RAFFLES INSTITUTION RAFFLES PROGRAMME - YEAR FOUR CHEMISTRY

FUELS

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Fossil fuels – Petroleum, Natural gas (which consists of mainly methane CH4) and Coal are sources of energy that can be combusted.

However, fossil fuels are a finite, non-renewable resource. The combustion of fossil fuels also poses pollution problems as harmful by-products such as Carbon Dioxide and Sulfur Dioxide are released.

Petroleum is a mixture of hydrocarbons and must be separated into different useful fractions via fractional distillation.

Fractional Distillation of Petroleum

Petroleum is heated in a furnace so that it vaporizes. The vapours are passed up a fractionating column. The fractions come out of the column at different heights depending on boiling point; fractions with small molecules have **lower boiling points** and come out at the **top** of the column, while fractions with large molecules have **higher boiling points** and come out at the **bottom** of the column.

Properties and Uses of Petroleum Fractions

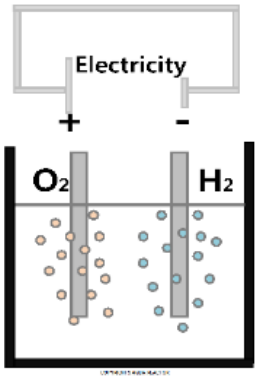
Name	**Uses**	Approximate Number of Carbon atoms per molecule	Boiling Point (°C)
Petroleum Gas	**Fuel for cooking.** **(Bottled gas for gas cooker)**	1 – 4	Below room temperature
Petrol/ Gasoline	**Fuel in cars (engines).**	5 – 10	35 – 75
Naphtha	**Feedstock for chemical industry (petrochemicals).**	8 – 12	70 – 170
Kerosene/ Paraffin	**Fuel for aircraft engines (and oil stoves).**	10 – 14	170 – 250
Diesel	**Fuel for diesel engines.**	15 – 25	250 – 340
Lubricating Oil	**Lubricant for engines and machines.** **Also for making polishes or waxes.**	19 – 35	340 – 500
Bitumen	**Road surfacing.**	>70	over 500
Order of **P**etroleum **F**ractions: **P**apa **P**ig's **N**ew **K**itten **D**oes **L**ove **B**alls **P**retty **G**ood **P**ay **N**o **K**idding **D**inner **L**unch **B**reakfast **P**rovided **F**ree			

Competing uses of oil as an energy source and a chemical feedstock

Most petroleum is used to provide fuel. Only a small amount (naphtha) is used as a chemical feedstock to make useful materials such as plastics and chemicals. However, since there is a limited amount of petroleum in the earth, many believe it is wasteful to use it for fuels and believe that it should be reserved for chemicals. If this is not done, a shortage of petroleum will result in a shortage of chemicals, as it will not be possible to produce plastics, drugs and other important chemicals.

Hydrogen Fuel Cell

Hydrogen, derived from water or hydrocarbons, is a potential fuel. It can react with oxygen (also known as combustion) to generate electricity directly in a hydrogen fuel cell. The Hydrogen fuel cell is a typical electrochemical cell (NOT an electrolytic cell). Hence, OIL RIG RED CAT AN OX all apply for the cell.



At the anode, oxidation occurs. The Hydrogen gas H2 in contact with the anode is oxidised to give aqueous H+ ions.

$H_2(g) \rightarrow 2H^+(aq) + 2e^-$

The H+ ions pass through the electrolyte and migrate to the cathode (Recall that ANions are attracted to the ANode and CATions are attracted to the CAThode). The electrons pass through the wire and then the cathode (hence producing a current and energy).

At the cathode, reduction occurs. The Oxygen gas O2 in contact with the cathode reacts with the H+ ions and is reduced to give water.

$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$

The overall reaction is: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

The advantages of the Hydrogen fuel cell are that its only by-product is water, a non-pollutant. Also, it is energy-efficient and has 50% efficiency as compared to around 20-30% for petrol.

However, the Hydrogen is expensive and difficult to obtain purely, and is also easily combustible. Also, the electrodes for the Hydrogen fuel cell are expensive.