Combustion

Definition and Process

Combustion is a chemical process in which a substance reacts with oxygen to give off heat. The substance that undergoes combustion is called combustible or fuel. Combustion may produce light either as a flame or as a glow. Fuels can be solid, liquid, or gaseous.

Examples of Combustion

Magnesium burns in air producing magnesium oxide with heat and light. Charcoal and coal also burn in air producing heat and light, though coal burns without a visible flame. Food in our body undergoes combustion with oxygen to release energy.

Conditions for Combustion

Combustion requires three essential elements: fuel, oxygen (from air), and heat (to raise the fuel to ignition temperature). Without oxygen, combustion cannot continue, as demonstrated by experiments with candles enclosed in glass jars.

Ignition Temperature

The ignition temperature is the lowest temperature at which a substance catches fire. Substances with low ignition temperatures are called inflammable substances, such as petrol, alcohol, and LPG.

Types of Combustion

Rapid combustion occurs when fuel burns quickly producing heat and light, such as in gas stoves. Spontaneous combustion happens without an apparent cause, like coal dust fires. Explosions are sudden reactions producing heat, light, sound, and gas rapidly, as in fireworks.

Solved Examples

Practice Set

- **Level 1:** What are the three essential elements required for combustion?
- **Level 1:** Define ignition temperature.
- **Level 2:** Explain why a candle flame goes out when covered with a glass jar.
- **Level 3:** Describe the differences between rapid combustion, spontaneous combustion, and explosion.

Answer Key

- **Level 1:** Fuel, oxygen, and heat are required for combustion.
- **Level 1:** Ignition temperature is the lowest temperature at which a substance catches fire.
- **Level 2:** The candle flame uses up the oxygen inside the jar; without oxygen, combustion cannot continue, so the flame goes out.
- **Level 3:** Rapid combustion is fast burning producing heat and light; spontaneous combustion occurs without external cause; explosion is a sudden reaction producing heat, light, sound, and gas.

Flame

Flame Characteristics

A flame is the visible, gaseous part of a fire. Flames vary in color and temperature depending on the fuel and combustion completeness. Candle flames are yellow-orange

due to incomplete combustion and glowing soot particles, while stove flames are blue indicating complete combustion.

Zones of a Candle Flame

The candle flame has three zones: the innermost dark zone with unburnt wax vapors, the middle yellow zone of partial combustion, and the outer blue zone of complete combustion. The outer blue zone is the hottest part of the flame.

Flame Formation

Substances that vaporize during burning produce flames, such as kerosene and wax. Solid fuels like charcoal burn without a flame, producing heat and glowing embers.

Solved Examples

Practice Set

- **Level 1:** Name the three zones of a candle flame.
- **Level 1:** Why is the outer zone of a candle flame blue?
- **Level 2:** Explain why charcoal burns without a flame.
- **Level 3:** Describe how the color of a flame indicates the completeness of combustion.

Answer Key

- **Level 1:** Innermost dark zone, middle yellow zone, outer blue zone.
- **Level 1:** Because complete combustion occurs there with sufficient oxygen.
- **Level 2:** Charcoal does not vaporize; it burns solidly producing heat and glowing embers but no flame.
- **Level 3:** Yellow or orange flames indicate incomplete combustion with soot particles; blue flames indicate complete combustion with less soot and higher temperature.

Fuels

Definition and Types

Fuels are substances that burn in air to produce heat. They can be solid (coal, wood), liquid (kerosene, petrol), or gaseous (natural gas, LPG). A good fuel is readily available, cheap, burns easily, produces large heat, and leaves minimal undesirable residues.

Fuel Efficiency and Calorific Value

Calorific value is the amount of heat energy produced by the complete combustion of 1 kg of fuel, measured in kilojoules per kilogram (kJ/kg). Fuels differ in calorific values; for example, cow dung cake has a lower calorific value than LPG or hydrogen.

Environmental Impact

Burning fuels releases pollutants like unburnt carbon particles causing respiratory problems, carbon monoxide which is poisonous, carbon dioxide contributing to global warming, and oxides of sulfur and nitrogen causing acid rain. Cleaner fuels like CNG produce fewer harmful products.

Solved Examples

Practice Set

- **Level 1:** List three types of fuels with examples.
- **Level 1:** What is calorific value?
- **Level 2:** Why is CNG considered a cleaner fuel?
- **Level 3:** Explain the environmental effects of burning fossil fuels.

Answer Key

- **Level 1:** Solid fuels (coal), liquid fuels (kerosene), gaseous fuels (natural gas).
- **Level 1:** The heat energy produced by complete combustion of 1 kg of fuel.
- **Level 2:** CNG produces fewer harmful gases like carbon monoxide and oxides of sulfur and nitrogen.
- **Level 3:** Burning fossil fuels releases pollutants causing respiratory diseases, global warming, and acid rain harming crops, buildings, and soil.

Quick Reference Table

Common Mistakes and Misconceptions

Glossary