

About the Book

This book has been specially designed for students preparing for the Jawahar Navodaya Vidyalaya Class 9th Entrance Examination 2027. This comprehensive, syllabus-based study book provides strong concept clarity, ample practice and exam-oriented preparation.


Key Features of the Book:

- ✓ This book is fully revised and updated according to the latest NCERT textbooks and the syllabus of the Jawahar Navodaya Vidyalaya Class 9th Entrance Examination.
- ✓ Detailed and chapterwise coverage of all subjects including General Science, Mathematics, Hindi and English is provided in a single book.
- ✓ 1800+ chapterwise practice questions are included to strengthen concepts and improve problem-solving speed.
- ✓ Solved Paper of the year 2026 is included to help students understand the real exam pattern and level of questions.
- ✓ The theory section is explained in simple and clear language so that students can easily understand every topic.
- ✓ Special focus has been given to frequently asked and important topics for the examination.
- ✓ This study book is a balanced combination of Theory + Practice Questions + PYQs + Solved Paper, ensuring smart revision and better time management.

With the help of this study book, students can give the right direction to their preparation, strengthen weak areas and move confidently towards success in the Jawahar Navodaya Vidyalaya Class 9th Entrance Examination 2027.

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Class 9th Entrance Exam
Study Book

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Jawahar Navodaya Vidyalaya Class 9th Entrance Exam Study Book

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AGRAWAL EXAMCART

Conducted By Navodaya Vidyalaya Samiti

JAWAHAR NAVODAYA VIDYALAYA

(Class 9th)
Entrance Exam 2027

COMPLETE STUDY BOOK

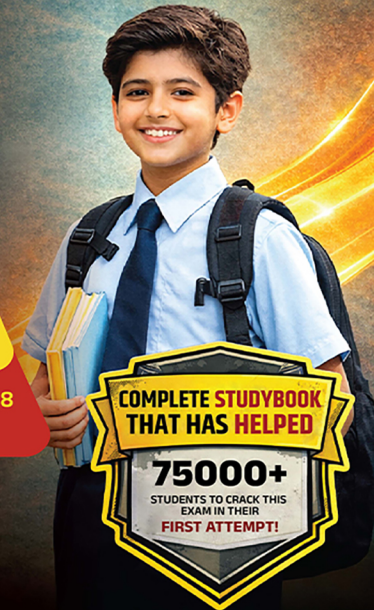
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General Science

Chapter No.	Chapter's Name (Complete Theory)	Practice Questions	PYQs (2007-2025)	Page No.
1.	Heat, Fossil Fuel (Coal and Petroleum), Calorific Value and Combustion of Flame	5	31	1-9
2.	Cell Structure and Functions	24	14	10-16
3.	Life Process of Plants and Animals	9	38	17-38
4.	Motion, Force, Friction (Relation Between Different Types of Friction) and Pressure	19	46	39-47
5.	Sound and Its Basics	14	19	48-52
6.	Reflection, Refraction and Dispersion of Light	15	38	53-62
7.	Metals and Non-Metals	10	34	63-69
8.	Synthetic Fibres and Plastics	15	27	70-78
9.	Magnet, Electric Current, Chemical Effects of Electric Current and Electroplating	21	35	79-86
10.	Stars and Solar Systems	26	19	87-97
11.	Pollution (Air, Water & Soil) and Global Warming	15	31	98-105
12.	Micro-Organisms and Food	14	30	106-118
13.	Some Natural Phenomenon, (Natural Calamities and Disaster Management)	15	3	119-124
14.	Crop Production, Cropping Seasons and Agricultural Practices	8	31	125-130
15.	Conservation of Plants and Animals (Biosphere Reserves, National Parks and Sanctuaries)	18	13	131-137
16.	Reaching Age of Adolescence, Change During Puberty, Endocrine Glands and Hormones	17	20	138-145
	Total Questions	245	429	

Mathematics

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2.	Square and Square Roots	35	36	11-14
3.	Cube and Cube Roots	38	24	15-17
4.	Exponents and Powers	31	26	18-22
5.	Ratio-Proportion	39	15	23-26
6.	Percentage	45	14	27-30
7.	Profit-Loss and Discount	56	24	31-35
8.	Simple Interest	57	5	36-39
9.	Compound Interest	30	16	40-43
10.	Time and Work	60	16	44-48
11.	Time, Speed and Distance	33	24	49-53
12.	Algebraic Expressions and Identities Including Factorization	45	51	54-60
13.	Linear Equations In One Variable	26	33	61-67
14.	Geometry	17	—	68-74
15.	Understanding Quadrilaterals (Parallelogram, Rhombus, Rectangle, Square, Kite)	30	20	75-80
16.	Mensuration	48	65	81-86
17.	Surface Area and Volume	46	50	87-91
18.	Statistics	17	1	92-97
19.	Data Handling	44	7	98-107
20.	Probability	34	12	108-112
Total Questions		788	457	

English

Chapter No.	Chapter's Name (Complete Theory)	Practice Questions	PYQs (2007-2025)	Page No.
1.	The Sentence	22	—	1-2
2.	The Noun : Kinds of Noun, Number & Gender	25	2	3-6
3.	The Pronoun	19	4	7-9
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5.	The Adjective	22	4	14-16
6.	Use of Degrees of Comparison	21	6	17-19
7.	The Adverb	25	—	20-22
8.	Preposition	20	13	23-25
9.	Conjunction	33	1	26-29

Chapter No.	Chapter's Name (Complete Theory)	Practice Questions	PYQs (2007-2025)	Page No.
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हिंदी

