MATRIX OLYMPIAD

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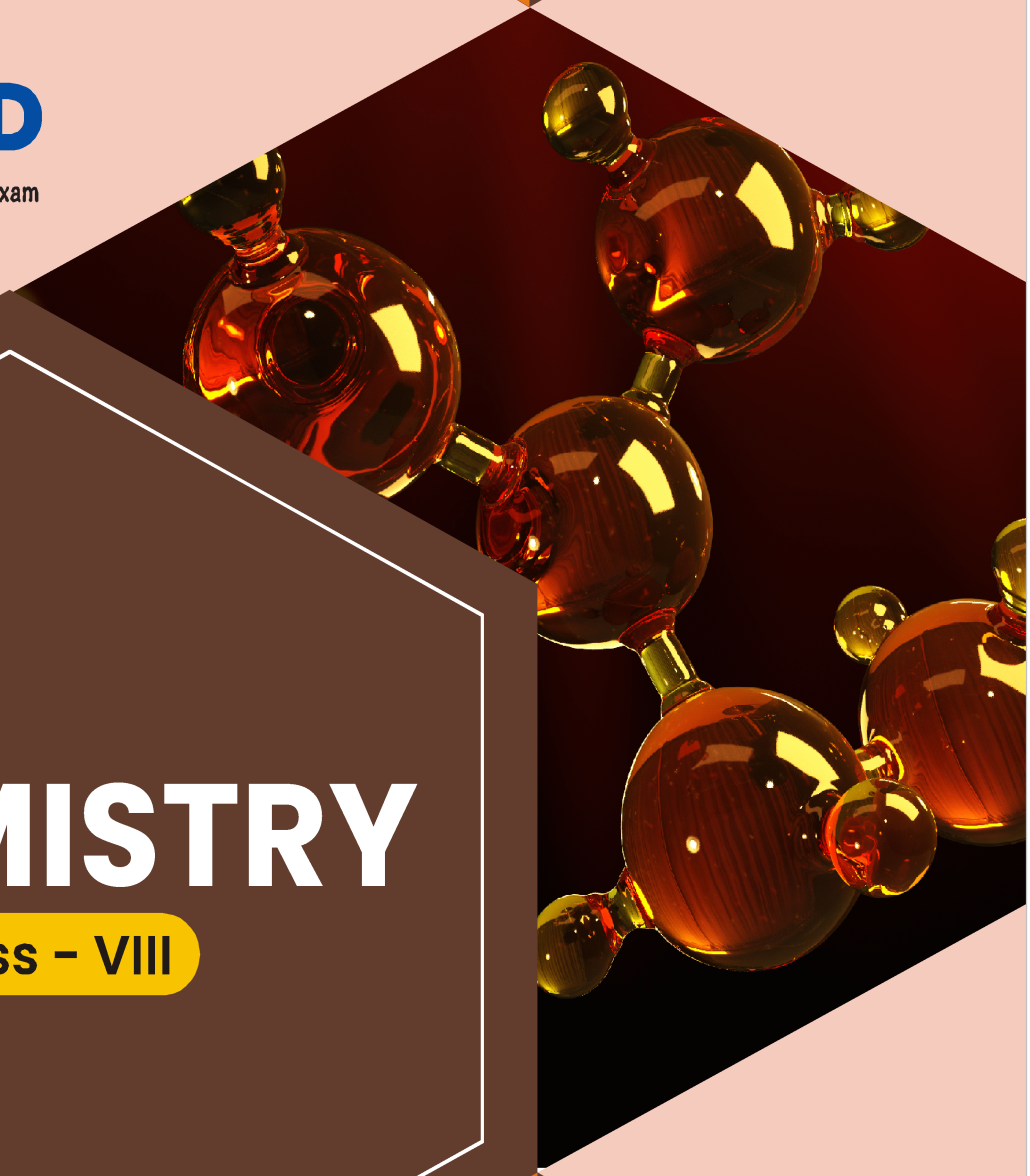

CHEMISTRY

Class - VIII

MATRIX

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Few words for the Readers

Dear Reader,

"*Matrix Olympiad is established to encourage school students to go a step further than their regular studies, and get a chance and exposure to competition on a wide scale. It also helps students enhance their learning of basic cognitive skills and deeper knowledge of subjects like Science, Mathematics, English, Mental Ability, Social Studies.“Matrix Olympiad helps students nurture their minds for higher targets of tomorrow and enables them to study School for JEE, NEET, CLAT, NDA, Olympiads , NSEJS, NTSE , STSE etc.*"

The above thought has been our guiding principle while designing and collating the study material for **Matrix Olympiad** . And hence, we hope that this particular material will be helpful towards your preparation for **Matrix Olympiad**.

Our team at **MATRIX** has put in their best efforts for making this particular module interesting and relevant for you. Additional efforts have been made to ensure that the content is easy to understand and error free to the extent possible. However, there might remain some inadvertent errors in answer keys and theoretical portion and we would welcome your valuable feedback regarding the same.

If there are any suggestions for corrections, please write to us at **smd@matrixacademy.co.in** and we would be highly grateful.

Finally, we would like to end this message by a famous quote by Ernest Hemingway - "*There is no friend as loyal as a book*." So, please give your study material the time and attention it deserves, and it will surely help you reach newer heights in your fight with competition examinations.

With love and best wishes !

Team MATRIX

CONTENTS

COMBUSTION AND FLAME

1

Concepts

Introduction

1. Combustion
2. Combustible and non-combustible substances
3. Products of combustion
4. Types of combustion
5. Conditions necessary for combustion
6. Flame
7. Fuels
8. Some commonly used fuels
   - 8.1 Hydrogen
   - 8.2 Compressed Natural Gas (CNG)
   - 8.3 Liquified Petroleum Gas (LPG)
9. Sun a source of energy
10. Fire Fighting

Solved Examples

NCERT Solutions

Exercise – I (Competitive Exam Pattern)

Exercise – II (Board Pattern Type)

Answer Key

INTRODUCTION

In everyday life, the process of burning is used for a variety of purpose. e.g. by the burning of LPG (Liquified Petroleum Gas), heat energy is produced which is used for different purposes like cooking of food.
For running vehicles, we use petrol or diesel oil. In factories, we use coal or fuel oil or natural gas.
The materials, such as wood, coke, LPG (Liquefied petoleum gas), petrol, diesel, natural gas have one property in common i.e, they produce heat on burning which is then put into different uses.
You are familiar with burning of a candle and a coal. The difference between the burning of a candle and the burning of a coal is, candle burns with flame whereas coal does not.
Let us study the chemical process of burning and the type of flame produced during this process.

1. COMBUSTION

Combustion is defined as the process of burning of a substance in the presence of air or oxygen with the liberation of heat and light.
Some substances, like magnesium catces fire and burns with a dazzling white flame when heated in air. Similarly, when a piece of paper is brought near candle flame, it burns, producing heat and light. The charcoal and coal burns in air producing carbon dioxide, heat and light.
"A chemical process in which a substance reacts with oxgen to give off heat is called **combustion**."
The substances which undergo combustion are known as combustible substances. It may also be called a fuel.

Figure : Burning of candles

Figure : Burning of wood

Focus Point

- The materials which produce heat energy on burning in air are called fuels.
- Combustion is one of the earliest chemical changes noted by humans.
- Food is a fuel for our body as it is broken down to simpler components on reaction with oxygen and heat is produced.
- It is not essential that light energy must be produced during combustion. Eg. Light and energy is not produced during combution of food.

2. COMBUSTIBLE AND NON-COMBUSTIBLE SUBSTANCES

(A) Combustible substances : Substances that burn in air or oxygen to produce heat and light are called combustible substances. They are also known as fuel.
E.g. LPG, kerosene, paper, cloth, wood etc. can be burnt. Hydrogen is a combustible gas.

(B) Non-combustible substances : Substances that do not burn in air or oxygen are called non-combustible substances.
E.g. Water, sand, glass, cement cannot be burnt. Carbon dioxide is a non-combustible gas.

LAB TIME
Let's Do & Learn

- **Objective :** To differentiate between combustible and non-combustible materials.
- **Method :** Collect some materials like straw, matchsticks, kerosene oil, paper, iron nails, stone pieces, glass, etc.
  Under the supervision of your teacher try to burn each of these materials one by one.
  If combustion takes place mark the material combustible, otherwise mark it as non-combustible.
- **Observation :**

Material	Combustible	Non-combustible
Wood	✓	
Paper	✓	
Iron nails		✓
Kerosene	✓	
Stone pieces		✓
Straw	✓	
Charcoal	✓	
Matchsticks	✓	
Glass		✓

- **Conclusion :** So we can conclude that for the combustion there must be a combustible substance.

3. PRODUCTS OF COMBUSTION

Products of combustion depend upon the nature of the combustible substance. Most of the fuels that we use are hydrocarbons. In combustion of hydrocarbons along with carbon dioxide and water, different forms of energy like heat, light etc. are also produced.

Focus Point

- Compounds of hydrogen and carbon are called hydrocarbons.
  E.g. LPG (main constituent is butane or C_4H_{10}), natural gas (methane or CH_4), petrol etc.
  When such fuels burn, the main products are carbon dioxide and water.
  E.g. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

4. TYPES OF COMBUSTION

(A) On the basis of rate of combustion, combustion can be broadly divided into following categories -

(i) Rapid combustion : Combustion in which a large amount of heat and light is released in a very short span of time.
E.g. Combustion of LPG.

(ii) Slow combustion : This type of combustion takes place very slowly and at low temperatures.
E.g. Respiration is an example of slow combustion.

(iii) Spontaneous combustion : The type of combustion in which a material suddenly bursts into flames without application of apparent cause.
E.g. Disastrous fire in coal mines, forest fires.
The chemical substance having low ignition temperature i.e. is very closed to room temperature start to burn on their own.
E.g. White phosphorus

(iv) Explosion
We generally have fireworks on festival days. When a cracker is ignited, a sudden reaction takes place with the evolution of heat, light and sound. A large amount of gas formed in the reaction is liberated. Such a reaction is called explosion. Explosion can also take place if pressure is applied on the cracker.

(B) On the basis of the amount of air supply and the products evolved, combustion can be classified in two types-

(i) Complete combustion : If the hydrocarbon fuels burn in sufficient amount of air or oxygen, then the combustion is known as complete combustion. Carbon dioxide, water, heat and light are the products of complete combustion.

(ii) Incomplete combustion : If the hydrocarbon fuels burn in insufficient amount of air or oxygen, then the combustion is known as incomplete combustion. Carbon monoxide, soot, water, heat and light are the main products of incomplete combustion.

5. CONDITIONS NECESSARY FOR COMBUSTION

The conditions necessary for combustion are as follows :

(i) Presence of combustible substance : Combustion is only possible if the substance is combustible.

(ii) Presence of supporter of combustion : Adequate supply of a supporter of combustion oxygen or air is essential for combustion.

(iii) Attainment of ignition temperature of the fuel : A substance begins to burn only after it has attained a certain minimum temperature or ignition temperature. This is the reason why a piece of wood has to be heated for some time before it catches fire.

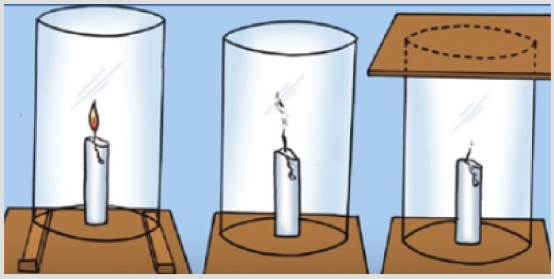
Focus Point

- Air contains 25% of O_2 by volume which is a supporter of combustion and 78% of N_2 and 1 % of noble gas by volume which are not the supporters of combustions.
- Rusting is a slow combustion.

LAB TIME
Let's Do & Learn

- **Objective:** Experiment to show that air is essential for burning.
- **Procedure :**

(i) Fix a lighted candle on a table. Put a glass chimney over the candle and rest it on a few wooden blocks in such a way that air can enter the chimney [Fig – (a)]. Observe what happens to the flame.
(ii) Now remove the blocks and let the chimney rest on the table. [Fig. (b)]. Again observe the flame.
(iii) Finally, put a glass plate over the chimney [Fig. (c)]. Watch the flame again.



(a) (b) (c)

Experiment to show that air is essential for burning

- **Observations:**

(i) The candle burns freely in case (a) when air can enter the chimney from below.
(ii) In case (b), when air does not enter the chimney from below, the flame flickers and produces smoke.
(iii) In case (c), the flame finally goes off because the air is not available at all.

- **Conclusion :** Air is necessary for combustion.

Focus Point

Inflammable substances : Substances that have low ignition temperature, catch fire easily. Such substances are known as inflammable substances. e.g. LPG, petrol, alcohol, nylon fibres etc.

(A) Petrol

(B) L.P.G gas cylinder

(C) Alcohol

♦ **Ignition temperature**

The minimum temperature at which a particular substance burns in the presence of air is called its ignition temperature. Ignition temperature is also called KINDLING temperature.

It is the minimum temperature to which a combustible substance must be heated, before it catches fire. Therefore, we see that a combustible substance cannot catch fire long as its temperature is lower than its ignition temperature e.g. Ignition temperature of phosphorus is 35º C. So, unless phosphorus is heated to 35ºC, it will not catch fire. However, if temperature of air is 35ºC or more, phosphorus will catch fire without heating. Similarly, kerosene oil and wood do not catch fire on their own at room temperature. But if both are heated a little, than kerosene oil will catch fire and not wood. This shows that ignition temperature of kerosene oil is lower than that of wood. Lets see the following activity which shows that a substance cannot burn untill it reaches its ignition temperature.

LAB TIME
Let's Do & Learn

• **Objective :** To show that minimum temperature is required for burning.

• **Method :**

(i) Make two paper cups by folding a sheet of paper.

(ii) Pour about 50 mL of water in one of the cups.

(iii) Heat both the cups separately with a candle (Fig).

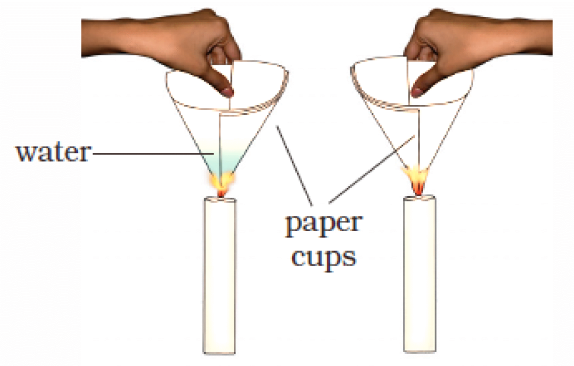


Figure : Heating water in a paper cup

• **Observation :**

You will observe that empty paper cup catches fire. However, the paper cup containing water does not catch fire and can be held for a long time on the flame. If we continue heating the cup, we can even boil water in the paper cup.

• **Conclusion :**

In case of empty paper cup, the temperature of paper rises sharply, till a stage comes when it catches fire. In case of paper cup with water, the ignition temperature of paper is not reached because the heat supplied to paper is transferred to water by conduction. Hence, it does not burn.

6. FLAME

• A flame is a region where combustion of fuel takes place. A flame is the product of a highly exothermic reaction.

• Exothermic reactions are those reactions in which energy is released. A flame is the visible (light - emitting) part of fire.

Kerosene Wax Coal Charcoal

Figure : Combustion of different fuels

Look at the combustible substance around you and try to find whether on burning some of these materials (given below) forms a flame or not.

Flame : A region of burning gases is called flame

Materials forming flame on burning			
S.No.	**Material**	**Form flame**	**Does not form flame**
1.	Candle	✓	
2.	Magnesium	✓	
3.	Camphor	✓	
4.	Kerosene stove	✓	
5.	Charcoal		✓

A substance will burn with a flame, only if some gaseous substance is there to burn.

