

3.91

Do yourself a solid.

3.091: Introduction to Solid State Chemistry
Maddie Sutula, Fall 2018
Recitation 9

1 VSEPR

Lewis dot structures are a great tool to visualize how electrons can be arranged in molecules. Further, drawing resonance structures and determining the formal charge can help us determine which structures are most stable. However, neither of these tools provide much insight into the physical configuration of a molecule in 3D space. For this, we turn to **V**alence **S**hell **E**lectron **P**air **R**epulsion theory, or VSEPR.

Once we draw a viable Lewis structure, we can use the following chart to translate the 2D representation to a 3D geometry:

VSEPR Geometries					
Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 Linear				
3	 Trigonal Planar	 Bent or Angular			
4	 Tetrahedral	 Trigonal Pyramid	 Bent or Angular		
5	 Trigonal Bipyramid	 Sawhorse or Seesaw	 T-shape	 Linear	
6	 Octahedral	 Square Pyramid	 Square Planar	 T-shape	 Linear

Chart courtesy of Boundless.com. License: CC BY-SA. This content is excluded from our Creative Commons license. For more information, see <https://ocw.mit.edu/fairuse>.

Example: Draw Lewis dot diagrams and determine the 3D VSEPR geometry of the following molecules: CH_4 , NH_3 , H_2O , SO_3 , SO_2 , CO_2

3.091

Do yourself a solid.

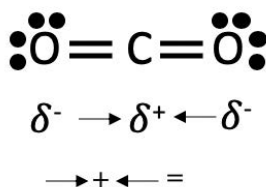
3.091: Introduction to Solid State Chemistry
Maddie Sutula, Fall 2018
Recitation 9

	Lewis dot diagram	Electrons around central atom	VSEPR description	Sketch of 3D model
CH ₄		-4 groups of electrons in bonds -0 lone pairs	tetrahedral	
NH ₃		-3 groups of electrons in bonds -1 lone pair	trigonal pyramidal	
H ₂ O		-4 groups of electrons in bonds -0 lone pairs	bent	
SO ₃		-4 groups of electrons in bonds -0 lone pairs	trigonal planar	
SO ₂		-4 groups of electrons in bonds -0 lone pairs	bent	
CO ₂		-4 groups of electrons -0 lone pairs	linear	

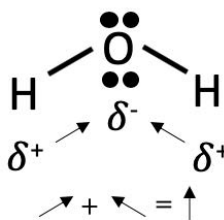
2 Polarity

The difference in electronegativity across a molecule can generate electric dipole moments. Dipole moments are vector quantities, and by convention point from a more positive region of charge to a more negative region. If individual dipoles within a molecule cancel, there is no net dipole.

Example: Determine whether CO_2 and H_2O have a net dipole moment.



In CO_2 , the two electronic dipoles are exactly opposite and cancel each other, so there isn't a net dipole. Carbon dioxide is not a polar molecule.



In H_2O , the electronic dipoles don't fully cancel, so there is a net dipole moment. Water is a polar molecule!

MIT OpenCourseWare
<https://ocw.mit.edu/>

3.091 Introduction to Solid-State Chemistry
Fall 2018

For information about citing these materials or our Terms of Use, visit: <https://ocw.mit.edu/terms>.