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**IDX G9 Chemistry S+ STUDY GUIDE ISSUE 6**

**By Winson and Kelvin**

**8.5 Drawing Lewis Structures**

**Key Concepts**

Steps to Draw Lewis Structures

Step 1: Calculate total valence electrons.

Step 2: Identify the central atom (least electronegative).

Step 3: Connect atoms with single bonds.

Step 4: Complete octets for outer atoms.

Step 5: Assign remaining electrons to the central atom.

Step 6: Use multiple bonds if the central atom lacks an octet.

**Formal Charge**

Formula:

Formal Charge = Valence e⁻ − (Bonding e⁻/2 + Nonbonding e⁻)

Best structure: Minimize charges; place negative charges on electronegative atoms.

Examples

CO₂:

O=C=O

(Formal charges: C=0, O=0)

NO₃⁻:

O=N-O⁻

(Resonance structure with double bond shifting)

**8.6 Resonance Structures**

**Key Concepts**

Definition: Multiple valid Lewis structures for a molecule or ion due to delocalized electrons.

Resonance Hybrid: Actual structure is an average of all resonance forms.

Evidence: Bond lengths/bond energies are intermediate between single/double bonds.

**Examples:**

O₃ (Ozone):

O=O-O ↔ O-O=O

(Both O-O bonds are 1.28 Å, shorter than single but longer than double)

CO₃²⁻ (Carbonate):

O=C-O⁻₂ ↔ two other resonance forms with double bond shifting

**8.7 Exceptions to the Octet Rule**

**1. Odd Number of Electrons**

Molecules with unpaired electrons (e.g., NO, ClO₂).

Example:

NO: N has 5 e⁻, O has 6 e⁻ → total 11 e⁻ (odd).

Lewis structure: N=O with one unpaired electron on N.

**2. Fewer Than 8 Electrons (Incomplete Octet)**

Elements like B and Be may form compounds with fewer than 8 electrons.

Example:

BF₃: B has 6 electrons (three single bonds to F).

Can accept a lone pair to form BF₄⁻.

**3. Expanded Octet**

Elements in Period 3+ (e.g., P, S, Cl) can use d orbitals to hold >8 electrons.

Examples:

PCl₅: P has 10 electrons (five single bonds to Cl).

SF₆: S has 12 electrons (six single bonds to F).

Practice Questions

Draw Lewis structures for:

SO₄²⁻

HCN

ClO₂⁻

Identify resonance structures for:

SO₂

NO₂⁻

Classify exceptions to the octet rule:

XeF₄

AlCl₃

NO