2.0 Alkanes

Alkanes are used for heating, cooking, and power generation. Others are used to synthesize drugs, pesticides, or other organic compounds.

The uses of alkanes are determined by the number of carbon atoms present.

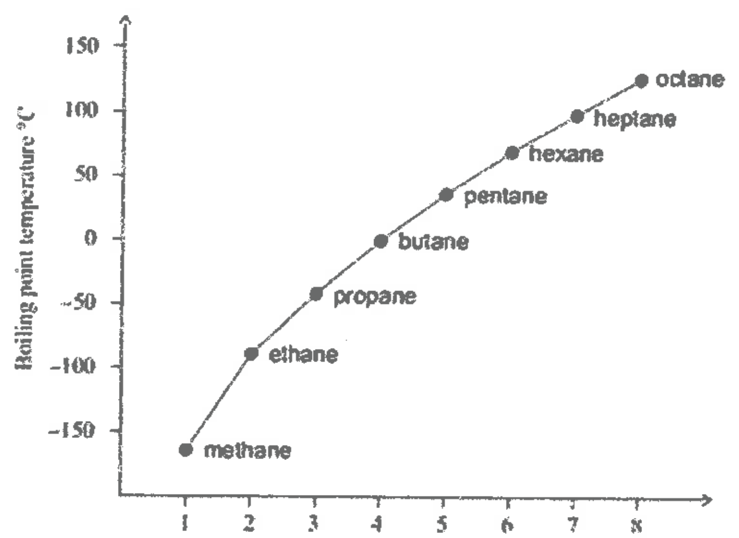
Table 3 Selected Uses of Alkanes

Length of carbon chain	Uses
1–4	Fuels such as natural gas for heating and cooking, propane for barbecues and soldering torches, and butane for lighters (**Figure 10**)
5–12	Fuels such as gasoline
12–18	Fuels such as jet fuel
18–20	Fuels such as home heating oil
20–30	Lubricating oils such as engine oil
30–40	Fuel oils such as ship fuel
40–50	Waxes and thick oils such as paraffin wax and petroleum jelly
More than 50	Tars used in road surfacing

Properties of Alkanes

- The first four alkanes are gases. Alkanes with 5-40 carbons are liquids, 40 or more carbon atoms are waxy solids.
- Generally, alkanes are less dense than water.
- Non-polar bonds combined with mostly symmetrical arrangement of H atoms causes alkanes to be non-polar molecules.

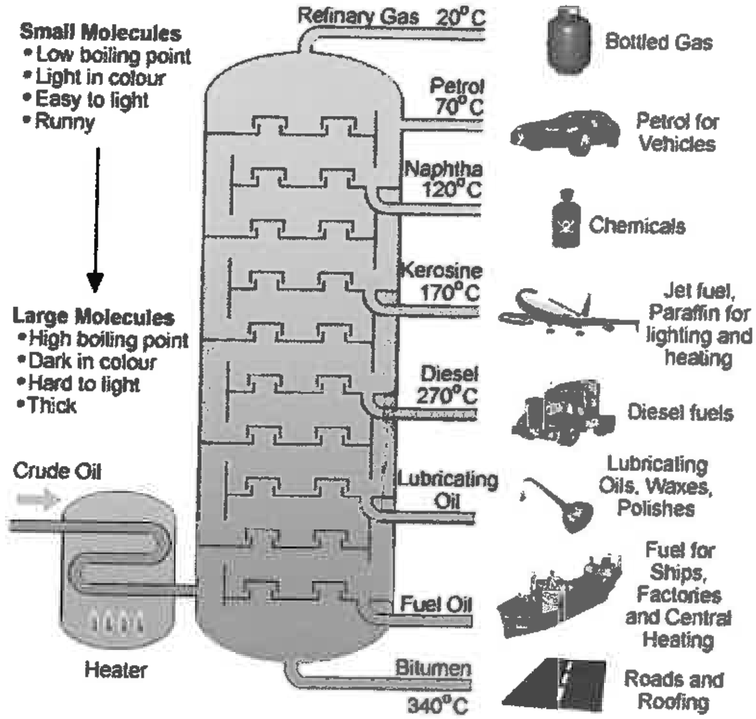
Boiling points vs number of carbon atoms of alkanes



- London Dispersion forces are the only intermolecular forces present, meaning that alkanes generally have low melting and boiling points.
- As alkanes become larger (more C atoms present), the IMFS increase. More heat energy is needed to overcome these forces and thus melting and boiling points increase.
- Insoluble in water but soluble in non-polar organic solvents, including other alkanes.

