

Chemical Bonding

Valence Electrons

- Atoms have core and valence electrons.
- Core electrons are closer to the nucleus than valence electrons
- Valence electrons are found in the outer s and p energy subshells
- Valence electrons hold atoms together in a chemical bond

Octet Rule for Valence Electrons

- Atoms combine in a way to attain 8 valence electrons
- Except for hydrogen and helium which have 2 valence electrons

Covalent bonds form by sharing electrons between atoms

- Mixtures of nonmetals form covalent bonds
- Atoms combine to form a molecule
- Molecules consist of atoms and are written as molecular formulas
- Examples

- H₂O – water
- NH₃ – ammonia
- CO – carbon monoxide
- CO₂ – carbon dioxide

Covalent bonds are strong and tend to be more flexible than ionic bonds

Ionic Bonds form by exchanging electrons between atoms

- Metals combine with nonmetals to form ionic bonds
- Atoms combine to form a salt
- Salts consist of a formula unit
- Examples

- NaCl – sodium chloride
- CaCl₂ – calcium chloride

- Metals acquire a positive charge becoming cations Na → Na⁺ or Ca → Ca²⁺
- Nonmetals acquire a negative charge becoming anions Cl → Cl⁻
- Ionic compounds are very strong and brittle
- Ionic bonds consist of ions, cations and anions

Cations

- Metals tend to form cations
- Cations are ions with a positive charge
- Cations result from losing valence electrons
- Na⁺ is a sodium ion (cation)
- Ca²⁺ is a calcium ion (cation)
- Al³⁺ is an aluminum ion (cation)
- Isoelectronic means having the same number of electrons
- Cations form with a charge to be isoelectronic with a previous noble gas
- Na⁺ is isoelectronic with neon, the previous noble gas
- Ca²⁺ is isoelectronic with argon, the previous noble gas
- Sodium, Na, is in Group IA, so it loses one electron becoming +1

Calcium, Ca, is in Group IIA, so it loses two electrons becoming +2
Aluminum, Al, is in Group IIIA, so it loses three electrons becoming +3
Cations are smaller than their corresponding atoms (nucleus attracts e^-)

Anions

Nonmetals tend to form anions
Anions are ions with a negative charge
Anions result from gaining valence electrons
 Cl^- is a chlorine ion (anion)
 O^{2-} is an oxide ion (anion)
 N^{3-} is the nitride ion (anion)
Isoelectronic means having the same number of electrons
Anions form with a charge to be isoelectronic with the next noble gas
 Cl^- is isoelectronic with argon, the next noble gas
 O^{2-} is isoelectronic with neon, the next noble gas
Chlorine, Cl, is in Group VIIA, so it gains one electron becoming -1
Oxygen, O, is in Group VIA, so it gains two electrons becoming -2
Nitrogen, N, is in Group VA, so it gains three electrons becoming -3
Anions are larger in size than their corresponding atoms (e^- repel)

Covalent Bonds

Form when 2 atoms share electrons
Example molecule – hydrofluoric acid
 $H - F$
H, one valence e^- , shares one e^- becoming isoelectronic with helium
F, seven valence e^- , shares one electron becoming isoelectronic with neon

Example molecule – carbon disulfide
 $S = C = S$

S, six valence e^- , share two e^- becoming isoelectronic with argon
C, four valence e^- , shares four e^- becoming isoelectronic with neon