

Chapter	13 Halogens	Class	1 st Year	Subject	Chemistry
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Give Short Answers of the Following Questions

1. The reducing power of halide ions decreases in the order: $I^- > Br^- > Cl^- > F^-$. Give reason.

Ans. Iodide is the best reducing agent due to its large size and low electronegativity, making electron loss easier. Fluoride, being small and highly electronegative, holds its electrons tightly and resists oxidation. As size increases and electronegativity decreases, the tendency to donate electrons (reducing power) increases.

2. The thermal stability of hydrogen halides decrease down the group. Why?

Ans. The thermal stability of hydrogen halides decreases in the order: $HF > HCl > HBr > HI$. This is because the H-X bond strength decreases down the group. HF has the strongest bond due to the small size of fluorine, making it more stable to heat. As the size of halogen increases from F to I, the H-X bond becomes weaker and easier to break on heating.

3. Bond strength in halogens decreases as we move down the group from chlorine to Iodine. Why?

Ans. Bond strength in halogens decreases as we move down the group from chlorine to iodine. This is due to the increase in the atomic size down the group which results in longer bond lengths and weaker bonds. Moving from top to bottom in group 17, the bond energy of halogens decreases gradually from chlorine to iodine.

4. The thermal stability of hydrogen halides decrease down the group. Why?

Ans. Halogens are non-polar and instantaneous dipole-induced forces play a significant role in determining the volatility of halogens. The forces depend on factors like molecular size, shape and polarizability, with stronger forces leading to lower volatility and higher boiling points. The first two halogens, i.e., fluorine (colourless or very light green) and chlorine (greenish yellow) are gases due to weaker intermolecular forces. Bromine is a liquid as its size is bigger and it possesses stronger intermolecular forces than fluorine and chlorine. Iodine has the strongest forces among the group, so it is in solid state at room temperature.

5. The reactivity of halogens with hydrogen decreases down the group. Why?

Ans. The reactivity of halogens with hydrogen decreases down the group: $F_2 > Cl_2 > Br_2 > I_2$. This is because bond dissociation energy of H-X decreases and halogens become less electronegative down the group. Fluorine forms a strong H-F bond and is highly reactive due to its small size and high electronegativity. As we move down, halogens form weaker H-X bonds and react less readily with hydrogen.

6. What is disproportionation reaction?

Ans. Those reactions in which a single element undergoes both oxidation and reduction simultaneously are known as disproportionation reactions. When chlorine reacts with cold and hot aqueous hydroxide (NaOH), it undergoes disproportion and forms different products according to the temperature of the reaction.

7. The thermal stability of hydrogen halides decrease down the group. Why?

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Ans. Chlorine undergoes disproportion when it reacts with cold aqueous sodium hydroxide (NaOH) forming sodium chloride (NaCl) and sodium chlorate (I) (NaClO).



Oxidation states of chlorine in the above reaction are given below:

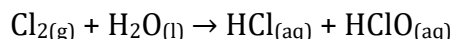
Chlorine in $\text{Cl}_2 = 0$

Chlorine in $\text{NaCl} = -1$

Chlorine in $\text{NaClO} = +1$

8. What happens when chlorine react with water?

Ans. When chlorine gas (Cl_2) is added to water, it undergoes hydrolysis to form a mixture of hydrochloric acid (HCl) and chloric (I) acid (HClO).



Chlorine (I) acid (HOCl) is a weak acid and partially dissociate in water to form hydrogen ions (H^+) and chlorate (I) ion (OCl^-).

9. How do pH chlorine dose affect the disinfection?

Ans. pH:

At pH around 6-7.5, HOCl predominates and makes the disinfection process more effective.

At higher pH (above 7.5), OCl^- predominates, it is less effective but still provides disinfection.

Chlorine Dose:

The higher the amount of chlorine, the more effective the disinfection. Sufficient chlorine must be added to get enough HOCl and OCl^- to kill bacteria.

Contact Time:

Contact time of water with chlorine must be long enough, to allow the disinfectants to penetrate and bacteria, viruses and protozoa.