अध्याय क्र.	अध्याय का नाम (सम्पूर्ण थ्योरी)	अभ्यास प्रश्न	PYQs (2007-2025)	पृष्ठ संख्या
1.	वर्ण-विचार	15	2	1-3
2.	वर्तनी विवेक	12	14	4-5
3.	पद भेद (व्याकरणिक कोटि) की पहचान	7	18	6-15
4.	पद-परिचय	18	—	16-18
5.	लिंग, वचन, कारक एवं काल	20	11	19-22
6.	उपसर्ग-प्रत्यय	25	6	23-26
7.	शब्द-भेद (स्रोत/उत्पत्ति : रूढ़, यौगिक, योगरूढ़ तथा तत्सम-तद्भव एवं देशज-विदेशज)	19	2	27-28
8.	संधि एवं संधि-विच्छेद	15	9	29-32
9.	समास	18	8	33-35
10.	शब्द विवेक (शब्द प्रयोग में सूक्ष्म अन्तर)	25	2	36-37
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अध्याय क्र.	अध्याय का नाम (सम्पूर्ण थ्योरी)	अभ्यास प्रश्न	PYQs (2007-2025)	पृष्ठ संख्या
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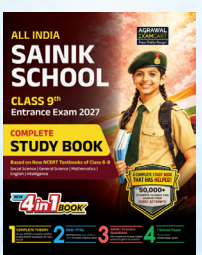
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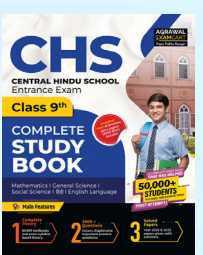

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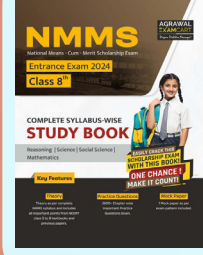

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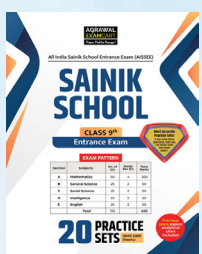

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(Guide book)



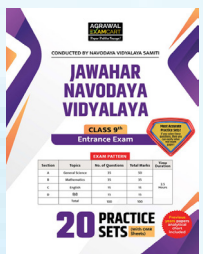

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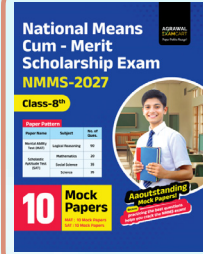

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Sainik School
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Jawahar Navodaya Vidyalaya
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NMMS
(Mock Papers)



Chapter 1

Heat, Fossil Fuel (Coal and Petroleum), Calorific Value and Combustion of Flame

1. Heat and Temperature

We experience cold and heat every day. Having less or more heat causes us to feel cold and heat. When heat flows out of our body we feel cold. If the heat flows into our body from the outer environment then we feel hot.

- Heat is a type of energy that is related to the motion of the molecules of a substance.
- The degree of hotness or coldness is called temperature.

The higher the temperature of the substance, the faster the movement of its molecules, thus, more energy exists in the form of heat. Heat always flows from a body at a higher temperature to a body temperature, therefore, during the summer when the temperature of the environment is more than our body, we feel hot, and in the winter the temperature outside is less than the temperature of the body, hence we feel cold.

The direction of heat flow between two objects depends on their temperature.

I. Effect of Heat as an Energy

Heat is a form of energy that is associated with the motion of the molecule of a substance.

II. Application of Heat in Daily Life

- Steam is formed due to heat.
- Clothes dry up in the sun due to the heat.
- Salt is obtained from seawater with the help of heat.

III. Conversion Of different Energies into Heat

There are many other types of energies transformed into heat.

- Burning candles causes chemical energy to change into heat.
- The electric energy in the electric furnace is converted into heat.
- In an electric heater electric energy is also changed into heat.

2. Effects of Heat

The higher the speed of the molecules of a substance, the higher its temperature and by providing heat the speed of its molecules increases. When any object is heated, one or more of the following effects may appear.

- Change in Size :** Metals like iron, mercury etc. expand on heating.
- Rise in Temperature :** When a body is heated, it becomes hot.
- Change of State :** Solid substances change to liquid and gases. Water in a liquid state changes to a solid, liquid and

gaseous state. For example, liquid water from ice and steam from water. The heat used to convert ice into water is called the latent heat of fusion.

- Change in Physical and Chemical Properties of a Substance :** Iron when heated, becomes red hot.
- Damage to Living Cells etc. :** If the leaf is lying in the sun, then it becomes dry. If the person remains in the sun for a long time, then the colour becomes black.

3. Measurement of Temperature

The measurement of the hotness or coldness of a body is known as its temperature.

To find out how hot or cold an object is we use a special device known as a thermometer.

I. Thermometer (Clinical Thermometer)

- The thermometer that measures our body temperature is called a clinical thermometer. A clinical thermometer consists of a long, narrow, uniform glass tube. It has a bulb at one end. This bulb contains mercury.
- Outside the bulb, a small shining thread of mercury can be seen. You can see a kink near the bulb.
- This kink prevents mercury levels from falling on its own when the thermometer is taken out of the mouth and we can read the thermometer easily.
- You will also find a scale on the thermometer. The scale we use is the Celsius scale, indicated by °C. A clinical thermometer reads temperature from 35°C to 42°C only.

In a thermometer, another scale is also used to measure temperature which is known as the Fahrenheit scale (°F). On the Fahrenheit scale thermometer reads from 94°F to 108°F only.

The normal temperature of a healthy person is 37°C or 98.6°F.

II. Laboratory Thermometer

To measure the temperature of other objects, there are other thermometers. One such thermometer is known as the laboratory thermometer.

A Laboratory thermometer consists of a long, narrow glass tube. The lower end of this tube is like a bulb. This tube contains mercury or alcohol. Its upper end is sealed. The glass tube is kept in ice cubes. The point in the tube where mercury becomes steady after getting cooled is marked as 0°C.