Focus Point

- A flame (from Latin Flamma) is the visible (light-emiting), gaseous part of a fire. It is caused by a highly exothermic reaction taking place in a thin zone. If a fire is hot enough to ionize the gaseous components, it can become a plasma.

♦ **Colour of Flame :**
Colour of flame depends on the temperature, amount of air supplied, and the substance burning. e.g.flames produced by hydrocarbon fuels are either blue or yellow.

♦ **Types of Flame :**
A flame can be of two types :
(i) Luminous flame (ii) Non-luminous flame

S.No.	Luminous flame	Non-luminous flame
1.	This flame is accompanied with sufficient amount of heat and light.	This flame is accompanied with heat but very little light.
2.	This type of flame is observed when there is insufficient oxygen.	This type of flame occurs because of complete combustion of hydrocarbons in the presence of excess of oxygen.
3.	It leaves black soot and other residue.	This type of flame does not leave any residue.
4.	Yellow flame is luminous flame.	Blue flame is non-luminous flame.

♦ **Combustion of candle wax :**

Candles are usually made of paraffin wax, which is obtained from petroleum. When a candle is burnt, following observations can be made -
(i) The wick burns and it stands in a pool of liquid wax.
(ii) There is a small portion of unburnt wick between the flame and the liquid wax.
(iii) The liquid wax is trapped in a cup of solid wax.
(iv) The liquid or solid wax never catches fire. Also the flame never travels down to burn either liquid wax or the solid wax.
What actually happens in the process of burning of a candle?
(i) It is only the wax vapours that burn. Neither liquid wax nor solid wax burn.
(ii) When a candle wick is lit, the heat produced from the flame melts the wax.
(iii) The wick soaks or absorbs the molten wax.
(iv) The heat of the flame vapourizes the molten wax in the wick.
(v) The gaseous wax burns in the flame, which keeps the flame alive. This process goes on till the entire wax gets burnt.

♦ **Structure of candle flame :**

(A) Outermost non-luminous zone of complete combustion : This zone is faintly visible and surrounds the yellow luminous part of the flame. In this zone, the wax vapour undergoes complete combustion because plenty of air is present around it. This zone is the hottest part of the candle flame.

(B) Central (or middle) luminous zone of incomplete combustion : The central luminous zone is the major part of the candle flame. This zone is bright yellow and luminous, and lies below the outermost non-luminous zone. In this zone, wax vapour undergoes incomplete combustion because not enough of air is present here. The incomplete combustion of wax vapour produces carbon particles. These unburnt carbon particles get heated up and start glowing. These glowing carbon particles make the flame luminous. Thus, the central zone of the candle flame is luminous due to the incomplete combustion of wax vapour in this zone. This part of the flame has moderate temperature.

(C) Inner dark zone of no combustion : The dark zone around the wick is called inner dark zone of no combustion. In this zone very little or no combustion takes place because in this zone no air is present. This part of the flame is the least hot.

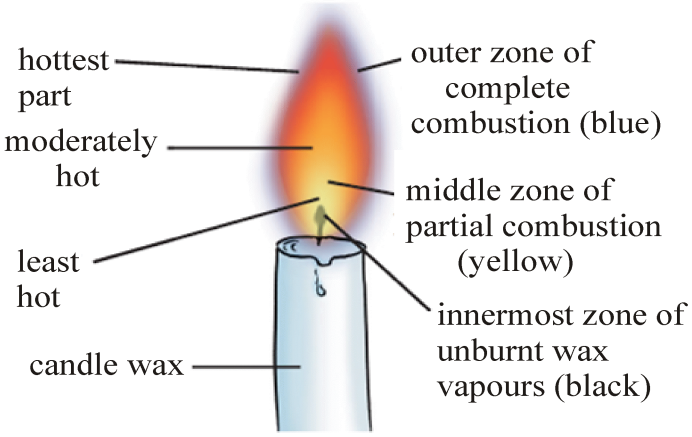


Figure : Structure of candle flame

Focus Point

- In 1826, Michael Faraday first made the world aware of the full details of process by which a candle works.
- The vaporised fuel in a wax candle or an oil flame is hydrogen and carbon or their compounds (hydrocarbons.)
- Luminous zone of a flame is mainly due to incomplete burning of carbon. In the case of fuel gas (LPG or CNG) there is no soot formation. The gases burn with a blue flame oxidising hydrocarbons completely.

Focus Point

- Eulachon (oolichan) is known as candlefish. Its name is derived from the fact that it is so full of fat during spawning (production of eggs in large numbers) that caught, dried and strung on a wick, it can be used as a candle.
- Goldsmiths blow the outermost zone of a flame with a metallic blow-pipe because outermost zone has very high temperature.

LAB TIME
Let's Do & Learn

• **Objective :** To show the presence of wax vapour in dark inner zone.
• **Procedure :** 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 tubing in the dark inner zone as shown in figure.

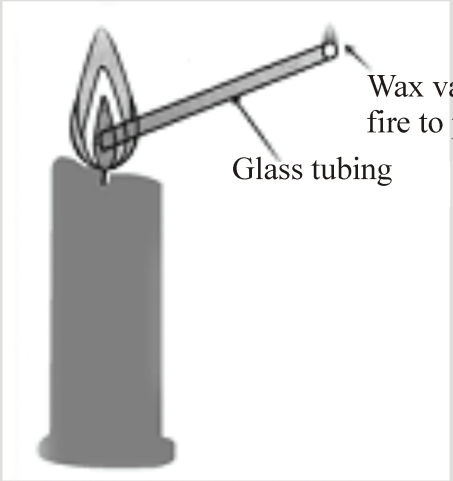


Figure : Presence of wax vapour in dark inner zone.

• **Observation :**
You will notice that the glass tubing is filled with slightly greyish white vapour, which starts coming out from the other end of glass tubing. Bring a lighted matchstick near the end of the glass tubing from which vapour is coming out.
• **Conclusion :**
You will notice that vapour catches fire and burn with flame similar to that of the candle flame These vapours are of wax, which are produced due to the heat of candle flame.

LAB TIME
Let's Do & Learn

Objective : To prove that luminous zone of the candle flame contains unburnt particles of carbon.
Procedure : Take a candle of medium size and fix it on a table. Light the candle. When the flame is absolutely steady, introduce a clean glass slide into the luminous part of the flame, by holding it with fire tongs. Hold the glass slide in position for about 30 seconds and then remove it.
Observation :
You will observe a circular grey (black) ring is formed on the glass slide, such that no deposition is there in the middle of ring. The black colour is due to deposition of unburnt carbon particles in the luminous zone of the flame.
Conclusion :
The centre of the ring does not have any carbon particles, because, this part was over dark inner zone, which does not have unburnt carbon particles

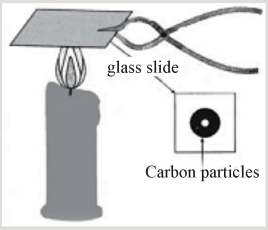


Figure : Formation of unburnt carbon particles in luminous flame

LAB TIME
Let's Do & Learn

- **Objective :** To prove that non-luminous flame is the hottest part of candle flame
- **Procedure :**Hold a thin and long copper wire across the candle flame as shown in Fig. for 30 seconds or more.
- **Observation :** You will notice that copper wire gets red hot in non-luminous part of the flame. However, it gets blackened in the luminous part of the flame.

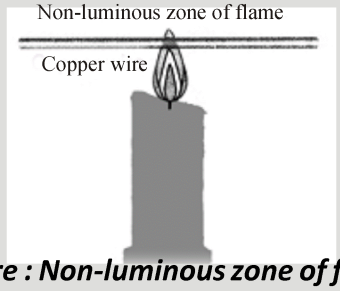


Figure : Non-luminous zone of flame

Conclusion : This observation proves that non luminous flame is the hottest part of candle flame.

Focus Point

- **Spherical flame**
  The National Aeronautics and Space Administration (NASA) of the United States has recently discovered that gravity also, indirectly, plays a role in flame formation and composition. In zero gravity place or in outer space, the efficiency of a flame goes to the maximum possible limit. In zero-gravity 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.

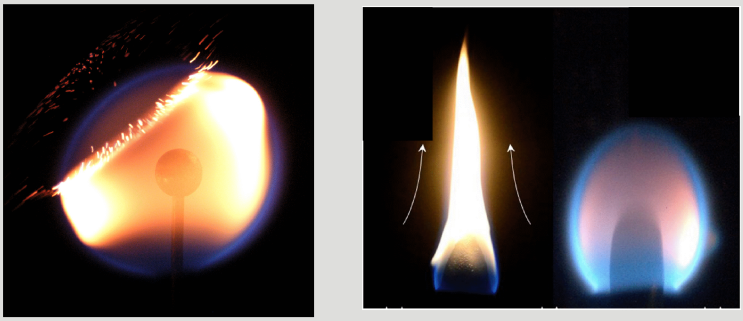


Figure : Spherical flame

7. FUELS

Fuels are substances that produce heat and light energy on burning. e.g. wood, coal, cow dung cakes, kerosene, LPG etc. are used as fuels for cooking and heating. Petrol, diesel, etc. are used in automobiles. Some fuels are available in direct form and can be burnt as such to release energy. They are called primary fuels.Examples of these are coal, petroleum and wood. Some fuels are derived from the primary fuels. They are called secondary fuels. Examples of these are coal gas, petroleum gas and water gas.

Focus Point

- Some fuels are also used to generate electricity.Electricity can be produced from a veriety of energy sources,including coal,nuclear energy,hydropower,natural gas,wind energy,solar energy and stored hydrogen.

♦ **Types of Fuels :**

Fuels may be classified as follows -

(i) Solid fuels: Fuels that exist in solid state at room temperature are called solid fuels. Firewood, charcoal,cow dung cakes, agricultural waste and coal are some examples of solid fuels.

(ii) Liquid fuels : Fuels that exist in liquid state at room temperature are called liquid fuels. Kerosene, petrol, diesel and fuel oil are some examples of liquid fuels.

(iii) Gaseous fuels : Fuels that exist in gaseous state at room temperature are called gaseous fuels.Petroleum gas, natural gas and biogas are some commonly used gaseous fuels.

♦ **Characteristic of Fuels :**

Important characteristics of a fuel are as follows :

(i) Calorific value : The amount of heat produced by complete burning of per unit mass of a fuel is known as calorific value of that fuel. The higher the calorific value of a fuel, the more heat it produces when burned. The higher the calorific value of a fuel, the better fuel it is.

Calorific value of some fuels

Fuel	Calorific value (KJ/g)
Cow-dung cakes	7
Wood (dry)	17-22
Coal	25-33
Coke	28-31
Charcoal	30
Biogas	35-40
Petrol	45
Kerosene	45
LPG	55
Methane	50
Hydrogen	150

(ii) Efficiency : When a fuel is burnt, some of the energy produced is given off as waste heat, which cannot be used for cooking or other purposes. So, the efficiency of fuel is decreased. The energy of fuels can be converted into usable forms of energy such as heat energy, mechanical energy etc. This conversion is done by energy conversion devices. Till date, no fuel-burning device is known to exhibit 100% efficiency.

Approximate values of efficiencies of some energy conversion devices.

Energy conversion device	Efficiency
Petrol engine	25% - 35%
Diesel engine	38% - 50%
Fossil fuel powered electricity generating plant	33% - 48%
solar cell	10% - 40%

♦ **Characteristic of an ideal Fuel (or good Fuel)**

While choosing the most appropriate fuel for our domestic use or for use in industry, we should keep in mind the following characteristics of an ideal fuel or a good fuel.

(i) It should have a high calorific value : In other words, an ideal fuel (or good fuel) is that which gives us more heat per unit weight.

(ii) It should burn without giving out any harmful gases : An ideal fuel (or good fuel) is that which does not pollute air on burning by giving out poisonous gases.

(iii) It should have a proper ignition temperature, so that it can be burned easily : The ignition temperature of an ideal fuel (or good fuel) should be neither too low nor too high. Because if the ignition temperature of the fuel is very low, then the fuel will catch fire too easily and hence it will be very unsafe to use it. On the other hand, if the ignition temperature is too high, then it will be very difficult to burn the fuel.

(iv) It should not be more valuable for some other purpose than a fuel : An ideal fuel (or good fuel) should not have a more important use than being burnt to obtain heat. For example, though coke is a good fuel but it is more valuable as a reducing agent in the extraction of metals. So, coke should not be used as a fuel. It should better be used as a reducing agent in metallurgy.

(v) It should be cheap and easily available : An ideal fuel (or good fuel) is that which is not expensive and which is available in plenty everywhere.

(vi) It should be easy to handle, safe to transport, and convenient to store : An ideal fuel (or good fuel) is that which does not create any safety risks during handling, during its transportation from one place to another or during its storage.

(vii) It should not leave much residue behind after burning : An ideal fuel (or good fuel) should have low percentage of non-volatile materials which do not burn, so that it may burn completely without leaving much ash.

(viii) It should burn smoothly : An ideal fuel (or good fuel) should have a moderate rate of combustion and should burn at a steady rate. In other words, the fuel should not burn either too fast or too slow.

Focus Point

- Matchsticks are made of suitable wood. These wooden sticks are coated with a mixture of antimony trisulphide and potassium chlorate. The rubbing surface, present on the match box has powered glass and a little red phosphorus.
- When the head of matchstick is rubbed against the rubbing surface, some red phosphorus is converted to white phosphorus whch reacts antimony trisulphide and starts burning.

♦ **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 -

(i) Carbon fuels like wood, coal, petroleum release unburnt carbon particles. These fine particles are dangerous pollutants causing respiratory diseases, such as asthma.

(ii) Incomplete combustion of these fuels give carbon monoxide gas. It is a 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.

(iii) Combustion of most fuels release carbon dioxide in the environment. Increased concentration of carbon dioxide in the air is believed to cause global warming.

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

(iv) Burning of coal and diesel release sulphur dioxide gas. It is an externally suffocating and corrosive gas. Sulphur dioxide 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.

(v) Wood is also used as fuel, Burning of wood gives a lot of smoke which causes air pollution and is also very harmful for humans. It may lead to many respiratory problems. Cutting of trees for obtaining wood lead to deforestation which is quite harmful to environment.

(vi) Carbon particles of smoke or the ash get suspended in the air. Excessive amount of them in the air causes breathing problems.

♦ **Greenhouse Effect**

The solar heat radiations consists of infra–red radiations of very short wavelength, as the sun is at an extremely high temperature. These radiations easily pass through the atmosphere. On reaching the surface of the earth, these radiations are absorbed, with the result that the temperature of earth rises during the day time (as shown in figure) However at night, the earth radiates out the heat radiations at a temperature far below the temperature of the sun. Thus, the heat radiations are of a very long wavelength.

- **The various green house gases are :** Carbon dioxide, methane, water vapour, chlorofluorocarbons (CFCs), nitrous oxide (N_2O) and aerosols.
- **Harmful results of the Greenhouse effect :** The rise in temperature of atmosphere due to excessive greenhouse effect (or global warming) will melt the ice on the earth's pole. The huge amount of water produced by the melting of polar ice will raise the level of water in the seas and oceans, causing floods in the low–lying areas of the earth. This will cause damage to life and property. The global warming will also lead to a change in the climate of almost all the parts of the earth.

- **Useful Applications of Greenhouse effect :** The name 'greenhouse effect' comes from the fact that this effect is used in the upbringing of green plants in small houses made of glass walls and glass roofs which are called green houses (as shown in figure). The glass walls and glass roof of a greenhouse allow the sun's heat rays to go in freely but do not allow the heat rays reflected by the soil, plants and other things in the greenhouse to go out. In this way, more and more of sun's heat rays are trapped inside the greenhouse and the temperature rises in it. So, even without an internal supply of heat, the temperature inside a green house becomes higher than that of outside. This heat is beneficial for the growth of plants inside the greenhouse (when the outside temperature is very low during winter season). Thus, greenhouse acts as a heat trap.

