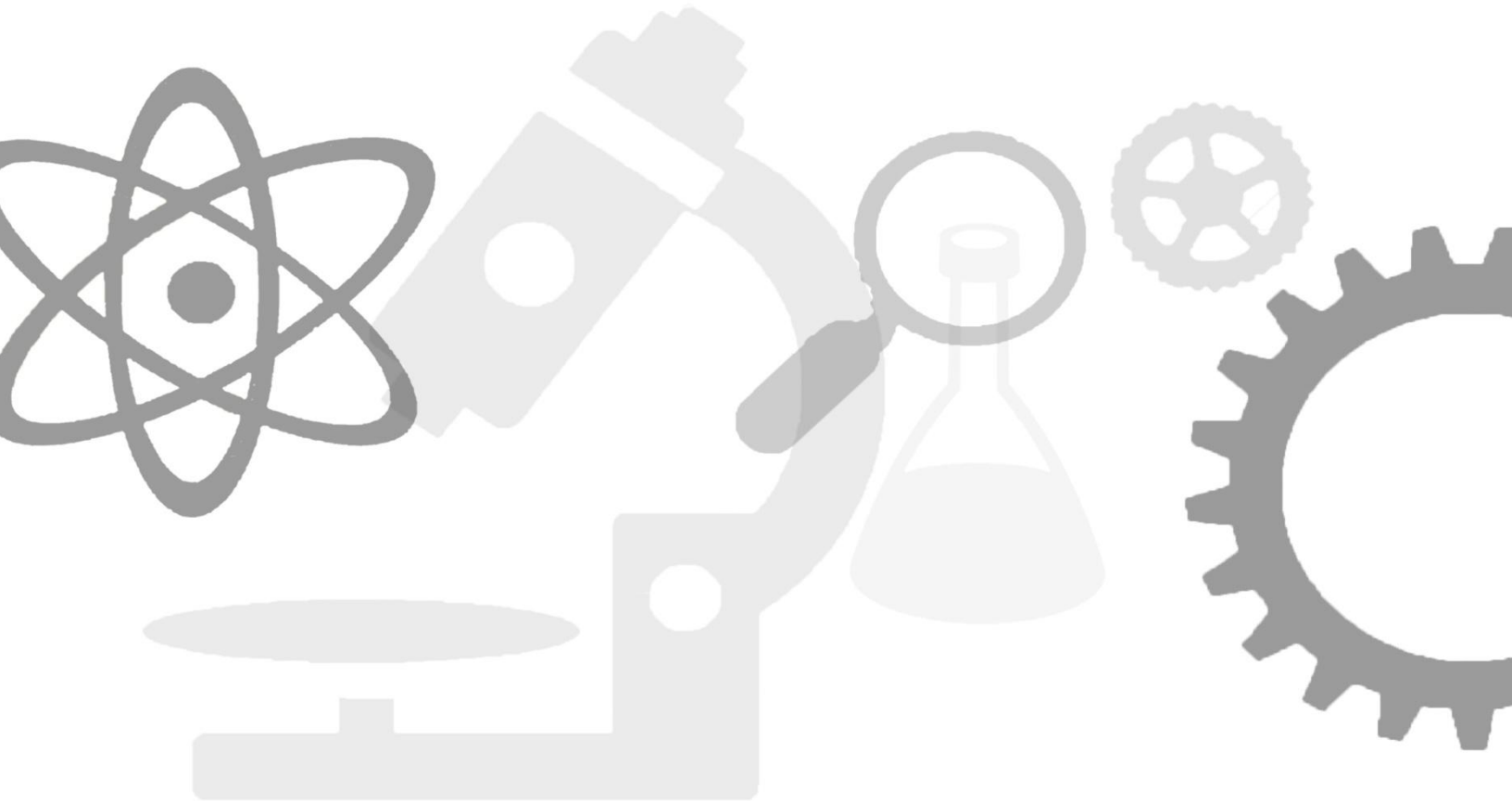
SCIENCE



Combustion and Flame

Combustion

- A chemical process in which a substance reacts with the oxygen of the air to give heat and light is called combustion.
- The substance which undergoes combustion is said to be combustible and is called a fuel.
- The fuel may be a solid, liquid or gas.
- During combustion, light is also given off sometimes, either as a flame or as a glow.
  Example:
  Magnesium burns in the air and combines with oxygen to form magnesium oxide, liberating heat and light.

$$\text{Magnesium} + \text{Oxygen} \xrightarrow{\text{Combustion}} \text{Magnesium oxide} + \text{Heat} + \text{Light}$$

Combustible and Non-combustible Substances

Combustible substances: Substances which undergo combustion or burn are called combustible substances.
Examples: Paper, cloth, cooking gas (LPG), CNG, kerosene oil, wood, charcoal
Non-combustible substances: Substances which do not undergo combustion are called non-combustible substances.
Examples: Stones, cement, bricks, soil, sand, water, iron nails

Conditions Necessary for Combustion

- Presence of a combustible substance (a substance which can burn)
- Presence of a supporter of combustion (like air or oxygen)
- Heating the combustible substance to its ignition temperature

Ignition Temperature and Inflammable Substances

Ignition temperature: The lowest temperature at which a substance catches fire is called its ignition temperature.
Inflammable substances: The substances which have very low ignition temperature and can easily catch fire with a flame are called inflammable substances.
Examples: Petrol, alcohol, liquefied petroleum gas (LPG)

How Do We Control Fire?

Fire can be extinguished in three ways:

Remove the Fuel

- Fuel is a food for fire. So, when a fire starts, all the combustible materials should be removed so that the fire does not spread.

