Periodic Table

Periodic Law
- For elements arranged in order of increasing atomic number (number of protons) the chemical and physical properties repeat periodically

Valence level or shell
- Outermost energy level

Periods and Groups
- Period – horizontal row (period number tells number of energy levels)
- Group – vertical column (elements have similar properties)

Atomic radius
- Half the distance between adjacent nuclei

First ionization energy (1^{st} IE)
- Energy required to remove the easiest valence electron (from a neutral atom)

Electronegativity (EN)
- Measures ability of an atom to attract electrons in a chemical bond

Allotropes
- Different forms of an element in the same phase
- Examples: C, O, P, S
  - Carbon: diamond, graphite, coal, buckyballs
  - Oxygen: gas (O_2) and ozone (O_3)

Metals
- To the left of the stepped line, lose e^- to form cations (+ ions), cations smaller than atoms, low 1^{st} IE, low EN, metallic luster, malleable, ductile, good conductors, high MP and PB

Nonmetals
- To the right of the stepped line, gain e^- to form anions (– ions), anions larger than atoms, high 1^{st} IE, high EN, nonmetallic luster (not reflective like metals), brittle, poor conductors, low MP and BP

metalloids
- Touch two lines on the steps (except Al is a metal), B, Si, Ge, As, Sb, Te, have characteristics of between metals and nonmetals (some characteristics of both)

Group 1
- Alkali metals, lose 1 e^-, very reactive, low 1^{st} IE, low EN, cations smaller than atoms

Group 2
- Alkaline earth metals, lose 2 e^-, very reactive, low 1^{st} IE, low EN, cations smaller than atoms

Transition metals
- Groups 3-12, multiple oxidation numbers, 2 valence e^- (except Cr and Cu have 1), ions have many bright colors both as solids and in solution

Groups 14-16
- Contain nonmetals at top, metalloids, metals at bottom

Group 17

Halogens, reactive nonmetals, high 1st IE, high EN, $F_{2\,(g)}$, $Cl_{2\,(g)}$, $Br_{2\,(l)}$, $I_{2\,(s)}$

Group 18

Noble gases, very nonreactive, stable octet (except He), all are gaseous at STP

General Periodic Table trends

Groups (going down)

1st IE decreases (more e^- shells, e^- farther from p^+, less attraction, easier to steal)

EN decreases (more e^- shells, e^- farther from p^+ so less attraction)

atomic radius increases (more e^- shells)

atomic mass increases

Group number gives number of valence electrons for 1, 2, and subtract 10 from 13-18

Periods (L to R)

1st IE increases (more p^+, more attraction, harder to steal e^-)

EN increases (more p^+, more attraction for e^-)

atomic radius decreases (more p^+, more attraction for e^-)

atomic *generally* increases (several exceptions Co – Ni and Te – I)

Period number gives number of electron shells

Trends to know:

Metal / nonmetal trends: metallic properties increase down and to the left

Most active metal is Fr in the bottom left corner

Most active nonmetal is F in the upper right corner

Noble gases are stable and mostly nonreactive

Atomic radius trends: atomic radius increases down and to the left

Ionic radius trends: cations are smaller than atoms, anions are larger than atoms

1st ionization energy: increases up and to the right

Electronegativity: increases up and to the right

Reasons trends occur:

Group trends are caused by increasing number of electron shells as atomic number increases

Groups have similar properties because they all have the same number of valence electrons

Period trends are caused by increasing number of protons as atomic number increases

Oxidation states change from + to – as atomic number increases

Number of valence electrons increases as atomic number increases