

carbon and hydrogen only, and the bond type decides everything else

The four families

Alkanes

C_nH_{2n+2} , only single bonds, saturated; nicknamed paraffins for low reactivity

Alkenes

C_nH_{2n} , one or more $C=C$, also called olefins

Alkynes

C_nH_{2n-2} , one or more $C\equiv C$

Arenes

benzene's ring: a delocalised system, not just another unsaturation

Degree of unsaturation *

for $C_nH_mN_pX_q$ (O, S don't count)

$$DoU = \frac{2n+2+p-m-q}{2}$$

each ring OR each pi bond counts as one degree; the formula alone can't tell you which, only how many

Isomer count climbs fast

- methane, ethane, propane: no structural isomer possible
- butane: 2 isomers, n-butane and isobutane
- pentane: 3 isomers, n-pentane, isopentane, neopentane; hexane: 5
- conformations: rotation about a single C-C bond, not a connectivity change
- ethane's staggered form: lowest energy, bonds as far apart as possible
- eclipsed form: highest energy, bonds directly aligned, one behind the other

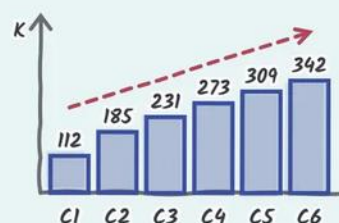
both shown by Newman or sawhorse formulas

Making alkanes

- industrial: fractional distillation of crude petroleum
- catalytic hydrogenation of an alkene/alkyne: Pt/Pd at room temp, or Ni hot and pressured
- Wurtz reaction: $2R-X + 2Na$ in dry ether gives $R-R + 2NaX$, best for symmetrical alkanes
- Grignard route: $R-X + Mg$ in dry ether gives $R-Mg-X$
- $R-Mg-X + H_2O$ then gives $R-H + Mg(OH)X$; moisture-free conditions are essential
- reduction of alkyl halides: $Zn/dil. HCl$ supplies nascent H, $R-X + 2[H] \rightarrow R-H + HX$

Physical properties of alkanes

- C-H, C-C bonds are non-polar; only weak van der Waals forces hold alkanes together
- straight chains boil higher than their branched isomers: more surface, more van der Waals contact
- melting point depends on crystal packing instead: a symmetric branched isomer can melt HIGHER
- e.g. neopentane melts at $-16.6^\circ C$ vs n-pentane's $-129.8^\circ C$, despite boiling lower
- at room temp: C1-C4 gases, C5-C17 liquids, C18 onward solids



boiling point in kelvin for the n-alkanes C1 to C6: it climbs with chain length, more surface area, more van der Waals contact

insoluble in water, soluble in organic solvents