Step by Step: Polarity and Hybridization of Molecular Structures / Lewis Structures

Polarity

Polar means (+)/(-) ends on the molecule. The ends are different!

** unsymmetrical (**un**balanced) = {(+) and (-) end to the molecule} = **polar**

symmetrical (balanced**, it will not have (+)/(-) ends, the ends are the same) = **nonpolar**

[2 prefixes not together (un & non)]

If the molecule's atoms/bonds and electron pairs are unbalanced, it will be polar.

If the molecule's atoms/bonds and electron pairs are balanced, it will be nonpolar.

Hybridization **(a mixture of orbitals)**

Look through the hybridization notes. Notice the trend, as we keep adding bonds and electron pairs, we keep adding orbitals in a certain order.

If we have 1 bond, then we use the "s" orbital (**s** orbital).

If we have 2 bonds, then we use a "s" and a "p" orbital (**sp** hybrid).

If we have 3 groups (combination of bonds and lone pairs), then we use a "s" and 2 "p" orbitals (**sp^2** hybrid).

(Remember, there are up to 3 "p" orbitals, that we can use, because there were 3 pictures for the "p" orbitals.)

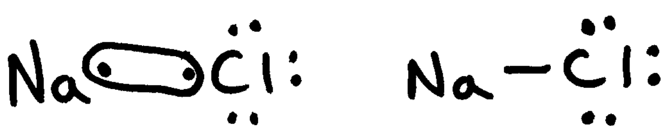
If we have 4 groups (combination of bonds and lone pairs), we use a "s" and 3 "p" orbitals (**sp^3** hybrid).

If we have 5 groups (combination of bonds and lone pairs), we use a "s" and 3 "p" orbitals and a 'd" orbital. (**dsp^3** hybrid). {The "d" always comes first.}

If we have 6 groups (combination of bonds and lone pairs), we use a "s" and 3 "p" orbitals and 2 'd" orbitals. (**d^2sp^3** hybrid). {The "d" always comes first.}

****Notice the order is "s", then "p", then another "p", then another "p", then "d", then another "d".****

Ex. 1) NaCl

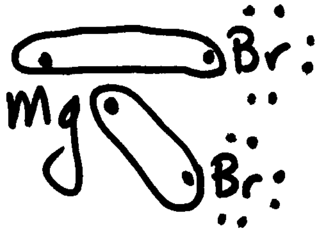


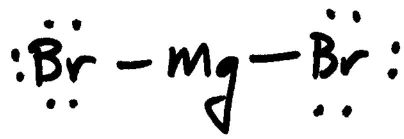
linear, 180°

The Na and Cl are on opposite ends, which appears balanced. But the Na and Cl have different electronegativites and will pull the electrons differently, so it is unbalanced, so polar.

There is only one bond around the Na, so there is no hybrid. It is only using a "s" orbital.

Ex. 2) $MgBr_2$



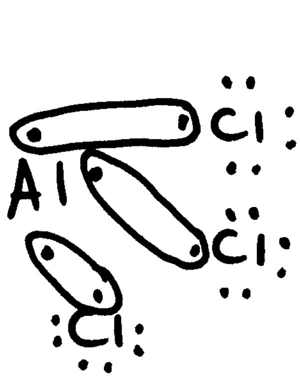


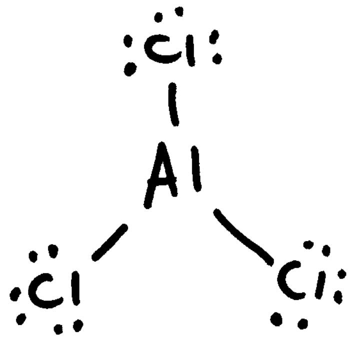
linear, 180°

The Br's are balanced on opposite sides of the Mg. Both Br's will pull the electrons the same; Br and Br are the same element. It is balanced, so nonpolar.

There are 2 bonds, use a "s" and a "p", so sp hybrid.

Ex. 3) $AlCl_3$



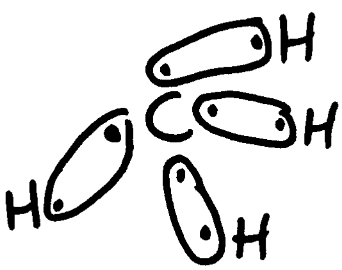


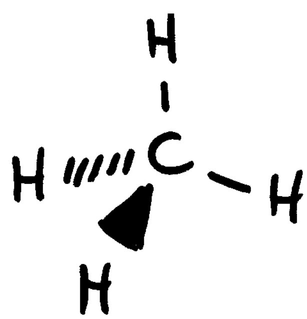
trigonal planar, 120°

The Cl's are balanced around the Al. They are all equidistant around at angles of 120°. Each Cl will pull the electrons the same, so overall it is balanced, so nonpolar.

