Combustion

i. What is Combustion?

Combustion is a chemical process in which a substance reacts rapidly with an oxidant, usually oxygen from the air, to produce heat and light. The common term for combustion is burning.

- **Chemical Reaction:** It's a chemical change, meaning new substances are formed.
- **Exothermic Process:** It releases energy in the form of heat and light. "Exo" means out, and "thermic" means heat.
- **General Equation (for common fuels):** Fuel + Oxygen → Carbon Dioxide + Water + Heat + Light

Example: When you burn a piece of wood, the wood (fuel) reacts with oxygen in the air. This reaction produces ash, carbon dioxide gas, water vapor, and gives off the heat and light that we see as a fire.

ii. Key Points and Important Terms

Combustible Substance (Fuel): A substance that can undergo combustion.

- **Examples:** Wood, paper, petrol, diesel, Liquefied Petroleum Gas (LPG), coal, cloth.
- Fuels can be solid (coal, wood), liquid (petrol, kerosene), or gas (LPG, CNG).

Incombustible Substance: A substance that does not burn.

- **Examples:** Stone, glass, metal, sand, water.

Supporter of Combustion: A substance that helps a combustible substance to burn. For most fires on Earth, the supporter is oxygen from the air.

Ignition Temperature: The minimum temperature at which a substance catches fire and starts to burn.

- A substance will not catch fire if its temperature is lower than its ignition temperature.
- **Example:** A matchstick can light a piece of paper (low ignition temperature) but cannot immediately light a thick wooden log (high ignition temperature).

Inflammable Substances: Substances that have a very low ignition temperature and can easily catch fire with a small spark.

- **Examples:** Petrol, alcohol, LPG, deodorant spray, perfume.

Important Note: The word "inflammable" means the same as "flammable." It does not mean "non-flammable."

The Fire Triangle: For a fire to start and continue, three things are necessary:

- **Fuel:** The substance that will burn.
- **Heat:** To raise the fuel to its ignition temperature.
- **Oxygen:** To sustain the reaction.

Removing any one of these three things will extinguish the fire. This is the principle behind firefighting.

iii. Detailed Examples (Types of Combustion)

There are different types of combustion based on how fast the reaction occurs.

Type of Combustion	Description	Example
Rapid Combustion	Combustion that happens very quickly, producing a large amount of heat and light in a short time.	Burning of LPG in a kitchen stove.

Lighting a matchstick. | | Spontaneous Combustion | Combustion that occurs on its own, without any external heat source. The material slowly heats up until it reaches its ignition temperature. | Forest fires started by the sun's heat.

Coal dust fires in coal mines.

A pile of oily rags self-heating and catching fire. | | Explosion | A very fast combustion that takes place in a confined space, producing a huge amount of heat, light, sound, and a large volume of gas. | * Bursting of a firecracker. A bomb blast. |

iv. Common Misconceptions and Clarifications

Misconception	Clarification
"Inflammable means it cannot burn."	FALSE. "Inflammable" and "Flammable" both mean the substance catches fire very easily (e.g., petrol). A substance that does not burn is called "Non-flammable" or "Incombustible" (e.g., stone).
"All burning produces a flame."	FALSE. Some substances burn without a flame. For example, charcoal glows red and produces heat but does not produce a prominent flame. This is called glowing combustion.
"Smoke is the fuel for the fire."	FALSE. Smoke is a collection of unburnt particles (like carbon) and gases that are a *product* of incomplete combustion, not the fuel itself.
"Water always puts out a fire."	FALSE. Water is effective on fires involving wood or paper. However, you should NEVER use water on electrical fires (risk of electrocution) or

Misconception	Clarification
	oil/petrol fires (water is denser and will sink, causing the burning oil to spread).

v. Practice Problems with Step-by-Step Solutions

Problem 1: A carpenter is working with wood shavings, while a welder is working with iron pieces. Which material is more likely to catch fire by accident? Explain why using the concept of ignition temperature.

Solution:

- **Step 1:** Identify the materials. The materials are wood shavings (fuel) and iron pieces (incombustible).
- **Step 2:** Recall the concept of ignition temperature. Ignition temperature is the minimum temperature needed for a substance to burn.
- **Step 3:** Compare the properties. Wood is a combustible substance with a relatively low ignition temperature. Iron is a metal and is incombustible under normal conditions (it has an extremely high melting/ignition point).

Conclusion: The wood shavings are far more likely to catch fire. They have a much lower ignition temperature than iron and will easily ignite from a stray spark or heat source.

Problem 2: Riya's mother was cooking, and the oil in the pan caught fire. Riya panicked and was about to throw water on it. Her father stopped her and covered the pan with a lid. Was her father's action correct? Explain using the Fire Triangle.

Solution:

- **Step 1:** Analyze the situation. The fire is an oil fire. The proposed actions are using water vs. using a lid.
- **Step 2:** Recall the Fire Triangle. A fire needs Fuel (oil), Heat (from the stove), and Oxygen (from the air). To stop the fire, one of these must be removed.
- **Step 3:** Evaluate Riya's action (throwing water). Water is denser than oil. It would sink to the bottom of the pan, and the burning oil would float on top and splash out, spreading the fire. This is incorrect and dangerous.
- **Step 4:** Evaluate the father's action (covering with a lid). Placing a lid on the pan cuts off the supply of fresh air (oxygen) to the fire.

Conclusion: The father's action was correct. By removing the oxygen component from the Fire Triangle, the fire was extinguished safely.

Problem 3: Classify the following as Rapid, Spontaneous, or Explosion. a) A firecracker bursting. b) Burning of petrol in a car engine. c) A pile of hay in a barn catching fire on a hot day without a spark.

Solution:

- **Explosion:** A firecracker involves a very fast reaction in a confined space, producing heat, light, and a loud sound.
- **Rapid Combustion:** The burning of petrol is a very fast, controlled process designed to produce energy quickly.
- **Spontaneous Combustion:** The hay heats up internally due to decomposition until it reaches its ignition temperature and burns on its own.

vi. Summary of Main Concepts

- Combustion is the scientific term for burning—a chemical reaction that produces heat and light.
- Three things are essential for combustion: Fuel, Oxygen, and Heat (The Fire Triangle).
- The ignition temperature is the minimum temperature a fuel needs to reach before it can burn.
- Substances with very low ignition temperatures are called inflammable (e.g., petrol, LPG).
- Combustion can be Rapid (LPG stove), Spontaneous (forest fire), or an Explosion (firecracker).
- A candle flame has three zones: Inner (dark), Middle (yellow), and Outer (blue), each with different temperatures and levels of combustion.
- Fire can be controlled by removing fuel, cutting off the oxygen supply, or cooling the fuel below its ignition temperature.