GENERAL CHEMISTRY STANDARD 4.1

4.1: Use the modern Periodic Table to predict an element's chemical and physical properties

THE PERIODIC TABLE

- First Iteration – 1869 – Dimitri Mendeleev (Russian Chemist)
  - First person to publish the classification of elements
  - Eventually became the Periodic Table
  - Arranged in order of atomic mass NOT atomic number (used today)
  - Elements with similar properties in same horizontal rows
  - Left empty places for future elements to be discovered

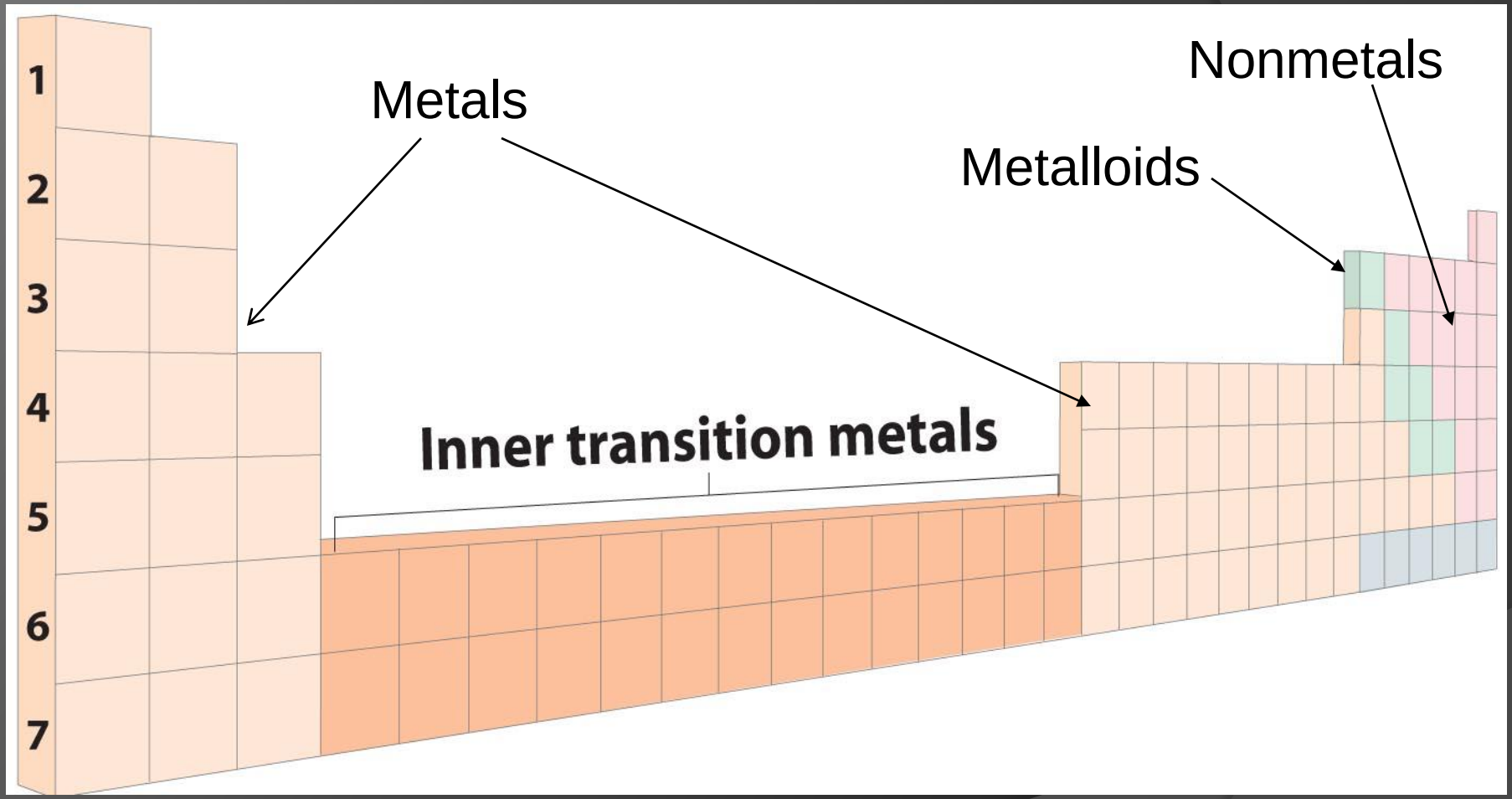
- Several problems with Mendeleev's first Periodic Table
  - Iodine was similar in mass to Tellurium but different properties
  - Iodine was different in mass than Chlorine and Bromine but had similar properties

