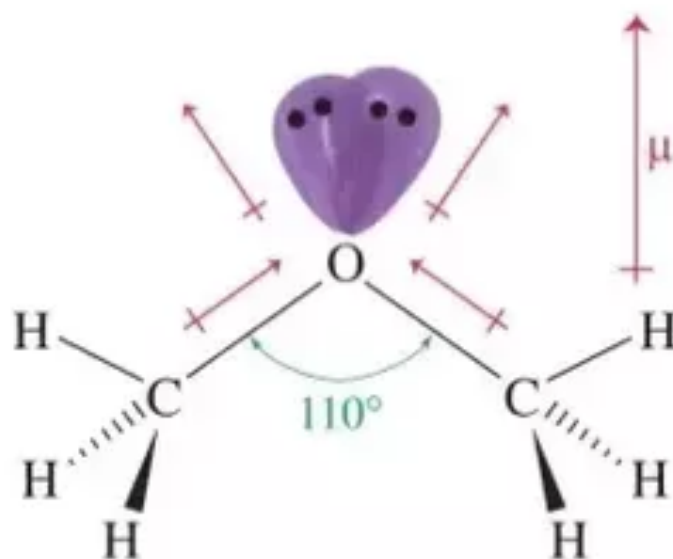


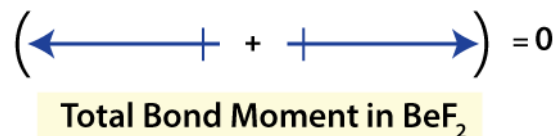
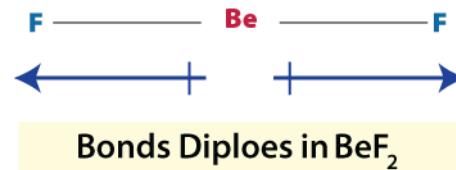
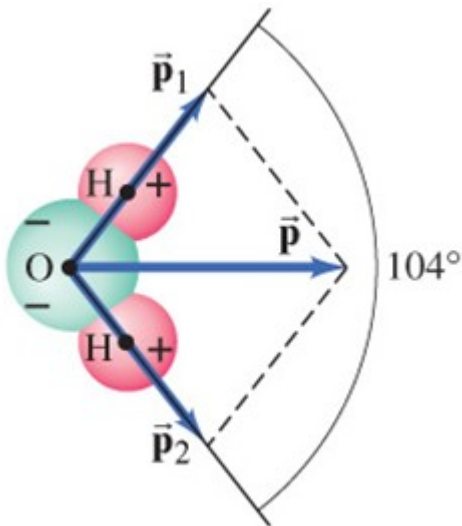
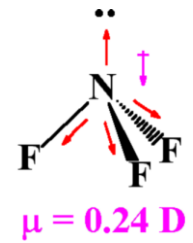
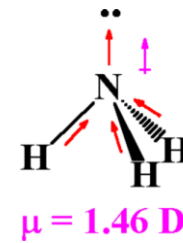
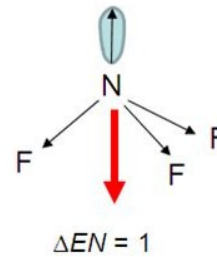
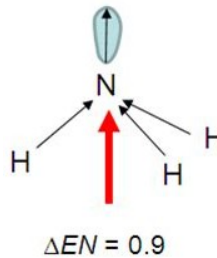
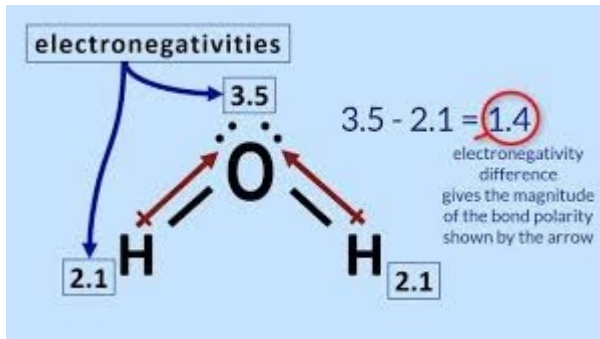
Structure and Polarity

- Oxygen is sp^3 hybridized.
- Bent molecular geometry.
- C—O—C angles is 110° .
- Polar C—O bonds.
- Dipole moment of 1.3 D.

