

Lesson 7 (3.3): Polar Bond and Polar Molecules

Table 1 Summary of Chemical Bonds

Ionic bonds	Covalent bonds
form between ions	form between atoms
are created by transfer of valence electrons between atoms to form ions	are created by sharing of pairs of valence electrons between atoms
result in large crystal lattices	result in individual molecules

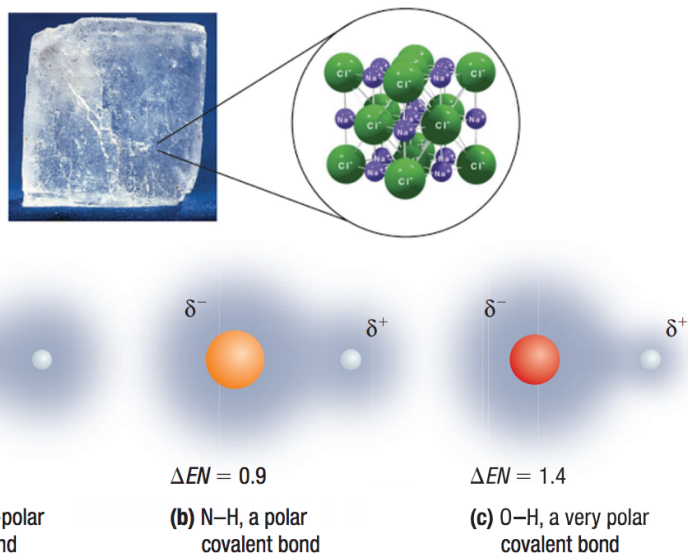


Figure 2 A covalent bond's polar nature depends on the electronegativity difference between the bonding atoms.

Recall:

When two atoms with sufficiently different electronegativities combine, a polar covalent bond or an ionic bond will be formed...BUT –

Not every molecule that has polar covalent bonds is a polar molecule!

In fact, **the dipole moment** (one end of the bond is negative and the other end is positive) created by polar bonds can be cancelled out if the molecular shape is symmetrical give arise to non-polar molecule.

To predict molecular polarity, consider two things:

- 1) the types of bonds in the molecule
- 2) the geometric shape of the molecule

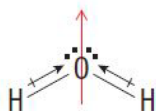


VSEPR Theory (Molecular Shapes)

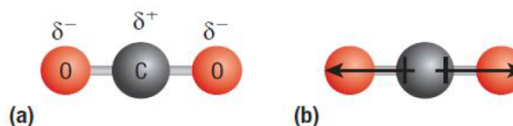
A = the central atom, X = an atom bonded to A, E = a lone pair on A

Note: There are lone pairs on X or other atoms, but we don't care. We are interested in only the electron densities or domains around atom A.

Total Domains	Generic Formula	Picture	Bonded Atoms	Lone Pairs	Molecular Shape	Electron Geometry	Example	Hybridization	Bond Angles
1	AX		1	0	Linear	Linear	H ₂	s	180
2	AX ₂		2	0	Linear	Linear	CO ₂	sp	180
	AXE		1	1	Linear	Linear	CN ⁻		
3	AX ₃		3	0	Trigonal planar	Trigonal planar	AlBr ₃	sp ²	120
	AX ₂ E		2	1	Bent	Trigonal planar	SnCl ₂		
	AXE ₂		1	2	Linear	Trigonal planar	O ₂		
4	AX ₄		4	0	Tetrahedral	Tetrahedral	SiCl ₄	sp ³	109.5
	AX ₃ E		3	1	Trigonal pyramid	Tetrahedral	PH ₃		
	AX ₂ E ₂		2	2	Bent	Tetrahedral	SeBr ₂		
	AXE ₃		1	3	Linear	Tetrahedral	Cl ₂		



- 2 lone pairs
- causes bent structure
- bond dipoles add together to give the water molecule a net dipole
- molecules with net dipoles are POLAR MOLECULES!

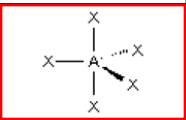
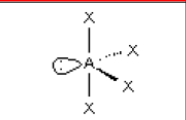
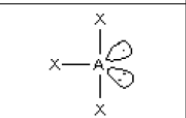
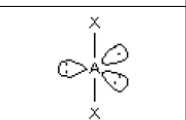
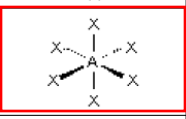
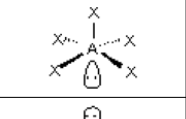
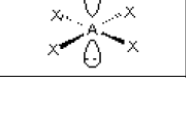


- linear shape
- bond polarities are equal and opposite, so they cancel each other out
- no net dipole
- CO₂ is a NON-POLAR MOLECULE!



