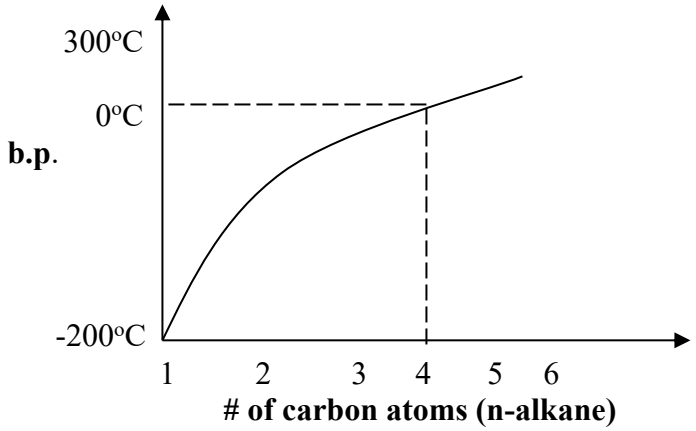
**Recall :** Bond Energy Example on page 6 of September 19th notes

## Physical Properties of Alkanes:

### Boiling Point

Intermolecular forces are dominated by London forces / Dispersion forces (temporary dipoles)

- Alkanes are non-polar because H and C have similar electronegativity leading them to interact with themselves through London Forces which causes a trend in boiling point:

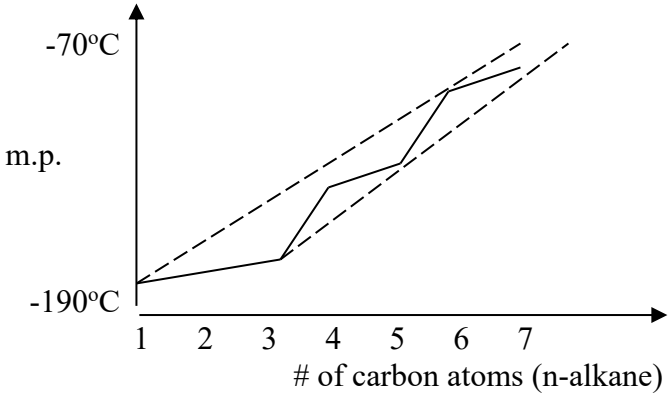


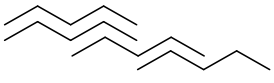

**London Forces (temporary dipoles) hold molecules together**

The boiling point increases as the size of the alkane increases because the longer carbon chains have greater surface area to experience London Forces. As the boiling point increases, the graph reaches a plateau where alkane starts to decompose (#C > 20)

### Melting point

- Melting points are related to the crystal structure packing efficiency
- The predicted line (dotted line) is not what we observe, but a zig zag line (continuous) resulting from crystal structure packing.
- Even numbered alkanes pack better in a crystal lattice
- Alkanes are flammable and will combust into $CO_2$ and $H_2O$

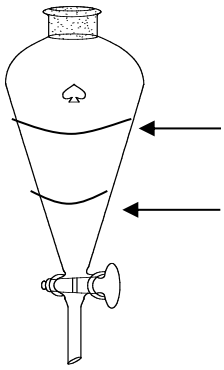


**Solubility**

- Alkanes are soluble in other organic solvents (like dissolves like)
- Not miscible (soluble) with water → floats due to lower density
- Low density ($\rho$ = rho = g/cm$^3$)
    - $\rho$ water ~ 1 g/cm$^3$ or 1 g/mL
    - $\rho$ alkanes ~ 0.65 - 0.75 g/cm$^3$

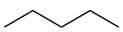
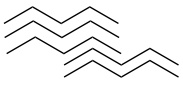
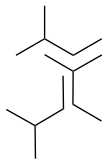
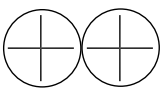
Separatory Funnel *(density separation)*



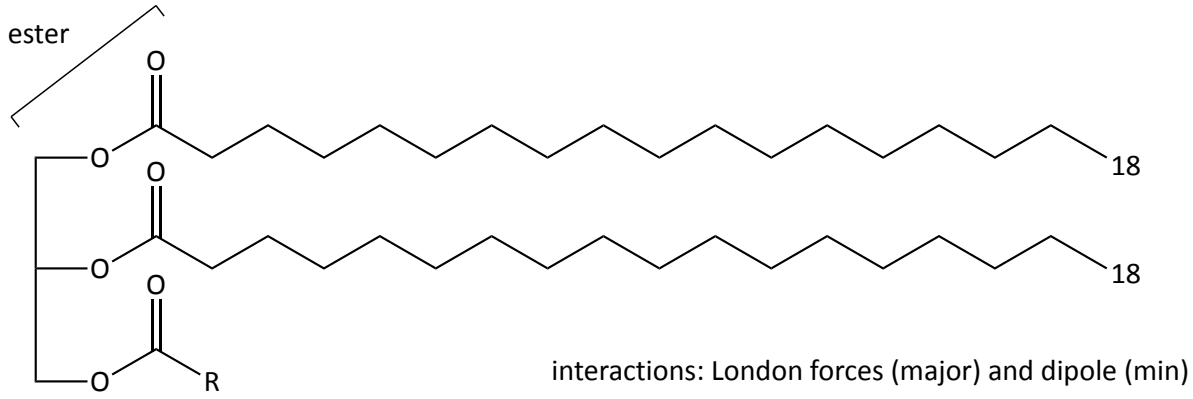
Alkanes are less dense than water (0.65-0.75 g/mL)