Now the tube is kept in the steam of boiling water. The mercury starts to expand inside the tube. The point in the tube where mercury becomes steady is marked as 100 °C. The intervening space between the two points is divided into

100 equal parts. Thus, the measure of each small division is 1°C. Generally, the range of this thermometer is -10°C to 110°C.

4. Propagation of Heat

The process of transfer or displacement of heat is called propagation of heat.

I. Conduction : The heat reaches the end of less temperature from the end of the higher temperature, and after some time the other end of the metal becomes hot. This method of heat transfer is called **conduction**.

II. Convection : The materials which allow heat to pass through them easily are conductors of heat. For example, aluminium, iron and copper. The materials which do not allow heat to pass through them easily are poor conductors or insulators of heat such as plastic and wood.

When water is heated, the water near the flame gets hot. Hot water rises. The cold water from the sides comes in to take its place. This water also gets hot and rises and water from the sides moves down. This process continues till the whole water gets heated. This mode of heat transfer is known as convection.

The air near the heat source gets hot and rises. The air from the sides comes in to take its place. In this way, the air gets heated. This air also gets hot. Thus, the process continues to take place.

Applications of Convection in Daily Life :

(i) **Chimney:** Smoke and hot gases from homes and factories rise due to convection and get out through the chimney.

(ii) **Ventilators :** There are usually installed high up on the walls, when warm air enters the room, it rises and escapes through the ventilator.

III. Radiation : There is no medium such as air in most parts of the space between the earth and the sun, hence, from the sun the heat comes to us through another process known as **radiation**. The transfer of heat by radiation does not require any medium. When we sit in front of a room heater, we get heat from this process.

Our body too gives heat to the surroundings and receives heat from it through radiation.

A hot utensil kept away from the flame cools down as it transfers heat to the surroundings by radiation. It means that all hot bodies radiate heat. When this heat falls on some object, a part of it is absorbed and a part is reflected.

5. Natural Resources

We use various materials for our basic needs. Some of them are found in nature and some have been made by human efforts. These have been classified as under :

The resources which are obtained from nature are called natural resources. These are of two types :

(i) **Inexhaustible Natural Resources :** These resources are present in unlimited quantities in nature and are not likely to be exhausted by human activities. Examples : Sunlight, air, etc.

(ii) **Exhaustible Natural Resources :** The amount of these resources in nature is limited and thus these can be exhausted by excessive human usage. Examples : Forests, coal, petroleum, minerals, wild life, natural gas, etc.

Man-Made Resources

- When a natural resource undergoes drastic change by human intervention, it becomes human-made resource. For example; iron ore is processed to make steel and hence steel is a man-made resource, Buildings, bridges, railways, machines, etc. are examples of human-made resources. Technology is also a human-made resource.

- Exhaustible natural resources like coal, petroleum and natural gas were formed from the dead remains of living organisms (fossils), therefore, they are called **fossil fuels**. Wood is not a fossil fuel.

- The study of fossils is called paleontology.

- It takes millions of years for fossil fuels to form.

6. Coal

- Coal is a complex mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

- It is believed that millions of years ago, the forests got buried under the surface of earth and had no contact with oxygen. They slowly started to decompose and formed dense sponge like material called peat. Over millions of years, due to tremendous pressure and heat, finally these got transformed into coal.

- As coal mainly contains carbon, the slow process of conversion of dead vegetation into coal is called **carbonization**. Upon heating in air, coal burns and produces mainly carbon dioxide. Diamond is an allotrope of carbon.

- Coal is used as a fuel in large furnaces and industries, production of bricks, thermal power stations, making food and other domestic purposes. For obtaining coal large and deep mines are made in the earth's crust. Pure coal is obtained from relatively deep and dangerous mines.

- Charcoal is produced from the wood of trees. Like coal it also has the capability of radiating energy continuously.

- Coal is classified into five main categories based on the amount of carbon it contains and the heat energy it can produce :

(i) **Peat :** It is the first stage of coal and contains 10-15% of carbon. It is the poorest variety of coal.

(ii) **Lignite** : The carbon content is 25-35%.

(iii) **Subbituminous Coal** : It contains 35-44% carbon

(iv) **Bituminous Coal** : It contains 45-86% carbon. It is common household fuel and industrial fuel.

(v) **Anthracite Coal** : It contains 86-97% carbon

- **Destructive/Fractional Distillation of Coal** : The process of heating coal in the absence of air is called the destructive distillation of coal. When coal is heated in the absence of air, a number of products are obtained such as Coke, Coal tar and Coal gas. On destructive distillation, 1000 kg of coal gives 700kg of coke, 100 liters of ammonia, 50 litres of coal tar and 400 m³ of coal gas.

(i) **Coke** : It contains 80% carbon. It is porous and the purest form of coal. It is a good fuel and burns without smoke. It is largely used as a reducing agent in the extraction of metals from their ores. It is also used in making fuel gases like water gas and producer gas.

(ii) **Coal Tar (Liquid)** : It is a mixture of different carbon compounds. Its fractional distillation gives many chemical substances (Benzene, Toluene, Phenol and Aniline) which are further used in the preparation of dyes, explosives, paints, synthetic fibers, drugs, photographic materials, roofing materials and pesticides.

Naphthalene balls (also obtained from coal tar) are used to repel moths and other insects. Initially coal tar was used in metalling the roads but these days bitumen, a petroleum product is used. **Bitumen** is a sticky, black, highly viscous liquid or semi-solid form of petroleum.

(iii) **Coal Gas** : Coal gas is mainly a mixture of hydrogen, methane and carbon monoxide. It is obtained during the processing of coal to get coke. It is an excellent fuel. It was earlier used for lighting houses, factories and streets in Mumbai until 1950. Now it is mainly used as a source of heat.