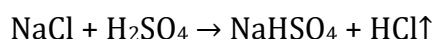
10. Write reaction of halides with concentrated Sulphuric acid.

Ans. Halides react differently with concentrated sulphuric acid (H_2SO_4) depending on their nature:

Fluoride (F^-) and Chlorine (Cl^-):

Act as acids only – produce HF or HCl gas.

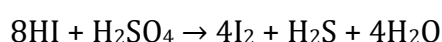
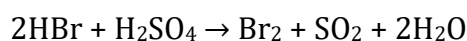
Example:



Bromide (Br^-) and Iodide (I^-):

Act as reducing agents – reduce H_2SO_4 and are oxidized to Br_2 or I_2 .

Example:



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Trend: Reducing ability increases from $\text{Cl}^- < \text{Br}^- < \text{I}^-$.

11. Which halogen is the least reactive, which is the most reactive? Give reason.

Ans. • Most reactive halogen: Fluorine (F_2)

• Least reactive halogen: iodine (I_2)

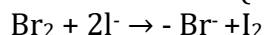
Reason:

- As we go down Group 17 in the periodic table
- Atomic size increases
- Electronegativity decreases
- Bond energy decreases

This makes fluorine the most reactive because it attracts electrons strongly iodine is the least reactive because its larger atoms hold electrons less tightly.

**12. The ionic equation for a reaction is: $\text{Br}_2 + 2\text{I}^- \rightarrow 2\text{Br}^- + \text{I}_2$
Explain which species is oxidized in this reaction. Why?**

Ans. The given reaction is a redox (displacement) reaction:



Observations:

Oxidation: $\text{I}^- \rightarrow \text{I}_2 + 2\text{e}^-$ (iodide is oxidized, losing electrons).

Reduction: $\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^-$

Displacement:

- Br_2 (stronger oxidant) displaces I^- from its compound, confirming the trend:
- Br_2 is more reactive than I_2 in the halogen reactivity series.

In short:

- Spontaneous reaction (Br_2 has higher reduction potential than I_2).
- Net ionic form (spectator ions omitted)
- Species is oxidized in this Reaction:
- Iodide ion (I^-) is oxidized.
- loses electrons and forms iodine (I_2).
- Oxidation means loss of electrons.

So, iodide is oxidized and bromine is reduced.

13. What the role of London dispersion forces in the trend of volatility of halogens?

Ans. Role of London dispersion forces in the trend volatility of Halogens:

- London dispersion forces are weak forces between molecules.
- As you move down the group, atoms become larger, so dispersion forces become stronger.
- Stronger forces mean lower volatility (less easily turned to gas).
- This is the reason that fluorine (gas) is most volatile and iodine (solid) is least volatile.

14. How does the reactivity of halogens with hydrogen vary?

Ans. Reactivity decreases down the group:

- Fluorine reacts explosively with hydrogen.
- Chlorine reacts quickly in light.
- Bromine reacts slowly.

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- Iodine reacts very slowly and incompletely.
This is due to decreasing bond strength and oxidizing power down the group.

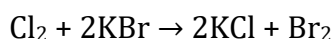
15. Which halogen is used as an antiseptic? How does it work?

Ans. Halogen is used as an Antiseptic:

- Iodine is used as an antiseptic.
- It kills bacteria by oxidizing their cell contents.
- Often used in the form of tincture of iodine (iodine + alcohol).

16. What is the colour change when chlorine displaces bromine?

Ans. Chlorine displaces bromine from a solution of potassium bromine:

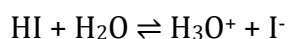
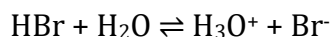
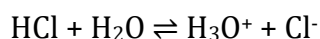
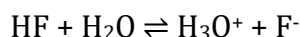


Observation:

- Colourless solution turns reddish-brown due to the formation of bromine.

17. How the halogen acids are ionized in water?

Ans. Halogen acids ionize in water and form Halide ions and hydronium ions (H_3O^+)



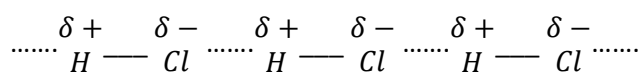
18. Why HF is weaker acid than HCl?