Water (1.0 g/mL)

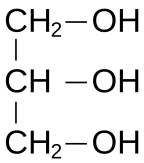
**Example: Pentane**

| | m.p. | b.p. | | |
|---|---|---|---|---|
|  **n-pentane** | -129 | 36 |  | n-pentane has high bp due to multiple contacts of straight chains (London Forces) |
|  **isopentane 2-methylbutane** | -160 | 28 |  | isopentane is less packed, less interacting surface area |
|  **neopentane** | -13 | 9 |  | m.p. of neopentane determined by good crystal packing of spherical shape. Ball-like shape means surface contact area small and boiling point lower |

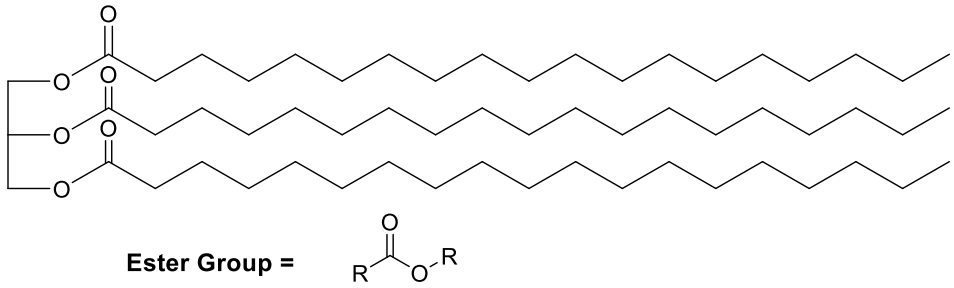
E.g.




**Glycerol**




**Triglyceride** (Saturated fat)

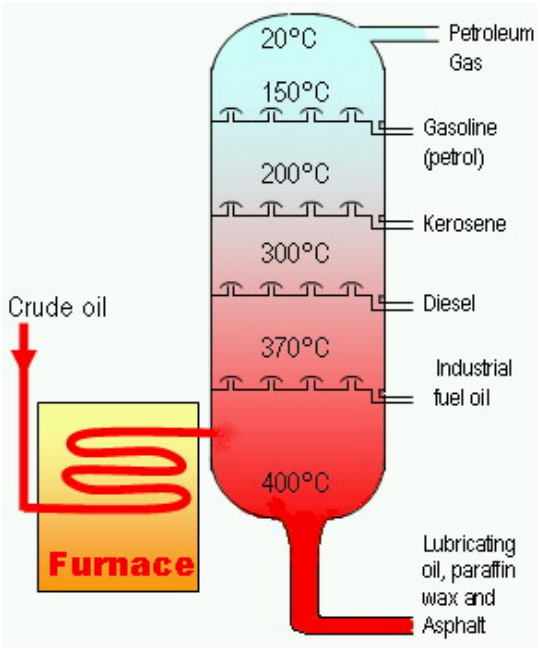



Molecules are held predominantly by London Forces. Some dipole-dipole interactions can occur due to the ester groups present.

**Source of Alkanes**

- Petroleum

**Distillation of Petroleum:**



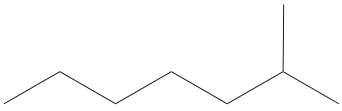

Low Temperatures

High Temperatures

- Petroleum is a mixture of alkanes and other hydrocarbons (>>200 compounds)
- Hydrocarbons with lower boiling points come off at the top such as butane, pentane etc.

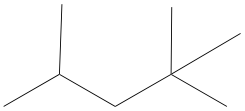
**Fuel (gasoline)**

A fuel composed of 100% "isooctane" (incorrect name) will have an octane rating of 100. 2,2,4-trimethylpentane "isooctane" is the best burning. Heptane is the worst burning (explosive burning). A fuel that burns like a mixture of 89:11 "isooctane" to heptane has a 90 octane rating.



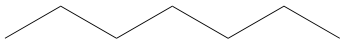
isooctane

2-methylheptane



incorrectly also called "isooctane"

2,2,4-trimethylpentane



heptane

At the pump you typically see an octane rating between 88 and 94.