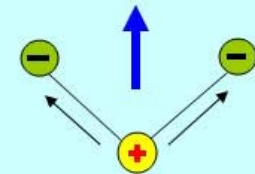


Polarita molekuly, dipólový moment

Dipolový moment molekuly = vektorový součet všech vazebných dipolů. Může být nulový, i v případě nenulových vazebných dipolů které se navzájem kompenzují (např. SF_6 , SiF_4 , CF_4 , ...)



Black Arrows = Dipoles
Blue Arrow = Generated Dipole Moment



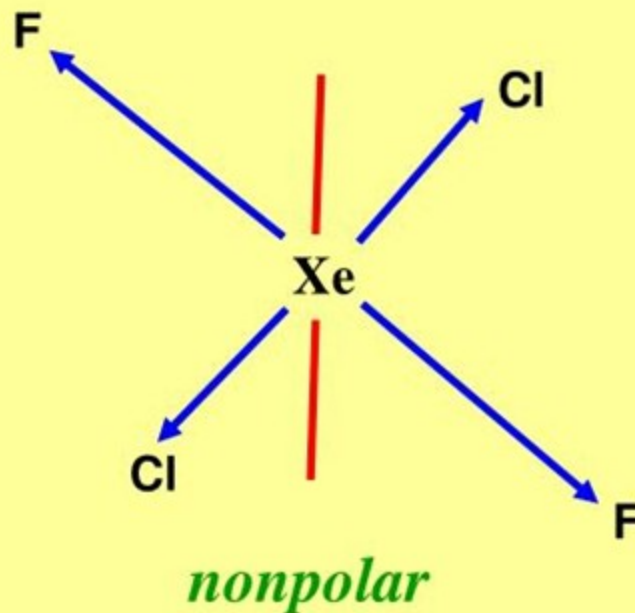
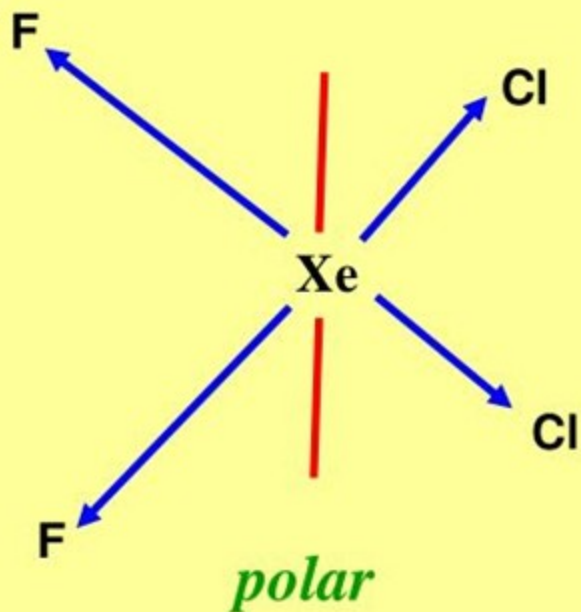
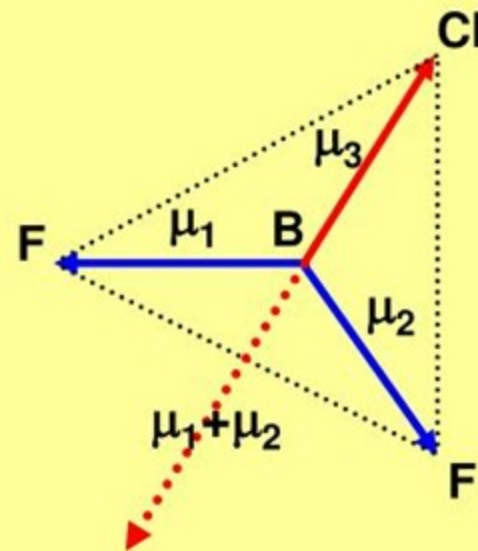
Black Arrows = Dipoles
Dipoles Cancel Each Other Out
Dipole Moment = Zero



