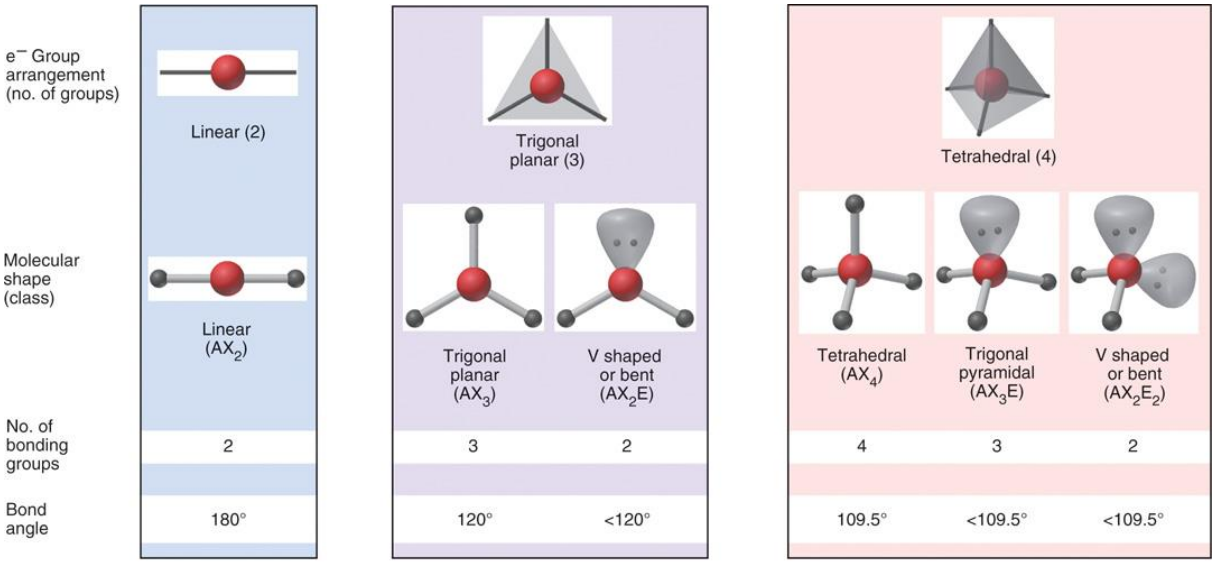
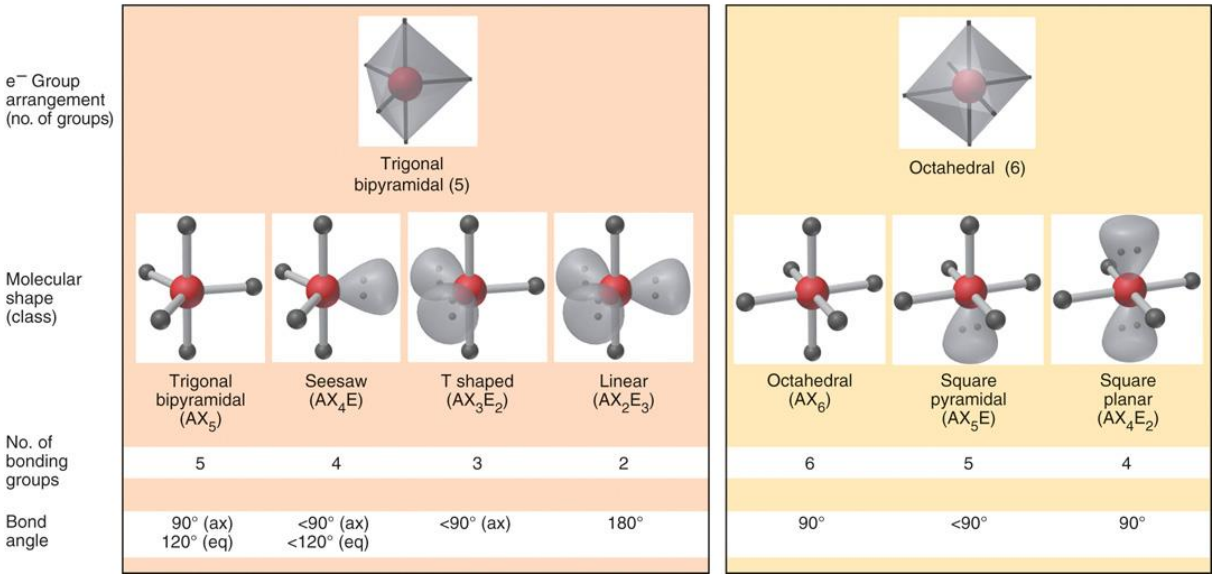
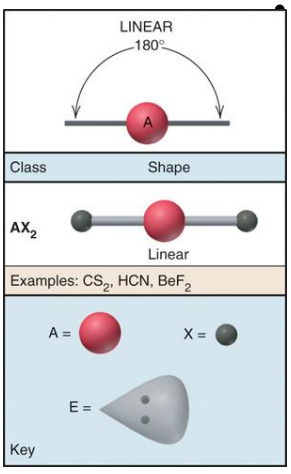
VSEPR for Chemistry 1000: The Silberberg Summary and Representation on Paper