Figure : 5. Green house agriculture

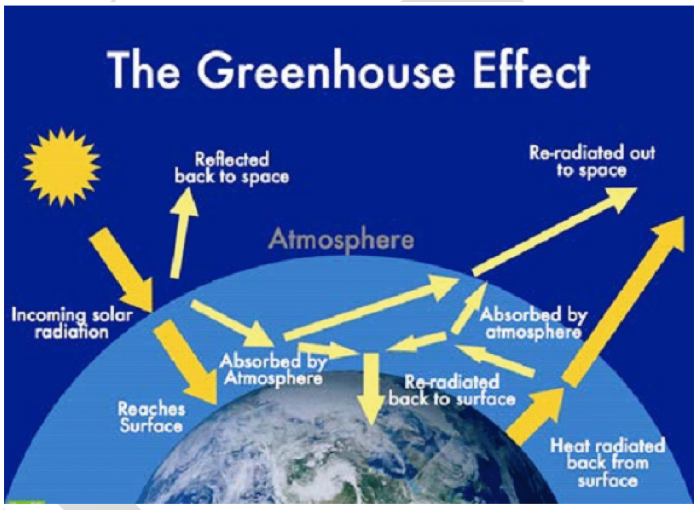


Figure : 6. Green house effect

♦ **Acid Rain**

Rain which has been made more acidic than the normal rain due to the dissolved pollutants, such as sulphur dioxide and nitrogen oxides is called Acid rain.

These gases are added to the atmosphere in the following ways :

(1) All fossil fuels contain sulphur. On burning, sulphur produces Sulphur dioxide. Petroleum refineries emit large amount of these gases.

(2) Internal combustion engines of the motor vehicles make small amounts of nitrogen and oxygen to react together and form nitric oxide. The nitric oxide further reacts with the oxygen of the air to form nitrogen dioxide. The nitrogen dioxide and sulphur dioxide dissolve in the water vapour present in the air to form nitric acid and sulphuric acid.

(3) 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 rain water and form acids. Such rain is called acid rain. It is very harmful for crops, buildings and soil. The use of diesel and petrol as fuels in automobiles is being replaced by CNG (Compressed Natural Gas), because CNG produces the harmful products in very small amounts. CNG is a cleaner fuel.

The nitrogen dioxide and sulphur dioxide dissolve in the water vapour present in the air to form nitric acid and sulphuric acid.

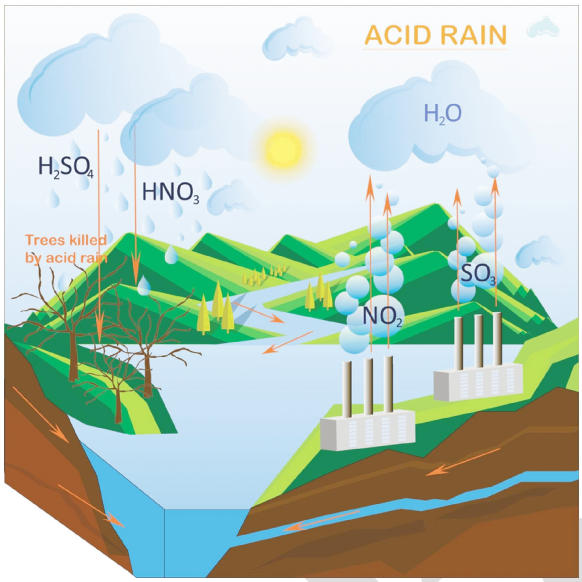


Figure : Formation of acid rain

$CO_2(g)$ + H_2O $\longrightarrow$ $H_2CO_3(aq.)$

Carbon dioxide — Water — Carbonic acid

$2NO_2(g)$ + H_2O $\longrightarrow$ $HNO_3(aq.) + HNO_2(aq.)$

Nitrogen dioxide — Water — Nitric acid — Nitrous acid

$SO_2(g)$ + H_2O $\longrightarrow$ $H_2SO_3(aq.)$

Sulphur dioxide — Water — Sulphurous acid

$SO_3(g)$ + H_2O $\longrightarrow$ $H_2SO_4(aq.)$

Sulphur trioxide — Water — Sulphuric acid

When it rains, nitric acid and sulphuric acid, other acids in small amounts is washed down to the Earth.

8. SOME COMMONLY USED FUELS

8.1 HYDROGEN

Hydrogen has the following advantages as a fuel :

- It has the highest calorific value (150 kJ/g) among all the fuels.
- It leaves no residue on burning.
- Burning of hydrogen does not produce any harmful emission.
- The gases emitted on burning hydrogen consist only of water.

$2H_2 + O_2 \longrightarrow 2H_2O$ + Heat energy

The disadvantage of using hydrogen as a fuel is that it has low ignition temperature (below room temperature). Moreover, it is costlier also.

However, hydrogen is still considered to be the future fuel.

Focus Point

- Scientist are working on using hydrogen as a fuel, as it has the highest calorific value and creates no pollution after burning. Some success has been achieved and hydrogen is expected to be the fuel of the future.

8.2 COMPRESSED NATURAL GAS (CNG)

CNG consists mainly of methane (CH_4). Methane has the high calorific value (50 kJ/g). There are certain advantages of using it as a fuel :

- It leaves no residue after combustion.
- It does not emit any suspended particulate matter (SPM) and sulphur dioxide gas.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + Heat energy

- It has a high calorific value (through less than that of hydrogen).
- The disadvantage of using CNG as a fuel is that it has low ignition temperature. With the development of safety devices, the accidents due to its use as a fuel have been minimised.

Because of its reasonable cost, it is becoming a popular fuel. The barrier in its wide usage is that it is available only where arrangements for its supply through pipes have been made.

CNG is being increasingly used as a fuel in automobiles, cars, buses and trucks, for generating electricity and for producing fertilisers and other chemicals. It helps in reducing air pollution.

8.3 LIQUIFIED PETROLEUM GAS (LPG)

- Petroleum gas is a mixture of three gaseous hydrocarbons, namely, ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}). But the main constituent of petroleum gas is butane. Petroleum gas can be liquefied easily by applying pressure. In the liquid form, it is known as Liquefied Petroleum Gas (LPG). It is supplied to consumers in iron cylinders. LPG changes back to gas when the pressure is released at the burner.
- LPG is a colourless, odourless and an inflammable gas. It is difficult to detect its leakage from the cylinders. To detect its leakage from cylinders, it is mixed with a little of ethyl mercaptan (C_2H_5SH), a thio alcohol having a characteristic unpleasant or foul smell. The calorific value of LPG is quite high (55 kJ/g).
- It does not leave any residue on burning and the emissions are free from SPM (suspended particulate matter).

$2C_2H_6 + 7O_2 \longrightarrow 4CO_2 + 6H_2O$ + Heat energy

$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$ + Heat energy

$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$ + Heat energy

- The only problem with its usage is that LPG has low ignition temperature. However, the accidents are minimum when it is used as a fuel.
- The availability of LPG is more widespread than CNG as it is supplied in iron cylinders which are easily transportable. It is more expensive than CNG , but for domestic use, its price is subsidised by the government.

COMPARISON OF VARIOUS FUELS

Fuel	Calorific value	Storage	Residuc	Pollutants	Ignition temperature	Transport	Cost
Hydrogen	Highest	Difficult	No residue	No polutants	Very low	Pipeline	High
CNG	very high	Difficult	No residue	No polutants	Low	Pipeline	Low
LPG	High	Easy	No residue	No polutants	Low	Cylinders	Moderate
Kerosene	Moderte	Easy	No residue	CO	Low	Tankers	Moderate
Petrol	Moderte	Easy	No residue	CO	Low	Tankers/ pipeline	High
Diesel	Moderte	Easy	No residue	SPM, SO_2	Moderate Pipeline	Tankers/	High
Coal	Low	Difficult	Ash	SPM,SO_2	High	Difficult	High

Focus Point

- Processed fuel oil (PFO) is an oil made from a mixture of used lubricating oils. Due to its low carbon emission, it is often used as a replacement for heavy fuel oil and medium fuel oil.

9. SUN A SOURCE OF ENERGY

The various sources of energy, such as coal, natural gas or any fraction of petroleum, wood, hydroelectric power, wind power, and nuclear power, are ultimately dependent upon the sun.

- Plants grow by synthesising their food in the presence of sunlight (photosynthesis).
- These plants are fossilized to form fossil fuels. They are also food for animals, which in turn are a source of gobar gas or are fossilized to form coal and petroleum.
- The heat of the sun causes rain and, hence, we have waterfalls which are used as a source of hydroelectric power.
- The heat of the sun causes winds, tides and ocean waves. Efforts have also been made to explore solar energy for generating electricity.

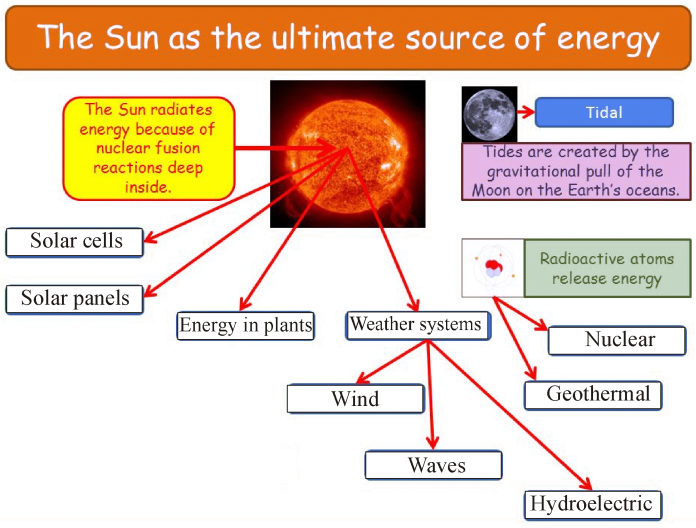


Figure : The sun as ultimate source of energy

However, these efforts have not met with any appreciable success so far. The various processes are shown diagrammatically in figure.

10. FIRE FIGHTING

• We have learnt that there are three essential requirements for producing fire. These are : fuel, air (oxygen) and heat to raise the temperature of the fuel beyond its ignition temperature. Therefore, a fire can be controlled by removing one or more of these requirements.

• Those substances that possess characteristics which enable them to control fires are used in fire fighting. Some of the substances used for this purpose are water, carbon dioxide, dry ice, sand, foam, woollen blankets, etc.

• In order to control a fire, it is necessary to cool the materials on fire to a temperature below their ignition temperatures and to disrupt their contact with air and, thereby cut off the supply of oxygen. Water is used to extinguish fire in case when the burning materials are solids or liquids and heavier than water. Water cannot be used to put out fires as combustible substances like oil or petrol which are lighter than water.

• Carbon dioxide, dry ice, foam and sand are used to control fires due to liquids lighter than water such as or petrol.

♦ **Fire extinguishers**

Fire extinguishers are devices to put off an accidental fire. They are painted red for easy identification. Some common types of fire extinguisheres are :

(i) 'Dry-powder' Fire extinguisher : In this case, a mixture of sand and baking soda (sodium bicarbonate) is thrown over the burning material. The heat of the fire decomposes sodium bicarbonate releasing carbon dioxide.

$$\underset{\text{Sodium bicarbonate}}{2NaHCO_3} \longrightarrow \underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2}$$

The carbon dioxide produced, being heavier than air, puts out the flame.

(ii) 'Soda-acid' Fire extinguisher : Soda-acid extinguisher is the most commonly used fire extinguisher. The steel cylinder contains a solution of sodium bicarbonate ($NaHCO_3$). In the upper part, there is a bottle filled with concentrated sulphuric acid. When the knob is struck, the acid bottle breaks and sodium bicarbonate solution comes in contact with the concentrated sulphuric acid. This produces carbon dioxide. The carbon dioxide produced is ejected at the nozzle under pressure, together with the solution in the container. The carbon dioxide smothers the flame whereas the water (from $NaHCO_3$ solution) has a cooling effect on the burning material.

$$\underset{\text{Sodium bicarbonate}}{2NaHCO_3} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4} + \underset{\text{Water}}{2H_2O} + \underset{\text{Carbon dioxide}}{2CO_2}$$

(iii) 'Foam-type' fire extinguisher : Foam type fire extinguisher is similar to the soda-acid extinguisher. However, the sodium bicarbonate solution also contains a substance saponin or turkey red oil which produces a foam with the gas and solution issuing from the nozzle. The foam being light will float on the surface of oil fires, thus, cutting off the air supply.

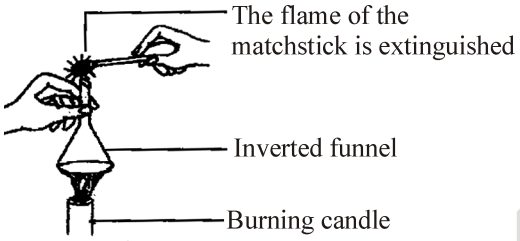
SOLVED EXAMPLES

SE. 1

How will you show that carbon dioxide is produced during combustion?

Ans. Hold an inverted funnel above the flame. Bring a lighted matchstick near the mouth of the funnel. It is observed that the burning matchstick is put off.

Carbon dioxide is produced by the burning of the wax which extinguishes the flame.



SE. 2

How will you show that water vapours are formed during combustion?

Ans. Place few ice cubes in a glass. Light a candle and hold the glass containing ice cubes at some distance above the flame. After some time the water droplets condense on the outer surface of glass. It shows that burning wax produces water vapours which are condensed in the form of water droplets outside the glass. Wax is a hydrocarbon and it produces carbon dioxide and water on combustion.

Hydrocarbon + Oxygen $\longrightarrow$ Carbon dioxide + Water vapour + Energy

SE. 3

What is the blue zone in a candle flame ?

Ans. If observed carfully, a very small area near the base of the flame is blue. Since oxygen is not available for combustion in this area, carbon monoxide is formed as a result of incomplete combustion. The blue colour at the bottom is due to combustion of carbon monoxide.

SE. 4

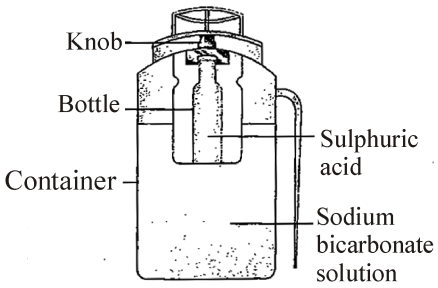
How does a candle flame work ? Explain the phenomena.

Ans. When the candle burns, the was around the wick melts and vapories because the molten wax rises upward through the wick. The vapours burn in air and this produces a flame. Thus, the combustible substance and the supporter of combustion both are in gaseous state. In case of a candle flame, the wax vapour and the oxygen of air are in gaseous state. Hence, when a combustible substance is in vapour state and burns, it produces flame.

SE. 5

Explain the construction and working of a soda acid type fire extinguisher.

Ans. **Construction :** It contains sodium bicarbonate solution. The small bottle contains sulphuric acid. This bottle is attached to the knob.



A soda-acid type fire extinguisher

Working :

For a chemical reaction to take place, the knob is struck. The bottle breaks and sulphuric acid reacts with sodium bicarbonate liberating large amount of CO_2 gas with great force.

$2NaHCO_3$ + H_2SO_4 $\longrightarrow$ Na_2SO_4 + $2H_2O$ + $2CO_2$

Sodium bicarbonate, Sulphuric acid, Sodium sulphate, Water, Carbon dioxide

It forms a blanket around the fire, cutting off the air supply, due to which the fire gets extinguished.

SE. 6

What are the conditions which are necessary for combustion to take place?

Ans. There are three conditions which are necessary for combustion. These are :

(i) Presence of a combustible material : A piece of metal or glass does not burn if we try to burn it. But paper or wood can be burnt easily.

(ii) Attainment of ignition temperature : A wet piece of wood does not catch fire but a dry piece burns easily. This is because in wet wood, water does not allow the wood to reach its ignition temperature.

