

**INTRODUCTION**

The most important source of energy is fuels. Flame is a region where combustion (or burning) of gaseous substance takes place. Most of the combustible substances on burning produce a flame. A flame is obtained by burning of vapours of the substances.

Whenever a substance is burnt it produces heat. The heat is produced due to a chemical reaction. Let us study the chemical process of burning and the type of flame produced during this process.

**What is combustion?**

A chemical process in which of a substance reacts with oxygen to give off heat is called combustion. Combustion is the exothermic process. The substance that undergoes combustion is said to be combustible it is also called a fuel.

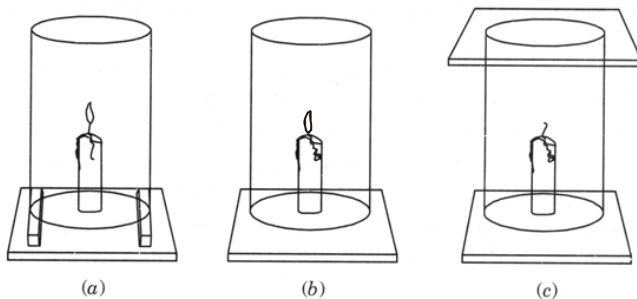
**For example :** Charcoal burns in air to give carbon dioxide and heat.



Methane burns in air forming carbon dioxide, water and heat.

**ACTIVITY**

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



**Showing that air is essential for burning**

Observe what happens to the flame. Now remove the blocks and let the chimney rest on the table. Again observe the flame. Finally put a glass plate over the chimney. We find that for combustion air is necessary. The candle burns freely in case (a) when air can enter the chimney from below. In case (b) when air does not enter the chimney from below, the flame flickers and produces smoke, in case (c) the flame finally goes off because the air is not available. This activity shows that air is necessary for combustion.

**Combustible and Non combustible substances :**

Substances such as paper, kerosene, petrol, straw and wood etc, which burns easily are known as combustible substances.

Substances that don't burn easily are called non combustible substances. For example iron, glass, diamond etc.

**Ignition temperature or kindling temperature :**

The lowest temperature at which a substance starts burning is known as its kindling temperature or ignition temperature. For example, the ignition temperature of white phosphorous is 35°C. Hence it catches fire on slight heating. The ignition temperature of red phosphorous is 260°C. Therefore, white phosphorous is kept immersed in water. Whereas red phosphorous is stored in ordinary bottles.

### ACTIVITY

Make two paper cups by folding of paper pour about 150 ml of water in one of the cups. Heat both the cups separately with a candle.

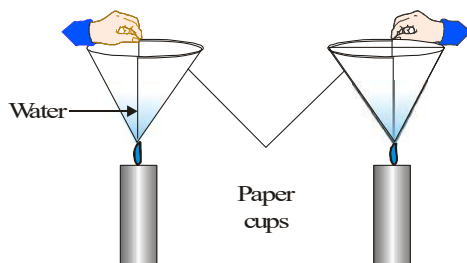


Fig. Heating water in a paper cup.

**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.

**The substances which have very low ignition temperature and can easily catch fire with a flame are called inflammable substances. For example petrol, alcohol, LPG etc.**

**Condition necessary for combustion :**

For combustion, the following three conditions are essential

- (1) Presence of a combustible substance.
- (2) Presence of a supporter of combustion.
- (3) Attainment of ignition or kindling temperature.

**How do we control fire?** Water cools the combustion material so that its temperature is brought below its ignition temperature. **Fire produced by the burning of oil or petrol cannot be controlled by throwing water on it because water being heavier than oil, settles down below the oil and oil continues to burn.** In the case of fires caused by burning liquid fuels such as kerosene oil can be controlled by throwing sand or soil over it.

There are various types of fire extinguishers used for controlling a fire. The job of a fire extinguisher is to cut off the supply of air or bring down the temperature of the fuel.

Soda-acid fire extinguisher is based on the principle of cooling the fire. Carbon dioxide liberated by the reaction of sulphuric acid with sodium bicarbonate solution comes out with a stream of liquid water at high pressure. Water puts off the fire by lowering the temperature of the combustible material below its ignition temperature and carbon dioxide cuts off the supply of air to the combustible substance.

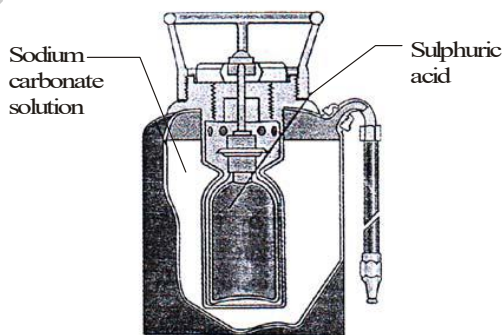


Fig : Cross section of soda-acid extinguisher

**Types of combustion :**

Combustion is mainly of three types

- (1) Rapid Combustion
- (2) Spontaneous combustion
- (3) Explosion

- Rapid Combustion :** The combustion in which the gas burns rapidly and produces heat and light is called rapid combustion.  
**For example :**  
When a burning matchstick is brought near a gas burner and the gas tap is opened, the gas immediately starts burning with the production of heat and light.
- Spontaneous Combustion :** The combustion in which no external heat is given is known as spontaneous combustion.  
**For example :** Burning of white phosphorus in air.

### ACTIVITY

Take a small dry piece of white phosphorous. Dissolve it in a small quantity of carbon disulphide ( $\text{CS}_2$ ), taken in a beaker. Dip a piece of filter paper in this solution. Now hold the filter paper with a pair of tongs and wave it in the air.

We observe that  $\text{CS}_2$  gets off evaporated and the filter paper burns into flame. It is due to the slow oxidation of white phosphorous. Heat is produced during this process till the white phosphorus reaches its ignition temperature ( $35^\circ\text{C}$ ). It is directly surrounded by enough oxygen, hence, it starts burning. This type of combustion reaction is known as spontaneous combustion.