There are 3 bonds, use a "s", "p" and a "p", so sp^2.

Ex. 4) CH_4



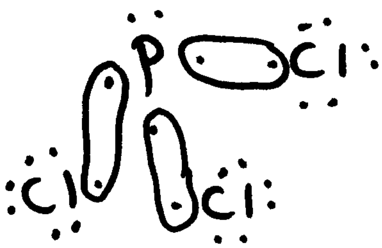


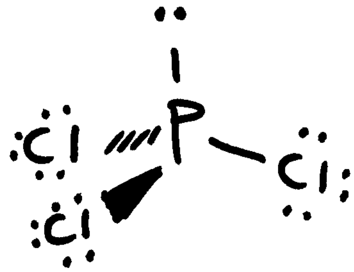
tetrahedral, 109.5°

The H's are balanced around the C. They are all equidistant around the C at the same angle of 109.5°. Each H pulls the electrons the same, so overall it is balanced, so nonpolar.

There are 4 bonds, use a “s”, “p”, “p”, and a “p”, so sp^3.

Ex. 5) PCl_3



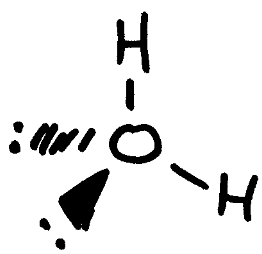


trigonal pyramidal, 107^o

There are 3 bonds and a lone pair of electrons. There are electrons on top, but none down below. There are chlorines on bottom, but none on top. The top and bottoms are not the same. It is not balanced, polar.

There are 4 groups (3 bonds and 1 lone pair of electrons) , use a “s”, “p”, “p”, and a “p”, so sp^3.

Ex. 6) H_2O

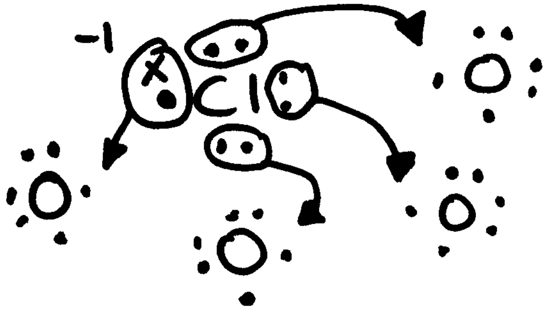


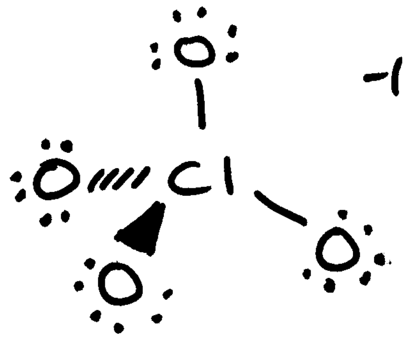
bent, 104.5^o

There are 2 bonds and 2 pairs of electrons. If you look at the molecule from left to right, there are 2 lone electron pairs on the left, but on the right there are two hydrogens. The left and right are not the same, so it is not balanced, polar.

There are 4 groups (2 bonds and 2 lone pair of electrons) , use a “s”, “p”, “p”, and a “p”, so sp^3.

Ex. 7) ClO_4^-



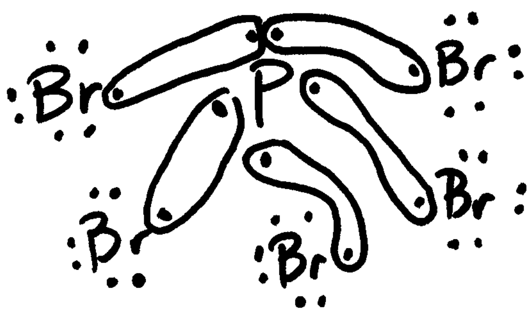


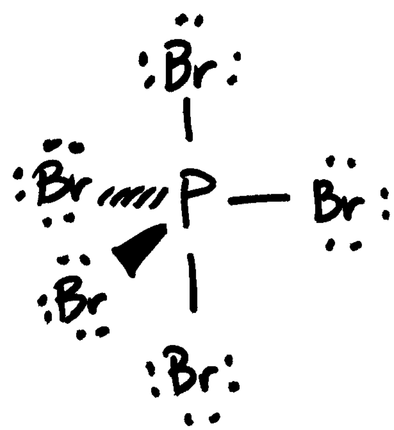
tetrahedral, 109.5°

The O's are balanced around the Cl. They are all equidistant around the Cl at the same angle of 109.5°. Each H pulls the electrons the same, so overall it is balanced, so nonpolar.

