Motion®

PHYSICS
CLASS - X
BOOKLET - 1

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ELECTRICITY

MAGNETIC EFFECTS OF ELECTRIC CURRENT

ANSWER KEY

CHAPTER

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ELECTRICITY

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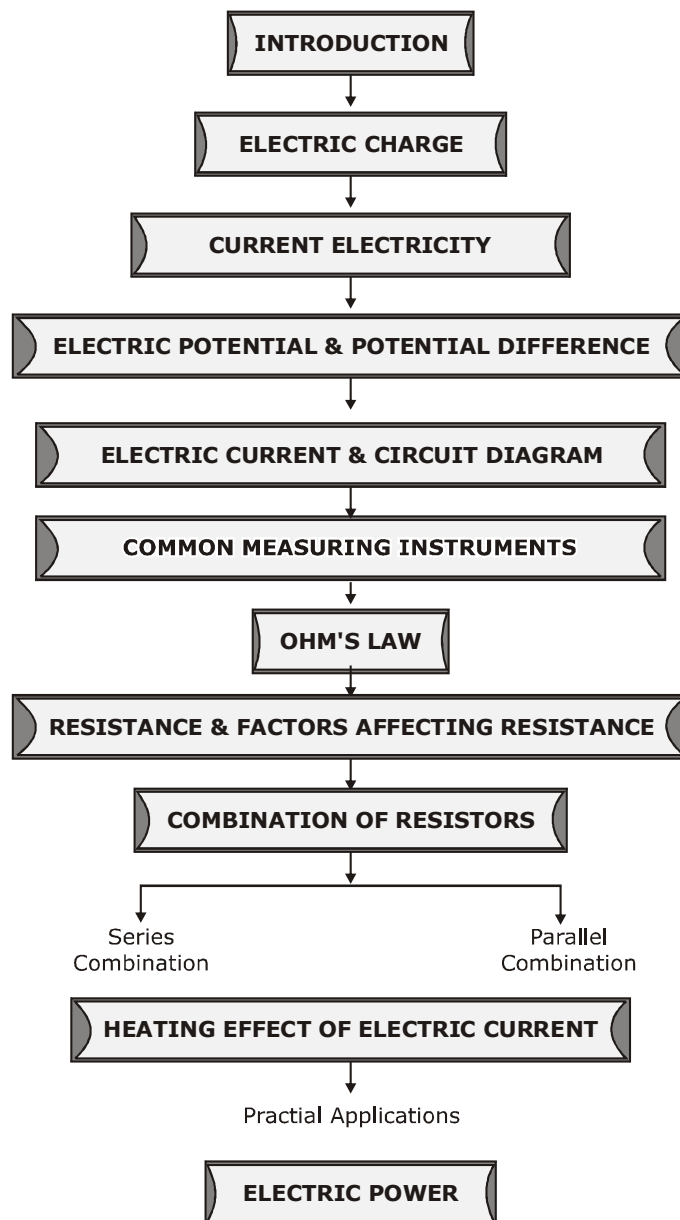
INTRODUCTION

Electricity is an indispensable part of life in today's world. It is a controllable and convenient form of energy for a variety of uses in houses, schools, industries, etc. Modern industrial societies rely heavily on the use of electricity not only for lightening but also for running machinery of factory, information and communication systems, heating, travelling, cooking, entertainment, etc. Electricity had made life faster and easier. The early Greek philosophers knew that if you rubbed a piece of amber, it would attract bits of straw. This ancient observation is a direct ancestor of the electronic age in which we live. (The strength of the connection is indicated by our word electron, which is derived from the Greek word for amber).

ELECTRIC CHARGE

If you walk across a carpet in dry weather, you can produce a spark by bringing your finger close to a metal doorknob. Television advertising has alerted us to the problem of 'static cling' in clothing. It happens due to a property named electric charge.

Electric charge may be defined as the intrinsic property of certain fundamental particles (electron, proton, etc) due to which they produce electric and magnetic effects.

1. **Types of Electric Charge:** There are two types of charges. They are:

   (A) Positive charge: A body having deficiency of electrons.

   (B) Negative charge: A body having excess of electrons.

2. **Charging of a Body:** There are a number of methods to charge a body as:

   (A) Charging by friction

   (B) Charging by conduction

   (C) Charging by induction etc.

3. **Properties of Electric Charge:**

   (A) Like charges repel and unlike charges attract each other.

   (B) Charge is a scalar quantity.

   (C) Charge is always quantized.

   (D) Charge is conserved.

   (E) Charge is always associated with mass.

4. **Unit of Charge:** The charge on an electron is so small that it is not convenient to select it the unit of charge. In practice, coulomb is used as the unit of charge, i.e. SI unit of charge is coulomb abbreviated as C. One coulomb of charge is equal to the charge on 625×10^{16} electrons.

   <div align="center">

   1 coulomb = charge on 625×10^{16} electrons or 6.25×10^{18} electrons

   </div>

   Thus, when we say that a body has a positive charge of one coulomb (i.e + 1C) it means that the body has a deficit of 625×10^{16} electrons from the normal due share.

5. **Coulomb's Law**

The electric force of interaction between two charged particles at rest is directly proportional to the product of two charges ($\propto q_1 q_2$) and inversely proportional to the square of distance $\left(\propto \dfrac{1}{r^2}\right)$ between them.

$$F \propto \frac{q_1 q_2}{r^2}$$

$$F = \frac{k q_1 q_2}{r^2}$$

Where, k is the constant of proportionality and has a value of 9×10^9 Nm^2/C^2 (in vacuum).

(i) This force is directed along the line joining the two charges.

(ii) For like charges, it is repulsive (positive in sign) and for unlike charges, it is attractive (negative in sign)

(iii) Coulomb's force is analogous to the gravitational force. Both forces vary inversely as the square of the seperation between two particles.

Info Bubble

Electric field: It is the region around a cahrge particle in which electrostatic force of attraction or repulsion can be experienced by another charge.

Electric field intensity due to a charge Q at a point in space around it is defined as the force that a unit positive charge would experience if placed at that point.

Electric field at a distance r from a charge Q is given as

$E = \dfrac{kQ}{r^2}$; where k is a constant. Its value is 9×10^9 Nm^2/C^2 in vacuum.

Force exerted by charge Q on another charge q at a distance r is

$F = \dfrac{kQq}{r^2}$ (By Coulomb's law)

F = qE

The SI unit of electric field in N/C or V/m.

Electric field lines due to positive and negative charge may be represented diagrammatically, as shown below.
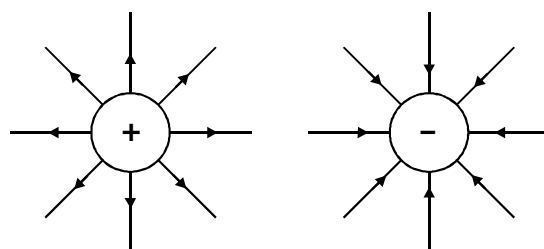
CURRENT ELECTRICITY

Static Electricity: A branch of physics which deals with the study of the electric charges at rest and their effects is known as electrostatic or static electricity.

