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Class 11
Chemistry

Chapter 12

Halogens

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CH 12 : HALOGENS

Introduction to halogens

Halogen, any of the six nonmetalic elements that constitute (Group VII A) of periodic table. The halloge elements are flourine (F), chlorine (Cl), bromine (Br), iodine (I), astatine (At), and tennessine (Ts). The word "halogen" is derived from Greek words "halous" meaning salt and "gen" meaning former so it means "salt former" or "salt maker". When halogens react with metals, they produce a wide range of salts, includings sodium chloride, silver bromide and potassium iodide.

Physical Properties

- The halogens have a strong and often nasty smell.
- The halogens elements are extremely toxic.
- They are poor conductors of heat and electricity.
- Low melting and boiling points.

Volatility

As, you move down the group, the halogens become less volatile and darker. The decrease in their volatility is due to the increase in shell size. Halogen molecules are non-polar.

Reactivity of Halogens

The reactivities of the halogens decrease down the group.

$$F > Cl > Br > I > At$$

-Reasons

Increase in size: This is due to the fact that the atomic radius increases in size with an increase of electronic energy levels. This lessens the attraction for valence electrons of other atoms, decreasing reactivity.

Decrease in Electronegativity: This decrease also occurs because electronegativity decreases down a group; therefore, there is less electron "pulling". In addition, there is a decrease in oxidizing ability down the group.

Oxidizing properties of Halogens

Halogens serve as a strong oxidizing agent due to their high electronegativity and electron affinity, allowing them to take electrons from other elements quickly and easily and oxidize them. As a result, it is an excellent oxidizing agent.

$$At < I < Br < Cl < F$$

Flourine is such a strong oxidizing agent that conducting solution reactions is difficult. Chlorine can accept electrons from both iodined and bromide ions. Bromine and Iodine will not be able to recover those electrons from choloride ions produced.

$$F_2 + 2KCl \longrightarrow 2KF + Cl_2$$

$$F_2 + 2KBr \longrightarrow 2KF + Br_2$$

Reactions of halogens with hydrogen

Halogens react with hydrogen to form hydrogen halides.

$$H_2 + X_2 \longrightarrow 2HX$$

The relative reactivity of halogens in these reactions decreases from fluorine to iodine.

- Fluorine combines explosively with hydrogen even in the cold and darkness to form hydrogen fluoride gas.
- Chlorine and hydrogen explode when exposed to sunlight or flame to form hydrogen chloride gas.
- Bromine vapour and hydrogen together produce a small explosion when ignited, hydrogen bromide gas is produced.
- Iodine and hydrogen combine only partially even with continued heating.

Thermal Stability of Hydrogen Halides (HX)

The thermal stability of hydrogen halides or the trend concerning how these compounds decompose when heated, generally decreases as you move down the group

$$HF > HCl > HBr > HI$$

This trend results primarily from the strength of the hydrogen-halogen bond, which becomes weaker as the radius of the halogen atom gets larger. Hydrogen fluoride is the most thermally stable due to its strongest bond resulting from the smallest size of flourine. Hydrogen iodine, on the other hand, is the least stable because iodine is the largest halogen atom and thus forms the weakest bond with hydrogen.

Acidic Stength of Halogen Acids

The order of acidic strength of halogon acids.

$$HI > HBr > HCl > HF$$

The more the bond length b/w hydrogen and other atoms the more acidic it is in nature. That is why as the size of iodine is the largest the bond length will be more and hence it will have highest acidic strength in all given halogen. As fluorine is very electronegative but at the same time its ionic size is small that is why HF is considered to be one of the weakest acids

Reactivity of Halide Ions

The reducing power of an anion depends on how easily it can lose electrons. As you go down the group reducing power of a halide ions increases due to a decrease in attraction b/w the nucleus and valance electrons, so the ease with which a halide ion can lose electrons increases. Hence I^- has the strongest reducing power and F^- the weakest.

-With Sulphuric acid

Flouride and Chloride ions are weak reducing agents so they can not reduce concentrated H_2SO_4

$$NaF + H_2SO_4 \longrightarrow NaHSO_4 + HF$$

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$$

But bromide ions have enough strong reducing power and can reduce concentrated H_2SO_4 to sulphur dioxide.

$$2HBr + H_2SO_4 \longrightarrow SO_2 + Br_2 + H_2O$$

Iodide ions are even stronger reducing agent and can reduce concentrated H_2SO_4 to hydrogen sulphide.

$$8HI + 4H_2SO_4 \longrightarrow 4H_2S + 4I_2 + 4H_2O$$

-Reaction with silver nitrate

When the ageous solution of silver nitrate is treated with ageous solution of a halide salt. Colored precipitates are formed.

$$X^{-1} + AgNO_3 \longrightarrow AgX + NO_3^{-1}$$

Chloride form white ppt. which remain un-dissolved on adding aquause ammonia.
Bromide form cream or off-white ppt. which partially dissolve in aqeuse ammonia.
Iodide form yellow ppt. which remains undissolved in aquous ammonia.

- Reaction of Chlorine with water

Chlorine dissolves in water producing hydrochloric acid (HCl) and hypochlorus acid (HOCl), which is a very reactive species.

$$Cl_2 + H_2O \longrightarrow HCl + HOCl$$

It decomposes to produce atomic oxygen which can kill bacteria present in water. For this reason, Cl_2 is used in the purification of bacteria. This process is called chlorination.

$$HOCl \longrightarrow HCl + [O]$$

In sunlight, or on standing, HOCl decomposes to produce O_2.

$$HOCl \longrightarrow HCl + O_2$$