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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
- 

## 2. Isotopes of Oxygen

| Isotope         | Protons | Neutrons | Abundance | Notes                     |
|-----------------|---------|----------|-----------|---------------------------|
| <sup>16</sup> O | 8       | 8        | 99.76%    | Stable and most abundant. |

| Isotope         | Protons | Neutrons | Abundance | Notes                                 |
|-----------------|---------|----------|-----------|---------------------------------------|
| <sup>17</sup> O | 8       | 9        | 0.04%     | Stable, used in research.             |
| <sup>18</sup> O | 8       | 10       | 0.20%     | Stable, used in paleoclimate studies. |

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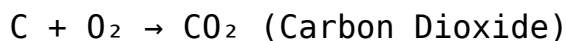
### 3. Physical Properties

- 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<sub>2</sub>)
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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<sub>2</sub> (Molecular Oxygen): Essential for life and respiration.
  - O<sub>3</sub> (Ozone): Protects Earth from UV radiation.

#### Combustion Reaction:



### 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  $\text{H}_2\text{O}$  into hydrogen and oxygen.
  - Chemical Methods: Decomposition of hydrogen peroxide ( $\text{H}_2\text{O}_2$ ).
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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 ( $\text{O}_3$ ) purifies and disinfects water. |
| Chemical Industry        | Oxidizer in the production of chemicals.              |
| Spacecraft and Aviation  | Breathing systems and fuel oxidizer.                  |

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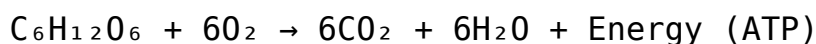
## 8. Oxygen Compounds

| Compound          | Formula                 | Use                                 |
|-------------------|-------------------------|-------------------------------------|
| Water             | $\text{H}_2\text{O}$    | Essential for all known life forms. |
| Carbon Dioxide    | $\text{CO}_2$           | Photosynthesis, respiration.        |
| Ozone             | $\text{O}_3$            | Protects Earth from UV radiation.   |
| Iron Oxide (Rust) | $\text{Fe}_2\text{O}_3$ | Corrosion product of iron.          |
| Silicon Dioxide   | $\text{SiO}_2$          | Glass, sand, and ceramics.          |

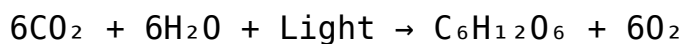
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## 9. Biological Importance of Oxygen

- Essential for Cellular Respiration:



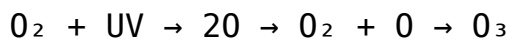
- Photosynthesis:
  - Plants produce oxygen by splitting water during photosynthesis.



- Component of Water and Organic Molecules - Crucial for life processes.
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## 10. The Ozone Layer (O<sub>3</sub>)

- Formation:



- 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.
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### 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.