Current Electricity: A branch of physics which deals with the study of the electric charges in motion and their effects is known as current electricity.

The source of all electricity is charge. As charge is the basis of all electrical phenomena, we need to know the amount of charge on a body. It is measured in coulombs. Coulomb is the SI unit of charge and its symbol is C.

Matter is generally made of protons, electrons and neutrons. Each proton carries a charge of 1.6×10^{-19} coulomb, and each electron carries an equal negative charge. Neutrons do not carry any net charge. Normally, a body has equal number of protons and electrons, and is therefore, electrically neutral. In certain situations, the balance of charges in a body is disturbed.

For example:- when a glass rod is rubbed with a silk cloth, some electrons get transferred from the glass rod to the silk. The silk cloth, which gains electrons, becomes negatively charged. And the glass rod, which is left with more protons than electrons, becomes positively charged.

Charged particles or objects can exert forces on each other. While like (similar) charges repel each other, unlike charges attract. Another important thing about charged particles is that they can flow, i.e., they can move in a particular direction. This flow of charged particles is called an electric current. Charged particles such as electrons are present in all substances. But they do not flow on their own. For flow of charges, there has to be a potential difference.

1. ELECTRIC POTENTIAL

The electric potential at a point in an electric field is defined as the amount of work done in moving a unit positive charge from infinity to that point, without acceleration or without a change in K.E. against the electric force, Mathematically.

$$\boxed{V = \frac{W}{q}}$$

Since work is measured in joule and charge in coulomb, therefore electric potential is measured in joule per coulomb (J/C). This unit occurs so often in our study of electricity, so it has been named as volt, in honour of the scientist Alessandra Volta (the inventor of the voltaic cell).

$$\boxed{1\,\text{Volt} = \frac{1\,\text{joule}}{1\,\text{coulomb}}}$$

Electric potential is a scalar quantity, therefore it is added algebraically. For a positively charged body, electric potential is positive and for a negatively charged body, electric potential is negative.

(A)   Electric Potential Difference: Consider a charge Q placed at a point P. Let A and B be two other points (B being closer to A) as shown in figure.
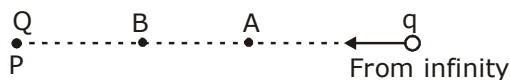
If a charge q is brought from infinity to A, work W_A will be done.

The potential at A will then be, $V_A = \dfrac{W_A}{q}$

If charge q is brought from infinity to B, the work done will be W_B.

The potential at B will then be, $V_B = \dfrac{W_B}{q}$

The quantity $V_B - V_A$ is called the potential difference between points A and B in the electric field of charge Q. Mathematically we have,

$$V_B - V_A = \dfrac{W_B}{q} - \dfrac{W_A}{q}$$

Electric potential difference is also measured in volt.

2. UNIT OF POTENTIAL DIFFERENCE

The unit of potential difference (and potential) is the volt, whose symbol is V. One volt is the potential difference between two points in a current carrying conductor when 1 joule of work is done to move a charge of 1 coulomb from one point to the other.

$$\dfrac{1\,\text{Joule}}{1\,\text{Coulomb}} = 1\,\text{volt or } 1V = 1JC^{-1}$$

The potential difference between two points is sometimes also called the voltage.

PRACTICE YOUR CONCEPTS

1. What is the state of a rod which attracts a negatively charged balloon?

Ans. A negatively charged rod will never be attracted to a negatively charged balloon. However, a positively charged rod will be attracted to a negatively charged balloon as unlike charges attract.

Also a neutral rod will be attracted to a negatively charged balloon (as neutral objects are attracted to any charged object). Thus, the rod is either in neutral or positive state.

2. What do you think would be potential difference of a particle having charge 3 Coulombs, doing work of 15 Joules to move from point A to point B in a circuit?

Ans. Work done be the charge to move from point A to point B = 15J

Therefore, Electric Potential Difference

$(V_{AB}) = \dfrac{W_{AB}}{q} = \dfrac{15}{3} = 5\,\text{Volt}$ Hence, the potential difference of the particle is 5 Volt.

3. How many electrons are present in $1\mu C$?

Ans. $1e = 1.6 \times 10^{-19}$ C   So, $1C = \dfrac{1}{1.6 \times 10^{-19}} = 6.24 \times 10^{18}$ electrons

So, $1\,\mu c = 6.24 \times 10^{12}$ electrons

ELECTRIC CURRENT

Consider a metallic wire ACB connected across a cell of potential difference V. Since the end A is connected to the positive terminal, it is at a higher potential than the end B. In metals, some electrons are loosely bound to the atoms, and can move within it. These are called free electrons. In the metallic wire, these electrons (negative charges) move from the low-potential side B to the high-potential side A. After reaching A, they enter the cell.

The chemical reactions in the cell drive these electrons to the negative terminal. From there, they re-enter the wire at the end B. Thus, there is a continuous flow of electrons in the wire from B to C to A.

We say that there is an electric current in the wire. In a metal, the flow of negative charges constitutes the current.
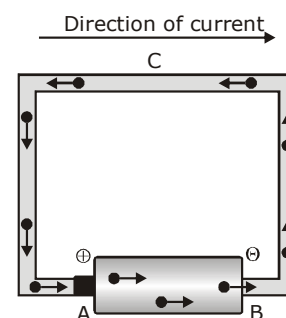
Current in a wire connected to a cell

An electric current can also be a flow of positive charges. So, a flow of charge is called an electric current.By convention, the direction of current is taken as the direction of flow of positive charges. Thus, the direction of current is opposite to the direction of flow of negative charges. So, **when a wire is connected to a cell, the current in the wire is from the positive-terminal end to the negative-terminal end.**

1. **MEASUREMENT OF CURRENT**

    The charge passing per unit time through a given place(area) is the magnitude of the electric current at that place. Thus,

    $$i = \frac{Q}{t}$$

    Here Q is the charge that passes through a place in time t.

    Unit of current From Equation, we find that current is charge divided by time. The SI unit of charge is the coulomb and that of time is the second. The SI unit of current, therefore, is **coulomb / second**. This unit is called the **ampere**, whose symbol is **A**. Thus, if one coulomb of charge passes through a place in one second, the current there is 1 ampere.

2. **CONDUCTORS AND INSULATORS**

    Materials that conduct electricity easily are called good conductors or simply, conductors. And, materials that do not conduct electricity easily are called insulators.

    All metals conduct electricity because they have some loosely bound free electrons, which flow when a potential difference is applied. However, some metals conduct electricity better than others. Silver is the best conductor. But because of the high cost of silver, electric wires are made of copper, or in some cases aluminium.

    Most non metallic solids do not conduct electricity. Although diamond and graphite are both forms of carbon (a non metal), graphite is a conductor while diamond is an insulator. Insulators do not conduct electricity because their electrons are tightly bound to the atoms. Rubber, plastics, wood, glass and porcelain are some examples of insulators. Insulators have many uses. For example, they are used as

protective covers on electric wires and electrician's tools. Certain liquids also conduct electricity. While distilled water is an insulator, addition of certain salts, acids or bases allows it to conduct electricity. Under normal circumstances, gases do not conduct electricity.