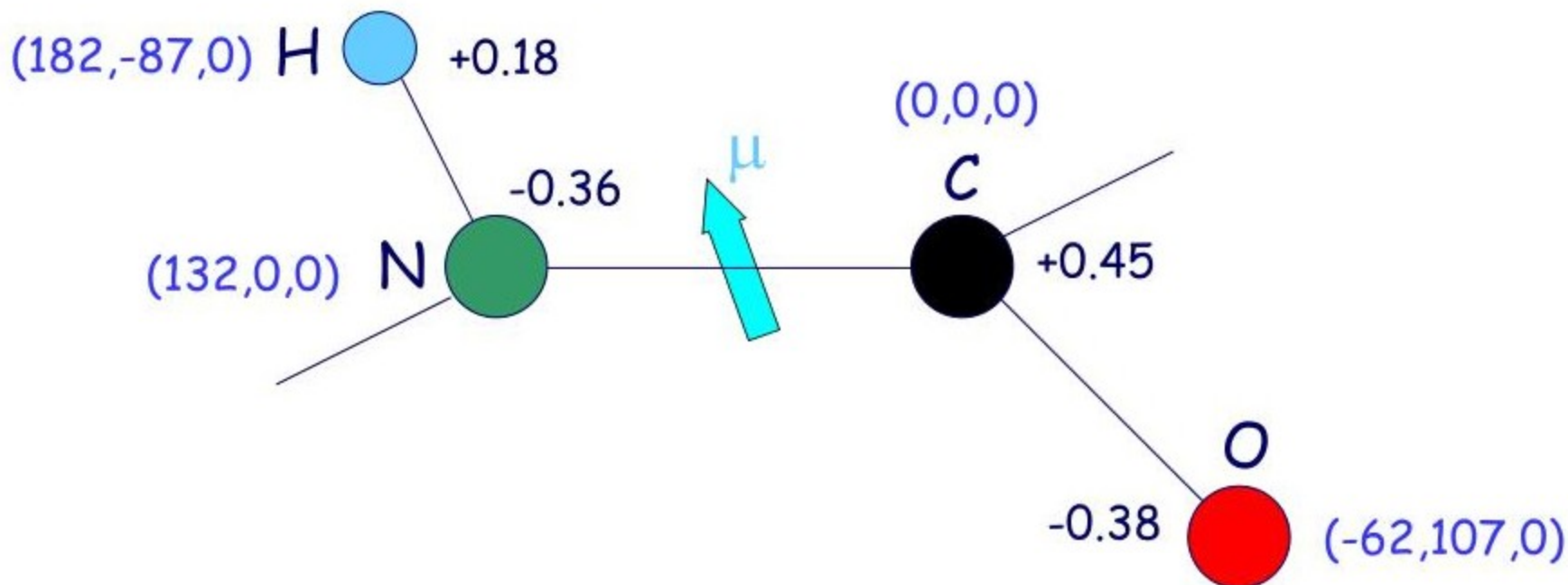
Different ligand atoms



$|\mu_1 + \mu_2| > |\mu_3|$
Net dipole moment $\neq 0$



Calculating a Molecular dipole moment



$$\begin{aligned}\mu_x &= (-0.36e) \times (132 \text{ pm}) + (0.45e) \times (0 \text{ pm}) \\ &\quad + (0.18e) \times (182 \text{ pm}) + (-0.38e) \times (-62 \text{ pm}) \\ &= 8.8e \text{ pm} \\ &= 8.8 \times (1.602 \times 10^{-19} \text{ C}) \times (10^{-12} \text{ m}) \\ &= 1.4 \times 10^{-30} \text{ C m} = 0.42 \text{ D}\end{aligned}$$

Nonpolar



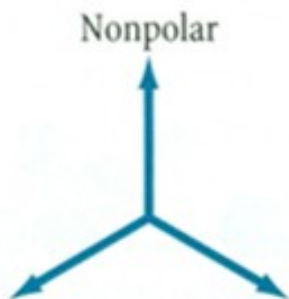
The dipole moments of two identical polar bonds pointing in opposite directions will cancel. The molecule is nonpolar.

