Reactivity of non-metals —

The reactivity of non-metals depends on their oxidising power.

Oxidising power of halogen decreases as it moves down the group.

∴ Fluorine is the strongest oxidising agent.

$X^- = Cl^-$, Br^- and I^-

$$2X^-(aq) + Cl_2(g) \longrightarrow X_2 + 2Cl^-(aq) \quad [X^- = Br^-, I^-]$$

$$\overset{-1}{2Br^-}(aq) + \overset{0}{Cl_2}(g) \longrightarrow \overset{0}{Br_2}(l) + \overset{-1}{2Cl^-}(aq)$$

Layer test —

The basis of identifying Bromine (Br^-) and Iodine (I^-) ions in a laboratory by carbon tetrachloride [CCl_4] or carbon disulphide [CS_2] is known as layer test.

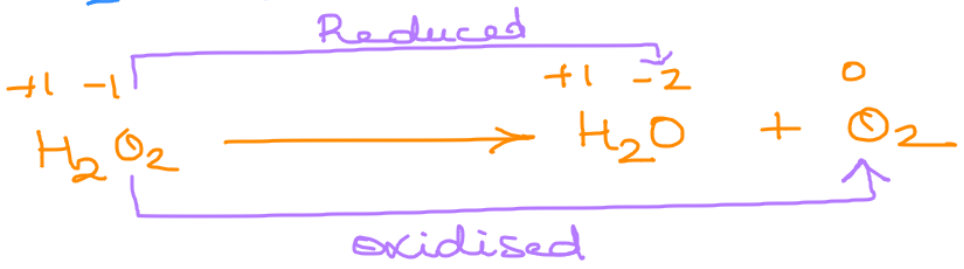
4. Disproportionation reaction —

In such reactions one element in one oxidation state is simultaneously oxidised & reduced.

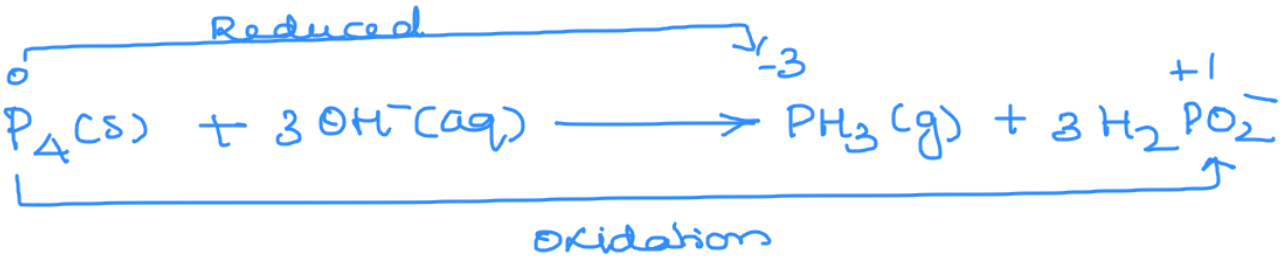
i.e one reacting substance in a disproportionation reaction always contains an element that can exhibit at least three oxidation states.

e.g (1) H_2O_2 [Hydrogen peroxide]

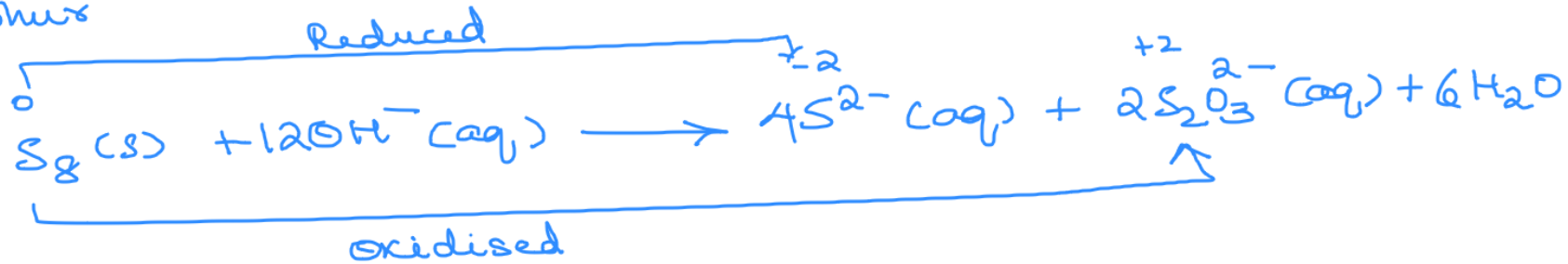
$$2H_2O_2(aq.) \longrightarrow 2H_2O(l) + O_2(g)$$