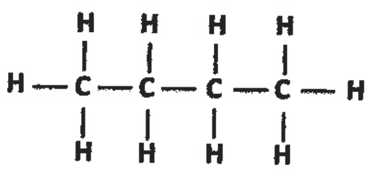
Fractional Distillation

- Chemists can use the unique boiling points of alkanes to <u>separate</u> mixtures.
- As the boiling point of each alkane is reached, the alkane boils out of the mixture and can be collected once it is condensed.
- This enables oil and gas companies to separate crude oil into its lighter fractions (natural gas) and heavier fractions (used to make lubricating oil, asphalt).

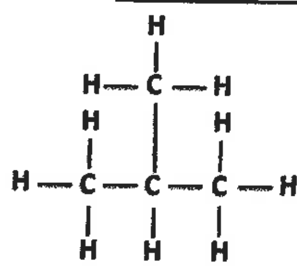


Structural Isomers

- Most hydrocarbons with 4 or more C exhibit <u>structural isomerism</u> – when two molecules have the same molecular formula but different <u>arrangements</u> of atoms in space.



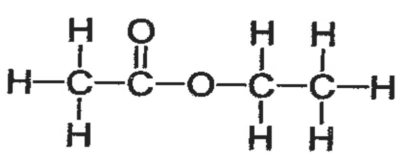
butane (C_4H_{10})



2-methylpropane (C_4H_{10})

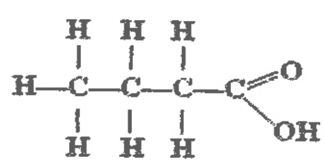
- Different structural arrangements mean different chemical and physical properties.

Ethyl Acetate ($C_4H_8O_2$)



Rum extract smell

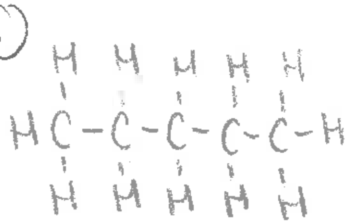
Butyric Acid ($C_4H_8O_2$)

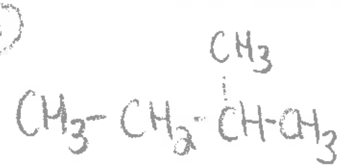


Rancid butter smell

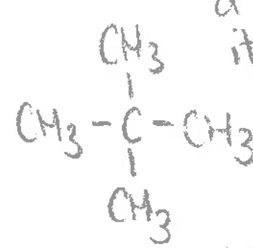
Example: Draw all the structural isomers that exist for pentane. C_5H_{12}

*hint: if its a different name, it is an isomer!

① 

② 

2-methylbutane

③ 

2,2-dimethylpropane

Reactions of Alkanes

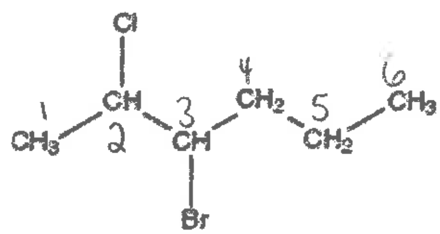
- Alkanes are fairly unreactive. They do not react with acids, bases, or strong oxidizing agents, which makes them valuable as lubricating materials and as the backbone for structural materials such as plastics.

- They do however undergo combustion and substitution reactions.

- Alkanes react in a specific type of substitution reaction called halogenation - where a hydrogen atom is replaced by a halogen (Cl, Br, etc.) to form an alkyl halide. chloro, eg. bromo, fluoro, iodo...

- Alkyl halides are named by writing the root of the halogen first, with the suffix *-o*, followed by the name of the parent alkane. If necessary, use numbers to denote the location and write the substituent groups alphabetically.

Example: (a) Name the following.



3-bromo,2chlorohexane

(b) Draw a structural diagram for 1,1-dibromocyclohexene.

- Due to the high electronegativity of halogens, alkyl halides are often polar molecules with dipole-dipole IMFs.

- This means that the boiling and melting points of alkyl halides are higher than those of corresponding alkanes.

Table 1 Boiling Points of Some Hydrocarbons and Corresponding Organic Halides

Hydrocarbon	Boiling point (°C)	Alkyl halide	Boiling point (°C)
CH_4	−164	CH_3Cl	−24
C_2H_6	−89	C_2H_5Cl	12
C_3H_8	−42	C_3H_7Cl	46
C_4H_{10}	−0.5	C_4H_9Cl	78