THE PERIODIC TABLE

- Second Iteration – 1914 – Henry Moseley
  - Arranged elements by atomic number instead of atomic mass
  - Addressed many of the problems of Mendeleev's Table

- **Modern Periodic Law**: The chemical and physical properties of the elements are periodic functions of their atomic numbers
  - **Period**: A horizontal row on the Periodic Table
  - **Group**: A vertical column on the Periodic Table. Also known as a family.
  - Elements in the same group have similar chemical and physical properties
    - Same number of valence electrons (usually)
    - Same oxidation number (usually)
    - Exceptions include transition elements and metalloids

THE PERIODIC TABLE



4.1: Use the modern Periodic Table to predict an element's chemical and physical properties

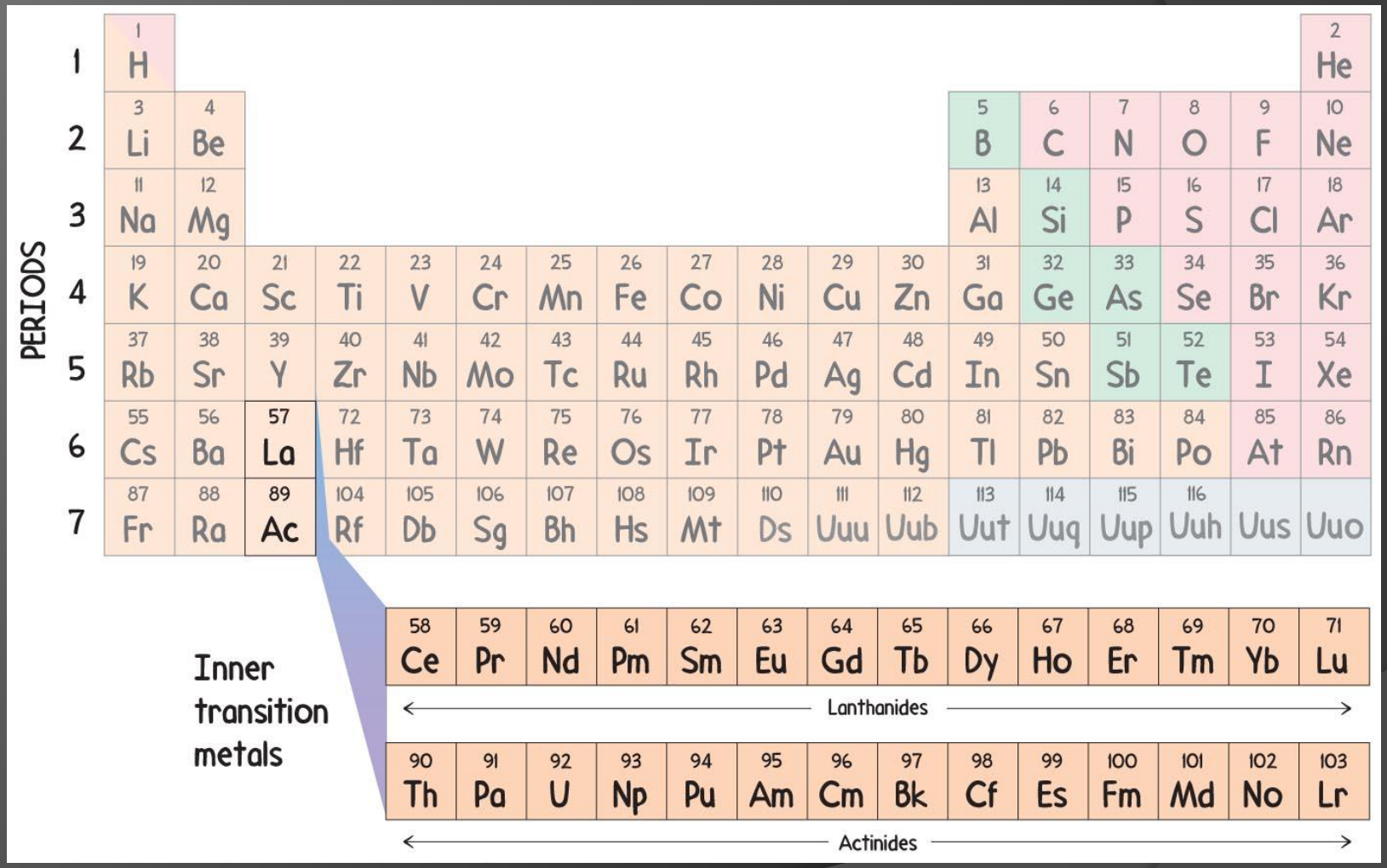
METALS, NONMETALS, METALLOIDS

- Metals
  - An element that is typically hard, opaque, shiny, and has good electrical and thermal conductivity
  - Metals are **malleable** (can be hammered into shape without breaking or cracking) and **ductile** (can be drawn into a thin wire)
- Nonmetals
  - An element that mostly lacks metallic attributes
  - Nonmetals tend to be highly volatile (easily vaporized), have low elasticity, and are good insulators of heat and electricity
- Metalloids
  - An element whose properties are intermediate between those of metals and solid nonmetals. They are electrical semiconductors.
  - Examples include boron, silicon, germanium, arsenic, antimony, tellurium, polonium, and astatine.

METALS AND NONMETALS

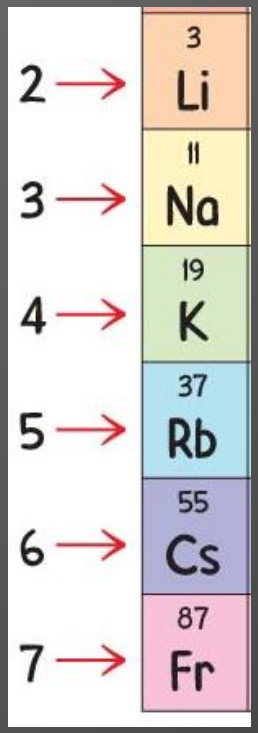
- Metals
  - Easily lose electrons
  - Form positive ions (**cation**) when they lose valence electrons
  - **Valence Electron**: Electrons in the outermost shell of electrons
    - Electrons in the orbital with the highest principal quantum number