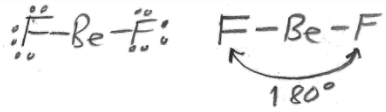


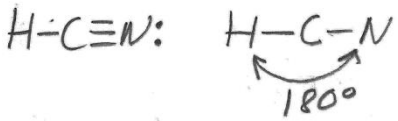


The Two-Electron Pair Shape Family **Examples** **Practice**

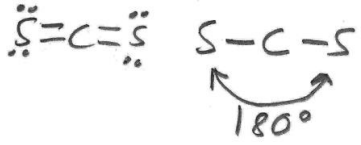


Note that *separate diagrams* should be used for the Lewis Diagram and the VSEPR structure. The VSEPR diagram should be *accurate for structure* and does not show bonding. Always indicate the bond angles, (i) on the diagram as shown, or (ii) catalogued beside the picture as follows: ∠(FBeF) = 180° This method is useful when there are *lots* of values.

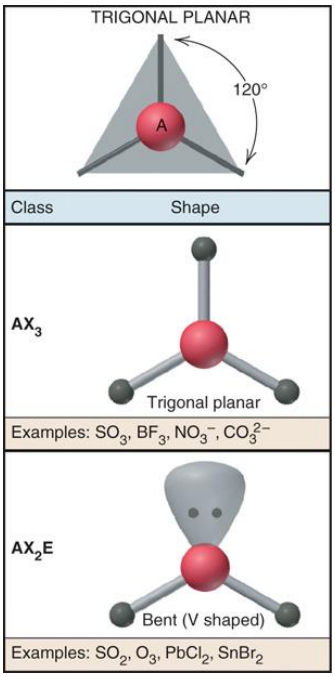
$\underline{Be}F_2$  $\underline{Be}H_2$

HCN  $N\underline{C}O^-$

The ∠ symbol means "angle" and is taken from geometry. Thus the ∠(ABA) = 120° or ∠(ABA) > 120° or ∠(ABA) < 120° are all possible designations.

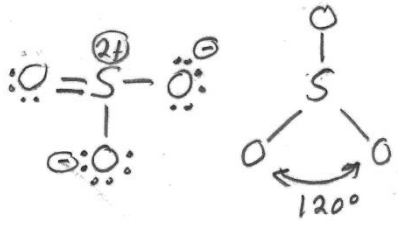
$\underline{C}S_2$  $\underline{C}O_2$

The Three-Electron Pair Shape Family **Examples** **Practice**



- *Any valid resonance "isomer"* can be used to determine the structure.
- Remember, that for the purpose of determining shape, multiple bonds count as single structure-determining electron pairs around a central atom.
- For AX_2E and other "XE" structure the VSEPR diagram is best drawn with the position of the "invisible" lone pairs shown (O_3 middle); alternate (O_3 r.h.s.) is permitted.

