CHAPTER 7: Covalent Bond & Molecular Compounds

Part 1: Covalent Bonds

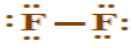
• **Covalent bond:** it's a chemical bond that results from sharing valence electrons.
• Electron-dot diagrams can be used to show valence electrons of atoms. In a Lewis structure, they can represent the arrangement of electrons in a molecule.
• A line or a pair of vertical dots between the symbols of elements represent a single covalent bond in a Lewis structure.
Ex, a hydrogen molecule is written as H—H or H:H.
• ***There is three types of covalent bonds***
o **Single bond:** when one electron gets shared. (**σ** Sigma bonds are single covalent bonds.) 
o **Double bond:** when two electrons get shared. 
o **Triple bond:** when three electrons get shared 
• ***Sigma bonds(σ)***: are strong bond and can form when an s orbital overlaps with another s orbital or a p orbital, or two p orbitals overlap end-to-end.
• ***A pi bond(π):*** represented by the Greek letter pi (π), forms when parallel orbitals overlap and share electrons.
• A multiple covalent bond consists of one sigma bond and at least one pi bond.
• ***Bond length***: The distance between the two bonded nuclei at the position of maximum attraction.
o The shorter the bond length, the stronger the bond.
o As the number of shared electron pairs increases, the bond length decreases.
• ***Bond- dissociation energy:*** The amount of energy required to break a specific covalent and it is always a positive value.
• **Nonpolar covalent bond (or pure covalent):** it means that electrons in bonds between identical atoms have electronegativity difference of zero—meaning that the electrons are equally shared between the two atoms.
Examples: O_2, N_2, H_2
• ***Polar covalent bond:*** is when different elements have different electronegativities, the electron pairs in a covalent bond between different atoms are not shared equally.
• The Greek letter delta (δ) is used to represent a partial charge. In a polar covalent bond, δ - represents a partial negative charge and δ + represents a partial positive charge.

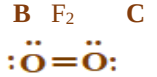
Q1 **When an atom shares electrons with another atom or ion in order to reach the noble gas form a bond form between them called:**
CH 7
A Covalent bond **B** Metallic bond
C Ionic bond **D** Hydrogen bond
Covalent bond: it's a chemical bond that results from sharing valence electrons →A

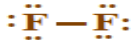
Q2 **Covalent bonds are different from ionic bonds because:**
CH 7
A Atoms in a covalent bond lose to another atom
B Atoms in a covalent bond do not have noble-gas electron configurations
C Atoms in a covalent bond share electrons with another atom
D Atoms in covalent bonds gain electrons from another atom
Covalent bond: it's a chemical bond that results from sharing valence electrons →C

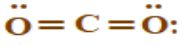
Q3 **Which of the following molecules contains a triple bond? (Atomic number N = 7, O = 8, F =9, Cl = 17)**
CH 7
A Cl_2 **B** F_2 **C** O_2 **D** N_2

→D

4 **Which of the following molecules contains single bond? (Atomic number N = 7, O = 8, F =9, C = 6)**
CH 7
A CO_2 **B** F_2 **C** O_2 **D** N_2

→B

Q5 **Which of the following molecules contains double bond? (Atomic number N = 7, O = 8, F =9, H = 1)**
CH 7
A H_2 **B** F_2 **C** O_2 **D** N_2

→C

Q6 **Which of the following contain sigma bonds only (Atomic number N = 7, O = 8, F =9, C = 6)**
CH 7
A N_2 **B** O_2
C F_2 **D** CO_2

σ Sigma bonds are single covalent →C

Q7 **How many sigma bond and pi bond are in CO_2 (Atomic number N = 7, O = 8, F =9, C = 6)**
CH 7
A 1 sima 2 pi bonds **B** 3 sigma 1 pi binds
C 2 sigma 3pi bonds **D** 2 sigma 2 pi bonds

CO_2 has 2 sigma and 2 pi bonds →D

Q8 **Which of the following is polar covalent bond? (Atomic number O = 8, C = 6, H= 1, Cl = 17)**
CH 7
A Cl-Cl **B** H-O
C C-C **D** H-H
Polar covalent bond: is when different elements have different electronegativities →B

Q9 **Which of the following is non-polar covalent bond? (Atomic number N = 7, O = 8, F =9, C = 6, H= 1, Cl = 17)**
CH 7
A H-Cl **B** H-O
C C-C **D** H-N
Non-polar covalent bond it means that electrons in bonds between identical atoms →C

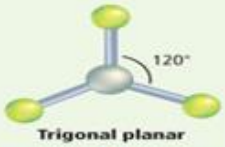
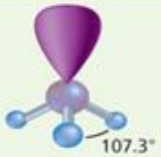
CHAPTER 7: Covalent Bond & Molecular Compounds

Part 2: VSEPR Model

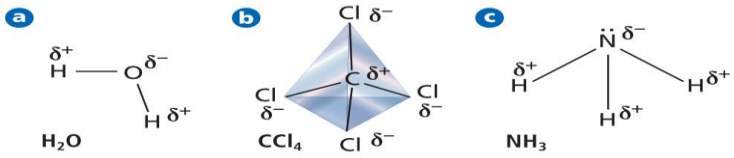
- The shape of a molecule determines many of its physical and chemical properties.
- Molecular geometry (shape) can be determined with the Valence Shell Electron Pair Repulsion model, or VSEPR model which minimizes the repulsion of shared and unshared atoms around the central atom.

Hybridization is a process in which atomic orbitals mix and form new, identical hybrid orbitals.
Carbon often undergoes hybridization, which forms an sp^3 orbital formed from one's orbital and three p orbitals.
Lone pairs also occupy hybrid orbitals.