3.　CIRCUIT DIAGRAM

A closed path in which a current can flow is called an electric circuit. An electric circuit may have one or more electric elements such as bulbs (or lamps), cells, switches (or plug keys), metal wires, etc. Each element of a circuit has a specific function to play. For example, wires can be used to connect one element to the next. And a plug key or a switch can be used to either complete or break the closed path, thereby starting or stopping the current in the circuit.

Some common circuit elements and their symbols are shown in Figure.
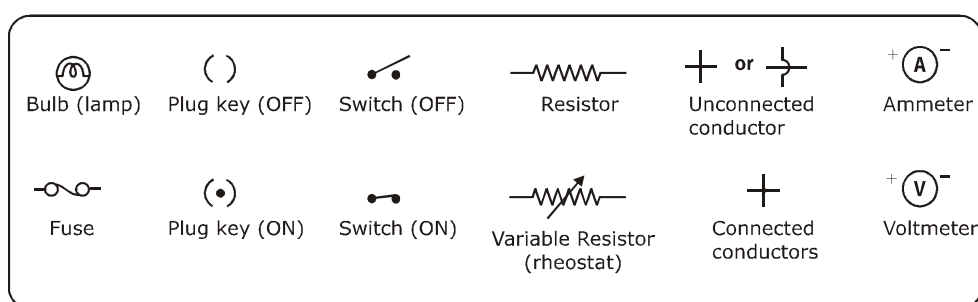
Some symbols used in circuit diagrams

4.　COMMON MEASURING INSTRUMENTS

The electric current in a circuit is measured by an instrument called the ammeter, and the potential difference between two points in it is measured by a voltmeter (in voltage stabilizers). In these meters, a needle moving over a graduated scale gives the value of the measured quantity. Each meter has two terminals. The terminal marked '**+**' is connected by a wire to the higher-potential side of a circuit, while the terminal marked '**–**' is connected to the lower-potential side.

5.　USING AN AMMETER TO MEASURE CURRENT

To measure the current through an element of a circuit, an ammeter is connected in such a way that the current flowing through it also flows through the element. Such a connection is called a series connection. In Figure, the current 'i' flowing through the lamp also flows through the ammeter. The reading of the ammeter gives the current through the lamp. Note that if the ammeter is removed, there will be a gap, and the current through the circuit will stop.
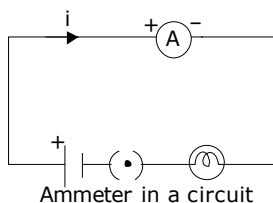
Ammeter in a circuit

Two or more electric elements are said to be connected in series if the current flowing through one also flows through the rest. An ammeter is always connected in series in a circuit.

6.   **USING A VOLTMETER TO MEASURE POTENTIAL DIFFERENCE**

Figure shows a circuit that has two lamps L_1 and L_2 connected to a cell. We want to measure the potential difference across the lamp L_2, i.e., between the points A and B. As A is on the side of the positive terminal of the cell, its potential is higher than that of B. So, the '**+**' terminal of the voltmeter is connected to A, and the '**−**' terminal, to B. The reading of the voltmeter gives the potential difference across L_2. The current flowing through the voltmeter is different from those flowing through the other elements of the circuit. Also, even if the voltmeter is removed, the current continues to flow in the circuit. Note that the potential difference across L_2 and the voltmeter is the same. Such a connection is called a **parallel connection**.

Voltmeter in a circuit
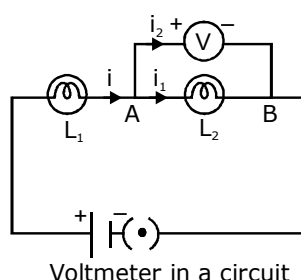
Two or more electric elements are said to be connected in parallel if the same potential difference exists across them.

7.   **GALVANOMETER**

A galvanometer is an instrument that can detect the presence of a current in a circuit. The pointer remains at zero (the centre of the scale) for zero current flowing through it. It can deflect either to the left or to the right of the zero mark depending on the direction of current.

Galvanometers are of two types:

(i) Moving coil galvanometer

(ii) Moving magnet galvanometer

It is used to make ammeter and voltmeter as follows:

(A)   **Ammeter:** Ammeter is an electrical instrument which measures the strength of current in 'ampere' in a circuitry which is always connected in series in circuit so that total current (to be measured) may pass through it. The resistance of an ideal ammeter is zero (practically it should be minimum).

(B)   **Voltmeter:** It is an electrical instrument which measures the potential difference in 'volt' between two points of electric circuit. The only difference between ammeter and voltmeter is that ammeter has its negligible (approximately zero) resistance so that it may measure current of circuit passing through it more accurately giving the deflection accordingly, while the voltmeter passes negligible current through itself so that potential difference developed due to maximum current passing through circuit may be measured.

Voltmeter has very high resistance and the resistance of an ideal voltmeter is infinite.

A voltmeter is always connected in parallel.
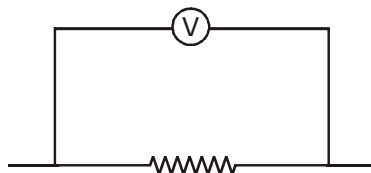
PRACTICE YOUR CONCEPTS

4. An electric bulb is connected in an electric circuit. If 10C charge flows through this bulb in 5 seconds, Find the current flowing through the bulb.

Ans. Charge, Q = 10C

Time taken, t = 5s

Current, $I = \dfrac{Q}{t} = \dfrac{10}{5} = 2A$

5. What is ammeter?

Ans. Ammeter is an electrical instrument which measures the strength of current in 'ampere' in a circuitry which is always connected in series in circuit so that total current (to be measured) may pass through it. The resistance of an ideal ammeter is zero (practically it should be minimum).

6. Draw the symbol of switch (off).

Ans.

Switch (OFF)

OHM'S LAW

The electric current through a metallic element or wire is directly proportional to the potential difference applied between its ends, provided the temperature remains constant.

If a potential difference V is applied to an element and a current i passes through it,

$$i \propto V$$

$$\text{or} \quad i = \left(\dfrac{1}{R}\right)V$$

Thus **Ohm's Law** $\boxed{V = iR}$

$$\boxed{1\,\text{ohm} = \dfrac{1\,\text{volt}}{1\,\text{ampere}}}$$
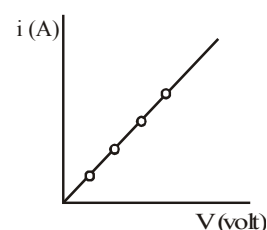
Here R is a constant for the given element (metallic wire) at a given temperature and is called its resistance. It is the property of a conductor to resist the flow of charges through it.

PRACTICE YOUR CONCEPTS

7.   In which direction does current is conventionally shown to flow in a circuit?

Ans.   Electric current flows from the positive terminal to the negative terminal.

