



### Key Properties

Atomic Mass	1.008
Category	Nonmetals
State at 20°C	gas
Melting Point	-259.16°C
Boiling Point	-252.879°C
Density	0.089 g/L
Electron Config	1s1
Electronegativity	2.2
Year Discovered	1766
Discovered By	Henry Cavendish

### Did You Know?

- 1 It is the most abundant chemical substance in the universe, constituting roughly 75% of all baryonic mass.
- 2 It's the only element that can exist without neutrons; its most common isotope (protium) is just one proton and one electron.
- 3 Hydrogen gas is so light that Earth's gravity is not strong enough to hold it, and it floats off into space.
- 4 The Sun and other stars are composed primarily of hydrogen, which they convert to helium through nuclear fusion to produce energy.
- 5 When cooled to extremely low temperatures, hydrogen becomes a liquid metal, a state that may exist in the cores of gas giants like Jupiter.

#### APPEARANCE

A colorless, odorless, tasteless gas.

#### SUPERHERO PERSONA

"Captain Universe, the simplest, lightest, and most common hero, fueling the very stars."

#### EVERYDAY CONNECTION

The water you drink and the airships of classic science fiction

#### POP CULTURE

The fuel for the Hindenburg airship and starships in 'Star Trek'.

## Overview of Hydrogen

Hydrogen is the lightest and most abundant element in the universe, with atomic number 1. It is a colorless, odorless, and highly flammable gas that plays a fundamental role in both the cosmos and life on Earth. The name comes from the Greek words hydro ("water") and genes ("former"), reflecting its property of forming water when burned in oxygen.

## Uses of Hydrogen

Hydrogen has a wide range of applications, from clean energy to vital industrial processes:

**Clean energy:** Hydrogen is seen as a fuel of the future. In fuel cells, it generates electricity with water as the only byproduct, powering cars, buses, and even entire buildings without producing greenhouse gases.

**Industrial applications:** Hydrogen is a key raw material in the Haber process for making ammonia, which is crucial for fertilizers. It is also used to make methanol, plastics, and pharmaceuticals, to desulfurize fuels in oil refining, and to hydrogenate oils to produce margarine and other fats.

**Other applications:** Its low density once made it the preferred gas for airships and balloons, though its flammability (notably in the Hindenburg disaster) ended this practice. Hydrogen is also used as a protective atmosphere in glassmaking and as a flushing gas in semiconductor manufacturing.

## Biological Role of Hydrogen

Hydrogen is an essential element for life. It is a fundamental component of water and of nearly all biological molecules. While it usually remains bonded to carbon and oxygen, providing structural stability, the chemistry of life occurs at the more reactive sites involving elements like oxygen, nitrogen, and phosphorus.

## Natural Abundance and Production of Hydrogen

Hydrogen makes up about 75% of all normal matter in the universe, forming the bulk of the sun, stars, and gas giant planets like Jupiter. On Earth, it is found mostly in water (H<sub>2</sub>O) and in hydrocarbons.

**Production on Earth:** Commercial hydrogen is primarily produced by steam reforming of natural gas, creating a mixture called syngas (hydrogen and carbon monoxide). Another method is electrolysis of water, which is cleaner but more energy-intensive.

## History of Hydrogen

1766 – **Discovery:** British chemist Henry Cavendish identified hydrogen as a distinct gas, calling it "inflammable air." He showed it was lighter than air and that it formed water when burned.

1931 – **Isotopes:** A heavier isotope, deuterium (<sup>2</sup>H), was discovered by Harold Urey. Another, tritium (<sup>3</sup>H), was later identified and is radioactive.

**Naming:** French chemist Antoine Lavoisier gave hydrogen its name, emphasizing its role as the "water-former."

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