

## Announcements

Monday, April 13, 2009

### Discussion assignment 2:

- Topic reservation due before class today - reserve one ASAP if you have not yet.
- Phase 2: 6-8 paragraph essay - instructions are posted in D2L. Due before class Monday, Apr 27.

**Lecture quiz 3** will be available in D2L before noon Tuesday. It will be due before class next Monday, Apr 20.

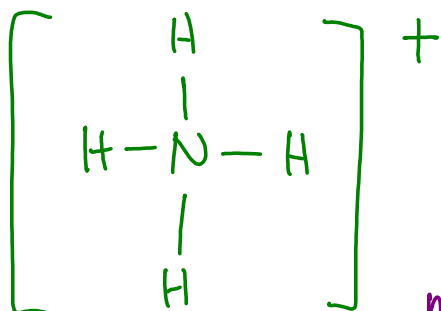
Lec 9 post and Lec 10 pre assignments will be in MC Tuesday before noon - due before class next Mon, Apr 20

# Lewis structures of polyatomic ions

## Polyatomic ion: charged molecule

lose 1 e<sup>-</sup>

NH<sub>4</sub><sup>+</sup> (ammonium ion): tot # ve<sup>-</sup> = 5 + 4(1) - 1 = 8ve



### check:

correct tot. #ve<sup>-</sup>? ✓

full octets/duets? ✓

no longer check # bonds per atom

Polyatomic ions do not follow the rules for the normal number of covalent bonds to atoms (this is one reason they are charged!)

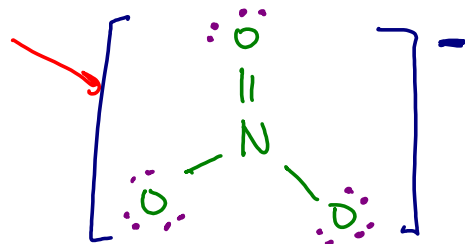
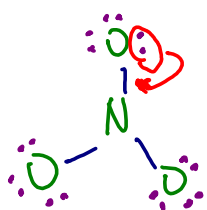
add 1 e<sup>-</sup>

NO<sub>3</sub><sup>-</sup> 5 + 3(6) + 1 = 24 ve total

★ put O's around other element

★ try only single bonds first

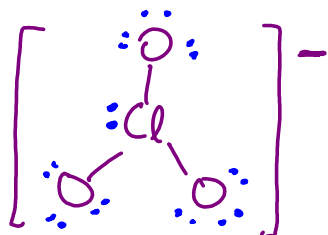
draw 18 dots (around outside first)



total ✓  
octets ✓



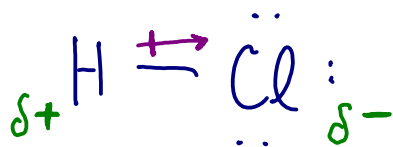
7 + 3(6) + 1 = 26 total



Polar covalent bonds

F: most EN element  
H & C: similar EN

An HCl molecule:



$\delta$  = Greek lowercase delta, means "partial"

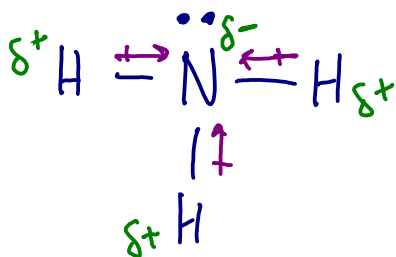
dipole arrow:



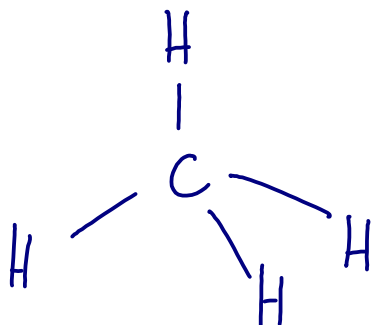
points toward  
more EN atom

NH<sub>3</sub>

3 polar covalent bonds



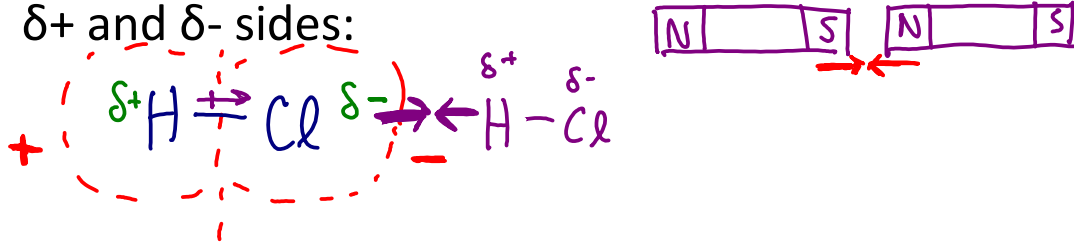
CH<sub>4</sub>



nonpolar covalent bonds  
(C & H: similar)

## Polarity of molecules

HCl is a **polar** molecule because it can be separated into  $\delta+$  and  $\delta-$  sides:



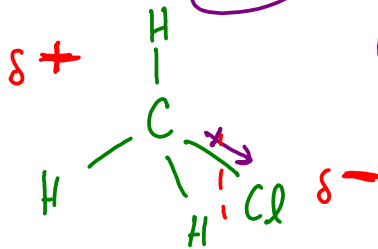
**Net dipole moment:** one dipole arrow that represents the polarity of the entire molecule. It points from the  $\delta+$  side to the  $\delta-$  side.

for HCl:  $\rightarrow$

A **nonpolar** molecule:

- cannot be separated into  $\delta+$  and  $\delta-$  halves
- may have polar bonds that completely cancel each other
- has no net dipole moment

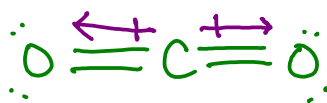
Is  $\text{CH}_3\text{Cl}$  polar or nonpolar?



1 polar bond = polar molecule

net dipole moment:  $\rightarrow$

Is  $\text{CO}_2$  polar or nonpolar? (draw it with the correct shape)



two arrows totally cancel

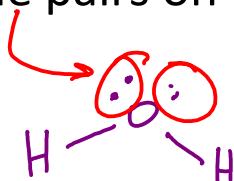
no net dipole moment

## Shapes of molecules

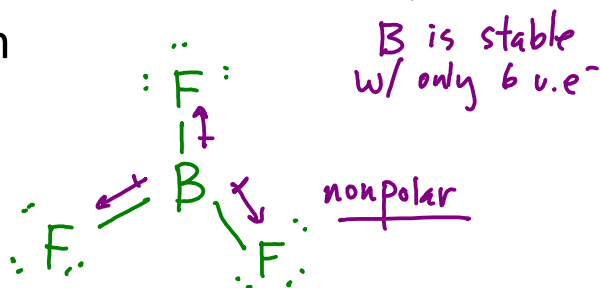
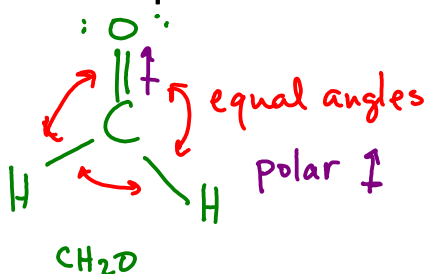
**Linear shape:** 2 atoms attached to the central atom, no lone pairs on the central atom



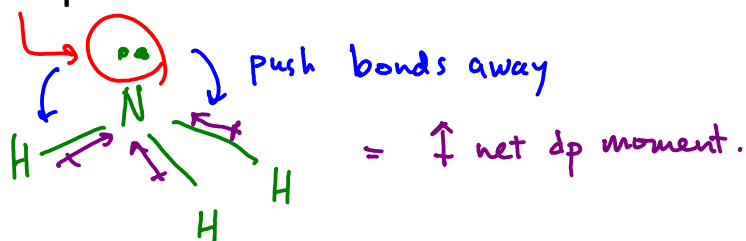
**Bent shape:** 2 atoms attached to the central atom, lone pairs on the central atom



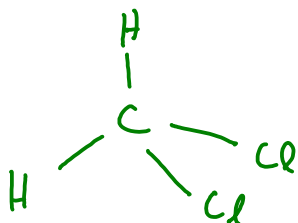
**Trigonal planar shape:** 3 atoms on central atom, no lone pairs on central atom