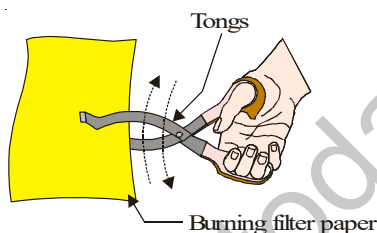


Fig. Filter paper dipped in the solution of white phosphorous dissolved in  $\text{CS}_2$  burns in air

- Explosion :** The combustion in which large amount of gases are evolved with the production of a tremendous amount of heat, light and sound is called explosion.  
**For example :** When a cracker is ignited, a sudden reaction, oxidation process takes place and in which at high speed large amount of gas is evolved with the production of tremendous amount of heat, light and sound.

**Difference between rapid and spontaneous combustion :**

Rapid combustion	Spontaneous combustion
1. It is to be initiated once.	1. It takes place by itself
2. External heat is required to start it once	2. No external heat is required to start it.
3. Large amount of heat and light is evolved in a short time	3. Small amount of heat and light is evolved.
4. <b>Example :</b> Burning of domestic cooking gas in a gas burner	4. Burning of white phosphorous on its own when kept exposed in air for some time.

**Disadvantages of incomplete combustion :**

During incomplete combustion following problems may arise.

- During incomplete combustion, a part of the unburnt carbon passes into the atmosphere in the form of soot. This not only wastes the fuel, but also pollutes the atmosphere.
- During incomplete combustion, carbon monoxide is formed. This gas is highly poisonous in nature and can cause respiratory problems.

**Flame :** A region of burning gases is called flame. LPG is gas, the region in which it burns constitutes a flame. Wax is solid but it produces flame, when we light a candle with a match stick the heat of burning match stick not only melts wax but also changes it into wax vapour. The wax vapour mixes with air and then catches fire to produce a flame.

**Structure of flame :** The candle flame is divided into four different zones.

**Blue zone :** Near the bottom of the flame, there is a zone of blue colour. This is called blue zone. There fresh air rapidly mixes with wax vapour formed from the molten wax. A part of wax vapour almost completely burns and gives rise to blue flame.



**Structure of candle flame**

**Dark inner zone :** This zone consists of unburnt wax vapour given off by the molten wax. It is coldest part of the flame. It is slightly dark because a part of wax vapour decompose on heating to form carbon particles.

## ACTIVITY

To show the presence of wax vapour in dark inner zone. Take a candle of medium size and fix it on a table. Light the candle when the flame of the candle is absolutely steady, introduce a glass tube in the dark inner zone. We observe that the glass tubing is filled with slightly greyish white vapour which starts coming out from the other end of glass tubing. Vapour catches fire and burn with flame. These vapour of wax, which are produced due to the heat of candle flame.



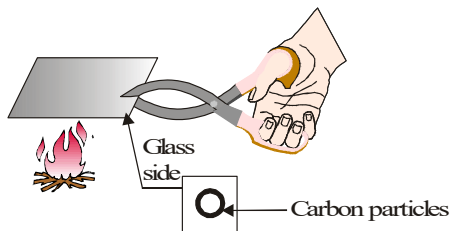
**Fig. Dark inner zone contains unburnt wax vapour**

**Luminous zone :** In this zone a partial combustion of wax vapour takes place with the liberation of lot of heat energy. The heat energy so liberated partly decomposes the wax vapour into carbon particles. The carbon particles in turn get very hot and emit yellowish light. So the colour of this zone is pale yellow. The unburnt carbon particles are present in this zone.

## ACTIVITY

To show that luminous zone of the candle flame contains unburnt particles of carbon.

Take a candle and fix it on a table. Light the candle when the flame is absolutely steady, introduce a clean glass slide into the luminous zone. We observe a circular grey (black) ring is formed on the glass slide. The black colour is due to the deposition of unburnt carbon particles in the luminous zone of the flame.



## Non Luminous Zone :

It is a zone of complete combustion of wax vapour and carbon particles. The air from the sides of the flame mixes with unburnt wax vapour and carbon particles from the luminous zone and completely burns them to form carbon dioxide gas and water vapour. It is the hottest part of the flame. Which hardly visible.

### The Chemical History Of A Candle

The credit for inventing the first primitive candles should go to Egyptians; it was they who first started using papyrus reeds soaked in tallow (animal fat). These were often used to light their homes and cliff caves.

In 1826 Michael Faraday first made the world aware of the full details process by which a candle works. His brilliant series of research-based lectures on (and entitled) *The Chemical History of a candle* at the Royal Institution were delivered as a part of Christmas lecture - a tradition that still continues. This lecture was later printed in book form in 1860. What Faraday basically said was that when you burn a candle you see the formation of "A beautiful cup". This cup is formed as the air near the candles moves upward due to the force of the current produced by heat of the candle.

1. List conditions under which combustion can take place.
2. Explain how the use of CNG in automobiles has reduced pollution in our cities.
3. Compare LPG and wood as fuels.
4. Give reasons.
  - (a) Water is not used to control fires involving electrical equipment
  - (b) LPG is a better domestic fuel than wood.
  - (c) Paper by itself catches fire easily whereas a piece of paper wrapped around an aluminium pipe does not.
5. Explain how  $\text{CO}_2$  is able to control fires.
6. It is difficult to burn a heap of green leaves but dry leaves catches fire easily. Explain.

**Fuel :** Any substance which is easily available and burn in air at moderate rate producing large amount of heat energy without leaving behind any undesirable residue is called a fuel.

