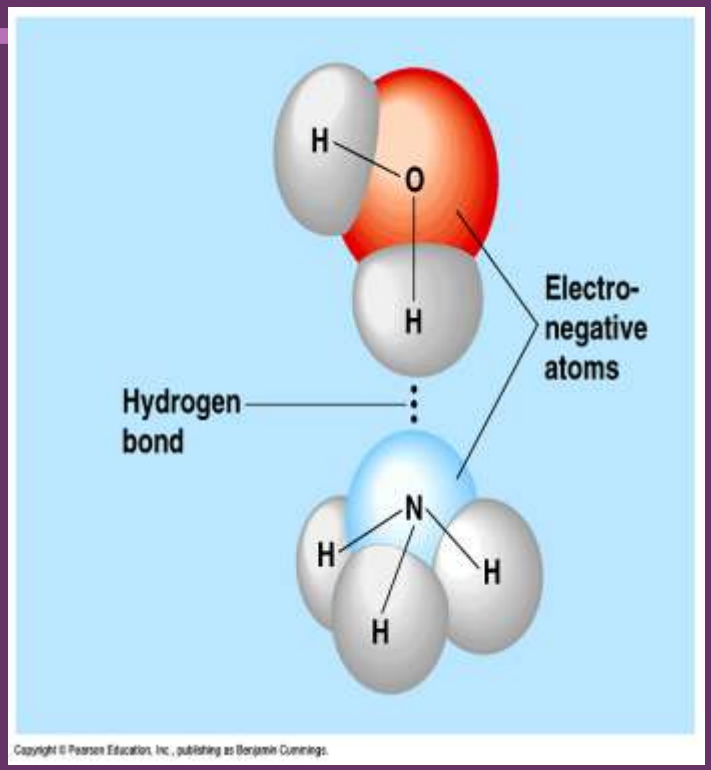


Polarity and Intermolecular Forces

Types of bonds

- **Ionic** – transfer of e- from one atom to another
- **Covalen**t - sharing of e- between atoms

  a) *nonpolar covalent* – equal sharing of e-

  b) *polar covalent* – unequal sharing of e-

Polar bonds and Electronegativity

- Electronegativity is the ability of an atom to attract electrons in a chemical bond
- Polar bonds result when a highly electronegative atom bonds to a less electronegative atom

Determining Polarity

- A covalent bond is polar if there is a significant difference between the electronegativities of the two atoms (see below):

Electronegativity Difference	Type of Bond
0-0.3	Nonpolar covalent
0.4-1.9	Polar covalent
2.0 or greater	Ionic

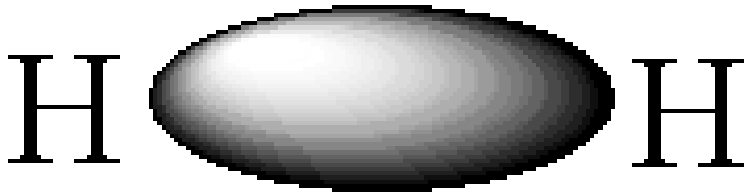
Polar-covalent bonds and Dipoles

Electronegativity of 2.5

Electronegativity of 4.0

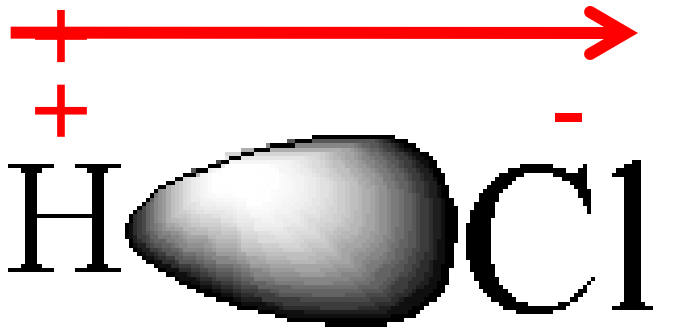
Fluorine has a stronger attraction for the electrons. They are still shared, but spend more time around the fluorine giving partial opposite charges to opposite ends of the bond (a **dipole**)

Nonpolar Bond (no dipole) vs. Polar Bond (dipole)



electrons are evenly distributed

electron cloud



Electrons are polarized toward Cl.

