The Petrochemical Industry

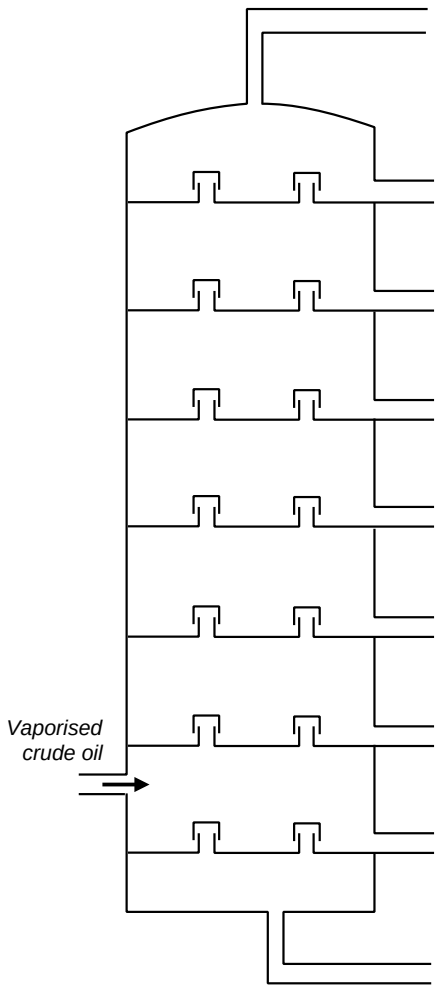
Crude Oil

In the past, most important organic chemicals were derived from coal. Nowadays, natural gas and crude petroleum provide an alternative source.

- complex mixture of hydrocarbons... **arenes**, **cycloalkanes** and **alkanes**
- composition varies according to its source
- it is a dark coloured, viscous liquid
- consists mostly of alkanes with up to 40 carbon atoms, plus water, sulphur and sand
- can be split up into fractions by **FRACTIONAL DISTILLATION**
- high boiling fractions may be broken down into useful lower boiling ones - **CRACKING**
- **ISOMERISATION** produces branched alkanes
- **REFORMING** produces cycloalkanes and arenes

Fractional Distillation

- separates the compounds according to their boiling point
- at each level a mixture of compounds in a similar boiling range is taken off
- rough fractions can then be distilled further to obtain narrower boiling ranges
- some fractions are more important - *usually the lower boiling point ones*



Approximate boiling range / °C	*C's per molecule*	*Name of fraction*	*Use(s)*
< 25	1 - 4	LPG (Liquefied Petroleum Gas)	*Calor Gas* *Gamping Gas*
40-100	4 - 12	GASOLINE	*Petrol*
100-150	7 - 14	NAPHTHA	*Petrochemicals*
150-200	11 - 15	KEROSINE	*Aviation Fuel*
220-350	15 - 19	GAS OIL	*Central Heating Fuel*
> 350	20 - 30	LUBRICATING OIL	*Lubrication Oil*
> 400	30 - 40	FUEL OIL	*Power Station Fuel* *Ship Fuel*
> 400	40 - 50	WAX, GREASE	*Candles* *Grease for bearings*
> 400	> 50	BITUMEN	*Road surfaces, Roofing*

CRACKING

Process

- involves the breaking of C-C bonds in alkanes
- converts heavy fractions into higher value products

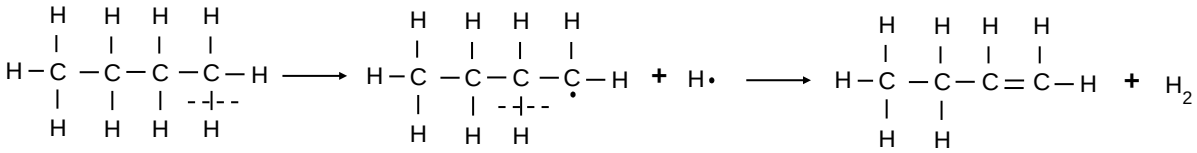
- two types THERMAL **Free radical** mechanism
  CATALYTIC **Carbocation** (carbonium ion) mechanism