SO_3

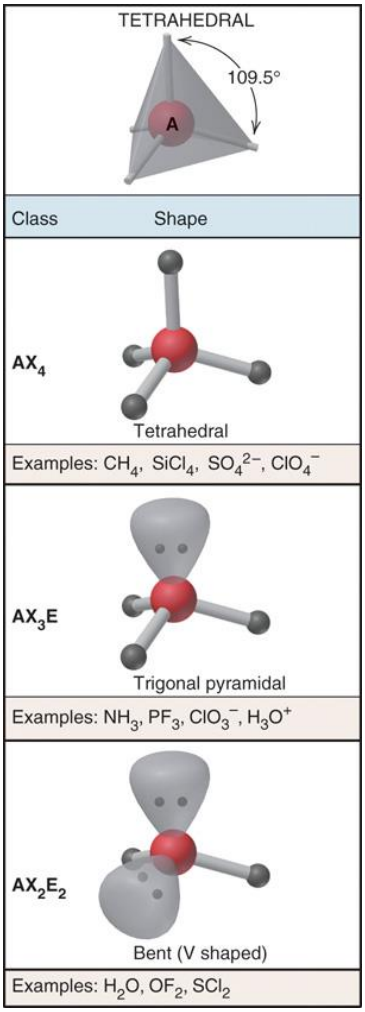


CO_3^{2-}

O_3

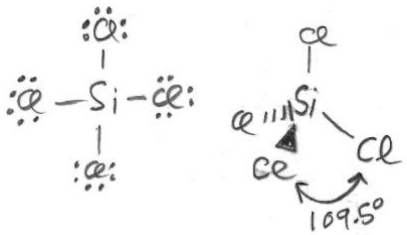
SO_2

The Four-Electron Pair Shape Family **Examples** **Practice**



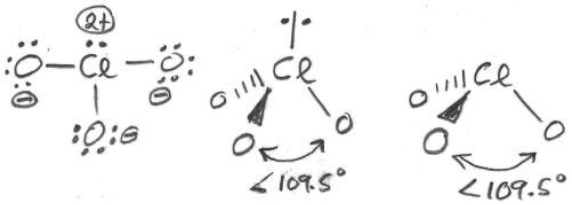
- For *non-flat* structures you **must** use "Wedges notation" to represent the 3D shape.
- The shapes drawn here attempt to be accurate perspective renderings of the views shown by the computer graphics at l.h.s. from Silberberg.
- Solid wedges come **forward** of the paper; dashed wedges go **behind** the paper.
- Wedges are *shorter* than line bonds because the perspective reduces apparent length.

