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1. General Information

- Symbol: Al
- Atomic Number: 13
- Atomic Mass: 26.98 u
- Group: 13 (Boron Group)
- Period: 3
- Block: p-block
- Electron Configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
- Valence Electrons: 3
- Phase at Room Temperature: Solid

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2. Isotopes of Aluminium

Isotope	Protons	Neutrons	Abundance	Notes
^{27}Al	13	14	100%	Only stable isotope.
^{26}Al	13	13	Trace	Radioactive, used in dating meteorites.

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3. Physical Properties

- Color: Silvery-white
- Odor: Odorless
- Density: 2.70 g/cm³
- Melting Point: 660.3°C
- Boiling Point: 2,470°C
- State at STP: Solid
- Lightweight and Ductile – Can be easily shaped and drawn into wires.

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4. Chemical Properties

- Highly Reactive (Forms Oxide Layer):
  - Reacts with oxygen to form aluminium oxide (Al_2O_3), creating a protective layer that prevents further corrosion.
- Amphoteric Nature:
  - Reacts with both acids and bases.
- Good Conductor of Heat and Electricity.
- Non-Magnetic and Non-Sparking.

Reaction with Oxygen:

$$4Al + 3O_2 \rightarrow 2Al_2O_3$$

Reaction with Hydrochloric Acid:

$$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2\uparrow$$

Reaction with Sodium Hydroxide:

$$2Al + 2NaOH + 6H_2O \rightarrow 2Na[Al(OH)_4] + 3H_2\uparrow$$

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5. Occurrence and Abundance

- Third most abundant element in Earth's crust (8.1%).
- Never found free in nature – Occurs in compounds.
- Common Ores:
  - Bauxite ($Al_2O_3 \cdot xH_2O$) – Primary source of aluminium.
  - Cryolite (Na_3AlF_6) – Used in aluminium extraction.

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6. Industrial Production of Aluminium

- Bayer Process (Extraction of Alumina):

  $$Bauxite \rightarrow Al_2O_3 \text{ (via caustic soda)}$$

- Hall-Héroult Process (Electrolysis):

  $$Al_2O_3 \rightarrow Al \text{ (Molten Electrolysis with Cryolite)}$$

- Anodes (Carbon) are consumed during electrolysis.

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7. Uses of Aluminium

Application	Description
Aerospace and Automotive	Lightweight parts for fuel efficiency.
Construction	Window frames, roofing, and structural components.
Packaging	Foil, cans, and beverage containers.
Electrical Industry	Power lines and cables (light and conductive).
Consumer Goods	Laptops, smartphones, and appliances.

Application	Description
Transportation	High-speed trains and marine vessels.
Medical Equipment	Lightweight surgical tools and equipment.

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8. Important Aluminium Compounds

Compound	Formula	Use
Aluminium Oxide	Al_2O_3	Abrasives, ceramics, refractories.
Aluminium Hydroxide	$Al(OH)_3$	Antacid, fire retardant.
Aluminium Sulfate	$Al_2(SO_4)_3$	Water treatment, paper industry.
Aluminium Chloride	$AlCl_3$	Catalysts in chemical reactions.
Aluminium Nitrate	$Al(NO_3)_3$	Waterproofing textiles, corrosion prevention.

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9. Biological Role of Aluminium

- No known biological role in humans.
- Non-toxic in small amounts, but excessive exposure may lead to health concerns.
- Used in Medicine:
    - Antacids and vaccines (as aluminium salts).

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10. Aluminium in Environmental Chemistry

- Recyclable: 75% of aluminium ever produced is still in use.
- Eco-Friendly: Reduces energy consumption by 95% when recycled.
- Environmental Concerns:
    - Bauxite mining can cause deforestation and soil erosion.
    - Aluminium oxide dust can irritate the respiratory system.

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11. Safety and Hazards

- Stable in Air due to the oxide layer.
- Fine Aluminium Dust is Flammable and can explode.
- Health Risks:
    - Prolonged exposure to aluminium dust can lead to lung issues.
    - Aluminium toxicity is rare but can affect the nervous system.

Handling Precautions:

- Store in a dry place to avoid corrosion.
- Handle aluminium dust carefully to prevent fire hazards.

Fun Facts About Aluminium:

- Discovered in 1825 by Hans Christian Ørsted.
- Once more valuable than gold due to the difficulty of extraction.
- The cap of the Washington Monument is made of pure aluminium.
- Aluminium is used in spacecraft due to its strength-to-weight ratio.