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# TEXAS IS AN ENERGY STATE DOES THAT INCLUDE HYDROGEN?

An overview of hydrogen in the Lone Star State

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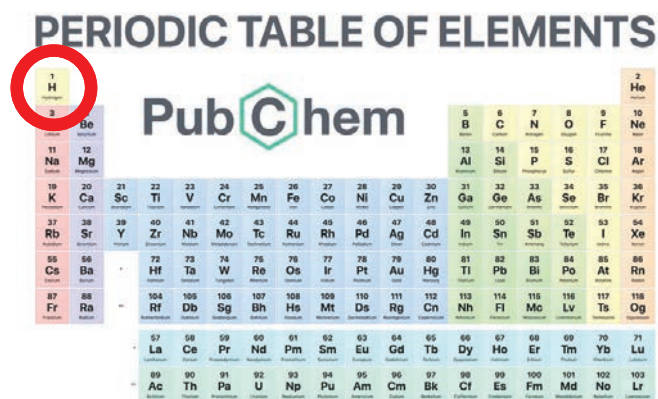
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## But first, what is hydrogen?

- Hydrogen, **H**, is a colorless, odorless, nonmetallic, tasteless, highly flammable gas.
- In general, hydrogen gas comes in pairs:  $H_2$
- Hydrogen is generally discussed in mass terms
  - kg or metric ton (1,000 kg)

**PERIODIC TABLE OF ELEMENTS**

PubChem

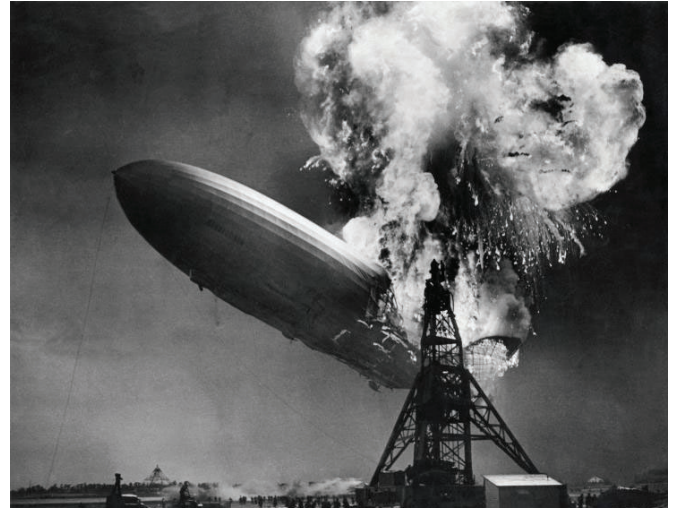


The image shows a standard periodic table of elements. The element Hydrogen (H) is circled in red. The table includes element symbols, atomic numbers, and names. The PubChem logo is prominently displayed in the center of the table.

<https://pubchem.ncbi.nlm.nih.gov/periodic-table/>

## Hydrogen is flammable and has had some disasters

- Hindenburg Zeppelin
  - May 6, 1937,  
Manchester, NJ
  - 36 deaths
  - Cause still debated



## Hydrogen is interesting for several reasons

- Advantages
  - The lightest and most abundant chemical element in the universe
  - Colorless, odorless gas
  - Low density
  - Carbon-free
  - Easy to use
  - It has a high energy density
    - More than twice as energy dense as natural gas per kg

## Hydrogen has tradeoffs

- Disadvantages: Difficult to make, move and store
  - Make: Usually manufactured from other sources (hydrocarbons, water,...), which requires energy and money
  - Move: Low density means large volumes must be moved for equivalent energy
  - Store: Small molecular cross-section means it easily leaks out of storage
- There is no real “natural source” on this planet where hydrogen can be mined
- On a volumetric basis
  - ~1/3 as much energy as natural gas per cubic foot

## Hydrogen is easy to use as a fuel and building block

- Thermochemical: make heat to make motion to make power
  - Gas turbines
  - Internal combustion engines
- Electrochemical: make electrons
  - Fuel cells
- Chemical: make useful materials or fuels
  - A building block or process chemical

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17<sup>th</sup> Annual Renewable Energy Law Institute session  
"Texas is an energy state — does that include Hydrogen? "