CK- 12  **Assigning Oxidation Numbers**

**Iron what?**

When reactions involve electrons being transferred, but not the obvious gain of Oxygen or loss of Hydrogen, it can become difficult to identify REDOX reactions and the atoms undergoing oxidation and reduction. To enable Chemists to easily discern REDOX reactions from reactions which do not involve electron transfer, a technique of tracking the movement of electrons within a reaction was devised. This technique is referred to as “oxidation numbers”. Oxidation numbers are assigned to individual atoms within a chemical reaction. The technique for using oxidation numbers to identify REDOX reactions is relatively simple. Firstly oxidation numbers are assigned to every atom in a chemical equation (using a set of rules below). Secondly, any atom whose oxidation number has changed (contrasting reactants with products) has lost or gained electrons.

# Assigning Oxidation Numbers

The **oxidation number** is a positive or negative number that is assigned to an [atom](https://www.ck12.org/c/physical-science/atom?referrer=crossref) to indicate its degree of oxidation or reduction. In oxidation-reduction processes, the driving force for [chemical change](https://www.ck12.org/c/physical-science/chemical-change?referrer=crossref) is in the exchange of electrons between chemical [species](https://www.ck12.org/c/biology/species?referrer=crossref). A series of rules have been developed to help us:

1. The oxidation number of a free element is always 0. The atoms in He and N2, for example, have oxidation numbers of 0.
2. The oxidation number of a monatomic ion equals the charge of the ion. For example, the oxidation number of Na+ is +1; the oxidation number of N3- is -3.
3. The usual oxidation number of hydrogen is +1. The oxidation number of hydrogen is -1 in compounds containing (metals) that are less ​[electronegative](https://www.thoughtco.com/definition-of-electronegativity-604347) than hydrogen, as in CaH2 and NaH.
4. The oxidation number of oxygen in compounds is usually -2. Exceptions include OF2 because F is more electronegative than O, and peroxides (X2O2), due to the structure of the peroxide ion, which is [O-O]2-.
5. The oxidation number of a [Group IA element](https://www.thoughtco.com/alkali-metals-606645) in a compound is +1.
6. The oxidation number of a [Group IIA element](https://www.thoughtco.com/alkaline-earth-metals-properties-606646) in a compound is +2.
7. The oxidation number of a [Group VIIA element](https://www.thoughtco.com/halogen-elements-and-properties-606650) in a compound is -1, except when that element is combined with one having a higher electronegativity. The oxidation number of Cl is -1 in HCl, but the oxidation number of Cl is +1 in HOCl, because it is combined with O.
8. The sum of the oxidation numbers of all of the atoms in a neutral compound is 0.
9. The sum of the oxidation numbers in a polyatomic ion is equal to the charge of the ion. For example, the sum of the oxidation numbers for SO42- is -2.

**Sample Problem: What is the oxidation number for Mn in the** [**compound**](https://www.ck12.org/c/physical-science/compound?referrer=crossref) **KMnO4?**

The oxidation number for K is +1 (rule 2)

The oxidation number for O is -2 (rule 4)

Since this is a [compound](https://www.ck12.org/c/physical-science/compound?referrer=crossref) (there is no charge indicated on the molecule), the net charge on the molecule is zero (rule 8)

So we have

When dealing with oxidation numbers, we must always include the charge on the atom.

Another way to determine the oxidation number of Mn in this [compound](https://www.ck12.org/c/physical-science/compound?referrer=crossref) is to recall that the permanganate [anion](https://www.ck12.org/c/chemistry/anion?referrer=crossref) (MnO4) has a charge of -1. In this case:

**Sample Problem: What is the oxidation number for iron in Fe2O3?**

If we have the compound FeO, then O = -2 and Fe = +2. Iron is one of those materials that can have more than one oxidation number.

The [halogens](https://www.ck12.org/c/physical-science/halogens?referrer=crossref) (except for fluorine) can also have more than one number. In the compound NaCl, we know that Na is +1, so Cl must be -1. But what about NaClO3?

Not quite what we expected, but Cl, Br, and I will exhibit multiple oxidation numbers in compounds.

# Review

1. What is the oxidation number for the [element](https://www.ck12.org/c/physical-science/element?referrer=crossref) zinc?
2. Nitrogen can exist in several oxide forms. What is the oxidation number of N in NO? in N2O? in NO2?
3. What is the oxidation number of H in HCl? in NaH?