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1. General Information

- Symbol: Cl
- Atomic Number: 17
- Atomic Mass: 35.45 u
- Group: 17 (Halogens)
- Period: 3
- Block: p-block
- Electron Configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
- Valence Electrons: 7
- Phase at Room Temperature: Gas

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2. Isotopes of Chlorine

Isotope	Protons	Neutrons	Abundance	Notes
^{35}Cl	17	18	75.8%	Most abundant isotope.
^{37}Cl	17	20	24.2%	Stable, less common.

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3. Physical Properties

- Color: Yellow-green
- Odor: Pungent, bleach-like smell
- Density: 3.21 g/L (at STP)
- Melting Point: -101.5°C
- Boiling Point: -34.04°C
- State at STP: Gas (diatomic Cl_2)
- Solubility: Slightly soluble in water (forms chlorine water).

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4. Chemical Properties

- Highly Reactive Halogen:
  - Strong oxidizing agent.
  - Combines readily with metals to form salts (e.g., NaCl).
- Toxic and Corrosive:
  - Causes irritation to skin, eyes, and lungs.
- Forms Ionic and Covalent Compounds:
  - Common oxidation states: -1, +1, +3, +5, +7.

Reaction with Sodium (Salt Formation):

$2Na + Cl_2 \rightarrow 2NaCl$

Reaction with Water (Disinfection):

$Cl_2 + H_2O \rightarrow HCl + HOCl$ (Hypochlorous acid)

Reaction with Hydrogen:

$H_2 + Cl_2 \rightarrow 2HCl$

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5. Occurrence and Abundance

- 21st most abundant element in Earth’s crust.
- Found in:
  - Seawater (NaCl) – Major source.
  - Rock Salt (Halite, NaCl).
  - Volcanoes and deep-sea vents.
- Atmospheric Presence: Trace amounts.

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6. Industrial Production of Chlorine

- Electrolysis of Brine (Chlor-alkali Process):

  $2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$

- Membrane, diaphragm, and mercury cell methods are used.

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7. Uses of Chlorine

Application	Description
Water Treatment	Disinfects drinking water and swimming pools.
Bleach Production	Used in sodium hypochlorite (NaClO).
PVC Production	Polyvinyl chloride (plastic manufacturing).
Pharmaceuticals	Chlorine compounds in drugs and disinfectants.
Pesticides and Herbicides	DDT, insecticides, and other agrochemicals.
Metallurgy	Extracts metals from ores.
Textiles and Paper	Bleaching agent for paper and fabrics.

Application	Description
Chemical Manufacturing	Used to produce solvents (e.g., chloroform, CCl_4).

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8. Important Chlorine Compounds

Compound	Formula	Use
Sodium Chloride (Table Salt)	NaCl	Essential for life and food.
Hydrochloric Acid	HCl	Industrial acid, digestion (stomach).
Sodium Hypochlorite	NaClO	Bleach, disinfectant.
Chlorine Dioxide	ClO_2	Water purification.
Chloroform	$CHCl_3$	Solvent, anesthetic (formerly used).
Polyvinyl Chloride (PVC)	$(C_2H_3Cl)_n$	Pipes, cables, and flooring.

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9. Biological Importance of Chlorine

- Essential for Life (as Chloride Ion, Cl^-):
  - Regulates osmotic pressure and acid-base balance in the body.
  - Aids in digestion (HCl in stomach acid).
- Chloride ions are necessary for nerve and muscle function.

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10. Chlorine in Environmental Chemistry

- Disinfection:
  - Used to kill pathogens in drinking water.
- Ozone Depletion:
  - Chlorofluorocarbons (CFCs) contribute to ozone layer destruction:

$$CFCl_3 + UV \rightarrow Cl + CFCl_2$$
$$Cl + O_3 \rightarrow ClO + O_2$$

- Pollution:
  - Chlorine gas leaks pose serious environmental hazards.

11. Safety and Hazards

- Highly Toxic:
  - Can cause severe respiratory damage if inhaled.
  - Causes skin and eye burns.
- Reactive with Organic Materials:
  - Can form toxic chlorinated compounds.
- Fire Risk:
  - Combines with hydrogen or hydrocarbons explosively.

Handling Precautions:

- Use in well-ventilated areas.
- Wear protective clothing and masks.
- Store in sealed, corrosion-resistant containers.

Fun Facts About Chlorine:

- Chlorine gas was used in WWI as a chemical weapon.
- Discovered in 1774 by Carl Wilhelm Scheele.
- Chlorine compounds make up 1.9% of ocean mass (mostly as NaCl).
- Bleach (NaClO) uses chlorine as the active ingredient.