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1. General Information

- Symbol: Ca
- Atomic Number: 20
- Atomic Mass: 40.08 u
- Group: 2 (Alkaline Earth Metals)
- Period: 4
- Block: s-block
- Electron Configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
- Valence Electrons: 2
- Phase at Room Temperature: Solid

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2. Isotopes of Calcium

Isotope	Protons	Neutrons	Abundance	Notes
^{40}Ca	20	20	96.9%	Most abundant, stable.
^{42}Ca	20	22	0.65%	Stable.
^{43}Ca	20	23	0.14%	Stable.
^{44}Ca	20	24	2.08%	Stable.
^{48}Ca	20	28	0.19%	Rare, used in nuclear research.

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3. Physical Properties

- Color: Silvery-white
- Odor: Odorless
- Density: 1.55 g/cm³
- Melting Point: 842°C
- Boiling Point: 1,484°C
- State at STP: Solid
- Soft Metal: Can be cut with a knife.

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4. Chemical Properties

- Moderately Reactive:
  - Reacts readily with water to form calcium hydroxide ($Ca(OH)_2$) and hydrogen gas (H_2).
  - Reacts with oxygen to form a thin layer of calcium oxide (CaO).
- Forms Alkaline Solutions in water.
- Burns with a Bright Orange-Red Flame.

Reaction with Water:

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2\uparrow$$

Reaction with Oxygen:

$$2Ca + O_2 \rightarrow 2CaO$$

5. Occurrence and Abundance

- 5th most abundant element in Earth’s crust.
- Found in:
  - Minerals: Limestone ($CaCO_3$), Gypsum ($CaSO_4 \cdot 2H_2O$), Fluorite (CaF_2).
  - Bones and Teeth: Makes up 99% of body calcium in humans.
- Seawater: Contains calcium ions (Ca^{2+}).

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6. Industrial Production of Calcium

- Electrolysis of Molten Calcium Chloride ($CaCl_2$):

  $$CaCl_2 \rightarrow Ca + Cl_2$$

- Thermal Reduction:

  $$CaO + Al \rightarrow Ca + Al_2O_3$$

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7. Uses of Calcium

Application	Description
Construction	Limestone and gypsum used in cement and plaster.
Steel Production	Removes impurities as a flux.
Chemical Manufacturing	Produces calcium compounds (e.g., $CaCl_2$, $Ca(OH)_2$).
Pharmaceuticals	Supplements and antacids.
Glass and Ceramics	Calcium carbonate ($CaCO_3$) strengthens glass.
Fertilizers	Calcium nitrate ($Ca(NO_3)_2$) enriches soil.

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8. Important Calcium Compounds

Compound	Formula	Use
Calcium Carbonate	$CaCO_3$	Chalk, limestone, antacids.
Calcium Oxide (Quicklime)	CaO	Cement, steel, and paper.
Calcium Hydroxide	$Ca(OH)_2$	Plaster, water treatment.
Calcium Chloride	$CaCl_2$	De-icing roads, food preservative.
Calcium Nitrate	$Ca(NO_3)_2$	Fertilizer.
Calcium Sulfate	$CaSO_4$	Plaster of Paris, drywall.

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9. Biological Importance of Calcium

- Essential for Life:
  - Builds bones and teeth (hydroxyapatite).
  - Regulates nerve function, muscle contractions, and blood clotting.
- Cellular Function:
  - Calcium ions (Ca^{2+}) play a role in cell signaling and enzyme activation.
- Daily Requirement:
  - Adults: 1,000–1,200 mg/day.

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10. Calcium in Environmental Chemistry

- Water Hardness:
  - Calcium ions cause hard water, forming scale in pipes.
- Carbonate Cycle:
  - Calcium carbonate in oceans helps regulate CO_2 levels through the carbon cycle.
- Soil Health:
  - Calcium enhances soil structure and plant growth.

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11. Safety and Hazards

- Reacts with Water:
  - Generates heat and hydrogen gas, which can ignite.
- Irritant:
  - Calcium hydroxide (slaked lime) can cause skin and eye burns.
- Non-Toxic in Small Quantities:
  - Excessive intake can cause hypercalcemia (calcium buildup in the body).

Handling Precautions:

- Store in dry environments to prevent reactions with moisture.
- Use protective gear (gloves, goggles) when handling calcium compounds.

Fun Facts About Calcium:

- Calcium was isolated in 1808 by Sir Humphry Davy.
- Calcium carbonate forms stalactites and stalagmites in caves.
- Calcium ions are essential for the “glow” in fireflies.
- Bone fossils and shells are primarily composed of calcium minerals.