chem - 11

Polar and Non-Polar Covalent Molecules

Non-Polar covalent Bond - results from a zero difference in electronegativity b/n the bonded atoms. It is a covalent bond with equal sharing of bonding electron pairs.

Eg. The covalent bond in the following molecules: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2, PH_3, etc is non-polar.

Polar covalent Bond - results when atoms having electronegativity differences bond together. Electron pairs are not equally shared. One end of the bond is partially -ve and the other is partially +ve.

Eg. The covalent bond in: HCl, HF, CH_4, NH_3, H_2O, CO_2, etc. In such molecules there is unequal electron density distribution.

* All polar molecules contain polar covalent bonds. Some non-polar molecules can also contain polar covalent bonds.

Eg. $\overset{\delta-}{O}=\overset{\delta+}{C}=\overset{\delta-}{O}$

* The overall polarity of a molecule can be determined by vectorially summing up the polarities of all the bond dipoles in the molecule.

Eg. in CO_2, $\overset{\delta-}{O}=\overset{\delta+}{C}=\overset{\delta-}{O}$, the vector sum of the two bond dipoles is equal to zero. Thus the CO_2 molecule is non-polar molecule.

* Both the shape of the molecule and the polarity of the bonds are necessary to determine whether a molecule is polar or non-polar.

* In all symmetrical molecules (CO_2, BF_3, CCl_4, PF_5, SF_6) the vector sum of the bond dipoles is zero and the molecule is non-polar.

* **Dipole Moment (μ)** - is a measure of molecular polarity. It is defined as the product of partial charges (δ) on the ends of the molecule and the distance b/n them. $\mu = \delta \times d$.

The SI unit of dipole moment is coulomb meter ($C \times m$). The non-SI unit commonly used to express dipole moment is called debye (D).

$1D = 3.33564 \times 10^{-30}$ C.M.

* For non-polar molecules the dipole moment is zero. For polar molecules the dipole moment > 0.

* The polarity of a bond is related to the difference in electronegativities of the bonded atoms.

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The guidelines we apply to decide polarities of bonds:
If the electronegativity difference is 2.0 or greater, the bond is considered ionic. A general rule is that when the electronegativity difference exceeds 1.7, the percent ionic character exceeds 50%. The greater the difference in electronegativities of bonded atoms, the greater is the percent ionic character of the bond.

Exercise

1. Predict the polarity of the following molecules. Include a shape diagram, bond dipoles and the final resultant dipole (if nonzero) of the molecule.
   a) Boron trifluoride, $BF_3(g)$ b) Oxygen difluoride $(OF_2)(g)$
   c) Diboron tetrafluoride, B_2F_4 d) Phosphorus trichloride, PCl_3
   e) Carbon tetrabromide, CBr_4.
2. Rand (inorder of increasing polarity) of the bonds formed b/n O and C, Ca and Cl, N and S, O and Si. Are any of these bonds considered ionic?

Electronegativity of Some Elements

Atoms	EN	Atom	EN
H	2.1	Li	1.0
C	2.5	Na	0.9
N	3.0	Be	1.5
O	3.5	Mg	1.2
F	4.0	Al	1.5
S	2.5	K	0.8
Cl	3.0	Ca	1.0
P	2.1		
Br	2.8		
I	2.4		

3. Classify each molecule as polar or non-polar.
   A) H_2CO B) CH_2Cl_2 C) BH_3 D) CH_3Cl E) NO F) CO
4. Draw Lewis structure for A) CH_3NO_2 B) PF_5 C) SF_4 D) SeF_4

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5. Identify the cpds containing both ionic and covalent bonds.

A) KOH B) KNO_3 C) $LiIO_3$ D) $BaCO_3$

6. Determine what is wrong with each Lewis structure and write the correct structure

A) $\cdot\ddot{N}=\ddot{N}\cdot$ B) $:\ddot{S}-Si-\ddot{S}:$ C) $H-H-\ddot{O}:$ D) $:\ddot{I}-N-\ddot{I}:$ (with $:\ddot{I}:$)

7. Both CO and BCl_3 have zero dipole moments. But $C=O$ and $B-Cl$ moments are not zero. Explain.

Properties of Covalent Compounds and Elements

Covalent cpds and elements are molecular substances. The molecules are held together by weak intermolecular (IMAF) attraction forces. Thus:

- Most of them are gases, some are liquids and few are low melting point soft solids at room temperature.
- have low melting and boiling points.
- Most are soluble in non-polar solvents like CCl_4, C_6H_6, CS_2..
- Polar covalent substances are soluble in water.
- are volatile (have smells).
- Some aqueous polar covalent substances are electrolytes.
- Most covalent substances (aqueous solutions as well as their liquid forms are non-electrolytes.

Molecular Geometry

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