Remove the Heat

- The most common fire extinguisher is water, but it works for ordinary fires.
- When water is thrown on a burning substance, it gets cooled below its ignition temperature and stops burning.
- If electrical equipment is on fire, water may conduct electricity and can give electric shock to people involved in fire fighting.
- Water is also not suitable for fires involving oil and petrol. Because water is heavier than oil, it sinks below the oil and the oil keeps on burning at the top.

Cut off the Air Supply

- For fires involving electrical equipment and inflammable materials such as petrol, carbon dioxide is the best extinguisher.
- Being heavier than oxygen, carbon dioxide covers the fire like a blanket.
- As a result, the contact between the fuel and oxygen is cut off and the fire is controlled.

Carbon Dioxide

- Carbon dioxide is stored at high pressure as a liquid in cylinders.
- On releasing it from the cylinder, it expands enormously in volume and cools down.
- It forms a blanket around the fire and brings down the temperature of the fuel. So, it is an excellent fire extinguisher.
- CO_2 is also produced by releasing a lot of dry powder of chemicals such as sodium bicarbonate or potassium bicarbonate. Near the fire, these chemicals give off CO_2.

Types of Combustion

Rapid Combustion

The reaction in which a large amount of heat and light are produced in a short period of time is called rapid combustion.

Example: Burning of LPG in a gas stove to give heat and light is an example of rapid combustion.

Spontaneous Combustion

The reaction which occurs on its own is called spontaneous combustion.

Example: Burning of phosphorus on its own at room temperature is an example of spontaneous combustion.

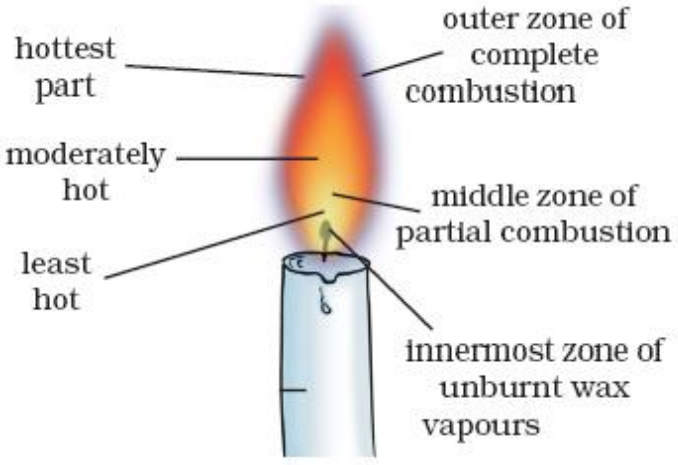
Explosive Combustion

A very fast combustion in which a large amount of heat, light and sound are produced is called explosive combustion.

Example: Bursting of crackers during festivals is an example of explosive combustion.

Flame and Structure of Flame

A flame is a region where the combustion or burning of gaseous substances takes place along with the evolution of heat and light.



Different zones of candle flame

Inner zone

- This is the dark zone which lies around the wick of the candle.
- It is the innermost zone of the flame.
- This zone contains unburnt vapours of wax.
- As there is no air available in this zone, no combustion takes place. Therefore, it is the least hot part of the flame.

Luminous middle zone

- The middle zone is the brightest zone of the flame.
- In this zone, there is an inadequate supply of air.
- Therefore, there is an incomplete combustion of wax vapours, resulting in the formation of carbon monoxide and unburnt carbon particles.
- These unburnt carbon particles glow and produce a yellow flame. This zone is moderately hot.

Non-luminous zone

- The outermost zone of the flame is called the zone of complete combustion.
- In this zone, the complete combustion of wax vapours takes place, forming carbon dioxide and water vapour.
- This is the hottest zone of the flame.
- It is also referred to as the non-luminous zone.

Blue zone

- At the bottom of the flame lies a blue zone.
- The blue colour is due to the burning of carbon monoxide produced in the zone of incomplete combustion of carbon.

Fuels

- The material which is burnt to produce heat is called a fuel.
  Examples: Wood, coal, LPG, kerosene, petrol, diesel, natural gas and biogas are some common fuels.
- There are three types of fuels:
  - Solid fuels
  - Liquid fuels
  - Gaseous fuels

Characteristics of Ideal Fuel

- It has a high calorific value.
- It burns easily in air at a moderate rate.
- It has a proper ignition temperature.
- It does not produce any harmful gases or leaves behind any residue after burning.
- It is cheap, readily available and easy to transport.

Fuel Efficiency

- Different fuels produce different amounts of heat on burning.
- The amount of heat produced by the complete burning of 1 kilogram of a fuel is called its calorific value.
- The calorific value of a fuel is expressed in the unit of kilojoules per kilogram.

Burning of Fuels Leads to Harmful Products

- The burning of fuels such as wood, coal and petroleum products releases unburnt carbon particles in the air. These fine particles are dangerous pollutants which can cause respiratory diseases such as asthma.
- The incomplete combustion of fuels produces a very poisonous gas called carbon monoxide. Excessive inhaling of carbon monoxide can kill a person.
- Burning of fuels releases carbon dioxide into air in the environment. The increased percentage of carbon dioxide in the air causes global warming.
- Burning of coal and diesel releases sulphur dioxide gas. It is an extremely suffocating and corrosive gas. Moreover, petrol engines give off gaseous oxides of nitrogen. Oxides of sulphur and nitrogen dissolve in rainwater and form acids. Such rain is called acid rain.
  The use of diesel and petrol as fuels is being replaced by CNG because it is a cleaner fuel and produces lesser amount of harmful products.