**Trigonal pyramidal shape:** 3 atoms on central atom, lone pairs on central atom

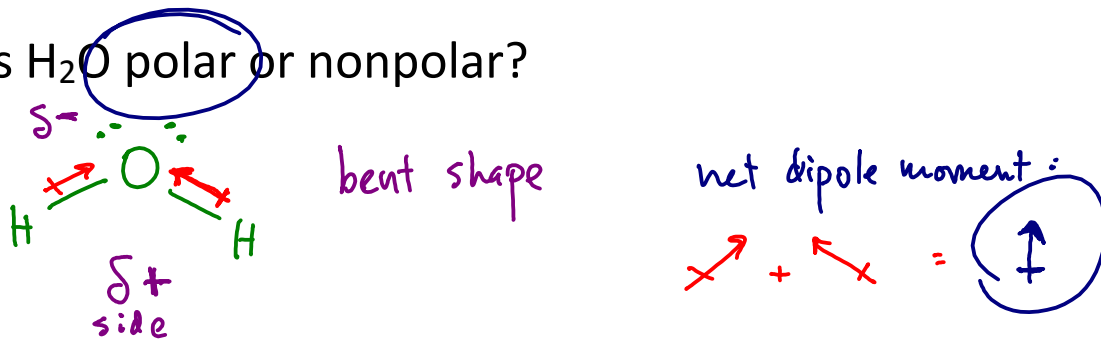


**Tetrahedral shape:** 4 atoms attached to central atom

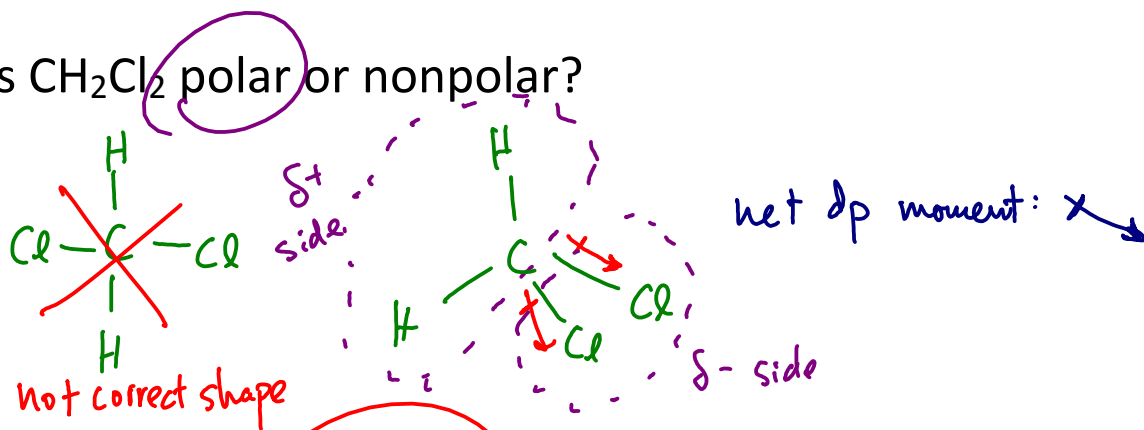


## Polarity of molecules

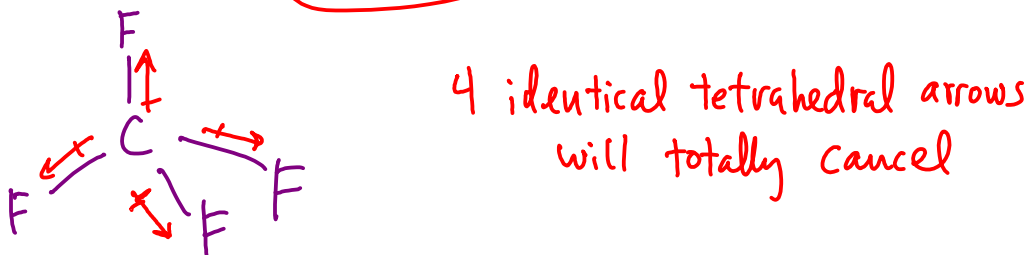
Is  $\text{H}_2\text{O}$  polar or nonpolar?



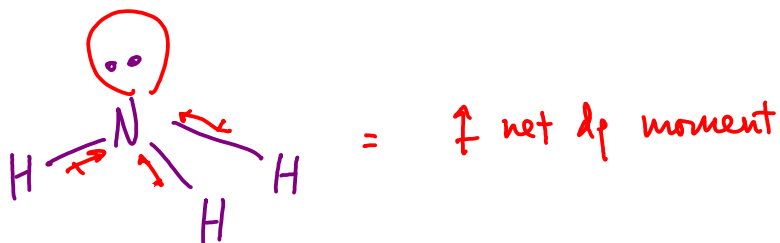
Is  $\text{CH}_2\text{Cl}_2$  polar or nonpolar?



Is  $\text{CF}_4$  polar or nonpolar?



Is  $\text{NH}_3$  polar or nonpolar?



Is  $\text{FCN}$  polar or nonpolar?

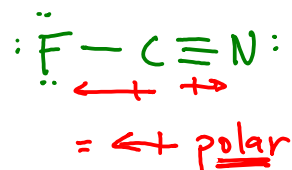
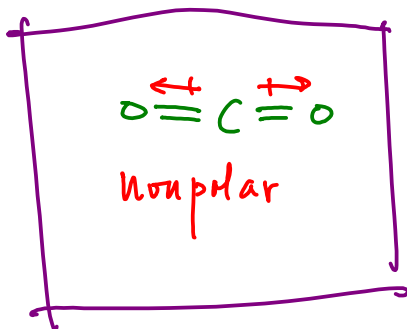


# Shapes and polarity

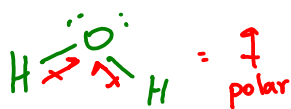
If all bonds have equal polarity:

If bonds have unequal polarities:

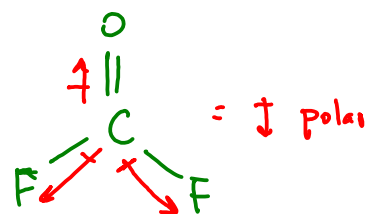
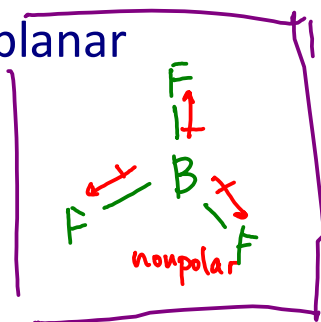
Linear



Bent ↘  
impossible to cancel  
arrows completely



Trigonal planar



Trigonal pyramidal

impossible to cancel arrows completely

★ practice  
w/ models  
lab.

Tetrahedral