There are 4 bonds, use a "s", "p", "p", and a "p", so sp^3.
(The -1 charge was only necessary to tell us to add another electron when drawing the structure. It does not affect the polarity or hybridization.)

Ex. 8) PBr_5





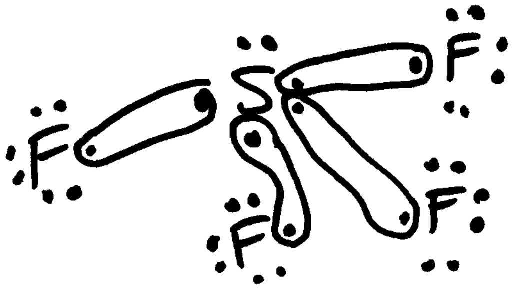
trigonal bipyramidal, 90° & 120°

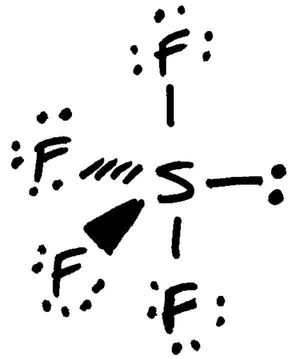
For the next molecules, divide them up: top/bottom and around the middle. The top Br balances the bottom Br. Around the middle there are 3 Br's that are each separated by 120° (all at the same angle), so the middle Br's are balanced. Over all the top/bottom are balanced and the middle is balanced, so balanced, nonpolar.

There are 5 bonds, use a "s", "p", "p", "p", and a "d" so dsp^3.

(Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals. Next we must use “d” orbitals.)

Ex. 9) SF_4





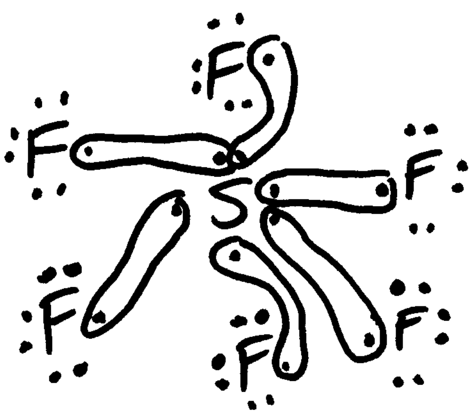
**e$^-$ must be around the middle

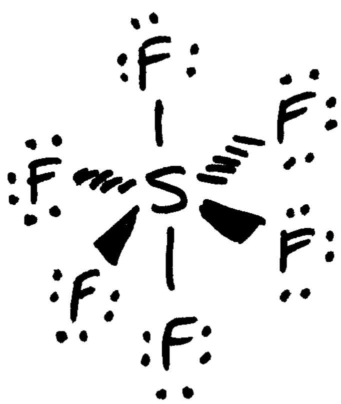
seesaw, <90^o & < 120^o
(irregular tetrahedran, bisphenoid)

For this molecule the top and bottom F’s will balance each other. But the middle is unbalanced, since there are 2 F’s and one lone pair of electrons. If one part is unbalanced, the whole molecule is unbalanced, polar.

There are 5 groups (4 bonds and 1 lone pair of electrons), use a “s”, “p”, “p”, “p”, and a “d” so dsp^3.
(Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)

Ex. 10) SF_6



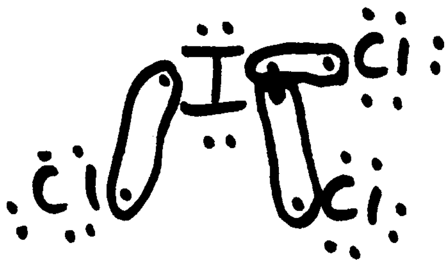


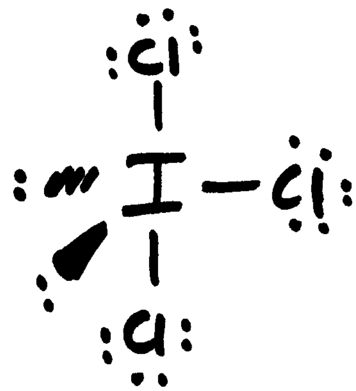
octahedral, 90^o

For this molecule the top F balances the bottom F. Around the middle there are 4 F’s that are each separated by 90^o (all at the same angle), so the middle F’s are balanced. Over all the top/bottom are balanced and the middle is balanced, so balanced, nonpolar.
There are 6 bonds, use a “s”, “p”, “p”, “p”, “d” and a “d” so d^2sp^3.

(Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)

Ex. 11) ICl_3





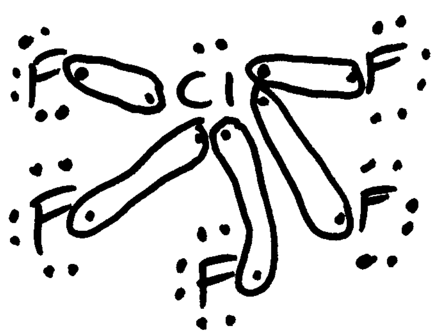
T-shaped, <90^o

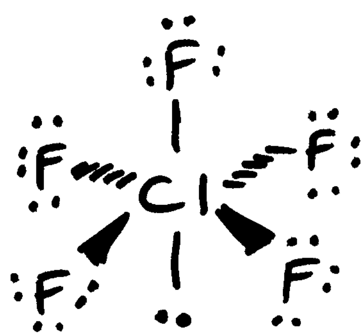
(e$^-$ must be around middle)

For this molecule the top and bottom Cl’s will balance each other. But the middle is unbalanced, since there is one Cl and 2 lone pairs of electrons. If one part is unbalanced, the whole molecule is unbalanced, polar.

There are 5 groups (3 bonds and 2 lone pairs of electrons), use a “s”, “p”, “p”, “p”, and a “d” so dsp^3.
(Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)

Ex. 12) ClF_5



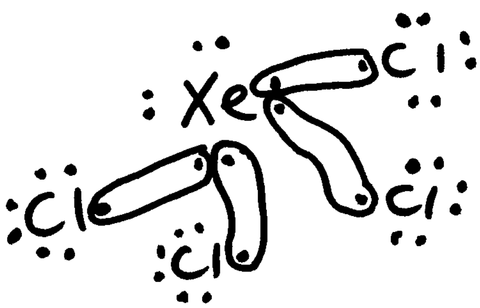


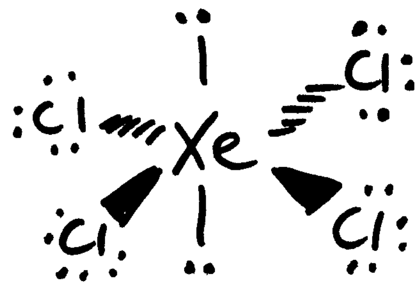
square pyramidal, <90^o

For this molecule the top F does not balance the bottom lone pair electrons. Around the middle there are 4 F’s that are each separated by 90^o (all at the same angle), so the middle F’s are balanced. Over all the top/bottom are unbalanced and the middle is balanced. If any part is unbalanced, overall it will be unbalanced, so polar.

There are 6 groups (5 bonds and one lone pair of electrons), use a “s”, “p”, “p”, “p”, “d” and a “d” so d^2sp^3. (Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)

Ex. 13) $XeCl_4$



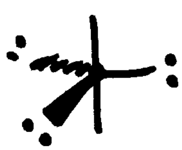


square planar, 90^o

**** e- must be across from each other**

For this molecule the top lone pair of electrons balances the bottom lone pair of electrons. Around the middle there are 4 Cl’s that are each separated by 90^o (all at the same angle), so the middle Cl’s are balanced. Over all the top/bottom are balanced and the middle is balanced, so nonpolar.

There are 6 groups (4 bonds and 2 lone pair of electrons), use a “s”, “p”, “p”, “p”, “d” and a “d” so d^2sp^3. (Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)



linear, 180^o

For this molecule the top and bottom atom’s will balance each other. The middle is also balanced, since there are 3 lone pairs of electrons. It is all balanced, so nonpolar.

There are 5 groups (2 bonds and 3 lone pairs of electrons), use a “s”, “p”, “p”, “p”, and a “d” so dsp^3. (Remember there were only 3 “p” orbital pictures last chapter, so we can only use 3 “p” orbitals.)

End of Notes