#### Characteristics of a good fuel :

1. It should be cheap and readily available.
2. It should be easy to store
3. It should burn at a slow rate and its combustion should be controllable.
4. It should have low ignition temperature.
5. It should produce very small amount of residues such as ash.
6. It should have large calorific value.
7. It should not produce gases which pollute the air.
8. It should not produce any hazards during transportation.

#### Classifications of fuels :

On the basis of physical state fuels are classified into three parts.

1. **Solid fuels :** The fuels which occur in a solid state at room temperature are called solid fuels.

**Example :** Wood, agricultural residues, charcoal, coal, coke etc.

2. **Liquids fuels :** The fuels which occur in a liquid state at room temperature are called liquid fuels.

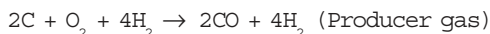
**Example :** Liquefied hydrogen, petrol, oil, kerosene, diesel etc.

3. **Gaseous fuels :** The fuels which occur in a gaseous state at room temperature are called gaseous fuels.

**Example :** Water gas, producer gas, coal gas, compressed natural gas (CNG) and gobar gas etc.

i. **Natural gas** ( $\text{CH}_4$ ) : Natural gas is obtained from petroleum mills and mainly contains methane and small quantities of ethane, gobar gas plants contain mainly methane and is a kind of bio-gas produced from animal & plant waste degradation.

ii. **Producer gas** ( $\text{N}_2 + \text{CO}$ ) : Producer gas is a mixture of nitrogen and carbon monoxide in the ratio of 2 : 1. It is prepared by passing air over red hot coke. It is used as a fuel in industries.



iii. **Water gas** ( $\text{H}_2 + \text{CO}$ ) : Water gas is mainly a mixture of hydrogen and carbon monoxide in the ratio of 1 : 1. It is prepared by passing steam over red hot coke at  $1000-1400^\circ\text{C}$ . Water gas is also known as blue gas because it burns with blue flame.



water gas is a much better fuel than producer gas because both hydrogen and carbon monoxide of water gas are combustible.

iv. **Coal gas** ( $\text{CH}_4 + \text{H}_2 + \text{CO}$ ) : Coal gas is a mixture of methane, hydrogen and carbon monoxide. It is obtained by destructive distillation of coal.

v. **Liquefied petroleum gas (LPG)** : LPG is mainly mixture of two hydrocarbon, butane and isobutane which are Liquefied by compressing. A strong smelling substance called ethyl mercaptan ( $\text{C}_2\text{H}_5\text{SH}$ ) is added to LPG gas cylinders to help in the detection of gas leakage.

#### Advantages of LPG :

i. **LPG** has high calorific value, hence it is a good fuel.

ii. It burns with a smokeless flame, so it does not cause pollution.

iii. It does not produce any poisonous gas on burning.

iv. It is very easy to handle and convenient to store.

v. It is a very neat and clean domestic fuel.

#### Calorific value of a fuel :

The amount of heat energy produced on completely burning one kilogram of fuel in pure oxygen is called calorific value of the fuel.

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The amount of heat energy produced on completely burning one gram of fuel in pure oxygen is called calorific value of the fuel.

The calorific value of the fuels is expressed in kilojoules per kilogram ( $\text{kJ/kg}$ ) or ( $\text{kJ/gm}$ ). This value of a fuel depends on its chemical composition and on the amount of water and ash it contains. For example peat has more water than coal, so it has a lower calorific value than coal.

#### Some common fuels and their calorific values

S.No.	Fuels	Calorific value (cal/ gram)
1	Wood	4000
2	Coal	7000
3	Coke	8000
4	Diesel	10,500
5	Kerosene	11,200
6	Petrol	11,400
7	Natural gas	8000-12000

#### Uses of fuels :

1. For cooking food in our homes in the form of a kerosene, coal, liquefied petroleum gas (LPG) etc.
2. For transporting men and materials by road, sea and air.
3. For heating boilers in the industries.
4. For generating electricity in thermal power plants.

DO YOU KNOW?

**Burning Of Candle An Irreversible Phenomenon**

When a candle is lit, the candle wax melts and burns at the same time. While the melted wax can be solidified, we cannot get back the gases evolved in the burning process. So burning of a candle is an irreversible process.

**Flame At Zero Gravity**

In zero gravity, such as the environment of outer space, the hot combustion products move away from the fuel source, resulting in a spherical flame front. The flame is also believed to be more bluish and efficient in such conditions.

**Harmful effects of burning fuels :** The increasing fuel consumption has harmful effects on the environment. The main products formed during the fuel combustion which produce harmful effect are.

1. Carbon fuels like wood, coal, petroleum release unburnt carbon particles. These fine particles are dangerous pollutants causing respiratory disease, such as asthma.
2. Incomplete combustion forms carbon monoxide gas. It is very poisonous gas. **It is dangerous to burn coal in a closed room. The carbon monoxide gas produced can kill persons sleeping in that room.**
3. Combustion of most fuels releases carbon dioxide in the environment. Increased percentage of carbon dioxide in the air causes global warming.

Global warming is the rise in temperature of the earth. This results in melting of polar glaciers. This leads to a rise in sea level and floods in the sea coast.

4. Burning of coal and diesel releases sulphur dioxide gas. It is an extremely suffocating and corrosive gas. Sulphur dioxide and nitrogen oxide dissolve in rain water to form acid. Such rain is called acid rain. It is very harmful for crops, buildings and soil.

- Q. Make a labelled diagram of a candle flame.
- Q. Name the unit in which the calorific value of fuel is expressed.
- Q. Which zone of a flame does a goldsmith use for melting gold and silver and why?
- Q. In an experiment 4.5kg of fuel was completely burnt. The heat produced was measured to be 180000kJ. Calculate the calorific value of the fuel.
- Q. Can the process of rusting be called combustion? Discuss.
- Q. Abida and Ramesh were doing an experiment in which water was to be heated in a beaker. Abida kept the beaker near the wick in the yellow part of the candle flame. Ramesh kept the beaker in the outermost part of the flame. Whose water will get heated in a shorter time.

## QUICK REVISION

- » Combustion is a chemical process in which a substance reacts with oxygen to give off heat and light.
- » A fuel is a substance which gives heat on burning.
- » Combustible substances are those which burn easily, e.g., paper, wood.
- » Non-combustible substances are those which do not burn easily, e.g., iron, glass.
- » Ignition temperature : The minimum temperature to which a substance is heated before it starts burning.
- » Inflammable substances are those which have a very low ignition temperature and can easily catch fire with a flame.
- » Fire extinguisher is based on the principle that either they cut off the supply of air to the combustible substance or it brings down the temperature of the combustible substance below its ignition temperature.
- » Types of combustion :
  - Ⓐ Rapid combustion : In this type of combustion, the substance burns rapidly till the whole substance burns completely.
  - Ⓑ Spontaneous combustion : In such a combustion, a substance with low ignition temperature catches fire on its own.
  - Ⓒ Explosion : A reaction in which substance burns with the evolution of heat, light and a large amount of gas is called explosion.
- » Calorific value is the amount of heat energy produced on complete combustion of 1 kg of fuel. It is expressed as kJ/kg.
- » Conditions essential for combustion :
  - Ⓐ Presence of combustible material.
  - Ⓑ Presence of supporter of combustion, i.e., oxygen.
  - Ⓒ Attainment of ignition temperature.
- » Characteristics of a good fuel :
  - Ⓐ It should have high calorific value.
  - Ⓑ It should not leave ash behind.
  - Ⓒ It should be easy to store, transport and handle.
  - Ⓓ It should have a convenient ignition temperature.
- » Acid Rain : Oxides of sulphur and nitrogen dissolve in rain water to form acids. This is known as acid rain.
- » Flame is a region where combustion of gases takes place.
- » Global warming is the rise in temperature of the environment of the earth
- » Fuels are of three types :
  - Ⓐ Solid fuel : wood, coal
  - Ⓑ Liquid fuel : Kerosene, petrol.
  - Ⓒ Gaseous fuel : LPG, Coal gas, CNG.
- » Zones of a flame :
  - Ⓐ Non luminous zone or zone of complete combustion
  - Ⓑ Luminous zone or zone of incomplete combustion
  - Ⓒ Innermost zone or zone of no combustion.



## FOR SUMMATIVE ASSESSMENT

1. Which fuels are used for running automobiles ?  
(A) Cowdung (B) Petrol (C) Diesel (D) (B) and (C)
2. Which of the following fuel is used in industry ?  
(A) Coal (B) CNG (C) Petrol (D) All of the above
3. Which of the following fuel burns without a flame ?  
(A) Candle (B) Coal (C) Kerosene oil (D) None of these
4. When magnesium burns with oxygen to form ?  
(A)  $Mg(OH)_2$  (B)  $MgCO_3$  (C)  $MgO$  (D) All of the above
5. Which of the following are produced by nuclear reactions ?  
(A) Sun (B) Heat (C) Light (D) All of the above
6. Which is necessary for combustion ?  
(A) Water (B) Air (C) Both (D) None of these
7. Which gas is the best extinguisher ?  
(A)  $CO_2$  (B)  $CO$  (C) Water vapour (D) None of these
8. Which fuel is an extremely good domestics fuel ?  
(A) Charcoal (B) LPG (C) Gobar gas (D) All of the above
9. Incomplete combustion of fuels gives -  
(A)  $CO_2$  gas (B)  $CO$  gas (C)  $CO + H_2$  (D) None of these
10. Which fuel have more calorific value ?  
(A) Wood (B) Coal (C) Kerosene (D) LPG
11. The unburnt Carbon particles causing respiratory diseases such as -  
(A) TB (B) Asthma (C) Both (D) None of these
12. The substances which have very low ignition temperature and can easily catch fire with a flame are called :  
(A) Luminous substances  
(B) Combustible substances  
(C) Inflammable substances  
(D) All of these
13. The heat and light that come from burning materials is known as :  
(A) Fire (B) Fuel (C) Flame (D) All of these
14. The conditions which are required for combustion to take place are:  
(A) Fuel (B) Ignition temperature  
(C) Oxygen (D) All of these
15. How fire can be put off?  
(A) By throwing water on it (B) By using fire extinguishers  
(C) By throwing sand or soil over it (D) Any of these methods.

**FILL IN THE BLANKS**

- On burning, solid fuels leave \_\_\_\_\_ and \_\_\_\_\_.
- Fuels are compounds of \_\_\_\_\_ and \_\_\_\_\_.
- $4P + 5O_2 \longrightarrow$  \_\_\_\_\_
- \_\_\_\_\_ and \_\_\_\_\_ are non-combustible substances.
- Substances that burn easily are called \_\_\_\_\_ substances.
- A candle flame consists of \_\_\_\_\_ important zones.
- A liquid fuel used in home is \_\_\_\_\_.
- Combustion is of \_\_\_\_\_ types.
- The innermost zone of flame is known as \_\_\_\_\_.
- Burning of wood and coal causes ..... of air.
- Fuel must be heated to its ..... before it starts burning.
- Fire produced by oil cannot be controlled by .....

**MARK 'T' IF THE STATEMENT IS TRUE AND 'F' IF IT IS FALSE**

- Substances burn in air and form carbon dioxide.
- Burnt fuel should always leave some residue.
- Water gas is a mixture of carbon monoxide and nitrogen.
- Calorific value of coke is more than that of coal.
- Natural gas mainly contains methane and traces of ethane and propane.
- Wood burns with a flame.
- There is a blue colour zone at the base of the wick.
- Presence of a combustible substance is not essential for a substance to burn.
- Red phosphorus can be stored in a bottle.
- Coal gas is obtained from destructive distillation of coal.
- Only gases or vapours burn with a flame.
- Burning of LPG is slow combustion.
- Coal is an inflammable fuel.
- Blue zone of a candle flame is the coolest.
- CO in air causes acid rain.

