



Oxidation States and Redox Reactions

Oxidation States:

An oxidation state, or oxidation number, is a number assigned to an element within a compound or molecule to represent how many electrons the element is capable of gaining or losing.

Charge and formal charge are similar to the oxidation state, but these are different and separate concepts, even though the values tend to be the same in most cases.

The following rules work for most compounds. If there is a conflict between two rules, always pick the rule that comes first.

- An individual atom that is uncombined with any other element has an oxidation state of 0.
- O_2 , N_2 , H_2 , C, and Ag would all have oxidation states of 0.
- The sum of the oxidation states of all the atoms in a compound must equal the charge.
- The oxidation state of a calcium ion (Ca^{+2}) would be +2.
- Since NaCl doesn't have a charge, the sum of the oxidation state for Na and Cl must be zero, so Na has a oxidation number of +1, while Cl has one of -1.
- In a compound, the oxidation state for Group 1 metals is +1 and Group 2 metals is +2.
- Sodium's oxidation state is +1 since it is a Group 1 metal.
- The oxidation state for F is -1 in a compound.
- The oxidation state for H is +1 in a compound.
- The oxidation state for O is -2 in a compound.
- In a two-element compound with metals, Group 15 elements will have an oxidation state of -3, Group 16 elements will have one of -2, and Group 17 elements will be -1.
- In HBr, H would have an oxidation state of +1 and Br would have an oxidation number of -1.

For most compounds, you can immediately identify almost all of the elements' oxidation states; usually, you're left with one unknown oxidation state. In these cases, you would solve for the remaining oxidation number using Rule 2.

Redox Reactions:

Redox stands for REDuction and OXidation reactions and signifies the transfer of electrons within a reaction; in these reactions, the oxidation states of at least two elements will change during the reaction. Reduction is the gain of electrons, while oxidation is the loss of electrons. Oxidation numbers can help to understand if an element is gaining or losing electrons. If the oxidation number increases over the course of the reaction, then the element is being oxidized. Conversely, if the oxidation number decreases, then the element is reduced in that reaction. There are several ways to remember the relationship between electron movement and redox:

- **OIL RIG: O**xidation **I**s **L**oss and **R**eduction **I**s **G**ain
- **LEO** the lion goes **GER: L**oss of **E**lectrons is **O**xidation and **G**ain of **E**lectrons is **R**eduction
- **RED CAT** and **AN OX: RED**uction occurs at the **CAT**hode, while the **AN**ode has **OX**idation occurring

The reducing agent, or reductant, is the compound that loses electrons and is oxidized. The oxidizing agent, or oxidant, is the compound that gains electrons and is reduced in the reaction.

For more information on oxidation states and redox reactions, make an appointment with a [content tutor](#). Appointments are available in person at the [Student Success Center](#) or online