REDOX REACTIONS

What is Oxidation and Reduction?

Oxidation: oxygen is gained

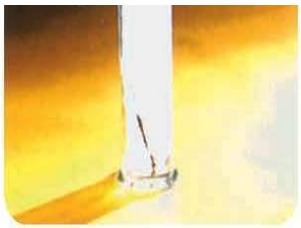
Magnesium burns in air with a dazzling white flame. A white ash is formed. The reaction is:

magnesium + oxygen ⟶ magnesium oxide

$2Mg\,(s) + O_2\,(g) \longrightarrow 2MgO\,(s)$

The magnesium has gained oxygen. We say it has been oxidised.

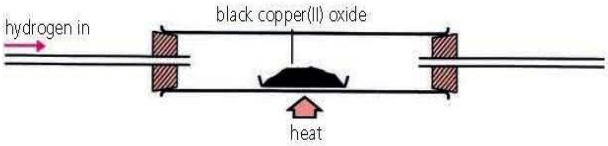
A gain of oxygen is called *oxidation*. The substance has been oxidised.



▲ Magnesium burning in oxygen.

Reduction: oxygen is lost

Now look what happens when hydrogen is passed over heated copper(II) oxide. The black compound turns pink:



This reaction is taking place:

copper(II) oxide + hydrogen ⟶ copper + water

$CuO\,(s) + H_2\,(g) \longrightarrow Cu\,(s) + H_2O\,(l)$

This time the heated substance is *losing* oxygen. It is being **reduced**.

A loss of oxygen is called *reduction*. The substance is reduced.

Write a word and chemical equation to illustrate:-

(a) Oxidation of Aluminium

(b) Reduction of Lead(II)oxide by Carbon

Another definition of Oxidation and Reduction is as follows:

Remember OILRIG!
Oxidation **I**s **L**oss of electrons.
Reduction **I**s **G**ain of electrons.

Two ways to show oxidation
You can show oxidation (the loss of electrons) in two ways:

$Mg \longrightarrow Mg^{2+} + 2e^-$

or

$Mg - 2e^- \longrightarrow Mg^{2+}$

Both are correct!

From half-equations to the ionic equation

Adding the balanced half-equations gives the **ionic equation** for the reaction.
An ionic equation shows the ions that take part in the reaction.

For example, for the reaction between chlorine and potassium bromide:

$$Cl_2 + 2e^- \longrightarrow 2Cl^-$$
$$2Br^- \longrightarrow Br_2 + 2e^-$$
$$Cl_2 + \cancel{2e^-} + 2Br^- \longrightarrow 2Cl^- + Br_2 + \cancel{2e^-}$$

The electrons cancel, giving the ionic equation for the reaction:

$$Cl_2 + 2Br^- \longrightarrow 2Cl^- + Br_2$$

Redox: a summary

Oxidation is gain of oxygen, or loss of electrons.
Reduction is loss of oxygen, or gain of electrons.
Oxidation and reduction always take place together, in a **redox reaction**.

The rules for oxidation states

1 Each atom in a formula has an oxidation state.

2 The oxidation state is usually given as a Roman numeral.
Note these Roman numerals:

number	0	1	2	3	4	5	6	7
Roman numeral	0	I	II	III	IV	V	VI	VII

3 Where an element is not combined with other elements, its atoms are in oxidation state 0.

4 Many elements have the same oxidation state in most or all their compounds. Look at these:

Element	Usual oxidation state in compounds
hydrogen	+I
sodium and the other Group I metals	+I
calcium and the other Group II metals	+II
aluminium	+III
chlorine and the other Group VII non-metals, in compounds without oxygen	−I
oxygen (except in peroxides)	−II

5 But atoms of transition elements can have variable oxidation states in their compounds. Look at these:

Element	Common oxidation states in compounds
iron	+II and +III
copper	+I and +II
manganese	+II, +IV, and +VII
chromium	+III and +VI

So for these elements, the oxidation state is included in the compound's name. For example iron(III) chloride, copper(II) oxide.

6 Note that in any formula, the oxidation states must add up to zero.

OXIDIZING AND REDUCING AGENTS

An oxidising agent oxidises another substance – and is itself reduced
A reducing agent reduces another substance – and is itself oxidised.

Oxidants and reductants

- Oxidising agents are also called **oxidants**.
- Reducing agents are called **reductants**.

Remember OILRIG!

Oxidation Is Loss of electrons.
Reduction Is Gain of electrons.

1. Potassium Manganate(VII): An Oxidizing agent

$$\underset{\text{manganate(VII) ion (purple)}}{MnO_4^-(aq)} \xrightarrow{\text{reduction}} \underset{\text{manganese(II) ion (colourless)}}{Mn^{2+}(aq)}$$

Colour Change from purple to Colourless

2. Potassium dichromate(VI) : Oxidizing agent

$$\underset{\text{dichromate(VI) ion (orange)}}{Cr_2O_7^{2-}(aq)} \xrightarrow{\text{reduction}} \underset{\text{chromium(III) ion (green)}}{2Cr^{3+}(aq)}$$

This colour change means that potassium dichromate(VI) can be used to test for the presence of reducing agents.

Outside the lab, it is used to test for alcohol (ethanol) on a driver's breath, in the **breathalyser test**. It oxidises ethanol to ethanal:

$$\underset{\text{ethanol}}{C_2H_5OH} \xrightarrow{K_2Cr_2O_7} \underset{\text{ethanal}}{CH_3CHO}$$

So a colour change proves that the driver had been drinking.

3. Potassium iodide: A reducing agent

$$\underset{\text{colourless}}{2I^-(aq)} \xrightarrow{\text{oxidation}} \underset{\text{red-brown}}{I_2(aq)}$$

Qu: Construct a table to summarize the above O.A/R.A, Reactions and Colour changes