

# Helium (He) - The Lightest Noble Gas and the Second Most Abundant Element in the Universe

## Table of Contents



- [1. General Information](#)
- [2. Isotopes of Helium](#)
- [3. Physical Properties](#)
- [4. Chemical Properties](#)
- [5. Occurrence and Abundance](#)
- [6. Production and Extraction](#)
- [7. Uses of Helium](#)
- [8. Unique Properties of Helium](#)
- [9. Helium and Space Exploration](#)
- [10. Safety and Handling](#)
  - [Fun Facts About Helium:](#)

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## 1. General Information

- Symbol: He
  - Atomic Number: 2
  - Atomic Mass: 4.0026 u
  - Group: 18 (Noble Gases)
  - Period: 1
  - Block: s-block
  - Electron Configuration:  $1s^2$
  - Valence Electrons: 2
  - Phase at Room Temperature: Gas
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## 2. Isotopes of Helium

Isotope	Protons	Neutrons	Abundance
$^3\text{He}$	2	1	Trace (Rare)
$^4\text{He}$	2	2	99.999%

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- $^4\text{He}$  is produced by nuclear fusion in stars and during the radioactive decay of heavy elements (alpha decay).
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## 3. Physical Properties

- Color: Colorless
  - Odor: Odorless
  - Density: 0.1786 g/L (at STP)
  - Melting Point: Does not solidify at standard pressure.
  - Boiling Point:  $-268.93^{\circ}\text{C}$  (4.2 K)
  - State at STP: Gas
  - Inert and Non-Flammable - Helium does not readily react with other elements.
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## 4. Chemical Properties

- Inert: Helium is part of the noble gases and is chemically non-reactive.
  - Non-Toxic and Non-Flammable - Safe to use in various applications.
  - Monoatomic Gas (He): Helium exists as single atoms under normal conditions.
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## 5. Occurrence and Abundance

- Second most abundant element in the universe (after hydrogen).
- On Earth:
  - Found in natural gas deposits.
  - Formed through alpha particle decay of radioactive elements in the Earth's crust.

- Extracted by fractional distillation of liquefied natural gas (LNG).

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## 6. Production and Extraction

Method	Description
Fractional Distillation	Extracted from natural gas where helium is concentrated.
Nuclear Reactions	Produced as a byproduct of radioactive decay (alpha decay).
Star Fusion	Created in massive quantities in stars through nuclear fusion.

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## 7. Uses of Helium

Application	Description
Cryogenics	Cooling superconducting magnets (e.g., MRI machines).
Balloons and Blimps	Non-flammable and lighter than air.
Pressurizing Agent	Used in rocket fuel tanks.
Diving and Breathing Mixtures	Heliox (Helium + Oxygen) prevents nitrogen narcosis.
Electronics and Fiber Optics	Used to create inert atmospheres.
Scientific Research	Superfluid studies at near absolute zero.
Welding	Inert gas for arc welding.

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## 8. Unique Properties of Helium

- Lowest Boiling Point of Any Element: 4.2 K (-268.93°C).
  - Cannot Solidify at Normal Pressure: Even at absolute zero, helium remains a liquid unless under high pressure.
  - Superfluid Helium ( $^4\text{He}$ ): Helium exhibits zero viscosity at temperatures near absolute zero, allowing it to flow without friction.
  - Second Lightest Element - Only hydrogen is lighter.
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## 9. Helium and Space Exploration

- **Rocket Fuel Purge:** Helium is used to pressurize and purge fuel tanks in rockets.
  - **Cooling Systems:** Essential for cooling space instruments and satellites.
  - **Balloon Flights:** Used for high-altitude weather balloons.
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## 10. Safety and Handling

- **Non-Toxic and Safe to Inhale in Small Quantities** – But excessive inhalation displaces oxygen, causing suffocation.
  - **Asphyxiation Risk:** In confined spaces, helium can cause oxygen displacement.
  - **Storage:** Stored in pressurized cylinders and cryogenic tanks.
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### Fun Facts About Helium:

- Helium was discovered on the Sun before being found on Earth (spectroscopy in 1868).
- Helium makes your voice high-pitched because it travels faster through the vocal cords.
- Stars constantly produce helium through nuclear fusion, turning hydrogen into helium.