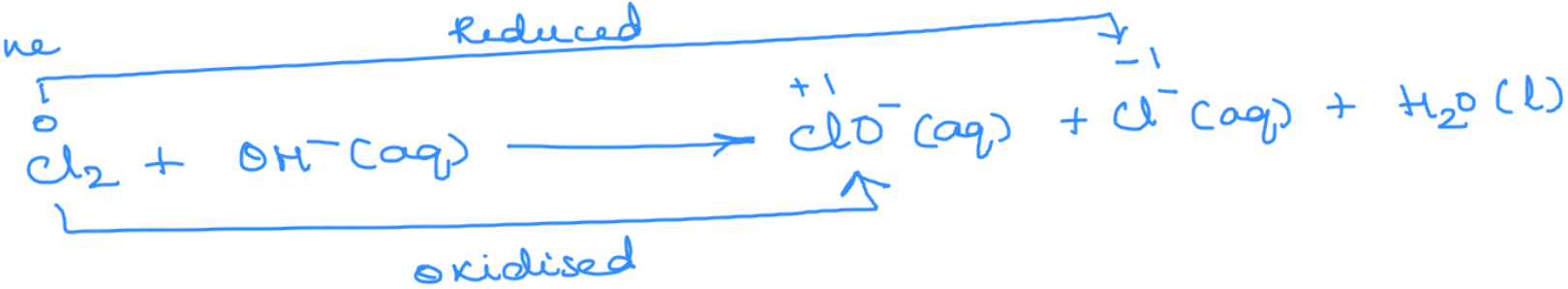


Oxygen decreases from −1 to −2 in (H_2O) and increases from −1 to 0 in O_2.

(iii) 

[Phosphorus]

(iii) Sulphur 

(iv) Chlorine 

Balancing of oxidation – Reduction reactions —

Two methods —

1. Oxidation number method
2. Ion electron method or half equation method.

1 Oxidation number method —

The total increase in oxidation number must be equal to total decrease in oxidation number.

Steps for balancing redox equations by oxidation number method.

Step 1 :

Write redox skeletal equation for all the known reactant & product of the reaction.

Step 2 :

Indicate the oxidation number of all the atoms in each compound above the symbol of the element.

Step 3:

Identify the elements or element which undergoes a change in oxidation number.

Usually only two elements will be involved one whose oxidation number increases [reducing agent] & the other whose oxidation number decreases [oxidising agent].

Step 4:

Calculate the increase / decrease in oxidation numbers per atom. If more than one atom of the same element is involved find out the total increase or decrease in O.N. with the number of atoms which are undergoing the change.

Step 5:

Equate the increase in oxidation number with decrease in oxidation number on the reactant side by

multiplying the formulae of the oxidising and reducing agents.

Step 6 :

Balance the equation with respect to all other atoms except hydrogen & oxygen.

Step 7 :

Finally balance hydrogen and oxygen.

For balancing oxygen atoms add water molecules to the side deficient in it.

For balancing hydrogen atom [depends upon medium — acidic/basic].

(i) For reactions taking place in acidic medium add H^+ ion to the side deficient in hydrogen atom

(ii) For reactions taking place in basic medium add H_2O molecule to the side deficient in hydrogen atoms

and simultaneously add equal number of OH^- ions on the other side of the equation.

Step 3:

Finally balance the equation by cancelling common species present on both sides of the equation.

