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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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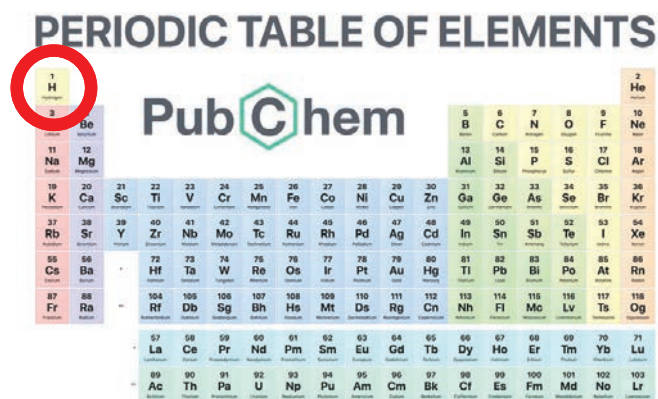
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But first, what is hydrogen?

- 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

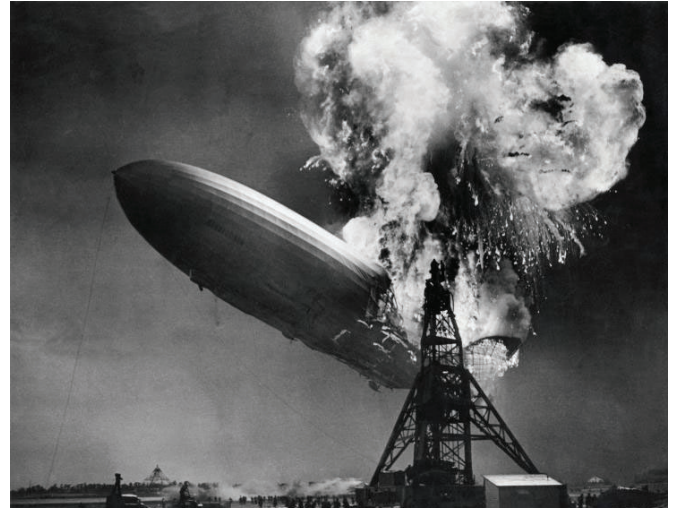
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1 H Hydrogen																	2 He Helium																		
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon																		
11 Na Sodium	12 Mg Magnesium	13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon											19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon	55 Cs Cesium	56 Ba Barium	57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium	
87 Fr Francium	88 Ra Radium	89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson				

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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"Texas is an energy state — does that include Hydrogen? "