8.   Name the components of the following circuit starting from the positive terminal of the battery in the direction of flow of current.
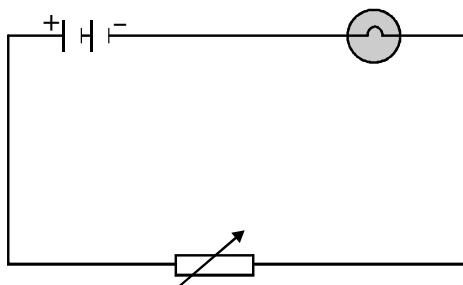
Ans.   Battery, Variable Resistance and bulb level. When water flows through the pipe, it experiences various opposing forces like friction by the walls of the pipe. In other words, it experiences resistance. An analogy can be established between the water system and electric circuits. Just as water experiences opposition, current flowing through the conductor also experiences resistance due to various factors.

9.   If the potential difference across a 2Ω resistor is 2V find the current.

Ans.   V = IR

          2 = I × 2

          I = 1 A

RESISTANCE & FACTORS AFFECTING RESISTANCE

From equation, $$i = \dfrac{V}{R}$$

So, for a given potential difference, $$i \propto \dfrac{1}{R}$$

Thus, for a given potential difference, the current is inversely proportional to the resistance. The higher is the resistance, the lower is the current. If the resistance is doubled, the current is halved. Good conductors have low resistance, while insulators have very high resistance.

1.   UNIT OF RESISTANCE

Potential difference is measured in volts, and current is measured in amperes. From Equation, R = V/i. So, the unit of resistance is **volt/ampere**. This unit is called the **ohm**, and its symbol is Ω. We can define one ohm as follows.

If a potential difference of 1 volt is applied across an element, and a current of 1 ampere passes through it, the resistance of the element is called 1 ohm.

---

2. ON WHAT DOES RESISTANCE DEPEND ?

The resistance of the conductor depends on:

(A)   its length

(B)   its area of cross-section

(C)   the nature of its material

(D)   temperature (resistance increases with increase in temperature)

Resistance of a uniform metallic conductor is directly proportional to its length (ℓ) and inversely proportional to the area of cross-section (A).

$$R \propto \ell \quad \text{and} \quad R \propto \frac{1}{A}$$

Combining eqs. we get $\qquad\qquad R \propto \frac{\ell}{A} \quad \text{or} \quad \boxed{R = \rho \frac{\ell}{A}}$

Where ρ **(rho)** is a constant of proportionality and is called electrical resistivity of the material of the conductor.

3. RESISTIVITY (ρ) :

Here, ρ is a constant for a given material at a given temperature. It is called the resistivity of the material. the resistivity of a material is the resistance per unit length of a unit cross section of the material. The SI unit of a material depends on its temperature. For metals and alloys of metals, the resistivity increases with rise in temperature. The SI unit of resistivity is Ω **m**.

Material		Resistivity(Ωm)
Metals	Silver	1.6×10^{-8}
	Copper	1.7×10^{-8}
	Aluminium	2.8×10^{-8}
	Tungsten	5.8×10^{-8}
	Iron	9.7×10^{-8}
Alloys	Manganin	48.2×10^{-8}
	Nichrome	100×10^{-8}
Semiconductors	Germanium	4.7×10^{-3}
	Silicon	2.5×10^{3}
Insulators	Diamond	5×10^{12}
	Fused quartz	$10^{16} - 10^{19}$

4. EFFECT OF STRETCHING OF A WIRE ON RESISTANCE

Let a wire of length l_1 and cross sectional area A_1 be stretched to a length l_2 and its cross sectional area becomes A_2.

Therefore,   Volume before stretching = Volume after stretching

$$l_1 A_1 = l_2 A_2$$

and $\qquad \dfrac{R_2}{R_1} = \dfrac{l_2}{l_1} \times \dfrac{A_1}{A_2}$

If information of lengths before and after stretching is given, then use

$$\frac{A_1}{A_2} = \frac{l_1}{l_2}$$

$$\frac{R_2}{R_1} = \left(\frac{l_2}{l_1}\right)^2$$

If information of radius r_1 and r_2 is given then use.

$$\frac{l_2}{l_1} = \frac{A_1}{A_2}$$

So $\quad \frac{R_2}{R_1} = \left(\frac{A_1}{A_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^4$

Reciprocal of resistivity of a conductor is called its conductivity. It is represented by $\sigma \left\{ \sigma = \frac{1}{\rho} \right\}$

5. EFFECT OF TEMPERATURE ON RESISTANCE

The variation of resistance of wire with temperature can be calculated with the formula.

$$\mathbf{R_t = R_0 (1 + \alpha \Delta T)}$$

Where R_t and R_o are the resistances at t°C and 0°C respectively and α is the temperature coefficient of the resistance of the substance.

The graph drawn between the resistance R_t and temperature t is found to be a straight line.
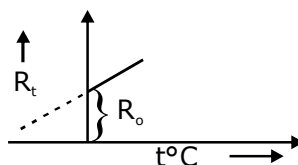
Info Bubble

Two wires of the same length are made from different materials. The resistance of a wire is given by, $R = \rho \frac{\ell}{A}$ where ρ is the resistivity of the wire material, and ℓ and A are respectively, the length and cross-sectional area of the wire. Even when the wires have the same length, they may have the same resistance, if the cross-sectional areas of the wires are chosen so that the ratio $\rho \frac{\ell}{A}$ is the same for each. That is

$$\rho_1 \frac{\ell}{A_1} = \rho_2 \frac{\ell}{A_2} \text{ or } \frac{A_2}{A_1} = \frac{\rho_2}{\rho_1}$$

This is the condition for each wire of different materials to have the same resistance when they have same length.

PRACTICE YOUR CONCEPTS

10. Why alloys do not oxidise (burn) readily at high temperature?

Ans. Because with the change in temperature their resistivity changes less rapidly.

11. The length of a silver wire is 2m. Diameter of the wire is 2mm. Calculate the resistance of the silver wire if the resistivity of silver is 1.6×10^{-8} Ω m.

Ans. Area of cross section.

$A = \pi r^2$

Where r = radius of cross section

Given the diameter of cross section,

the radius is calculated as: $r = \dfrac{d}{2} = \dfrac{2}{2} = 1mm$

$A = 3.14 \times (1 \times 10^{-3})^2$

$= 3.14 \times 10^{-6}$ sq.m   ...(i)

The resistance of the conductor is given by,

$R = \rho \dfrac{L}{A}$

Here,

L = length of the conductor = 2m

A = Area of cross section = 3.14×10^{-6} sq.m... from (1)

$\rho = 1.6 \times 10^{-8}$ Ω m

Therefore, $R = 1.60 \times 10^{-8} \times \dfrac{2}{3.14 \times 10^{-6}} = 0.01\Omega$

12. The resistivity of copper is given to be 1.6×10^{-8} Ω m. Resistance of the copper wire is 100Ω. The radius of cross section is 0.5 mm. Calculate the length of the wire.

Ans. Area of cross section,

$A = \pi r^2$

Where r = radius of cross section

$A = 3.14 \times (0.5 \times 10^{-3})^2$

$= 7.8 \times 10^{-7}$ sq.m

The resistance of the conductor is given by,

$R = \rho \dfrac{L}{A}$

Here,

R = resistance of the conductor = 100Ω

A = Area of cross section = 7.8×10^{-7} sq.m.... from (1)

$\rho = 1.62 \times 10^{-8}$ Ω m

The resistance of the conductor is given by,

$R = \rho \dfrac{L}{A}$

Therefore, $L = R\dfrac{A}{\rho} = 100 \times \dfrac{7.85 \times 10^{-7}}{1.62 \times 10^{-8}}$

$= 4845.6 \, m$

COMBINATION OF RESISTORS

A conducting material (e.g., a wire) of a particular resistance meant for use in a circuit is called a resistor. A resistor is sometimes simply referred to as a resistance. It is represented by the symbol ⌐√√√√⌐. Two or more resistors can be connected in series, in parallel or in a manner that is a combination of these two.

## 1.   SERIES CONNECTION OF RESISTORS

Two or more resistors are said to be connected in series if the current flowing through one also flows through the rest.

The total potential difference across the combination of resistors connected in series is equal to the sum of the potential differences across the individual resistors.

$$V = V_1 + V_2 + V_3$$

2.   EQUIVALENT RESISTANCE IN SERIES CONNECTION

Figure (a) shows three resistors of resistances R_1, R_2 and R_3 connected in series. The cell connected across the combination maintains a potential difference V across the combination. The current through the cell is i. The same current i flows through each resistor.

(a)   (b)
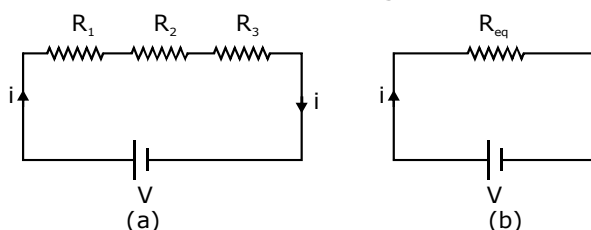
Let us replace the combination of resistors by a single resistor R_{eq} such that the current does not change, i.e., it remains i. This resistance is called the **equivalent resistance** of the combination, and its value is given by Ohm's law as R_{eq} = V/i

Thus $V = iR_{eq.}$

The potential differences V_1, V_2 and V_3 across the resistors R_1, R_2 and R_3 respectively are given by

Ohm's law as : $V_1 = iR_1$, $V_2 = iR_2$, $V_3 = iR_3$

Since the resistors are in series, $V = V_1 + V_2 + V_3$

Substituting the values of the potential differences in the above equation,

$$iR_{eq} = iR_1 + iR_2 + iR_3$$

or $iR_{eq} = i(R_1 + R_2 + R_3)$

or $\boxed{R_{eq} = R_1 + R_2 + R_3}$

Similarly, for n resistors connected in series,

Equivalent resistance of resistors in series : $\boxed{R_{eq} = R_1 + R_2 + R_3 + ... + R_n}$

3. **PARALLEL CONNECTION OF RESISTORS**

The total current flowing into the combination is equal to the sum of the currents passing through the individual resistors.

$$i = i_1 + i_2 + i_3$$

If resistors are connected in such a way that the same potential difference gets applied to each of them, they are said to be connected in parallel.

4. **EQUIVALENT RESISTANCE IN PARALLEL CONNECTION**

Figure (a) shows three resistors of resistances R_1, R_2 and R_3 connected in parallel across the points A and B. The cell connected across these two points maintains a potential difference V across each resistor. The current through the cell is i. It gets divided at A into three parts i_1, i_2 and i_3, which flow through R_1, R_2 and R_3 respectively.
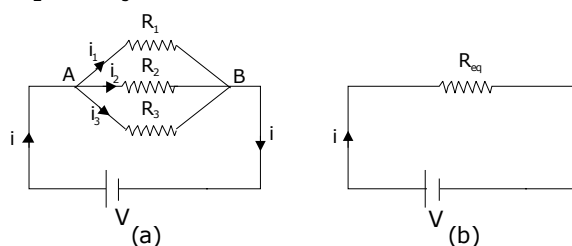
Let us replace the combination of resistors by an equivalent resistor R_{eq} such that the current i in the circuit does not change (Fig). The equivalent resistance is given by Ohm's law as $R_{eq} = V/i$.

Thus,

$$i = \frac{V}{R_{eq}}$$

The currents i_1, i_2 and i_3 through the resistors R_1, R_2 and R_3 respectively are given by Ohm's law as

$$i_1 = \frac{V}{R_1}, \quad i_2 = \frac{V}{R_2}, \quad i_3 = \frac{V}{R_3}$$

Since the resistors are in parallel,

$$i = i_1 + i_2 + i_3$$

Substituting the values of the currents in the above equation,

$$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

or

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Similarly, if there are n resistors connected in parallel, their equivalent resistance R_{eq} is given by

Equivalent Resistance of resistors in parallel : $\boxed{\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + ... + \dfrac{1}{R_n}}$

For two resistances R_1 and R_2 connected in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1 + R_2}{R_1 R_2} \quad \text{or} \quad \boxed{R = \frac{R_1 R_2}{R_1 + R_2}}$$

The equivalent resistance in a parallel connection is less than each of the resistances.

When a resistance is joined parallel to a comparatively smaller resistance, the equivalent resistance is very close to the value of the smaller resistance.

NOTE : If a resistor connected in series with others is removed or fails, the current through each resistor becomes zero. On the other hand, if a resistor connected in parallel with others fails or is removed, the current continues to flow through the other resistors.

5.   DISTRIBUTION OF CURRENT IN TWO RESISTORS IN PARALLEL

Consider the circuit in fig. The resistors R_1 and R_2 are connected in parallel. The current i gets distributed in the two resistors.

$$i = i_1 + i_2 \qquad\qquad .....(i)$$

Applying Ohm's law to the resistor R_1

$$V_A - V_B = R_1 i_1. \qquad\qquad .....(ii)$$

And applying Ohm's law to the resistor R_2

$$V_A - V_B = R_2 i_2 \qquad\qquad .... (iii)$$

From (ii) and (iii), $R_1 i_1 = R_2 i_2$ or $i_2 = \dfrac{R_1}{R_2} i_1$

Substituting for i_2 in (i), we have

$$i = i_1 + \frac{R_1}{R_2} i_1 = i_1 \left(1 + \frac{R_1}{R_2}\right) = i_1 \frac{R_1 + R_2}{R_2}$$

$$\text{or } i_1 = \frac{R_2}{R_1 + R_2} i$$

Similarly, $i_2 = \dfrac{R_1}{R_1 + R_2} i$

Thus, $\boxed{\dfrac{i_1}{i_2} = \dfrac{R_2}{R_1}}$

The current through each branch in a parallel combination of resistors is inversely proportional to its resistance.
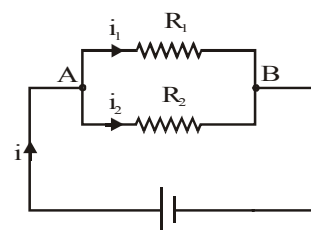
Info Bubble

