4
Chapter

Combustion and Flame

We'll cover the following key points:

- Combustion and its Types
- How do We Control Fire
- Flame
- Fuel

Hi, I'm EeeBee

Do you Remember:

Fundamental concept in previous class.

In class 5th we learnt

- Types of Fuel

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

By the end of this lesson, students will be able to:

- Investigate the structure and characteristics of flames.
- Evaluate different fire extinguishing techniques and their effectiveness.
- Understand the environmental and health impacts associated with combustion.
- Develop communication skills through written tasks and presentations.
- Comprehend the concept of combustion and recognize the conditions needed for it to occur.

Guidelines for Teachers

Educators can start this topic with practical examples, hands-on activities, and engaging discussions to encourage critical thinking. Safety measures should be emphasized during demonstrations, and the purpose of various fire-extinguishing methods should be explained. Teachers can encourage students to consider the broader role of combustion in daily life, including the efficiency of fuels, environmental impacts, and safety. This approach can stimulate curiosity and deepen students' understanding of the subject.

NCF Curricular Goals and Competencies

This unit supports CG-6 (C 6.1), which emphasizes exploring scientific processes by engaging students with scientific knowledge and fostering scientific inquiry.

COMBUSTION AND FLAME

Mind Map

Combustion

A chemical process in which a substance reacts with oxygen to give off heat is called combustion.

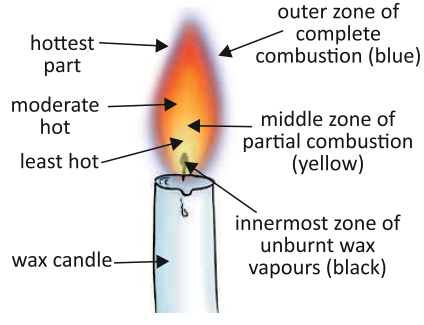
- **Fuel :-** The substance that undergoes combustion is said to be combustible.
- **Ignition temperature : -** The lowest temperature at which a substance catches fire is called its ignition temperature.
- **Inflammable substances : -** The substances which have very low ignition temperature and can easily catch fire with a flame are called inflammable substances.

How Do We Control Fire?

- Water cools the combustible material so that its temperature is brought below its ignition temperature.
- Water vapours also surround the combustible material, helping in cutting off the supply of air.

Fire extinguisher

- Fire extinguishers are portable devices designed to suppress and control small fires
- For fires with electrical equipment and flammable materials like petrol, CO_2 is the best extinguisher.

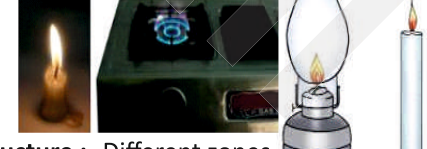


Types of Combustion

- **Rapid combustion : -** The gas burns rapidly and produces heat and light. Such combustion is known as rapid combustion.
- **Spontaneous combustion** :- Spontaneous combustion is when material bursts into flames without an apparent cause.
- **Explosion** :- When a cracker ignites, it undergoes a sudden reaction, releasing heat, light, sound, and a large amount of gas

Flame & its structure

Colours of a flame



Structure :- Different zones of candle flame

Fuel & its Efficiency

- **Definition**

The sources of heat energy for domestic and industrial purposes are mainly wood, charcoal, petrol, kerosene etc. These substances are called fuels.

Calorific value

The amount of heat energy produced on complete combustion of 1 kg of a fuel is called its calorific value.

➢ Unit:- kilojoule per kg (kJ/kg)

Burning of Fuels Leads to Harmful Products

- Increasing fuel consumption harms the environment by releasing unburnt carbon, carbon dioxide causing global warming
- Emitting harmful gases like sulphur dioxide and nitrogen oxides, leading to acid rain.
- Diesel and petrol in automobiles are being replaced by cleaner CNG due to lower harmful emissions.

Based on NCERT*

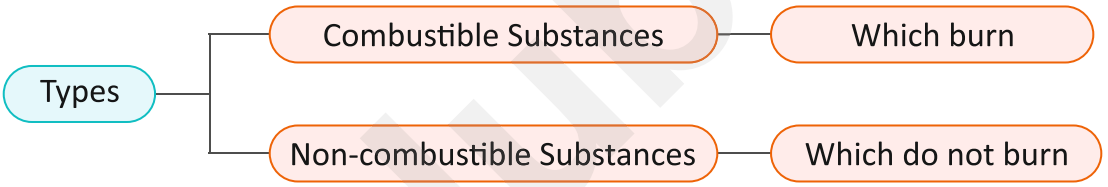
Introduction

We are familiar with the burning of different substances. In our day to day life, we come across with the burning of substances like cow dung, jute stick (santhi), wooden piece, coal, liquefied petroleum gas (LPG), candle, etc. to produce heat and light. The scientific term used for burning is combustion. The process of burning of substances in air or oxygen with the production of heat and light is called combustion. During combustion, light is given off either as a flame or as a glow.