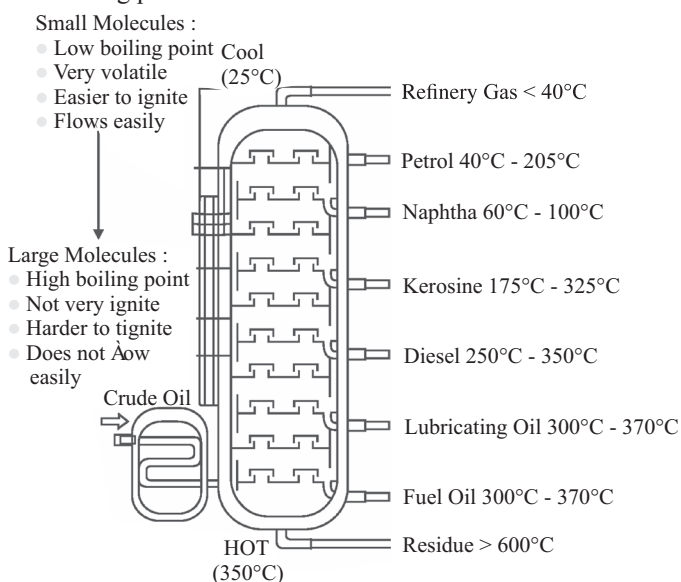
(iv) **Liquid Ammonia** : It is used to make fertilizers.

7. Petroleum

- It is dark brownish to green coloured viscous liquid. It is also a fossil fuel. It has a strong foul smell due to the presence of sulphur containing compounds in it. It is generally referred to as crude oil and black gold.
- Its name is derived from Latin words Petra (meaning rock) and Oleum (meaning oil). Thus, petroleum literally means "Rock Oil". Petroleum is a complex mixture of solid, liquid and hydrocarbons, mixed with salt water and earthy particles. It is always found trapped between two impervious rocks.
- Iran, Iraq, Kuwait and other Arab countries are the major petroleum-producing countries in the world.
- **Formation of Petroleum** : It is believed that petroleum is formed by the anaerobic (in the absence of oxygen)

decomposition of extremely small sea animals and plants which got buried in the sea bed millions of years ago.

- **Occurrence of Petroleum** : Petroleum occurs at a moderate depth (500 m to 200 m) between the 2 layers of impervious rocks. The petroleum is lighter than water and thus it can float over it. Above petroleum, natural gas is found and it is found trapped between the rock cap and petroleum layer.
- **The Drilling of Oil Wells to get Petroleum** : To get petroleum, a hole is drilled in the Earth's crust & when it reaches the rock cap, the natural gas comes out first with a great pressure. When the pressure of gas subsides, petroleum starts flowing out due to the pressure of natural gas.
- **Refining of Petroleum** : Petroleum being a mixture of several hydrocarbons cannot be used in natural form. Before being put to use, it has to be purified or refined. The process of separating the various components of petroleum from one another is known as the refining of petroleum and is carried out in petroleum refineries. This is done by a process called "Fractional Distillation" in which, on heating the crude oil, its different components get separated on their respective boiling points.



- **Uses of Petroleum** : Many useful substances are obtained from petroleum and natural gas. These are termed as 'Petrochemicals'. These are used in the manufacture of detergents, fibres (polyester, nylon, acrylic etc.), polythene and other man-made plastics.

- **Below are the Various Constituents of Petroleum and their uses**

S. No.	Constituents of petroleum	Uses
1.	Petroleum Gas in Liquid form (LPG)	Fuel for home and industry

S. No.	Constituents of petroleum	Uses
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.



Do you know?

- ★ The world's first petroleum well was drilled in Pennsylvania, USA in 1859.
- ★ In 1867, oil was struck at Makum in Assam. In India, oil is found in Assam, Gujarat, Mumbai High and in the river basins of Godavari and Krishna.

8. Natural Gas

- Natural gas was formed millions of years ago along with petroleum when small sea plants & animals died & got buried under the earth. Further due to anaerobic conditions these got changed to gas. Natural gas is used for cooking and generating electricity.
- It also occurs in coal mines and petroleum wells. It mainly contains 90% methane.
- **Composition of Natural Gas** : It consists mainly of methane (about 85%), ethane (about 10%) propane (about 3%) and butane. The way of using natural gas is in form of CNG (Compressed Natural Gas) or LNG (Liquified Natural Gas).
- **CNG** : When natural gas is compressed at high pressure then it is called CNG. CNG is used for power generation and nowadays auto, buses and cars run on it, CNG is a cleaner fuel than petrol or diesel because it is less polluting. The great advantage of CNG is that it can be supplied through pipes and hence used in burning in homes and industries. Such a network of pipelines exists in Vadodara (Gujarat), some parts of Delhi and other places.
- **Occurrence** : It is generally found trapped between impermeous rocks, sometimes along with petroleum & sometimes without petroleum. In our country, Tripura, Rajasthan, Maharashtra and in the Krishna Godavari Delta are the reserves of natural gas.
- **Liquefied Petroleum Gas (LPG)** : It is an important product of natural gas. LPG is the abbreviation or short form for liquefied petroleum gas. Main components of LPG are propane, butane and small quantities of methane. Like all fossil fuels, it is a non-renewable source of energy.

It is extracted from crude oil and natural gas. Normally, the gas is stored in liquid form under pressure in a steel container, cylinder or tank. LPG is highly inflammable and must therefore be stored away from sources of ignition and in

a well-ventilated area, so that any leak can disperse safely. It is used for standard heating and cooking purposes. Hydrogen gas obtained from natural gas, is used in the production of fertilisers (urea). Propane and butane are the two major components of LPG in the ratio 40:60.



Do you know?

- ★ Burning of fuels causes air pollution which leads to global warming. So we need to use fuels only when it is necessary. In India, the Petroleum Conservation Research Association (PCRA) advises people how to save petrol/diesel while driving.
- ★ Sunlight is a renewable natural resource.
- ★ Fossil fuels are found in limited quantities. If we continue to use them in the present manner, they will soon run out. Therefore, alternate sources of energy need to be explored.

9. Alternative Sources of Energy

- **Biodiesel** : It is a fuel obtained from vegetable oils such as Soyabean oil, Jatropha oil, Cornoil, Sunflower Oil, Cotton seed oil, Rice bran oil and Rubber seed oil.
- **Wind Mills** : When wind blows, they rotate and current is produced in the dynamo.
- **Solar Energy** : Sun is the foremost energy source that makes life possible on our earth. Solar energy is harnessed using (i) solar cookers (ii) solar water heaters (iii) solar cells.
- **Gobar Gas** : It is obtained by the fermentation of cow dung in the absence of air (anaerobic conditions). It mainly contains methane and a little ethane. It is widely used in rural areas for cooking and operating engines.



Do you know?

- ★ Hydrogen could be the best alternative fuel. It is a clean fuel as it gives out only water while burning. Moreover, it has the highest energy content. It does not pollute the air.
- ★ Sewage sludge can be decomposed by microorganisms to produce methane gas along with impurities like carbon dioxide and hydrogen sulphide. After removing these impurities, methane gas can be used as an efficient fuel.
- ★ Sails in boats and ships are used to harness wind energy.
- ★ Fossil fuels are found in limited quantities. If we continue to use them in the present manner, they will soon run out. Therefore, alternate sources of energy need to be explored.

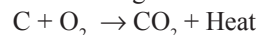
10. Combustion

- A chemical process in which a substance reacts with oxygen to give off heat is called **combustion**.
- When there is no continuous supply of air (such as a candle covered with a glass), the flame goes out.
- The substances such as paper and fuel etc., which undergo combustion are known as **combustible substances**. Sometimes, heat is accompanied by light, either as a flame or as a glow, during combustion.

- Combustion is a chemical process. Some materials burn with flame like a candle while some materials burn without flame-like coal.

- A combustion reaction may be written as :

(i) Charcoal burns in air to give carbon dioxide and heat.



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



- It is important to note that different substances burn at different temperatures. For a substance to burn, some minimum temperature is required and this minimum temperature is known as “**Ignition Temperature**”. For example, the Ignition temperature of phosphorus is 35°C. So, unless phosphorus is heated to 35°C, it will not catch fire.
- Substances which have very low ignition temperature or can easily catch fire are called **Inflammable Substances**. eg. Petrol, Alcohol, LPG, etc.
- **Necessary conditions for combustion :**
 - ❖ The heat-ignition temperature must be within access.
 - ❖ Fuel-Fuel should be combustible.
 - ❖ Oxygen- a suitable amount of oxygen must be available there.

- **Ignition Temperature of Different Materials**

Material	Ignition Temperature
White Phosphorus	35 degree Celsius
Petrol	246 degree Celsius
Kerosene	220 degree Celsius
Diesel	210 degree Celsius
Wood	300 degree Celsius
Coal	454 degree Celsius
Piece of paper	233 degree Celsius
Alcohol	365 degree Celsius



Do you know?

- ★ In the sun, heat and light are produced by nuclear reactions.
- ★ Nuclear fusion takes place inside the sun's nucleus, where hydrogen nuclei (protons) combine to form helium nuclei. Protons - This process, known as the proton chain, involves a series of nuclear reactions that release vast amounts of energy in the form of light and heat.
- ★ Combustion is an oxidation process.

- **Controlling Fire :** There are 3 conditions necessary for producing and sustaining combustion.
 - Presence of a combustible substance (Fuel)
 - Presence of a supporter of combustion. (Air for oxygen)
 - Attainment of ignition or kindling temperature. (Heat)
 Thus, fire can be controlled by removing one or more of these requirements for producing and sustaining combustion. The fire extinguisher also tries to cut off the supply of air or bring down the temperature of the fuel or both, to control the fire.

- **Fire Fighting :** News of fire breaking out in homes, shops and factories due to carelessness and faulty equipment is common. But what is more important is to timely control it. Combustion or Fire sustain due to the presence of all the necessary conditions of Fire. So, it can be controlled by removing one or more of these.

It is quite difficult to remove fuel from the site of the fire, So, the fire is extinguished by the following two factors.

- ❖ By cutting off the supply of air: The supply of air can be stopped by covering the burning solid fuel with soil, sand and a blanket.

- ❖ By cooling the combustible material below its ignition temperature: Water is the most common fire extinguisher. Water cools the combustible material below its ignition temperature. This prevents the fire from spreading. Water vapours also surround the combustible material, helping in cutting off the supply of air. But water works only when things like wood and paper are on fire.

If electrical equipment is on fire, water may conduct electricity and harm those trying to douse the fire.

Water is also not suitable for fires involving oil and petrol. Water is heavier than oil. So, it sinks below the oil, and the oil keeps burning on top.

For fires involving electrical equipment and inflammable materials like petrol, carbon dioxide is the best extinguisher. Carbon dioxide covers the fire like a blanket. Since the contact between the fuel and oxygen is cut off, the fire is controlled.

- **Fire Extinguishers :** For fires involving electrical equipment and inflammable materials like petrol, carbon dioxide (CO₂) is the best fire extinguisher and not water. CO₂, being heavier than oxygen, covers the fire like a blanket, hence cutting off the contact of fuel with oxygen and bringing down the temperature.

Dry powder of chemicals like sodium bicarbonate (baking soda) or potassium bicarbonate release CO₂ near fire. Hence, are another good source to extinguish fire.