Polar



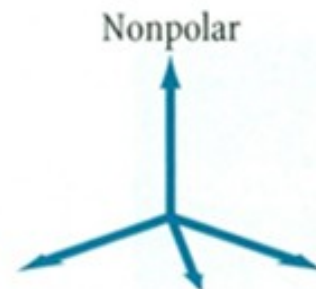
The dipole moments of two polar bonds with an angle of less than 180° between them will not cancel. The resultant dipole moment vector is shown in red. The molecule is polar.

Nonpolar



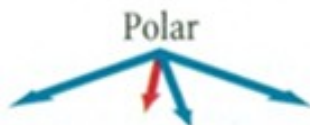
The dipole moments of three identical polar bonds at 120° from each other will cancel. The molecule is nonpolar.

Nonpolar



The dipole moments of four identical polar bonds in a tetrahedral arrangement (109.5° from each other) will cancel. The molecule is nonpolar.

Polar



The dipole moments of three polar bonds in a trigonal pyramidal arrangement (109.5° from each other) will not cancel. The resultant dipole moment vector is shown in red. The molecule is polar.

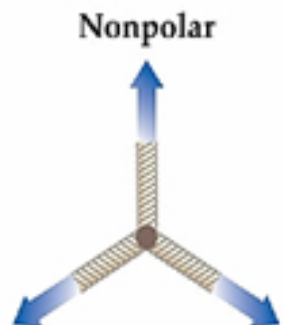
TABLE 10.3 Common Cases of Adding Dipole Moments to Determine Whether a Molecule Is Polar



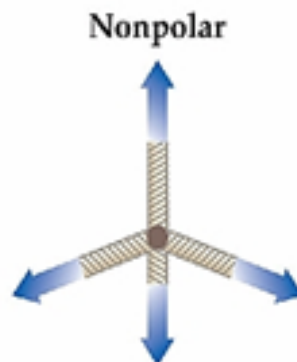
Two identical polar bonds pointing in opposite directions will cancel. The molecule is nonpolar.



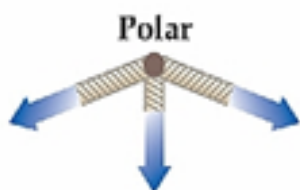
Two polar bonds with an angle of less than 180° between them will not cancel. The molecule is polar.



Three identical polar bonds at 120° from each other will cancel. The molecule is nonpolar.



Four identical polar bonds in a tetrahedral arrangement (109.5° from each other) will cancel. The molecule is nonpolar.

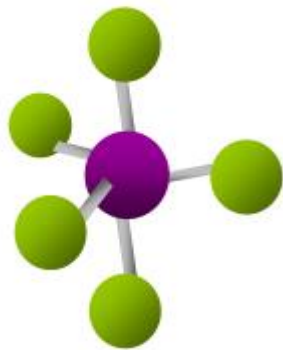


Three polar bonds in a trigonal pyramidal arrangement (109.5°) will not cancel. The molecule is polar.

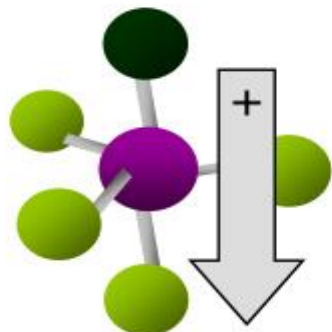
Note: In all cases where the polar bonds cancel, the bonds are assumed to be identical. If one or more of the bonds are different than the other(s), the bonds will not cancel and the molecule is polar.

Molecular Geometry

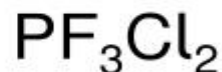
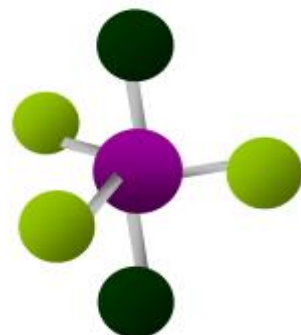
Dipole Moment and Polarity



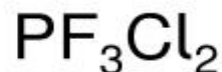
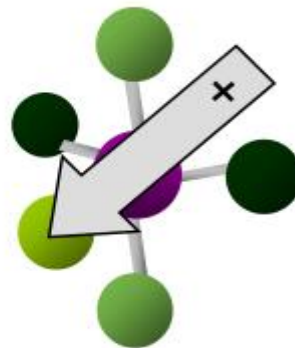
Non polar
VSEPR shape
identical atoms



Polar
VSEPR
shape
atoms differ



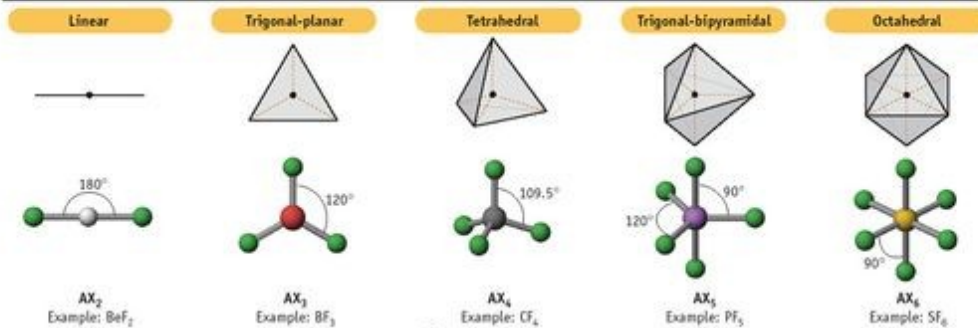
Non polar
Atoms differ. **BUT** can
be divided into
nonpolar VSEPR
shapes:
**linear + triangular
planar**



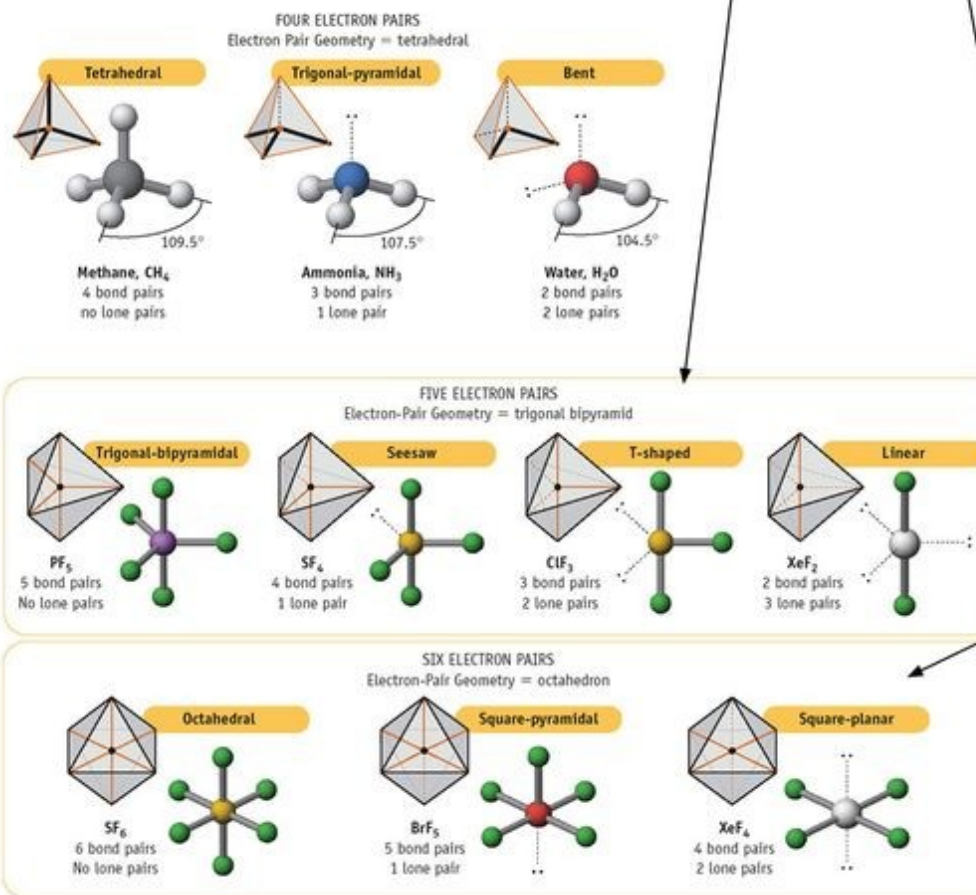
Polar
Atoms differ. Doesn't
divide into nonpolar
VSEPR shapes