Molecular Shapes

Molecule	Total Pairs	Shared Pairs	Lone Pairs	Hybrid Orbitals	Molecular Shape*	
$BeCl_2$	2	2	0	sp	 Linear	The $BeCl_2$ molecule contains only two pairs of electrons shared with the central Be atom. These bonding electrons have the maximum separation, a bond angle of 180°, and the molecular shape is linear.
$AlCl_3$	3	3	0	sp^2	 Trigonal planar	The three bonding electron pairs in $AlCl_3$ have maximum separation in a trigonal planar shape with 120° bond angles.
CH_4	4	4	0	sp^3	 Tetrahedral	When the central atom in a molecule has four pairs of bonding electrons, as CH_4 does, the shape is tetrahedral. The bond angles are 109.5°.
PH_3	4	3	1	sp^3	 Trigonal pyramidal	PH_3 has three single covalent bonds and one lone pair. The lone pair takes up a greater amount of space than the shared pairs. There is stronger repulsion between the lone pair and the bonding pairs than between two bonding pairs. The resulting geometry is trigonal pyramidal, with 107.3° bond angles.
H_2O	4	2	2	sp^3	 Bent	Water has two covalent bonds and two lone pairs. Repulsion between the lone pairs causes the angle to be 104.5°, less than both tetrahedral and trigonal pyramid. As a result, water molecules have a bent shape.

- Covalently bonded molecules are either polar or non-polar.
- Non-polar molecules are not attracted by an electric field.
- Polar molecules align with an electric field.



The bent shape of a water molecule makes it polar.

The symmetry of a CCl_4 molecule results in an equal distribution of charge, and the molecule is nonpolar.

The asymmetric shape of an ammonia molecule results in an unequal charge distribution and the molecule is polar.

Q10 The sp^3 hybrid orbital in CH_4 has what shape?
CH 7 **A** Linear **B** Trigonal planar **C** Tetrahedral **D** Octahedral
Tetrahedral →C

Q11 What is the molecular shape of a compound with the hybrid sp orbital?
CH 7 **A** Linear **B** Trigonal planar **C** Tetrahedral **D** Spherical
Linear →A

Q12 Which of the following is a polar molecule?
CH 7 **A** CCl_4 **B** H_2 **C** BH_3 **D** NH_3
NH_3 →D

Q13 The hybridization orbitals and shape of CO_2 is
CH 7 **A** Sp, Bent **B** sp^3, Linear **C** sp^2, Tetrahedral **D** sp, Linear
sp, Linear →D

Q14 Which of the following is nonpolar molecule?
CH 7 **A** $CHCl_3$ **B** H_2O **C** BeH_2 **D** NH_3
BeH_2 →C

Q15 The hybridization of H_2O is
CH 7 **A** sp **B** sp^3 **C** sp^2 **D** sp^3d
sp^3 →B

Q16 The hybridization of NH_3 is
CH 7 **A** sp **B** sp^3 **C** sp^2 **D** sp^3d
sp^3 →B

1 Do it? The hybridization orbitals and shape of BH_3 is
A Sp, Bent **B** sp^3, Trigonal planar **C** sp^2, Trigonal planar **D** sp, Linear

Part 3: Naming Molecular Compounds

Ex. N_2O

- The first element is always named first using the entire element name, N is the symbol for nitrogen.
- The second element is named using its root and adding the suffix -ide, O is the symbol for oxygen so the second word is oxide.
- Prefixes are used to indicate the number of atoms of each element that are present in the compound, There are two atoms of nitrogen and one atom of oxygen so the first word is dinitrogen and the second word is monoxide.

Prefixes in Covalent Compounds

Number of Atoms	Prefix	Number of Atoms	Prefix
1	mono-	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

Formula	Common Name	Molecular Compound Name
H_2O	water	dihydrogen monoxide
NH_3	ammonia	nitrogen trihydride
N_2H_4	hydrazine	dinitrogen tetrahydride
HCl	muriatic acid	hydrochloric acid

Q17 **Give the binary molecular name for water (H_2O)**
CH 7
A Dihydrogen oxide
B Dihydroxide
C Hydrogen monoxide
D Dihydrogen monoxide
Dihydrogen monoxide →D

Q18 **What is the molecular name for hydrazine (N_2H_4)?**
CH 7
A Nitrogen tetrahydride
B Dinitrogen tetrahydride
C Dinitrogen hydride
D Dinitrogen tetrachloride
Dinitrogen tetrahydride →B

Q19 **The formula of dichlorine monoxide is**
CH 7
A Cl_2O_2 **B** Cl_2O
C Cl_3O **D** ClO
Cl_2O →B

Q20 **What is the name of PF_3**
CH 7
A Triphosphorus fluoride
B Triphosphorus trifluoride
C Phosphorus trifluoride
D Phosphorus tetrafluoride
Phosphorus trifluoride →C

Q21 **What is the name of N_2O_4**
CH 7
A Nitrogen dioxide
B Dinitrogen trioxide
C Tetraoxgen dinitride
D Dinitrogen tetraoxide
Dinitrogen tetraoxide →D

Q22 **Which of the following the formula of Triphophorus pentaoxide**
CH 7
A P_5O_3
B P_3O_4
C P_3O_5
D P_2O_5
P_3O_5 →C

2 **What is the name of SF_6**
Do It?
A Hexasulfide fluorine
B Sulfur hexafluoride
C Sulfur pentafluoride
D Disulfuric tetrafluoride

3 **The chemical formula of tetraphosphur octoxide is**
Do It?
A P_2O_4
B P_3O_6
C P_4O_8
D P_8O_4

Chapter 7: Do It Answer key

1	2	3
C	B	C