**MATCH THE FOLLOWING**

- Match the substances given in column A with their uses given in column B.

Column-A	Column-B
(i) Candle	i Kerosene
(ii) Sodium	ii Destructive distillation
(iii) Blown out candle	iii Fractional distillation of petroleum
(iv) Coal	iv Methane
(v) Diesel	v Rusting
(vi) Paper	vi Coal
(vii) Natural gas	vii Fowl smell
(viii) Slow combustion	viii Smelly stream of gas
(ix) Thermal power	ix Combustible
(x) Ethyl mercaptan	x Flame

2. Match the substances given in column A with their uses given in column B.

**Column-A**

- (i) Combustible
- (j) Non-combustible
- (k) Ignition temperature
- (l) Flame
- (m) Water

**Column-B**

- (i) Kindling temperature
- (j) Zone of combustion
- (k) Fire extinguisher
- (l) Petrol
- (m) Diamond
- (n) Sand

**VERY SHORT ANSWER TYPE QUESTIONS**

- What is a combustible substance?
- What is an inflammable substance?
- What will happen if air supply is stopped to a burning substance?
- What is a fire extinguisher?
- What is a primary fuel?
- What happens to natural gas when it is burnt?
- When a substance is burnt in the presence of oxygen, what is the phenomenon known as?
- What type of combustion takes place when the food you've eaten is used to provide energy for your body?
- What kind of substances are paper, wood and kerosene?
- Who described in detail the chemical history of a candle?
- Which fuel are you using at home?
- When a substance catches fire, what is that temperature known as?
- What is that value on which the efficiency of a fuel is determined?
- What is that substance known as which is burnt to use its heat energy?
- What is power generated by the heat produced by burning fuel?

**SHORT ANSWER TYPE QUESTIONS**

- Why doesn't wet wood burn easily?
- Differentiate between solid and liquid fuels.
- Why do some substances produce flame?
- What happens to the wax when a candle is burnt? Is it possible to get this wax back?
- State any two reasons why you consider a particular fuel best.
- What really is an explosion?
- What is the middle zone of a burning candle known as? Why?
- What holds the flame of the candle?
- Why is domestic fuel known as LPG? What do the letters stand for?
- Mention any two cost effective ways of cooking.
- What do you mean by calorific value?
- Differentiate between luminous and non-luminous flame?
- What do you mean by ignition temperature of a substance?
- What is the difference between a combustible and non combustible substance?
- How does a forest catch fire?

## LONG ANSWER TYPE QUESTIONS

1. What are the characteristic of a 'good' fuel?
2. Explain the different zones of a candle with the help of a well-labelled diagram.
3. How did Michael Faraday describe the formation of a beautiful cup in a burning candle?
4. Discuss the various type of gaseous fuels.
5. Petrol does not catch fire on its own at room temperature. Why?
6. Wet paper do not burns while a dry paper catches fire easily. Why?
7. What are the conditions necessary for combustion to take place?
8. Describe the different types of combustion, giving suitable examples.
9. How can we best manage energy sources?
10. What is slow combustion? Explain with at least two suitable examples supported by equations representing the reaction.

## OBJECTIVE

## ANSWER KEY

## EXERCISE-1

## For Summative Assessment

1. D 2. A 3. B 4. C 5. B 6. B 7. A 8. B 9. B 10. D 11. C 12. C 13. C 14. D 15. D

## Fill in the blanks

1. Unburnt carbon, particles smoke 2. Carbon, hydrogen 3.  $2P_2O_5$  4. Glass, Iron 5. Combustible  
6. Four 7. LPG 8. Three 9. Dark 10. Pollution 11. Kindling temperature 12. Water

## True/False

1. T 2. F 3. F 4. T 5. T 6. T 7. T 8. F 9. T 10. T 11. T 12. F 13. F 14. F 15. F

## Match the column

1. (1) → (x), (2) → (i), (3) → (viii), (4) → (ii), (5) → (iii), (6) → (ix), (7) → (iv), (8) → (v), (9) → (vi), (10) → (vii).  
2. (1) → (iv), (2) → (v), (3) → (i), (4) → (ii), (5) → (iii)

1. Which of the following is not the attribute of a good fuel?  
(A) Low calorific value (B) Moderate rate of combustion  
(C) Fairly cheap and easily available (D) Safe to handle, store, and transport
2. Calorific value of a fuel may be defined as :  
(A) The amount of heat produced when 1 kg of a fuel is completely burnt  
(B) The amount of heat produced when 1g of a fuel is completely burnt  
(C) The amount of heat produced when 10 g of a fuel is completely burnt  
(D) The amount of heat produced in kilojoules when 1 g of a fuel is completely burnt
3. Which of the following fuels has the highest calorific value?  
(A) Petrol (B) Hydrogen (C) LPG (D) Natural gas
4. In which zone of a candle flame does complete combustion take place?  
(A) Inner (B) Outer (C) Middle (D) All three zones
5. Which of the following is not a necessary condition of combustion?  
(A) Presence of combustible substance (B) Presence of a supporter of combustion  
(C) Attainment of ignition temperature of the fuel (D) Presence of carbon dioxide.
6. A luminous flame appears :  
(A) Red (B) Green (C) Yellow (D) Blue
7. Which one of the following is a non-combustible substance?  
(A) Coal (B) Iron (C) Straw (D) Wood
8. Which zone is hotter than luminous zone?  
(A) Non-luminous zone (B) Dark zone (C) Blue zone (D) None of these
9. Water cannot be used in :  
(A) Oil fire (B) Forest fire (C) Building fire (D) Electrical fire
10. Which is a zone of no combustion?  
(A) Blue zone (B) Dark zone (C) Luminous zone (D) All of the above
11. Which is not used as a fire extinguisher?  
(A) Water (B) Carbon dioxide (C) Oxygen (D) All of the above
12. Glass is :  
(A) Non-combustible (B) Combustible (C) None of these (D) All of the above
13. Camphor  
(A) Vaporizes in air (B) Condenses in air (C) Both (A) & (B) (D) None of these
14. Carbon monoxide burns with :  
(A) No flame (B) Yellow flame (C) Blue flame (D) All of the above
15. For combustion reactions :  
(A) Air is essential (B) Combustible substance is essential  
(C) Both (A) & (B) (D) None of these
16. Dark zone is :  
(A) Visible (B) Invisible (C) Green in colour (D) None of these

**FILL IN THE BLANKS**

1. Burning of wood and coal causes \_\_\_\_\_ of air.
2. A liquid fuel used in homes is \_\_\_\_\_
3. Fuel must be heated to its \_\_\_\_\_ before it starts burning.
4. Fire produced by oil cannot be controlled by \_\_\_\_\_
5. The combustion caused by gas is known as \_\_\_\_\_ combustion.
6. \_\_\_\_\_ substances have a low ignition temperature.
7. \_\_\_\_\_ wax burns in a candle flame.
8. Combustion does not take place in the \_\_\_\_\_ zone of the candle flame.
9. Burning of white phosphorus is an example of \_\_\_\_\_ combustion.
10. Respiration is a type of \_\_\_\_\_ combustion.

**MARK 'T' IF THE STATEMENT IS TRUE AND 'F' IF IT IS FALSE**

1. Incomplete combustion of wax vapours take place in the outer zone of the candle flame.
2. The outer zone of the candle flame is also known as luminous zone.
3. Carbon soot and carbon monoxide are produced during incomplete combustion of hydrocarbon fuels.
4. Water is a combustible substance.
5. Wood is a combustible substance.
6. Oxygen is a supporter of combustion.
7. Combustion is a chemical process in which a substance reacts to give off heat.
8. Combustion cannot take place in the sun since there is no air in the sun.
9. Usually substances catch fire at one fixed temperature.
10. The substances which have very high ignition temperature are called inflammable substances.
11. The combustion in which a substance burns rapidly and produces heat and light is called rapid combustion.

**MATCH THE COLUMN-A WITH COLUMN-B**

- | 1.  | Column-A                  |     | Column-B       |
|-----|---------------------------|-----|----------------|
| (1) | Acid Rain                 | i   | $\text{CO}_2$  |
| (2) | Supporter of Combustion   | ii  | Global warming |
| (3) | $\text{CO}_2$             | iii | Ironrails      |
| (4) | Inflammable substance     | iv  | Matchsticks    |
| (5) | Combustible substance     | v   | Petrol         |
| (6) | Non-combustible substance | vi  | $\text{O}_2$   |

**VERY SHORT ANSWER TYPE QUESTIONS**

1. Name two liquids which have low ignition temperature.
2. Name two non-combustible substances.
3. Name two combustible substances.
4. Which gas is evolved after burning of coal and diesel ?
5. Which gas is evolved in incomplete combustion ?
6. What is the colour of the innermost zone of a candle flame ?
7. In which season dry grass catches fire ?
8. Name two inflammable substances.
9. Write the name of essential requirements for producing fire ?
10. Why LPG produce more heat than other fuel ?

**SHORT ANSWER TYPE QUESTIONS**

1. Define the following terms : ignition temperature, calorific value of fuels, and combustion.
2. Differentiate between combustible and non-combustible substances.
3. What are the three conditions necessary for combustion?
4. List some measures by which you can conserve energy
5. Name the petroleum product used for making candles.
6. What is a flame? List the differences between luminous and non-luminous flames.
7. Describe the various zones of a candle flame with the help of a neat, labelled diagram.
8. Differentiate between rapid and slow combustion.
9. Give two examples each for solid fuels, liquid fuels, gaseous fuels, and inflammable substances.
10. Write four characteristics of an ideal fuel.
11. Give two examples of non-renewable sources of energy.
12. Give two examples of renewable sources of energy. Explain why they are considered renewable.
13. Hydrogen has the highest calorific value. Still, it cannot be used for domestic cooking purposes. Why?
14. How does burning of fossil fuels contribute towards air pollution?

**LONG ANSWER TYPE QUESTIONS**

1. What is a fuel? What are the requirements of a good fuel?
2. How are fuels classified? Explain with examples.
3. Give the method of preparation of any two gaseous fuels.
4. How is petroleum refined? What are the various fractions obtained during the refining process? Mention their uses.
5. Under what conditions do combustion reactions take place?
6. What are the different types of combustion? Explain briefly.
7. Draw a neat labelled diagram of a candle flame and explain the various parts.
8. One of the characteristics of an ideal fuel is that it should have a moderate rate of combustion. What will happen if it has a high or a low rate of combustion?
9. A wet cotton handkerchief soaked in alcohol will not catch fire even it is set fire to? Why?
10. Why does a flame always point upwards on earth, but is spherical in space?

**OBJECTIVE****ANSWER KEY****EXERCISE-2****For Summative Assessment**

1. A 2. A 3. B 4. B 5. D 6. C 7. B 8. C 9. D 10. B 11. C 12. A 13. A 14. B 15. C 16. B

**Fill in the blanks**

1. Pollution 2. LPG 3. Kindling temperature 4. Water 5. Spontaneous 6. Inflammable 7. Vapour of  
8. Dark 9. Spontaneous 10. Slow

**True/False**

1. F 2. F 3. T 4. F 5. T 6. T 7. T 8. T 9. T 10. F 11. T

**Match the column**

1. (1) → (i), (2) → (vi), (3) → (ii), (4) → (v), (5) → (iv), (6) → (iii)

1. List conditions under which combustion can take place.

**Ans.** There are three essential conditions of combustion:

- Ⓐ Presence of a combustible substance.
- Ⓑ Presence of oxygen, i.e., supporter of combustion.
- Ⓒ Attainment of ignition temperature.

2. Fill in the blanks:

- Ⓐ Burning of wood and coal causes ..... of air.
- Ⓑ A liquid fuel, used in homes is .....
- Ⓒ Fuel must be heated to its ..... before it starts burning.
- Ⓓ Fire produced by oil cannot be controlled by .....

**Ans.** (a) Pollution (b) LPG (c) Ignition temperature (d) Water.

3. Explain how the use of CNG in automobiles has reduced pollution in our cities.

**Ans.** CNG is cheap, readily available and highly combustible. It has high calorific value.

It does not produce gases or residues when used in automobiles, so it reduced the pollution in our cities.

The use of CNG in automobiles has reduced pollution in our cities because CNG produces the harmful product in very small amount and it is a cleaner fuel.

4. Compare LPG and wood as fuels.

**Ans.**

<i>LPG</i>	<i>Wood</i>
1. No residue after burning.	1. Leave a lot of ash on burning.
2. Can be transport through pipe lines, and cylinder.	2. Cannot be transport easily like LPG.
3. Burn easily.	3. Catch fire with more difficulty.
4. Low ignition temperature.	4. High ignition temperature.
5. No smoke on burning.	5. Burn with smoke.

5. Give reasons:

- Ⓐ Water is not used to control fires involving electrical equipment.
- Ⓑ LPG is a better domestic fuel than wood.
- Ⓒ Paper by itself catches fire easily whereas a piece of paper wrapped around an aluminium pipe does not.

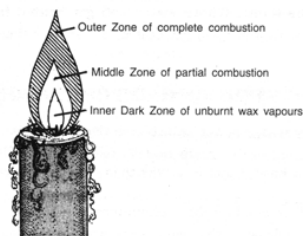
**Ans.** Ⓐ Water is not used to control the fire involving electric equipment because it is a good conductor of electricity and harm those trying to douse the fire.

Ⓑ LPG is better domestic fuel than wood because it neither produce gases nor residues that pollute the environment.

Ⓒ The paper by itself catches fire easily because its ignition temperature is low, while a piece of paper wrapped around an aluminium pipe does not catches fire, because its ignition temperature rises.

6. Make a labelled diagram of a candle flame.

**Ans.**



**Fig.** Different zones of a candle flame



7. Name the unit in which the calorific value of a fuel is expressed.

**Ans.** The calorific value of a fuel is expressed in a unit called kilojoule per kg (kJ/kg).

8. Explain how  $\text{CO}_2$  is able to control fires.

**Ans.**  $\text{CO}_2$ , being heavier than oxygen, covers the fire like blanket and also brings down the temperature of fuel. Since the contact between the fuel and oxygen is cut off, the fire is controlled.

9. It is difficult to burn a heap of green leaves but dry leaves catch fire easily. Explain.

**Ans.** To burn a heap of green leaves is difficult, because its ignition temperature is high, but dry leaves catch fire easily as its ignition temperature switches to low.

10. Which zone of a flame does a goldsmith use for melting gold and silver and why?

**Ans.** A goldsmith uses the outermost zone of a flame for melting gold and silver because it is the hottest zone of the flame (temperature  $\approx 800^\circ\text{C}$ ) and is non-luminous in nature.

11. In an experiment 4.5 kg of a fuel was completely burnt. The heat produced was measured to be 180,000 kJ. Calculate the calorific value of the fuel.

**Ans.** The calorific value of the fuel:

$$\text{Calorific value} = \frac{\text{kJ}}{\text{kg}} = \frac{180,000}{4.5} \text{ kJ/kg} = 40,000 \text{ kJ/kg}.$$

12. Can the process of rusting be called combustion? Discuss.

**Ans.** The process of rusting cannot be called as combustion because neither release of energy nor heat and light are produced during it, while in combustion- release of energy takes place with heat and light.

13. Abida and Ramesh were doing an experiment in which water was to be heated in a beaker. Abida kept the beaker near the wick in the yellow part of the candle flame. Ramesh kept the beaker in the outermost part of the flame. Whose water will get heated in a shorter time?

**Ans.** Ramesh's water will get heated in a shorter time.

#### IMPORTANT QUESTIONS

1. Why water is not suitable as fire extinguisher for fires involving oil and petrol?

**Ans.** As we know, water is heavier than oil so it sinks below the oil and oil keep burning on the top.

2. Define combustible substances.

**Ans.** The substance that can reacts with oxygen and gives off heat and light i.e., undergo combustion, is called combustible substances.

3. With the help of given table, mark the combustible and non-combustible substances of your daily life.

<i>Material</i>	<i>Combustible/Non-combustible</i>
Wood	
Paper	
Iron nails	
Kerosene oil	
Stone piece	
Straw	
Charcoal	
Match sticks	
Glass	

Ans.

<i>Material</i>	<i>Combustible/Non-combustible</i>
Wood	Combustible
Paper	Combustible
Iron nails	Non-combustible
Kerosene oil	Combustible
Stone piece	Non-combustible
Straw	Combustible
Charcoal	Combustible
Match stick	Combustible
Glass	Non-combustible

4. Why we wrap a blanket around a person who caught fire?

Ans. We wrap a blanket around a person who caught fire, because the fire stops getting the oxygen in required amount for combustion and it extinguishes.

5. In what form (solid, liquid, gas) carbon dioxide be stored in cylinders?

Ans. Carbon dioxide can be stored as a liquid in cylinders.

