Charged Atoms in Lewis Structures

Unit: Covalent Bonding & Molecular Geometry

MA Curriculum Frameworks (2016): HS-PS1-2

Mastery Objective(s): (Students will be able to…)

- Draw Lewis structures in which one or more atoms has a formal charge.

Success Criteria:

- Lewis structures show the correct number of bonds.
- Lewis structures show the correct number of unpaired electrons in the correct locations.
- Individual charges are assigned correctly. (Positive charges on least electronegative atom, negative charges on most electronegative atom, *etc.*)
- Total charge adds up to the correct value.

Tier 2 Vocabulary: bond, charge

Language Objectives:

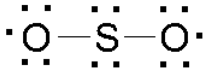
- Explain how charges are assigned to Lewis structures.

Notes:

Lewis structures show the shape of a molecule and how the atoms share electrons with each other. If a molecule exists, that means it must have a Lewis structure.

If you can't find a way to draw the Lewis structure for a molecule using neutral atoms, you may need to take electrons away from one atom and distribute them to other atoms, creating atoms with charges.

For example, consider the sulfur dioxide (SO_2) molecule. Sulfur and oxygen both have 6 valence electrons and need two bonds. If you draw the following:



sulfur has enough bonds, but each oxygen needs one more electron.

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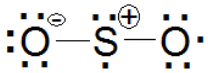
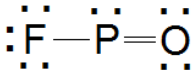
If you move one electron from sulfur to one of the oxygens, you have the following situation:



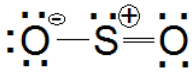
(Notice that when an atom in a Lewis structure has a charge, the charge is written next to the atom and circled.)

One way to think of charged atoms in Lewis structures is to *temporarily* substitute the charged atom with a neutral atom that has the same number of valence electrons, draw the Lewis structure, and then switch the atoms back.

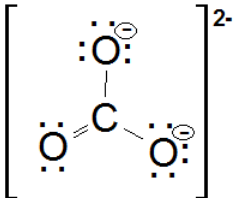
When we take an electron away from S to make it S^+, the S^+ atom has the same number of valence electrons as P, so we could temporarily substitute P for S. Similarly, when we add an electron to O to make it O^-, the O^- atom has the same number of electrons as F, so we could temporarily substitute F for O. If we made both of these substitutions, the compound would be OPF. We would place a double bond between P and O, to give the following Lewis structure:



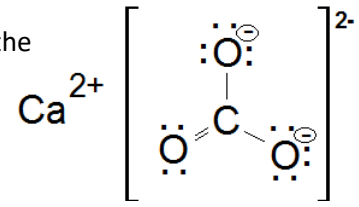
Now, we switch the F back to O^- and the P back to S^+, which gives the correct Lewis structure for SO_2:



If you are drawing a Lewis structure for a charged polyatomic ion, you need to show the overall charge as well as the charges on the individual atoms. To do this, put the entire structure in square brackets and write the overall charge outside the brackets, as in the example to the right:



This means that when we write the formula $CaCO_3$ for the ionic compound calcium carbonate, the actual arrangement of the atoms is:



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Homework Problems

Draw a correct Lewis structure for each of the following compounds.

1. PF_3
2. O_2
3. H_2S
4. $AsCl_3$
5. CBr_4
6. HI
7. HSCN
8. SCl_2
9. NH_2SeF
10. CH_3OH
11. SiO_2
12. CH_3COOH
13. POF
14. SO_4^{2-}
15. NO_3^-
16. PO_4^{3-}

Use this space for summary and/or additional notes: