Class: 12th

Subject: Chemistry

Chapter 5: The Halogens And The Noble Gases

🩸 Key Points – Halogens & Noble Gases (10 Important MCQs)

1. The reactivity of halogens _____ down the group.

(a) Increases

(b) Decreases ✅

(c) Remains same

(d) First increases then decreases

2. Which halogen is a solid at room temperature?

(a) Fluorine

(b) Chlorine

(c) Bromine

(d) Iodine ✅

3. Fluorides are usually _____ in nature.

(a) Covalent

(b) Metallic

(c) Ionic ✅

(d) Polar

4. Fluorine shows which oxidation state only?

(a) +1

(b) -1 ✅

(c) +5

(d) +7

5. The oxidizing power of halogens decreases in the order:

(a) $F_2 > Cl_2 > Br_2 > I_2$ ✅

(b) $I_2 > Br_2 > Cl_2 > F_2$

(c) $Cl_2 > F_2 > Br_2 > I_2$

(d) $F_2 > Br_2 > I_2 > Cl_2$

6. Which of the following ions is not a reducing agent?

(a) I^-

(b) Br^-

(c) Cl^- ✅

(d) F^- ✅

7. The halogens and their compounds are widely used for:

(a) Alloy formation

(b) Bleaching and refrigeration ✅

(c) Fuel production

(d) Radioactive tracing

8. Noble gases are placed in which group of the periodic table?

(a) VI A

(b) VII A

(c) 0 (Zero) or VIII A ✅

(d) V A

9. The low melting and boiling points of noble gases are due to:

(a) Strong ionic bonds

(b) Weak forces of attraction ✅

(c) Metallic bonding

(d) Hydrogen bonding

10. Xenon forms which types of compounds?

(a) Only oxides

(b) Only fluorides

(c) Oxides, fluorides, and oxyfluorides ✅

(d) Only chlorides

🩸 Important MCQs:

1. The elements fluorine, chlorine, bromine, iodine and astatine are called:

(a) Noble gases

(b) Alkali metals

(c) Halogens ✅

(d) Transition elements

2. The word halogen means:

(a) Gas formers

(b) Salt formers ✅

(c) Metal formers

(d) Acid formers

3. Astatine is a:

(a) Stable element

(b) Radioactive element ✅

(c) Noble gas

(d) Transition metal

4. The most stable isotope of astatine has a half-life of:

(a) 8.3 seconds

(b) 8.3 minutes

(c) 8.3 hours ✅

(d) 8.3 days

5. Halogens exist as:

(a) Monoatomic molecules

(b) Triatomic molecules

(c) Diatomic molecules ✅

(d) Polyatomic molecules

6. Fluorine and chlorine at room temperature are:

(a) Solids

(b) Liquids

(c) Gases ✅

(d) None of these

7. Bromine is a:

(a) Greenish gas

(b) Red-brown liquid ✅

(c) Black solid

(d) Colourless gas

8. Iodine appears as a:

(a) Yellow gas

(b) Greyish black solid ✅

(c) Red-brown liquid

(d) Colourless gas

9. Halogens are:

(a) Unreactive metals

(b) Reactive non-metals ✅

(c) Inert gases

(d) Transition elements

10. The general electronic configuration of halogens is:

(a) ns^2np^4

(b) ns^2np^5 ✅

(c) ns^2np^6

(d) ns^2np^3

11. The halogen with the highest ionization energy is:

(a) Iodine

(b) Bromine

(c) Chlorine

(d) Fluorine ✅

12. The halogen that holds its electrons most tightly is:

(a) Iodine

(b) Fluorine ✅

(c) Bromine

(d) Chlorine

13. The van der Waal's forces are strongest in:

(a) Fluorine

(b) Chlorine

(c) Bromine

(d) Iodine ✅

14. None of the halogens occur freely in nature because they are:

(a) Metals

(b) Inert

(c) Highly reactive ✅

(d) Insoluble in water

15. In nature, halogens are mostly found as:

(a) Free elements

(b) Oxides

(c) Halide ions (F^-, Cl^-, Br^-, I^-) ✅

(d) Hydroxides

16. All the free halogens act as:

(a) Reducing agents

(b) Oxidizing agents ✅

(c) Catalysts

(d) Bleaching agents

17. The oxidizing power of halogens:

(a) Increases down the group

(b) Decreases down the group ✅

(c) Remains same

(d) Changes irregularly

18. The correct order of oxidizing power among halogens is:

(a) $I_2 > Br_2 > Cl_2 > F_2$

(b) $F_2 > Cl_2 > Br_2 > I_2$ ✅

(c) $Cl_2 > F_2 > Br_2 > I_2$

(d) $F_2 > I_2 > Cl_2 > Br_2$

19. The oxidizing power of halogens depends upon:

(a) Ionization energy

(b) Energy of dissociation

(c) Electron affinity

(d) Both (b) and (c) ✅

20. The halogen with lowest energy of dissociation and highest hydration energy is:

(a) Iodine

(b) Bromine

(c) Chlorine

(d) Fluorine ✅

21. Fluorine can oxidize:

(a) Only chloride ion

(b) All halide ions ✅

(c) Only iodide ion

(d) Only bromide ion

22. Chlorine can oxidize:

(a) Only iodide ions

(b) Both bromide and iodide ions ✅

(c) Only fluoride ions

(d) All halide ions

23. Bromine can oxidize:

(a) Fluoride and chloride ions

(b) Only iodide ions ✅

(c) Chloride ions

(d) None of these

24. The standard reduction potential (E°) of F_2 is:

(a) +1.07 V

(b) +1.36 V

(c) +2.87 V ✅

(d) +0.54 V

25. The bleaching action of chlorine is due to its:

(a) Reducing nature

(b) Oxidizing nature ✅

(c) Catalytic property

(d) Acidic property

26. Hydrogen fluoride (HF) is a:

(a) Colourless gas

(b) Colourless volatile liquid ✅

(c) Red-brown liquid

(d) Yellow gas

27. Hydrogen halides give fumes in:

(a) Dry air

(b) Moist air ✅

(c) Pure nitrogen

(d) Oxygen atmosphere

28. Hydrogen fluoride attacks:

(a) Iron

(b) Glass ✅

(c) Copper

(d) Aluminum

29. The high boiling point of HF is due to:

(a) Ionic bonding

(b) Metallic bonding

(c) Hydrogen bonding ✅

(d) Van der Waal's forces

30. The bond strength of H–X decreases from:

(a) HI to HF

(b) HF to HI ✅

(c) HBr to HF

(d) HCl to HF

31. The acidic strength of hydrogen halides increases in the order:

(a) HI < HBr < HCl < HF

(b) HF < HCl < HBr < HI ✅

(c) HCl < HI < HBr < HF

(d) HBr < HCl < HF < HI

32. Hydrogen iodide is the:

(a) Weakest reducing agent

(b) Strongest reducing agent ✅

(c) Weakest acid

(d) Weakest halide

33. The oxide of iodine important for analytical use is:

(a) I_2O_4

(b) I_2O_5 ✅

(c) I_2O_3

(d) I_2O_2

34. Chlorine dioxide (ClO_2) is used as a:

(a) Fertilizer

(b) Antiseptic and bleaching agent ✅

(c) Fuel

(d) Acid-base indicator

35. The reaction of chlorine with NaOH at 15°C produces:

(a) NaCl and NaClO ✅

(b) NaCl and $NaClO_3$

(c) Only NaCl

(d) NaOH and $NaClO_3$

36. The reaction of chlorine with hot NaOH produces:

(a) NaCl and NaClO ✅

(b) NaCl and $NaClO_3$ ✅

(c) NaCl and $NaClO_2$

(d) Only NaCl

37. The type of reaction in which chlorine acts as both oxidizing and reducing agent is called:

(a) Neutralization

(b) Redox

(c) Disproportionation ✅

(d) Combination

38. The strength of oxyacids increases with:

(a) Decrease in oxidation state

(b) Increase in oxidation state ✅

(c) Decrease in number of oxygen atoms

(d) None of these

39. The strongest acid among the oxyacids of chlorine is:

(a) Hypochlorous acid (HClO)

(b) Chlorous acid ($HClO_2$)

(c) Chloric acid ($HClO_3$)

(d) Perchloric acid ($HClO_4$) ✅

40. Bleaching powder is chemically known as:

(a) Calcium chloride

(b) Calcium hypochlorite ✅

(c) Sodium hypochlorite

(d) Calcium carbonate

41. Freon is the commercial name of:

(a) Fluorides of carbon

(b) Fluorochlorocarbons ✅

(c) Hydrocarbons

(d) Chlorides of carbon

42. Freons are mainly used as:

(a) Solvents

(b) Insecticides

(c) Refrigerants and aerosol propellants ✅

(d) Bleaching agents

43. Teflon is a polymer of:

(a) Ethylene

(b) Tetrafluoroethylene ✅

(c) Vinyl chloride

(d) Styrene

44. Teflon is used for:

(a) Making fertilizers

(b) Non-stick coating and corrosion-proof parts ✅

(c) Fuel for rockets

(d) Cement industry

45. Halothane is used as:

(a) Disinfectant

(b) Anaesthetic ✅

(c) Insecticide

(d) Catalyst

46. Fluorides in toothpaste help to:

(a) Polish teeth

(b) Build protective coating on teeth ✅

(c) Whiten teeth only

(d) Dissolve tartar

47. Chlorine is used in the manufacture of:

(a) Acetic acid

(b) Hydrochloric acid ✅

(c) Nitric acid

(d) Sulphuric acid

48. Bleaching powder is prepared by using:

(a) Fluorine

(b) Chlorine ✅

(c) Bromine

(d) Iodine

49. Chlorine is used as a disinfectant in:

(a) Hospitals only

(b) Swimming pools and water treatment plants ✅

(c) Factories

(d) Laboratories

50. Polyvinyl chloride (PVC) is manufactured using:

(a) Iodine

(b) Chlorine ✅

(c) Bromine

(d) Fluorine

51. Chloroform and carbon tetrachloride are:

(a) Fuels

(b) Solvents ✅

(c) Explosives

(d) Bleaching agents

52. Ethylene dibromide is added to leaded gasoline to:

(a) Increase octane number

(b) Remove lead oxide and sulphate deposits ✅

(c) Reduce friction

(d) Decrease engine power

53. Silver bromide (AgBr) is mainly used in:

(a) Refrigeration

(b) Photography ✅

(c) Welding

(d) Batteries

54. Iodine is widely used in the:

(a) Plastic industry

(b) Pharmaceutical industry ✅

(c) Textile industry

(d) Food preservation

55. Tincture of iodine is used as a:

(a) Preservative

(b) Germicide and disinfectant ✅

(c) Bleaching agent

(d) Fuel

56. Lack of iodide in diet causes:

(a) Diabetes

(b) Goiter ✅

(c) Anemia

(d) Asthma

57. Iodized salt contains:

(a) Sodium fluoride

(b) Sodium or potassium iodide ✅

(c) Sodium bromide

(d) Sodium chloride only

58. Noble gases are also called:

(a) Reactive gases

(b) Rare gases ✅

(c) Metallic gases

(d) Acidic gases

59. Noble gases are obtained mainly from:

(a) Sea water

(b) Air by liquefaction ✅

(c) Rocks

(d) Volcanoes

60. Helium is formed on Earth as a result of:

(a) Radioactive decay ✅

(b) Photosynthesis

(c) Combustion

(d) Evaporation

🩸 Important Short Questions and Answers (Exam Point of View)

🌟 Topic: Key Points – Halogens & Noble Gases

Q1. Why are halogens highly reactive elements?

Answer:

👉 Halogens are highly reactive because they need only one electron to complete their outermost shell and achieve a stable octet configuration.

Q2. What is the trend of intermolecular forces in halogens down the group?

Answer:

👉 Intermolecular forces increase down the group; hence fluorine and chlorine are gases, bromine is liquid, and iodine is solid at room temperature.

Q3. What type of bonds do halogens form with s-block and p-block elements?

Answer:

👉 Halogens form ionic bonds with s-block metals and covalent bonds with p-block elements.

Q4. Mention the oxidation states shown by halogens.

Answer:

👉 Halogens show oxidation states of −1, +1, +3, +5, and +7.

Q5. Why does fluorine exhibit only the −1 oxidation state?

Answer:

👉 Fluorine shows only −1 oxidation state because it is the most electronegative element and cannot lose or share electrons positively.

Q6. How does the oxidizing power of halogens change down the group?

Answer:

👉 The oxidizing power of halogens decreases down the group in the order:

$F_2 > Cl_2 > Br_2 > I_2$

Q7. How does the reducing power of halide ions vary from iodine to fluoride?

Answer:

👉 Reducing power decreases from iodide to fluoride ion, i.e.,

$I^- > Br^- > Cl^- > F^-$

Q8. In which group of the periodic table are noble gases placed and why?

Answer:

👉 Noble gases are placed in Group 0 (Group VIIIA) because they have completely filled outermost electron shells.

Q9. Why do noble gases have very low melting and boiling points?

Answer:

👉 Noble gases have low melting and boiling points due to very weak van der Waals forces between their atoms.

Q10. Write the names of any two compounds of xenon.

Answer:

👉 **Two important compounds of xenon are:**

1. Xenon tetrafluoride (XeF_4)

2. Xenon trioxide (XeO_3)

🩸 Important Short Questions:

1. What are halogens?

Answer:

👉 The elements fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At) are called halogens. They are very reactive non-metals and are known as “salt formers.”

2. What is the origin of the word "halogen"?

Answer:

👉 The word halogen comes from Greek words “hals” meaning salt and “gennan” meaning to form, because halogens form salts when combined with metals.

3. Which halogen is rare and radioactive?

Answer:

👉 Astatine (At) is a rare halogen and is radioactive. Its most stable isotope has a half-life of 8.3 hours.

4. In what form do halogens exist?

Answer:

👉 Halogens exist as diatomic molecules (X_2) in all phases — gas, liquid, or solid.

5. What are the physical states and colors of halogens at room temperature?

Answer:

👉 Fluorine – pale yellow gas,

- **Chlorine** – greenish-yellow gas,
- **Bromine** – red-brown liquid,
- **Iodine** – shiny greyish-black solid.

6. What is the general electronic configuration of halogens?

Answer:

👉 The general electronic configuration of halogens is $ns^2\ np^5$, which means they are one electron short of a stable octet.

7. Why do halogens have high electronegativity and electron affinity?

Answer:

👉 Because they need only one electron to complete their octet, halogens strongly attract electrons, giving them high electronegativity and large negative electron affinity.

8. Which halogen holds its electrons most tightly and why?

Answer:

👉 Fluorine holds its electrons most tightly due to its small atomic size and high ionization energy.

9. Why are van der Waal's forces strongest in iodine molecules?

Answer:

👉 Iodine atoms are larger in size, so their molecules have stronger van der Waal's forces due to greater intermolecular attraction.

10. In what form are halogens found in nature?

Answer:

👉 Halogens are not found in free form; they occur as halide ions (F^-, Cl^-, Br^-, I^-) in compounds such as sea salt, salt lakes, and underground salt beds.

11. What are oxidizing agents?

Answer:

👉 Substances that gain electrons and cause oxidation of other substances are called oxidizing agents.

12. How do halogens act as oxidizing agents?

Answer:

👉 Halogens gain electrons and are converted into halide ions, thus oxidizing other elements.

13. What is the order of oxidizing power of halogens?

Answer:

👉 $F_2 > Cl_2 > Br_2 > I_2$

14. Why does fluorine have the highest oxidizing power?

Answer:

👉 Because it has low bond dissociation energy, high electron affinity, and high hydration energy of its ions.

15. Which halogen cannot oxidize chloride or bromide ions?

Answer:

👉 Iodine cannot oxidize chloride or bromide ions because it is the weakest oxidizing agent.

16. Write a chemical equation showing chlorine oxidizing bromide ions.

Answer:

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

17. What happens when chlorine acts as a bleaching agent?

Answer:

👉 Chlorine oxidizes coloured substances (like dyes or litmus) to colourless compounds.

18. What is meant by standard reduction potential (E°)?

Answer:

👉 It is the measure of the tendency of a species to gain electrons, indicating its oxidizing power.

5.5 Compounds of Halogens — Hydrides (HX)

19. How do halogens react with hydrogen?

Answer:

👉 Halogens react with hydrogen to form hydrogen halides (HX).

Example: $H_2 + Cl_2 \longrightarrow 2HCl$

20. Why is the reaction between H_2 and F_2 explosive?

Answer:

👉 Because fluorine is highly reactive and the reaction releases a large amount of energy.

21. Which hydrogen halide attacks glass?

Answer:

👉 Hydrogen fluoride (HF) attacks glass and is stored in Teflon or copper containers.

22. Why is hydrogen fluoride a liquid while other hydrogen halides are gases?

Answer:

👉 Due to strong hydrogen bonding between HF molecules.

23. What is the order of acid strength among hydrogen halides?

Answer:

👉 HF < HCl < HBr < HI

24. Which hydrogen halide is the strongest reducing agent?

Answer:

👉 Hydrogen iodide (HI) is the strongest reducing agent.

5.5.2 Oxides of Halogens

25. How is chlorine dioxide (ClO_2) prepared?

Answer:

👉 By reducing sodium chlorate ($NaClO_3$) with NaCl, SO_2, or CH_3OH in acidic solution.

26. Mention one use of chlorine dioxide.

Answer:

👉 It is used for bleaching wood pulp and disinfecting drinking water.

27. What is the anhydride of perchloric acid?

Answer:

👉 Chlorine heptaoxide (Cl_2O_7) is the anhydride of perchloric acid ($HClO_4$).

28. What is the formula and one use of iodine pentoxide?

Answer:

👉 **Formula**: I_2O_5

Use: It is used for quantitative analysis of carbon monoxide (CO).

5.5.3 Reaction of Chlorine with NaOH

29. What type of reaction occurs when chlorine reacts with NaOH?

Answer:

👉 A disproportionation reaction, where chlorine is both oxidized and reduced.

30. Write the reaction of chlorine with cold NaOH.

Answer:

👉 $Cl_2 + 2NaOH \longrightarrow NaCl + NaOCl + H_2O$

From: 5.6 & 5.7 — Commercial Uses of Halogens and Noble Gases

31. What are freons and where are they used?

Answer:

Freons are fluorochlorocarbons (like CCl_2F_2, $CClF_3$) used as refrigerants and aerosol propellants.

32. What is Teflon and mention one of its important uses.

Answer:

Teflon is a polymer of tetrafluoroethylene ($-CF_2-CF_2-$) used for non-stick cookware and corrosion-proof coatings.

33. How does fluoride help in dental care?

Answer:

Fluorides in toothpastes form a protective coating on teeth and prevent tooth decay.

34. Write any two uses of chlorine.

Answer:

1. Used in water treatment and disinfectants.

2. Used in the manufacture of PVC, chloroform, and hydrochloric acid.

35. What is the main use of bromine in industry?

Answer:

Bromine is used as a fungicide and in making ethylene dibromide for leaded gasoline.

36. Mention two uses of iodine.

Answer:

1. Used as a disinfectant and germicide.

2. Used in the manufacture of iodized salt to prevent goiter.

37. What are noble gases and why are they called so?

Answer:

Noble gases are inert elements (He, Ne, Ar, Kr, Xe, Rn) with complete outer electron shells, hence chemically inactive.

38. How is helium obtained commercially?

Answer:

Helium is isolated from natural gas by liquefaction and separation because it does not condense easily.

39. What is the main source of neon, argon, krypton, and xenon?

Answer:

They are obtained by fractional liquefaction of air.

40. Why do noble gases have low boiling points?

Answer:

Due to weak van der Waals forces between their monoatomic particles.

41. What is the general trend of boiling points in noble gases?

Answer:

Boiling points increase down the group from helium to radon.

42. Name the three fluorides of xenon.

Answer:

Xenon difluoride (XeF_2), xenon tetrafluoride (XeF_4), and xenon hexafluoride (XeF_6).

43. Write one use of xenon and krypton.

Answer:

Xenon ⟶ Used in bactericidal lamps.

Krypton ⟶ Used in flash lamps for high-speed photography.

44. What is the reaction between XeF_4 and H_2O?

Answer:

$XeF_4 + 2H_2O \longrightarrow XeO_3 + 4HF$

45. Mention any two uses of helium.

Answer:

1. Used in weather balloons.

2. Used as a cooling medium in nuclear reactors.

🩸 EXERCISE

Q1. Fill in the blanks:

(i) The halogen with the highest electronegativity is _____.

Answer: Fluorine ✅

(ii) HI is a _____ agent.

Answer: Reducing ✅

(iii) The only halogen acid which is not a strong acid is _____.

Answer: HF (Hydrofluoric acid) ✅

(iv) Tincture of _____ is a common antiseptic.

Answer: Iodine ✅

(v) The halogen with the lowest melting and boiling points is _____.

Answer: Fluorine ✅

(vi) Bleaching powder is prepared from _____ and _____.

Answer: Chlorine and Calcium hydroxide ✅

(vii) _____ is the halogen which causes burns on the skin which heal slowly.

Answer: Bromine ✅

(viii) _____ is used for making unshrinkable wool.

Answer: Chlorine ✅

(ix) A mixture of _____ and _____ is used for breathing by the sea divers.

Answer: Helium and Oxygen ✅

(x) Noble gas used to fill fluorescent tubes is _____.

Answer: Krypton ✅

Q2. Indicate True or False:

(i) HF is used for etching glass.

Answer: True ✅

(ii) HI is weaker reducing agent as compared to HF.

Answer: False ❌

(iii) Bleaching powder is completely soluble in water.

Answer: False ❌

(iv) The formula of perchloric acid is $HClO_2$.

Answer: False ❌ (Correct formula: $HClO_4$)

(v) On warming, aqueous $KClO_3$ disproportionates as follows.

Answer: True ✅

(vi) α-particles emitted by radioactive elements are ions of radon.

Answer: False ❌ (They are ions of helium)

(vii) Radon is the only one of the noble gases that is radioactive.

Answer: True ✅

(viii) The molecules of the noble gases are all monoatomic.

Answer: True ✅

(ix) Argon is used to fill electric bulbs.

Answer: True ✅

(x) The noble gas which is present in the largest amount in atmosphere is krypton.

Answer: False ❌ (It is Argon)

Q3. Multiple choice questions – Encircle the correct answer (answers given):

(i) Which of the following hydrogen halide is the weakest acid in solution?

(a) HF ✅

(b) HBr

(c) HI

(d) HCl

(ii) Chlorine heptaoxide (Cl_2O_7) reacts with water to form:

(a) Hypochlorous acid

(b) Chloric acid

(c) Perchloric acid ✅

(d) Chlorine and oxygen

(iii) Hydrogen bond is the strongest between the molecules of:

(a) HF ✅

(b) HCl

(c) HBr

(d) HI

(iv) Which halogen will react spontaneously with Au(s) to produce Au^{3+}?

(a) Br_2

(b) F_2 ✅

(c) I_2

(d) Cl_2

(v) The anhydride of $HClO_4$ is:

(a) ClO_3

(b) ClO_2

(c) Cl_2O_5

(d) Cl_2O_7 ✅

(vi) Bleaching powder may be produced by passing chlorine over:

(a) calcium carbonate

(b) hydrated calcium sulphate

(c) anhydrous calcium sulphate

(d) calcium hydroxide ✅

(e) magnesium hydroxide

(vii) Which is the strongest acid?

(a) HClO

(b) $HClO_2$

(c) $HClO_3$

(d) $HClO_4$ ✅

(viii) Which halogen occurs naturally in a positive oxidation state?

(a) Fluorine

(b) Chlorine ✅

(c) Bromine

(d) Iodine

(ix) An element that has a high ionization energy and tends to be chemically inactive would most likely be:

(a) an alkali metal

(b) a transition element

(c) a noble gas ✅

(d) a halogen

(x) Which of the following represents the correct electronic configuration of the outermost energy level of an element of zero (VIIIA) group in the ground state?

(a) s^2p^2

(b) s^2p^4

(c) s^2p^5

(d) s^2p^6 ✅

🌟 Q.4: What is Bleaching Powder? How it is Prepared Commercially? Give its Uses.

❖ Definition:

👉 Bleaching powder is a white powder having a strong smell of chlorine.

It is chemically known as Calcium oxychloride ($Ca(OCl)_2$) and is commonly used for bleaching, disinfection, and purification purposes.

Chemical Formula:

$Ca(OCl)_2$

Other Name:

- Chlorinated lime or Calcium oxychloride.

🔸 Commercial Preparation of Bleaching Powder:

Bleaching powder is prepared on a large scale by passing chlorine gas over dry slaked lime (calcium hydroxide) in specially designed chambers known as Hasenclever's plant or Bachmann's process.

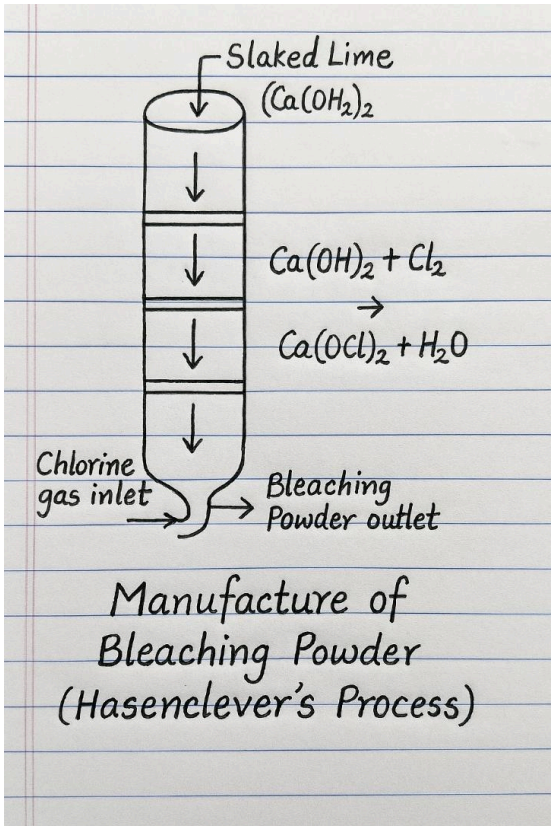
✦ Chemical Reaction:

$Ca(OH)_2 + Cl_2 \longrightarrow Ca(OCl)_2 + H_2O$

Explanation:

- Dry chlorine gas is passed over dry slaked lime ($Ca(OH)_2$).
- The reaction takes place at room temperature.
- The product formed is Bleaching Powder ($Ca(OCl)_2$) along with water (H_2O).

✦ Digram:



💡 Properties of Bleaching Powder:

- It is a white powder with a pungent chlorine-like smell.
- It is soluble in water, but a part of it remains suspended.
- It is unstable in moist air and decomposes slowly, releasing chlorine.

🧴 Uses of Bleaching Powder:

1. Disinfectant:

👉 Used for disinfecting drinking water, swimming pools, drains, and public places.

2. Bleaching Agent:

👉 Used to bleach cotton, paper, wood pulp, and textiles.

3. Oxidizing Agent:

👉 Used in laboratories and industries as a powerful oxidizing agent.

4. Deodorizing Agent:

👉 Used for removing bad odours and purifying air in hospitals and sanitation areas.

5. Preparation of Other Chemicals:

👉 Used for making chloroform ($CHCl_3$) and other chlorine-based compounds.

✦ **Summary:**

- **Bleaching powder** is calcium oxychloride, prepared by passing chlorine gas over dry slaked lime.
- **It is widely** used for disinfection, bleaching, and purification of water and fabrics.

🌟 **Q.5 (a) Discuss the Oxides of Chlorine.**

❖ **Introduction:**

Chlorine combines with oxygen to form several oxides in which the oxidation state of chlorine varies from +1 to +7. These oxides are unstable, explosive, and act as powerful oxidizing agents. They can be acidic, neutral, or basic in nature depending on the oxidation state of chlorine.

🔹 **1. Dichlorine Monoxide (Cl_2O):**

Oxidation state of Cl: +1

Physical state: Brownish-yellow gas.

Preparation: Formed by passing dry chlorine over heated mercury(II) oxide.

Chemical equation:

$Cl_2 + HgO \longrightarrow Cl_2O + Hg$

Properties:

- Reacts with water to form hypochlorous acid (HClO).
- Acts as a strong oxidizing and bleaching agent.

🔹 2. Chlorine Dioxide (ClO_2):

Oxidation state of Cl: +4

Physical state: Yellowish-green gas with a pungent smell.

Preparation: By reducing sodium chlorate with sulfur dioxide.

Equation:

$2NaClO_3 + SO_2 \longrightarrow 2ClO_2 + Na_2SO_4$

Properties:

- Very explosive in pure form.
- Used as a bleaching agent for paper and textiles.

🔹 3. Dichlorine Heptaoxide (Cl_2O_7):

Oxidation state of Cl: +7

Physical state: Colorless oily liquid.

Preparation: By dehydration of perchloric acid ($HClO_4$) with phosphorus pentoxide (P_2O_5).

Equation:

$2HClO_4 \longrightarrow Cl_2O_7 + H_2O$

Properties:

- Most stable oxide of chlorine.
- Reacts with water to form perchloric acid ($HClO_4$).
- Powerful oxidizer but less explosive compared to other oxides.

⚙️ General Characteristics of Chlorine Oxides:

- They are strong oxidizing agents.
- Most are volatile and unstable.
- They decompose explosively on heating or exposure to light.
- They are acidic in nature, forming corresponding oxyacids with water.

🌟 (b) What are Disproportionation Reactions?

❖ Definition:

A disproportionation reaction is a type of redox reaction in which the same element is simultaneously oxidized and reduced, forming two different products.

🔹 Example:

When chlorine gas reacts with cold dilute sodium hydroxide, it forms sodium chloride (NaCl) and sodium hypochlorite (NaClO).

Equation:

$Cl_2 + 2NaOH \longrightarrow NaCl + NaClO + H_2O$

Here:

- One atom of Cl is reduced from 0 to −1 (in NaCl).
- Another atom of Cl is oxidized from 0 to +1 (in NaClO).

Thus, the same element (chlorine) undergoes oxidation and reduction simultaneously.

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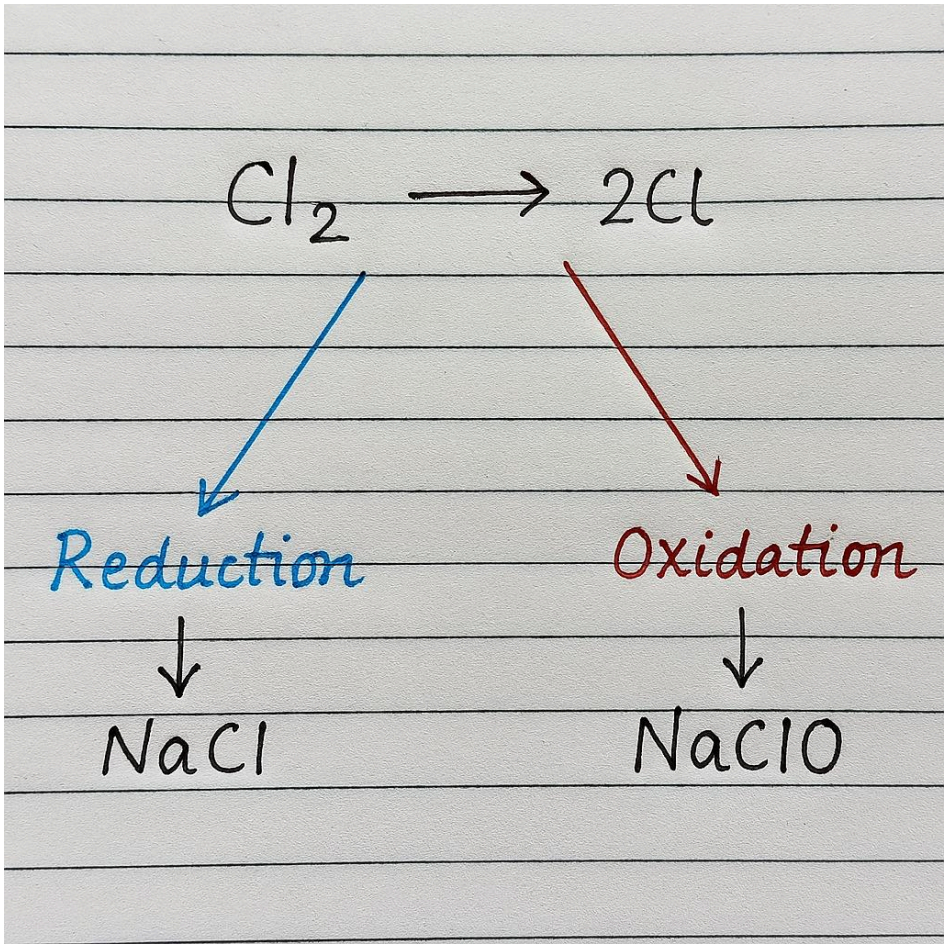

✦ **Summary:**

- **Chlorine forms** several oxides (Cl_2O, ClO_2, Cl_2O_7) with oxidation states from +1 to +7.
- **These oxides** are unstable and strong oxidizers.
- **Disproportionation** involves one element undergoing both oxidation and reduction — e.g., chlorine in reaction with NaOH.

🌟 **Q.6. Discuss the system of nomenclature used for oxyacids of halogens. Support your answer with examples.**

❖ **Introduction:**

- Halogens form several oxyacids that contain oxygen, hydrogen, and a halogen (such as chlorine, bromine, or iodine).
- **The nomenclature** of these acids depends on the oxidation state of the halogen.

As the oxidation state increases, the acid strength and oxidizing power also increase.

⚙️ **General Formula:**

The general formula of a halogen oxyacid is HXO_n, where X represents any halogen (Cl, Br, I) and n varies according to the oxidation state of the halogen.

System of Naming Oxyacids:

The naming pattern uses prefixes and suffixes to show the oxidation state of the halogen:N

Lowest oxidation state: Prefix “hypo–” + suffix “–ous acid”

Next higher oxidation state: Suffix “–ous acid”

Still higher oxidation state: Suffix “–ic acid”

Highest oxidation state: Prefix “per–” + suffix “–ic acid”

Example with Chlorine Series:

Chlorine forms four main oxyacids depending on its oxidation state:

1. $HClO$ ⟶ Hypochlorous acid ⟶ (Oxidation state +1)

2. $HClO_2$ ⟶ Chlorous acid ⟶ (Oxidation state +3)

3. $HClO_3$ ⟶ Chloric acid ⟶ (Oxidation state +5)

4. $HClO_4$ ⟶ Perchloric acid ⟶ (Oxidation state +7)

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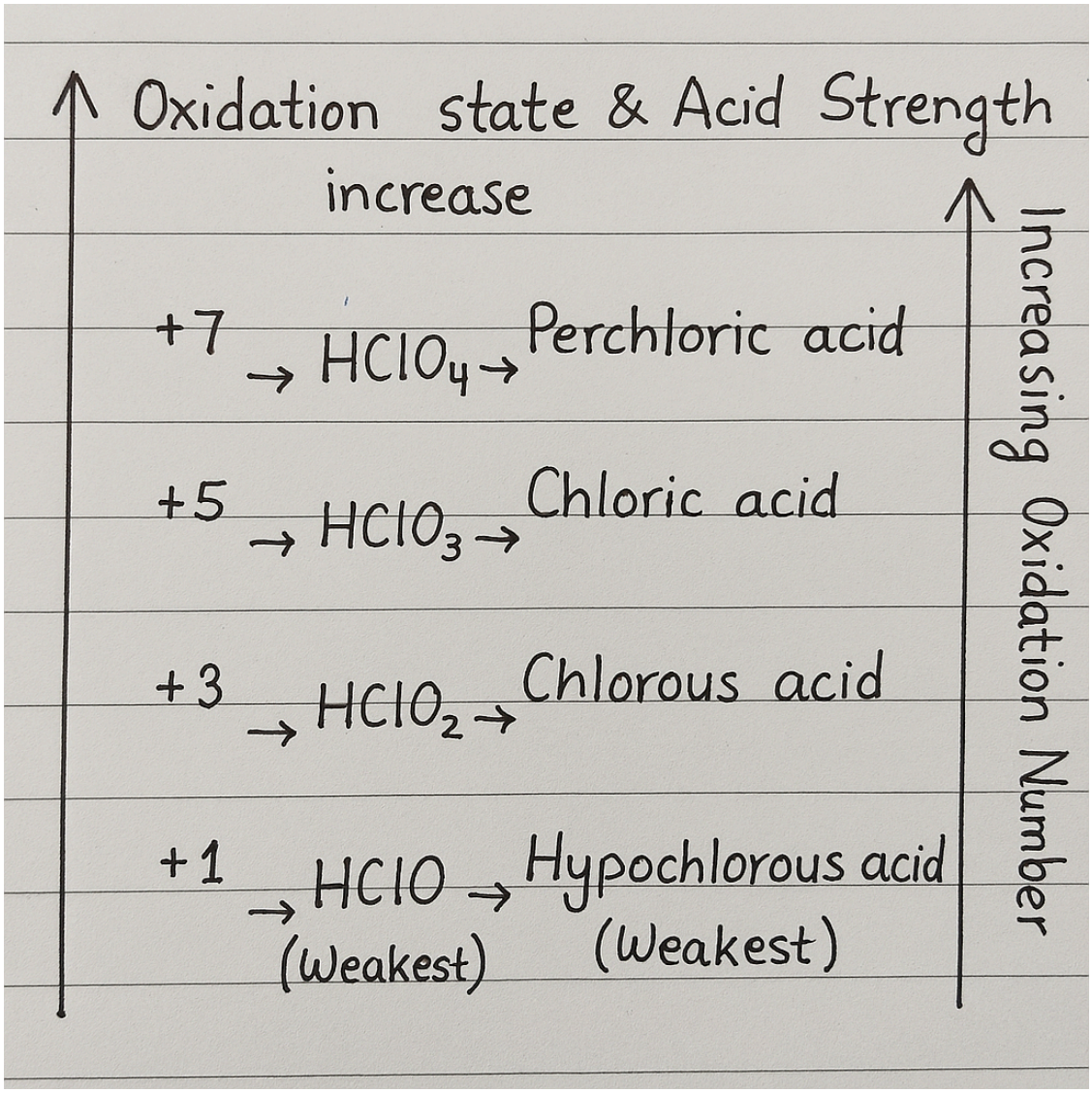

🔹 **Other Examples:**

The same naming system applies to bromine and iodine.

Bromine series:

$HBrO$ ⟶ Hypobromous acid

$HBrO_2$ ⟶ Bromous acid

$HBrO_3$ ⟶ Bromic acid

$HBrO_4$ ⟶ Perbromic acid

Iodine series:

HIO ⟶ Hypoiodous acid

HIO_2 ⟶ Iodous acid

HIO_3 ⟶ Iodic acid

HIO_4 ⟶ Periodic acid

💡 **Key Points to Remember:**

“Hypo–” = lowest oxidation state

“Per–” = highest oxidation state

“–ous” = lower oxidation state

"–ic" = higher oxidation state

Acid strength increases as oxidation number increases

✦ **Summary:**

Halogens form several oxyacids where oxidation states vary from +1 to +7.

Their names follow a clear pattern: hypo–ous ⟶ –ous ⟶ –ic ⟶ per–ic, depending on oxidation state.

Example:

$HClO$, $HClO_2$, $HClO_3$, $HClO_4$ = Hypochlorous, Chlorous, Chloric, and Perchloric acids.

As oxidation state increases, the acid strength and oxidizing ability also increase.

🌟 **Q.7 (a) How the halogen acids are ionized in water?**

❖ **Answer:**

- **Halogen acids** (also called hydrogen halides) include **HF**, **HCl**, **HBr**, and **HI**.

- **When these acids** dissolve in water, they ionize (dissociate) to produce **hydronium** ions (H_3O^+) and **halide** ions (X^-).

The process of ionization shows how strongly the acid donates a proton (H^+) to water molecules.

⚙️ Ionization Reaction:

The general reaction for a hydrogen halide in water is:

$$HX + H_2O \longrightarrow H_3O^+ + X^-$$

Examples:

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

$$HBr + H_2O \longrightarrow H_3O^+ + Br^-$$

$$HI + H_2O \longrightarrow H_3O^+ + I^-$$

$$HF + H_2O \rightleftharpoons H_3O^+ + F^- \text{ (partial ionization)}$$

👉 All hydrogen halides except HF ionize completely in water, so they are strong acids.

HF ionizes partially, so it is a weak acid.

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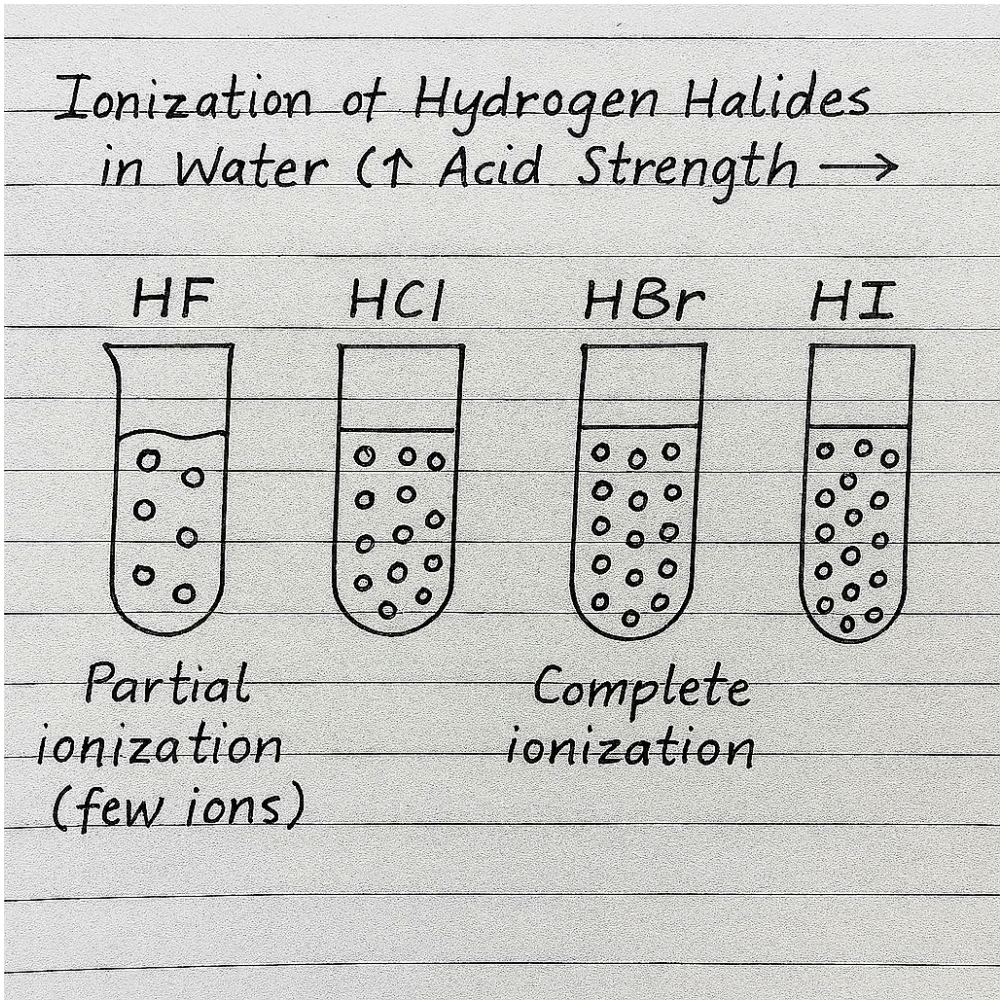

🌟 **(b) Why HF is weaker acid than HCl?**

❖ **Answer:**

Hydrofluoric acid (HF) is a weak acid, while hydrochloric acid (HCl) is strong.

The weakness of HF can be explained by the following reasons:

🔹 1. Strong H–F Bond:

- The **bond between hydrogen** and **fluorine** is very **strong** due to fluorine's high electronegativity and small atomic radius.
- **This makes** it **harder** to **break** the bond, so fewer **H^+ ions** are released in solution.

H–F bond energy = 565 kJ/mol (very high)

🔹 2. Strong Hydrogen Bonding:

- **In aqueous solution,** HF molecules form hydrogen bonds with water and with each other.
- **These bonds stabilize** the molecules, reducing the extent of ionization.

🔹 3. Low Degree of Ionization:

- **Because of the strong** H–F bond and hydrogen bonding, HF ionizes only partially in water.

Therefore, it produces a lower concentration of H_3O^+ ions, making it a weak acid.

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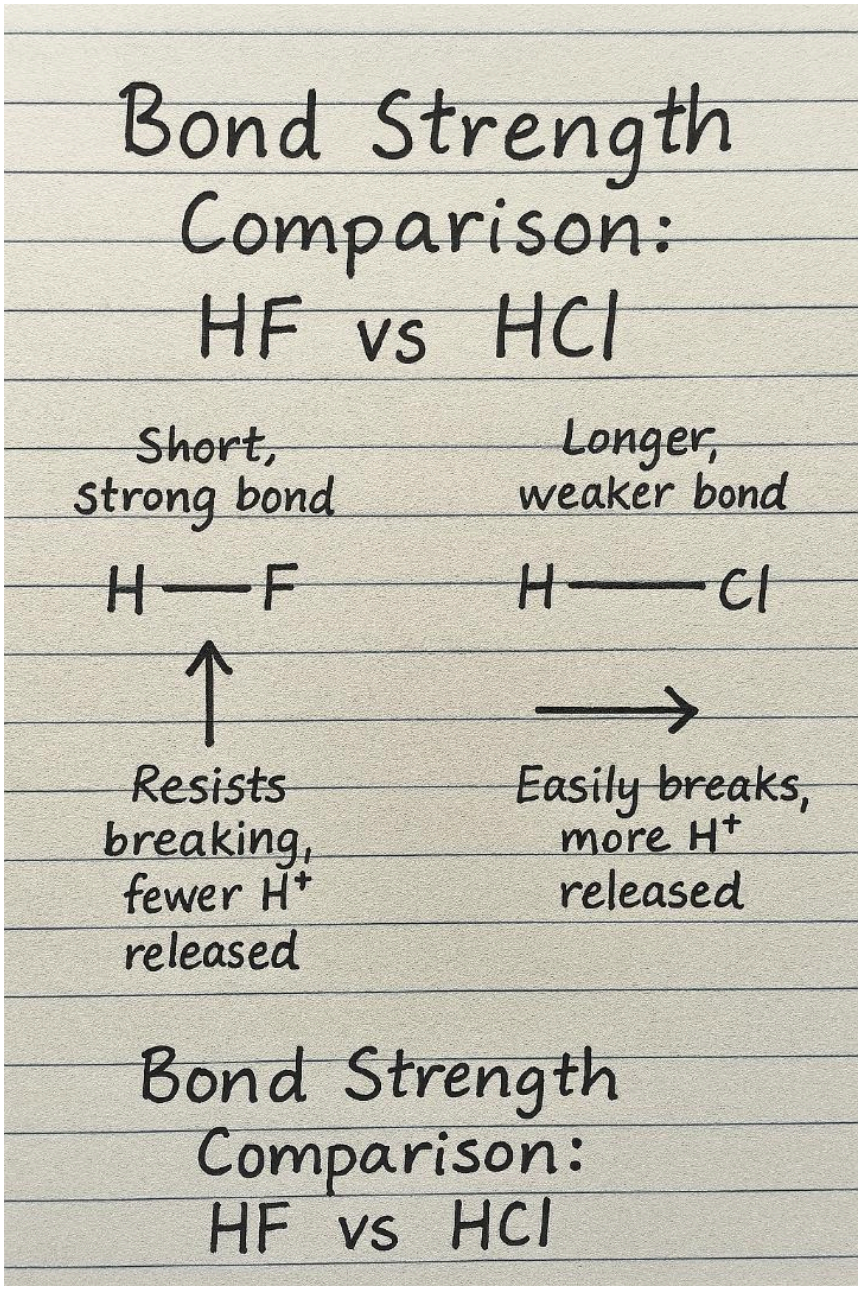

✦ **Summary:**

- All hydrogen halides ionize in water to form hydronium and halide ions.

HF is the only weak acid among them because:

- It has a **very strong** H–F bond,
- **Forms hydrogen** bonds with water,
- **And ionizes** incompletely.

Hence, the acidic strength increases in the order:

HF < HCl < HBr < HI

🌟 Q.8 In the following sets, arrange the substances in order of the property indicated. Give reasons

(a) Arrange in order of increasing acidic character:

$HClO < HClO_2 < HClO_3 < HClO_4$

Reason:

Acidic strength of oxyacids of a given element increases with the number of oxygen atoms attached to the central atom. Extra oxygens withdraw electron density by the −I and −R effects, which (1) stabilizes the conjugate base (XO^-) by delocalizing the negative charge and (2) pulls electron density

away from the O—H bond making the proton easier to lose. Thus HClO (hypochlorous, +1) is weakest and $HClO_4$ (perchloric, +7) is strongest.

(b) Arrange in order of increasing oxidizing power:

$I_2 < Br_2 < Cl_2 < F_2$

Reason:

Oxidizing power of halogens decreases down the group, so the smallest atom (fluorine) is the strongest oxidizing agent. This is shown by their standard reduction potentials (higher E° → stronger oxidant):

F_2 (+2.87 V) > Cl_2 (+1.36 V) > Br_2 (+1.07 V) > I_2 (+0.54 V).

Factors behind this trend: fluorine has high electron affinity, relatively low bond-dissociation energy in the reaction conditions, and large hydration energy for F^- — all favoring reduction of F_2 to F^-. As atomic size increases down the group, these effects diminish, so oxidizing power falls.

✦ **Summary:**

(a) More oxygens ⟶ stronger oxyacid (HClO ⟶ $HClO_4$).

(b) Oxidizing power: increases up the group ⟶ I_2 weakest, F_2 strongest.

🌟 Q.9 What happens when bleaching powder reacts with the following reagents:

(dil. H_2SO_4, excess conc. H_2SO_4, NH_3, HI and CO_2)

❖ Introduction:

- **Bleaching powder** is chemically known as Calcium Oxychloride ($CaOCl_2$).
- It is **prepared by** passing chlorine gas over dry slaked lime ($Ca(OH)_2$).

Equation:

$$2Ca(OH)_2 + 2Cl_2 \longrightarrow Ca(OCl)_2 + CaCl_2 + 2H_2O$$

Bleaching powder acts as a source of chlorine and shows both oxidizing and bleaching properties.

Its reactions with various reagents show its oxidizing behavior and ability to release chlorine.

1️⃣ Reaction with Dilute Sulphuric Acid (H_2SO_4 (dil.))

Equation:

$CaOCl_2 + H_2SO_4$ (dil.) $\longrightarrow CaSO_4 + 2HClO$

Explanation:

- When **bleaching powder** reacts with cold dilute H_2SO_4, Hypochlorous acid (HClO) is formed.
- **HClO** is unstable and acts as a powerful bleaching and disinfecting agent.
- The **bleaching action** of bleaching powder is mainly due to HClO formation.

Result:

Formation of HClO (active oxygen compound) used in bleaching and sterilization.

2️⃣ Reaction with Excess Concentrated Sulphuric Acid (conc. H_2SO_4)

Equation:

$CaOCl_2 + H_2SO_4$ (excess) $\longrightarrow CaSO_4 + H_2O + Cl_2$ ⬆️

Explanation:

- When excess of strong acid is added, chlorine gas is liberated.

- This chlorine gas has a strong bleaching and oxidizing action.
- The reaction also shows that bleaching powder contains “available chlorine”, which is released by acids.

Result:

- Chlorine gas (Cl_2) is evolved.
- This reaction is used to test the presence of bleaching powder.

3️⃣ Reaction with Ammonia (NH_3)

Equation:

$3CaOCl_2 + 2NH_3 \longrightarrow 3CaCl_2 + 3H_2O + N_2$ ⬆️

Explanation:

- When ammonia gas is passed over bleaching powder, nitrogen gas is evolved.
- The hypochlorite ion (OCl^-) in bleaching powder oxidizes ammonia (NH_3) to nitrogen gas (N_2).
- This is an oxidation reaction, showing bleaching powder’s oxidizing nature.

Result:

Nitrogen gas (N_2) is released with formation of calcium chloride ($CaCl_2$).

4️⃣ Reaction with Hydrogen Iodide (HI)

Equation:

$CaOCl_2 + 2HI \longrightarrow CaCl_2 + H_2O + I_2$ ⬇️

Explanation:

- When **bleaching powder** reacts with hydrogen iodide, elemental iodine (I_2) is formed.
- **This happens** because **hypochlorite** ion oxidizes iodide ions (I^-) to iodine (I_2).
- The **appearance** of brown color or violet vapors of iodine confirms the reaction.

Result:

Iodine (I_2) is liberated — a redox reaction (oxidation of $I^- \longrightarrow I_2$).

5️⃣ Reaction with Carbon Dioxide (CO_2)

Equation:

$CaOCl_2 + CO_2 \longrightarrow CaCO_3$ ⬇️ + Cl_2 ⬆️

Explanation:

- When **carbon dioxide** gas is passed through bleaching powder, it releases chlorine gas.
- At the **same time, calcium** carbonate ($CaCO_3$) is formed as a white precipitate.

This shows why bleaching powder loses its chlorine on exposure to air, since CO_2 in air slowly reacts with it.

Result:

Chlorine gas (Cl_2) is evolved and calcium carbonate is formed.

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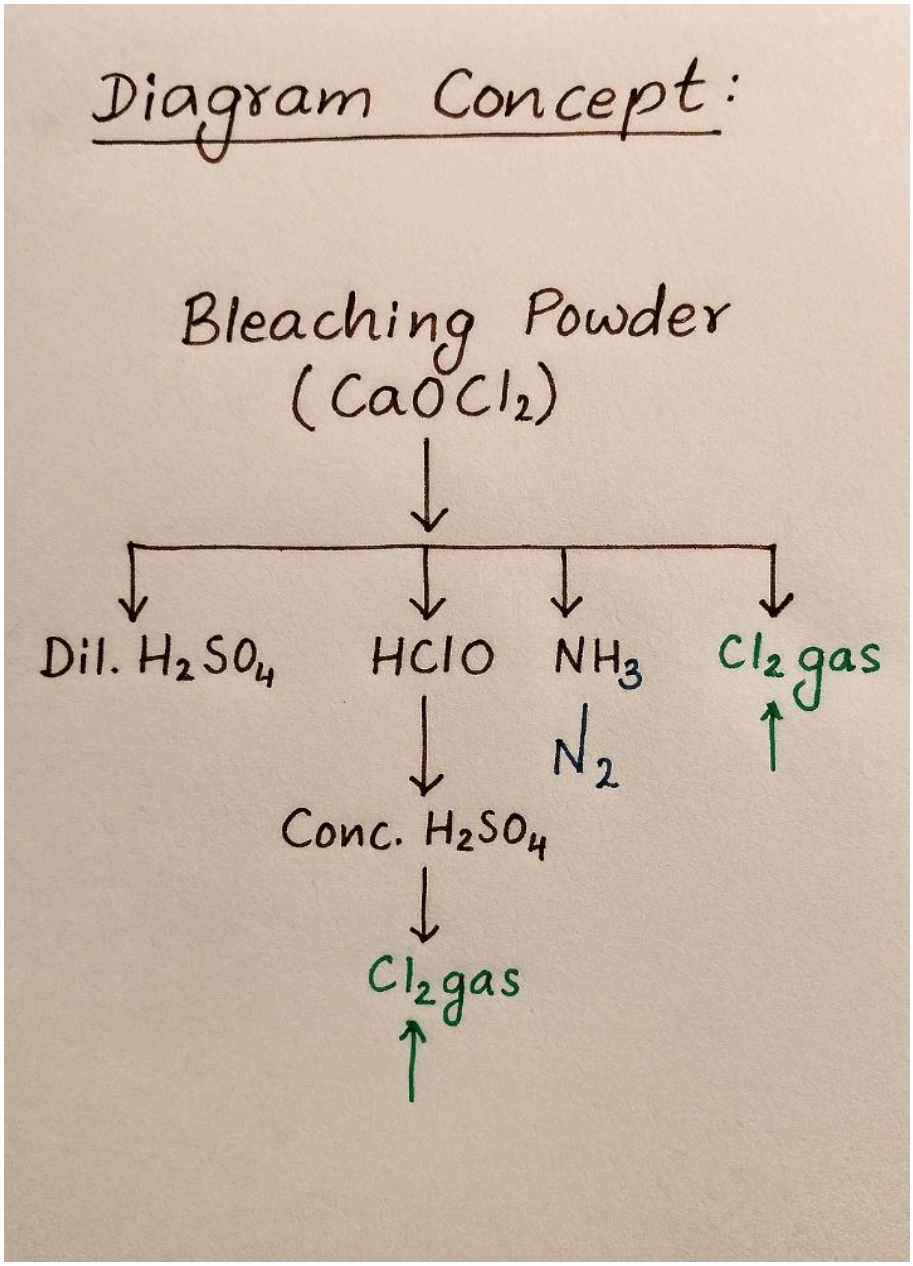

✦ **Summary:**

👉 Bleaching powder is a mild oxidizing agent that releases chlorine or oxygen-containing species when treated with acids or reducing agents.

It reacts differently with each reagent, showing its oxidizing, bleaching, and disinfecting properties, which make it useful in water treatment, bleaching, and sanitation.

🌟 **Q.10 Discuss the various commercial uses of halogens and their compounds.**

❖ **Introduction:**

- **The halogens** — fluorine (F), chlorine (Cl), bromine (Br), iodine (I), and astatine (At) — are highly reactive non-metals.
- **They form a wide** range of compounds used in industries, medicine, water purification, and household products.
- **Their usefulness** depends on their oxidizing nature, disinfecting ability, and reactivity with other elements.

1️⃣ Uses of Fluorine and Its Compounds

🔹 **(a) Sodium fluoride (NaF) and stannous fluoride (SnF_2)**

- Used in toothpaste to prevent tooth decay by making enamel resistant to acids.

🔹 **(b) Teflon (Polytetrafluoroethylene, PTFE)**

- **A fluorocarbon** polymer made from tetrafluoroethylene.

- **Used as a non-stick** coating for cookware and also in electrical insulation and chemical industries.

🔹 (c) Freon (CCl_2F_2)

- Used as a refrigerant in air conditioners and refrigerators.

(**Note:** Its use is being reduced due to ozone layer damage.)

🔹 (d) Uranium hexafluoride (UF_6)

- Used in nuclear fuel processing for uranium isotope separation.

2️⃣ Uses of Chlorine and Its Compounds

🔹 (a) Water Purification

- Chlorine is widely used to disinfect drinking water and swimming pools by killing harmful bacteria.

🔹 (b) Bleaching Agent

- Bleaching powder ($CaOCl_2$) and chlorine gas are used to bleach textiles, paper, and wood pulp.

- **(c) Manufacture of Chemicals**

  - Chlorine is used in making PVC (polyvinyl chloride), hydrochloric acid (HCl), chloroform, carbon tetrachloride (CCl_4), and DDT (a pesticide).

- **(d) Medicine**

  - Used in the preparation of disinfectants, antiseptics, and chlorinated drugs.

3 Uses of Bromine and Its Compounds

- **(a) Silver bromide (AgBr)**

  - Used in photographic films due to its light sensitivity.

- **(b) Ethylene dibromide ($C_2H_4Br_2$)**

  - Added to gasoline to prevent lead deposition in engines.

- **(c) Fire Retardants**

  - Bromine compounds are used in flame-proofing materials and fire extinguishers.

- **(d) Medicine**

  - Bromides are used as mild sedatives and tranquilizers in pharmaceuticals.

4️⃣ Uses of Iodine and Its Compounds

- **(a) Tincture of Iodine**

  - An antiseptic solution of iodine in alcohol, used to disinfect wounds.

- **(b) Potassium iodide (KI)**

  - Added to table salt to prevent goitre caused by iodine deficiency.

- **(c) Photography**

  - Used in silver iodide (AgI), another light-sensitive compound in photography.

- **(d) Medicine**

  - Iodine compounds are used in thyroid medications and radiographic imaging.

5️⃣ Uses of Astatine (At)

- It is radioactive and very rare in nature.
- Used only in scientific research and radiotherapy for thyroid cancer.

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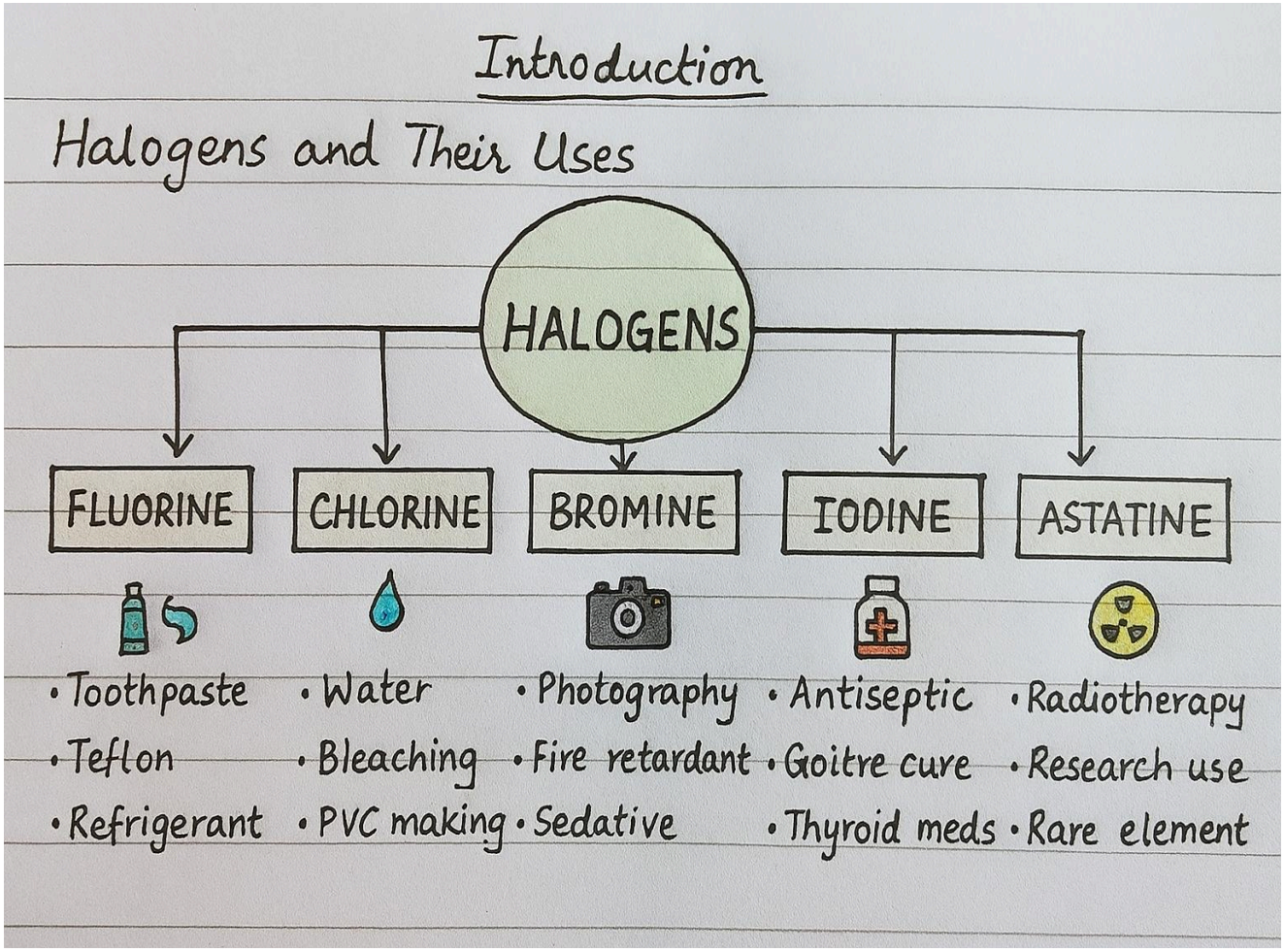

✦ Summary:

- **Halogens** and their compounds are indispensable in daily life and industry.
- They are used in bleaching, disinfection, refrigeration, photography, medicine, and plastics manufacturing.
- **Among them,** chlorine is the most widely used industrial halogen, while iodine and fluorine have important medical applications.
- **Their reactivity** and oxidizing power make them commercially and scientifically valuable elements.

🌟 Q.11 What are noble gases? Explain their inertness on the basis of their electronic configuration.

❖ Introduction:

- The noble gases are a group of elements found in Group 18 (Zero or VIIIA group) of the periodic table.

They include: Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe), and Radon (Rn).

- **These gases are colourless**, odourless, tasteless, monoatomic, and occur in small amounts in the atmosphere.
- Because of their stable electronic configurations, they are also called inert gases or rare gases.

💡 Explanation of Inertness:

- The inertness (lack of chemical reactivity) of noble gases is mainly due to their completely filled valence electron shells.

⚛️ Electronic Configuration of Noble Gases:

Element	Symbol	Atomic Number	Electronic Configuration
Helium	He	2	$1s^2$
Neon	Ne	10	$1s^2\ 2s^2\ 2p^6$
Argon	Ar	18	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
Krypton	Kr	36	$[Ar]\ 4s^2\ 3d^{10}\ 4p^6$
Xenon	Xe	54	$[Kr]\ 5s^2\ 4d^{10}\ 5p^6$
Radon	Rn	86	$[Xe]\ 6s^2\ 4f^{14}\ 5d^{10}\ 6p^6$

🔸 Reason for Chemical Inertness:

1. Complete Valence Shells:

- **Each noble gas** (except helium) has eight electrons in its outermost shell.
- **Helium** has two electrons, which completes its first shell ($1s^2$).
- **A complete** outer shell makes them **chemically stable** and non-reactive.

2. High Ionization Energy:

- **Since** their outer shells are full, it requires a large amount of energy to remove an electron.
- **Hence**, they do not form positive ions easily.

3. Zero Electron Affinity:

- Noble gases have no tendency to gain or lose electrons, because they already possess stable configurations.

4. No Available Vacant Orbitals:

- Their valence shells are fully filled, leaving no vacant orbitals to accommodate additional electrons.

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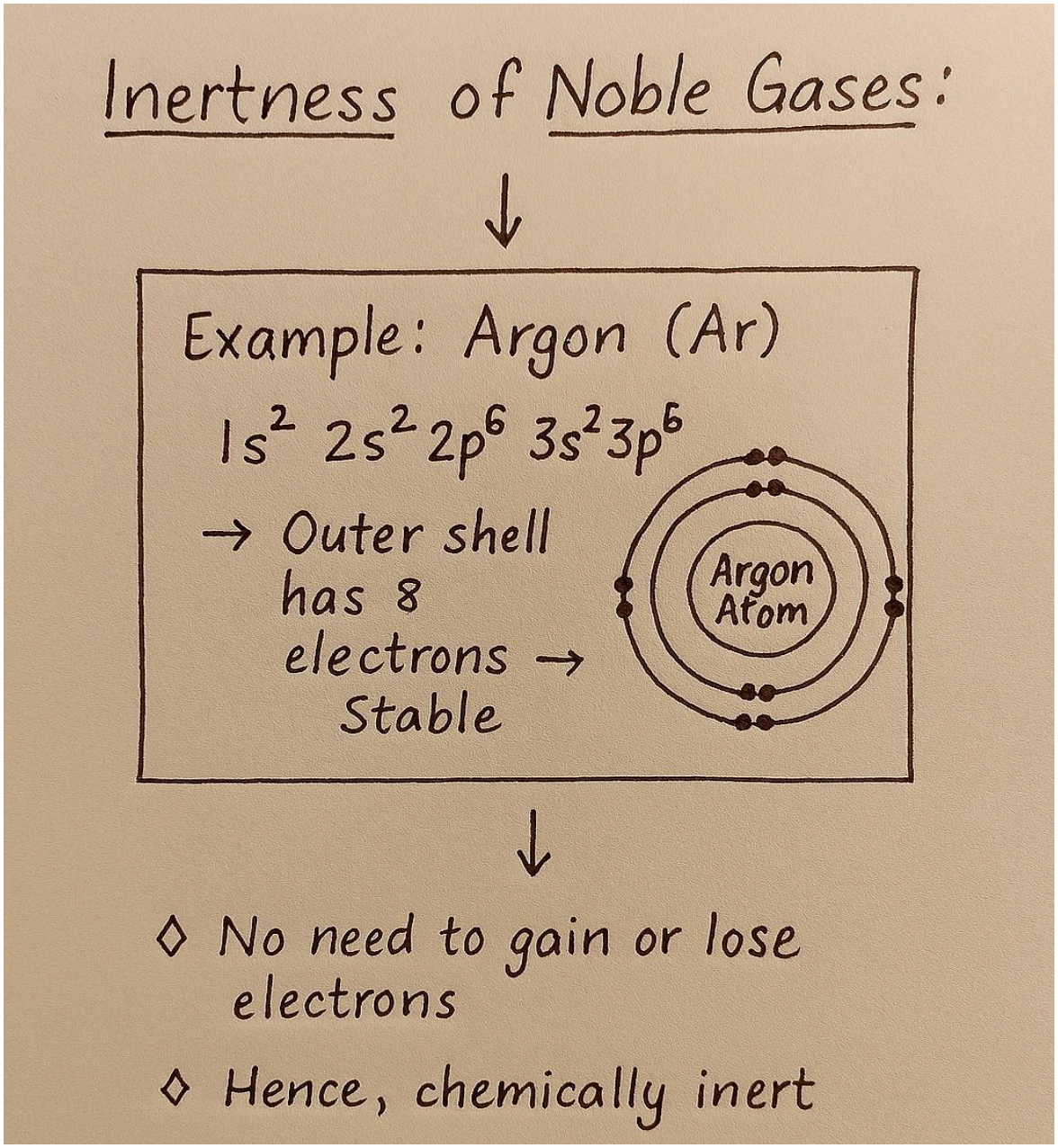


✦ **Summary:**

- **Noble gases** are Group 18 elements known for their chemical inertness.

- **Their valence** shells are completely filled (stable octet or duet).
- **Due to this stable** configuration, they have no tendency to form bonds.
- **However,** under special conditions, heavier noble gases (like xenon and krypton) can form compounds with fluorine and oxygen.
- **Their stability** and non-reactivity make them valuable for lighting, welding, and scientific applications.

🌟 Q.12 Write notes on the following:

(i) Oxyfluorides of Xenon

❖ Introduction:

- **Oxyfluorides** of xenon are compounds containing xenon, oxygen, and fluorine.
- **These compounds** are formed when fluorides of xenon react with limited amounts of water or silica (SiO_2).
- **They show** that xenon can exhibit oxidation states greater than zero, proving that noble gases can form compounds under special conditions.

✦ Important Oxyfluorides of Xenon:

1. Xenon Oxytetrafluoride ($XeOF_4$):

- It is formed by the reaction of xenon tetrafluoride (XeF_4) with silica.

Reaction:

$XeF_4 + SiO_2 \longrightarrow XeOF_4 + SiF_4$

- It is a **colourless**, volatile liquid.
- **Stored** in nickel vessels because it is corrosive.
- On **reaction** with water, it forms xenon trioxide (XeO_3).

$XeOF_4 + 2H_2O \longrightarrow XeO_3 + 4HF$

2. Xenon Oxydifluoride ($XeOF_2$):

- Obtained when xenon reacts with oxygen difluoride (F_2O) in an electric discharge.

$Xe + F_2O \longrightarrow XeOF_2$

It is a colourless gas, less stable than $XeOF_4$.

💡 Properties:

- Both $XeOF_4$ and $XeOF_2$ are powerful oxidizing and fluorinating agents.
- They decompose slowly when exposed to moisture or heat.
- These compounds prove that noble gases, especially xenon, are not completely inert.

🗒️ Summary of (i):

Xenon forms two main oxyfluorides: $XeOF_4$ and $XeOF_2$.

They are volatile, oxidizing, and fluorinating in nature.

Their formation proves that noble gases can participate in chemical reactions under specific conditions.

(ii) Applications of Noble Gases

❖ Introduction:

- Noble gases, though inert, have many important commercial and scientific uses because of their non-reactive, colourless, and monoatomic nature.

🔸 Main Applications:

1. Helium (He):

- **Used for filling** weather balloons and airships (non-inflammable).
- **Used in arc welding** as an inert protective atmosphere.
- **A mixture** of 80% He and 20% O_2 is used for breathing by deep-sea divers.
- Acts as a cooling agent in nuclear reactors.

2. Neon (Ne):

- **Used in neon** sign boards and advertising lights.
- **Gives a bright** red glow in electric discharge tubes.
- Used in **high-voltage** indicators and TV tubes.

3. Argon (Ar):

- Used for **filling electric** bulbs and **fluorescent** tubes to prevent oxidation of filaments.
- Used in arc **welding** and cutting.
- Used in **Geiger counters** (radiation detectors).

4. Krypton (Kr):

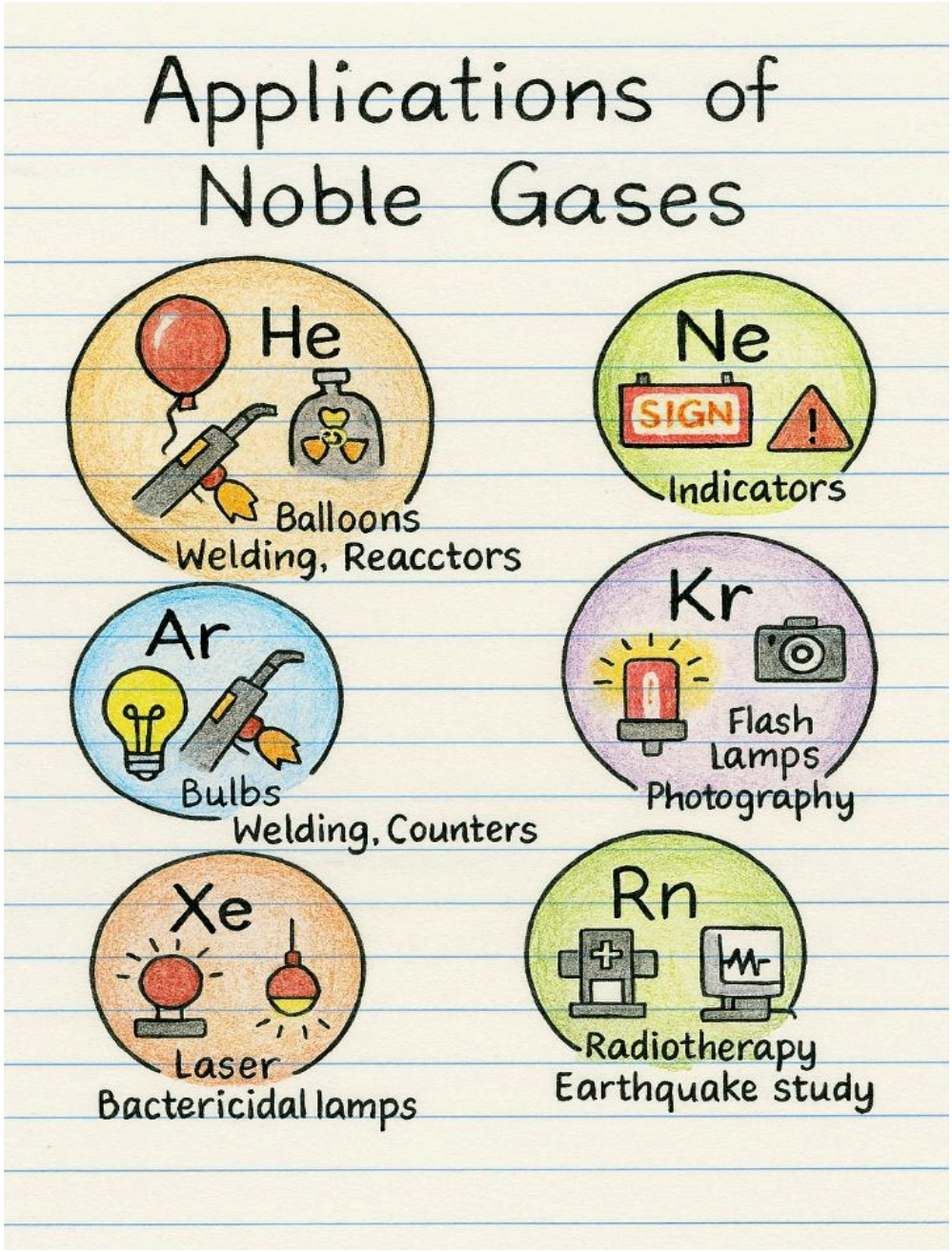
- Used in **flash lamps** for high-speed photography.
- Also used in **fluorescent** tubes and laser **technologies**.

5. Xenon (Xe):

- Used in **bactericidal** lamps and high-intensity arc lamps.
- Also used in **anaesthesia research** and **photographic flash tubes.**

6. Radon (Rn):

- **Being radioactive**, it is used in radiotherapy for cancer treatment.
- Also helps in **earthquake prediction** and geological research.



🗒️ Summary of (ii):

- **Noble gases** are chemically inert but industrially useful.
- **They are used** in lighting, welding, cooling, and medical applications.
- **Each noble gas** has unique applications based on its physical properties.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.