6. With the help of an experiment, show that oxygen (air) is necessary for the burning of a candle.

Ans. To show the experiment we have to fix three lighted candle on a table, and put a glass chimney over it.

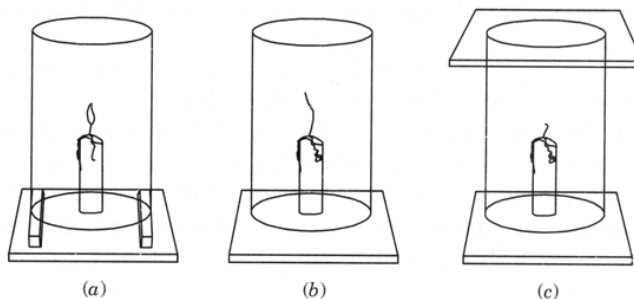


Fig. Showing that air is essential for burning

The chimney (Fig. a) rested on wooden blocks in such a way that air can enter the chimney-the candle will continue burning, because air can enter the chimney from below.

The chimney (Fig. b) rested on the table with no way for air-the flame flickers and produces smoke.

The chimney (Fig. c) rested on table and covered from top with glass plate-the flame goes off because the air is not available.

7. What do you mean by inflammable substances?

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

8. What is rapid combustion?

Ans. A combustion that takes place at a high speed is known as rapid combustion.

9. What is spontaneous burning?

Ans. In a heap of several substances, when they catches fire, they undergo slow oxidation with evolution of heat. At certain stage when the temperature becomes more than the ignition temperature of anyone of the constituent- all of a sudden, it starts burning. This is called spontaneous burning.

10. Give the characteristics of Ideal fuel?

- Ans.**
1. It is readily available.
  2. It is cheap.
  3. It burns easily at moderate rate.
  4. It produces a large amount of heat.
  5. It does not leave behind any undesirable substances.

11. Charcoal does not burn with flame but glows only.

**Ans.** Charcoal does not burn with flame because it is not volatile in nature or does not vapourise on burning, so it glows only.

12. What is meant by the term 'fuel'?

**Ans.** A fuel is a substance, which may be burnt to produce considerable heat without the formation of undesirable products.

13. Why we are advised never to sleep in a room with burning coal fire in it?

**Ans.** The carbon monoxide gas produced by incomplete combustion of coal can kill persons sleeping in that room because it is a poisonous gas.

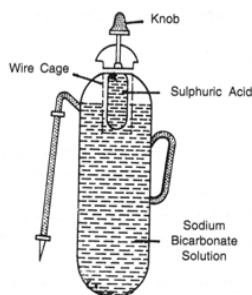
14. Why water is not used to control the fire by electric short circuit? **Ans.** Water is not used at all to control the fire by electric short circuit because it is a good conductor of electricity and may result in electrocution or electric shock.

15. What are the constituents of a foam type fire extinguisher?

**Ans.** The foam type fire extinguisher is also called as 'Soda acid' fire extinguisher. The constituents are:

- Ⓐ Dilute sulphuric acid                      Ⓑ Sodium bicarbonate (soda).

When it is operated, it comes out under pressure in the form of a foam, which covers the surface of fire and controls it.

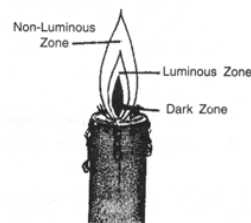


**Fig.** Foam type fire extinguisher

16. Describe the various zones of a flame.

**Ans.** A flame has four zones in it:

- Ⓐ The outermost thin transparent faint bluish nonluminous region of complete combustion. It is the hottest zone of the flame.
- Ⓑ The middle bright luminous zone of partial combustion. It is the moderately hot zone.
- Ⓒ The innermost, coldest dark zone, consists of hot vapour and called as zone of no combustion.
- Ⓓ Blue zone near the bottom of the flame is due to burning of CO. CO is formed due to incomplete combustion.



**Fig.** Different zones of a candle flame

17. What are the different harmful products formed by the burning of a fuel?

**Ans.** The harmful product formed by the burning of a fuel:

1. Carbon fuels release unburnt carbon particles. These fine particles are dangerous pollutants causes respiratory problems.
2. Incomplete combustion of carbon fuels gives carbon mono oxide a poisonous gas that can even kill a person sleeping in a closed room.

18. Explain the term "global warming".

**Ans.** The combustion of fuels release carbon dioxide in the environment. When the percentage of carbon dioxide increases in the air and makes the earth surface hot-it is believed to cause global warming.

19. What is acid rain?

**Ans.** The gases like nitrogen oxide, sulphur dioxide etc. present in the atmosphere as pollutants when these gases dissolve in rain water and form acids and reaches to the earth as rain called as acid rain.

20. Why CNG is preferable for vehicles in respect to petrol and diesel?

**Ans.** CNG (compressed natural gas) is preferable for vehicles in respect to petrol and diesel, because:

- (a) It leaves least residues.      (b) It is cheaper.      (c) It is eco-friendly.

21. Why any of the fuel is not considered as an ideal fuel?

**Ans.** The fuel is not considered as an ideal fuel because all the fuels are differ in their cost and efficiency, i.e., its calorific value.

22. "Food is a fuel for our body". Explain how?

**Ans.** In our body, food is broken down by reaction with oxygen and heat is produced that is why food is a type of fuel for our body.

23. What chemicals are used in the preparation of matchsticks?

**Ans.** The head of safety match contains only antimony trisulphide and potassium chlorate.

24. Which have higher ignition temperature - kerosene oil or wood.

**Ans.** The kerosene oil has lower ignition temperature than wood.

25. What are the three essential requirements for producing fire?

**Ans.** The three essential requirements are

- (i) Fuel                      (ii) Air (to supply oxygen)  
(iii) Heat (to raise the temperature of the fuel beyond the ignition temperature).
-