Rules for Assigning the Oxidation State or Oxidation Number (ON)

1. **For a monatomic ion the ON is equal to the charge**. [For Fe^{3+} ON = +3 ; for Cl^- ON = –1]

2. **For an atom in elemental form the ON = zero**. [For Na(s) ON = 0 ; for O_2(g) ON = 0]

3. Group I atoms have ON = +1 in compounds (except hydrogen has ON = –1 in hydrides, e.g. NaH), Group II metals have ON = +2

   [For K in KNO_3 ON = +1 ; for Ca in $CaSO_4$ ON = +2 ; for H in H_2O ON = +1]

4. Fluorine in compounds has ON = –1; chloride, bromide and iodide have ON = –1.

   [For Cl in $MgCl_2$ ON = –1 ; for F in ClF_3 ON = –1]

5. **Oxygen is assigned ON = –2 whenever possible**. [For O in $NaNO_3$ ON = –2 ; for O in H_2O_2 ON = –1 because H has ON = +1; for O in O_3 ON = 0 because O_3 is elemental ; for O in H_3PO_4 ON = –2]

6. **Oxidations numbers for all atoms must add up to the charge in all molecules, ions, and radicals**.

   In $NaNO_3$ Na has ON = +1 ; O has ON = –2 ; so <u>N has ON = +5</u> because (+1) + (+5) + (–2)×3 = 0.

   In $Cr_2O_7^{2-}$ O has ON = –2 ; so (each) <u>Cr has ON = +6</u> because (+6)×2 + (–2)×7 = –2.

   In $KClO_4$ K has ON = +1 ; O has ON = –2 so <u>Cl has ON = +7</u> because (+1) + (+7) + (–2)×4 = 0.

Definitions:

Loss of **E**lectrons is **O**xidation **LEO** or **Oxidation** is increase in oxidation number

Gain of **E**lectrons is **R**eduction **GER** or **Reduction** is decrease in oxidation number

$$\overbrace{}^{\text{oxidation}} \qquad 0 \longrightarrow +2$$

$$Cu(s) + 2\,Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2\,Ag(s)$$

$$\underbrace{}_{\text{reduction}} \qquad +1 \longrightarrow 0$$

Copper(II) is the oxidation product. Silver solid is the reduction product.

Copper solid is the **reducing agent**. Silver(I) is the **oxidizing agent**.

The reducing agent is the reactant in the oxidation half-reaction; it is itself oxidized—it gives up electrons.

The oxidizing agent is the reactant in the reduction half-reaction; it is itself reduced—it takes in electrons.