

The Periodic Table

Objectives

- ❑ State the original periodic law proposed by Mendeleev.
 - ❑ Explain how the modern periodic law proposed by Moseley differed from Mendeleev's periodic law.
 - ❑ Classify the elements according to their groups (families) and periods (series) in the periodic table.
 - ❑ Designate a group of elements in the periodic table using both the American convention (IA – VIIA) and the IUPAC convention (1 – 18).
 - ❑ Properly use the following terms in describing an element: Alkali Metal, Alkaline Earth Metal, Halogen, Noble Gas, Representative element, Transition Element, Rare Earth Element, Lanthanide Series, Actinide Series, and Transuranium Element.
-

Objectives

- ❑ Describe the trend in atomic size within a group or period of elements.
 - ❑ Describe the trend in metallic character within a group or period of elements.
 - ❑ Predict the physical properties of an element given the properties of other elements in the same group.
 - ❑ Predict a chemical formula for a compound given the formulas of other compounds containing an element in the same group.
 - ❑ Predict the highest energy sublevel for an element given its position in the periodic table.
 - ❑ Predict the electron configuration for an element given its position in the periodic table.
-

Objectives

- ❑ Predict the number of valence electrons for any representative element.
 - ❑ Draw the electron dot formula for any representative element.
 - ❑ Describe the trends in ionization energy in the periodic table.
 - ❑ Identify the group with the highest ionization energies and the group with the lowest ionization energies.
 - ❑ Predict the ionic charge for any representative element.
 - ❑ Write the predicted electron configurations for selected ions.
-

Precursors to the Periodic Table

Dobereiner (1829) Triads: Li, Na, K
Ca, Sr, Ba
Cl, Br, I

Newlands (1865) Octaves

H	F	Cl	Co,Ni	Br	Pd	I	Pt,Ir
Li	Na	K	Cu	Rb	Ag	Cs	Ti
Be	Mg	Ca	Zn	Sr	Cd	Ba,V	Pd
B	Al	Cr	Y	Ce,La	U	Ta	Th
C	Si	Ti	In	Zr	Sn	W	Hg
N	P	Mn	As	Di,Mo	Sb	Nb	Bi
O	S	Fe	Se	Ru,Rh	Te	Au	Os

Mendeleev's Periodic Table

- ❑ Elements arranged in order of increasing atomic mass.
 - ❑ Elements with similar properties arranged in vertical columns.
 - ❑ Predicted the existence of 3 undiscovered elements.
 - ❑ The periodic table is now arranged in order of increasing atomic number, but the results are almost identical.
-

Periodic Table Terminology

- ❑ Group or Family – The elements in a vertical column of the periodic table.
 - ❑ Period or Series – The elements in a horizontal row of the periodic table.
 - ❑ Alkali Metals – The elements in Group 1: Lithium to Francium.
 - ❑ Alkaline Earth Metals – The elements in Group 2: Beryllium to Radium.
 - ❑ Halogens – The elements in Group 17: Fluorine to Astatine.
 - ❑ Noble Gases – The elements in Group 18: Helium to Radon.
-

Periodic Table Terminology

- ❑ Representative Elements – Elements found in the A groups. Elements with predictable chemical properties.
 - ❑ Transition Elements – Elements found in the B groups. Elements with less predictable chemical properties.
 - ❑ Lanthanide Series or Rare Earth Elements – Elements between Lanthanum and Hafnium. These elements are usually placed below the main body of the periodic table.
 - ❑ Actinide Series – Elements between Actinium and Rutherfordium. These elements are usually placed below the body of the periodic table. They are all radioactive and most do not occur in nature.
-

Periodic Trends

□ Atomic Size:

- The size decreases from bottom to top in a column.
 - There are fewer energy levels in an atom with lower atomic number.
 - Size decreases from left to right in a period.
 - Atomic number and therefore the charge on the nucleus increases. Electrons fill energy sublevels that are all about the same distance from the nucleus so nucleus exerts a stronger force and the size decreases.
-

Periodic Trends

□ Metallic Character:

- Elements on the left side of a period have stronger metallic properties than elements on the right side of a period. Metals react by losing one or more outer electrons. The outer electrons are closer to the nucleus and therefore held more tightly in element on the right side of a period.
 - Elements toward the top of a column have less metallic character than elements near the bottom. Electrons are closer to the nucleus in atoms near the top of a column and therefore are held more tightly.
-

Periodic Trends

□ Physical Properties:

- Density: Density tends to increase from the top of a column to the bottom.
 - Melting Point: Melting points tend follow a pattern from the top of a column to the bottom.
 - Boiling Point: Boiling points tend to follow a trend from the top of a column to the bottom.
-

Periodic Trends

□ Chemical Properties:

- Reaction with oxygen: The elements in a group react with oxygen to form compounds with similar chemical formulas. CaO , MgO , SrO , and BaO or Li_2O , Na_2O , K_2O , Rb_2O .
 - Reaction with water: The elements in certain groups react with water to form compounds with similar chemical formulas. LiOH , NaOH , KOH , and RbOH or $\text{Ca}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$, and $\text{Ba}(\text{OH})_2$.
-

The Basis for the Periodic Table: Filled Energy Levels

- Groups 1 and 2: s sublevels are filled.
 - Groups 13 (IIIA) - 18 (VIIIA): p sublevels are filled.
 - Groups 3 (IIIB) - 10 (IIB): d sublevels are filled.
 - Inner Transition Elements: f sublevels are filled.
-

Valence Electrons

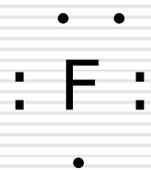
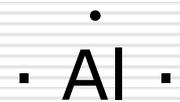
- ❑ Valence Electrons are the electrons in the highest energy level and therefore farthest from the nucleus.
 - ❑ The number of valence electrons is given by the last digit in the group number. (Group 17 has 7 valence electrons for example.)
 - ❑ The number of valence electrons determines the element's properties.
-

Electron Dot Formulas

- Symbol - Represents the core (nucleus plus non-valence electrons).
 - One dot for each valence electron.
 - No more than two dots on each side.
 - Usually one dot is placed on each side before two dots are added to any one side.
-

Electron Dot Formulas

□ Examples:



Trends in Ionization Energy

- ❑ Ionization energy is highest for the noble gases.
 - ❑ Ionization energy is lowest for the alkali metals.
 - ❑ Ionization energy increases from left to right in a period.
 - ❑ Ionization energy increases from bottom to top in a group.
-

Ions

- In general, metals lose electrons and nonmetals gain electrons.
 - Metals lose their valence electrons when they react with nonmetals.
 - Alkali metals lose 1 electron.
 - Alkaline earth metals lose 2 electrons.
 - Group 13 metals lose 3 electrons.
-

Ions

- Nonmetals gain electrons to complete their highest energy level.
 - Halogens gain 1 electron.
 - Group 16 elements gain 2 electrons.
 - Group 15 elements gain 3 electrons.
 - The noble gases do not normally react to form ions.
-

Ionic Charge

- Ionic charge is the charge that an ion has as a result of gaining or losing electrons.
 - Notation: A number written as a superscript to indicate the number of electrons gained or lost and a plus or minus sign to indicate if the charge on the ion is positive (electrons lost) or negative (electrons gained).
-

Ionic Charge

□ Examples:

