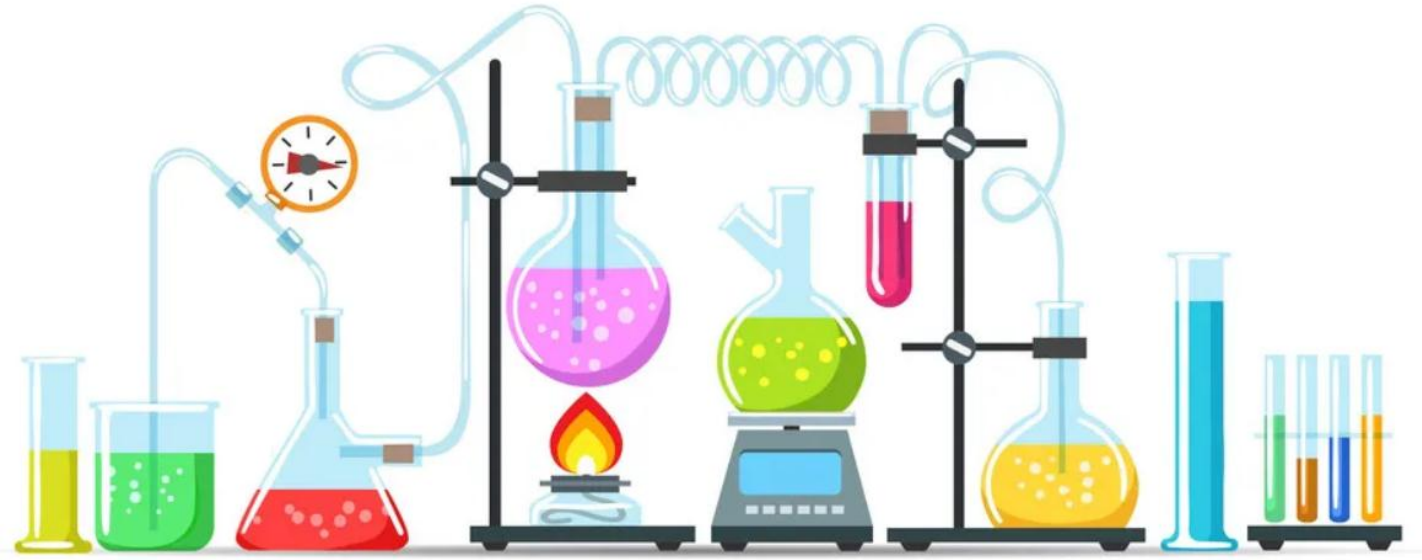
SCIENCE

Chapter 6: Combustion and Flame



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Combustion and Flame

Combustion

- A chemical process in which a substance reacts with the oxygen of the air to give heat and light is called combustion.
- The substance which undergoes combustion is said to be combustible and is called a fuel.
- The fuel may be a solid, liquid or gas.
- During combustion, light is also given off sometimes, either as a flame or as a glow. Example:
  Magnesium burns in the air and combines with oxygen to form magnesium oxide, liberating heat and light.

$$\text{Magnesium} + \text{Oxygen} \xrightarrow{\text{Combustion}} \text{Magnesium oxide} + \text{Heat} + \text{Light}$$

Combustible and Non-combustible Substances

Combustible substances: Substances which undergo combustion or burn are called combustible substances.

Examples: Paper, cloth, cooking gas (LPG), CNG, kerosene oil, wood, charcoal

Non-combustible substances: Substances which do not undergo combustion are called non-combustible substances.

Examples: Stones, cement, bricks, soil, sand, water, iron nails

Conditions Necessary for Combustion

- Presence of a combustible substance (a substance which can burn)
- Presence of a supporter of combustion (like air or oxygen)
- Heating the combustible substance to its ignition temperature

Ignition Temperature and Inflammable Substances

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.

Examples: Petrol, alcohol, liquefied petroleum gas (LPG)

How Do We Control Fire?

Fire can be extinguished in three ways:

Remove the Fuel

- Fuel is a food for fire. So, when a fire starts, all the combustible materials should be removed so that the fire does not spread.

Remove the Heat

- The most common fire extinguisher is water, but it works for ordinary fires.
- When water is thrown on a burning substance, it gets cooled below its ignition temperature and stops burning.
- If electrical equipment is on fire, water may conduct electricity and can give electric shock to people involved in fire fighting.
- Water is also not suitable for fires involving oil and petrol. Because water is heavier than oil, it sinks below the oil and the oil keeps on burning at the top.

Cut off the Air Supply

- For fires involving electrical equipment and inflammable materials such as petrol, carbon dioxide is the best extinguisher.
- Being heavier than oxygen, carbon dioxide covers the fire like a blanket.
- As a result, the contact between the fuel and oxygen is cut off and the fire is controlled.

Carbon Dioxide

- Carbon dioxide is stored at high pressure as a liquid in cylinders.
- On releasing it from the cylinder, it expands enormously in volume and cools down.
- It forms a blanket around the fire and brings down the temperature of the fuel. So, it is an excellent fire extinguisher.
- CO_2 is also produced by releasing a lot of dry powder of chemicals such as sodium bicarbonate or potassium bicarbonate. Near the fire, these chemicals give off CO_2.

Types of Combustion

Rapid Combustion

The reaction in which a large amount of heat and light are produced in a short period of time is called rapid combustion.
Example: Burning of LPG in a gas stove to give heat and light is an example of rapid combustion.

Spontaneous Combustion

The reaction which occurs on its own is called spontaneous combustion.

Example: Burning of phosphorus on its own at room temperature is an example of spontaneous combustion.

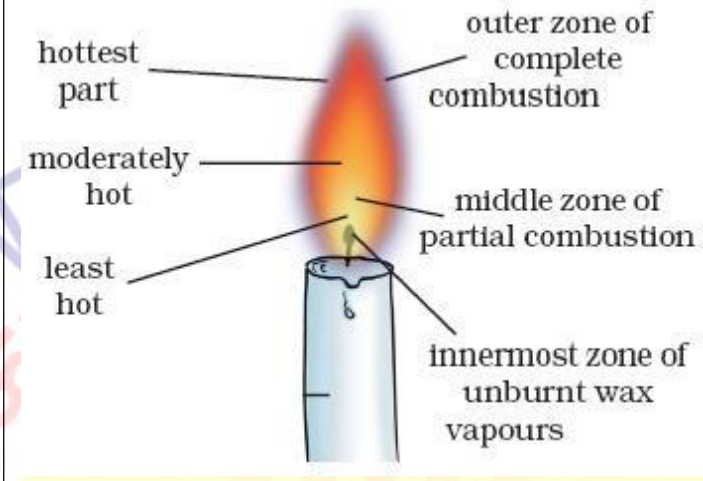
Explosive Combustion

A very fast combustion in which a large amount of heat, light and sound are produced is called explosive combustion.

Example: Bursting of crackers during festivals is an example of explosive combustion.

Flame and Structure of Flame

A flame is a region where the combustion or burning of gaseous substances takes place along with the evolution of heat and light.



Different zones of candle flame

Inner zone

- This is the dark zone which lies around the wick of the candle.
- It is the innermost zone of the flame.
- This zone contains unburnt vapours of wax.
- As there is no air available in this zone, no combustion takes place. Therefore, it is the least hot part of the flame.

Luminous middle zone

- The middle zone is the brightest zone of the flame.
- In this zone, there is an inadequate supply of air.
- Therefore, there is an incomplete combustion of wax vapours, resulting in the formation of carbon monoxide and unburnt carbon particles.
- These unburnt carbon particles glow and produce a yellow flame. This zone is moderately hot.

Non-luminous zone

- The outermost zone of the flame is called the zone of complete combustion.
- In this zone, the complete combustion of wax vapours takes place, forming carbon dioxide and water vapour.
- This is the hottest zone of the flame.
- It is also referred to as the non-luminous zone.

Blue zone

- At the bottom of the flame lies a blue zone.
- The blue colour is due to the burning of carbon monoxide produced in the zone of

incomplete combustion of carbon.

Fuels

- The material which is burnt to produce heat is called a fuel.
  Examples: Wood, coal, LPG, kerosene, petrol, diesel, natural gas and biogas are some common fuels.
- There are three types of fuels:
  - ✓ Solid fuels
  - ✓ Liquid fuels
  - ✓ Gaseous fuels

Characteristics of Ideal Fuel

- It has a high calorific value.
- It burns easily in air at a moderate rate.
- It has a proper ignition temperature.
- It does not produce any harmful gases or leaves behind any residue after burning.
- It is cheap, readily available and easy to transport.

Fuel Efficiency

- Different fuels produce different amounts of heat on burning.
- The amount of heat produced by the complete burning of 1 kilogram of a fuel is called its calorific value.
- The calorific value of a fuel is expressed in the unit of kilojoules per kilogram.

Burning of Fuels Leads to Harmful Products

- The burning of fuels such as wood, coal and petroleum products releases unburnt carbon particles in the air. These fine particles are dangerous pollutants which can cause respiratory diseases such as asthma.
- The incomplete combustion of fuels produces a very poisonous gas called carbon monoxide. Excessive inhaling of carbon monoxide can kill a person.
- Burning of fuels releases carbon dioxide into air in the environment. The increased percentage of carbon dioxide in the air causes global warming.
- Burning of coal and diesel releases sulphur dioxide gas. It is an extremely suffocating and

corrosive gas. Moreover, petrol engines give off gaseous oxides of nitrogen. Oxides of sulphur and nitrogen dissolve in rainwater and form acids. Such rain is called acid rain.
The use of diesel and petrol as fuels is being replaced by CNG because it is a cleaner fuel and produces lesser amount of harmful products.

Combustible Substances and fuel

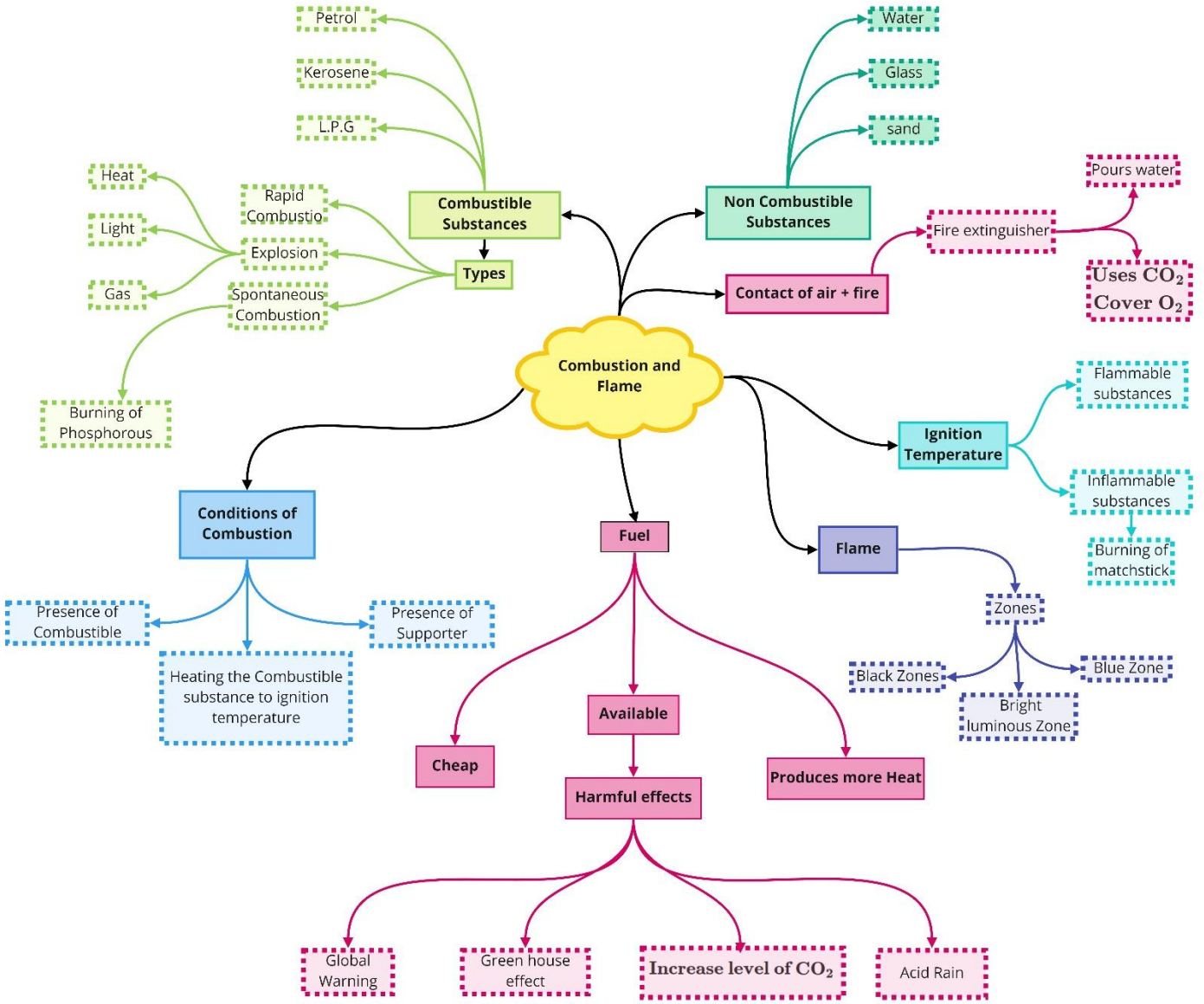
- A fuel is a substance that is burnt to provide heat .
- The substances which burn easily and causes a fire are called combustible or inflammable substances.
- Fuel come in different forms. Fuels are of different types such as
  - ✓ wood
  - ✓ coal
  - ✓ charcoal
  - ✓ petrol
  - ✓ diesel
  - ✓ Compressed natural gas (CNG) and
  - ✓ liquified petroleum gas (LPG)
- Petrol is a highly combustible substance and the most commonly used inflammable substance.

Non-Combustible substances

Material	Combustible/ Non-combustible
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

The substances which don't burn are called non-combustible substances or non-inflammable substances. For example -Stone, Glass, Iron, nails.

Class : 8th Science
Chapter.6 Combustion and Flame



Important Questions

Multiple Choice Questions-

Question 1. Which of the following fuel produces ash on burning?

(a) wood

(b) LPG

(c) petrol

(d) diesel

Question 2. The zone of a flame used by goldsmith for melting gold and silver is:

(a) innermost zone

(b) middle zone

(c) outermost zone

(d) all of these

Question 3. Can the process of rusting he called combustion?

(a) yes

(b) no

(c) can't say

(d) none of these

Question 4. Is heat and light produced by Sun a combustion process?

(a) yes

(b) no

(c) can't say

(d) none of these

Question 5. Heat and light produced in the sun is by:

(a) combustion

(b) nuclear reactions

(c) burning

(d) none of these

Question 6. Ignition temperature is the:

(a) temperature at which a substance catches fire

(b) highest temperature at which a substance catches fire

(c) lowest temperature at which a substance catches fire

(d) none of these

Question 7. Which of them can be easily burnt with the help of a matchstick?

(a) wooden chips

(b) straw

(c) wooden log

(d) all of them

Question 8. A mgtchstjck does not catch fire on its own at room temperature because its:

(a) ignition temperature is more than room temperature

(b) ignition temperature is less than room temperature

(c) ignition temperature is same as room temperature

(d) none of these

Question 9. Which of the following gas extinguishes fire:

(a) oxygen

(b) hydrogen

(c) carbon dioxide

(d) nitrogen

Question 10. Combustion that takes place at a very fast rate is called:

(a) rapid combustion

(b) spontaneous combustion

(c) explosion

(d) none of these

Question 11. The coldest zone of candle is:

(a) the middle zone

(b) the innermost zone

(c) the outermost zone

(d) none of these.

Question 12. Smoke contains:

(a) unburnt carbon particles

(b) burnt carbon particles

(c) unburnt sulphur particles

(d) unburnt lead particles.

Question 13. The colour of the non-luminous zone is:

(a) white

(b) yellow

(c) blue

(d) black

Question 14. Which of the following fuel has the highest calorific value:

(a) cow dung cake

(b) Wood

(c) coal

(d) Petrol

Question 15. The fuel which replaces use of diesel and petrol as fuels in automobiles is:

(a) LPG

(b) biogas

(c) CNG

(d) none of these

Very Short:

1. What are fuels?
2. Name two fuels that are used in your homes.
3. What fuels are used for running automobiles?
4. What is the full form of CNG?
5. What is the difference between burning of a candle and burning of coal?

6. Classify the fuels.

7. What are combustible substances?

8. Do all the fuels burn with a flame?

9. What are the products of combustion?

10. Name some combustible substances.

Short Questions:

1. State the difference between burning of a candle and burning of a fuel like coal
2. Explain combustion and combustible along with examples.
3. Food is a fuel for the body. Justify this statement.
4. Identify the materials in which combustion can take place Wood, paper, kerosene oil, iron nails, brick, stone, charcoal.
5. On putting glass over a lighted candle, the candle flame flickers and produce smoke, why so?
6. What is acid rain? Write its effects.
7. When the clothes of a person catch fire, the person is covered with a blanket to extinguish fire, explain why?
8. What is forest fire?
9. What do you mean by ignition temperature? Why a matchstick dose not catch fire on its own at room temperature?
10. Why does the matchstick start burning on rubbing it on the side of matchbox?

Long Questions :

Question 1. Why isn't hydrogen gas used as a domestic or industrial fuel, although it has a very high calorific value? State three reasons for the answer.

Question 2. Explain how water gets boiled in paper cup without burning it.

Question 3. Why does a piece of paper burn with yellow flame? Give a reason.

Question 4. It is observed at petrol pumps and airports, that hydrocarbon fire extinguishers are used, instead of soda-acid fire extinguisher. Give reasons why.

Question 5. Explain complete combustion.

Answer

MCQ

1. Answer

(a) wood

Wood produces ash on burning.

2. Answer

(c) outermost zone

The zone of a flame used by goldsmith for melting gold and silver is outermost zone because it is the hottest zone.

3. Answer

(a) yes

Yes, the process of rusting can be called combustion because it produces heat.

4. Answer

(b) no

No, heat and light produced by sun is not a combustion process.

5. Answer

(b) nuclear reactions

Heat and light produced in the sun is by nuclear reactions.

6. Answer

(c) lowest temperature at which a substance catches fire

Ignition temperature is the lowest temperature at which a substance catches fire

7. Answer

(b) straw

Straw can be easily burnt with the help of a matchstick because the ignition temperature of straw is very less and heat produced from lighted matchstick is more than the ignition temperature of straw and therefore it starts burning.

8. Answer

(a) ignition temperature is more than room temperature

A matchstick does not catch fire on its own at room temperature because its ignition temperature is more than room temperature.

9. Answer

(c) carbon dioxide

Carbon dioxide gas extinguishes fire.

10. Answer

(a) rapid combustion

Combustion that takes place at a very fast rate is called rapid combustion.

11. Answer

(b) the innermost zone

The coldest zone of candle is the innermost zone.

12. Answer

(b) burnt carbon particles

Smoke contains unburnt carbon particles.

13. Answer

(c) blue

The colour of the non-luminous zone is blue.

14. Answer

(d) Petrol

Petrol has higher calorific value than petrol.

15. Answer

(c) CNG

CNG has replaced use of diesel and petrol as fuels in automobiles because it is non-pollutant fuel.

Very Short-

1. Answer: The substances which provide heat and light are called fuels.
2. Answer: (i) L.P.G (ii) Kerosene.
3. Answer: Petrol, diesel and CNG.
4. Answer: CNG stands for Compressed Natural Gas.
5. Answer: A candle burns with a flame whereas coal does not.
6. Answer: The fuels are classified into solid, liquid and gas.
7. Answer: The substances that undergo combustion are called combustible substances.
8. Answer: No, all the fuels do not burn with a flame.
9. Answer: Carbon dioxide, water vapour, heat and light.
10. Answer: Wood, paper, kerosene oil, charcoal etc.

Short Answer-

1. **Answer:** Candle burns with a flame but coal does not burn with a flame also coal is a carbon product and its burning is harmful for environment but candle is made from wax

its burning is not as much harmful as burning of coal.

2. **Answer:** The chemical process in which a substance reacts with oxygen to give off heat is called combustion. In combustion the release of heat can result in the production of light in the form of either glowing or a flame. The substance which undergoes combustion is called combustible or fuel. Fuel may be solid, liquid or gas.

   Example: Burning of a coal shows the process of combustion and coal here is combustible or fuel.

3. **Answer:** Food is a fuel for our body because inside our body food is broken down into simpler form by reaction with oxygen and with the release of heat and energy.

4. **Answer:** Wood, paper, kerosene oil, charcoal

5. **Answer:** Take two lighted candle A and B, and place them on a table, now put a transparent glass over candle B and see what happens to the candle B, we will observe that candle flame flickers and produces smoke and finally it goes off, this is because on putting glass over it, the air supply was cut off and candle was unable to burn in the absence of air.

6. **Answer:** The oxides of sulphur and nitrogen dissolve in rain water to form acids.

   Such rain containing acids is called acid rain. It is very harmful for crops, buildings and soil.

7. **Answer:** To cut off the air supply of the fire, so that the fire gets off and the person could be saved from fire.

8. **Answer:** A forest fire is a natural disaster consisting of a fire which destroys a forested area, and is dangerous for the people living in forest area as well as for the wildlife. During extreme heat of summer, at some places dry grass catches fire, the fire gets spread from grass to tree, and very soon whole forest catches fire. It is very difficult to control such fires.

9. **Answer:** The lowest temperature at which a substance catches fire or the lowest temperature at which combustion begins and continues in a substance is called its ignition temperature.

   Match Stick cannot catch fire on its own at room temperature because it can catch fire only at its ignition temperature not at room temperature.

10. **Answer:** The striking surface of the matchbox contains red phosphorus and the head of the matchstick contains potassium chlorate. So when the matchstick is rubbed on the matchbox, some of the red phosphorus is converted to white phosphorus, a chemical i.e. so volatile that it ignites in air.

Long Answer-

1. **Answer:**

Although hydrogen gas has a very high calorific value, it is not used as a domestic or industrial fuel due to the following reasons:

- It is expensive.
- It burns with an explosion.
- It is extremely inflammable, so it is risky to store and transport hydrogen.

2. Answer:

When we heat the paper cup containing water, the heat given to it is rapidly transferred to water from the paper cup. The temperature of water goes on increasing until it attains its boiling point, and starts boiling. As, during this process, the heat is continuously being transferred to water; the paper cup does not attain its ignition temperature. Hence, it does not burn.

3. Answer:

The inadequate supply of oxygen during the combustion of the piece of paper produces solid carbon particles that rise up in the flame. They become hot and glow to give off yellowish light. This makes the piece of paper burn with a yellowish flame.

4. Answer:

At petrol pumps and airports, there is more probability of fire break out due to oil. In such situations, soda-acid fire extinguisher does not work as it contains water or uses water to take off fire by cooling down the place. Water being heavier than oil sinks to bottom and hence, fire does not get controlled. In such a case, hydrocarbon fire extinguisher is very useful, as it contains turkey red oil, which causes the foaming of carbon dioxide gas under pressure. The foam covers the surface of the burning substances and dispels the supply of air to control fire.

5. Answer:

This type of combustion involves complete burning of the combustible substance. No residue is left behind. Ash or smoke is not given off during or after this type of combustion. Mostly gases, such as hydrocarbons go through this form of combustion. On combustion, hydrocarbon produces carbon dioxide, water, and heat.