On the basis of combustion, substances may be divided into two types.

In History...

The study of combustion dates back to ancient times, but the modern understanding of combustion as a chemical reaction began in the 17th century. In 1667, Dutch chemist Jan Baptista Van Helmont conducted experiments that suggested air played a role in combustion. Later, in the 18th century, scientists like Joseph Priestley and Antoine Lavoisier made significant contributions by identifying oxygen as a key element involved in combustion. Lavoisier's work on the "Law of Conservation of Mass" helped explain that combustion is a chemical reaction where substances combine with oxygen to release energy, forming heat and light. This laid the foundation for modern chemistry and our understanding of flames.



Combustible Substances

Substances that burn in air or oxygen to produce heat and light are called combustible substances.

For example : cow dung, jute stick, wooden pieces, coal, candle, kerosene, LPG, etc.

Non-combustible Substances

Substances that do not burn in air or oxygen are called non-combustible substances, for example iron, stone, etc.

Supporter of Combustion

Oxygen is essential for combustion. Without oxygen, combustion cannot take place. So the oxygen or air is called supporter of combustion.

Ignition Temperature

Different substances catch fire at different temperatures. The lowest temperature at which a substance catches fire is called its ignition temperature. A combustible substance cannot catch fire or burn as long as its temperature is lower than its ignition temperature. We can recall our some of the day to day experience to compare the ignition temperature of some of the common substances.

Inflammable substance

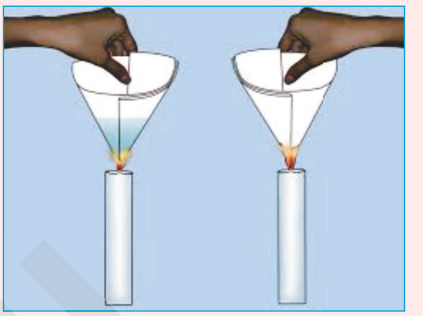
The substances which have very low ignition temperature and can easily catch fire with a flame are called inflammable substances. Examples of inflammable substances are petrol, alcohol, Liquified Petroleum Gas (LPG), etc. Can you list some more inflammable substances?

Activity

Make two paper cups by folding a sheet of paper. Pour about 50 mL of water in one of the cups. Heat both the cups separately with a candle .

Observation : The empty paper cup starts burning, while the water in another paper cup becomes hot.

Conclusion : The heat supplied to the paper cup is transferred to water by conduction. So, in the presence of water, the ignition temperature of paper is not reached. Hence, it does not burn.



Heating water in a paper cup

Combustion and its Types

Ayra is helping her mother, Hina, in the kitchen. She observes her mother using a matchstick to ignite the gas stove.

KEYWORDS

Liquefied Petroleum Gas (LPG): is a flammable mixture of hydrocarbon gases, primarily propane and butane, used as fuel for heating, cooking, and vehicles.

Combustion can be of three types — spontaneous, rapid, and explosion.

Spontaneous combustion

When a substance does not need external heat to start the combustion and it catches fire suddenly on its own, the process is called spontaneous combustion. This might prove to be dangerous. Spontaneous combustion of coal dust near the coal mines is one such example. This may lead to a major accident, risking the lives of the coal mine workers.

Spontaneous combustion

- You might have heard of major outbreaks of forest fire, especially during summers.
- This could be caused by even a slight spark of a cigarette or a natural cause like lightning or heat of the sun which ignites the dry leaves, twigs, and then the fire spreads through the woods.

There are certain substances which catch fire when they come in contact with air.

- Sodium is stored under kerosene. Can you recall the reason for this?
- When white phosphorus is kept in air for some time, it will automatically catch fire. Phosphorus reacts with air to form an oxide, and the reaction is exothermic. The heat generated ignites the rest of the white phosphorus. To avoid this, it should be stored in water.

Rapid Combustion

Rapid Combustion

Rapid combustion occurs when a substance catches fire instantly and produces heat and light. Even a small burning agent like a matchstick or a lighter can cause the fire. In rapid combustion, a large amount of heat is released in a very short time. Example of rapid combustion can be sighted in case of lighting up of LPG gas stove in the kitchen, which produces heat and light immediately. Similarly, a candle starts burning when a lighted matchstick is brought near its wick.

Explosion

A combustion that is sudden and releases a large amount of heat, light, and sound is called explosion. This type of combustion takes place when firecrackers explode.

We often hear of explosion taking place in factories manufacturing crackers. This puts the lives of people working there in danger.

Explosion: Crackers

Did you know

Combustion is like nature's fiery chemistry show—it's an exothermic process, meaning it releases heat. But here's the twist: sometimes, this reaction happens so slowly that you barely notice any temperature change! During combustion, the fuel and the oxidizer team up to create new chemical substances called exhaust. Most of this exhaust is the result of the fuel and oxygen forming brand-new compounds.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Apply Concept in Real-Life Context

Apply

Why do certain substances require special storage conditions for safety, like white phosphorus in water? Describe why these precautions are necessary.

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

In what ways can a wildfire start naturally, and what human activities increase the risk of wildfires?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. Define combustion in simple terms.
2. Explain the types of combustion with examples.
3. How does ignition temperature affect combustion?
4. Outline the basic requirements for combustion to occur.

Creative Task

Create

Why is oxygen crucial for combustion?

Try the following experiment to investigate:

- Light a small piece of paper and place it under a glass jar.

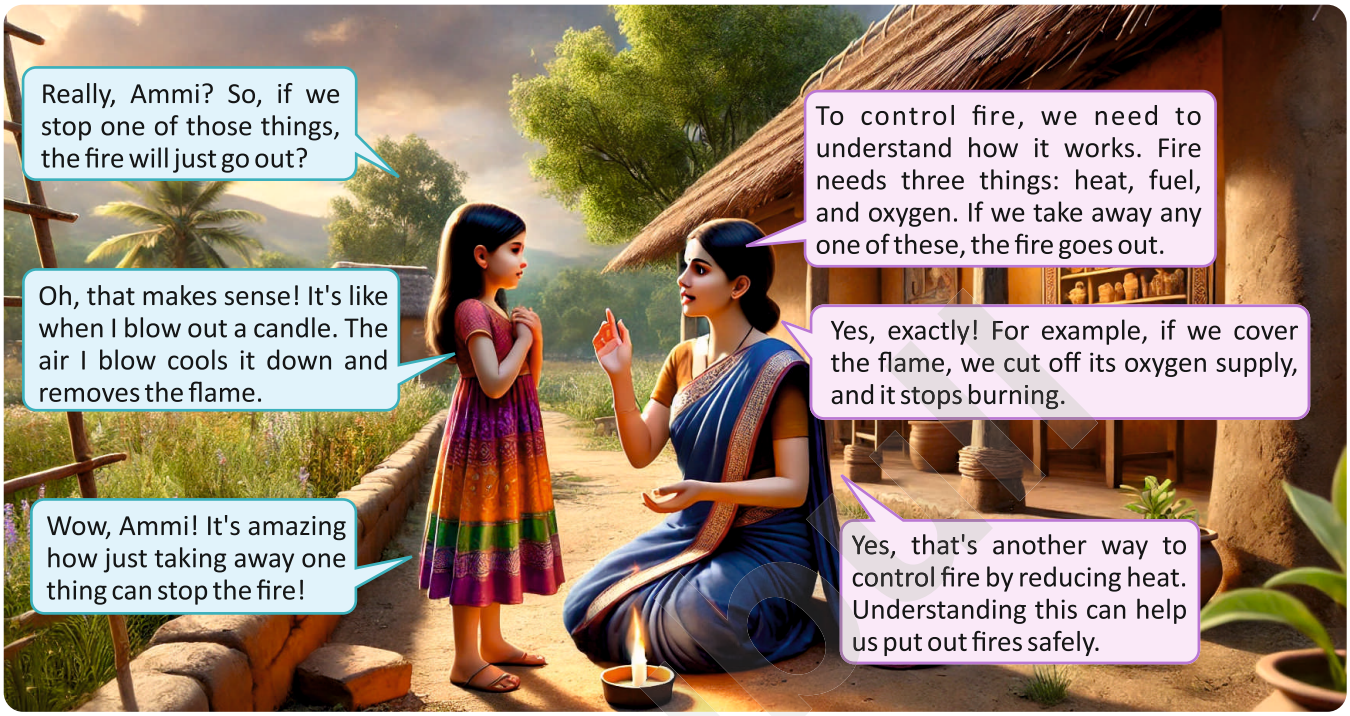
Record your observations, explaining what they reveal about oxygen's role in combustion, and note your findings in your notebook.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Bloom's Taxonomy

How do We Control Fire

Ayra is helping her mother, Hina, in the kitchen. She observes her mother carefully putting out a small flame on the stove.



Sometimes fire breaks out in homes, shops, factories or elsewhere and we need to control it. Let us see how do we control such fire. We have learnt in previous section that there are three essential requirements for producing fire. These are:

- Fuel (that burns)
- Air (to supply oxygen) and
- Heat (to raise the temperature of the fuel up to ignition temperature).

So, fire can be controlled by removing one or more of these requirements, i.e., fire can be controlled by :

- Removing the fuel i.e., burning substance.
- Cutting the supply of air.
- Lowering the temperature of the burning substance below its ignition temperature.

Fire brigade station

- Generally every town/city has a fire brigade station to control the fire. The job of a fire extinguisher is to cut off the supply of air, or to bring down the temperature of the fuel, or both. Notice that the fuel in most cases cannot be eliminated. If, for instance, a building catches fire, the whole building is the fuel.

Fire brigade controls the fire by pouring water on the fire. Water cools the combustible material and brings its temperature below the ignition temperature so that fire stops. Water vapours also surround the combustible material, helping in cutting off the supply of air. So, the fire is extinguished.

Firemen extinguish the fire by throwing water under pressure

Fire extinguisher

The most common fire extinguisher is water. But water works only when things like wood and paper are on fire. If electrical equipment is on fire, water may conduct electricity and harm those trying to douse the fire. Water is also not suitable for fires involving oil and petrol. Do you recall that water is heavier than oil? So, it sinks below the oil, and oil keeps burning on top.

For fires involving electrical equipment and inflammable materials like petrol, carbon dioxide (CO_2) is the best extinguisher. CO_2, being heavier than oxygen, covers the fire like a blanket. Since the contact between the fuel and oxygen is cut off, the fire is controlled. The added advantage of CO_2 is that in most cases it does not harm the electrical equipment. Following are the two simplest CO_2 fire extinguishers:

Soda-acid type fire extinguisher

The construction of soda-acid type fire extinguisher is shown in figure below. It consists of three parts:

Container | Bottle | Knob

The cylindrical container contains sodium bicarbonate solution. The small bottle contains concentrated sulphuric acid. This bottle is attached to the knob. In case of fire, the knob is struck. The bottle breaks and sulphuric acid reacts with sodium bicarbonate liberating large amount of CO_2 gas with great force. It forms a blanket of CO_2 around the fire, cutting off the supply of air to the fire so that the fire gets extinguished.

Fire extinguisher

$$2NaHCO_3 + H_2SO_4$$

(sodium bicarbonate) (sulphuric acid)

$$Na_2SO_4 + 2H_2O + 2CO_2$$

(sodium sulphate) (water) (carbon dioxide)

Co_2 fire extinguisher

In this fire extinguisher, CO_2 is stored at high pressure as liquid in a cylinder. When released from the cylinder, CO_2 expands enormously in volume and cools down. So, it not only forms a blanket around the fire, it also brings down the temperature of the fuel. That is why it is an excellent fire extinguisher.

Did you know

Controlling fire relies on managing its key elements: heat, fuel, and oxygen. By limiting or enhancing these, we can ignite, sustain, or extinguish flames. Techniques like using water to cool, sand to smother, or controlled airflow to fuel the fire are common. Modern tools like extinguishers and fire-retardant materials make fire management precise and efficient. Whether for warmth, cooking, or safety, controlling fire is an essential skill rooted in understanding its nature.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Apply Concept in Real-Life Context

Apply

1. Why do certain fire extinguishing materials require careful handling and specific storage conditions? Describe why these precautions are essential for safety.

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

1. How can natural events cause fires, and what human actions can either prevent or reduce the spread of fires?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. List and describe various methods of fire control, providing examples of situations where each method is most effective.
2. What role does understanding the fire triangle (fuel, heat, oxygen) play in choosing an effective fire control method?

Creative Task

Create

Why is it crucial to remove one of the elements of the fire triangle to control or extinguish a fire?
Try the following experiment to investigate:

1. Light a candle and place it on a non-flammable surface.
2. Use a glass jar to cover the candle, and observe what happens.

Record your observations, explaining what they reveal about the fire triangle and the role of oxygen in fire control, and note your findings in your notebook.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Bloom's Taxonomy

Flame

After learning about combustion, Ayra is now curious about flames. Here's her conversation with her mother :

Most of the substances on burning produce flame. Mainly, the colour of the flame is either yellow or blue.

- A matchstick, a candle and a kerosene lamp burn with a yellow flame.
- LPG burns with a blue flame.

In fact, the substances which vaporises during burning produce flame. For example–kerosene oil and molten wax rise through the wick and are vaporised during burning and form flames. Charcoal, on the other hand, does not vaporise and so does not produce a flame.

A flame is a shining zone in which a combustible gaseous material undergoes combustion producing heat and light. Let us perform the following activity to classify the substances which on burning form flame or do not form flame:

Activity

Aim : To demonstrate that the substances that vapourise easily during burning form flames.

Things required : A candle, a matchbox, and a glass tube.

Method : Place one end of a glass tube into the innermost part of the flame at an angle of 45°. Bring a lighted matchstick at the upper end. What do you observe?

Observation : The upper end of the tube will light up.

Conclusion : The wax vapour present in the inner zone rises up, flows up the tube and serves as the fuel for this second flame.

Structure of a flame

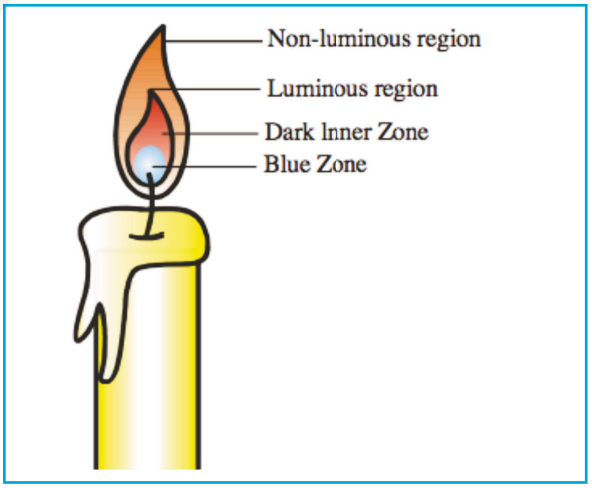
- **Luminous flame** — A yellow flame which produces heat and appreciable amount of light is called a luminous flame. It is obtained due to incomplete combustion of fuel, i.e., when fuel burns in insufficient quantity (limited supply) of air. Example: flame of kerosene lamp.
- **Non-luminous flame** — A blue flame which produces heat and very little light is called non-luminous flame. It is obtained by complete combustion of fuel, i.e., when fuel burns in sufficient quantity (regular supply) of air. Example: flame of LPG stove.

Colours of a candle flame and the flame of a kitchen stove

Flames of kerosene lamp, candle and Bunsen burner.

Structure of a Candle Flame

A candle is made up of paraffin wax and a cotton thread (called wick). The wick is kept at the centre of a column of paraffin wax all along its height. Paraffin wax is a petroleum product obained from the residue left after the fractional distillation of crude oil. It is a mixture of higher hydrocarbons. It contains very high percentage of carbon. When candle is lit, the wax melts and rises up through the wick due to capillary action and gets vaporised. The wax vapours then burn and produce a luminous flame. The candle flame is yellow due to incomplete combustion of wax.



Different zones of candle flame

KEYWORDS

Paraffin wax: A soft, colorless, odorless wax made from saturated hydrocarbons, typically derived from petroleum.

Hydrocarbons: Organic compounds consisting solely of hydrogen and carbon atoms, found in fossil fuels and other natural substances.

A candle flame consists of the following four zones :

- Outermost non-luminous zone of complete combustion : It is hottest part of the flame. Due to complete combustion, no residue is left on an object placed in this zone.
- Central or middle luminous zone of incomplete combustion : It is a major zone of the flame which is moderately hot. Due to incomplete combustion, unburned carbon particles remain present in this zone which glow to produce the yellow flame. It leaves black soot and other residue on an object placed in this zone.
- Inner dark zone of no combustion : It is least hot zone around the wick. In this zone, very little or no combustion takes place because this zone does not get air.
- The lowest blue zone : At the base of the flame, carbon monoxide produced in the dark zone due to incomplete combustion burns here to produce the blue flame due to complete combustion.

Why does the wick of a candle not burn?

In a burning candle, the heat is taken by wax to vaporise and hence the wick remains cool and does not burn.

Let's recall what we know

Apply Concept in Real-Life Context

Apply

The outermost layer of the flame is used for certain industrial applications. Explain why this zone is suitable for such uses.

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

Find out the emergency contact number for the fire department in your area. Why is it essential to know this number?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. How would you define a flame?
2. Which region of a candle flame has the lowest temperature?
3. Identify situations where using water or carbon dioxide is appropriate for putting out a fire.

Creative Task

Create

Which part of the candle flame is the hottest?

To determine the hottest part of a candle flame, use a copper wire, heat it in different flame sections, and observe the temperature effects.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Bloom's Taxonomy

SCAN TO ACCESS

Take a Task

Watch Remedial

Fuel

Now that Ayra has learned about combustion, flames, and fire safety, her mother starts explaining the concept of fuel.

A combustible substance which on burning produces a large amount of heat and light is called fuel. Examples of fuel are wood, charcoal, petrol, kerosene, LPG, cow dung cakes etc. Fuels may be solid, liquid or gases at room temperature. Examples:

Solid fuels	Liquid fuels	Gaseous fuels
• Cow dung cakes • Wood • Charcoal • Agricultural wastes etc.	• Petrol • Diesel • Kerosene etc.	• Liquefied Petroleum Gas (LPG) • Compressed Natural Gas (CNG) • Bio gas (gobar gas) • Coal gas • Water gas • Petroleum gas etc.