$\chi = 2.1$ $\chi = 3.0$

Showing Polarity of a Bond

$\delta+$ $\delta-$

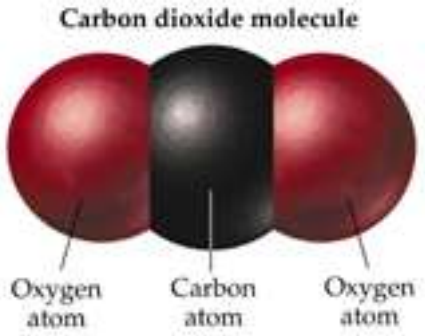
H - F or  H - F

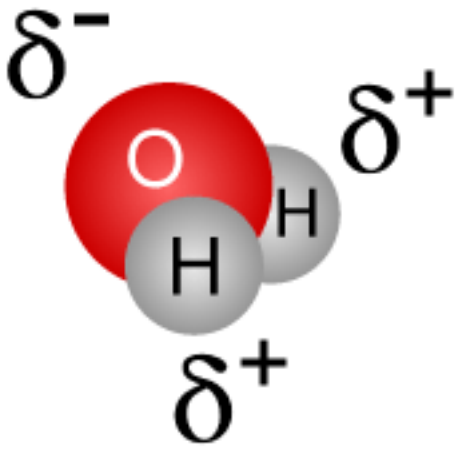
Give the electronegativity difference and determine the bond type in the following molecules

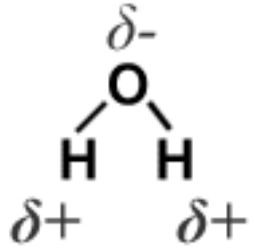
1)	CH_4	1)	polar
2)	HCl	2)	polar
3)	NaF	3)	ionic
4)	$MgCl_2$	4)	ionic
5)	SO_2	5)	polar
6)	NH_3	6)	polar
7)	H_2O	7)	polar
8)	KCl	8)	ionic
9)	CsF	9)	ionic
10)	Cl_2	10)	nonpolar

Determining Polarity of Molecules

- If one end of a molecule is slightly positive and another end is slightly negative the molecule is polar
- Polarity depends on the shape of the molecule
- Ex. CO_2 (nonpolar) and H_2O (polar)