Reaction between zinc and hydrochloric acid —

Step 1:

$$Zn + HCl \longrightarrow ZnCl_2 + H_2$$

Step 2:

$$\overset{0}{Zn} + \overset{+1\ -1}{HCl} \longrightarrow \overset{+2\ -1}{ZnCl_2} + \overset{0}{H_2}$$

Step 3:

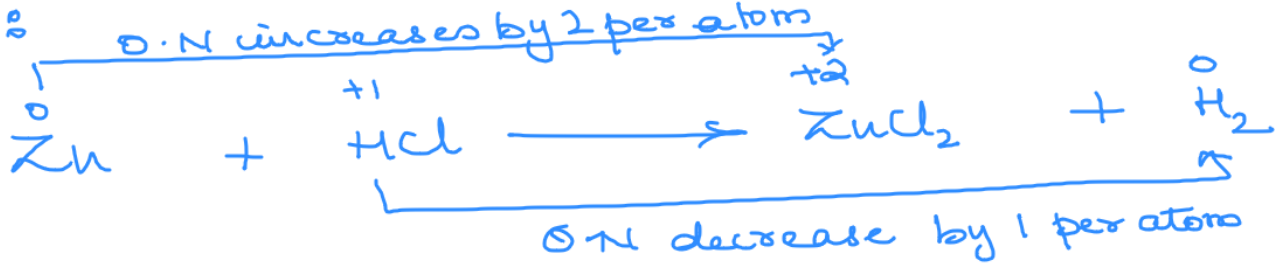
$$\overset{0}{Zn} + \overset{+1\ -1}{HCl} \longrightarrow \overset{+2\ -1}{ZnCl_2} + \overset{0}{H_2}$$

Oxidation number of zinc has increased from 0 to +2

While oxidation number of hydrogen has decreased from +1 to 0. oxidation number of chlorine remains the same on both sides of the equation.

∴ Zinc is reducing agent & HCl is oxiding agent.

Step 4 :



Step 5 :

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Zn atom is multiplied by 1 and HCl by 2.

Step 6 :

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Que. Copper reacts with nitric acid. A brown gas is formed and the solution turns blue. The equation may be written as

$$Cu + NO_3^- \longrightarrow NO_2 + Cu^{2+}$$

Balance the equation by oxidation number method.

Ans. **Step 1:** Skeletal equation

$$Cu + NO_3^- \longrightarrow NO_2 + Cu^{2+}$$

Step 2: Writing oxidation number of each atom

$$\overset{0}{Cu} + \overset{+5\,-2}{NO_3^-} \longrightarrow \overset{+4\,-2}{NO_2} + \overset{+2}{Cu^{2+}}$$

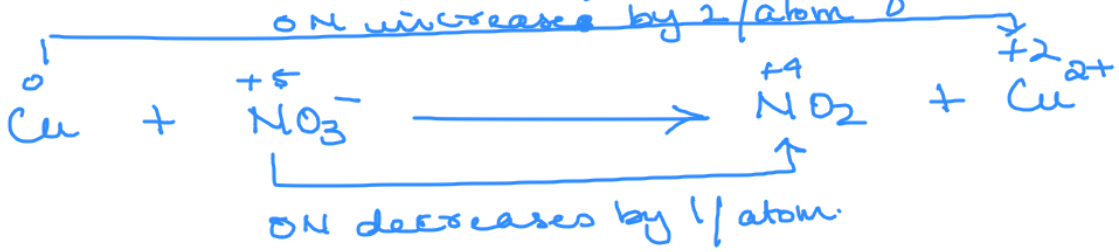
Step 3:

$$\overset{0}{Cu} + \overset{+5}{NO_3^-} \longrightarrow \overset{+4}{NO_2} + \overset{+2}{Cu^{2+}}$$

oxidation number of copper has increased from 0 to +2

while nitrogen decreases from +5 to +4.

Step 4: Show the increase / decrease of oxidation number



Step 5: Balance increase / decrease in oxidation number by multiplying NO_3^- by 2 and Cu by 1.

$$Cu + 2NO_3^- \longrightarrow NO_2 + Cu^{2+}$$

Step 6: Balance other atoms except H & O

$$Cu + 2NO_3^- \longrightarrow 2NO_2 + Cu^{2+}$$

Step 7: Reaction ~~takes~~ takes place in acidic medium so add H^+ ions to the side deficient with H^+ and balance H and O atom.

$$Cu + 2NO_3^- + 4H^- \longrightarrow 2NO_2 + Cu^{2+} + 2H_2O$$