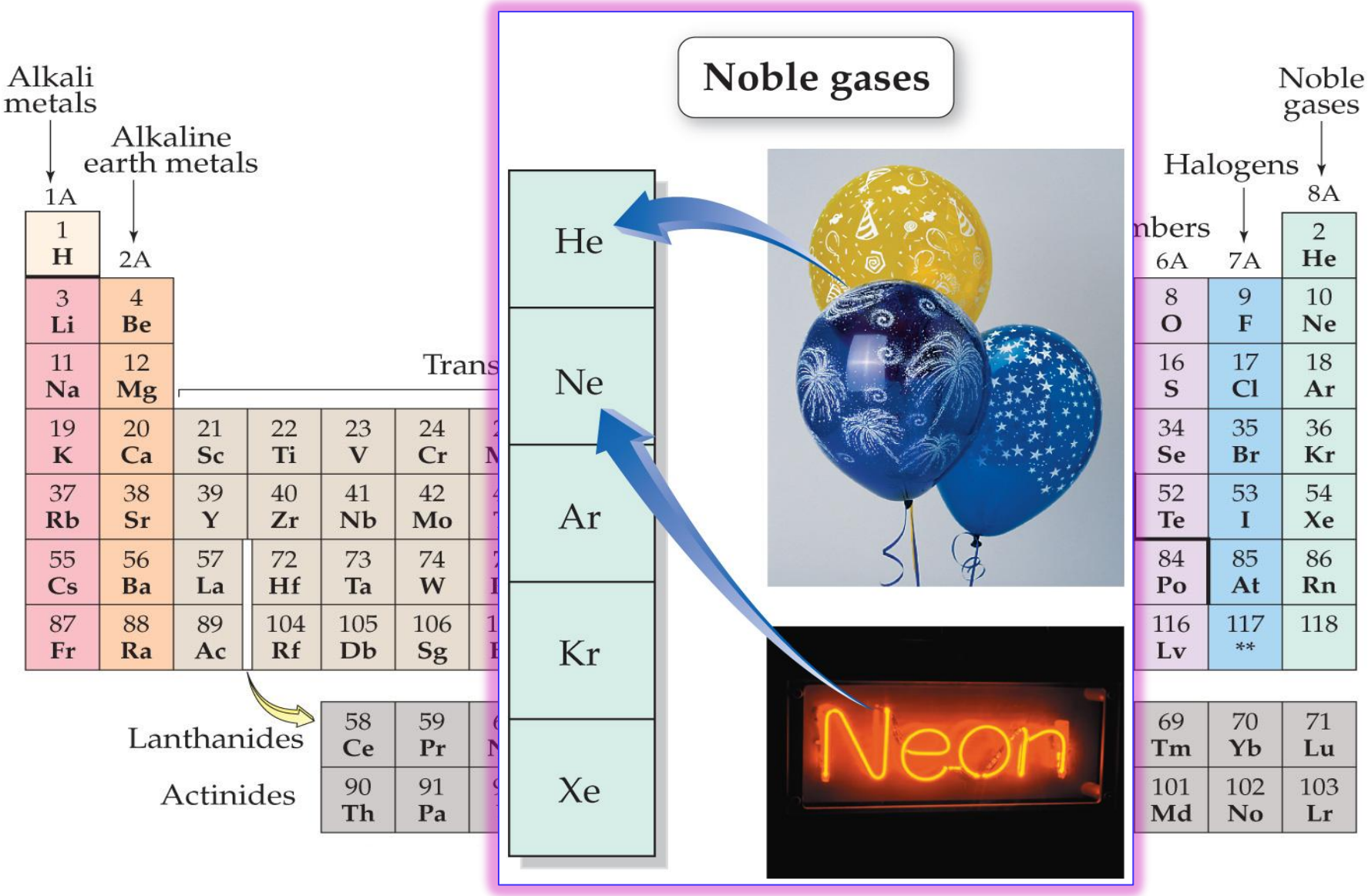
$CuFeS_2$
Chalcopyrite
"Fool's gold"

Groups 7A Halogens



The word "halogen" means "salt former" or "salt maker". When halogens react with metals, they produce a wide range of salts.