● If 'n' number of resistors each of same value connected in series, then the equivalent resistance of the series combination of 'n' resistors is given by

$$R_{eq} = nR$$

● If 'n' number of resistors each of same value connected in parallel, then the equivalent resistance of the parallel combination of 'n' resistors is given by

$$R_{eq} = \frac{R}{n}$$

● In the given figure Bulbs A and B are connected in series across the emf of the battery, whereas bulb C is connected by itself across the battery. Voltage drop across C has the same magnitude as the battery voltage, whereas this same voltage is split between bulbs A and B. As a result, bulb C will glow more brightly than either of bulbs A and B, which will glow equally brightly. Bulb D has a wire connected across it i.e., a short circuit, so that potential difference across bulb D is zero and it doesn't glow. If bulb A fails, B goes out, but bulb C will glow. If bulb C fails, there is no effect on the other bulbs. If bulb D fails we cannot detect this event, because bulb D was not glowing initially; also, there is no effect on the other bulbs.
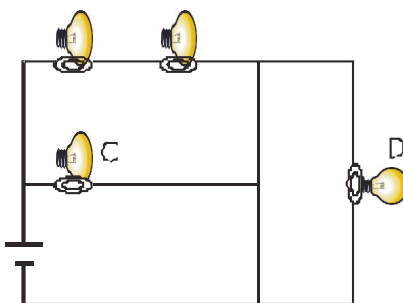
6.   DEVICES IN SERIES AND PARALLEL

You must have seen tiny bulbs strung together for decorating buildings during festivals like Diwali, and occasions like marriages, etc. These bulbs are connected in series, and the mains voltage is applied to the combination. The potential difference (V) of the mains gets divided across the bulbs ($V = V_1 + V_2 + V_3 + \dots$).

So, a small potential difference exists across each bulb, close to that required to make the bulb work. However, the same current flows through all the bulbs. So, if one bulb goes bad, the current through it stops, and this stops the current through the rest of the bulbs as well. To make the chain of lights work, we have to find and replace the defective bulb. This problem does not occur with the lights in our house.

That is because **in houses, lights, fans, etc., are connected in parallel**. In parallel connection, the same mains voltage gets applied to each device, but the current through each is different. If one of them goes bad, the current in the other branches of the parallel connection does not stop. Another advantage of parallel connection is that, unlike series connection, each device can draw a different current, as per its requirement.

PRACTICE YOUR CONCEPTS

13. Find current which is passing through battery.
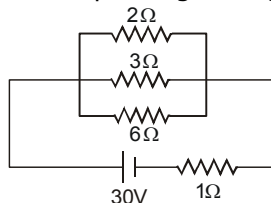
Ans. Here potential difference across each resistor is not 30 V

∵ battery has internal resistance here the concept of combination of resistors is useful.

$$\frac{1}{R_p} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

So, $R_p = 1$

$R_{eq} = R_p + 1 = 1 + 1 = 2\Omega$

$$i = \frac{30}{2} = 15A$$

14. A piece of wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R', then the ratio R/R' is :

(A) 1/25   (B) 1/5   (C) 5   (D) 25

Ans. Resistance of each one of the five parts = $\dfrac{R}{5}$

Resistance of five parts connected in parallel is given by

$$\frac{1}{R'} = \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5} + \frac{1}{R/5}$$

or $\dfrac{1}{R'} = \dfrac{5}{R} + \dfrac{5}{R} + \dfrac{5}{R} + \dfrac{5}{R} + \dfrac{5}{R} = \dfrac{25}{R}$

or $\dfrac{R}{R'} = 25$

Thus, (D) is the correct answer.

15. Show how you would connect three resistors, each of resistance 6Ω, so that the combination has a resistance of (i) 9Ω (ii) 2Ω.

Ans. (i) In order to get a resistance of 9 Ω from three resistors, each of resistance 6 Ω, we connect two resistors in parallel and this parallel combination (or resistance 3Ω) in series with the third resistor as shown in fig.
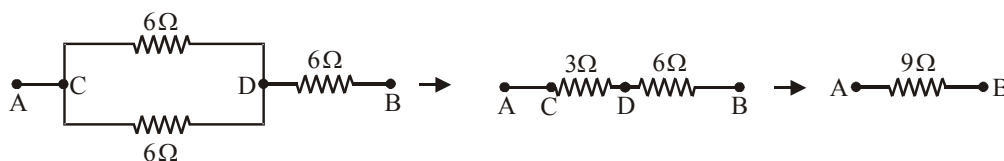

(ii) In order to get a resistance of 2Ω from three resistors, each of resistance 6 Ω, we connect all the three resistors in parallel as shown in fig (b) as equivalent resistance in parallel combination,

i.e., R_p is given by $R_p = \dfrac{6\Omega}{3} = 2\Omega.$
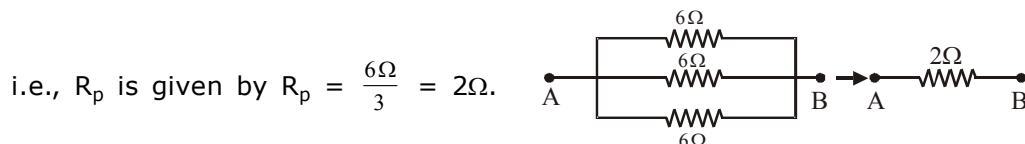
CELL

- The main function of the cell is to convert chemical energy into electrical energy.
- Electro chemical cells are of three types –
  (A) Primary Cell   (B) Secondary cell   (C) Fuel cell.

1.   **Primary Cell:–** It is an electrochemical cell which cannot be recharged but the chemicals have to be replaced after a long use.
- The reactions taking place in the cell are irreversible Eg :– Daniel cell, Dry cell etc.

2.   **Secondary Cell:–** Electrical energy can be converted into chemical energy and chemical energy can be converted into electrical energy in these cells.
- The chemical reaction taking place in these cells are reversible Eg : – Edison cell, iron nickel cell.

3.   **Fuel Cell:–** It is an electro chemical cell that converts the chemical energy from a fuel into electricity through an electrochemical reaction of hydrogen fuel with oxygen or another oxidizing agent.