THERMAL

- HIGH PRESSURE ... 7000 kPa
- HIGH TEMPERATURE ... 400°C to 900°C
- FREE RADICAL MECHANISM
- HOMOLYTIC FISSION
- PRODUCES MOSTLY ALKENES ... *e.g. ETHENE for making polymers and ethanol*
- PRODUCES HYDROGEN ... *used in the Haber Process and in margarine manufacture*

Examples *Bonds can be broken anywhere in the molecule by C-C bond fission or C-H bond fission*

C-H fission

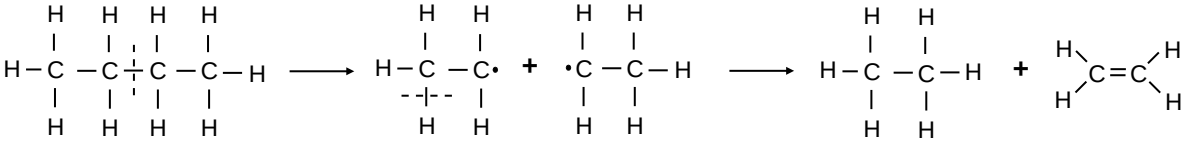


A C-H bond breaks to give a hydrogen radical and a butyl radical.

The hydrogen radical abstracts another hydrogen leaving two unpaired electrons on adjacent carbon atoms. These join together to form a second bond between the atoms.

an alkene and hydrogen are formed

C-C fission



C-C bond breaks to give two ethyl radicals.

One ethyl radical abstracts a hydrogen from the other, thus forming ethane. The unpaired electrons on adjacent carbons join together to form a second bond.

an alkene and an alkane are formed

CATALYTIC

- SLIGHT PRESSURE
- HIGH TEMPERATURE ... 450°C
- ZEOLITE CATALYST
- CARBOCATION (carbonium ion) MECHANISM
- HETEROLYTIC FISSION
- PRODUCES BRANCHED or CYCLIC ALKANES & AROMATIC HYDROCARBONS
- MOTOR FUELS ARE A PRODUCT

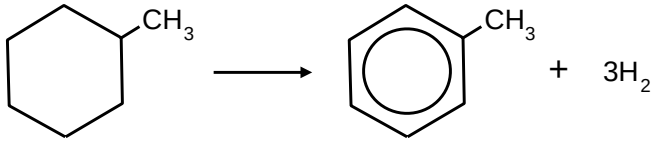
Zeolites Crystalline aluminosilicates - clay like substances

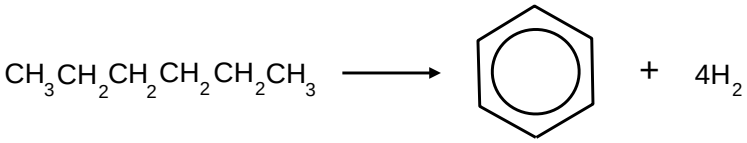
REFORMING

Process • converts **alkanes** to **cycloalkanes** and **cycloalkanes** to **arenes**

Catalyst • platinum and rhenium or
platinum and iridium

Examples





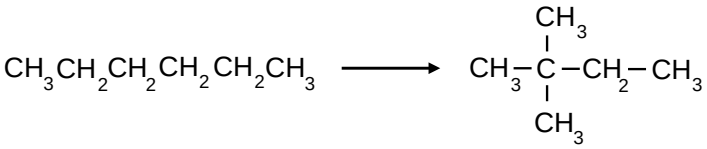
ISOMERISATION

Process • converts **straight chain** alkanes to **branched** alkanes

Catalyst • platinum

Reason • branched alkanes are used in car engines as combustion is easier and smoother because the molecules break down easier.

Example



Q.1 *What factors govern the importance of a particular fraction of distilled crude oil?*

Q.2 *Draw the structure of the most branched isomer of octane.*

Q.3 *Why were lead compounds added to petrol?*