Groups 8A Noble Gases



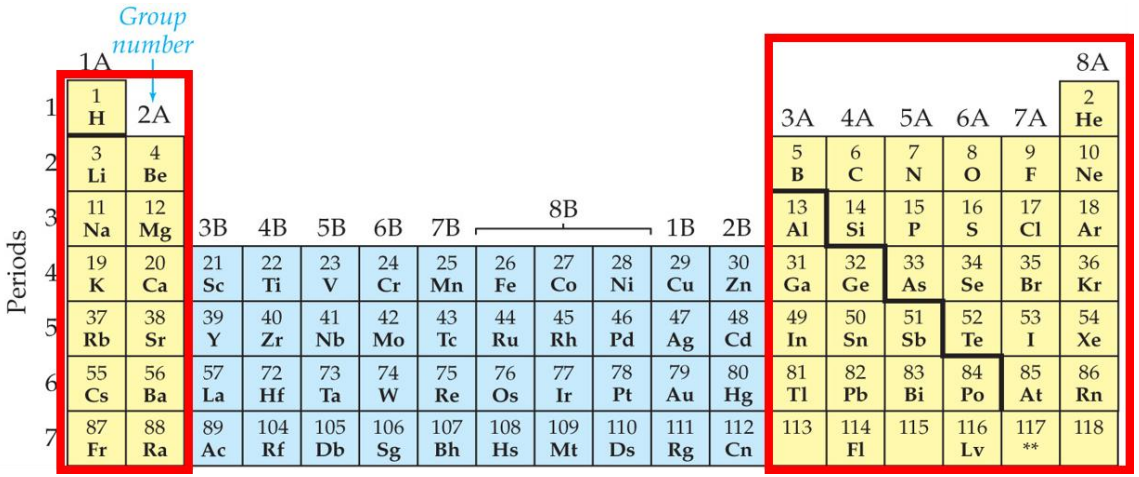
Practice Self-Exercise

1. Atoms of each of the following elements are essential for life. Give the group name for the following elements:

- Calcium
- Chlorine
- Sodium
- Sulfur

2. Give the group name for each of the following elements:

- Krypton
- Selenium
- Barium
- Lithium



Chapter Unit 2.6

Ionic and Molecular Compounds

Atom

Protons, neutron and electrons

Protons = # Electrons

Atoms are neutral / uncharged particles

Ion

Protons, neutron and electrons

Protons ≠ # Electrons

Ions are charged particles

Cations vs Anions

Cation – positively charged particle (atom has lost one or more electrons)

Ex: $Li \rightarrow Li^+ + 1e^-$ Lithium ion charge = 1+

Anion – negatively charged particle (atom has gained one or more electrons)

Ex: $F + 1e^- \rightarrow F^-$ Fluorine ion charge = 1-

Ion Charge = # protons - # electrons

Valence Electrons

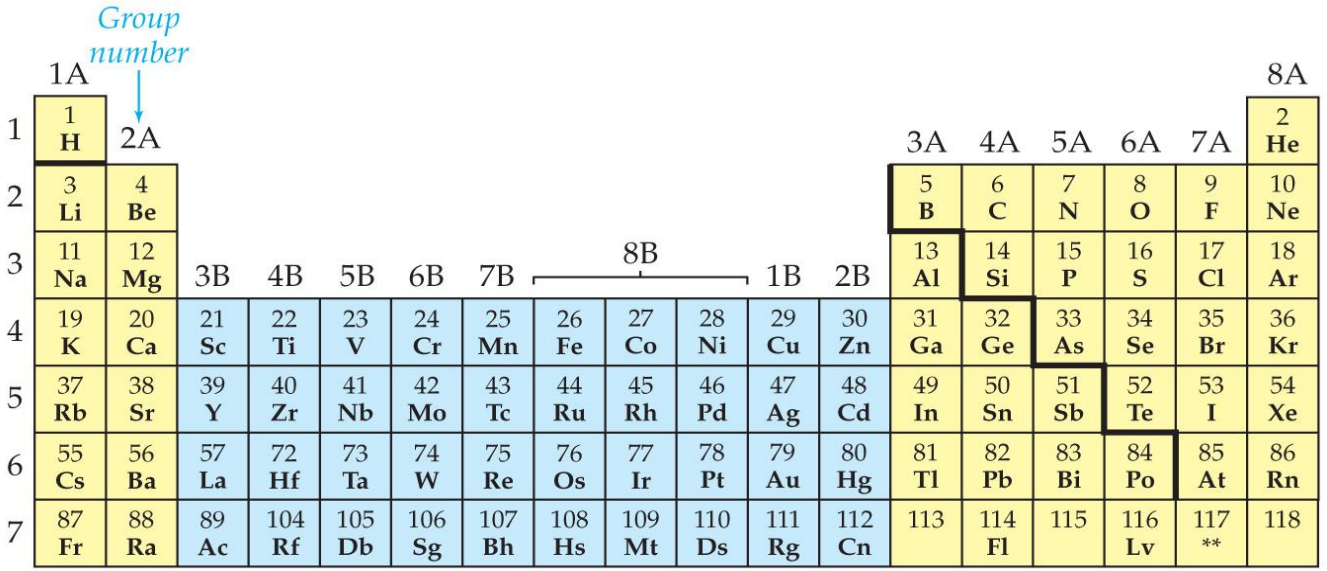
Valence electrons: located in the outer most shell of an atom.

