**What Is VSEPR?**

The *V*alence *S*hell *E*lectron *P*air *R*epulsion (VSEPR) model:

* Is based on the number of regions of high electron density around a central atom.
* Can be used to predict structures of molecules or ions that contain only non-metals by minimizing the electrostatic repulsion between the regions of high electron density.
* Can also be used to predict structures of molecules or ions that contain multiple bonds or unpaired electrons.
* Does fail in some cases.

**Valence-Shell Electron-Pair Repulsion (VSEPR) Models**

* The 3-dimensional structure of BF3 is different from PF3, and this is difficult to comprehend by considering their formulas alone. However, the Lewis [dot structure](http://www.chem.ucalgary.ca/courses/350/Carey5th/Ch01/ch1-3depth.html) for them are different, and the electron pair in :PF3 is the reason for its structure being different from BF3 (no lone pair).
* Three-dimensional arrangements of atoms or bonds in molecules are important properties as are bond-lengths, bond angles and bond energies. The Lewis dot symbols led us to *see* the non-bonding electron pairs.

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| --- | --- | --- |
| **Molecular shapes and steric numbers (SN)** | | |
| **Example** | **SN** | **Descriptor** |
| BeCl2, CO2 | 2 | Linear |
| BF3, SO3  SO2E, OO2E | 3 | Trigonal planar bent |
| CH4 NH3E H2OE2 | 4 | Tetrahedral pyramidal bent |
| PF5 SF4E ClF3E2 | 5 | Trigonal bypyramidal butterfly T-shape |
| SF6, OIF5 BrF5E XeF4E2 | 6 | octahedral pyramidal square planar |
| E represents a lone electron pair. *SN* is also called the **number of VSEPR pairs** or **number of electron pairs**. | | |

* [The Valence-Shell Electron-Pair Repulsion](http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch8/vsepr.html) (VSEPR) models consider the unshared pairs (or lone electron pairs) and the bonding electrons. These considerations of lone and bonding electron pairs give an excellent explanation about the molecular shapes. The VSEPR model counts both bonding and nonbonding (lone) electron pairs, and calls the total number of pairs the **steric number** (*SN*). If the element A has *m* atoms bonded to it and *n* nonbonding pairs, then
* *SN = m + n*
* *SN* is useful for predicting shapes of molecules. If X is any atom bonded to A (in single, double, or triple bond), a molecule may be represented by AXmEn where E denote a lone electron pair. This formula enables us to predict its geometry. The common *SN*, descriptor, and examples are given in the table on the right.
* Note that the *SN* is also called the **number of VSEPR pairs** or **number of electron pairs**. The VSEPR model has another general rule:

***Lone pairs of electrons take up more space than bonded pairs****making the bond angle, say H-O-H for water less than the tetrahedral angle of 109.5 °. Actually, the H-O-H angle in water is 105 °.*

* The geometry of the molecules with their SNs equal to 2 to 6 is given in the Table. The first line for each is the shape including the lone electron pair(s). If the lone electron pairs are ignored, the geometry of the molecule is given by another descriptor.
* To get an idea about the shapes of molecules and ions, three dimensional models are the best to use. However, good computer graphics sometimes also illustrate very well. The link [VSEPR Illustration: View and manipulate molecular models](https://phet.colorado.edu/en/simulation/molecule-shapes) gives excellent graphics, and you may enjoy seeing some of the graphics of the molecules.
* Another link showing beautiful photographs of models of [Molecular Geometry](http://chem.illinois.edu/chemdoodleweb/table.html)is also interesting.



