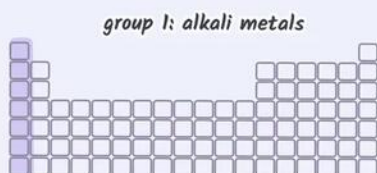


hydrogen alone at the top, then the alkali metals and the alkaline earths beneath

Hydrogen: where does it belong?

- H's config is $1s^1$: matches ns^1 (group 1) by outer count
- but also resembles ns^2np^5 (group 17): one more electron completes a shell either way
- chemically H shows BOTH resemblances: forms M^+X^- halides like an alkali metal
- $H_2 + Cl_2 \rightarrow 2HCl$ matches $2Na + Cl_2 \rightarrow 2NaCl$
- and reacts with metals to form hydrides, like a halogen forms a halide
- H^+ is unique: a bare proton, never exists freely
- always attached to something else, e.g. $H^+ + H_2O \rightarrow H_3O^+$
- this dual, unresolved character places hydrogen SEPARATELY, above group 1
- but not counted among the alkali metals



group 1 runs down the far-left column; hydrogen sits above it, in the same column, but is not one of the alkali metals

Occurrence *

- most abundant element in the universe, ~70% of its mass
- principal element of the sun and stars
- on Earth: 10th most abundant by mass, 3rd by atom count
- occurs free as dihydrogen, H_2 , hence its common name

Isotopes of hydrogen

name	symbol	Z	A	N	abundance	stability
hydrogen (protium)	^1_1H	1	1	0	99.98%	stable
deuterium	^2_1H (D)	1	2	1	0.015%	stable
tritium	^3_1H (T)	1	3	2	trace	radioactive, $t_{1/2} = 12.4$ yr

all three carry the SAME 1 proton and 1 electron; only the neutron count changes, exactly the definition of isotopes

Preparation of dihydrogen

- laboratory: $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
- or zinc with aqueous NaOH: $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$
- industrial electrolysis: dilute H_2SO_4 gives 2 volumes H_2 at the cathode per 1 O_2
- high-purity (>99.5%) H_2 comes from electrolysis warm $Ba(OH)_2$ between nickel electrodes
- industrial, from hydrocarbons: steam + hydrocarbon/coke over Ni at 1270 K gives 'syngas' ($CO + H_2$)
- water-gas shift: $CO + H_2O \rightarrow CO_2 + H_2$ (iron chromate catalyst) converts the CO
- CO_2 is then scrubbed out with sodium arsenite
- today's split: ~77% petrochemicals, ~18% coal, ~4% electrolytic, ~1% other

