

## 9.1 – Introduction to Oxidation and Reduction

### 9.1.1 - Define oxidation and reduction in terms of electron loss and gain

**Oxidation** – The loss of electrons from a substance. This may happen through the gain of oxygen or loss of hydrogen

**Reduction** – The gain of electrons. This may happen through the loss of oxygen, or gain of hydrogen, or decrease in oxidation number

### 9.1.2 - Deduce the oxidation number of an element in a compound

When oxidation numbers are assigned to an atom, we assume that the electron transfer was complete, even if this is not the case.

In order to deduce the oxidation number, we **use the following rules**:

- The oxidation number of each atom in a pure element is **zero** (such as  $O_2$ )
- The oxidation number of an atom in a monatomic ion is equal to the **charge of the ion** (such as  $S^{2-}$ )
- In compounds that contain oxygen, each oxygen atom has an oxidation number of **-2** (such as  $H_2O$  and  $CO_2$ ). The exceptions include  $OF_2$  (**+2**) and peroxides (**-1**)
- In compounds containing hydrogen, each hydrogen atom has an oxidation number of **+1** (such as  $NH_3$  and  $H_2O$ ). The exceptions include metal hydrides, like  $NaH$  (**-1**)
- For a molecule, the sum of the oxidation numbers of the constituent atoms equals **zero** (such as  $CH_4 = C^{-4} + 4H^{+1} = 0$ )
- For a polyatomic ion, the sum of the oxidation numbers of the constituent atoms equals the **charge of the ion** (such as  $PO_4^{-3} = P^{+5} + 4O^{-2} = -3$ )
- In a compound, the most electronegative atom is assigned the **negative oxidation number** (such as  $SF_6 = F^{-1}$  and  $S^{+6}$ )



By convention, the sign (+ or -) is written **before the oxidation number**, for example:  $\text{Mn}^{+7}$

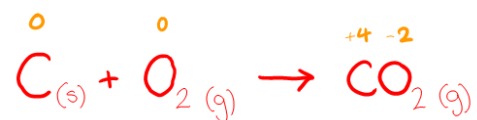
### 9.1.3 - State the names of compounds using oxidation numbers

Since elements like the transition metals can have a few oxidation states, the oxidation number is written with the name of the element in a compound using **Roman numerals**.

Examples include iron (II) oxide or nitrogen (IV) oxide. The oxidation number is always written in brackets after the name of the element.

### 9.1.4 - Deduce whether an element undergoes oxidation or reduction in reactions using oxidation numbers

Using the **change in oxidation number** of an atom, we can determine whether oxidation or reduction has occurred in a reaction. In the equation, the numbers are written above the element.



In the carbon atom, the oxidation number has increased by four, whilst the oxygen atoms have decreased by two. If the oxidation number **increases**, then oxidation has occurred, whilst if the number **decreases**, then reduction has occurred.