    - Can only be located in *s* and *p* orbitals
    - Maximum of eight valence electrons
- Nonmetals
  - Very difficult to lose electrons → tend to instead gain electrons
  - Form negative ions (**anion**) when they gain valence electrons
- **Octet Rule**: Atoms want a full outer shell of valence electrons when bonding (full outermost shell of valence electrons).

LANTHANIDE AND ACTINIDE SERIES



GROUP 1 – ALKALI METALS

- One valence electron
- Form +1 ions
- NOTE: Hydrogen, a nonmetal, is located in the first column because it has one valence electron.



Reactivity of Alkali Metals

- Increases from top to bottom within the group
- Cesium is so reactive it must be stored in Argon (an inert gas) to avoid reacting with air
- Potassium and Sodium are stored in oil to avoid reacting with air

GROUP 2 – ALKALINE EARTH METALS

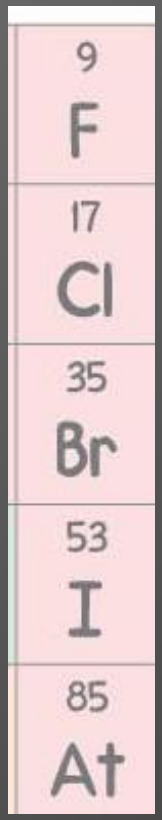
- Two valence electrons
- Form +2 ions

Reactivity of Alkaline Earth Metals

- Increases from top to bottom within the group
- Beryllium does not react with water
- Magnesium reacts with hot water
- Calcium and the heavier Alkaline Earth metals react with cold water (sometimes violently)

GROUP 7 - HALOGENS

- Seven valence electrons
- Form -1 ions



Reactivity of Halogens

- Highly electronegative atoms (high attraction of electrons)
- As atomic mass increases within group, boiling and melting points decrease
  - Fluorine and Chlorine are gases at room temperature
  - Bromine is a liquid at room temperature
  - Iodine and Astatine are solids at room temperature

GROUP 8 – NOBLE GASES

- Eight valence electrons
- Do not form ions – called *inert* for lack of chemical reactivity
-

Reactivity of Noble Gases

- These gases are **inert** – nonreactive
- Very low boiling points – all gases at room temperature
- No odor, color, or flavor under ordinary conditions
- Not flammable