Determination of internal resistance of a cell:–
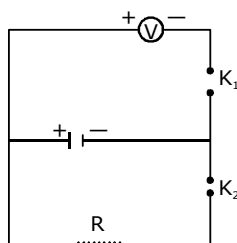
Connect a voltmeter to a cell through key K_1. Also, connect a resistor R to a cell through K_2. First put in key K_1. The reading shown by voltmeter gives us the emf of the cell since negligible current flows through cell due to high resistance of the voltmeter, insert key K_2 also so that current flows through resistor R. If r is the internal resistance of the cell and V^- is the reading shown by voltmeter then. $E = I (R + r)$

IR = V   (i)

So   E = V + Ir

$$\left\{ r = \dfrac{E-V}{I} \right\}$$ (ii)
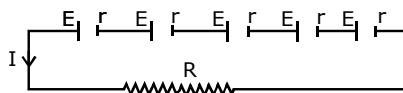
From (i) & (ii), $r = \dfrac{E-V}{(V/R)}$ or $\left[r = \left(\dfrac{E-V}{V} \right)R \right]$

---

1.   **Grouping of cell :–**

Cells in series

$\Downarrow$

$E_{eq} = E_1 + E_2 + E_3 + E_4 + \ldots\ldots\ldots\ldots\ldots E_n$

&

$r_{eq} = r_1 + r_2 + r_3 + r_4 + \ldots\ldots\ldots\ldots r_n$

•   If n cells each of emf E, are arranged in series and r is the internal resistance of each cell, then total emf = nE

$$\left[I = \frac{ne}{R + nr} \right]$$

There may be two cases.

(i)   If nr << R then I = $\dfrac{nE}{R}$ = n x (current due to one cell)

So series combination is advantageous.

(ii)   If nr >> R then I = $\dfrac{E}{R}$ = (current due to one cell)

So, series combination is not advantageous.

Note :– If polarity of m cells is reversed, then equivalent emf = (n–2m)E, while equivalent resistance is still nr+R, so current in R will be

$$I = \frac{(n - 2m)E}{nr + R}$$

2.   **Cells in Parallel**

If m cells each of emf E and internal resistance r be connected in parallel and if this combination is connected to an external resistance then the emf of the circuit is E.

Internal resistance of the circuit = $\dfrac{r}{m}$
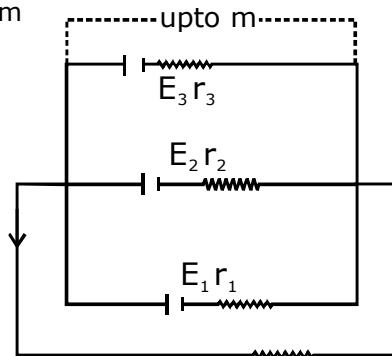
and $I = \dfrac{E}{R + \dfrac{r}{m}} = \dfrac{mE}{mR + r}$

There may be two cases :

(i)   If mR < <r then I = $\dfrac{mE}{r}$ = m x (current due to one cell)

   So, Parallel combination is advantageous.

(ii)   If mR > > r then I = $\dfrac{E}{R}$ = current due to one cell

   So, parallel combination is not advantageous.

If emf and internal resistance of each cell are different then,

$$E_{eq} = \dfrac{\dfrac{E_1}{r_1} + \dfrac{E_2}{r_2} + - - - - - - + \dfrac{E_n}{r_n}}{\dfrac{1}{r_1} + \dfrac{1}{r_2} + - - - - - - + \dfrac{1}{r_n}}$$

HEATING EFFECT OF ELECTRIC CURRENT

When an electric current passes through a bulb, the filament gets so hot that it glows and emits light. When a current passes through the filament of an electric iron, the iron becomes very hot. This increase in temperature is due to what is called 'the heat produced due to current'. Suppose a resistor R is connected to a cell. The cell maintains a potential difference V across the resistor, driving a current i through it.

So,   ***V = iR***   ......(i)
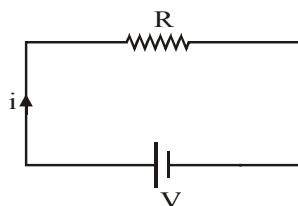
The current through the resistor is actually a flow of negative charges (electrons). Inside the cell, the negative charges flow from the positive to the negative terminal. The cell does work = QV to take a charge through the potential difference V between its terminals. This increases the energy of the charge by QV. This increased energy gets converted to heat in the resistor. So, the energy appearing as heat is given by

   U = QV   ......(ii)

The charge that passes through the wire in time t is

   Q =it.   ......(iii)

Using (i), (ii) and (iii), we find that the heat produced in the wire in time t is

   U =QV = (it) (iR) =i² Rt.

From Equation the heat produced is proportional to the square of the current, if R and t remain constant. So, if the current passing for a given time through a given resistance is doubled, the heat produced becomes four times. Similarly, for a given i and t, the heat produced is proportional to R. If the same current i passes through two resistances in a given time, more heat will be produced in the larger resistance. The heat produced can also be written as.

$$U = i^2Rt = \left(\frac{V}{R}\right)^2 Rt \qquad \text{or} \qquad \boxed{U = \frac{V^2}{R}t}$$

For a given V and t, the heat produced is inversely proportional to R. So, if the same potential difference is applied across two resistances, more heat will be produced in the smaller resistance.

We have seen above that the increased energy of a charge gets converted to heat in the resistor. The increase in energy comes from the work done by the cell. This uses up the chemical energy of the cell. So, the energy appearing as heat in the resistor ultimately comes at the expense of the chemical energy of the cell.

Not always is the work done by a cell converted to heat. Immediately after a motor is connected to a cell, the speed of the shaft of the motor increases. A part of the work done by the cell goes into producing the increase in kinetic energy. And a part is used to overcome friction, etc. When the motor achieves a constant speed, its kinetic energy does not change. So the work done by the cell is only used to overcome friction, etc. This appears as heat. That is why the cover over a motor becomes warm on use.

PRACTICE YOUR CONCEPTS

16. It is given that the electric power of heater is 2000 W and the potential difference is 200 V, then calculate the current flowing through the heater.

Ans. Given P = 2000W and V = 200V

We know that P = VI

$$I = P/V = \frac{2000}{200}$$

I = 10A

17. The heat produced in each second is 200J in 5Ω resistance. Calculate the Potential difference.

Ans. Given H = 200J and R = 5Ω

From Joule's law H = I²Rt

$$I = \sqrt{\frac{H}{Rt}}$$

$$I = \sqrt{\frac{200}{5 \times 1}}$$

I = 6.324 A

from Ohm's law V = IR

V = 6.324 × 5

V = 31.62 V

18. Name a few practical applications of heating effect of current.

Ans. Electric fues, Electric iron, Electric heater.

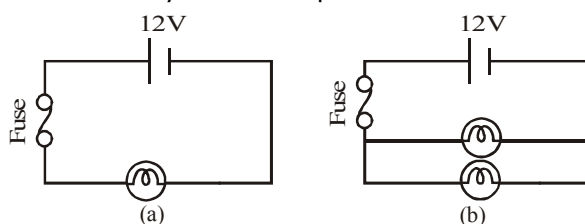# APPLICATIONS OF THE HEATING EFFECT OF CURRENT

The heating effect of electric current has many uses. Electric bulbs, room heaters, electric irons, immersion heaters, toasters, electric fuses and a number of other appliances work on this principle. In all of these, a wire of suitable resistance, commonly called the heating element, is connected to the power supply. The current passing through the element produces heat in it, which is used for some specific purpose.