Characteristics of a good fuel

A good fuel is one :

- which is readily available.
- which is cheap.
- which burns easily in air at a moderate rate.

- which produces a large amount of heat, i.e., its calorific value should be high.
- which does not leave behind any undesirable substances.
- which can be easily stored and easily transported.
- whose ignition temperature is higher than room temperature.

There is probably no fuel that could be considered as an ideal fuel. We should look for a fuel which fulfils most of the requirements for a particular use. LPG and CNG fulfil most of the criterion of a good or ideal fuel.

Fuel Efficiency

Most of our energy requirements are met by the fossil fuels and their products. But how do you decide which is the best fuel? In other words, how do you compare the efficiency of various types of fuels? The fuels are burned to produce heat. Some fuels produce more heat and while others produces less heat. Thus, the efficiency of various fuels can be compared by the amount of heat produced by them. In fact, a fuel is rated by its calorific value.

Calorific value is the amount of heat energy released by the complete combustion of 1 kg of a fuel. The heat generated by fuels when they burn is measured in joule or calorie (1 calorie =4.18 joule). The calorific value is expressed in kilojoule/kg.

A fuel with more calorific value releases more energy than the fuel with lower calorific value. The fuel with a higher calorific value is therefore more efficient. The table given below lists some of the fuels with their calorific values.

Calorific Values of Different Fuels

Fuel	Calorific Value (kJ/kg)
Cowdung cake	6000-8000
Wood	17000-22000
Coal	25000-33000
Petrol	45000
Kerosene	45000
Diesel	45000
Methane	50000
CNG	50000
LPG	55000
Biogas	35000-40000
Hydrogen	150000

Harmful effects of burning fuels

The burning of coal and oil causes the release of atmospheric pollutants such as sulphur dioxide, nitrogen oxides, carbon dioxide, and carbon monoxide. These gases readily form smog that pollutes the air. Carbon dioxide is the main greenhouse gas that contributes to global warming. Another environmental issue associated with the use of oil is the impact of oil drilling. Most of the oil wells lie under the ocean. Oil spill accidents are a major threat to the marine organisms and birds.

Carbon-containing fuels like wood and coal release unburnt carbon particles which form soot and are responsible for causing respiratory diseases like asthma. During incomplete combustion, the unburnt carbon not only causes wastage of the fuel but also pollutes the atmosphere by producing highly poisonous carbon monoxide gas. Carbon monoxide causes respiratory problems and may even prove fatal.

The sulphur contained in coal forms sulphur dioxide when it burns. Harmful nitrogen oxides, heavy metals, and carbon dioxide are also released into the air during coal burning. The harmful oxides dissolve in rainwater to form acids like nitric and sulphuric acids which fall to the ground as acid rain. This is harmful because it :

- damages green leaves of plants and trees.
- reaches the sources of surface water and
- underground water and deteriorates the quality of water, and
- causes damage to monuments.

The mining of coal results in the destruction of wide areas of land. Mining this fossil fuel is also difficult and may endanger the lives of mineworkers. Coal mining is considered one of the most dangerous jobs in the world.

KEYWORDS

Asthma: A chronic respiratory condition characterized by inflammation and narrowing of the airways, leading to difficulty breathing.

Acid Rain: Precipitation containing high levels of sulfuric and nitric acids, often resulting from air pollution, which can damage ecosystems and buildings.

Did you know

Fuel is the lifeblood of energy, the spark that powers everything from roaring engines to quiet generators. It's not just wood, gas, or oil—it's the energy potential waiting to ignite. The best fuels pack a punch, delivering maximum power with minimal waste. Whether it's liquid fuel driving a car or hydrogen propelling rockets, every type has its unique magic. Fuel isn't just energy—it's transformation, turning potential into action.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Apply Concept in Real-Life Context

Apply

1. Why should we avoid using a gas stove in a poorly ventilated area for an extended time?
2. What are the potential challenges or risks in using hydrogen as a primary household fuel?

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

1. Explain how food provides energy to our body similar to how fuel provides energy to machines.
2. What factors should be considered when choosing a fuel for industrial use versus household use?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. Describe different types of fuels and where they are commonly used.
2. Which fuel source provides the most energy efficiency, and which provides the least?
3. What environmental impacts arise from the burning of different fuels?

Creative Task

Create

Create an informative presentation on "Solar Energy – A Renewable Fuel Alternative," discussing its environmental benefits, technological advancements, and potential for widespread application. Use software like MS PowerPoint, Google Slides, or another similar tool.

Skills Practiced: Brainstorming, research, digital literacy, creativity

SUMMARY

1. Combustion and Its Types

Combustion is a chemical process in which a substance (fuel) reacts with oxygen to release energy in the form of heat and light. This process is vital for various human activities, from cooking to running vehicles and industries.

Types of Combustion:

1. **Rapid Combustion:** Happens quickly, producing heat and light, e.g., burning of fuels like LPG or wood.
2. **Slow Combustion:** Occurs over time without visible flames, e.g., cellular respiration in humans.
3. **Spontaneous Combustion:** Happens without an external ignition source, e.g., phosphorus catching fire in air.
4. **Explosion:** A sudden release of energy causing shockwaves, e.g., firecrackers or bombs.

2. How Do We Control Fire?

Controlling fire involves managing the fire triangle, which consists of heat, fuel, and oxygen. Removing any one of these elements can extinguish a fire:

- **Cooling:** Water is used to lower the temperature below the ignition point.
- **Smothering:** Sand, foam, or fire blankets block oxygen supply.
- **Cutting Fuel Supply:** Isolating or removing the fuel source stops the combustion process. Modern firefighting employs advanced techniques like fire-retardant chemicals, controlled burns, and automated sprinklers to prevent and manage fires effectively.

3. Flame

A flame is the visible part of fire, created during the combustion of a substance. It varies in shape, size, and color based on the type of fuel and combustion conditions.

Structure of a Flame:

- **Innermost Zone:** Dark, least hot, containing unburnt fuel particles.
- **Middle Zone:** Luminous, moderately hot, where incomplete combustion occurs.
- **Outer Zone:** Non-luminous, hottest part, with complete combustion.

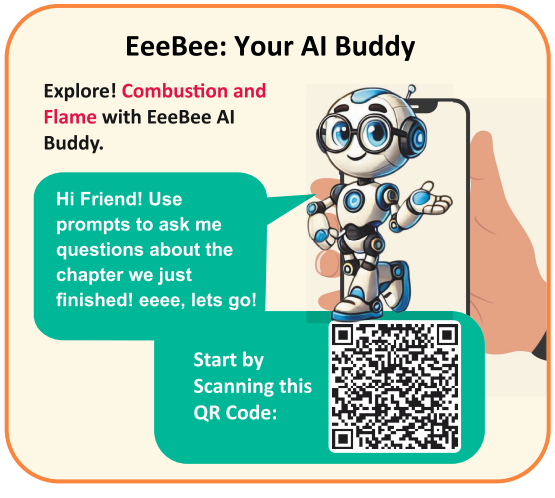
Types of Flames:

- **Blue Flame:** Indicates complete combustion, often seen with fuels like LPG.
- **Yellow Flame:** Indicates incomplete combustion, often producing soot.

4. Fuel

Fuels are classified into three main types:

1. Solid Fuels: Wood, coal, peat, and biomass.
2. Liquid Fuels: Kerosene, petrol, and diesel.
3. Gaseous Fuels: Natural gas, LPG, and hydrogen.



Gap Analyzer™
Take a Test

EXERCISE

That turn curiosity into confidence—let's begin!

A. Choose the correct answer.

1. Which of the following is necessary for combustion to take place?
   (a) Oxygen ☐ (b) Carbon dioxide ☐
   (c) Hydrogen ☐ (d) Nitrogen ☐
2. Which type of combustion occurs without external heating?
   (a) Rapid combustion ☐ (b) Spontaneous combustion ☐
   (c) Explosion ☐ (d) None of these ☐
3. Which part of a flame is the hottest?
   (a) Outer zone ☐ (b) Middle zone ☐
   (c) Inner zone ☐ (d) None of these ☐
4. What is the ideal property of a good fuel?
   (a) High ignition temperature ☐ (b) Low calorific value ☐
   (c) Low ignition temperature ☐ (d) High smoke production ☐
5. How does a fire extinguisher control fire?
   (a) By increasing oxygen supply ☐ (b) By cooling the fuel ☐
   (c) By cutting off the oxygen supply ☐ (d) By increasing heat ☐

B. Fill in the blanks.

1. The process of burning a substance in the presence of oxygen is called _____.
2. The flame of a candle has three zones: _____, _____, and _____.
3. _____ is the lowest temperature at which a substance catches fire.
4. Substances that catch fire easily are called _____.
5. The calorific value of a fuel is measured in _____.

