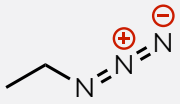
Formal charges

1. Introduction

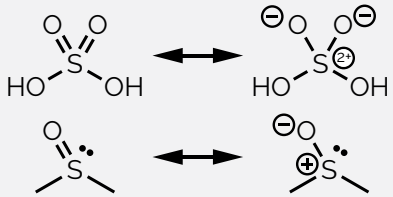


Formal charges highlight atoms with an ***unexpected*** number of bonds.

A drawing is ***wrong*** if appropriate formal charges are missing.

Two ways to determine formal charges are given below:

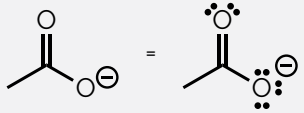
2. Exceptions



Elements of the 2nd row have a fixed number of (***expected***) bonds.

Elements of the 3rd row can have different numbers of bonds & still not have a formal charge - take care.

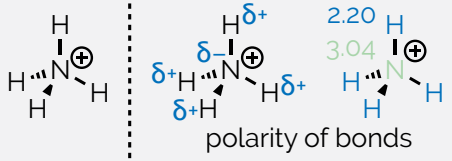
3. Drawing convention



By convention, when we draw a formal charge we rarely draw the lone pairs of electrons ***but*** they are still there.

Given a formal charge on an atom, you must be able to determine the number of unshared electrons.

4. Warning



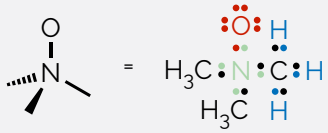
Formal charges show how electrons are shared.

But they do not replace electronegativity when determining polarity of a bond.

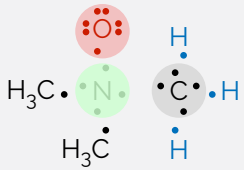
The example above shows a common mistake.

A. Lewis structure method

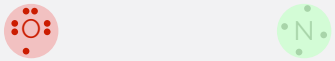
i. Draw the Lewis structure showing the electrons



ii. Split each covalent bond in half
Each bond was formed by sharing two electrons between two atoms so give one electron to each atom



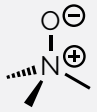
iii. Compare the number of valence electrons on the atom to the number it should have. If there is a difference the atom will have a formal charge
The number of valence electrons is given by the group number on the periodic table



oxygen
6 valence electrons
this oxygen 7e⁻

nitrogen
5 valence electrons
this nitrogen 4e⁻

iv. Assign formal charge to atom
if there are more valence electrons than predicted, the atom has a negative charge for each additional electron. If there are less it will have a positive charge.



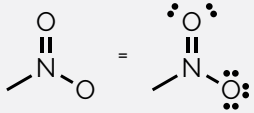
B. Formal charge formula method

The following equation determines the formal charge of an atom:

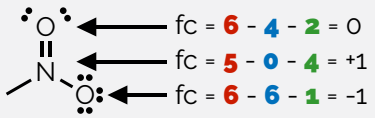
formal charge fc	=	valence electrons of element	-	number of unshared electrons	-	number of bonds

Example 1

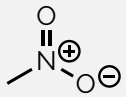
i. add unshared electrons



ii. apply formula to each atom

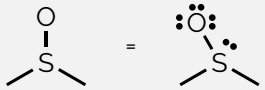


iii. add formal charge to drawing

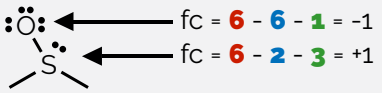


Example 2

i. add unshared electrons



ii. apply formula to each atom



iii. add formal charge to drawing