- **Examples:**
    - **Water (H_2O):** Bent structure, extensive H-bonding
    - **Ozone (O_3):** Resonance hybrid with partial π-character

2. Sulfur (S):

- **Limited pπ-pπ bonding**
- **Catenation** (S-S bonds common)
- **Uses d-orbitals**
- **Example: Sulfuric acid (H_2SO_4)**
- S=O bonds: dπ-pπ character

3. Selenium and Tellurium:

- Increasing metallic character
- Semiconductor properties

GROUP 17: HALOGENS

1. Bonding Characteristics:

- **High electronegativity**
- Form both covalent and ionic bonds
- **Oxidation states:** -1 to +7 (except F, max 0)
- **Examples:**
    - **Interhalogens (ClF, BrF_3, IF_7):** Various hybridizations
    - **Polyhalides (I_3^-):** 3c-4e bonding
    - **Hypohalous acids (HOX):** Polar O-H bond

2. Fluorine (F):

- **Highest electronegativity**
- **Small size** allows strong bonds
- **Limited oxidation states** (only 0 and -1)
- No d-orbital participation

GROUP 18: NOBLE GASES

1. Bonding (in compounds):

- **Xenon** forms maximum compounds
- **Hybridization:** sp^3d, sp^3d^2, sp^3d^3

- **Examples:**
    - **XeF_2:** Linear (sp^3d)
    - **XeF_4:** Square planar (sp^3d^2)
    - **XeF_6:** Distorted octahedral (sp^3d^3)

4. Special bonding phenomena in p-block elements

A. INERT PAIR EFFECT

Definition: Reluctance of ns^2 electrons to participate in bonding in heavier elements

Examples:

1. **Tl(I) vs Tl(III):** Tl^+ more stable than Tl^{3+}
2. **Pb(II) vs Pb(IV):** Pb^{2+} more stable than Pb^{4+}
3. **Bi(III) vs Bi(V):** Bi^{3+} more stable than Bi^{5+}

Reason:

- Poor shielding by d- and f-electrons
- Increased effective nuclear charge
- Relativistic effects in heavy elements

- **B. HYBRIDIZATION AND GEOMETRY**
- **Common Hybridizations in p-Block:**

Hybridization	Geometry	Examples
sp	Linear	CO_2, C_2H_2, $BeCl_2$
sp^2	Trigonal planar	BF_3, SO_3, NO_3^-
sp^3	Tetrahedral	CH_4, NH_4^+, SO_4^{2-}
sp^3d	Trigonal bipyramidal	PCl_5, SF_4
sp^3d^2	Octahedral	SF_6, PF_6^-
sp^3d^3	Pentagonal bipyramidal	IF_7

- **C. RESONANCE AND DELOCALIZATION**

Important Examples:

1. Carbonate Ion (CO_3^{2-}):

- **Resonance hybrid** of three equivalent structures
- **π-electron delocalization** over three O atoms
- All C-O bonds equal length (intermediate between single and double)

2. Benzene (C_6H_6):

- **Aromatic system** with delocalized π-electrons
- **Hückel's rule:** 4n+2 π-electrons (n=1)

3. Borazine ($B_3N_3H_6$):

- **"Inorganic benzene"**
- Delocalized but polarized π-system
- $B^{+}\delta$-$N^{-}\delta$ polarity reduces aromaticity

D. HYDROGEN BONDING

In p-Block Elements:

1. **With N, O, F:**
    - Strong hydrogen bonds
    - **Example:** Water, ammonia, HF
2. **With other elements:**
    - Weaker hydrogen bonds possible
    - **Example:** C-H···O, N-H···S bonds

Practical applications of bonding concepts

Predicting Properties from Bonding

1. **Melting/Boiling Points:**
    - Covalent network solids: Very high (diamond, SiC)
    - Molecular covalent: Low to moderate
    - Ionic compounds: High
2. **Electrical Conductivity:**
    - Metals: Good conductors
    - Covalent network: Insulators/semiconductors

- Molecular covalent: Insulators

3. **Solubility:**
   - "Like dissolves like" principle
   - Polar compounds dissolve in polar solvents
   - Non-polar in non-polar solvents

4. Synthetic Applications

1. **Designing New Materials:**
   - Semiconductors (Si, GaAs)
   - Superconductors (YBCO)
   - Polymers (silicones, polyphosphazenes)
2. **Catalysis:**
   - Lewis acid catalysts (BF_3, $AlCl_3$)
   - Phosphines as ligands in organometallic catalysts
3. **Pharmaceuticals:**
   - Boron compounds in cancer therapy (BNCT)
   - Organosulfur compounds in drugs

4. 7. SUMMARY TABLE: BONDING PATTERNS IN p-BLOCK

Group	Element	Characteristic Bonding	Example
13	B	Multicenter, electron-deficient	B_2H_6 (3c-2e bonds)
13	Al	Ionic/covalent mix	$AlCl_3$ (dimerizes)
14	C	Strong pπ-pπ, catenation	C_2H_4 (π-bond)
14	Si	pπ-dπ, limited catenation	SiO_2 (network)
15	N	Strong pπ-pπ, lone pair	N_2 (triple bond)
15	P	d-orbital participation	PCl_5 (sp^3d)
16	O	pπ-pπ, H-bonding	H_2O (bent)
16	S	pπ-dπ, catenation	S_8 (crown)

Group	Element	Characteristic Bonding	Example
17	F	High polarity, no d-orbitals	HF (H-bonded)
17	I	Multiple oxidation states	IF_7 (sp^3d^3)
18	Xe	Noble gas compounds	XeF_4 (square planar)

- **Important P-Block Compounds (with Applications)**

1. Boron Compounds (Group 13)

Boric Acid (H_3BO_3)

- Weak monobasic Lewis acid
- Planar structure

Applications

- Antiseptic and eye wash
- Glass and ceramic industry
- Nuclear reactors (neutron absorber)

Borax ($Na_2B_4O_7 \cdot 10H_2O$)

Applications

- Water softening
- Glass manufacture
- Flux in metallurgy

Borazines

- Inorganic analogue of benzene

Applications

- High-temperature ceramics
- Polymer chemistry

Borohydrides ($NaBH_4$)

Applications