8th Class

Combustion and Flame

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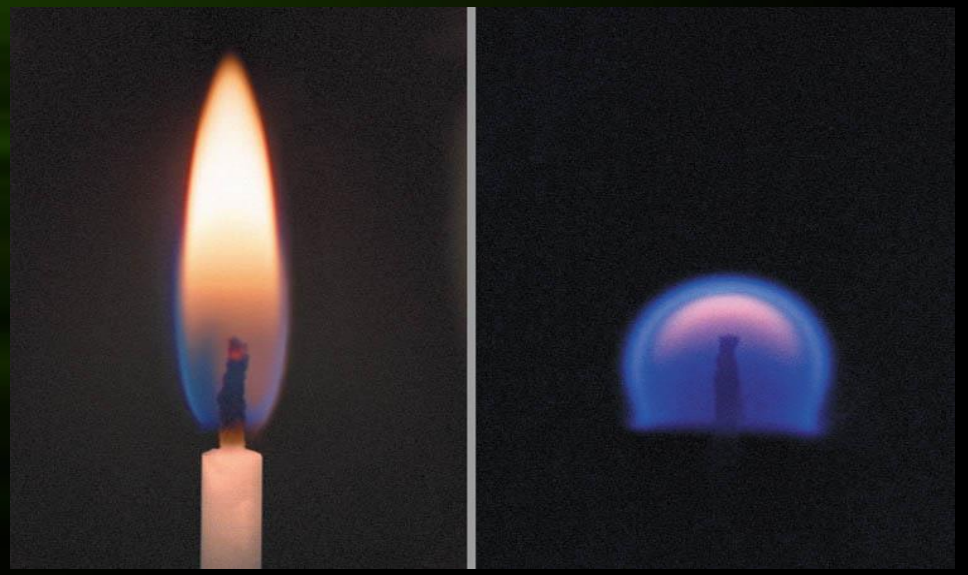
Combustion

The chemical process in which a substance reacts with oxygen to produce heat is called **combustion.**

The substance which undergoes combustion is called a **combustible substance**. It is also called a **fuel.**

Sometimes light is also produced during combustion either as a flame or as a glow.



Combustible substances

Substances which burn in air to produce heat and light are called combustible substances.

Example: wood, coal, charcoal, kerosene, petrol, diesel, liquified petroleum gas (LPG), compressed natural gas (CNG) etc.

- **Wood** **Coal** **LPG** **Kerosene**




NON COMBUSTIBLE SUBSTANCE

The substance that does not undergo combustion is called **non-combustible substance.**

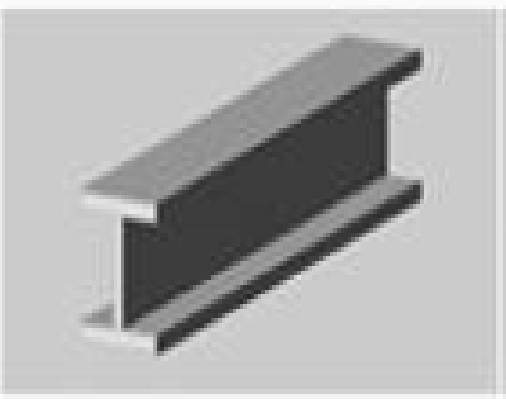
Examples: Rock, Steel, Water, Sand, etc.