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Total Domains	Generic Formula	Picture	Bonded Atoms	Lone Pairs	Molecular Shape	Electron Geometry	Example	Hybridization	Bond Angles
5	AX_5		5	0	Trigonal bipyramid	Trigonal bipyramid	AsF_5	sp^3d	90 and 120
	AX_4E		4	1	See Saw	Trigonal bipyramid	SeH_4		
	AX_3E_2		3	2	T shape	Trigonal bipyramid	ICl_3		
	AX_2E_3		2	3	Linear	Trigonal bipyramid	BrF_2^-		
6	AX_6		6	0	Octahedral	Octahedral	$SeCl_6$	sp^3d^2	90
	AX_5E		5	1	Square pyramid	Octahedral	IF_5		
	AX_4E_2		4	2	Square planar	Octahedral	XeF_4		

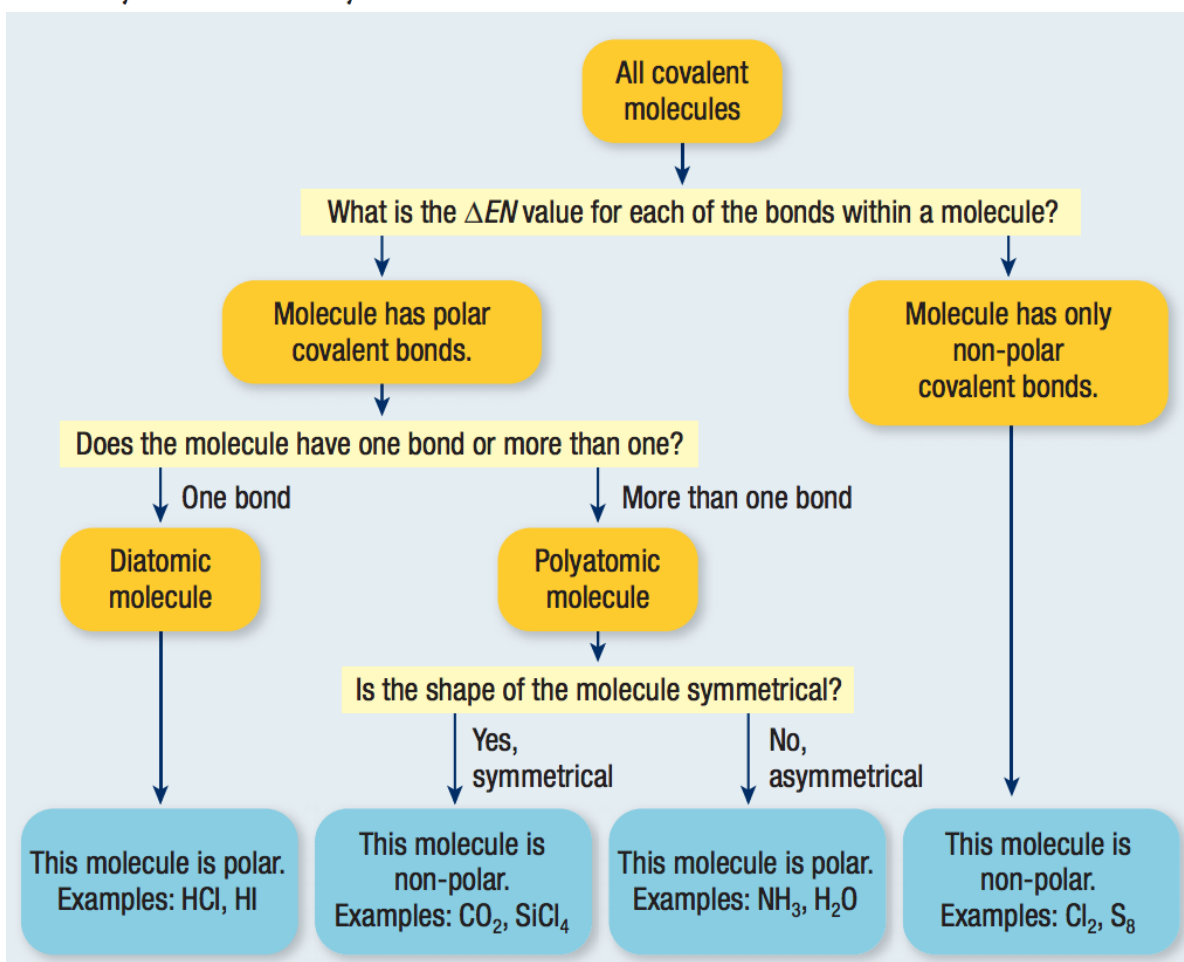
EX. 1: Predict whether tetrafluoromethane, CF_4 , is a polar or non-polar molecule.

EX. 2: Predict whether ammonia, NH_3 , is a polar or non-polar molecule.



3.3 Summary

- Whether a bond is polar covalent or non-polar covalent depends on the electronegativity difference between the two bonded atoms.
- Molecular polarity depends on the polarity of the bonds within the molecule and on the shape of the molecule.
- A diatomic molecule will be polar if the covalent bond is polar and non-polar if the bond is non-polar.
- A polyatomic molecule with only non-polar covalent bonds will be non-polar.
- A polyatomic molecule with several polar covalent bonds will be polar if the molecule is asymmetrical and non-polar if the molecule is symmetrical.
- Molecular diagrams and models help us to visualize whether a molecule is symmetrical or asymmetrical.



Watch it: Polar & Non-Polar Molecules: Crash course Chemistry #23

<https://www.youtube.com/watch?v=PVL24HAesnc>