- CO₂ extinguishers are the type of extinguishers that can withstand up to 1000 volts.
- Fire extinguishers contain chemicals such as sulphuric acid H₂SO₄ and sodium bicarbonate NaHCO₃.
- When a fire extinguisher is turned on, sulfuric acid reacts with sodium bicarbonate to produce carbon dioxide (CO₂) gas.



Do you know?

History of Matchsticks

- ★ More than five thousand years ago small pieces of pinewood dipped in sulphur were used as matches in ancient Egypt. A mixture of antimony trisulphide, potassium chlorate and white phosphorus with some glue and starch was applied on the head of a match made of suitable wood. When struck against a rough surface, white phosphorus got ignited due to the heat of friction. This started the combustion of the match. However, white phosphorus proved to be dangerous

both for the workers involved in the manufacturing of matches and for the users.

- ★ These days the head of the safety match contains only antimony trisulphide and potassium chlorate. The rubbing surface has powdered glass and a little red phosphorus (which is much less dangerous). When the match is struck against the rubbing surface, some red phosphorus gets converted into white phosphorus. This immediately reacts with potassium chlorate in the matchstick head to produce enough heat to ignite antimony trisulphide and start the combustion.
- ★ Limestone is mainly composed of calcium carbonate (CaCO_3) which is a chemical compound. When limestone undergoes a chemical reaction such as combustion or decomposition, it releases energy in the form of heat. This energy is stored within the chemical bonds of limestone and when these bonds are broken, the energy is released in the form of chemical energy. Therefore, the energy released from limestone is classified as chemical energy.
- ★ Solid carbon dioxide is called dry ice.

● **Types of Combustion :** Combustion is mainly of three types :

(i) **Rapid Combustion :** The combustion in which the gas burns rapidly and produces heat and light is called rapid combustion.

For example : When a burning matchstick is brought near a gas burner and the gas tap is opened, the gas immediately starts burning with the production of heat and light. Magnesium ribbon burns to form magnesium oxide and produces heat and light

(ii) **Spontaneous Combustion :** The combustion in which no external heat is given is known as spontaneous combustion.

For example: Forest fires are the result of spontaneous combustion due to heat of sun or lightning strike. Burning of white phosphorus in air at room temperature.

(iii) **Explosion :** The combustion in which large amount of gases are evolved with the production of a tremendous amount of heat, light and sound is called explosion.

For example : When a cracker is ignited, a sudden reaction, takes place in which at high speed large amount of gas is evolved with the production of tremendous amount of heat, light and sound.

● **Difference between Rapid and Spontaneous Combustion**

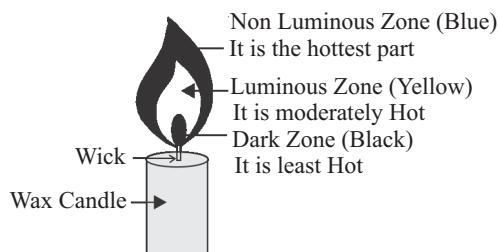
Rapid combustion	Spontaneous combustion
It is to be initiated once	It takes place by itself.
External heat is required	No external heat is required to start it
Large amount of heat is evolved in a short time	Small amount of heat and light is evolved

Rapid combustion	Spontaneous combustion
Example : Burning of domestic cooking gas	Burning of white phosphorous on its own when kept in air for some time

11. Flame

- A region of burning gases is called flame. A substance will burn with a flame, only if some gaseous substance is there to burn.
- The substances which vapourise during burning, give flames. For example, kerosene oil and molten wax rise through the wick and are vapourised during burning and form flames. Charcoal, on the other hand, does not vapourise and so does not produce a flame.
- **Structure of a Flame :** In order to understand the structure of a flame, light a wax candle and watch its flame. There are different coloured zones in the flame. Starting from the base of the flame, a flame has **three zones**.

Structure of Candle Flame



(i) **Outermost Non-luminous Zone of Complete Combustion (Blue)**

This zone is poorly visible and is slightly blue. It is the hottest part of the flame where complete oxidation (burning) of the fuel is taking place. Goldsmiths blow the outermost zone of a flame with a metallic blow-pipe for melting gold and silver.

(ii) **Luminous Zone of Partial Combustion (Yellow)**

In this region of the flame, hydrogen burns with a brilliant **yellow luminous flame**. Burning hydrogen combines with oxygen to form water vapour. Carbon also burns in this zone giving some luminosity to the flame and producing carbon dioxide. Some unburnt carbon particles are left which give rise to soot.

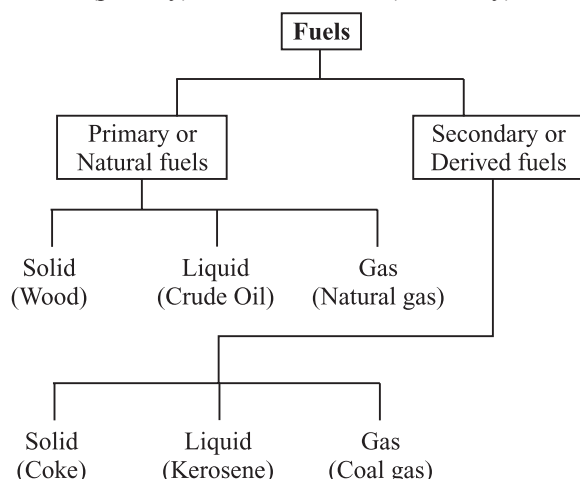
(iii) **Dark Innermost Zone of Unburnt Wax Vapours (Black)**

Surrounding the wick is the dark zone. There is no burning in this zone. If we pass a wooden splinter through the dark zone of the flame, it comes out unscratched (unburnt) showing that there is no 'burning' in this zone. However, some burnt wax vapours are present in this zone.

12. Fuel

- Any substance which is easily available and burns in air at a moderate rate, producing a large amount of heat energy, without leaving behind any undesirable residue is called **fuel**. For e.g., Wood, charcoal, petrol, kerosene, etc.

