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1. General Information

- Symbol: O
- Atomic Number: 8
- Atomic Mass: 15.999 u
- Group: 16 (Chalcogens)
- Period: 2
- Block: p-block
- Electron Configuration: $1s^2\ 2s^2\ 2p^4$
- Valence Electrons: 6
- Phase at Room Temperature: Gas

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2. Isotopes of Oxygen

Isotope	Protons	Neutrons	Abundance	Notes
^{16}O	8	8	99.76%	Stable and most abundant.

Isotope	Protons	Neutrons	Abundance	Notes
^{17}O	8	9	0.04%	Stable, used in research.
^{18}O	8	10	0.20%	Stable, used in paleoclimate studies.

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3. Physical Properties

- Color: Colorless
- Odor: Odorless
- Density: 1.429 g/L (at STP)
- Melting Point: -218.8°C
- Boiling Point: -183.0°C
- State at STP: Gas
- Form: Diatomic molecule (O_2)

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4. Chemical Properties

- Highly Reactive – Supports combustion and combines readily with most elements.
- Oxidizer: Causes other substances to burn.
- Forms Oxides: Combines with metals and non-metals to form oxides.
- Allotropes:
  - O_2 (Molecular Oxygen): Essential for life and respiration.
  - O_3 (Ozone): Protects Earth from UV radiation.

Combustion Reaction:

$C + O_2 \rightarrow CO_2$ (Carbon Dioxide)
$4Fe + 3O_2 \rightarrow 2Fe_2O_3$ (Rust)

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5. Occurrence and Abundance

- Third most abundant element in the universe.

- On Earth:
  - Atmosphere: 21% by volume.
  - Crust: 46% (in oxides and silicates).
  - Oceans: 85% (in water molecules).
  - Living Organisms: Component of water, proteins, and DNA.

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6. Industrial Production of Oxygen

- Fractional Distillation: Separation from liquid air.
- Electrolysis of Water: Splitting H_2O into hydrogen and oxygen.
- Chemical Methods: Decomposition of hydrogen peroxide (H_2O_2).

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7. Uses of Oxygen

Application	Description
Respiration and Medicine	Life support in hospitals and oxygen tanks.
Combustion and Energy	Supports burning of fuels in engines and rockets.
Steel Production	Used to remove impurities from molten iron.
Water Treatment	Ozone (O_3) purifies and disinfects water.
Chemical Industry	Oxidizer in the production of chemicals.
Spacecraft and Aviation	Breathing systems and fuel oxidizer.

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8. Oxygen Compounds

Compound	Formula	Use
Water	H_2O	Essential for all known life forms.
Carbon Dioxide	CO_2	Photosynthesis, respiration.
Ozone	O_3	Protects Earth from UV radiation.
Iron Oxide (Rust)	Fe_2O_3	Corrosion product of iron.
Silicon Dioxide	SiO_2	Glass, sand, and ceramics.

9. Biological Importance of Oxygen

- Essential for Cellular Respiration:

  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy (ATP)}$

- Photosynthesis:
  - Plants produce oxygen by splitting water during photosynthesis.

  $6CO_2 + 6H_2O + \text{Light} \rightarrow C_6H_{12}O_6 + 6O_2$

- Component of Water and Organic Molecules – Crucial for life processes.

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10. The Ozone Layer (O_3)

- Formation:

  $O_2 + UV \rightarrow 2O \rightarrow O_2 + O \rightarrow O_3$

- Protects Earth by absorbing harmful UV radiation.
- Depletion:
  - Caused by CFCs (chlorofluorocarbons), leading to environmental concerns.

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11. Safety and Hazards

- Supports Combustion: Increases fire risk in high concentrations.
- Oxygen Toxicity: Breathing pure oxygen at high pressures can cause lung damage.
- Cryogenic Burns: Liquid oxygen can cause severe frostbite.

Fun Facts About Oxygen:

- Oxygen makes up 65% of the human body by mass (mostly in water).
- The blue color of the sky is due to oxygen and nitrogen scattering sunlight.
- Fish extract oxygen from water using gills.
- Oxygen was discovered independently by Carl Wilhelm Scheele and Joseph Priestley in the 18th century.