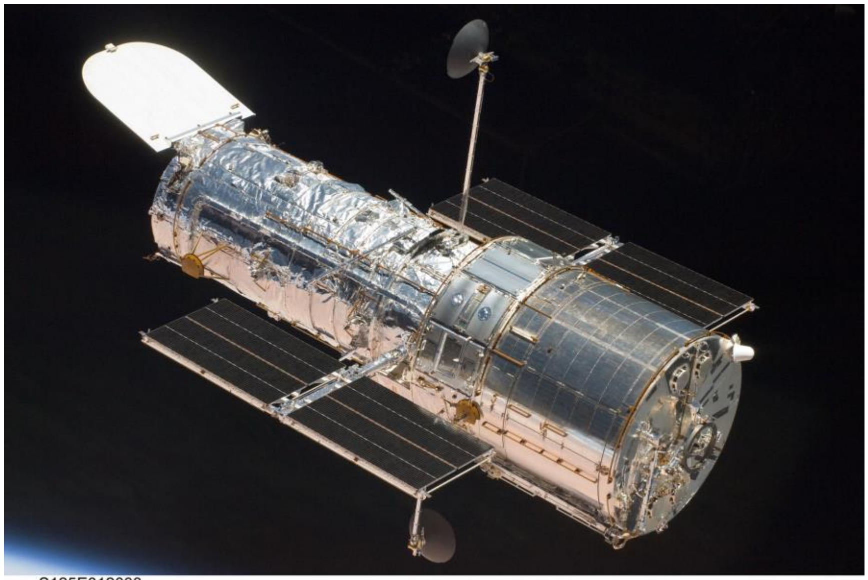
HYDROGEN AND ITS COMPONENTS

Discovery

In 1671, Robert Boyle discovered and described the reaction between iron filings and dilute acids, which resulted in the production of hydrogen gas. In 1766-81, Henry Cavendish was the first to recognize that hydrogen gas was a discrete substance, and that it produced water when burned. He named it "flammable air". In 1783, Antoine Lavoisier gave the element the name hydrogen (from the Greek υδρο-*hydro* meaning "water" and -γενης *genes* meaning "creator") when he and Pierre-Simon Laplace reproduced Cavendish's finding that water was produced when hydrogen was burned.

Hydrogen was liquefied for the first time by James Dewar in 1898 by using *regenerative cooling* and his invention, the **vacuum flask**. He produced solid hydrogen the next year. **Deuterium** was discovered in December 1931 by Harold Urey, and **tritium** was prepared in 1934 by Ernest Rutherford, Mark Oliphant, and Paul Harteck. Heavy water, which consists of deuterium in the place of regular hydrogen, was discovered by Urey's group in 1932.

The nickel hydrogen battery was used for the first time in 1977 aboard the U.S. Navy's Navigation technology satellite-2 (NTS-2). It had two caesium atomic clocks on board and helped to show that satellite navigation based on precise timing was possible. In the dark part of its orbit, the Hubble Space Telescope is powered by nickel-hydrogen batteries, which were finally replaced in May 2009, more than 19 years after launch, and 13 years passed their design life.



from NASA (accessed 2 Feb 2015)

Isotopes of hydrogen

Hydrogen has three naturally occurring isotopes, denoted ^{1}H, ^{2}H and ^{3}H. Other, highly unstable nuclei (^{4}H to ^{7}H) have been synthesized in the laboratory but are not observed in nature.

- ^{1}H is the most common hydrogen isotope with an abundance of more than 99.98%. Because the nucleus of this isotope consists of only a single proton, it is given the descriptive, but rarely used formal name of protium.
- ^{2}H, the other stable hydrogen isotope, is known as deuterium and contains one proton and one neutron in its nucleus. Essentially all deuterium in the universe is thought to have been produced at the time of the Big Bang, and has endured since that time. Deuterium is not radioactive, and does not represent a significant toxicity hazard. Water enriched in molecules that include deuterium instead of normal hydrogen is called heavy water. Deuterium and its compounds are used as a non-radioactive label in chemical experiments and in solvents for ^{1}H-NMR

spectroscopy. Heavy water is used as a neutron moderator and coolant for nuclear reactors. Deuterium is also a potential fuel for commercial nuclear fusion.

- ^{3}H is known as tritium and contains one proton and two neutrons in its nucleus. It is radioactive, decaying into helium-3 through beta decay with a half-life of 12.32 years. It is sufficiently radioactive that it can be used in luminous paint, making it useful in such things as watches where the glass moderates the amount of radiation getting out. Small amounts of tritium occur naturally because of the interaction of cosmic rays with atmospheric gases; tritium has also been released during nuclear weapons tests. It is used in nuclear fusion reactions, as a tracer in isotope geochemistry, and specialized in self-powered lighting devices. Tritium has been used in chemical and biological labeling experiments as a radiolabel.

Hydrogen is the only element that has different names for its isotopes in common use today. During the early study of radioactivity, various heavy radioactive isotopes were given their own names, but these names are no longer used, except for deuterium and tritium.

nuclide symbol	Z(p)	N(n)	isotopic mass (u)	half-life	decay mode	Daughter Isotope	representative isotopic composition
^{1}H	1	0	1.00782503207(10)	**Stable**			0.999885(70)
^{2}H - D	1	1	2.0141017778(4)	**Stable**			0.000115(70)
^{3}H - T	1	2	3.0160492777(25)	12.32(2) y	β	^{3}He	<1 in 10^{17} atoms

Properties of hydrogen

The difference of mass between isotopes of most elements is only a small fraction of the total mass and so this has very little effect on their properties, this is not the case for hydrogen. Consider chlorine with Z=17, there are 2 stable isotopes ^{35}Cl (75.77%) and ^{37}Cl (24.23%). The increase is therefore 2 in 35 or less than 6%. Deuterium and tritium are about double and triple the mass of protium and show significant physical and chemical differences particularly with regard to those properties related to mass, e.g. rate of diffusion, density, etc.

Some physical properties of the hydrogen isotopes.

isotope	MP /K	BP /K	ΔH_{diss} /kJmol^{-1}	Interatomic Distance /pm
H_2	13.99	20.27	435.99	74.14
D_2	18.73	23.67	443.4	74.14
T_2	20.62	25.04	446.9	74.14

Source : http://wwwchem.uwimona.edu.jm:1104/courses/CHEM1902/IC10K_MG_hydrogen.html