

- To help you determine Lewis structures, you can draw upon two tools: VSEPR and the octet rule.

Octet rule: Most atoms want eight valence electrons -- a full outer octet. This gives you an intuitive idea of what to expect. If you draw a Lewis diagram and one of the atoms in the molecule isn't surrounded by 8 electrons, either as lone pairs or shared in covalent bonds, you'd better make sure you haven't made a mistake. The octet rule doesn't hold 100% of the time, just most of the time.

Electron Bookkeeping:

- A methodical way to draw Lewis structures of molecules whose atoms follow the octet rule.
- It's also nice because when it breaks down it tips you off to exceptions to the octet rule like the expanded octet.

Step 1: Count the electron pairs needed

- Hydrogen wants 1 pair
- Group II's want 2 pairs
- Group III's want 3 pairs
- Everyone else wants 4 pairs

Step 2: Find the total number of covalent bonds possible

- Total # of possible cov. bonds = sum of the valence e⁻'s divided by 2
- * Remember to add or subtract electrons according to any ionic charge

Step 3: Calculate the actual number of covalent bonds

- Actual C.B.'s = step 1 - step 2

If you don't get enough bonds to draw the molecule, then it's an expanded octet.

Step 4: Calculate the number of σ bonds, π bonds, and nonbonding pairs

- # of σ bonds = # of atoms in the molecule - 1
- # of π bonds = Actual C.B.'s (step 3) - # of σ bonds
- # of nonbonding pairs = possible C.B.'s (step 2) - Actual C.B.'s (step 3)

Step 5: Draw the molecule (here are some prototypical examples)

	CH ₄	NH ₃	H ₂ O	CO ₂
step 1:	8	7	6	12
step 2:	4	4	4	8
step 3:	4	3	2	4
step 4:				
σ	4	3	2	2
π	0	0	0	2
nbp	0	1	2	4
step 5:				
	$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \\ :\text{N} - \text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{:} \quad \text{O} \quad \text{:} \\ \quad \quad \\ \text{H} - \text{O} - \text{H} \\ \text{:} \quad \quad \text{:} \end{array}$	$\text{:O} = \text{C} = \text{O:}$

Student Packet: 2.1: Covalent Bonding I: AssessMe questions

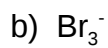
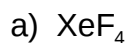
- 1) Which of the following compounds contains an atom that has an expanded octet?
- A) H_2O B) PH_3 C) PCl_3 D) PCl_5 E) I'm clueless
- 2) Which of the following contains the shortest oxygen — oxygen bond?
- A) O_2 B) O_3 C) O_2^{2-} D) H_2O_2 E) I'm clueless
- 3) Of the following, which is the best example of a nonpolar molecule containing polar bonds?
- A) F_2 B) SO_2 C) CS_2 D) PCl_5 E) I'm clueless
- 4) Which of the following is nonpolar?
- A) F_2O B) HCN C) CH_4 D) NO_2^+ E) I'm clueless
5. The number of orbitals in a d sublevel is
- A) 1 B) 3 C) 7 D) 5 E) I'm clueless
- 6) The exceptions to the Aufbau principle are explained by the fact that
- A) no two electrons can have the same quantum numbers.
B) the hybridization of orbitals between two sublevels.
C) an overall increase in the stability of the electron configuration.
D) the Bohr model's inability to deal with many-electron systems.
E) I'm clueless

Student Packet: 2.1: Covalent Bonding I: ShowMe questions

1) Write Lewis structures that obey the octet rule for the following compounds:



2) Draw Lewis structures for the following molecules:



3) Draw the resonance structures of NO_3^- . Indicate the formal charge on each atom.

4) Put the N — O bonds of NO^+ , NO , NO_2^- , and NO_3^- in order of increasing bond length.

Student Packet: 2.1: Covalent Bonding I: TestMe questions

- 1) Based on the following bond length data, predict the C-O bond length in CO_3^{2-} .
given: C-O is 1.43 Å; C=O is 1.23 Å; and C≡O is 1.09 Å
- A) 1.23 Å
 - B) 1.43 Å
 - C) 1.30 Å
 - D) 1.36 Å
 - E) None of the above
- 2) What is the formal charge of the central atom in BeCl_2 ?
- A) +2
 - B) +1
 - C) 0
 - D) 1
 - E) 2
- 3) For XeO_3 , which of the following formal charges are possible for Xe?
- A) +3
 - B) +3, +2, +1
 - C) +3, +2, +1, 0
 - D) +2, +1, 0, -1
 - E) 0
- 4) How many resonance structures are possible for ozone, O_3 ?
- A) 1
 - B) 2
 - C) 3
 - D) 4
 - E) 5
- 5) What is the valence electron count of the glycine molecule $\text{H}_2\text{NCH}_2\text{CO}_2\text{H}$?
- A) 28
 - B) 32
 - C) 34
 - D) 26
 - E) 30