AP CHEMISTRY CHEAT SHEET

Unit 2: MOLECULAR & IONIC BONDING AND STRUCTURE

Quick Overview

- **Focus:** bonding types, molecular geometry, polarity, and lattice energy.
- **Exam Lens:** connect electron configuration → bonding → molecular shape → properties.

Bonding Overview

Atoms bond to lower potential energy and reach stable electron configurations (octet).

- **Ionic bonding:** electron transfer between metal & non-metal; forms ions.
- **Covalent bonding:** electron sharing between non-metals.
- **Metallic bonding:** delocalized electrons in a "sea of electrons."

Mini formula box

Coulomb's Law:
$E = k(q_1q_2)/r$

Stronger charge or smaller radius → stronger attraction.

Ionic Bonds

- **Formed between cations (+) and anions (-).**
- **Lattice energy (U):** energy released when ions form a solid.
  $U \propto (\text{charge}_1 \times \text{charge}_2)/\text{distance}$.
- **Properties:** high melting point, brittle, conduct when molten or dissolved.

Mnemonic: "Charge tightens, size loosens" → higher charge or smaller ions = stronger lattice.

Hybridization

Orbitals mix to form equivalent hybrid orbitals.

- sp → linear (2 domains)
- sp^2 → trigonal planar (3)
- sp^3 → tetrahedral (4)
- sp^3d → trigonal bipyramidal (5)
- sp^3d^2 → octahedral (6)

Mnemonic: "Number of domains = number of letters in hybrid."

Common exam pitfalls

- **Forgetting that lattice energy increases with charge magnitude, not atomic size alone.**
- **Drawing wrong total valence electrons in Lewis structures.**
- **Mixing up electron geometry (based on domains) and molecular geometry (based on atoms).**
- **Misapplying hybridization (count lone pairs!).**

Population Ecology

- **Bond order = (# shared electron pairs).**
  Single < Double < Triple (in strength).
- **Bond energy ↑, bond length ↓ as order increases.**
- **Polarity:** difference in electronegativity (ΔEN).
  $\Delta EN < 0.4$ → nonpolar 0.4–1.7 → polar >1.7 → ionic.

Mini formula box

Bond dipole moment (μ) = $q \times r$

↑ distance or charge difference → ↑ polarity.

Lewis Structures & Resonance

Steps:

1. Count total valence electrons.
2. Place least EN atom center (except H).
3. Form bonds, distribute remaining e^- to satisfy octet.
4. Check for formal charge = valence − (nonbonding + ½ bonding).
   Lowest formal charges → most stable.

- **Resonance:** multiple valid Lewis structures → delocalized e^-.
- **Example:** O_3, NO_3^-, SO_3.

Molecular Polarity

- **Polar if bond dipoles don't cancel.**
- **Nonpolar if geometry is symmetric.**
  Examples:
  CO_2 → nonpolar (linear) H_2O → polar (bent)
  CH_4 → nonpolar (tetrahedral).

Visual Tip: Draw arrows toward more EN atoms; if they sum to zero → nonpolar.

Network & Metallic Solids

- **Network covalent:** atoms covalently bonded in 3D lattice (C, SiO_2).
  High melting point, hard, poor conductors.
- **Metallic:** lattice of positive ions + delocalized e^-; conduct, malleable, ductile.