

# Alkanes and Alkenes

## Chemical Reactions

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- Substitution
  - One atom or a group of atoms in a molecule is replaced by another atom or group of atoms from another substance.
  - $\text{C}_2\text{H}_5\text{Br} + \text{KOH (aq)} \rightarrow \text{C}_2\text{H}_5\text{OH} + \text{KBr}$
- Addition
  - Two or more molecules react to form a single product where atoms of one reactant are added to adjacent atoms across a carbon-carbon multiple bond.
  - $\text{C}_4\text{H}_8 + \text{H}_2 \rightarrow \text{C}_4\text{H}_{10}$
- Elimination
  - The removal of atoms attached to adjacent carbon atoms in an organic compound to form an unsaturated product and a small molecule.
  - $\text{C}_4\text{H}_9\text{OH} \rightarrow \text{C}_4\text{H}_8 + \text{H}_2\text{O}$
- Condensation
  - Two molecules combine with the removal of water or some other small molecule.
  - $\text{CH}_3\text{COOH} + \text{CH}_3\text{OH} \xrightarrow[\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O}]{\text{[Conc. H}_2\text{SO}_4 \text{ Catalyst}]}$
- Hydrolysis
  - Water reacted with a molecule, causing the reactant molecule to break down into smaller molecules
  - $\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O} \xrightarrow{\text{[dilute acid/alkali catalyst]}} \text{CH}_3\text{COOH} + \text{CH}_3\text{OH}$

## Alkanes

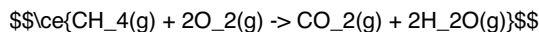
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### Unreactivity of Alkanes

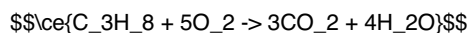
- Strong  $\text{C-C}$  and  $\text{C-H}$  covalent bonds → Hard to break
- Undergo **combustion**, **substitution** and **cracking**.

### Combustion

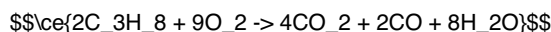
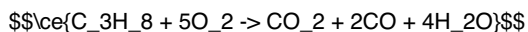
The complete combustion of an alkane produces carbon dioxide and water. The reaction is very important because it is highly exothermic.



#### Complete combustion of propane:



#### Incomplete combustion of propane (insufficient oxygen):



Substance X can be used to detect the presence of water. Identify substance X and describe any changes you would observe if water was present in the test-tube containing X.

Anhydrous copper(II) sulfate can be used to test for water. The white anhydrous copper(II) sulfate will change into blue hydrated copper(II) sulfate upon the addition of water.

Substance Y can be used to detect the presence of carbon dioxide. Identify substance Y and describe any change you would observe if carbon dioxide was present in the test-tube containing Y.

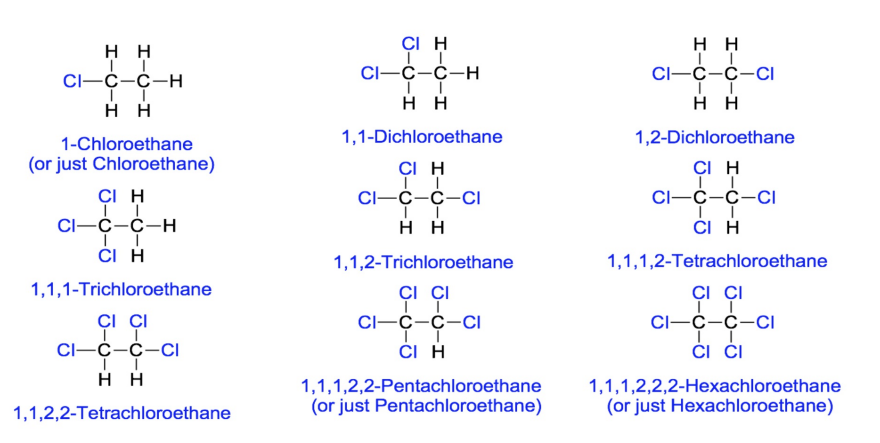
Limewater/aqueous calcium hydroxide can be used to test for carbon dioxide. A white precipitate will be formed when carbon dioxide is bubbled through limewater.

## Substitution

- Alkanes react with chlorine in the presence of ultra-violet light.
- In this reaction, UV light is used to break the covalent bond in the chlorine molecule to produce chlorine atoms.
- A hydrogen atom in methane is replaced by a chlorine atom.
- The products belong to a homologous series - *halogenoalkanes*.
- The reaction produces a complex mixture of products as multiple substitutions are also possible.

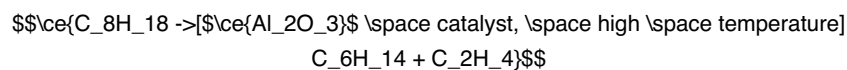


## All possible reaction products



## Cracking

Under **high temperatures** and in the presence of  $\text{Al}_2\text{O}_3$  catalyst, long chain alkanes can be broken down to smaller alkenes + alkanes/hydrogen gas



For:

- production of **smaller molecules with higher demand** (e.g. ethene, propene, petrol)
- Produce **hydrogen gas for fuel or for the Haber process** .