- If a fuel is present in its natural state then it is known as a natural fuel, while a fuel is known as a derived fuel if it is processed to improve its quality. It can be classified into natural (primary) fuels and derived (secondary) fuels.



- Characteristics of a Good Fuel**
 - It should be cheap and readily available.
 - It should be easy to store.
 - It should burn at a slow rate and its rate of combustion should be controllable
 - It should have low ignition temperature. Substances which have low ignition temperature burn easily.
 - It should produce a very small amount of residues such as ash.
 - It should have large calorific value.
 - It should not produce gases which pollute the air.
 - It should not produce any hazards during transportation.
- Classification of Fuels :** On the basis of physical state, fuels are classified into three types :
 - Solid Fuels :** The fuels which occur in a solid state at room temperature are called solid fuels. Example : Wood, agricultural residues, charcoal, coal, coke, etc.



Do you know?

★ Uranium is used as fuel in nuclear reaction.

- Liquid Fuels :** The fuels which occur in a liquid state at room temperature are called liquid fuels. Example : Liquefied hydrogen, petrol, oil, kerosene, diesel, etc.
 - Gaseous Fuels :** The fuels which occur in a gaseous state at room temperature are called gaseous fuels. Example : Water gas, producer gas, coal gas, compressed natural gas (CNG) and gobar gas, etc.
- Fuel Efficiency :** Any fuel contains carbon as its main constituent. During the combustion of fuel carbon combines with oxygen and liberates large amounts of heat. It is expected that a fuel liberates maximum amount of heat in a short time. The efficiency of a fuel can be understood from the following terms :

- Specific Energy :** Specific energy is the amount of energy produced by the **unit mass of a fuel**. It is defined as the **energy per unit mass**. It is used to measure the stored energy in certain substances. Its unit is **J/kg**.
- Calorific Value :** It is the quantity of heat produced by the complete combustion of 1 kg of fuel at constant pressure and normal conditions. In case of liquid or gaseous fuels to measure the calorific value, their volumes are taken into consideration while for solid fuels their masses are taken into account. It is measured in **Kilo Joule per Kilogram (kJ/Kg)**. **The more the calorific value of a fuel, the more is the efficiency of the fuel.**

$$\text{Calorific Value} = \frac{\text{Amount of heat liberated}}{\text{Total mass or volume of fuel}}$$

Examples for understanding Calorific Value :

Example : 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.

Solution :

Given : Weight of fuel burnt = 4.5 kg

To find : Calorific value = ?

Formula used :

$$\text{Calorific value} = \frac{\text{Amount of heat produced}}{\text{Weight of fuel burnt}}$$

$$\text{Calorific value} = \frac{180000}{4.5}$$

∴ Calorific value = 40,000 kJ/kg.

- Calorific value of some fuels is given in the following table :

Fuel	Calorific Value (KJ/kg)
Cow dung cake	6000 – 8000
Wood	17000 – 22000
Coal	25000 – 33000
Petrol	45000
Kerosene	45000
Diesel	45000
Methane	50000
CNG	50000
LPG	550000
Biogas	35000 – 40000
Hydrogen	150000

- Characteristics of Ideal Fuel :** An ideal fuel is one which :
 - Has high calorific value.
 - Do not cause any pollution or produce harmful gases on combustion.
 - Is easily available at low cost.

- (iv) Is easy to handle, store and transport.
- (v) Has moderate ignition temperature.
- (vi) Has moderate rate of combustion.

● **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 disease, such as asthma.
- (ii) **Incomplete combustion** forms 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 releases carbon dioxide in the environment. Increased percentage of carbon dioxide in the air causes **global warming**. Global warming is the rise in temperature of the earth. This results in melting

of polar glaciers which leads to rise in sea level and floods in the sea coast.

- (iv) Burning of coal and diesel releases sulphur dioxide gas. It is an extremely suffocating and corrosive gas. Sulphur dioxide and nitrogen oxide dissolve in rain water to form acid. Such rain is called **acid rain**. It is very harmful for crops, buildings and soil.
- (v) Wood is also used as a 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 leads to deforestation which is quite harmful to the environment. Therefore, wood is replaced by coal or other fuels such as LPG.
- (vi) Carbon particles of smoke or ash get suspended in the air. Excessive amounts of them in the air causes **breathing problems**.

Important Questions

1. The main constituents of petroleum, obtained through fractional distillation, do not include :
(A) Coal and Coke
(B) Petrol and Diesel
(C) Kerosene and Lubricating Oil
(D) Paraffin Wax and Bitumen
2. When an object is heated, the molecules that make up the object :
(A) Begin to move faster
(B) Begin to move slower
(C) Become heavier
(D) Become lighter
3. Which of the following is not a necessary condition for combustion ?
(A) Presence of a fuel having high calorific value
(B) Attainment of ignition temperature
(C) Presence of a combustible substance
(D) Presence of a supporter of combustion
4. The amount of energy produced on complete combustion of 1 kg of a fuel is called :
(A) calorific value (B) significant value
(C) heat value (D) internal energy
5. Which one of the following statements about energy is correct ?
(A) Energy can be created as well as destroyed
(B) Energy can be created but not destroyed
(C) Energy can neither be created nor destroyed
(D) Energy cannot be created but can be destroyed

All Chapterwise Questions (PYQs) from Previous Year 2007 to 2025

1. Which of the following fuels has maximum calorific value ?
(A) Wood (B) Coal
(C) Hydrogen (D) Petrol
[JNV 2025]
2. Select from the following a group of products obtained by refining of petroleum :
(A) Petrol, diesel, coaltar
(B) Bitumen, detergents, polyester
(C) Lubricating oil, paraffin wax, diesel
(D) Acrylic, nylon, coke
[JNV 2025]
3. The substance that does not produce flame on burning is :
(A) LPG (B) Molten wax
(C) Dry grass (D) Charcoal
[JNV 2025]
4. Which one amongst the following is a fuel with highest calorific value?
(A) Petrol (B) CNG
(C) Diesel (D) Wood
[JNV 2024]
5. Column I has some of the constituents of Petroleum and Column II has their uses. Correctly match the constituents with their uses:

Column I	Column II
(i) Paraffin wax	(a) Fuel for heavy motor vehicles
(ii) Bitumen	(b) Solvent for dry-cleaning
(iii) Diesel	(c) Paints
(iv) Petrol	(d) Vaseline

 (A) (i)-(d), (ii)-(c), (iii)-(b), (iv)-(a)
 (B) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)
 (C) (i)-(d), (ii)-(c), (iii)-(a), (iv)-(b)
6. Naphthalene balls used to repel moths and other insects are obtained from:
(A) Coal tar (B) Coke
(C) Coal gas (D) Bitumen
[JNV 2024]
7. If you burn 1 kg each of the following fuel in an efficient system, you will get maximum amount of heat when you burn :
(A) hydrogen (B) methane
(C) diesel (D) coal
[JNV 2022]
8. Which fuel has highest calorific value ?
(A) Methane (B) CNG
(C) LPG (D) Hydrogen
[JNV 2022]

9. Which one is not a fossil fuel ?
 (A) Coal (B) Petroleum
 (C) Natural gas (D) Wood
[JNV 2022]
10. Three constituents of petroleum are :
 (A) Kerosene, Petrol, Natural gas
 (B) Diesel, LPG, Coal gas
 (C) Bitumen, Lubricating oil, Paraffin wax
 (D) LPG, Explosives, Paints
[JNV 2022]
11. For the conservation of dense forests, (which buried under the soil) into the fossil (coal) the essential conditions required are :
 (A) High pressure and low temperature
 (B) High pressure and high temperature
 (C) Low pressure and high temperature
 (D) Low pressure and low temperature
[JNV 2022]
12. Which one is biodegradable ?
 (A) PVC bag (B) Aluminium
 (C) Bakelite (D) Paper
[JNV 2022]
13. Dead plants slowly get converted in to coal under :
 (A) low pressure and high temperature
 (B) high pressure and low temperature
 (C) high pressure and high temperature
 (D) low pressure and low temperature
[JNV 2021]
14. If we completely burn the same amount of the following fuels, the maximum amount of heat will be obtained on burning :
 (A) Petrol
 (B) Liquefied Petroleum Gas (LPG)
 (C) Diesel
 (D) Compressed Natural Gas (CNG)
[JNV 2021]
15. Which amongst the following is not a fossil fuel ?
 (A) Coke (B) Petrol
 (C) Wood (D) Diesel
[JNV 2021]
16. Which one of the following air pollutants produced due to incomplete combustion of petrol and diesel reduces the oxygen carrying capacity of blood ?
 (A) Smoke (B) Carbonmonoxide
 (C) Carbon dioxide (D) Nitrogen oxide
[JNV 2021]
17. Which of the following is a non-polluting fuel for vehicles ?
 (A) Petrol
 (B) Diesel
 (C) Kerosene
 (D) Compressed Natural Gas (CNG)
[JNV 2021]
18. Which of the following is not a constituent of petroleum?
 (A) paraffin wax (B) lubricating oil
 (C) coke (D) petrol
[JNV 2020]
19. The black thick liquid with unpleasant smell is known as _____.
 (A) kerosene (B) coal-tar
 (C) petrol (D) coke
[JNV 2020]
20. Which of the following is not a natural resource ?
 (A) Water (B) Mineral
 (C) Soil (D) Rayon
[JNV 2020]
21. Naphthalene balls are obtained from :
 (A) petroleum (B) paraffin wax
 (C) coal tar (D) coal gas
[JNV 2019]
22. Coal is formed from the remains of :
 (A) vegetation only
 (B) both vegetation and animals
 (C) animals only
 (D) None of the above
[JNV 2019]
23. When coal burns in air gas is mainly produced.
 (A) SO₂ (B) NO₂
 (C) CO (D) CO₂
[JNV 2019]
24. The process of separating the various constituents of petroleum is known as :
 (A) carbonisation (B) refining
 (C) distillation (D) purification
[JNV 2019]
25. Choose the correct statement from the following :
 (A) It is difficult to transport natural gas through pipes
 (B) The disadvantage of natural gas is that it cannot be used directly for burning in homes
 (C) Natural gas is stored under high pressure as compressed natural gas
 (D) Natural gas cannot be used for power generation
[JNV 2018]
26. If a person's clothes catch fire, the best way to extinguish the fire is to :
 (A) throw water on the clothes
 (B) use fire extinguisher
 (C) cover the person with a woolen blanket
 (D) cover the person with a polythene sheet
[JNV 2018]
27. On heating one end of iron rod, other end also gets heated. Such materials are called :
 (A) good conductor of heat
 (B) good insulator of heat
 (C) bad conductor of heat
 (D) heater
[JNV 2018]
28. Which of the gases is found in bio-gas ?
 (A) Ethane (B) Propane
 (C) Butane (D) Methane
[JNV 2018]
29. Which of the following has maximum energy ?
 (A) Blue light (B) Green light
 (C) Red light (D) Yellow light
[JNV 2016]
30. Power alcohol is :
 (A) Drinkable alcohol
 (B) Purified alcohol
 (C) Ethyl alcohol in the form of fuel
 (D) Purified Methyl alcohol
[JNV 2015]
31. What is RDX ?
 (A) An explosive
 (B) An apparatus to measure blood pressure
 (C) A gene
 (D) Fertilizer
[JNV 2015]

□□