have the highest energy of all electrons in an atom.

responsible for the **reactivity** and other properties of an atom.

Main Group Elements have same number of valence electrons as their group number (column)

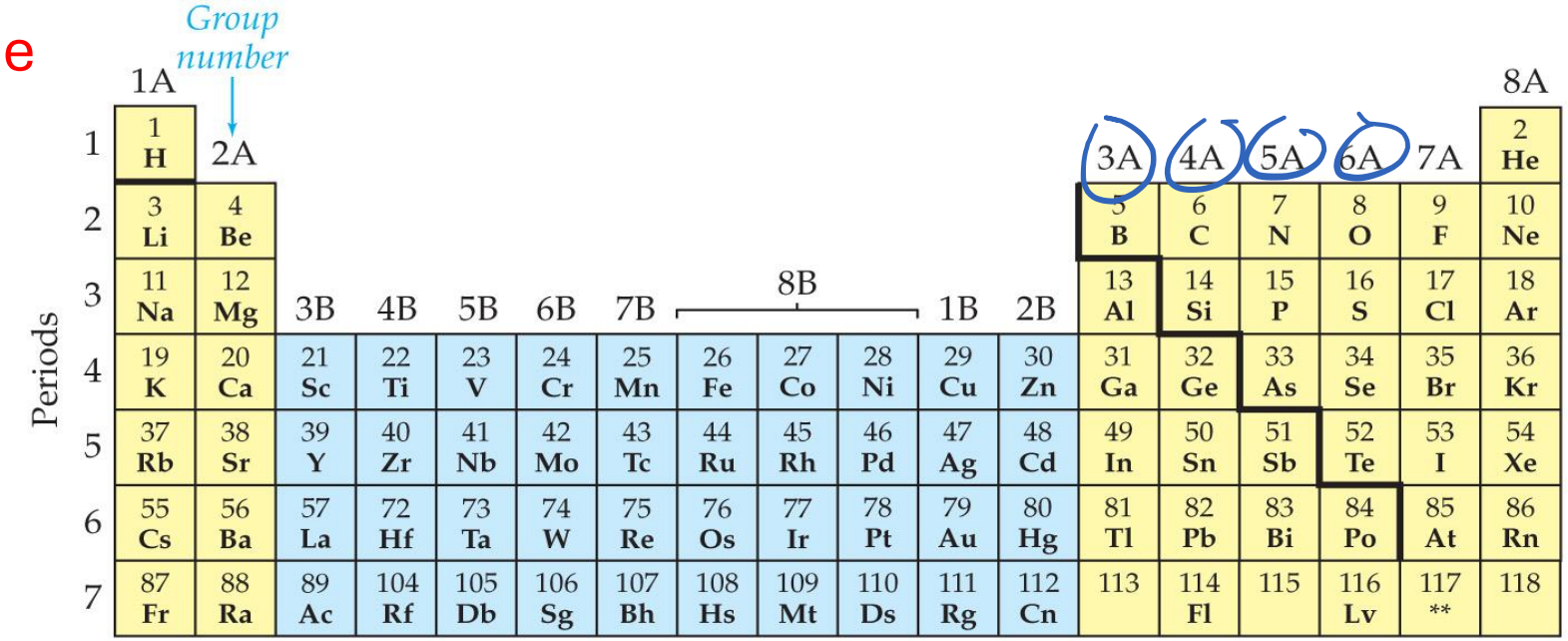
Li has 1 valence e^-, Be has 2 valence e^-, B has 3 valence e^-, …