Electron Pair Geometries

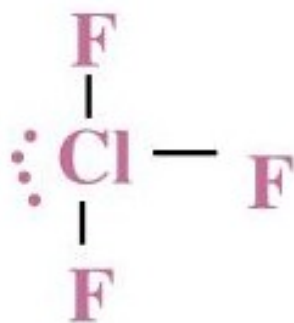
2 Structural Pairs 3 Structural Pairs 4 Structural Pairs 5 Structural Pairs 6 Structural Pairs



Molecular Geometries



Dipole Moment and Molecular Geometry



ClF_3

T-shaped

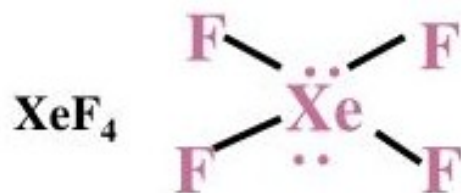
No symmetry \rightarrow polar



SF_4

SeeSaw

No symmetry \rightarrow polar



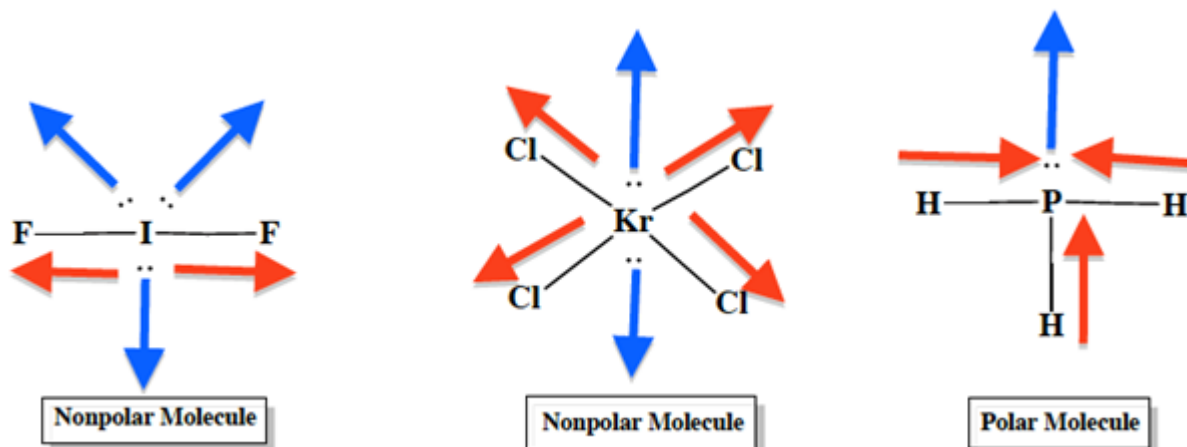