C. Write True or False.

1. Water is effective in extinguishing oil or electrical fires. _____
2. Spontaneous combustion happens without external heating. _____
3. The blue part of a flame indicates complete combustion. _____
4. LPG is an example of a solid fuel. _____

D. Define the following terms.

1. Combustion
2. Ignition Temperature
3. Calorific Value
4. Spontaneous Combustion
5. Flame

E. Match the columns.

Column A	Column B
1. Rapid combustion	(a) Fire extinguisher
2. Explosion	(b) Controlled burning
3. Blue zone of flame	(c) Sudden release of heat and gases
4. Incomplete combustion	(d) Produces soot
5. Carbon dioxide	(e) Complete combustion

F. Give reasons for the following statements.

1. A matchstick does not catch fire on its own at room temperature.
2. LPG is considered an efficient fuel.
3. Fire extinguishers are filled with carbon dioxide or foam.
4. Paper burns with a flame, but charcoal does not.
5. Excessive use of fossil fuels leads to pollution.

G. Answer in brief.

1. What is meant by combustion?
2. Describe the three zones of a candle flame.
3. Why is it important to use fuels with high calorific value?
4. How does water help extinguish fire in most cases?
5. What is the significance of controlling fire in daily life?

H. Answer in detail.

1. Explain the different types of combustion with examples.
2. Why does the outermost zone of a flame appear blue?
3. Discuss how fire extinguishers work and their types.
4. List and explain the characteristics of a good fuel.
5. Explain how controlling fire has shaped human civilization.

NEP Corner

Know about NEP 2020

Blended Learning Models

Schools and institutions are encouraged to adopt hybrid teaching models, combining traditional methods with online education for better engagement.

Skill-based Activity

Activity Time

STEM

DIY Smoke Detector

Try this experiment to learn how smoke detectors work and understand the importance of fire safety.

Materials needed: small plastic bottle, cotton balls, vinegar, baking soda, a candle, matches, and aluminum foil.

1. Place a piece of aluminum foil inside the plastic bottle, touching the inner walls.
2. Add a spoonful of baking soda into the bottle.
3. Light the candle and place it safely in a well-ventilated area.
4. Use cotton balls soaked in vinegar to gently fan smoke towards the mouth of the bottle.
5. Observe what happens when the smoke enters the bottle and reacts with the baking soda.

Note: Perform this experiment in a safe, open space under adult supervision.

Now answer these questions:

1. What did you observe when the smoke interacted with the baking soda in the bottle?
2. Why do you think the aluminum foil was added to the setup?

Skills Covered: Creativity, Observation, Critical Thinking, Data Analysis, Responsibility, Research

Crafty Fire Alarm Model

Art

Create a model of a fire alarm using simple materials to understand its parts. Gather an empty cardboard box, red and yellow paper, scissors, glue, and a bell (or any small item that resembles a bell).

1. Wrap the cardboard box with red paper.
2. Cut out a yellow circle and attach it to the front to resemble an alert button.
3. Add the bell to the top of the box to represent the alarm sound.

4. Label the box as "Fire Alarm" to finish the look.

Present your fire alarm model to the class and explain its components.

Skills Covered: Creativity, Imagination, Problem-solving, Environmental Awareness

Fire Department Visit

Group Activity

Organize a visit to your local fire department to understand their role in community safety. Observe the types of tools and equipment they use and the procedures they follow during an emergency. Ask about the different fire extinguishers and protective gear they utilize.

Divide the class into small groups and have each group create a presentation using MS PowerPoint or Google Slides on the emergency protocols they observed. Present and discuss your findings with the class.

Skills Covered: Critical thinking, Planning, Collaboration, Communication, Creativity, Teamwork, Problem-solving, Responsibility

Combustion Web Diagram

Case to Investigate

Create a web diagram showing the types of combustion (such as complete, incomplete, and spontaneous combustion) with examples and brief descriptions for each. Connect each type to real-life applications or situations.

Skills Covered: Observation, Critical thinking, Research, Analytical skills, Communication

Energy Use in the Community

Aligning with SDGs

Conduct a survey in your neighborhood by asking 15 households about the types of energy sources they use for activities like heating, cooking, and transportation. Record your data and analyze which types of energy are most and least common. Prepare a summary report to present in class.

SDG 7: Affordable and Clean Energy, SDG 11: Sustainable Cities and Communities, SDG 13: Climate Action, SDG 12: Responsible Consumption and Production

Skills Covered: Research, Brainstorming, Problem-solving, Presentation skills

Wildfire Prevention Awareness

Integrated Learning

Research the causes of wildfires and the steps taken to prevent them. Focus on both natural causes (like lightning) and human-made causes (such as campfires left unattended). Prepare an infographic or poster detailing how wildfires start and the preventive measures that can be taken by communities to minimize risks.

Integrated Learning: Environmental Science

Skills Covered: Brainstorming, Research, Investigation, Critical Thinking