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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
$^{19}\text{F}$	9	10	100%	Only stable isotope.

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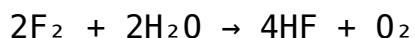
### 3. Physical Properties

- 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<sub>2</sub> (Diatomeric)
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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.
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#### Reaction with Water:



### 5. Occurrence and Abundance

- Rare as Elemental Fluorine (F<sub>2</sub>): Highly reactive, never found free in nature.
- Found in Minerals:
  - Fluorite (CaF<sub>2</sub>)
  - Cryolite (Na<sub>3</sub>AlF<sub>6</sub>)
  - Apatite (Ca<sub>5</sub>(PO<sub>4</sub>)<sub>3</sub>F)

- Earth's Crust: 0.054% by weight.
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## 6. Industrial Production of Fluorine

- Electrolysis of Hydrogen Fluoride (HF):



- Source Materials: Fluorite ( $\text{CaF}_2$ ) 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 ( $\text{UF}_6$ ) 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	$\text{UF}_6$	Uranium enrichment for nuclear power.
Sulfur Hexafluoride	$\text{SF}_6$	Electrical insulator in circuits.
Fluoropolymers	PTFE (Teflon)	Non-stick cookware, electrical insulation.

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## 9. Biological Role of Fluorine

- Not essential for life but important for dental health.
  - Strengthens tooth enamel by forming fluorapatite ( $\text{Ca}_5(\text{PO}_4)_3\text{F}$ ).
  - 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  $\text{SF}_6$ .
  - 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.
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## 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.