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

Table of Contents

---

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

---

2. Isotopes of Helium

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

- ^{4}He is produced by nuclear fusion in stars and during the radioactive decay of heavy elements (alpha decay).

---

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°C (4.2 K)
- State at STP: Gas
- Inert and Non-Flammable – Helium does not readily react with other elements.

---

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.

---

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).

---

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.

---

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.

---

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 (^{2}He): Helium exhibits zero viscosity at temperatures near absolute zero, allowing it to flow without friction.
- Second Lightest Element – Only hydrogen is lighter.

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.

---

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.

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.