

Oxidation-Reduction Reactions and Combustion

In electrolysis, where we used electricity to break apart water molecules, the connection with electricity was clear - one electrode pulled out electrons and produced oxygen gas bubbles and the other electrode sent in electrons and produced hydrogen gas bubbles. In the electrolyte (water with Epsom salt in our case) between the electrodes, ions drifted from one electrode to the other to complete the electrical circuit.

A battery has two electrodes made from different metals and an electrolyte solution between them. At one electrode electrons are produced in excess and at the other electrode they are consumed.

Electrolysis and batteries are two examples are oxidation-reduction reactions. Other obvious ones are corrosion and electroplating of metals.

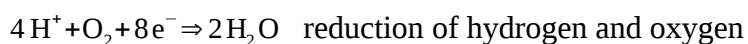
Combustion of hydrocarbons, however, is also considered an oxidation-reduction reaction, but we cannot use electrodes to interact with combustion.

Consider combustion of methane: $\text{CH}_4 + 2\text{O}_2 \Rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{energy}$

A carbon atom by itself has 4 outermost electrons, but would prefer to have its outer shell full with 8 electrons. A hydrogen atom has one electron in its outermost shell (its only shell) but would prefer to have that shell at its full capacity of 2 electrons or none at all. In the methane molecule, both atoms get their wish because the 4 electrons from the hydrogen join the 4 electrons in the carbon atom to make its shell feel full while the hydrogen nuclei hang along close by with no electrons.

An oxygen atom by itself has 6 electrons in its outermost shell, but would prefer to have that shell full with 8 electrons. When two oxygen atoms join together to make O_2 , they share their 4 outermost electrons in a double bond and each is content to consider itself to have a full outermost shell.

When methane is burned with oxygen, the following two half reactions can be considered to have happened:



The carbon and hydrogen in the first half reaction have lost electrons (oxidation) and the oxygen has gained electrons (reduction). This is remembered by **OIL RIG: Oxidation Involves Loss and Reduction Involves Gain**.

Both the hydrogen and oxygen in the second half reaction have gained electrons (reduction).