You should be able to draw Lewis structures for molecules and ions. From the Lewis structure, you should be able to apply VSEPR theory and electronegativity to determine whether the bonds and molecules are polar. To review, molecules are polar if they have polar bonds and the molecules are NOT symmetrical. Being able to determine bond and molecular polarity are the keys to success in future chemistry.

Is HCl polar? Is ClF polar?
HCl has an electronegativity difference of 1.1 pointing toward Cl (Cl is more electronegative). ClF has an electronegativity difference of 0.8 pointing toward F (F is more electronegative). Both are polar. We indicate the direction of polarity with an arrow or δ+ and δ- symbols. The polarity is toward Cl in one compound and away from Cl (toward F) in the other.

H–Cl   Cl–F
→   →   Using polarity arrow
δ+ δ-   δ+ δ-   Using δ notation

Both molecules have a permanent dipole moment (polar, dipolar) so these molecules will align in an electric field.

Which one is a polar molecule CO_2 or H_2O? Answer: Both have polar bonds because of the electronegativity difference. CO_2 is not a polar molecule because it has a linear structure from VSEPR theory, while H_2O is a polar molecule because it is bent. Molecular polarity makes a huge difference to physical properties between CO_2 and H_2O. CO_2 is a gas at room temperature and pressure, while H_2O is a liquid. This relates to the melting, boiling, and sublimation points of these substances.

Electronegativity

H 2.1																	He --
Li 1.0	Be 1.6											B 2.0	C 2.6	N 3.0	O 3.4	F 4.0	Ne --
Na 0.9	Mg 1.3											Al 1.6	Si 1.9	P 2.2	S 2.6	Cl 3.2	Ar --
K 0.8	Ca 1.0	Sc 1.4	Ti 1.5	V 1.6	Cr 1.7	Mn 1.6	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.7	Ga 1.8	Ge 2.0	As 2.2	Se 2.6	Br 3.0	Kr --
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.3	Nb 1.6	Mo 2.16	Tc 1.9	Ru 2.2	Rh 2.3	Pd 2.2	Ag 1.9	Cd 1.7	In 1.8	Sn 2.0	Sb 2.1	Te 2.1	I 2.7	Xe --
Cs 0.79	Ba 0.89		Hf 1.3	Ta 1.5	W 2.4	Re 1.9	Os 2.2	Ir 2.2	Pt 2.3	Au 2.5	Hg 2.0	Tl 2.0	Pb 2.3	Bi 2.0	Po 2.0	At 2.2	Rn --
Fr 0.7	Ra 0.89		Rf --	Db --	Sg --	Bh --	Hs --	Mt --	Uun --								
			La 1.10	Ce 1.12	Pr 1.13	Nd 1.14	Pm 1.13	Sm 1.17	Eu 1.2	Gd 1.20	Tb 1.1	Dy 1.22	Ho 1.23	Er 1.24	Tm 1.25	Yb 1.1	Lu 1.27
			Ac 1.1	Th 1.3	Pa 1.5	U 1.38	Np 1.38	Pu 1.36	Am 1.3	Cm 1.3	Bk 1.3	Cf 1.3	Es 1.3	Fm 1.3	Md 1.3	No 1.3	Lr 1.3

Polarity makes a huge difference in physical properties at room temperature:

Molecule	Molar Mass	Polar Molecule	Melting Point	Boiling Point	Sublimation Point
CO_2	44	No	-	-	-78.5°C
H_2O	18	Yes	0°C	100°C	-

H_2O melts at 0°C and boils at 100°C. CO_2 sublimes (goes directly from a solid to a gas) at a much colder temperature (-78.5°C) than water melts. Because CO_2 does not have a liquid state (it doesn't melt) at atmospheric pressure, it is called dry ice. Nonpolar substances are more likely to sublime than they are to melt or boil. We will discuss this more next semester.

Which of these are polar molecules: BF_3, HBF_2, NH_3? All have polar bonds. BF_3 is a nonpolar molecule (because of symmetry) with polar bonds. HBF_2 is a polar molecule with polar bonds. NH_3 is a polar molecule with polar bonds. The pyrimidal shape may look flat on paper, but it is not. In one 3D orientation, the three H groups point down and the lone pair points up. The net pull is up toward nitrogen. The pyrimidal shape arises because the lone pair is on the 4th leg of the tetrahedron (the parent shape). Having the lone pair in that position destroys the symmetry. It may help to build a model, such as in lab.

Is CH_4 polar? The electronegativity difference is 0.5, so the bonds are slightly polar by this definition. (Most chemists consider C-H bonds nonpolar.) Even though the bond is slightly polar, the tetrahedral symmetrical shape causes all polarity to cancel giving a nonpolar molecule. CH_4 is a nonpolar molecule. In fact, all hydrocarbons (contain just C and H) are considered nonpolar by chemists. Any slight polarity cancels because of overall symmetry of the hydrocarbon molecule.

Is CHF_3 polar? There is a polar bond, C-F. The molecule is not symmetrical (polarity is toward the 3 F groups), so the molecule is polar.

The bond order is the number of bonds between a pair of atoms. A single bond has a bond order of 1, while double and triple bonds have bond orders of 2 and 3 respectively. Higher bond orders mean shorter, stronger bonds. A triple bond is shorter and stronger than a double bond, and a double bond is shorter and stronger than a single bond. For example, in C-N, C=N, and CΞN, CΞN(0.116nm) is shorter and stronger than C=N (0.135nm), and C=N(0.135nm) is shorter and stronger than C-N (0.148nm).

Larger nuclei mean longer bonds. H is a smaller atom than Cl, so a C-H single bond (0.10nm) is shorter than a C-Cl single bond (0.18nm).

Shorter bonds also mean stronger bonds, so a C-H bond is stronger than a C-Cl bond in the example above. You are expected to know this because Cl is a larger atom than H.

The energy required to completely break a bond increases with increasing bond strength. A CΞC bond requires 810kJ, a CΞN bond requires 890kJ to break, while a NΞN requires 940kJ to break. A C-H bond requires 430kJ to break, while a C-Cl bond requires 330kJ to break. The ease of breaking a bond may determine which site in a molecule reacts first.