(iii) Supporter of combustion: Oxygen present in air is a supporter of combustion and is a necessary condition of combustion.

SE. 7

Give three conditions which can be used to put off fire.

Ans. Combustion needs three things fuel, oxygen and heat, so to put off fire, any one of the following can be done :

(i) Cut off the fuel supply

(ii) Remove the source of heat

(iii) Cut off the air supply.

SE. 8

When a person's clothes catch fire, you should quickly wrap him in a thick blanket and roll him on the ground. Why?

Ans. Covering the person with a thick blanket cuts off the air supply and stops the fire from spreading.

SE. 9

What are explosives? How do they work?

Ans. Explosives are materials that produce violent chemical reactions, on burning, with generation of a large amount of heat in a very short time (within seconds only). The gases which are produced as a result of explosion, quickly spread and the heat produced is carried out by the gases which are hot enough to burn the objects and initiate big fires.

SE. 10

Give an example of a very slow combustion.

Ans. Combustion is basically an oxidation reaction accompanied with evolution of large amount of heat or light or both. There are few reactions which are examples of combustion where metal is converted to oxide at a very slow rate, e.g., rusting of iron. When iron is exposed to air in presence of moisture for a very long time it gets corroded and forms rust, which is iron oxide.

$4Fe + 3O_2 + 2H_2O \longrightarrow 2Fe_2O_3 \square 2H_2O$

Rust

SE. 11

What is spontaneous combustion? Explain with an example.

Ans. There are some combustible substances that catch fire on their own when they are exposed to air. This phenomenon is known as spontaneous combustion. For example, sodium has to be kept immersed in kerosene, because if left exposed to open air, it catches fire on its own. Other examples of such substances are white phosphorus and potassium. That is the reason why these substances are stored in kerosene or water, in order to prevent exposure to oxygen in the air.

$4Na + O_2 \longrightarrow 2Na_2O$ + Energy

Sodium, Sodium oxide

$4P + 5O_2 \longrightarrow 2P_2O_5$ + Energy

White phosphorus, Phosphorus pentoxide

SE. 12

Why does kerosene burn with a blue flame in wick stove but produces a yellow flame when burnt in a lamp?

Ans. In a stove the kerosene undergoes complete combustion due to sufficient supply of oxygen which is provided through the holes in the

jacket around the wick. In a lamp due to presence of chimney around the flame, the supply of oxygen is limited resulting in incomplete combustion giving a yellow flame.

SE. 13

Define incomplete and complete combustion.

Ans. **Incomplete combustion :** The combustion reaction which takes place in presence of limited quantity of oxygen is called incomplete combustion. For example, carbon burns in limited supply of oxygen giving carbon monoxide.

$$2C + \underset{\text{(limited)}}{O_2} \xrightarrow[\text{Combustion}]{\text{Incomplete}} 2CO$$

Complete combustion : The combustion reaction in which the combustible material is completely burnt to form its oxide in presence of excess or sufficient amount of oxygen is called complete combustion. For example, carbon burns in excess of oxygen giving carbon dioxide.

SE. 14

Why is it dangerous to sleep in a closed room where coal is burning or stand in a garage keeping the engine of a car running?

Ans. Burning of coal in a closed room or standing in a garage keeping the engine of a car running results in incomplete combustion of carbon particles due to which carbon monoxide is released which is a highly poisonous gas and causes suffocation or even death.

SE. 15

Name few pollutants produced by combustion of fuels and mention their harmful effects.

Ans. (i) Dust - Allergic reactions
(ii) Smoke - Respiratory problems
(iii) Carbon monoxide - Choking of throat, may be fatal
(iv) Carbon dioxide - Greenhouse effect, global warming
(v) Oxides of sulphur - Lungs problems, acid rain (vi) Oxides of nitrogen - Lungs diseases, acid rain.

SE. 16

Give reasons :
(i) Both soda acid type and foam type extinguishers cannot be used in fighting electrical fires.
(ii) Liquid carbon dioxide fire extinguishers can be used for both electrical and oil fires.

Ans. (i) In both types of fire extinguishers, the resultant solution contains sodium sulphate, sodium bicarbonate and sometimes conc. H_2SO_4. These are electrolytes and may conduct electricity resulting in electric shocks or enhance short circuiting which can cause another fire.
(ii) Liquid carbon dioxide fire extinguisher generates CO_2, which settles down displacing air. This cuts off oxygen supply and hence both electrical and oil fires can be extinguished.

SE. 17

What is the job of a fire extinguisher? How does the fire brigade work to extinguish fire?

Ans. There are three requirements for producing fire: fuel, air and proper temperature. Fire can be controlled by removing one or more of these requirements. 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. In most of the cases, fuel cannot be eliminated.
When fire brigade arrives, it pours water on the fire. Water cools the combustible material, so that its temperature is brought below its ignition temperature. This prevents the fire from spreading. Water vapour also surrounds the combustible material, helping in cutting off the supply of air, and thus, the fire is extinguished.

SE. 18

Name any three gaseous fuels used either as domestic or as industrial fuel.

Ans. Natural gas is found in oil wells, trapped above the crude petroleum. It mainly contains methane and traces of ethane and propane.

Methane (CH_4) is used in another form in the villages of India as a main constituent of biogas. Gobar gas plants have become very common in villages. They produce biogas or gobar gas through decomposition of biomass. It is considered as a good domestic fuel. Water gas is prepared by passing steam over red-hot carbon. It contains carbon monoxide and hydrogen.

$C + H_2O \rightarrow [CO + H_2]$

(Water gas)

Producer gas is prepared by passing air over red-hot carbon. It contains carbon monoxide and nitrogen. It is not considered to be a good fuel on account of its nitrogen content. It is often used in industries as fuel.

$2C + O_2 + 2N_2 \rightarrow 2[CO + N_2]$

(Producer gas)

SE. 19

How do you get the flame in the candle?

Ans. When the candle burns, the wax around the wick melts and vaporizes because the molten wax rises upward through the wick. The vapours burn in air and this produces a flame. Thus, the combustible substance and the supporter of combustion both are in gaseous state. In case of a candle flame, the wax vapour and the oxygen of air are in gaseous state. Hence, when a combustible substance is in vapour state and burns, it produces flame.

SE. 20

Give two examples of each :

(a) Natural fuel

(b) Secondary fuel

(c) Primary fuel

(d) Fossil fuel

Ans. (a) Natural fuel - Coal, wood, natural gas

(b) Secondary fuel - Petrol, diesel, biogas

(c) Primary fuel - Coal, wood, cow dung cakes

(d) Fossil fuel - Coal, petroleum

SE. 21

What are the useful applications of greenhouse effect?

Ans. The name 'greenhouse effect' comes from the fact that this effect is to grow green plants in small houses made of glass walls and glass roofs which are called greenhouses. The glass walls and glass roof of a greenhouse allow the sun's heat rays to go in freely but do not allow the heat rays reflected by the soil, plants and other things in the greenhouse to go out. In this way, more and more of sun's heat rays are trapped inside the greenhouse and the temperature rises in it. So, even without an internal supply of heat, the temperature inside a greenhouse becomes higher than that of outside. This heat is beneficial for the growth of plants inside the greenhouse (when the outside temperature is very low during winter season). Thus, greenhouse acts as a heat trap.

NS. 1

List conditions under which combustion can take place.

Ans. The conditions necessary for combustion to take place are as follows:
(a) Presence of a combustible substance
(b) Presence of supporter of combustion
(c) Heating the combustible substance to its ignition temperature.
Combustion will not occur in the absence of any one of these.

NS. 2

Fill in the blanks.
(a) Burning of wood and coal causes ..... of air.
(b) A liquid fuel, used in homes is .....
(c) Fuel must be heated to its .... before it starts burning.
(d) Fire produced by oil cannot be controlled by ..... .

Ans. (a) pollution (b) kerosene
(c) ignition temperature
(d) water

NS. 3

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

Ans. The use of CNG in place of petrol and diesel reduce pollutions in following ways:
(i) It produces less carbon monoxide gas.
(ii) It produces less carbon dioxide gas.
(iii) It produces less amount of sulphur dioxide and nitrogen dioxide which cause acid rain,
(iv) No residue remain after combustion.

NS. 4

Compare LPG and wood as fuels.

Ans.

S. No.	LPG	Wood
1.	It is gaseous fuel.	It is solid fuel.
2.	It does not produce smoke.	It produces smoke.
3.	Its calorific value is more (55000 kj/kg)	Its calorific value is less(17000 kj/kg).
4.	It is easily stored in . cylinders	It requires more space to store.
5.	It does not cause any pollution.	It causes more pollution.

NS. 5

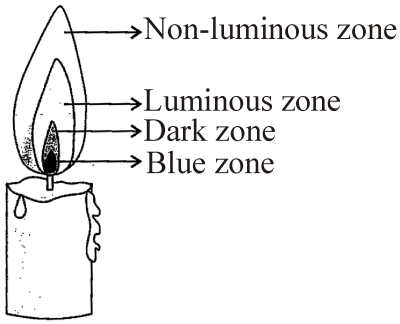
Give reasons :
(a) Water is not used to control fires involving electrical equipment.
(b) LPG is a better domestic fuel than wood.
(c) Paper by itself catches fire easily whereas a piece of paper wrapped around an aluminium pipe does not.

Ans. (a) Water is a good conductor of electricity. It conducts electricity and may result electric shock.
(b) LPG has more calorific value than wood and its produces no pollution. So LPG is a better domestic fuel than wood.
(c) The ignition temperature of paper is less, so it catches fire easily. It does not catch fire when wrapped around aluminium pipe because aluminium absorbs the heat so paper does not attain its ignition temperature.

NS. 6

Make a labelled diagram of candle flame.

Ans.



NS. 7

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

Ans. The unit of calorific value is kilojoule per kilogram (kj/kg).

NS. 8

Explain how CO_2 is able to control fire.

Ans. CO_2 forms a blanket around the fire, cutting off the air supply, due to which the fire gets extinguished.

NS. 9

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

Ans. The green leaves contain some water due to which the ignition temperature of leaves increases and they do not catch fire easily while dry leaves have no water so they catch fire easily.

NS. 10

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

Ans. A goldsmith uses the non-luminous zone (outermost zone) of candle flame to melt gold and silver because it is the hottest part of the candle flame and has high temperature.

NS. 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. Total mass of fuel = 4.5 kg
Total heat produced = 180,000 kj
Heat produced by burning 1 kg of fuel
= 180,000 kJ/4.5 kg = 40,000 kj/kg.
So, calorific value of fuel = 40,000 kj/kg.

NS. 12

Can the process of rusting be called combustion? Discuss.

Ans. Combustion is a chemical process in which a substance reacts with oxygen and gives out energy in the form of either heat or light or both. Rusting of iron is an exothermic process as heat is released during rusting. Hence, rusting is a kind of slow combustion.

NS. 13

Sneha and Ramesh were doing an experiment in which water was to be heated in a beaker. Sneha 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. The water heated by Ramesh will get heated in a shorter time because he kept his beaker near the hottest zone of the flame.

EXERCISE – I

ONLY ONE CORRECT TYPE

1. In which zone of a candle flame does complete combustion take place ?
(A) Inner (B) Outer
(C) Middle (D) All three zones

2. When oxygen supply is increased in a bunsen burner, the colour of the flame changes-
(A) From blue to yellow
(B) From yellow to blue
(C) From blue to red
(D) From yellow to red

3. A luminous flame appears
(A) Red (B) Green
(C) Yellow (D) Blue

4. The main constituent of LPG is-
(A) Methane (B) Butane
(C) Ethane (D) Propane

5. Which of the following is not a product of incomplete combustion?
(A) Carbon monoxide
(B) Carbon dioxide
(C) Water
(D) Heat

6. When a frying pan containing cooking oil is kept for long on a burning stove then cooking oil catches fire because-
(A) Its temperature is lower than its ignition temperature.
(B) Its temperature is reached to its ignition temperature.
(C) Its temperature is lower than critical temperature.
(D) Its temperature is higher than critical temperature

7. The gas which supports combustion is -
(A) CO_2 (B) He
(C) O_2 (D) Ne

8. Combustion is a –
(A) Physical process
(B) Chemical process
(C) Biological process
(D) Mechanical process

9. A by-product of combustion is -
(A) Oxygen (B) Light
(C) Air (D) Electric current

10. The gas evolved during incomplete combustion of wood or coal is -
(A) Chlorine (B) NO
(C) Oxygen (D) CO

11. 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

12. Calorific value of a fuel may be defined as -
(A) The amount of heat produced when 1000 kg of a fuel is incompletely burnt.
(B) The amount of heat produced when 1 g of fuel is incompletely 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 unit mass of a fuel is completely burnt.

13. Which of the following fuels has the highest calorific value?
(A) Petrol (B) Hydrogen
(C) LPG (D) Natural gas

14. 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.

15. Hydrogen is a very good fuel because-
(A) It has highest calorific value.
(B) Burning of hydrogen does not cause any pollution.
(C) Hydrogen can be easily prepared by the electrolysis of water.
(D) All of these

16. The white marble of Taj Mahal is changed to yellow because of -
(A) Global warming (B) Deforestation
(C) Fog (D) Acid rain

17. Sun produces heat and light by-
(A) Combustion
(B) Inflammation
(C) Nuclear reactions
(D) Photochemical reactions

18. The substance that forms a flame on burning is-
(A) Iron (B) Camphor
(C) Aluminium (D) Charcoal

19. The gas that causes Global Warming is -
(A) Carbon monoxide
(B) Sulphur dioxide
(C) Oxygen
(D) Carbon dioxide

20. Efficiency of a fuel is determined by its -
(A) Ignition temperature
(B) Calorific value
(C) Production of light
(D) Duration of burning.

21. How the pollution in the cities can be reduced by the use of CNG in automobiles?
(A) It produces less amount of sulphur dioxide and chlorine.
(B) It does not leave any residue or smoke after burning in the engine.
(C) It produces large amount of carbon dioxide.
(D) It is used in compressed form.

22. Acid rain which is very harmful for crops, buildings and soils is formed by dissolving
(A) Sulphur and nitrogen oxides released during the combustion of fuels
(B) Hydrogen and water released during combustion of fuels
(C) Metal oxides present in the soil
(D) Unburnt carbon particles released during combustion of fuels.

23. The formation of soot occurs when
(A) There is not enough oxygen for burning and few carbon particles are left unburnt
(B) There is enough oxygen for burning carbon particles
(C) There is not enough oxygen for burning hydrogen
(D) Hydrocarbon is converted to soot on heating.

24. Why does wax burn with a flame?
(A) Liquid wax is vaporized and the vapours of wax burn.
(B) Carbon from the wax vaporizes to burn.
(C) Carbon from the wax combines with oxygen to form carbon dioxide which burns.
(D) Hydrogen of the wax burns to form water.

25. The flame of the candle is
(A) Zone of non-combustion
(B) Zone of combustion
(C) Dark zone
(D) Zone of molten wax.

PARAGRAPH TYPE

Paragraph # 1

When a substance burns a flame is produced along with the formation of the burnt substance. During burning energy is also evolved in the form of heat and light. The flame produced has different zones which have different colours and temperatures. Substances which produce heat and light upon burning are calledfuels and have many uses. Pollution caused by the combustion of various fuels is posing a major threat to the environment.

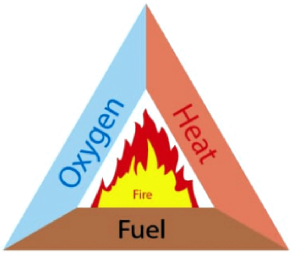
26. Which type of energy is produced during combution.
(A) Light
(B) Heat
(C) Both (A) and (B)
(D) Solar

27. One of the qulities of a good fuel is :
(A) It should have a high calorific value.
(B) It should have a low calorific value.
(C) It should have a very hight ignition temperature.
(D) It should produce a good amount of smoke and leave a lot of residue.

28. Which of the following is not a form of coal ?
(A) Anthracite
(B) Graphite
(C) Bituminous
(D) Lignite

Paragraph # 2

Fire Triangle



For the generation of fire, we need three thngs to be present simultaneously :
Some sort of fuel of combustible material.
A heat source to raise the temmperature of the fuel to its ignition temperature.
Enough oxygen to sustain combustion, So, if we remove any one of these resources, the fire can be controlled.

29. Which out of the following is correct about incomplete combustion ?
(A) It takes place is sufficient supply of oxygen
(B) A blue flame is produced.
(C) It burns with a clean non sooty flame.
(D) A yellow flame is produced.

30. Which out of the following is not required as an essential condition for combustion to take place ?
(A) Presence of a combustible material.
(B) Presence of a supporter of combustion.
(C) Boiling point should be reached.
(D) Ignition temperature should be reached.

31. Which of the following statement is NOT ture ?
(A) Falme can be seen only burning solids and liquids.
(B) Yellow zone of candle is also called luminous zone of flame.
(C) Innermost zone of a flame is the least hot zone.
(D) Blue zone indicates complete combustion of fuel.

MATCH THE COLUMN TYPE

32.

Column-I	Column-II
(P) Carbonised fossil fuel	(i) Dark zone
(Q) Ideal fuel	(ii)Non-luminous zone
(R) Invisible zone of candle flame	(iii) LPG
(S) The coolest zone of candle flame	(iv) Coal

(A) P → ii, Q → iv, R → i, S → iii
(B) P → i, Q → ii, R → iv, S → iii
(C) P → iv, Q → iii, R → i), S → i
(D) P → iv, Q → ii, R → i, S → iii

33.

Column-I	Column-II
(P) Natural gas	(i) Foul smell
(Q) Slow combustion	(ii) Methane
(R) Thermal power	(iii) Rusting
(S) Ethyl mercaptan	(iv) Coal

(A) P → ii, Q → iv, R → i, S → iii
(B) P → ii, Q → iii, R → iv, S → i
(C) P → ii, Q → iv, R → iii, S → i
(D) P → iii, Q → iv, R → i, S → ii

EXERCISE – II

VERY SHORT ANSWER TYPE

1. Write the name of the fish known as candle fish and why this name is given to it?
2. What type of substance are wood and diesel?
3. Give the terms used for 'the temperature at which a substance catches fire'.
4. Define combustion.
5. What are product of complete combustion?
6. Name the petroleum product used for making candles.
7. Give two examples each for solid fuels and gaseous fuels.
8. Give two examples of non-renewable sources of energy.
9. Give two examples of renewable sources of energy.
10. Write the formula of nitric acid.

SHORT ANSWER TYPE

1. Differentiate between rapid and slow combustion.
2. Diya wants to separate the following materials as combustible and non-combustible. Can you help her?
   Charcoal, chalk, stone, iron rod, copper coin, straw, cardboard, glass, paper, candle, wood.
3. Differentiate between complete and incomplete combustion.
4. What are the three conditions necessary for combustion ?
5. People usually keep Angethi/burning coal in their closed rooms during winter season. Why is it advised to keep the door open?

LONG ANSWER TYPE

1. What is a flame ? List the differences between luminous and non-luminous flames.
2. Describe the various zones of a candle flame with the help of a neat and labelled diagram.
3. Differentiate between combustible and non-combustible substances.
4. Write a short note on combustion of a wax candle.
5. Explain the green house effect.

FILL IN THE BLANKS

1. In a soda-acid type fire extinguisher _____ reacts with concentrated sulphuric acid to give out carbon dioxide.
2. The _____ zone in a candle flame is the zone of no combustion.
3. A substance will not catch fire and burn if its temperature is _____ than its ignition temperature.
4. The most important sources of energy that we need are the _____.
5. _____ is harmful for crops, soil and buildings.

TRUE AND FALSE

1. Different substances have different ignition temperatures.
2. When a substance undergoes combustion or burns completely, it produces carbon monoxide and water.
3. Sometimes light is also produced during combustion either as a flame or as a glow.
4. A substance can burn in any condition.
5. The efficiency of a fuel is determined by its calorific value.

Answer Key

EXERCISE–I														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	B	C	B	B	B	C	B	B	D	A	D	B	D	D
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	C	B	D	B	B	A	A	A	B	C	A	B	C	C
31	32	33												
D	C	B												

EXERCISE II

FILL IN THE BLANKS

1. $NaHCO_3$ **2.** Inner dark **3.** less **4.** Sun **5.** Acid rain

TRUE / FALSE

1. T **2.** F **3.** T **4.** F **5.** T

Space for Notes :

COAL AND PETROLEUM 2

Concepts

INTRODUCTION

Natural resources indicate the potential wealth of a country. The variety of substances that man gets from earth and nature to meet his basic needs are called natural resources. The word resource means a source of supplying a material generally held in reserve. Natural resources are both living and non living. Some of these resources are found in abundance, while others are found in limited quantities and that too in some restricted parts of our land. For this reason, the natural resources have to be widely used. However, in reality it is not so. They are being used indiscriminately.

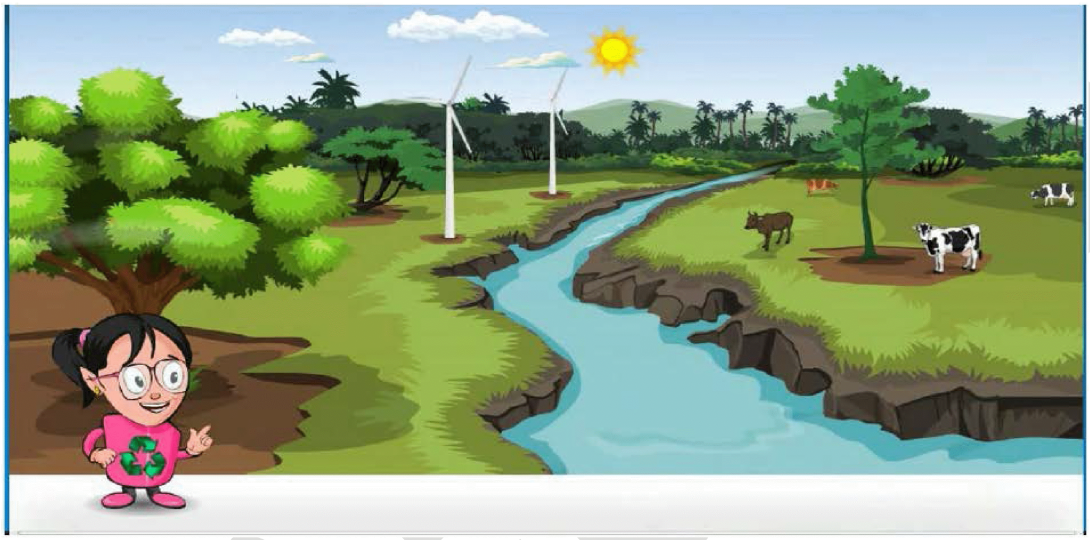
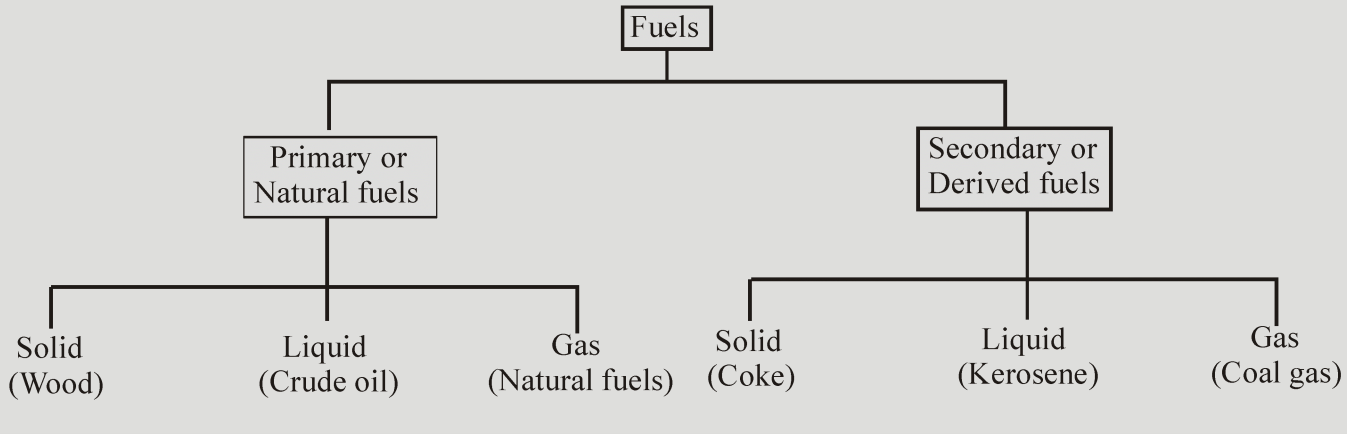


Figure : Natural resources

Focus Point

- Any substance which is easily and burns in air at a moderate rate, producing a large amount of heat energy, without leaving behind any undesirable residue is called fuel.



LAB TIME
Let's Do & Learn

- **Object :**To classify between natural and man-made things.
- **Meothd :** Observe various materials used by us in daily life. Classify them as natural and man-made.
- **Observation table :**

Natural objects	Man-made objects
Sun	Polythene bag
Moon	Glass
Stars	Cement
Soil	Television
Air	Soap
Water	Paper
Minerals	Utensil

- **Conclusion :** Some objects are man-made and some are found in nature.

1. NATURAL RESOURCES

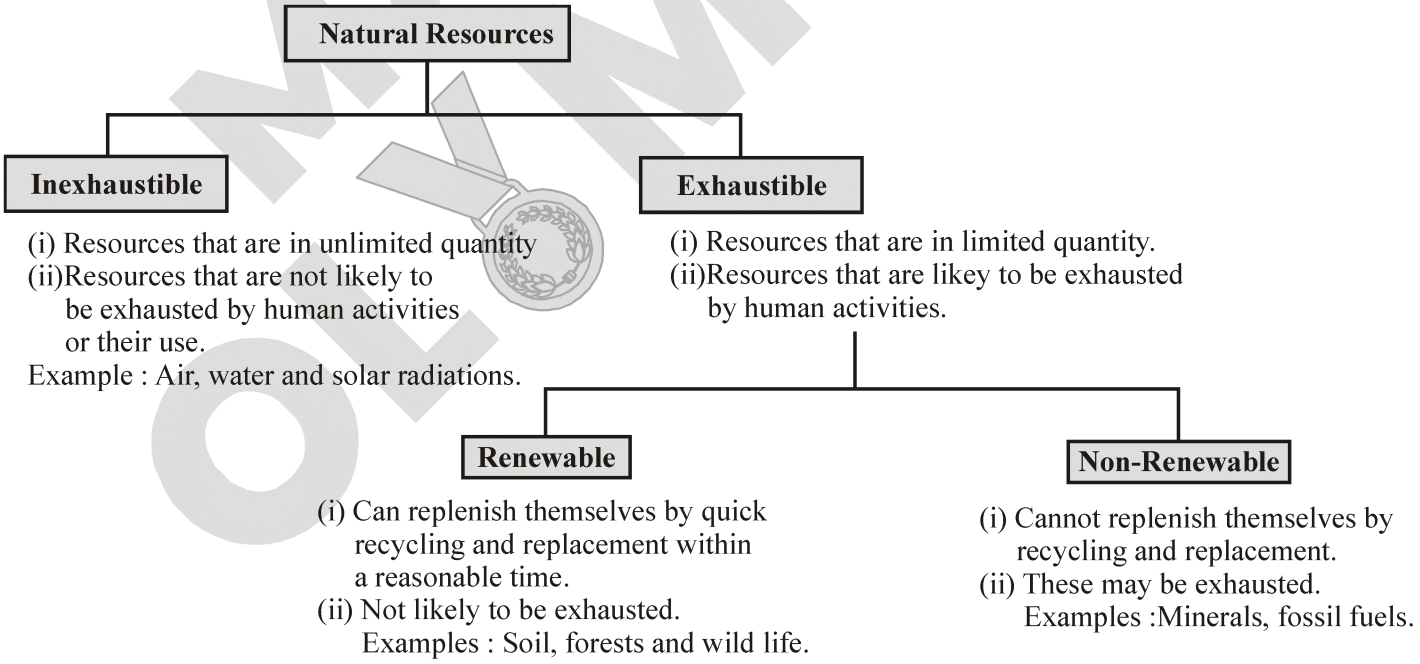
The resources which are obtained from the nature are called natural resources e.g. - air, water, soil, coal, petroleum etc.

♦Types of Natural resources

Depending upon the abundance and availability, natural resources are categorized into two types, i.e.

(i) Inexhaustible natural resources

(ii) Exhaustible natural resources



2. FOSSIL FUELS

Exhaustible natural resources like coal, petroleum or natural gas were formed from the dead remains of living organisms (fossils). So, these are called fossil fuels.

Coal and petroleum are very important natural resources and play a vital role in modern society. They are found in the earth's crust. Their easy availability and specific characteristics make them very important in the growth of industry. At present they are the chief sources of energy worldwide.

(i) Coal : Coal is one of the fuel used to cook food. Earlier it was used in railway engines to produce steam to run the engine. It is also used in thermal power plants to produce electricity. Coal is a mineral of dark brown or black colour formed from the remains of plants buried in the earth's crust millions of years ago.

- **Composition :** Coal is a impure form of carbon. It mainly consists of atoms of carbon, hydrogen and oxygen. A small amount of sulphur and nitrogen are also present in it.
- **Deposits :** The distribution of coal deposits is not uniform in the earth's crust. To the total coal reserves in the world, Asia contributes about one third, whereas North and South America contribute more than half. India has large deposits of coal. It is estimated that India has about 80 billion tones of proven coal deposits. The coal deposits are spread over in the states of Jharkhand, Madhya Pradesh and West Bengal.
- **Formation :** Coal and other fossil fuels take millions of years to form. About 300 million years ago the earth had dense forests in low lying wetland areas. Due to natural processes, like flooding, these forests got buried under the soil. As more soil deposited over them, they were compressed. The temperature also rose as they sank deeper contains mainly carbon ,the slow process of conversion of dead vegetaiton into coal is called carbonisation. Since it was formed the remains of vegetation, coal is also called a fossil fuel.

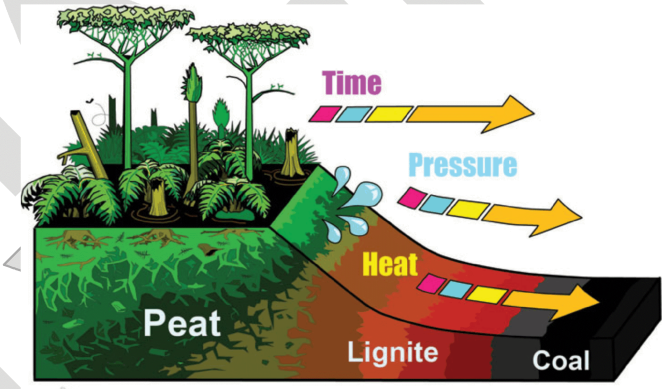
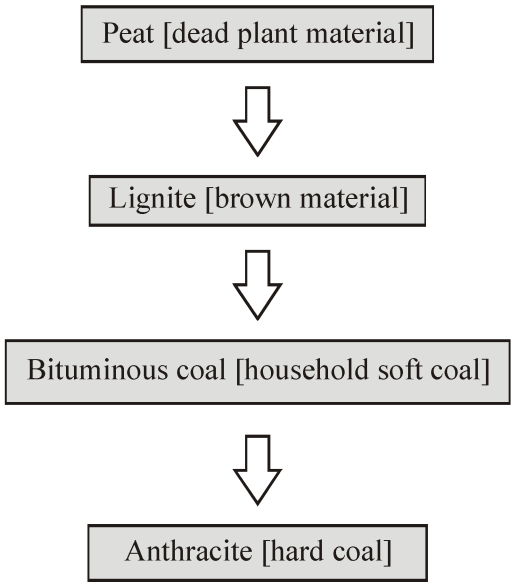


Figure : Coal formation

Focus Point

- Coal occurs in four main varieties viz. peat, lignite, anthracite and bituminous. Peat is the most inferior while anthracite is the most superior quality of coal among various varieties of coal.
- Carbon and hydrogen are the elements which make major part of coal and petroleum.
- The primary fossil fuels are coal, petroleum and natural gas. Together they account for 85% of the world's total energy.
- Forests are natural resources.
- Coal is the most abundant and one of the least expensive fossil fuel.



Types of coal	% of carbon content	Calorific value
Peat	50 – 60	10.5 – 12.6 KJ/g
Lignite	60 – 70	14.7 – 18.9 KJ/g
Bituminous	75 – 80	28 – 31 KJ/g
Antharacite	90 – 95	31 – 33 KJ/g

Figure : Type of coal

- **Destructive Distillation of Coal :**
  The process of heating coal in the absence of air is called the destructive distillation of coal. Coal contains number of elements such as carbon, hydrogen, oxygen, nitrogen and sulphur. When coal is heated in the absence of air, a number of products are obtained.

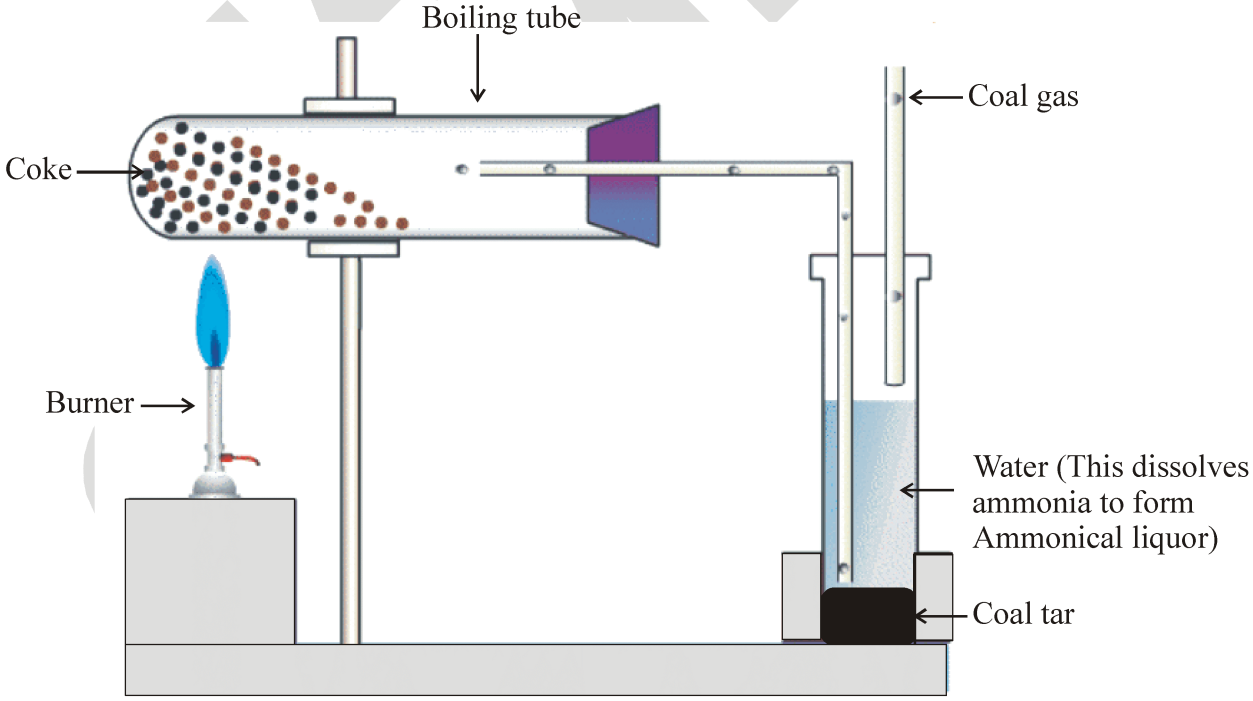


Figure : Experimental set up for the destructive distillation of coal

The main products obtained by the destructive distillation of coal are as follows :

(1) Coke (2) Coal tar (3) Ammonical liquor (4) Coal gas

(1) Coke : Coke contains 98% carbon. It is porous, tough, black and the purest form of coal. Like charcoal, it is a good fuel and burns without smoke. But it is seldom employed as a fuel because it can be put to more valuable use. Coke is used in the manufacture of steel and extraction of many metals. It is also used in making fuel gases like water gas and producer gas.

Focus Point

- Water gas is an equimolar mixture of carbon monoxide and hydrogen. It is obtained by passing steam over red- hot coke.

$$\underset{\text{Coke}}{C} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Water gas}}{(CO + H_2)}$$

- Producer gas is a mixture of carbon monoxide and nitrogen. It is obtained when air is passed over red hot coke.

$$2C + \underbrace{O_2 + 4N_2}_{\text{air}} \longrightarrow \underset{\text{Producer gas}}{(2CO + 4N_2)}$$

(2) Coal tar : Coal tar is a mixture of different carbon compounds. It is a thick, black liquid with unpleasant smell. The fractional distillation of coal tar gives many chemical substances which are used in the preparation of synthetic dyes, perfumes, explosives, paints, synthetic fibres, drugs and pesticides. Some of these chemical substances are benzene, toluene, phenol and aniline.Naphthalene balls used to repel moths and other insects are also obtained from coal tar. These days, bitumen, a petroleum product is used in place of coal tar for metalling the roads.

(3) Ammonical liquor : The ammonia gas produced as a result of destructive distillation of coal is absorbed in water. The aqueous solution of ammonia, i.e. ammonium hydroxide solution, is called ammonical liquor. It is used in the preparation of fertilizers such as ammonium sulphate and ammonium superphosphate.

(4) Coal gas : Coal gas is obtained during the processing of coal to get coke. Coal gas is mainly a mixture of hydrogen, methane and carbon monoxide. The gases present in coal gas are combustible and hence it is an excellent fuel. It has high calorific value. It was used for lighting houses, factories and streets in Mumbai (Bombay) until 1950. It was also used for cooking until recently.

Focus Point

- Coal gas was used for street lighting for the first time in London in 1810 and in New York around 1820. Now - a - days, it is used as a source of heat rather than light.
- The age when coal, petroleum and natural gas were formed is called carboniferous period. "Carboniferous" gets its name from carbon.
- Wildlife is an exhaustible natural resources so we have to take care of it.
- Bituminous coal is the most popular coal used for domestic purpose.
- When animal bone is burnt in absence of air then it yields an excellent fuel called animal charcoal.

♦ **Uses of coal :**

(1) Coal is used as a fuel to convert water into steam to run thermal power plants for the generation of electricity. It is also used as a fuel in homes and factories and to run steam engines.
(2) Coal is used in the preparation of fuel gases, such as coal gas.
(3) Coal is used in the preparation of synthetic petrol.
(4) Coal is also used in preparation of synthetic natural gas.
(5) The destructive distillation of coal gives coke, coal tar, coal gas etc.
(6) Coal is the source from which a number of organic compounds such as benzene, toluene, phenol, aniline, naphthalene and anthracene are obtained

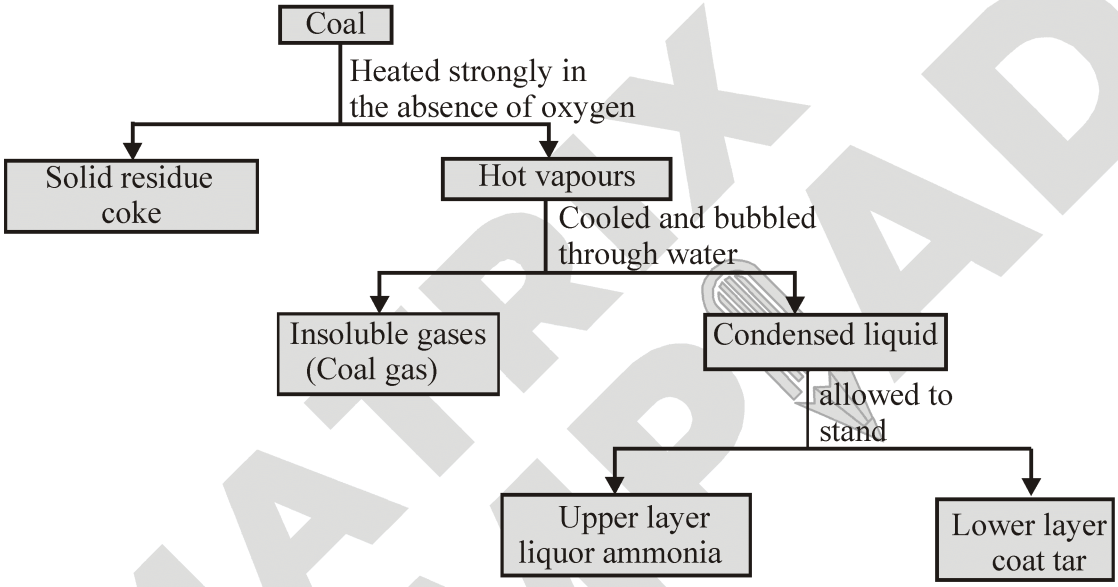


Figure : Destrucrtive Distilation of coal

3. PETROLEUM AND NATURAL GAS

3.1 PETROLEUM

Petroleum is a naturally occurring oil that consists chiefly of hydrocarbons with some other elements such as sulphur, oxygen and nitrogen. The unrefined form of petroleum is called crude oil.

Focus Point

- Petroleum is also called rock oil i.e. petra = rock, oleum = oil.
- The first oil well was found in Pennsylvania in USA in 1859. In India ,first oil well was found in 1867 in Digboi, Assam.
- The marine animals and plants which are burried under sea bed, get converted into petroleum.
- Petrol obtained from petroleum is used as a fuel.

♦ **Deposits :**

The major reserves of petroleum are in Saudi Arabia (largest producer of petroleum), Kuwait, Iraq, Russia, China,USA, Libya etc. The oil is obtained by drilling an oil well. When a well is drilled, natural gas comes out with great force. The crude oil comes out on its own due to gas pressure. After the pressure has subsided, it is pumped out of the well.

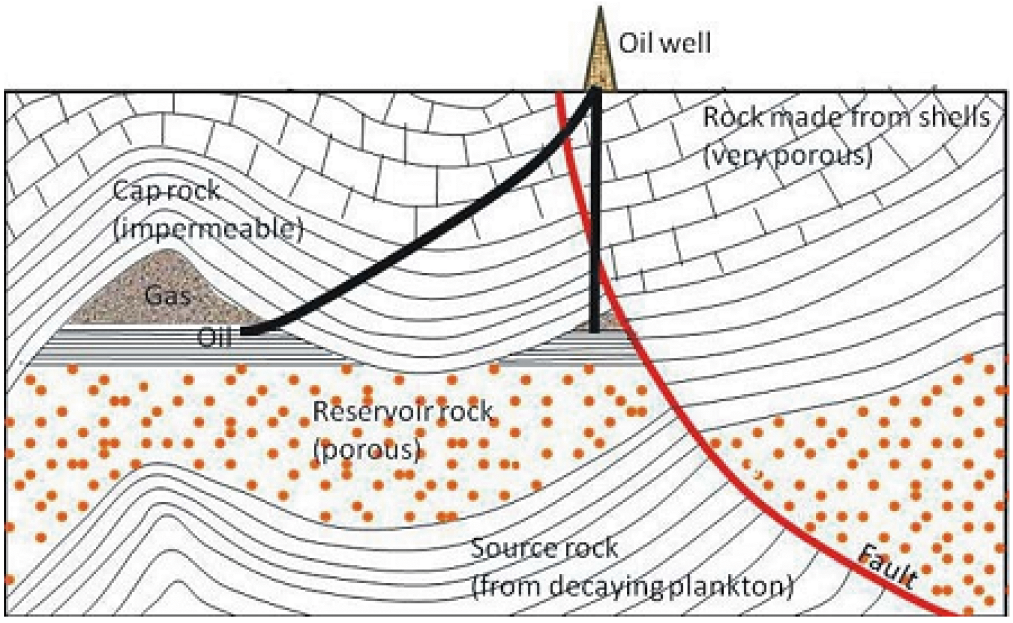


Figure : Formation of petroleum

♦ **Formation :**

It is believed that petroleum was formed from organisms living in the sea. The remains of these organisms were deposited in shallow depressions in the sea bed long long ago. These were covered by layers of sand and clay which compressed these remains. Over a period of millions of years, the organic matter present in the dead organisms underwent a series of processes before being finally transformed into petroleum. The petroleum so formed migrated from the source rock to be entrapped in large underground reservoirs beneath impermeable rocks. It often floats over a layer of water and is held in this position under pressure beneath a layer of natural gas.

♦ **Refining of petroleum :**

(i) Petroleum is a mixture of several hydrocarbons. It is a foul - smelling brown black liquid. It also contains water, salt and rocky materials. It cannot be used in this crude form either as a fuel or as a basic material to produce other useful components. Before being put to use, it has to be purified or refined.

(ii) The process of separating the various components of petroleum from one another is known as the refining of petroleum. This is done by a process called fractional distillation which is based on the fact that the different components of petroleum have distinctly different boiling points.

(iii) The components of petroleum are separated in a large fractionating column. Crude oil is piped to the refinery from a well. It is washed with acid and alkali (like solution) solutions to remove the basic and acidic impurities respectively. Crude oil is now heated to about 673K.

(iv) All the components except asphalt are converted in the vapour state. As the mixture of hot vapours rises up in the column, it begins to cool. The component with the highest boiling point condenses first and is collected. Those with low boiling points condense later. The residual gases escape uncondensed from the upper part of the column.

(v) The various components condensed at different heights of the column are collected separately. The components obtained at different heights in order from the bottom are asphalt, lubricating oil, paraffin wax, fuel oil, diesel, kerosene, petrol and petroleum gas.

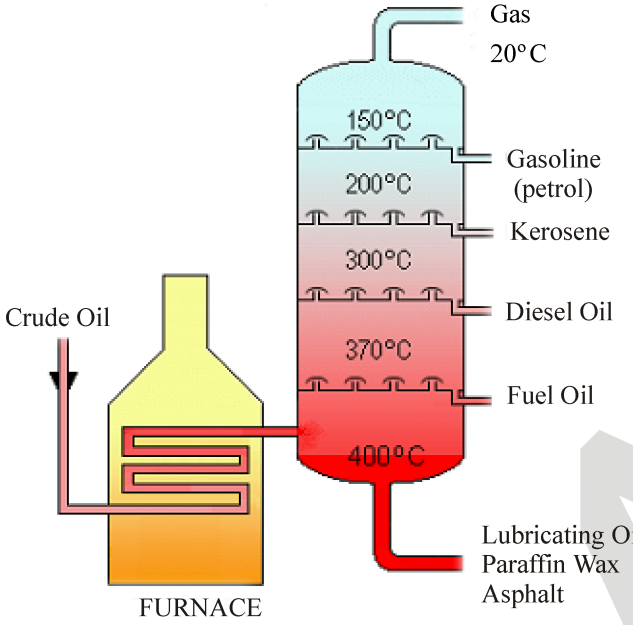


Figure : Fractional distillation of petroleum

♦ **Products of fractional distillation of petroleum :**

(a) Petroleum Gas : It is a mixture of ethane, propane and butane. Its main constituent is butane which burns by giving off a lot of heat. Butane is easily liquefied under high pressure. In the liquid form it is supplied in cylinders and is commonly known as Liquefied Petroleum Gas (LPG). It is a colourless, odourless and inflammable gas. A domestic gas cylinder contains about 14.2 kg of LPG. Liquified petroleum gas is the most commonly used as as a domestic fuel.

Focus Point

- A strong smelling substance called ethyl mercaptan (C_2H_5SH) is added to LPG to detect the leakage of gas from the cylinder. On being lighted, it burns with a blue flame. One gram of LPG produces about 50 KJ of heat.
- Oil shales are source rocks that have not been exposed to heat or pressure long enough to convert their trapped hydrocarbons to crude oil.
- The first oil well was drilled in Pennsylvania, USA in 1859. The oldest oil refinery in India is located at Digboi.
- In india, oil is found in Assam, Gujarat, Mumbai High and in the river basins of Godavari and Krishna.

LPG should be used with care. Any accidental leakage can cause an explosion. If there is any leakage of gas from the cylinder, the following precautions should be immediately taken –

(i) Any open flame in the vicinity of the gas should immediately be extinguished.

(ii) All doors and windows of the room in which the cylinder is kept should be opened to allow the gas to escape.

(iii) The tube and joints attached to the cylinder should be systematically checked for defects.

(b) Petrol : It is also called gasoline. It is used as a fuel in two - wheelers, three - wheelers and cars. It is also used as a solvent for the dry cleaning of clothes.

(c) Kerosene : It is used for domestic purpose, for lighting petromax, lanterns, lamps, stoves, etc. It is also used for making oil gas. A special grade of kerosene is used as aviation fuel in aeroplane jet engines.

(d) Diesel oil : It is used in cars, trucks, buses and locomotives. It is also used to run pumps in fields and in electric generators.

(e) Fuel oil : It is used in industries to heat boilers and furnace. It is a better fuel than coal because it burns completely leaving behind no ash, whereas coal burns producing a large amount of ash which has to be removed regularly.

(f) Lubricating oil : It is obtained by the fractionation of residual oil. It is used for lubricating machinery.

(g) Paraffin wax : It is obtained by the fractionation of residual oil. It is used for making candles, ointments, vaseline, grease, polishes etc. It is also used for water proofing of paper cartons.

(h) Residual oil : The residual oil obtained from the primary distillation of petroleum is known as reduced crude. Reduced crude is distilled in vaccum to yield bitumen (asphalt) as residue. Bitumen is largely used in making road surfaces, and also for coating cables to provide electrical insulation.

♦ Uses of different constituents of petroleum :

S.No.	Constituents of Petroleum	Uses
1.	Petroleum Gas in Liquid form (LPG)	Fuel for home and industry
2.	Petrol	Motor fuel, aviation fuel, solvent for dry cleaning
3.	Kerosene	Fuel for stoves, lamps and for jet aircrafts
4.	Diesel	Fuel for heavy motor vehicles, electric generators
5.	Lubricating oil	Lubrication
6.	Paraffin wax	Ointments, candles, vaseline etc.
7.	Bitumen	Paints, road surfacing

Focus Point

- The Indian Petrochemical Corporation Limited (IPCL) in Vadodara (Baroda) is one of the largest petrochemical units in the world.
- The main component of crude oil is hydrocarbon, which contains a lot of energy.
- Each fraction obtained during fraction distillation is not a single hydrocarbon but the mixture of a number of hydrocarbons.
- Oil eating bacteria in water bodies, biodegrade oil that has escaped to the surface.

3.2 NATURAL GAS

Natural gas is a naturally occurring mixture of gaseous hydrocarbons. It is found in porous sedimentary rocks in the earth's crust, usually in association with petroleum deposits. In India natural gas has been found in Tripura, Rajasthan, Maharashtra and in Krishna-Godavari delta.

Natural gas consists mainly of methane (CH_4) (about 85%), ethane (C_2H_6) (up to about 10%), propane (about 3%) and butane. Carbon dioxide, nitrogen, oxygen, hydrogen sulphide and sometimes helium may also be present.

Natural gas may be obtained from the earth's crust by digging wells in prospective areas. There are some wells which give out only natural gas, but most wells produce natural gas as well as petroleum. In fact, natural gas is obtained as a co-product in petroleum mining. Natural gas is formed from the decomposition of organic matter buried under sea beds millions of years ago.

♦ **Uses of natural gas :**

- Natural gas is used as a domestic and industrial fuel. Natural gas burns readily to produce a lot of heat. So, in many areas, natural gas is used as the main fuel for domestic and industrial heating purposes.

  Natural gas is called a clean fuel because it burns without producing smoke and causes no air pollution. Natural gas also does not produce any poisonous gases on burning. Moreover, it does not leave behind any residue on burning.
- These days natural gas is being used as a fuel in automobiles (cars, buses and trucks) in place of petrol and diesel. Natural gas is used as Compressed Natural Gas (CNG) in vehicles. CNG is being used as a fuel in automobiles to reduce air pollution.

Focus Point

- Natural gas is an almost ideal fuel. It produces large amount of heat (calorific value 55 KJ/g) when burnt.
- ONGC (Oil and natural gas corporation limited) is India's largest oil and gas explaration and production company.
- Hydrogen gas is an important product obtained from natural gas which is used in the production of fertiliser (urea).
- Amongst all fuels, hydrogen has the highest calorific value.

4. CONSERVATION OF FOSSIL FUELS

Coal and petroleum are fossil fuels, which took millions of years to form, will last only a few hundred years. This is so because they are being used recklessly. Moreover, burning of these fuels is a major cause of air pollution. It is thus necessary to use these fuels only when absolutely necessary.

In India, the Petroleum Conservation Research Association (PCRA) has provided some tips to advise people how to save petrol/diesel. These tips are :

(a) Drive at a constant and moderate speed as far as possible.

(b) Switch off the engine at traffic lights or at a place where you have to wait.

(c) Ensure correct tyre pressure.

(d) Ensure regular maintenance of the vehicle.

Focus Point

- Many museums use natural gas-fueled equipment not only to keep the lights on, but also to help maintain the proper humidity for conservation of art, fabrics and historic papers.

5. ALTERNATIVE SOURCES OF ENERGY

Some non-converntional sources of energy are also being tapped, e.g. solar energy, wind energy, various forms of ocean wave energy and ocean thermal energy, etc.

♦ **Solar Energy**

Solar energy be used directly to heat water. This hot water may be used directly in homes or used to generate steam in order to produce electricity. Solar dishes and parabolic reflectors are used to concentrate the Sun's energy and focus it. The reflectors are so designed that they can follow the Sun dawn to dusk.

Solar energy can also be converted directly into electricity, using photovoltaic or solar cells. The electricity is stored in batteries and used as needed. Solar energy can be used directly for cooking as well.

♦ **Wind Energy**

In earlier years, people used windmills to grind corn and pump water. Modern windmills can be used to turn turbines and generate electricity.

Focus Point

- Sugarcane is fermented to make alcohol which can be burnt to generate power. Alternatively, the cane can be crushed and the pulp (called bagasse) can be brunt, to make steam to drive turbines.

- **Hydroelectric power :** Hydroelectric power is electricity generated from the energy of falling water. It is an excellent energy source, and electricity has been generated in this way for some time. It is a very cheap source of electricity. One of the main advantage of this system is that it can be quickly used to supplement the national grid at times of high demand. A disadvantage of hydroelectric power schemes is that they often require valleys to be flooded and communities to be moved.
- **Tidal energy :** The ebb and flow of the tides drives turbines built into a dam or barrage across an estuary where the height difference betweeen high and low tides is large but there would be environmental disadvantages with such a scheme. For example, there would be a threat to the wild life around the estuary.
- **Geothermal energy :** Water is pumped into hot rocks in the Earth's crust far below the ground level. The internal heat of rocks converts the water to steam, which is used to drive turbines and hence generate electricity. This is a major source of electrical energy in Iceland. Geothermal energy is a natural, non-polluting source of energy.

Focus Point

Hydrogen - The Fuel of The Future

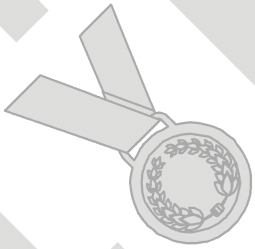
- It is widely believed that hydrogen will play an important part as a fuel in the future. It is already being trailed by major motor manufactureres as an alternative to fossil fuels such as petrol.
- Hydrogen burns cleanly to form water :

  Hydrogen + Oxygen $\rightarrow$ Water

  $2H_2(g)$ + $O_2(g)$ $\rightarrow$ $2H_2O(l)$
- Hence virtually no exhaust pollution is created. Also, hydrogen can be obtained in an almost unlimited supply from water by electrolysis. However, at presenty it is a costly alternative.

Focus Point

- The total fossil fuel used in the year 1997 is the result of 422 years of all plant matter that grew on the entire surface and in all the oceans of the ancient earth.
- When coal is preserved under the right pressure and temperature for ten thousands of years you may get diamonds from these coal pieces. Diamond and coal are both made up of carbon particles. Diamond is one of the purest form of carbon.
- Coke may burn with little or no smoke under combustible conditions, while bituminous coal would produce much smoke.



NATURAL RESOURCES

Various materials which are obtained from nature are called resources

Exhaustible natural resources

These are available in limited amount and can be exhausted by human activities, e.g. forests, mineral, coal, petroleum, natural gas, etc.

Fossil fuels

The exhaustible natural resources which are formed from the dead remain of living organisms are called fossil fuels.

Inexhaustible natural resources

These are resources cannot be exhausted by human activities, e.g. sunlight, air

Coal

Under high pressure and temperature, dead plants slowly convert into coal, this process is called carbonisation.
Coal + air→CO_2(mainly)

Petroleum

Dead sea organisms at high temperature and pressure transformed into petroleum and natural gas over millions of years

Natural gas

- It is formed from sea organisms.
- Used as fuel CNG (compressed natural gas)

Used for preparing different starting materials of chemicals and fertilizers.

Coke

- It is tough, porous and black.
- Pure form of carbon.
- Used in manufacturing of steel.

Refining of petroleum

The process of separating the various constituents of petroleum is known as refining.

Coal tar

- Black and thick liquid.
- Used in manufacturing synthetic dyes, paints, explosive, drugs.
- Naphthalene balls are also obtained by coal tar.

Constituents of petroleum

- Petroleum gas→ Fuel for home
- Petrols→ Fuel for automobiles
- Kerosene → Fuel for stoves and lamps

Diesel → Fuel for electric generator and heavy vehicles

- Lubricating oil → Lubrication
- Paraffin wax → Candle, ointments

Bitumen → Paints

Coal gas

Used as source of heat.
Used as fuel in many industries.

Fuels

Hydrogen as fuel

Hydrogen is considered the best fuel as it has the highest calorific value.

- However, as it is highly inflammable, there are difficulties associated with its transport, storage, and handling, It is, therefore, used as a fuel only where it is absolutely necessary (e.g., as rocket fuel).

Methane and LPG as fuels

- Both methane and LPG have fairly high calorific values. They burn with a smokeless fire and therefore, do not cause pollution.
- They are also easily stored and transported *via* cylinders or pipelines. Hence, they are ideal for use as domestic fuels.

Petrol and diesel as fuels

- Both petrol and diesel are mainly use in automobiles. Their main disadvatage is their limited availability.

Another disadvantage is that their combustion releases harmful gases into the atmosphere.

Fuels

Biofuels are fuels obtained from renewable biological sources like crops and animal wastes, which can be used to supplement or replace fossil fuels. Ethanol, methanol, and biodiesel are examples of biofuels.

SOLVED EXAMPLES

SE. 1

What is coal tar? Write its uses.

Ans. Coal tar is a thick black liquid formed during destructive distillation of coal. It is a mixture of about 200 substances which are mainly aromatic hydrocarbons.

Uses :

(i) It is used as a source of hydrocarbons.

(ii) It is used to get naphthalene and many other useful products. Naphthalene is used as a moth and insect repellent.

(iii) It is used in making road surfaces.

(iv) It is used to manufacture synthetic dyes, drugs, explosives, perfumes, plastics, paints, photographic materials, roofing materials, etc.

SE. 2

What are renewable and non-renewable natural resources?

Ans. **Renewable resources :** Renewable resources are those which either never run out, or those that are replaced within a reasonable period of time through natural processes. These are inexhaustible resources. Examples: Air, solar radiations and water.

Non-renewable resources : Non-renewable resources are those which once exhausted cannot be replenished within a short span of time. They take millions of years to get replenished. Hence, they are exhaustible resources. Examples : Coal and petroleum.

SE. 3

How do natural resources maintain a balance in nature?

Ans. The natural resources are interdependent. Many of the resources remain more or less constant because they are cycled within the environment by natural processes. Such resources when used are reproduced in nature over a period of time.

SE. 4

What are the different types of coal. Describe briefly.

Ans. Coal is mainly classified into three main types, depending upon the amount of carbon present in them. These are listed in the following table :

Type	Carbon content	Properties
Peat	50 - 60%	Brown in colour, soft
Lignite	60 - 70%	Black in colour, breaks very easily
Bituminous	75 - 80%	Black and hard
Anthracite	90 - 95%	Shiny black, very hard.

SE. 5

Why should coal and petroleum be conserved?

Ans. Today coal and petroleum are the chief sources of energy. Since, these are non-renewable resources, they should be conserved and used with frugality so that their sustainability may not be disturbed. If they are used less and conserved, they will last for a longer time since they cannot be formed in near future. Once they are over, we will have to manage only with the alternative sources of energy.

SE. 6

Classify the natural resources on the basis of their availability.

Ans. On the basis of the availability, various natural resources can be classified in the following two groups:

(i) Inexhaustible natural resources like air, water, sunlight, etc.

(ii) Exhaustible natural resources like forests, wildlife, mineral, coal, petroleum, etc.

SE. 7

What is a refinery? What is meant by refining of petroleum?

Ans. The plant (place) where crude oil is processed and refined into more useful petroleum products, is called a refinery. The process of separation of various fractions of petroleum by the process of fractional distillation is called refining of petroleum.

SE. 8

How is coke formed? Write its uses.

Ans. When coal is heated in absence of oxygen, the process is known as destructive distillation. During destructive distillation of wood, when the gaseous component (coal gas), liquid components (coal tar) and ammonia are removed, the black residue which is left is called coke. It is almost pure form of carbon. It is used in extraction of metals like iron in blast furnace and manufacture of steel by mixing it with iron.

SE. 9

Briefly explain the following:

(a) Water gas (b) Producer gas

Ans. (a) When steam is passed over red hot coke, it produces water gas which is a fuel gas. It is a mixture of carbon monoxide and hydrogen.

$$\underset{\text{Coke}}{C} + H_2O \longrightarrow \underbrace{CO + H_2}_{\text{water gas}}$$

(b) When air is passed over red hot coke, producer gas, which is a mixture of carbon monoxide and nitrogen, is formed.

$$\underset{\text{Coke}}{2C} + \underbrace{O_2 + 4N_2}_{\text{Air}} \longrightarrow \underbrace{2CO + 4N_2}_{\text{Producer gas}}$$

SE. 10

What are petrochemicals? What are their uses?

Ans. Many useful substances are obtained from petroleum and natural gas. These are called petrochemicals. Petrochemicals are used in the manufacture of fibres, polythene, plastics, fertilizers, dyes and drugs etc.

SE. 11

How does coal mining affect the environment?

Ans. Coal mining, causes many adverse environmental impacts. During mining of coal, a lot of methane, which is a dangerous greenhouse gas is released. It also interferes with groundwater and water table levels. Inhaling coal dust is harmful for humans.

Burning of coal, in addition greatly contributes to 'greenhouse gas' emissions, climate change and global warming. Strip mining (removal of soil and rock) severely alters the landscape, which damages the environmental value of the surrounding land.

Mountain top removal to extract coal is taken to be a large negative change to the environment.

SE. 12

What is global warming?

Ans. It is the rise in the average temperature of the earth's atmosphere. It results in melting of glaciers which leads to a rise in sea level causing floods in coastal areas. Global warming also results in change in weather's temperature and season's patterns. It is generally caused by increase in greenhouse gases especially carbon dioxide.

SE. 13

Is coke a better fuel than coal?

Ans. Yes. This is because coke does not produce smoke on burning and also coke produces more heat on burning as compared to coal.

SE. 14

Suggest some ways to conserve coal and petroleum.

Ans. (i) Coal and petroleum should be used as judiciously as possible. In order to protect the overuse of petrol, car pool may be encouraged or wherever possible the use of personal vehicles should be avoided.

(ii) Alternative sources of energy should be put to use.

(iii) Vehicles and engines must be tuned and maintained well to make them fuel efficient.

(iv) Wastage of energy like electricity, cooking gas, etc. should be checked.

SE. 15

Are all natural resources inexhaustible?

Ans. No, all natural resources are not inexhaustible. Those resources which are depleted at a faster rate than the rate at which they are replenished like, coal and petroleum are exhaustible. Those resources which are freely available like sunlight, wind, etc. are inexhaustible.

NS. 1

What are the advantages of using CNG and LPG as fuels?

Ans. The advantages of using CNG and LPG as fuels are as follows :

(i) CNG and LPG both are clean fuels.

(ii) Their cost is low.

(iii) They burn with a blue flame without any smoke.

Thus, they do not blacken utensils and pollute air.

(iv) They are very easy to handle, ignite and to put off.

(v) They have a very high calorific values.

(vi) They are easily available.

NS. 2

Name the petroleum product used for surfacing of roads.

Ans. Bitumen is the petroleum product used for surfacing of roads.

NS. 3

Describe how coal is formed from dead vegetation. What is this process called?

Ans. About 300 million years ago, there were dense forests in low-lying wetland areas on the earth. As the trees died, they got covered with sand and mud. More trees grew on this sand and mud. When these died, they too got covered. Sometimes earthquake and volcanoes buried entire forests deep down in the earth. The high temperature and high pressure inside the earth slowly converted the buried vegetation into coal. A coal contains mainly carbon. Thus, this slow process of conversion of wood into coal is called carbonization.

NS. 4

Fill in the blanks.

(a) Fossil fuels are ..... and .....

(b) Process of separation of different constituents from petroleum is called .....

(c) Least polluting fuel for vehicles is .....

Ans. (a) coal, petroleum, natural gas

(b) refining

(c) CNG

NS. 5

Tick true/false against the following statements.

(a) Fossil fuels can be made in the laboratory.

(b) CNG is more polluting fuel than petrol.

(c) Coke is almost pure form of carbon.

(d) Coal tar is a mixture of various substances.

(e) Kerosene is not a fossil fuel.

Ans. (a) False

(b) False

(c) True

(d) True

(e) False

NS. 6

Explain why fossil fuels are exhaustible natural resources.

Ans. Fossil fuels are limited in the nature and can be exhausted very soon by human activities. So fossil fuels are called exhaustible natural resources.

NS. 7

Describe characteristics and uses of coke.

Ans. Characteristics of coke :

(i) It is an almost pure form of carbon.

(ii) It is porous and black substance.

(iii) It is a bad conductor of heat and electricity.

(iv) It is tough.

Uses of coke :

(i) It burns easily and does not produce any smoke.

(ii) It is a very good reducing agent.

(iii) It is used in the manufacture of gaseous fuel. e.g., producer gas (N_2 + CO) and water gas (H_2 + CO).

(iv) It is used in the manufacture of steel and in the extraction of many metals.

NS. 8

Explain the process of formation of petroleum.

Ans. Petroleum is formed from the remains of tiny sea animals and plants that lived millions of years ago. As these organisms died, their bodies settled at the bottom of the sea and got covered with layers of sand and clay. In absence of air, high temperature and high pressure transformed the dead organisms into petroleum and natural gas.

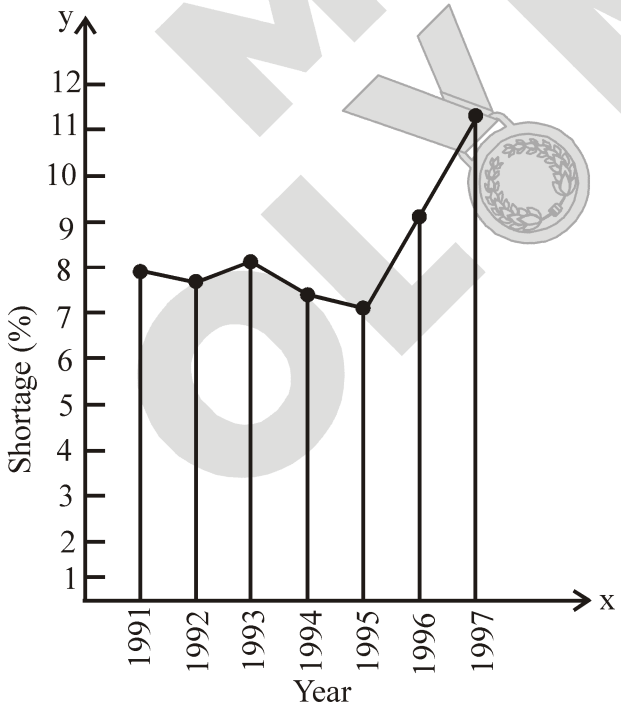
NS. 9

The following table shows the total power shortage in India from 1991-1997. Show the data in the form of graph. Plot shortage percentage for the year on the y-axis and the year on x-axis.

S.No	Year	Shortage(%)
1.	1991	7.9
2.	1992	7.8
3.	1993	8.3
4.	1994	7.4
5.	1995	7.1
6.	1996	9.2
7.	1997	11.5

Ans. Scale : Along x-axis : 1 unit = 1 year

Along y-axis : 1 unit = 1%



Space for Notes :

EXERCISE – I

ONLY ONE CORRECT TYPE

1. Main constituents of coal gas are –
   (A) H_2O, C_2H_6, O_2 (B) CH_4,CO_2,O_2
   (C) CH_4, H_2, CO (D) C_2H_6, N_2, O_2
2. Ammonical liquor is –
   (A) Ammonia absorbed in water
   (B) Ammonium hydroxide
   (C) Aqueous solution of ammonia
   (D) All of the above
3. Which of the following products obtained by destructive distillation of coal is not properly matched?
   (A) Coal tar - Dyes, explosives, paints
   (B) Coal gas – Fuel
   (C) Coke - Drinking purposes
   (D) Ammonical liquor – Fertilizers
4. Which is the superior quality of coal ?
   (A) Anthracite (B) Peat
   (C) Lignite (D) Bituminous
5. Least carbon containing coal is-
   (A) Peat (B) Lignite
   (C) Bituminous (D) Anthracite
6. Which of the following names represents the foul smelling, black, thick, viscous liquid obtained from destructive distillation of coal ?
   (A) Coke (B) Coal tar
   (C) Coal gas (D) None of these
7. Formation of coal from plant matter is called :
   (A) Destructive distillation
   (B) Carbonization
   (C) Both (A) & (B)
   (D) None of these
8. Coal and petroleum are :
   (A) Inexhaustible resources
   (B) Fossil fuels
   (C) Renewable resources
   (D) All of these
9. Heating of coal in the absence of air is called :
   (A) Destructive distillation
   (B) Carbonization
   (C) Both (A) & (B)
   (D) None of these
10. Producer gas is a mixture of :
    (A) CO and H_2 (B) CO and N_2
    (C) CO and H_2 (D) none of these
11. The distillation of crude petroleum to obtain various commercially useful fraction is called :-
    (A) Compression (B) Refining
    (C) Mining (D) None of these
12. Which of the following is used for refining of petroleum ?
    (A) Steam distillation
    (B) Distillation under reduced pressure
    (C) Solvent extraction
    (D) Fractional distillation
13. Which one of the following is not a petroleum product ?
    (A) Kerosene (B) Gasoline
    (C) Asphalt (D) Bees wax
14. The amount of LPG in a domestic gas cylinder is about –
    (A) 14.2 Kg (B) 13.2 kg
    (C) 12.2 Kg (D) 11.2 Kg
15. CNG stands for :
    (A) Conventional Natural Gas
    (B) Coal and Natural Gas
    (C) Compressed Natural Gas
    (D) Commercial Natural Gas
16. The main constituent of natural gas is –
    (A) Butane (B) Ethane
    (C) Propane (D) Methane
17. Largest producer of petroleum is :
    (A) China (B) Saudi Arabia
    (C) India (D) Japan
18. The substance added to detect the leakage of LPG is –
    (A) Methyl mercaptan
    (B) Ethyl mercaptan
    (C) Both (A) and (B)
    (D) None of these
19. Which of the following is used as a household fuel?
    (A) Gasoline (B) Paraffin wax
    (C) Kerosene (D) All of these

20. Which of the following is not true for natural gas ?
(A) It is generally found with petroleum deposits
(B) It can be liquefied under pressure
(C) It is a rich source of hydrogen
(D) It has a low calorific value

21. Petrol is used as a fuel in light automobiles such as motorcycles, scooters and cars while heavy vehicles like trucks and tractors run on.
(A) Diesel
(B) Fuel oil
(C) Lubricating oil
(D) Petroleum gas

22. 'P' is processed in industries to get some useful products such as 'Q', 'R' and 'S'. 'S' is obtained during the processing of 'P' to get 'Q', 'R' is a mixture of about 200 substance. Identify 'P', 'Q' 'R' and 'S' :

	P	Q	R	S
(A)	Coal	Coal tar	Coke	Coal gas
(B)	Coke	Coal	Coal tar	Coal gas
(C)	Coal	Coke	Coal tar	Coal gas
(D)	Coke	Coal	Coal gas	Coal tar

23. Which of the following is not a renewable energy?
(A) Nuclear energy
(B) Hydropowder energy
(C) Geothermal energy
(D) Solar energy

24. Which of the following is an incorrect match?
(A) An oily liquid formed when coal is heated in absence of air - Coal tar
(B) A gas found along with petroleum in reservoirs under the ground - Natural gas
(C) A thick black liquid found trapped in underground rocks - Petroleum
(D) A residue left behind when destructive distillation of coal is carried out - Charcoal

25. Which fraction of petroleum is used in making skin ointments and vaseline?
(A) Lubricating oil (B) Paraffin wax
(C) Bitumen (D) Fuel oil

PARAGRAPH TYPE

Paragraph # 1

When petroleum is extracted directly from the ground, it is referred to as crude oil. Crude oil was first extracted from the ground in china roughly 2500 years ago. Black gold is another name of pertoleum. 'The mother of all goods', as it is also known. This is primarily owing to the fact that crude oil is used to make gasoline, plastics, pharmaceuticals, synthetic fabrics and a variety of other items. It is compsed of a complicated mixture of hydrocarbon molecules and other chemical compounds. The petroleum by products are kerosene, pitch black, butane, diesel fuel, fuel oil, gasoline, paraffin wax etc.

26. What is the anothe name of petroleum ?
(A) Black gold (B) Crude oil
(C) Both (A) and (B) (D) None of these

27. Which of the following is not a petroleum products.
(A) kerosene (B) Beeswax
(C) Pitch black (D) None of the above

28. Petroleum is first extracted in_____ roughly 2500 years ago.
(A) India (B) Australia
(C) China (D) England

Paragraph # 2

About 300 million years ago the earth had dense forests in low lying wetland areas. Due to natural prioceses, like flooding, these forests got buried under the soil. As more soil deposited over them, they were compressed. The temperature also rose as they sank deeper and deeper. Under high pressure and high temperature, dead plants got slowly converted to coal. As coal contains mainly carbon, the slow process fof conversion of dead vegetation into coal is called carbonisation. Since it was formed from the remains of vegetation, coal is also called a fossil fuel.

29. When coal burns in air then_____
(A) Co_2 is formed (B) So_2 is formed
(C) Co is formed (D) H_2 is formed

30. What is the sources of coal formation.
(A) Plants (B) Animals
(C) Both A&B (C) None of these

31. By which of the given process is coal formed?
(A) Carbonisation (B) Distillation
(C) Vaporization (D) Evaporation

MATCH THE COLUMN TYPE

32.

Column-I (Type of coal)	**Column-II (% of carbon content)**
(P) Peat	(i) 90-95
(Q) Lignite	(ii) 50-60
(R) Anthracite	(iii) 75-80
(S) Bituminous	(iv) 60-70

(A) P → iv, Q → iii, R → ii, S → i
(B) P → ii, Q → iv, R → i, S → iii
(C) P → ii, Q → iii, R → iv, S → i
(D) P → i, Q → iii, R → ii, S → iv

33.

Column-I	**Column-II**
(P) Kerosene	(i) Road surfacing
(Q) Paraffin wax	(ii) Fuel for vehicles
(R) Bitumen	(iii)Manufacturing candles
(S) Gasoline	(iv) Jet engine fuel

(A) P → iv, Q → iii, R → i, S → iii
(B) P → ii, Q → iv, R → i, S → iii
(C) P → ii, Q → iii, R → iv, S → i
(D) P → i, Q → iii, R → ii, S → iv

Space for Notes :

EXERCISE – II

VERY SHORT ANSWER TYPE

1. Give an example of exhaustible natural resource.
2. Write the name of best quality of coal which contain maximum amount of carbon among the all varities.
3. What is the main constituent of coal ?
4. By which substance coal tar is being replaced now a days ?
5. What is producer gas?
6. What is the calorific value of natural gas ?
7. What is crude oil ?
8. What is the use of Bitumen?
9. Where was the first oil well drilled ?
10. Which country is largest producer of petroleum ?

SHORT ANSWER TYPE

1. Write the products obtained by processing of coal.
2. What are the natural resources?
3. What are the fossil fuels? Explain with examples.
4. Why should we use the fossil fuels economically and wisely ?
5. Explain the term carbonisation?

LONG ANSWER TYPE

1. Differentiate between inexhaustible and exhaustible natural resources.
2. Give the uses of the following :
   (i) coke (ii) coal tar (iii) coal gas
3. Name and describe the different varieties of coal.
4. Write a short note on the formation of coal.
5. Explain the process of refining of petroleum in detail.

FILL IN THE BLANKS

1. The resources that are naturally regenerated after consumption are called _____resources.
2. Fractional distillation takes place because the different substances in the mixture have different _____.
3. The slow process of conversion of dead vegetation into coal is called _____.
4. On burning coal produces carbon dioxide, nitrogen dioxide and large amount of _____.
5. _____ has highest carbon content 98% and has highest heat value.

TRUE AND FALSE

1. Petroleum is a non-renewable resource that can be recycled.
2. In a fractionating column, the fractions having high boiling points are present at the bottom of column.
3. Coal tar is a white thick liquid with a pleasant smell.
4. The crude oil is heated strongly in a distillation column.
5. Time and technology can change substances into resources.

Answer Key

EXERCISE–I														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C	D	C	A	A	B	B	B	A	B	B	D	D	A	C
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	B	B	C	D	A	C	A	D	B	C	B	C	A	C
31	32	33												
A	B	A												

EXERCISE II

FILL IN THE BLANKS

1. Renewable **2.** Boiling point **3.** Carbonization **4.** SO_2 **5.** Anthracite

TRUE / FALSE

1. F **2.** T **3.** F **4.** T **5.** T

SELF PROGRESS ASSESSMENT FRAMEWORK

(CHAPTER : COAL AND PETROLEUM)

CONTENT	STATUS	DATE OF COMPLETION	SELF SIGNATURE
Theory			
In-Text Examples			
Solved Examples			
NCERT Exercises			
Exercise I			
Exercise II			
Short Note-1			
Revision - 1			
Revision - 2			
Revision - 3			
Remark			

NOTES :

1. In the status, put "completed" only when you have thoroughly worked through this particular section.

2. Always remember to put down the date of completion correctly. It will help you in future at the time of revision.

Space for Notes :