Ions & Periodic Table

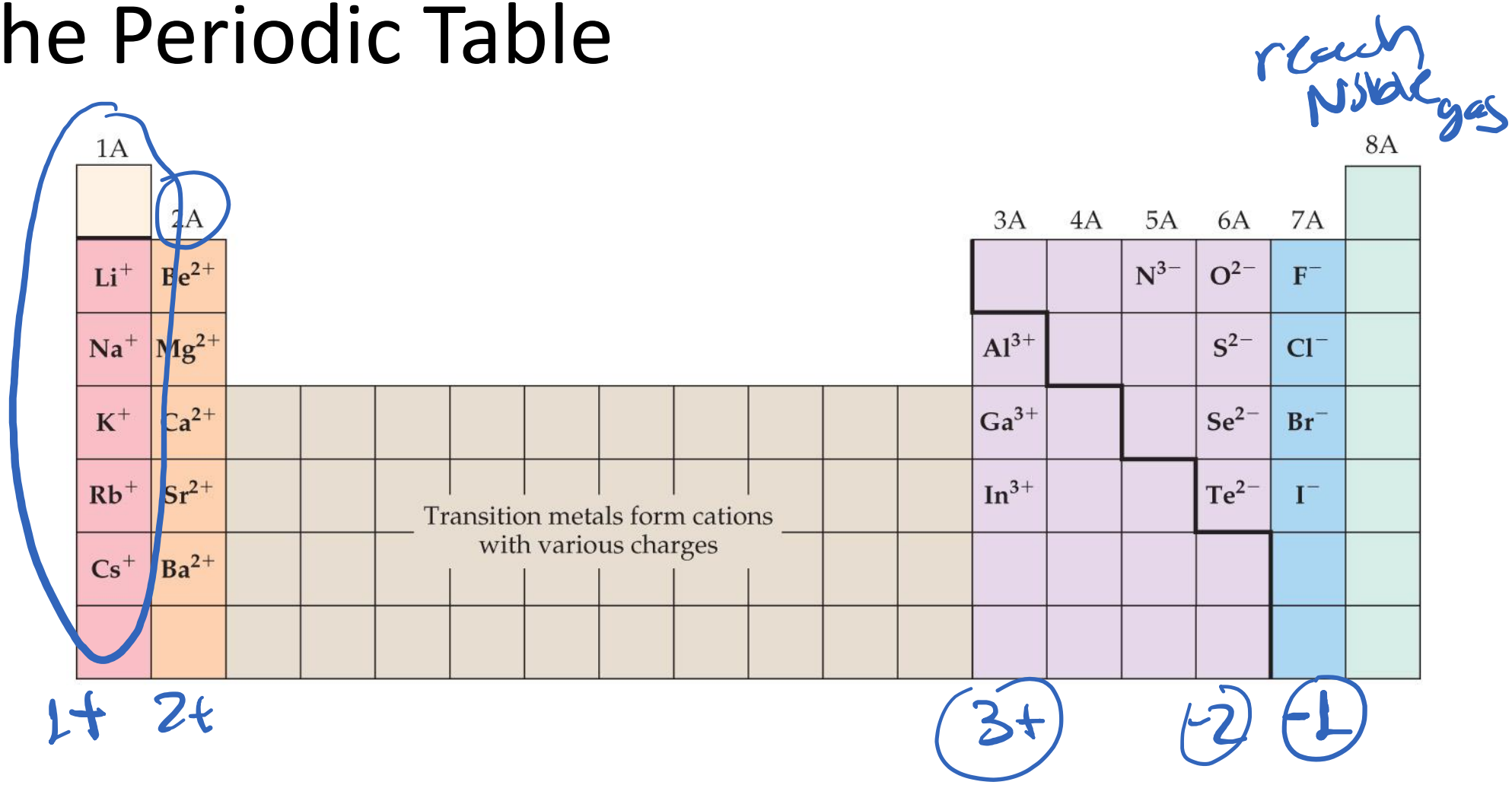
Main group elements tend to form ions that have the same number of **valence electrons** as the nearest noble gas.

- Li tends to lose 1 electron (become Li^+) to become like He
- Be tends to lose 2 electrons (become Mg^{2+}) to become like He
- F tends to gain 1 electron (become F^-) to become like Ne
- O tends to gain 2 electrons (become O^{2-}) to become like Ne



Ions and the Periodic Table

This is a very important slide to study!!!



Ions and the Periodic Table: Practice Exercise

(a) How many protons does potassium (K) have? 19

(b) What type of ion will K normally form? $+1$

(c) Write a reaction showing a K atom forming this ion. $K \rightarrow K^+ + e^-$

(d) What group/family does K belong to? alkali

(e) Determine the charge of a magnesium ion with 10 electrons

10e
2=12 protons neutral ^{12}Mg 12e $\rightarrow$ Mg^{2+}