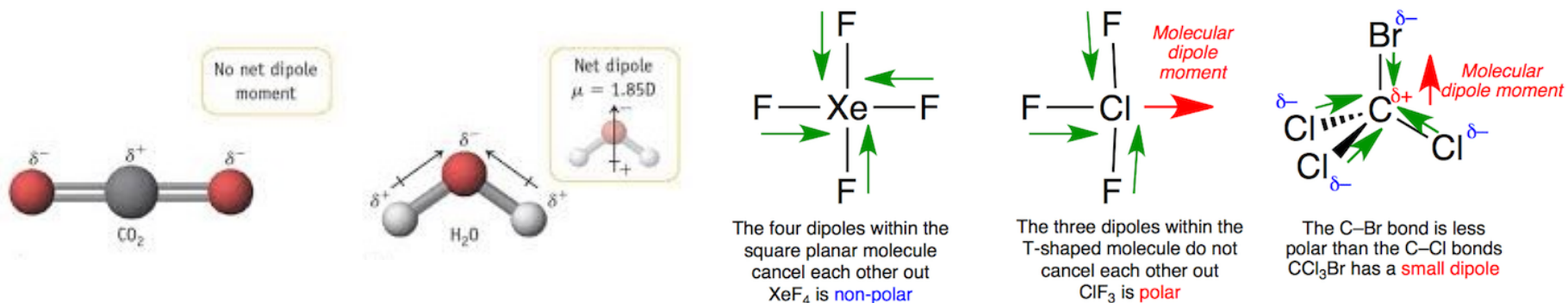
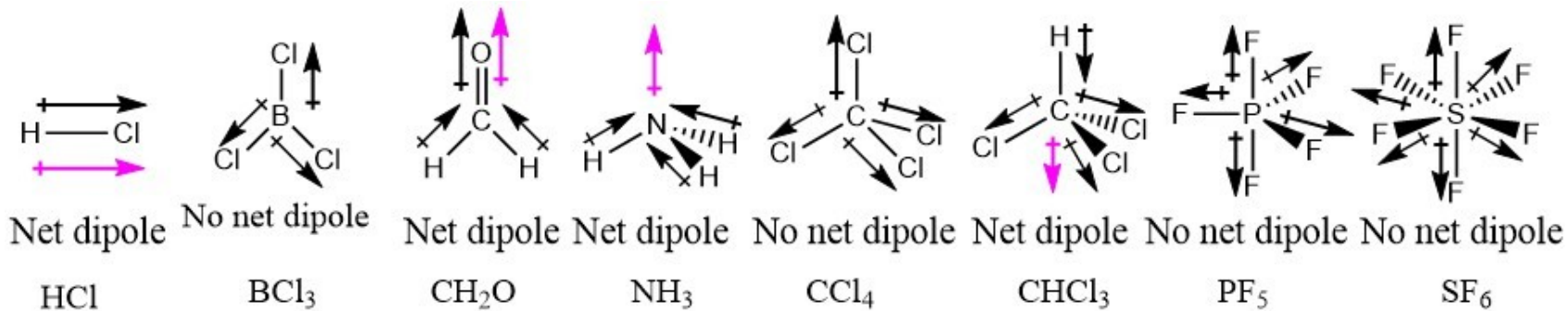
Square Planar
Symmetric \rightarrow non polar



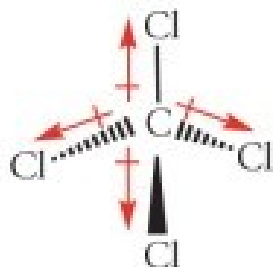
XeF_2

Linear

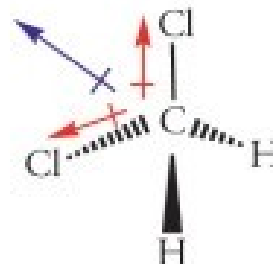
Symmetric \rightarrow non polar



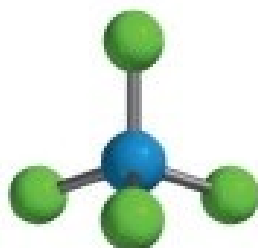
Blue arrow: direction of net dipole moment.



The bond moments cancel and there is no net polarity.