$SiCl_4$



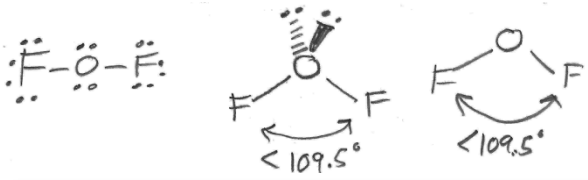
ClO_4^-

ClO_3^-



H_3O^+

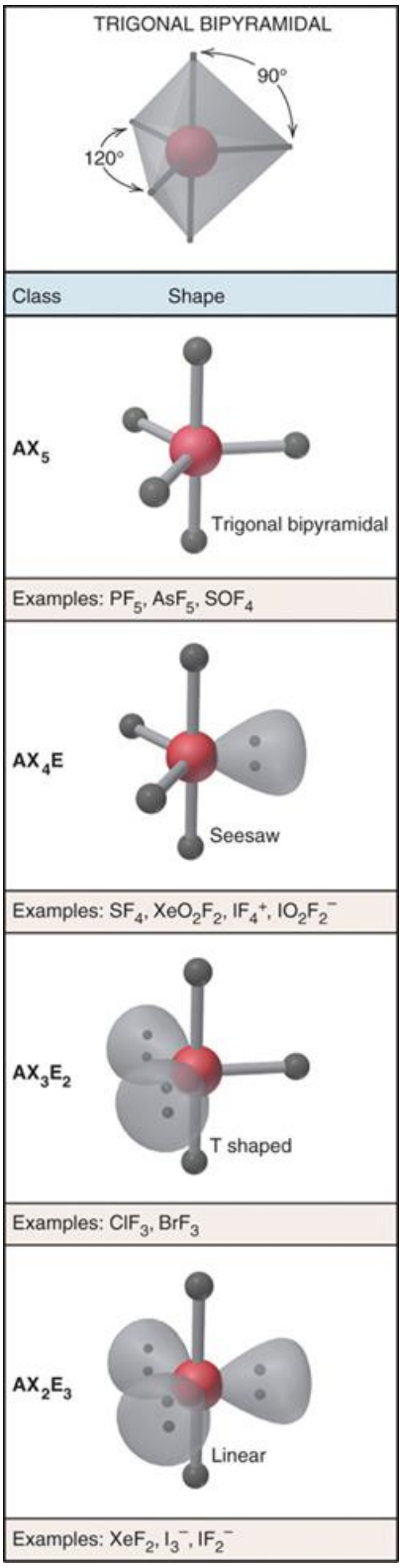
OF_2



SCl

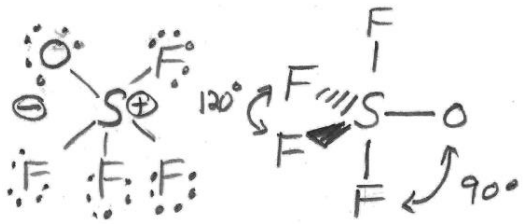
- For AX_2E_2, where the *shape* is flat, it is **highly preferable** to rotate the view so that the three visible atoms are drawn in the page of the paper.
- The first view (middle) showing the location of lone pairs in perspective is preferred.

The Five-Electron Pair Shape Family **Examples**

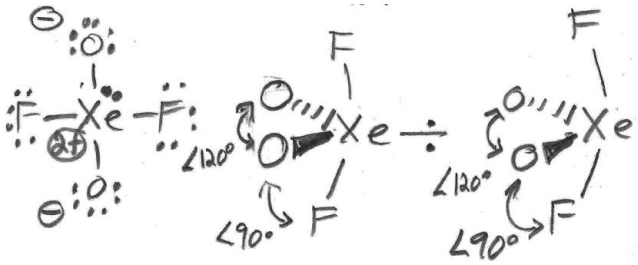


- The more structural electron pairs, the more space that is typically needed!
- SOF_4 is an interesting example of AX_5 geometry where the bond angles are probably *not* quite ideal, but without further knowledge it's hard to be sure.
- Also note that the O atom is *equatorial*: for **all trigonal bipyramidal** shape family structures, ***the most electronegative atoms always are in the axial position***.
- Again the option exists to draw in the LP or to leave them off; the first is better.
- Note that in XeO_2F_2 and ClF_3, the axial bonds bend back from perfect linear.
- But in XeF_2, all forces balance out and the shape is perfectly linear.

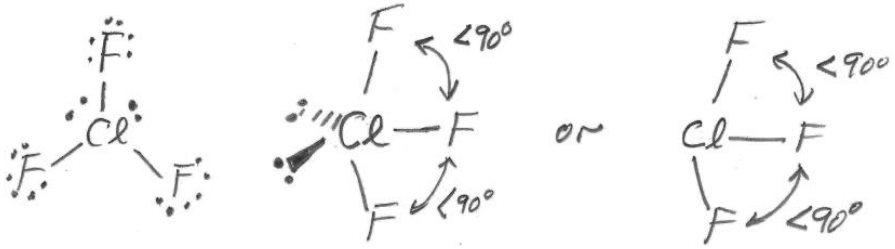
$\underline{S}OF_4$



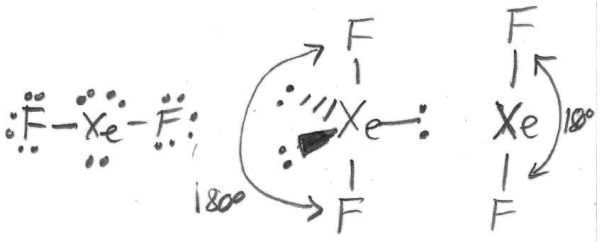
$\underline{Xe}O_2F_2$



$\underline{Cl}F_3$



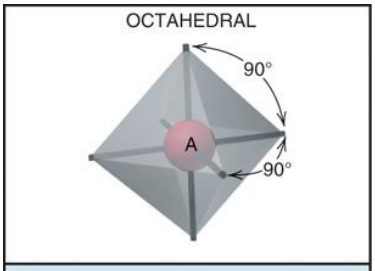
$\underline{Xe}F_2$

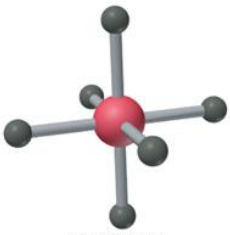
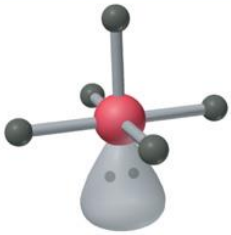
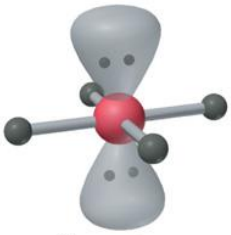


Practice

$\underline{As}F_5$ $\underline{S}F_4$ $\underline{Br}F_3$ I_3^-

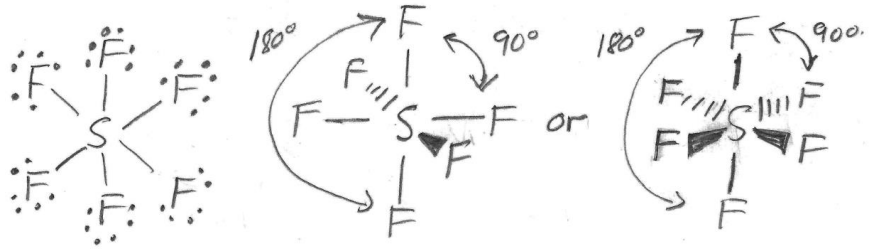
The Six-Electron Pair Shape Family **Examples**



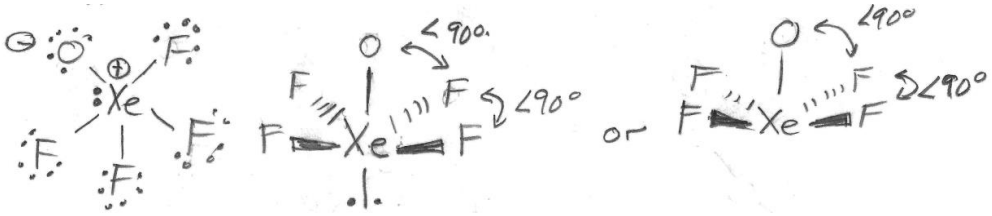
Class	Shape
AX_6	 Octahedral
Examples: SF_6, IOF_5	
AX_5E	 Square pyramidal
Examples: BrF_5, TeF_5^-, $XeOF_4$	
AX_4E_2	 Square planar
Examples: XeF_4, ICl_4^-	

- For the names of the shape, always use the name provided by Silberberg inside the respective boxes.
- Remember that in an AX_6 structure, *any atom can point up*, but in mixed terminal atoms there is again a tendency for the most electronegative atoms to go opposite.
- In the AX_5E square pyramidal case, the four equatorial atoms are *bent upwards* with the consequence that the central atom strangely points below the square plane.
- In the AX_4E_2 geometry, the lone pairs go opposite, so that the five atoms are found to be in a perfectly planar array. However, drawing with the LP is preferred.

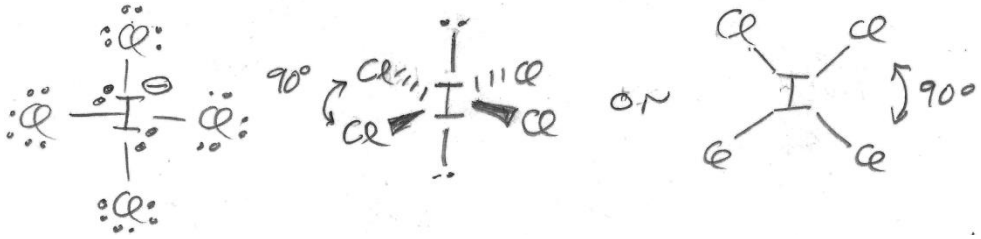
SF_6



$XeOF_4$



ICl_4^-



Practice

$XeOF_4$ TeF_5^- XeF_4