

Chapter 12 : Redox Reactions

reduction oxidation

★ A redox reaction is a chemical reaction which involve the oxidation of a substance and reduction of another substance.

★ Conditions of oxidation:

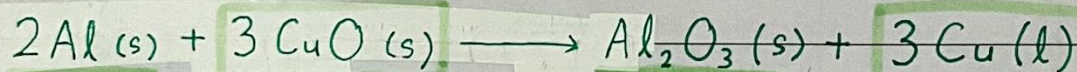
- ↳ gaining oxygen
- ↳ losing hydrogen
- ↳ losing electrons
- ↳ increasing in oxidation state

★ Conditions of reduction:

- ↳ losing oxygen
- ↳ gaining hydrogen
- ↳ gaining electrons
- ↳ decreasing in oxidation state

Gain/Loss of oxygen

E.g.



- ① : Aluminium gained oxygen, so it has been oxidised to aluminium oxide.
- ② : Copper (II) oxide lost oxygen, so it has been reduced to copper.

Gain/Loss of hydrogen

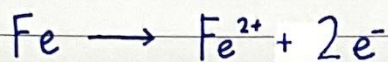
E.g.



- ③ : Hydrogen sulfide lost hydrogen, so it has been oxidised to sulfur.
- ④ : Chlorine gained hydrogen, so it has been reduced to hydrogen chloride.

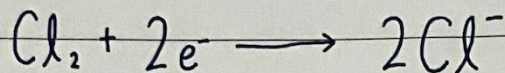
Gain/Loss of electrons

E.g.



As Fe lost 2 electrons, it has been oxidised to form a Fe^{2+} ion.

E.g.

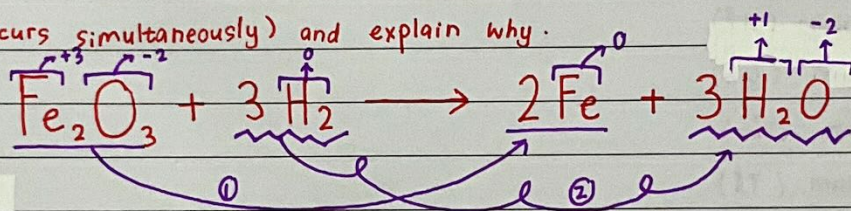


As Cl gained 1 electron, it has been reduced to become Cl^{-} ion.

Increase/decrease of oxidation state (+ common qns)

★ Oxidation state is the charge an atom of an element would have if it existed as an ion in a compound.

(E.g.) Q: State whether the reaction below is a redox reaction (oxidation & reduction occurs simultaneously) and explain why.



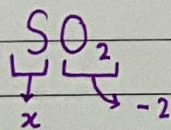
A: Yes, the reaction is a redox reaction.

① Fe is reduced as its oxidation state decreases from +3 in Fe_2O_3 to 0 in Fe.

② H is oxidised as its oxidation state increases from 0 in H_2 to +1 in H_2O .

Q: Calculate the oxidation state of sulfur in SO_2 .

A:



Let the oxidation state of S be x.

$$x + 2(-2) = 0$$

$$x - 4 = 0$$

$$x = 4$$

∴ oxidation state of S in $\text{SO}_2 = +4$.

★ Note that certain elements have default oxidation states.

- Group 1 metals = +1

↳ Lithium (Li)

↳ Sodium (Na)

↳ Potassium (K)

↳ Rubidium (Rb)

↳ Caesium (Cs)

↳ Francium (Fr)

- Group 2 metals = +2

↳ Beryllium (Be)

↳ Magnesium (Mg)

↳ Calcium (Ca)

↳ Strontium (Sr)

↳ Barium (Ba)

↳ Radium (Ra)

- Group 3 metals = +3

↳ Aluminium (Al)

↳ Gallium (Ga)

↳ Indium (In)

↳ Thallium (Tl)

↳ Nihonium (Nh)

- Group 17 Halogens = -1

↳ Fluorine (F)

↳ Chlorine (Cl)

↳ Bromine (Br)

↳ Iodine (I)

- Oxygen = -2 (O)

↳ In H_2O_2 = -1 (exception)

- Hydrogen = +1 (H)

↳ In metal hydrides = -1 (exception)

★ Oxidation agent is a substance which causes the other substance to be oxidised while it itself is reduced.

★ Reducing agent is a substance which causes the other substance to be reduced while it itself is oxidised.

Test for oxidising agent

1. Add aqueous potassium iodide, a reducing agent, to the substance. If the

Solution turns from colourless to brown, the I^- ions have lost electrons to form I_2 , thus they have been oxidised, and the substance is an oxidising agent.

2. Add aqueous iron(II) ion, which is a reducing agent, to the substance, and if the solution turns from green to orange, the Fe^{2+} ions have lost electrons to form Fe^{3+} , thus they have been oxidised, and the substance is an oxidising agent.

Test for reducing agents

★ Add acidified potassium manganate (VII), an oxidising agent, to the substance, and if the solution turns from purple to colourless, the MnO_4^- ions lose oxygen to form Mn^{2+} ions, thus they have been reduced, and the substance is a reducing agent.