LEWIS STRUCTURES AND POLYATOMIC MOLECULES

Connectivity

Thinking about how atoms and electrons are arranged in a molecule gets harder when there are more than two atoms. Often you need to decide how the atoms are arranged before writing the Lewis structure.

Let's draw the structure for carbonic acid, H_2CO_3. First we need to know which atoms are connected together. That will tell us which atoms are sharing electrons.

We could put one atom in the middle of the structure and arrange all the others around it. That may work sometimes, but often it gives the central atom too many bonds. A second-row atom can't have more than eight electrons in its valence shell. As a result, a carbon can't have more than four bonds, because there is no room for more electrons.

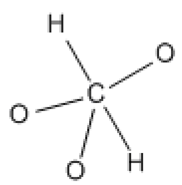

Figure IM4.1. A carbon atom with a problem: too many valence electrons.

We could try to attach all the atoms in a string. Long strings of atoms like this are not very common. There may be several reasons why this sort of arrangement isn't very stable. First, when we consider formal charge a little later, you will see that placing all the atoms in a row may cause unnecessary charge separation. Second, some atoms such as oxygen are not very stable when bonded to other atoms of the same kind. Repulsion between lone pairs may contribute to this instability. Because carbon often has no lone pairs, it is an exception and it can bond to itself.

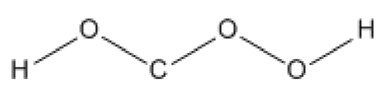

Figure IM4.2. A long string of atoms may still have problems when you start adding in the rest of the electrons.

Note that when we try to arrange the atoms in either way, we would probably avoid putting a hydrogen in the middle. That's because hydrogen's octet is just two electrons, so it can usually only make one bond. Knowing the number of bonds that other atoms usually form can also be helpful.

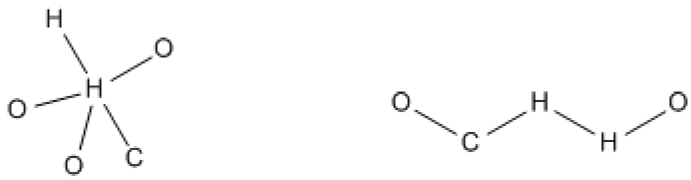

Figure IM4.3. Hydrogen atoms with problems: usually, atoms with lower numbers of valence electrons must be nearer the edge of the molecule.

Valence

Valence is the number of bonds an element usually forms - for example, the valence of carbon is four, nitrogen is three, oxygen is two, fluorine and hydrogen are one. Valence usually corresponds to the number of electrons needed to form an octet. However, there are exceptions: boron would need 5 electrons to form an octet, but since it only has three electrons to share, it can only form three covalent bonds.

Table IM4.1. Typical valences (number of bonds formed) for several second-row atoms.

atom	B	C	N	O	F
valence	3	4	3	2	1

Keeping valence in mind can help Lewis structures go more easily. In the case of carbonic acid, carbon might go in the middle, since it must form the most bonds to obtain an octet. Also, having two of the oxygens connected to hydrogens as well as to carbon helps them to attain their normal valence as well.

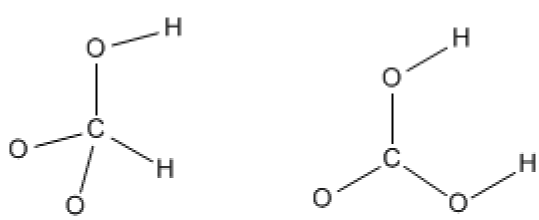

Figure IM4.4. Knowledge of valence suggests the structure on the right is more likely.

Once the connectivity has been filled in, we have a skeletal structure of the compound. Now we just need to fill in the extra electrons. Six from each oxygen is 18; four from carbon makes 22; one from each hydrogen makes 24 total electrons.

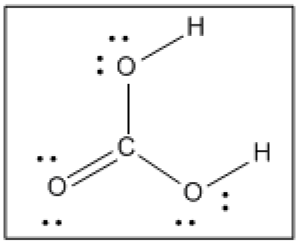

Figure IM4.5. Adding in the remaining 14 electrons leads to this structure.

