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1. General Information

- Symbol: F
- Atomic Number: 9
- Atomic Mass: 18.998 u
- Group: 17 (Halogens)
- Period: 2
- Block: p-block
- Electron Configuration: $1s^2\ 2s^2\ 2p^5$
- Valence Electrons: 7
- Phase at Room Temperature: Gas

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2. Isotopes of Fluorine

Isotope	Protons	Neutrons	Abundance	Notes
^{19}F	9	10	100%	Only stable isotope.

3. Physical Properties

- Color: Pale yellow
- Odor: Pungent (in gaseous form)
- Density: 1.696 g/L (at STP)
- Melting Point: -219.62°C
- Boiling Point: -188.12°C
- State at STP: Gas
- Molecular Form: F_2 (Diatomic)

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4. Chemical Properties

- Most Electronegative Element: 3.98 on the Pauling scale.
- Highly Reactive: Reacts with almost all elements (including noble gases under certain conditions).
- Strong Oxidizing Agent: Pulls electrons from other atoms.
- Reacts Violently with Water: Forms hydrofluoric acid (HF) and oxygen.
- Corrosive and Toxic in elemental form.

Reaction with Water:

$2F_2 + 2H_20 \rightarrow 4HF + 0_2$

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5. Occurrence and Abundance

- Rare as Elemental Fluorine (F_2): Highly reactive, never found free in nature.
- Found in Minerals:
    - Fluorite (CaF_2)
    - Cryolite (Na_3AlF_6)
    - Apatite ($Ca_5(PO_4)_3F$)

- Earth’s Crust: 0.054% by weight.

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6. Industrial Production of Fluorine

- Electrolysis of Hydrogen Fluoride (HF):

  $2HF \rightarrow H_2 + F_2$

- Source Materials: Fluorite (CaF_2) is used to produce hydrogen fluoride.

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7. Uses of Fluorine

Application	Description
Toothpaste and Water Fluoridation	Prevents dental cavities (as fluoride ions).
Refrigerants	Hydrofluorocarbons (HFCs), Teflon (PTFE).
Medicines	Fluorine-containing drugs (e.g., Prozac, Lipitor).
Nuclear Industry	Uranium hexafluoride (UF_6) for uranium enrichment.
Metallurgy	Used in aluminum refining (cryolite).
Rocket Propellants	Oxidizer in rocket fuel.
Non-stick Coatings	Teflon (polytetrafluoroethylene, PTFE).

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8. Important Fluorine Compounds

Compound	Formula	Use
Hydrofluoric Acid	HF	Glass etching, metal cleaning.
Sodium Fluoride	NaF	Water fluoridation, toothpaste.
Uranium Hexafluoride	UF_6	Uranium enrichment for nuclear power.
Sulfur Hexafluoride	SF_6	Electrical insulator in circuits.
Fluoropolymers	PTFE (Teflon)	Non-stick cookware, electrical insulation.

9. Biological Role of Fluorine

- Not essential for life but important for dental health.
- Strengthens tooth enamel by forming fluorapatite ($Ca_5(PO_4)_3F$).
- Trace amounts are beneficial; excess can cause fluorosis (tooth discoloration).

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10. Fluorine in Environmental Chemistry

- Fluorinated Greenhouse Gases (F-Gases): Potent greenhouse gases like HFCs and SF_6.
- Persistent in Environment: Fluorine-based compounds are chemically stable and hard to break down.

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11. Safety and Hazards

- Highly Toxic and Corrosive:
  - Fluorine gas can cause severe burns on contact.
  - Inhalation is fatal even in small quantities.
- Hydrofluoric Acid (HF): Penetrates skin, causing deep tissue damage and calcium depletion in bones.
- Proper Handling:
  - Use protective gloves and eyewear.
  - Store in corrosion-resistant containers.

Fun Facts About Fluorine:

- Fluorine is the most reactive element and can react with materials like glass and steel.
- The name “Fluorine” comes from the Latin word “fluere” meaning “to flow”.
- Teflon (PTFE), discovered by accident, is one of the best-known fluorinated

materials.

- Fluorine compounds are used in 25% of all pharmaceuticals.