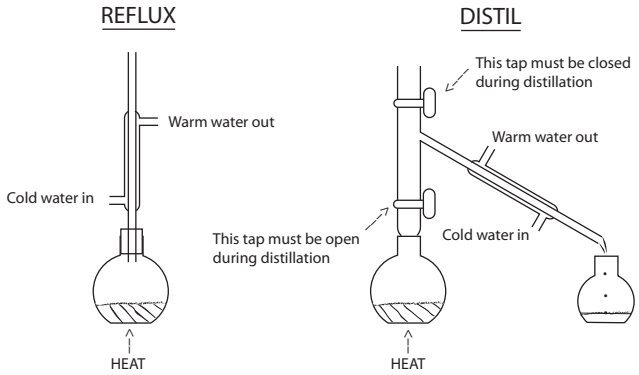
Fractional Distillation and Cracking : Saturday 1st December 2018

No of C atoms in the molecule	Uses of the hydrocarbon fraction[1]
C_1 – C_4	This fraction contains the **gases** that are used as fuels.
C_5 – C_{10}	The Americans are the biggest consumers of petrol in the whole world and they call petrol "**gasoline**" – *but the English call this fraction the "**petroleum**" fraction.*[2]
C_{11} – C_{12}	This is the "**kerosene**" or the **paraffin** fraction.[3]
C_{13} – C_{20}	These are all the **oils** such as diesel oil/heating oil/etc.
C_{20} and above	This fraction is the heavy stuff from which things like bitumen come. *[Bitumen is not one specific fraction, but is instead just the heavy "gunge" that is left over when all the lighter stuff has been distilled off.]*

The Separation of differing Carbon compounds by FRACTIONAL DISTILLATION

- *Two liquids that have different boiling points can be separated by boiling and then condensing* because the substance with the lower boiling point will boil first (i.e. at a lower temperature) and it will separate off as a gas thus leaving the second substance behind as a liquid. The substance that has boiled off at the lower temperature can then be cooled down and condensed and collected as a liquid. **The process of separating two (or more) liquids by boiling is called *distillation*.** (The boiling point of any non-polar substance will be heavily influenced by its molar mass i.e. the mass of 1 mole of the substance, and for hydrocarbons this will be determined mainly by how many C atoms there are in its molecule / by whether it is a straight chain or a branched chain compound / by whether it is a ring compound / etc.)

- **In Refluxing, a stopper must NOT be placed in the reflux tube otherwise there WILL be an explosion and you will be showered with fragments of broken glass and scarred and possibly even blinded!**



- The hydrocarbon compounds that man extracts from the earth (either from oil wells on dry land or from oil wells under the sea) come out in the form of natural gas (i.e. C_1 to C_4 compounds) or in the form of crude oil. Crude oil can be separated into its different component C_5 to C_{20} compounds by utilising the fact that Carbon compounds have inter-molecular vdW[4] forces of differing strengths, and each one therefore has a different boiling point.

---

[1] In the Petrochemical Industry, a "**fraction**" is a group of Carbon compounds in crude oil all of which have very similar boiling points.

[2] I believe that the German for petrol is "Benzin"/the French is "Essence"/the Italian is "Benzina"/and the Spanish is "Gasolina".

[3] In a **petrol** (spark-ignition) engine, a mixture of petrol vapour and air is injected in minute amounts into a cylinder and then compressed (and the petrol therefore must not explode during the compression phase), and then the compressed mixture is ignited by a spark causing an explosion. In a **diesel** engine *it is just the air that is compressed* and it thus becomes **very** hot, and diesel fuel is then injected into the very hot air and thereby explodes. In a **jet** turbine engine, paraffin (also called kerosene) is injected continuously into a very hot burning zone and explodes as soon as it reaches the burning zone. In petrol and in diesel engines, the exploding gases push pistons up and down and this kinetic energy is converted into forward motion, whereas in a jet turbine engine the aeroplane is thrust forward by the explosion of the gases in the engine. There are no pistons in a jet engine/there is no up-and-down motion that needs to be converted into forward motion. It is the thrust of the exhaust gases exiting the engine that pushes the aeroplane through the air.