Coming up with a Lewis structure requires a number of steps, but it usually follows a familiar pattern.

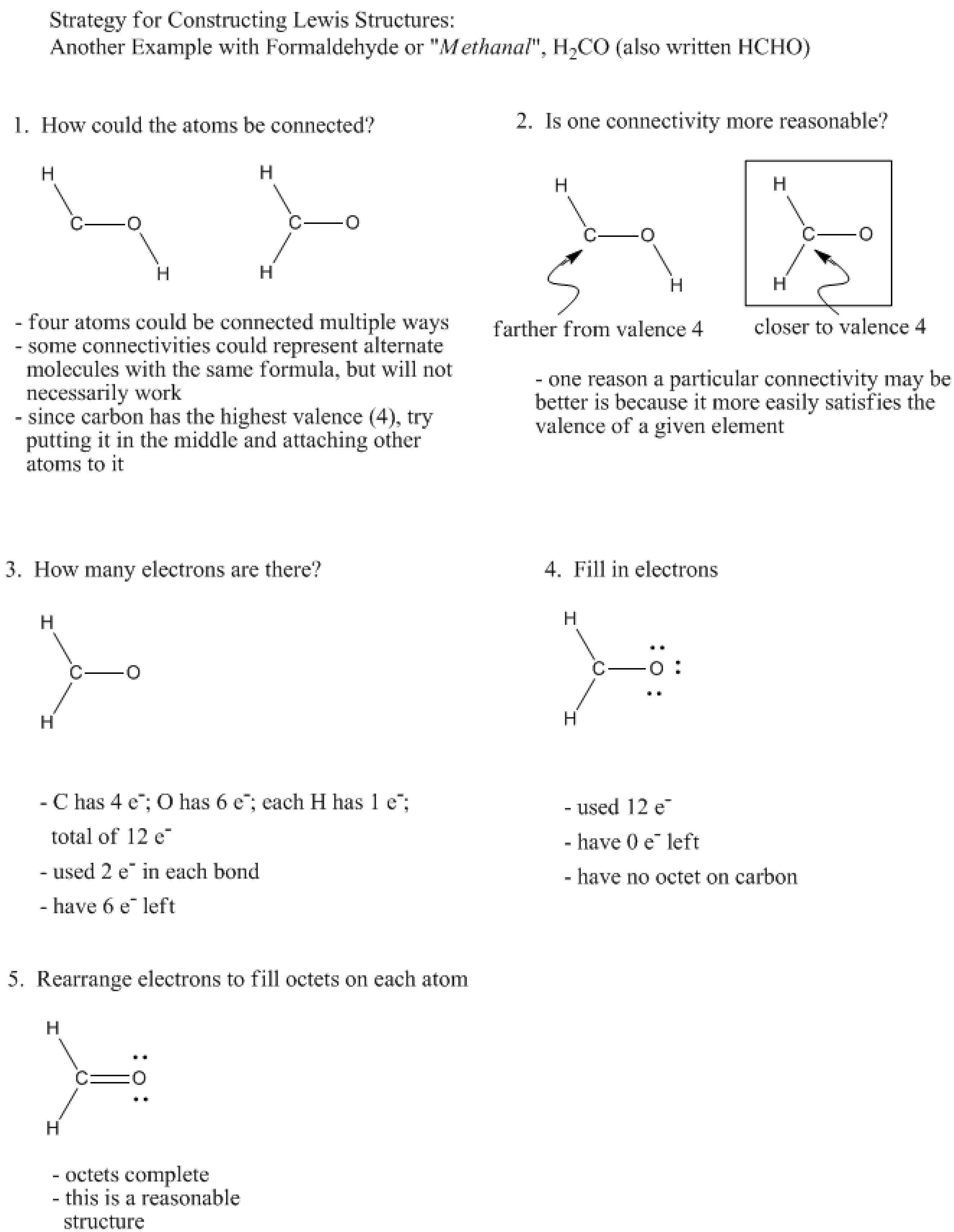

Figure IM4.6. A set of instructions for constructing a Lewis structure.

Source : http://employees.csbsju.edu/cschaller/Principles%20Chem/molecules/1_4_valence.htm