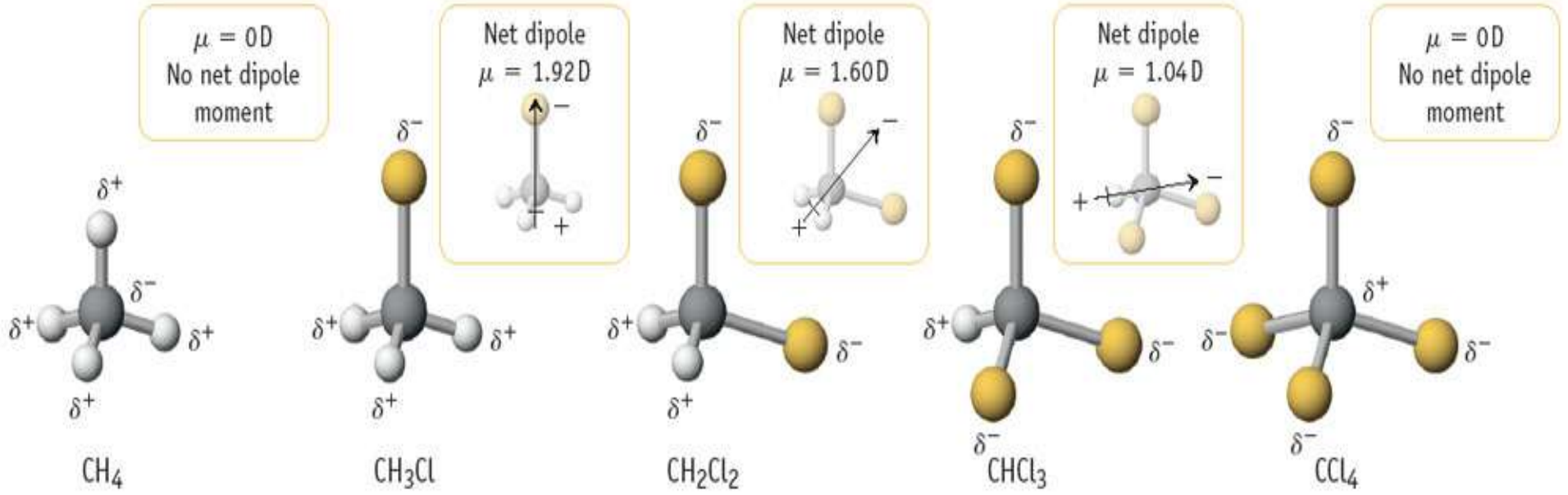


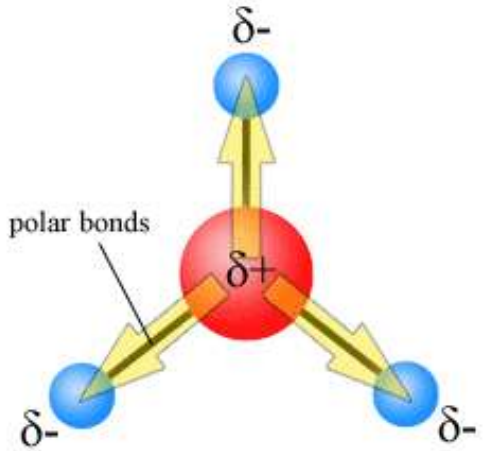


To determine polarity of a molecule you need the following:

- Lewis Structure
- ABE designation and molecular shape (using your chart)
- If surrounding atoms are identical in the following shapes, the molecule has no dipole (it's nonpolar):

  linear, trigonal planar, tetrahedral, trigonal bipyramidal, octahedral, square planar





Boron Trifluoride

Determine the Polarity of the following molecules:

1) Water
2) Carbon tetrachloride
3) Carbon monoxide
4) Carbon dioxide
5) Ammonia (NH_3)
6) Methyl chloride (CH_3Cl)
7) Sulfur dioxide
8) Boron trichloride
9) ICl_4^-

Intermolecular forces – the attractions between molecules

- Determine whether a compound is a solid, liquid or gas at a given temperature (determine melting and boiling points of substances)
- 3 Main Types:

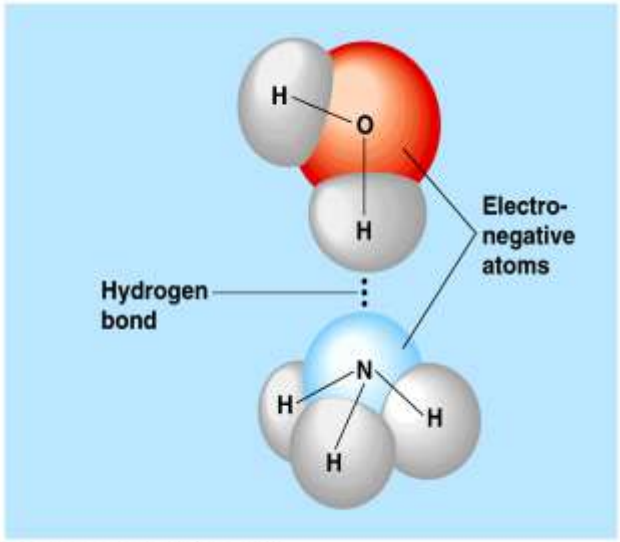
    a) Hydrogen bonding

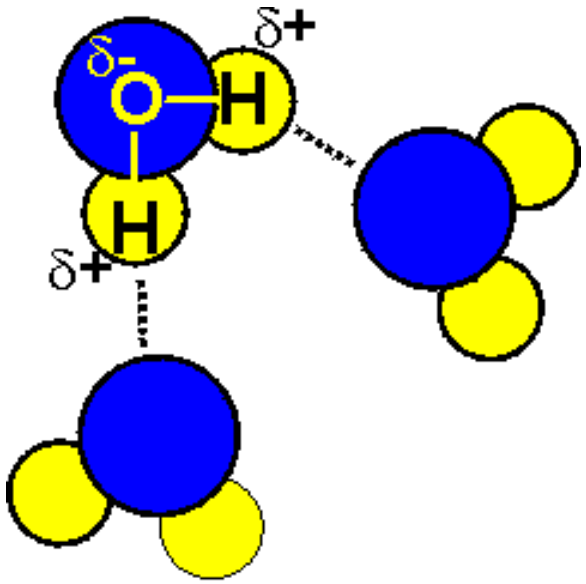
    b) Dipole-dipole interactions

    c) Dispersion forces

Hydrogen Bonding

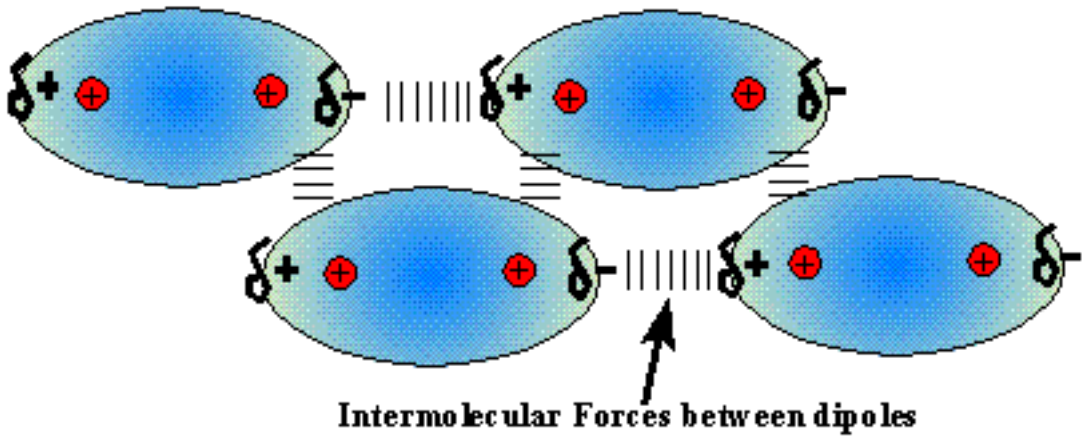
- Attraction formed between the hydrogen atom of one molecule and an electronegative atom of an adjacent molecule (O, N, or F)
- A type of dipole interaction and the strongest intermolecular force





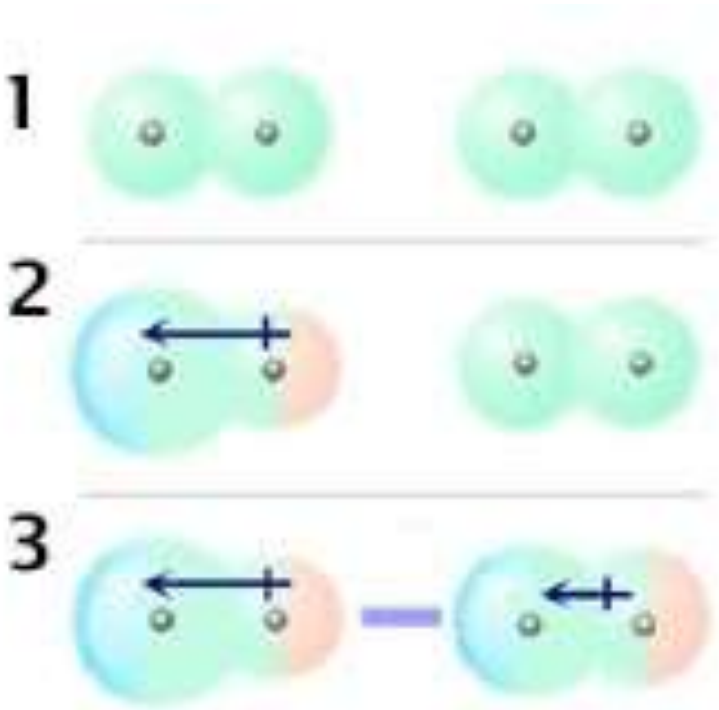
Dipole-dipole interactions

- Dipoles interact by the positive end of one molecule being attracted to the negative end of another molecule (similar to but much weaker than ionic bonds)



Dispersion Forces

- Caused by electron motion. Electrons around one molecule momentarily repel electrons a nearby molecule creating a momentary charge difference
- Can exist between nonpolar molecules as well as polar
- Weakest intermolecular force but increases as the number of electrons increases



Intermolecular forces and melting/boiling point

Stronger intermolecular forces

Weaker intermolecular forces

ion-ion

hydrogen bonding

dipole-dipole

dispersion

Higher melting and boiling points

Lower melting and boiling points