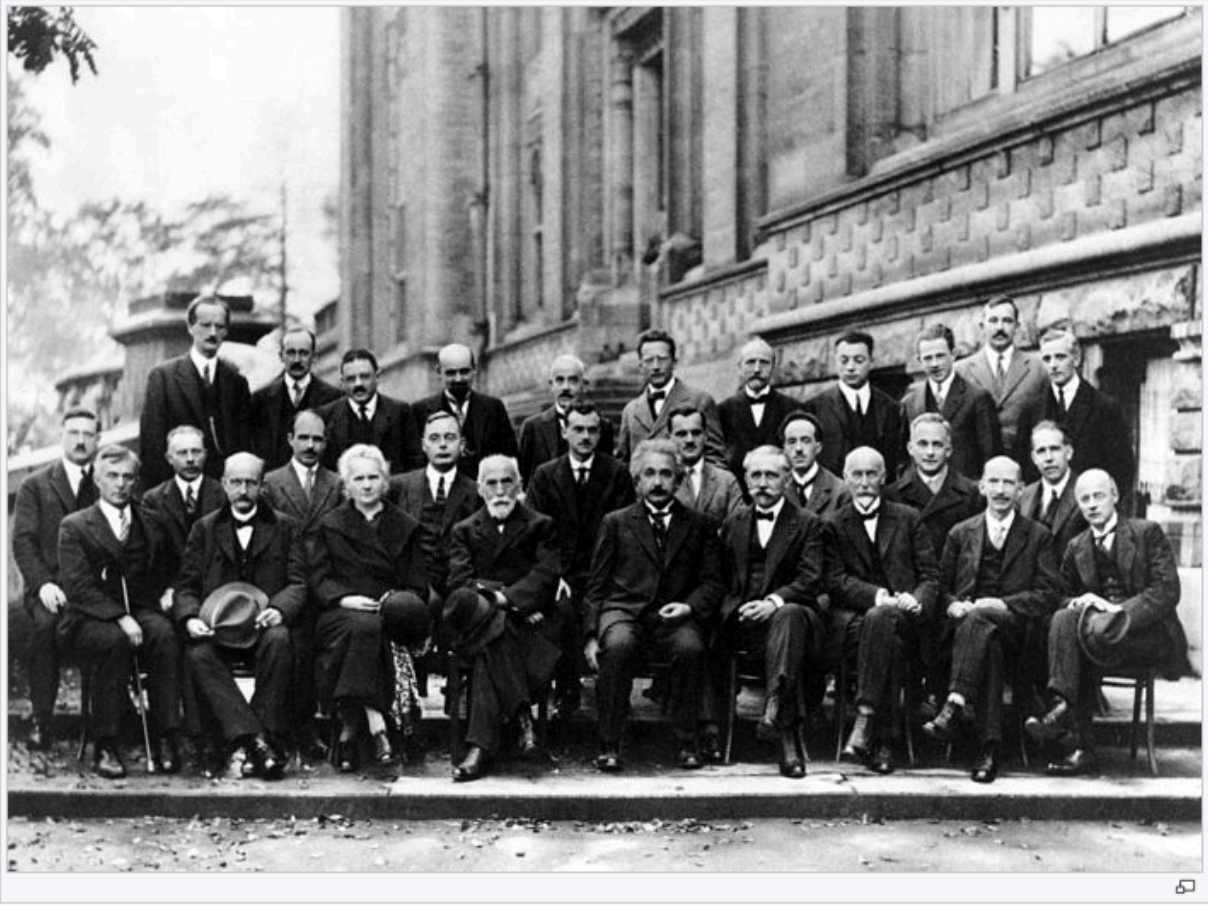
[4] Other scientists besides Johannes Diderik van der Waals (Nobel Laureate, 1910), notably a gentlemen called Fritz London (nominated for a Nobel Prize on five occasions, but tragically never received one)/Peter Debye (Nobel Laureate, 1936)/Willem Hendrik Keesom/et alii also did work in this field – but it is the concepts that are important, and not the names that are given to the different types of force involved. The reason that it is important for you to understand the nature of bonds and different types of forces of attraction is that when you understand the nature of the binding forces involved, then you will understand lots of other things such as the different boiling points of different substances/the amount of energy involved in different reactions/etc. The understanding of Chemistry is all about understanding the nature of the forces that bind things together.

- **Fractional distillation** : the longer a carbon chain, the greater will the vdW forces be, and the higher will be the boiling point of that particular substance. Therefore **by a process of boiling off and then condensing (i.e. by *fractional distillation*), crude oil can be separated into its different molar mass components (i.e. into C_1 to C_{20} compounds)**.

<u>CRACKING long chained alkanes to obtain shorter Alkanes and Alkenes</u>

- The Chemistry of petrol is very complicated and it would not be fair to expect an 'A' Level student to know the ins and outs of the Petrochemical Industry in detail. The syllabus does NOT require you to know about Knocking, but are expected to know viz. about **Cracking/Isomerisation**/and **Reforming**. [NB "**Platforming**" is just another form of Reforming (and there are many different forms of Reforming).]

The photograph below shows the people who attended the Solvay Conference of 1927. It was quite possibly the most important gathering of scientists in the whole of the history of Science. **17 of the 29 scientists who attended received Nobel Prizes!** In it you will see well-known people such as Albert Einstein and Marie Curie (the only female in the whole gathering!), but you will also see other people who were just as important in the development of scientific knowledge about the nature of matter e.g. Niels Bohr/Max Born/Louis de Broglie/Werner Heisenberg/Max Planck/Wolfgang Pauli/Erwin Schrödinger/et alii.



A. Piccard, E. Henriot, P. Ehrenfest, E. Herzen, Th. de Donder, E. Schrödinger, J.E. Verschaffelt, W. Pauli, W. Heisenberg, R.H. Fowler, L. Brillouin;
P. Debye, M. Knudsen, W.L. Bragg, H.A. Kramers, P.A.M. Dirac, A.H. Compton, L. de Broglie, M. Born, N. Bohr;
I. Langmuir, M. Planck, M. Curie, H.A. Lorentz, A. Einstein, P. Langevin, Ch.-E. Guye, C.T.R. Wilson, O.W. Richardson

Fifth conference participants, 1927. Institut International de Physique Solvay in Leopold Park.