Ans. HF is a weaker acid than HCL (Acidic strength $\propto$ Ionization)

A substance which has a tendency to give proton (H^+) in an aqueous solution is called acid. The strength of an acid is directly proportional to its proton (H^+) releasing power.

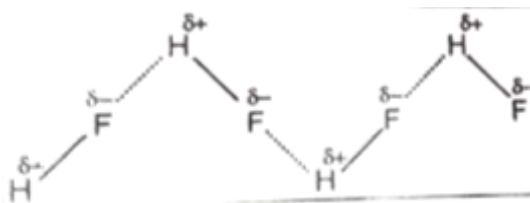
HF has weak acidic properties in aqueous solution to incomplete dissociation of HF molecule in water. In HF, strong hydrogen bonding is present and partially positive hydrogen is entrapped between two strong electronegative fluorine atoms. Moreover, HF has a strong polar covalent bond with high bond energy (566 kJ/mol). So, Hydrogen ions (H^+) are not released easily. As a result it becomes difficult for proton (H^+) to be ionized (released) resulting in lower concentration of hydrogen ions compared to stronger acids like HCL in water making HF a weaker acid.

On the other hand in HCl dipole-dipole interaction is present which is weaker than hydrogen bonding. Therefore proton (H^+) releasing power of HCl is more which makes it strong acid.



Therefore, it is not easy for HF to release H^+ as compared to HCL. It makes HF weaker acid than HCL.

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19. Describe a simple chemical test that could be used to distinguish between aqueous solutions of potassium bromide and potassium iodide. Include the reagents and expected observations.

Ans. Reagents:

- Chlorine water
- Organic solvent (like carbon tetrachloride or hexane)

Procedure & Observation:

- Add chlorine water to both solutions.
- Then shake with organic solvent.

Solution	Observation	Conclusion
KBr	Reddish-brown layer	Br ₂ formed
KI	Purple/violet layer	I ₂ formed

20. Explain the chemical principles behind the use of chlorine as a disinfectant in water purification. Include relevant chemical equations in your explanation.

Ans. Chlorine kills bacteria by forming hypochlorous acid (HOCl):



HOCl is a strong oxidizing agent. It penetrates and destroys bacteria cells.

21. Describe one significant disadvantage associated with the use of chlorine in water purification.

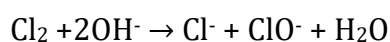
Ans. Disadvantage:

- **Chlorine** reacts with organic matter in water to form harmful by-products called trihalomethanes (THMs).
- These can be carcinogenic (cancer-causing).

22. What is disproportionation reaction? Give an example.

Ans. A disproportionation reaction is when one element is both oxidized and reduced in the same reaction.

Example:



Chlorine goes from 0 to -1 (reduced) and 0 to +1 (oxidized).

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23. Chlorine gas reacts differently with sodium hydroxide solution depending on the temperature and concentration.

Ans. Yes. It forms different products with cold and hot NaOH.

24. Write balanced chemical equations for the reaction of chlorine (Cl₂).

i) Cold, dilute sodium hydroxide (NaOH).

ii) Hot, concentrated sodium hydroxide (NaOH).

Ans. i) Cold dilute NaOH: $\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$

ii) Hot, dilute NaOH: $3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$

25. For each reaction in question 1), identify the oxidation states of chlorine in the reactant (Cl₂) and in each of the chlorine-containing products. Use these oxidation states to explain why both reactions are classified as disproportionation reactions.

Ans. Cold reaction:

- $\text{Cl}_2(0) \rightarrow \text{Cl}^- (-1) = \text{reduction}$
- $\text{Cl}_2(0) \rightarrow \text{ClO}^- (+1) = \text{oxidation}$

Hot reaction:

- $\text{Cl}_2(0) \rightarrow \text{Cl}^- (-1) = \text{reduction}$
- $\text{Cl}_2(0) \rightarrow \text{ClO}_3^- (+5) = \text{oxidation}$
- In both reactions, chlorine is oxidized and reduces- a disproportionation reaction.