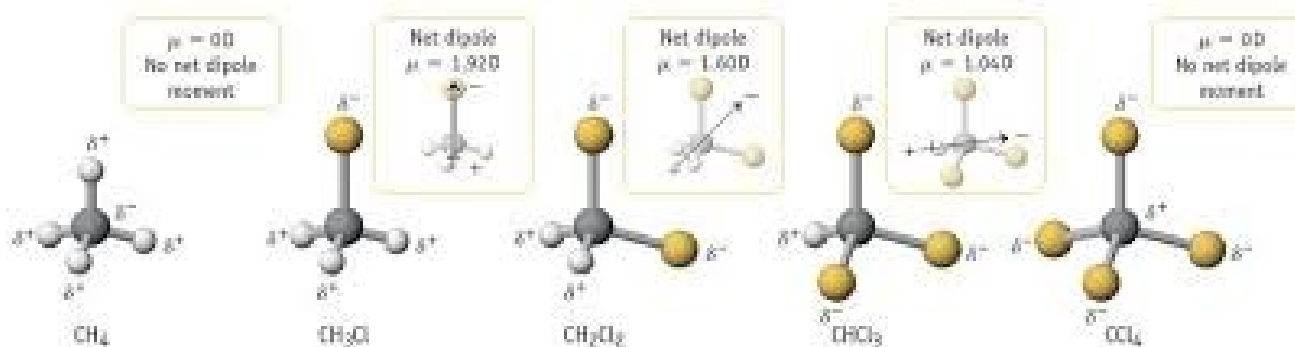
The bond moments do not cancel and there is a net polarity.



Tetrachloromethane

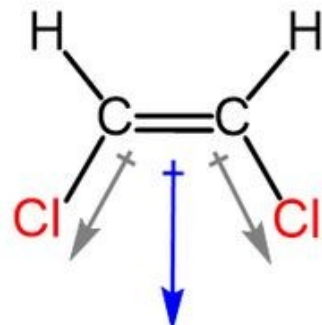


Dichloromethane



How the Molecular Dipole Moment Affects the Physical Properties

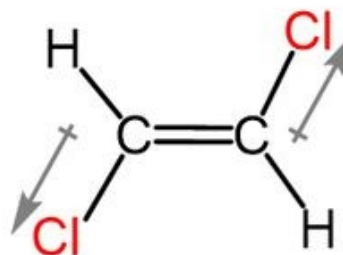
cis-1,2-Dichloroethene



net dipole moment

$$\mu = 1.9 \text{ D}$$

trans-1,2-Dichloroethene



Opposite dipoles cancel

$$\mu = 0 \text{ D}$$

bp 60 °C (*higher*)

vs

boiling point 48 °C

melting point -80 °C

vs

mp -50 °C (*higher*)

Intermolecular dipole-dipole interactions increase the b.p.

Symmetrical structures have higher melting point.

Proč jsou molekuly CO_2 , BF_3 , CCl_4 , PF_5 , SF_6 nepolární ?

NH_3 je polární, ale BF_3 je nepolární.

Proč?

Která z těchto molekul je polární ?

(a) SiF_4

(b) XeF_4

(c) BF_3

(d) SF_4

Která z molekul BF_3 , NH_3 a H_2O má nulový dipólový moment ?

Která z molekul CO_2 , BeCl_2 , ICl_4^- a SF_6 má nulový dipólový moment ?

Proč má molekula BeH_2 nulový dipól, přestože je vazba Be-H polární ?

Molekula H_2O má nenulový dipólový moment a molekula BeF_2 má nulový dipólový moment protože

- (a) Molekula H_2O má lineární tvar, zatímco molekula BeF_2 je lomená.**
- (b) Molekula BeF_2 má lineární tvar, zatímco molekula H_2O je lomená.**
- (c) fluor má vyšší elektronegativitu než kyslík.**
- (d) beryllium má vyšší elektronegativitu než kyslík.**

Dipólový moment molekuly CO_2 je nulový, zatímco u molekuly SO_2 je dipólový moment nenulový. Proč?