Sand

Stones

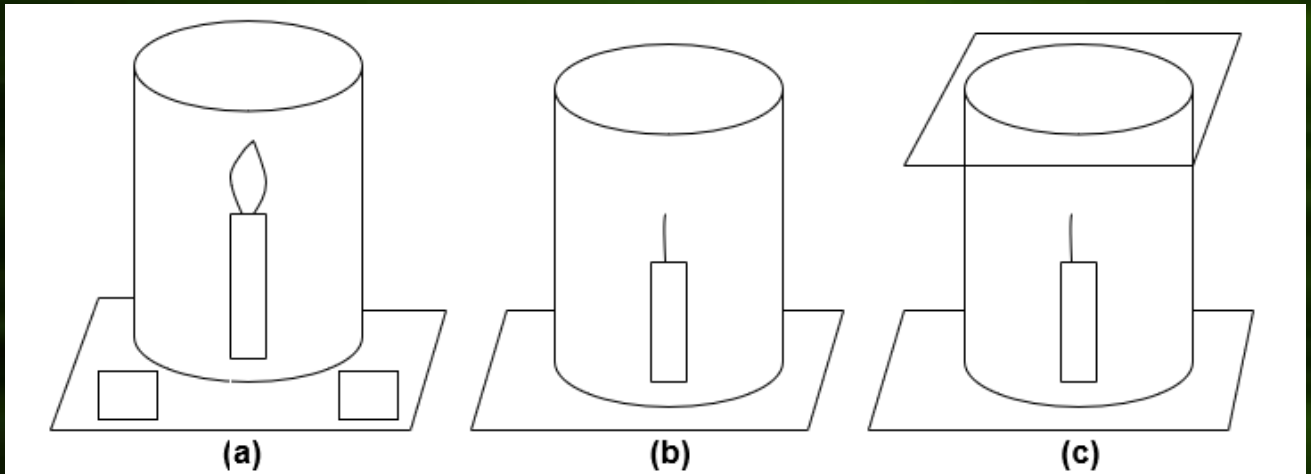
Concrete

Glass



Steel

Air is necessary for burning



Fix a lighted candle on a table. Put a glass chimney over the table and rest it on a few wooden blocks in such a way so that air can enter the chimney. Observe what happens to the flame.

- Now remove the blocks and let the chimney rest on the table. Again observe the flame.
- Then put a glass plate over the chimney. Observe the flame again.
- The candle burns freely in (a) because air enters the chimney from below.
- The candle stops burning in (b) because air does not enter the chimney from below.
- The candle does not burn in (c) because air is not available.
- This shows that air is necessary for burning.

Ignition temperature

The minimum temperature at which a substance catches fire and burns is called its ignition temperature.

- **A substance will not catch fire and burn if its temperature is lower than its ignition temperature.**

- **Different substances have different ignition temperatures.**
  Ex: The ignition temperature of kerosene is less than the ignition temperature of wood.

Ignition temperature

Substances which have very low ignition temperature and can easily catch fire with a flame are called inflammable substances.

Ex: Petrol, Alcohol, LPG, CNG etc.

LPG

Petrol

CNG

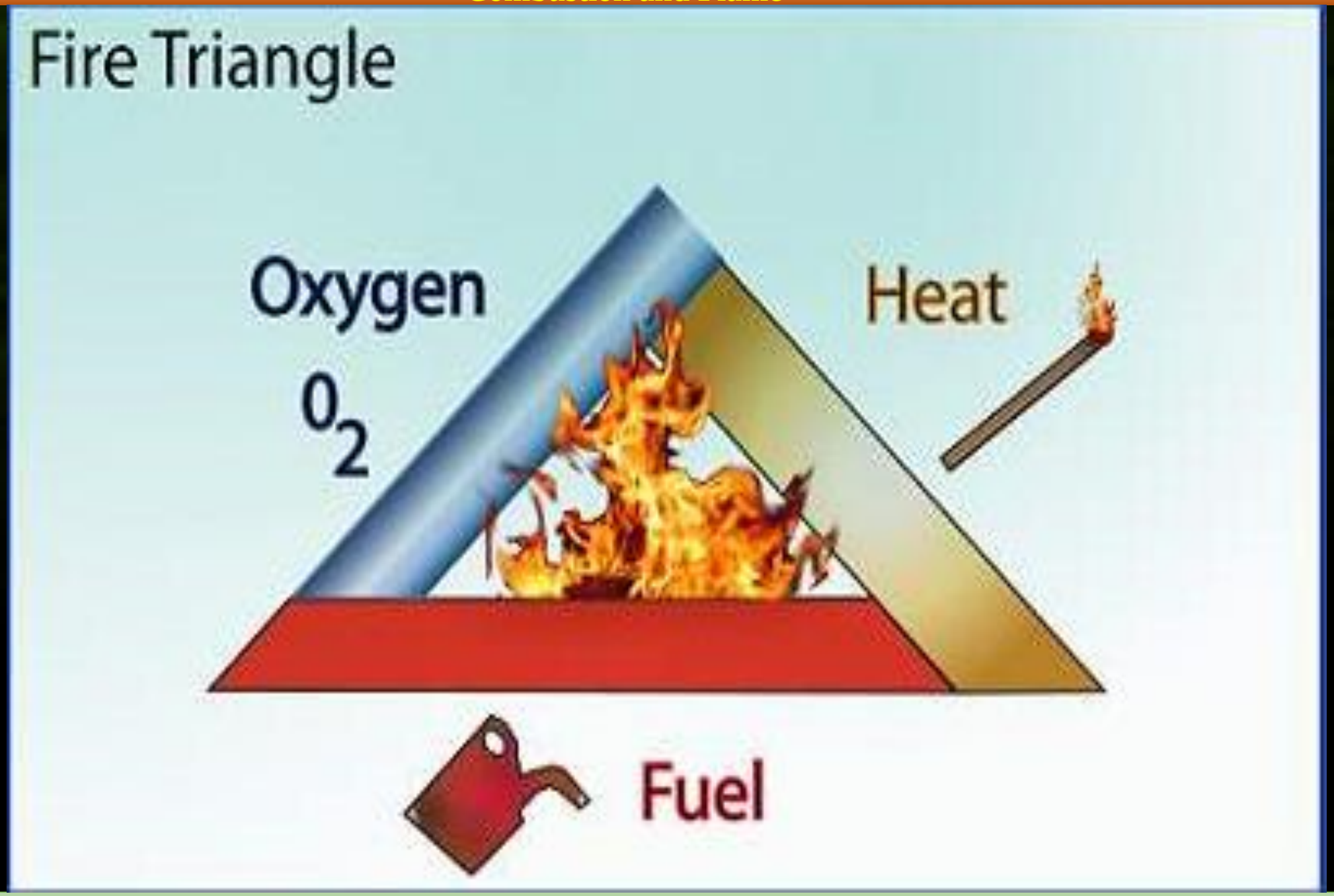
Ignition temperature of different materials	
White Phosphorus	35 ^{0}C
Petrol	246 ^{0}C
Kerosene	220 ^{0}C
Diesel	210 ^{0}C
Wood	300 ^{0}C
Coal	454 ^{0}C
Piece of paper	233 ^{0}C

Conditions necessary for combustion

The conditions necessary for combustion are

- Fuel
- Air (to supply oxygen)
- Heat (to raise the temperature beyond the ignition temperature

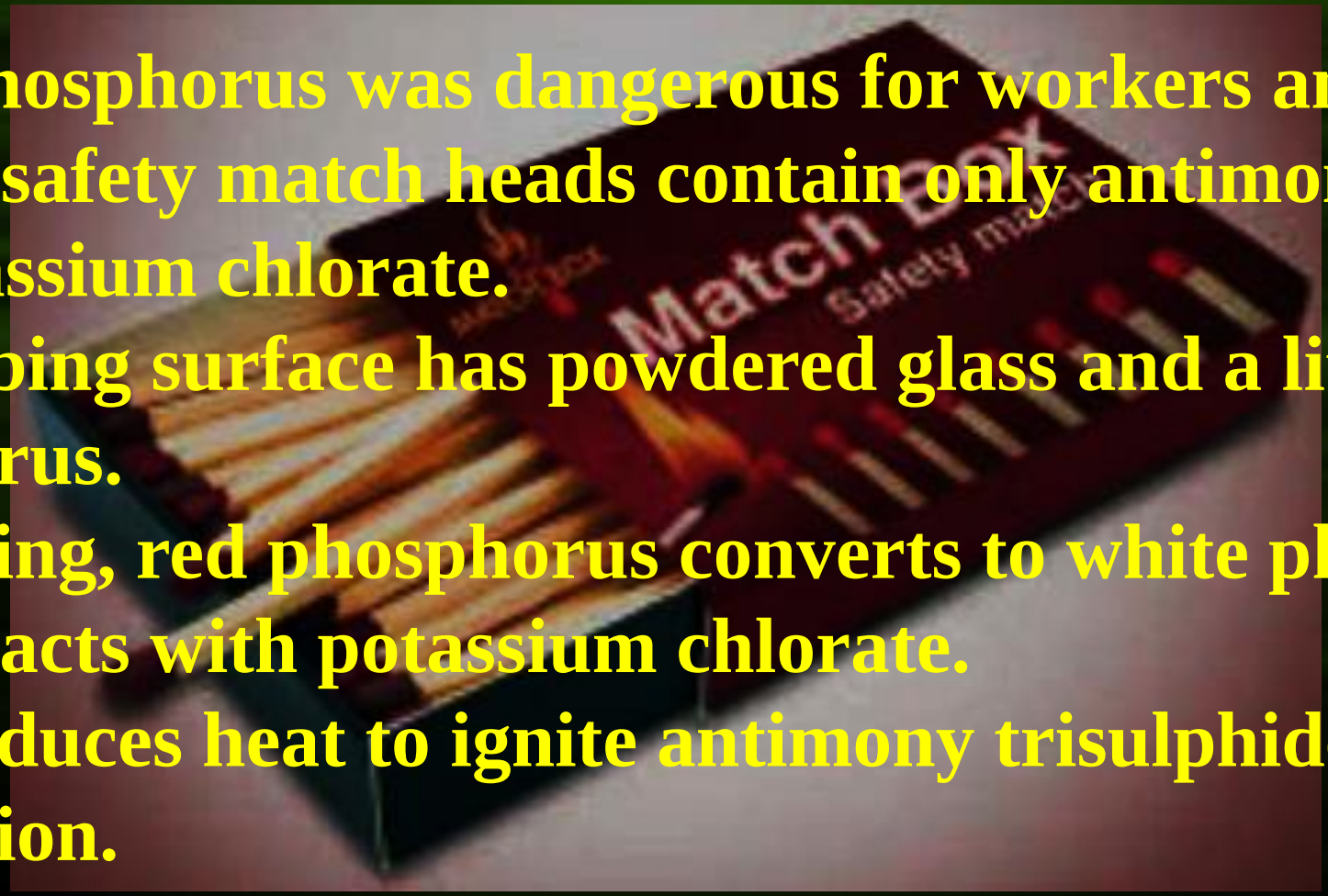
A substance will not burn without one or more of these conditions.


Fire Triangle
Oxygen
O_2
Heat
Fuel

History of the Matchstick

- The history of the matchstick is very old.
- More than five thousand years ago, small pieces of pinewood dipped in sulphur were used as matches in ancient Egypt.
- The modern safety match was developed about two hundred years ago.
- Early matches used antimony trisulphide, potassium chlorate, white phosphorus, glue and starch.

Modern Safety Matches



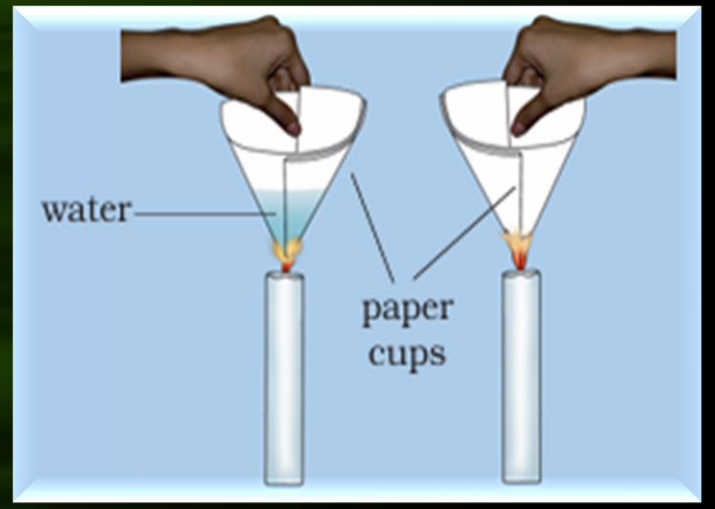
- ✓ White phosphorus was dangerous for workers and users.
- ✓ Modern safety match heads contain only antimony trisulphide and potassium chlorate.
- ✓ The rubbing surface has powdered glass and a little red phosphorus.
- ✓ On striking, red phosphorus converts to white phosphorus, which reacts with potassium chlorate.
- ✓ This produces heat to ignite antimony trisulphide and start combustion.

INFLAMMABLE SUBSTANCES

Substances that have a very low ignition temperature and hence can catch fire easily are called **inflammable substances.**

Ex: Petrol, Diesel, LPG etc.

Activity: Heating Paper Cups



- Make two paper cups by folding sheets of paper.
- Pour about 50 mL of water into one of the cups.
- Heat both cups separately using a candle.

Observation:

– The empty paper cup burns quickly.

– The cup with water does not burn because water absorbs heat and keeps the cup cool.

BASIC PRINCIPLES TO CONTROL FIRE

1. By cutting off the **supply of oxygen.**
2. By lowering the **ignition temperature.**
3. By separating the **combustible substance.**

How do we control fire?

1. By cutting off the **supply of oxygen.**
2. By lowering the **ignition temperature.**
3. By separating the **combustible substance.**

Methods of controlling fire

By using water

Water is the most common fire extinguisher. It can be used only when materials like wood, paper etc. are on fire.

Water cannot be used if electrical equipment's are on fire because water conducts electricity and can harm those trying to put out the fire.

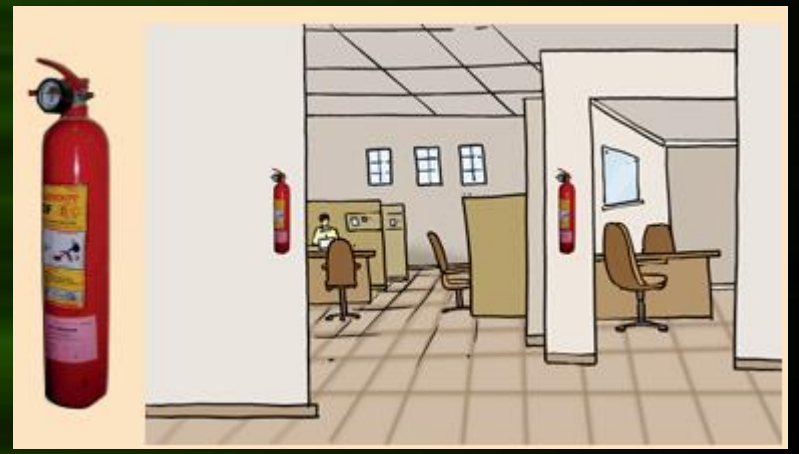
Water cannot be used to put out oil and petrol fires because they float on water and continue to burn.

By using carbon dioxide

Carbon dioxide is the best fire extinguisher to put out fire caused by inflammable materials like oil and petrol and electrical equipment's. Carbon dioxide is heavier than air and it covers the fire and cuts off the supply of oxygen and puts out the fire.

Carbon dioxide is stored at high pressure as liquid in cylinders. Chemicals like sodium bicarbonate (baking soda), potassium bicarbonate produce carbon dioxide near the fire.

FIRE EXTINGUISHER



- The most common **fire extinguisher** is **water**.
- 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.

- Rapid combustion
- Spontaneous combustion
- Explosion

Different Types of Combustions

Rapid Combustion

Combustion is very fast

Example

Matchstick near stove

Spontaneous

Combustion is on its own

Example

Coal Dust in Coal Mines

Explosion

Combustion causes Large amount of Heat, Light, Sound

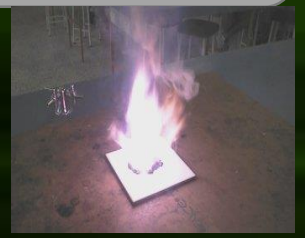
Example

Fire Crackers

Rapid combustion

Rapid combustion occurs when a substance burns quickly and produces large amounts of heat and light, such as LPG burning in a stove.

Spontaneous combustion



Spontaneous combustion occurs when a substance catches fire without being heated externally. Example: Phosphorus igniting in air.

Explosion

Explosion occurs when combustion takes place suddenly, producing heat, light, sound, and large volumes of gas. Example: Firecrackers are common

Flame

When a combustible substance vaporises during combustion it produces flame. Ex: Kerosene, Wax etc.

Substances which do not vapourises during burning do not produce flames.

Ex:- coal, charcoal etc.

Flame is the zone of combustion of a combustible substance.

Kerosene

Wax

Coal

Charcoal

STRUCTURE OF A FLAME

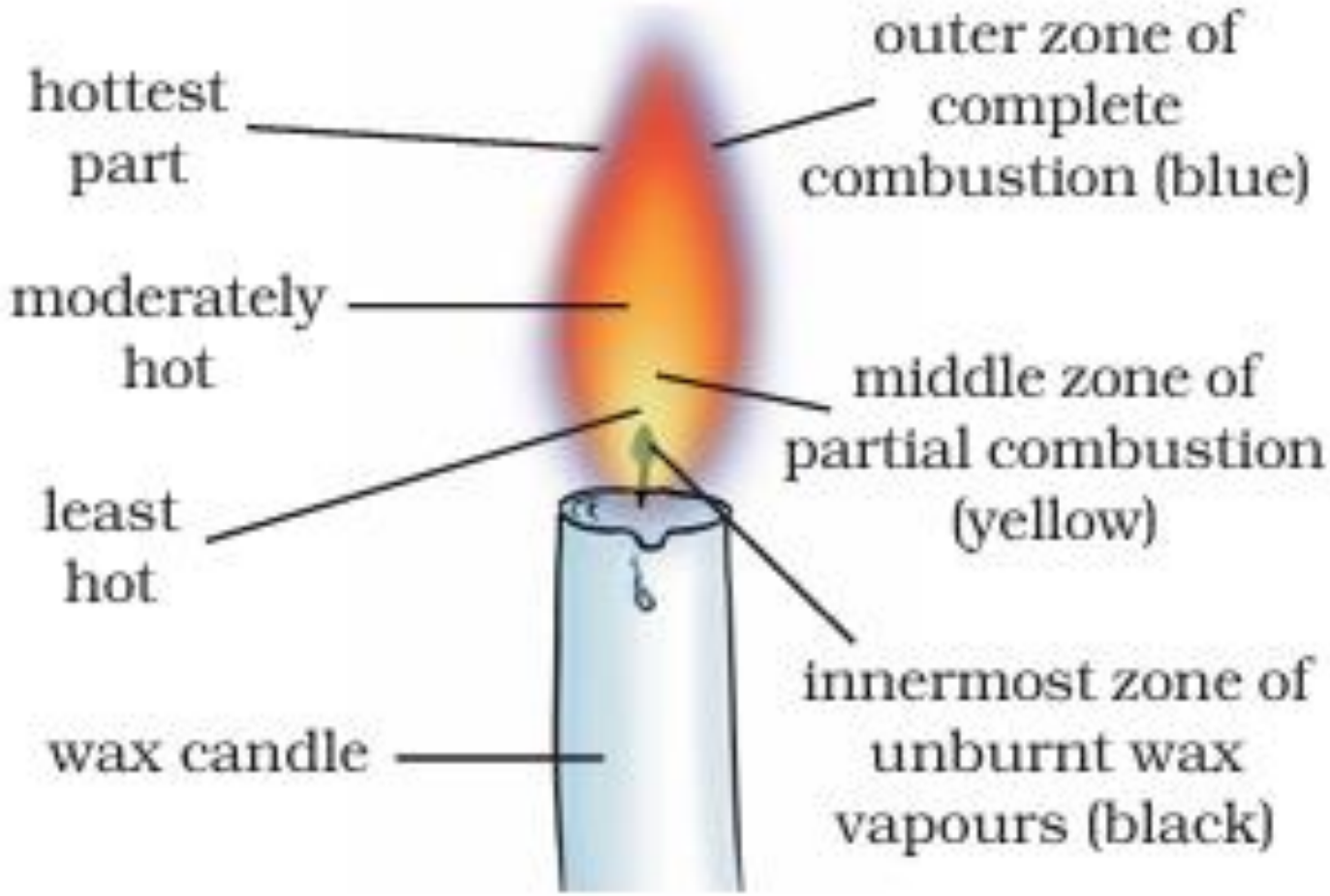
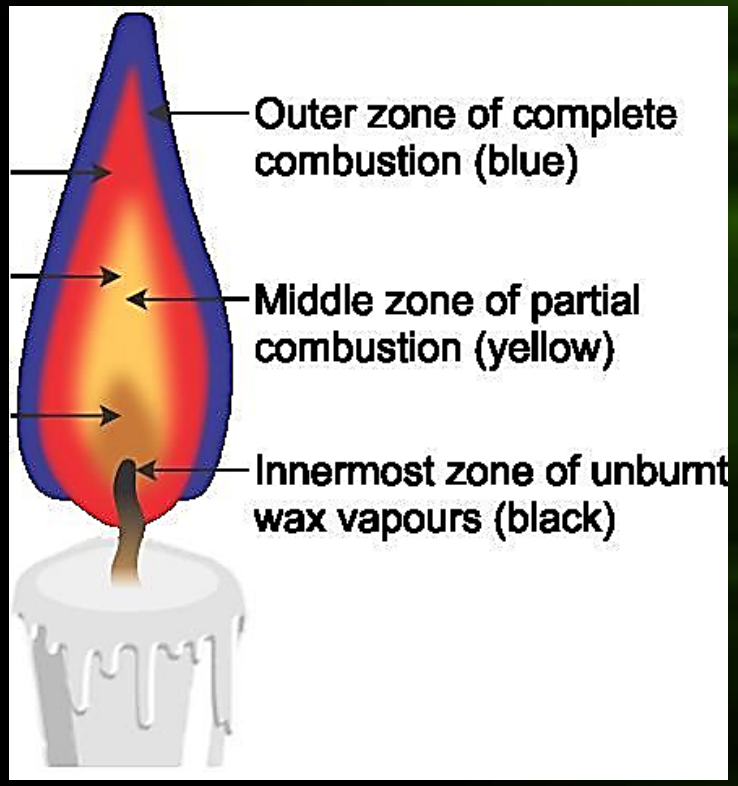


Fig. 10.13 : *Different zones of candle flame*

Structure of a candle flame

- Outer zone
- Middle zone
- Inner zone

STRUCTURE OF A FLAME



Outer Zone

Complete combustion of the fuel takes place and the colour of the flame is blue and is the hottest part of the flame. It is the non luminous part of the flame.

Middle Zone

Partial combustion of the fuel takes place and the colour of the flame is yellow and is moderately hot part of the flame. It is the luminous part of the flame.

Inner Zone

There are unburnt vapours of the fuel and the colour is black and is least hot part.

Fuel

A fuel is any substance that produces energy on burning.

Fuels are of three main types. They are :-

i) Solid fuels :- Wood, Coal, Charcoal etc.

ii) Liquid fuels :- Kerosene, Petrol, Diesel etc.

iii) Gaseous fuels :- CNG, LPG, Biogas, Hydrogen etc.

Solid fuels **Liquid fuels** **Gaseous fuels**

CHARACTERISTICS OF A GOOD FUEL

- It is readily available.
- It is cheaper.
- It is easy to store and transport.
- It burns at a moderate rate.
- It produces a large amount of heat.
- It does not leave behind any undesirable substances.
- It does not causes pollution.

Fuel Efficiency

The amount of heat energy produced on complete combustion of 1 kg of a fuel is called CALORIFIC VALUE.

The unit of calorific value is KILOJOULE PER KG (kJ/kg).

Fuel	Calorific Value (kJ/kg)
Cow dung 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

Hydrogen has the highest calorific value among all fuels.

Burning of Fuels Leads to Harmful Products

RESPIRATORY DISEASES:

Unburnt carbon particles releasing from wood, coal, petroleum cause severe respiratory diseases like asthma, etc.

Burning of Fuels Leads to Harmful Products

DEATH DUE TO CARBON MONOXIDE GAS:

Incomplete combustion of fuels produces carbon monoxide gas which can cause death.

Burning of Fuels Leads to Harmful Products

GLOBAL WARMING:

Global warming is the rise in the temperature of the atmosphere of the earth which is mostly due to release of carbon dioxide gas.

Global warming leads to:

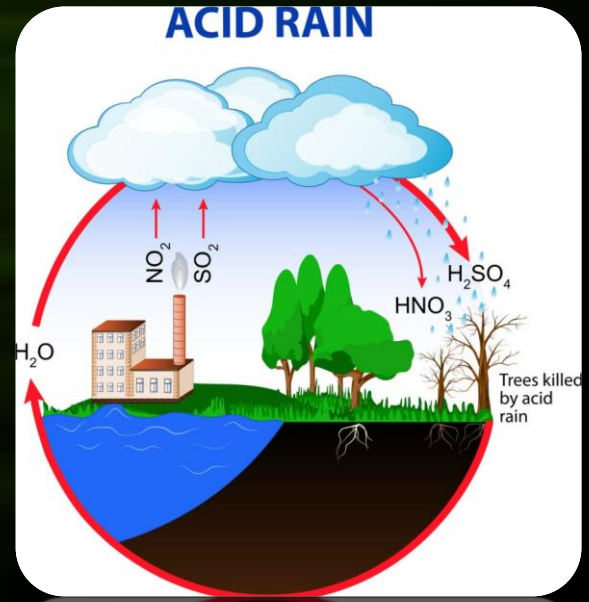
1) **rise in sea level causing flood in coastal areas.**
2) **Climate change.**
3) **Extinction of plants and animals.**

Burning of Fuels Leads to Harmful Products

ACID RAIN:

Burning of coal, diesel and petrol releases oxides of sulphur and nitrogen. These gases dissolve in rain water and form acids, which is called Acid Rain.

It is harmful for crops, buildings and soil.




thank you