1. **ELECTRIC BULB :** An electric bulb has a simple structure. It consists of a sealed glass bulb that has a tungsten filament connected to two electrical contacts. The bulb is filled with an unreactive gas like argon or nitrogen. To produce white light, the filament has to be heated to about 3000°C by passing a current through it. Obviously, the material of the filament should such that it does not melt at this temperature. Tungsten is used for the filament because its melting point is about 3400°C. The sealed glass bulb serves two purposes. First, it protects the filament from oxidation and the effects of humidity. Secondly, the small enclosed volume makes it easier to maintain the required temperature, as without it the loss of heat would be more.

2. **FUSE :** A fuse is a safety device that does not allow excessive current to flow through an electric circuit. It consists of a metallic wire of low melting point, fixed between the two terminals of a fuse plug. The fuse plug fits into a fuse socket connected in the circuit. Fuses are available in various shapes. The fuse plug is used in household wiring. It is made of porcelain.

    A fuse is connected in series with an appliance (such as a TV) or a group of appliances (such as the lights and fans in a room). So, the current through the fuse is the same as the current through the appliance or the group of appliances. If this current exceeds a safe value, the heat produced in the fuse wire causes it to melt immediately. This breaks the circuit, preventing any damage. Figure shows examples of how a fuse is connected in circuits.

    Good-quality fuse wires are made of tin, as it has a low melting point. Some fuse wires are made of an alloy of tin and copper. The thickness of the fuse wire depends on the circuit in which it is to be used. If a section of the circuit is meant to carry a maximum of 5A current, the fuse wire should also be able to carry currents up to 5A. Similarly, for wiring meant for 15A, the fuse wire should be thicker, and should be able to carry currents up to 15A.

3. **DISADVANTAGES OF THE HEATING EFFECT OF CURRENT**

    A current always produces some heat, whether we use the heat or not. If the heat produced cannot be utilized, it represents a wastage of energy. A considerable amount of energy is thus wasted in the transmission of electricity from the generating station to our homes. Sometimes, the heat produced in a device is so much that it can damage the device, unless proper cooling arrangements are made. To dissipate the heat produced in TV sets, monitors, etc., their cabinets have grills for air to pass. Certain components of a computer get so hot that they have fans to cool them.

ELECTRIC POWER

Power is the rate of doing work, or the rate at which energy is produced or consumed. The electrical energy produced or consumed per unit time is called electric power. In an electric circuit, the power is

$$P = \frac{U}{t} \quad = \quad \frac{i^2 Rt}{t} \quad = \quad i^2 R$$

Using $iR = V$

$$\boxed{P = Vi}$$

$$\boxed{P = \frac{V^2}{R}}$$

The energy consumed and power are related as

$$\boxed{U = Pt} \; .$$

1. UNIT OF POWER

The SI unit of energy is the joule, and that of time is the second. The SI unit of power is therefore joule/second. This unit is called the watt, whose symbol is **W**.

2. RATING OF ELECTRIC APPLIANCES

Take an electric bulb and see what is written on it. Apart from the name and the symbol of the company, we will find values of power and potential difference. For example, it could be 60W, 220V. It means that 220V should be applied across this bulb, and when 220V is applied, the power consumed will be 60W. We will find similar markings on all electric· appliances. For an electric appliance, the values of power and voltage taken together form what is called the rating of the appliance.

$\Rightarrow$ From the rating of an appliance, you can easily calculate its resistance by using the equation $P = \frac{V^2}{R}$. Note that higher the power rating, smaller the resistance. So, a 1000W heater has less resistance than a 100W bulb. We can also calculate the current drawn by an appliance by using the relation $i = \frac{P}{V}$.

3. KILO WATT HOUR

Power is the rate of energy consumed or produced. If 1 joule of energy is used per second, the energy is used at the rate of 1 watt. In other words, if energy is used at the rate of 1 watt, the total energy used in 1 second is 1 joule. How much energy is used in 1 hour if it is used at the rate of 1000 watt?

It is (1000 watt) × (3600 second) = 3,600,000 joule.

This amount of energy is called 1 kilowatt hour, written in short as **kWh.**

Thus, **1 kWh = 3,600,000 J = 3.6 × 10⁶ J**.

The electrical energy used in houses, factories, etc., is measured in kilowatt hours. The cost of electricity is fixed per kilowatt hour. **One kilowatt hour of electrical energy is called one unit.**

4. ELECTRICAL SAFETY

(A) **Earthing:** Earthing means to connect the metal case of electrical appliance to the earth (at zero potential) by means of a metal wire called "earth wire". In household circuits, we have three wires, the live wire, the neutral wire and the earth wire. One end of the earth wire is buried in the earth. We connect the earth wire to the metal case of the electrical appliance by using a three-pinplug.

The metal casing of the appliance will now always remain at the zero potential of the earth. We say that the appliance has been earthed or grounded. If, by chance, the live wire touches the metal case of the electric iron (or any other appliance) which has been earthed, then the current passed directly to the earth through the earth wire. It does not need our body to pass the current and therefore, we do not get an electric shock. Actually, a very heavy current flows through the earth wire and the fuse of house-hold wiring blows out or melts. And it cuts off the power supply. In this way, earthing also saves the electrical appliance from damage due to excessive current.

(B) **Miniature Circuit Breaker:** These days a device called a miniature circuit breaker (MCB) is also used instead of or in addition to fuses, in the household electric circuits. It is a switch that automatically switches off a circuit if the current in it exceeds the specified maximum limit.

PRACTICE YOUR CONCEPTS

19. Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A?

Ans. Resistance of each bulb, $r = \dfrac{V^2}{P} = \dfrac{(220)^2}{10} = 4840\,\Omega$

Total resistance in the circuit, $R = \dfrac{220V}{5A} = 44\,\Omega$

Let n be the number of bulb (each of resistance r) to be connected in parallel to obtain a resistance R.

Clearly, $R = \dfrac{r}{n}$ or $n = \dfrac{r}{R} = \dfrac{4840\,\Omega}{44\,\Omega} = 110$

20. Compare the power used in the 2Ω resistor in each of the following circuits :
(i) a 6 V battery in series with 1Ω and 2Ω resistors, and
(ii) a 4 V battery in parallel with 12Ω and 2Ω resistors.

Ans. (i) Since 6 V battery is in series with 1Ω and 2Ω resistors, current in the circuit,

$$I = \dfrac{6V}{1\Omega + 2\Omega} = \dfrac{6V}{3\Omega} = 2\,A$$

Power used in 2Ω resistor, $P_1 = I^2R = (2A)^2 \times 2\Omega = 8W$

(ii) Since 4 V battery is in parallel with 12Ω and 2Ω resistors, potential difference across 2Ω resistor, V = 4V.

Power used in 2Ω resistor, $P_2 = \dfrac{V^2}{R} = \dfrac{(4V)^2}{(2\,\Omega)} = 8W$

Clearly, $\dfrac{P_1}{P_2} = \dfrac{8W}{8W} = 1$

21. Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to the electric mains supply. What current is drawn from the line if the supply voltage is 220 V?

Ans. Resistance of first lamp, $r_1 = \dfrac{V^2}{P} = \dfrac{(220)^2}{100} = 484\,\Omega$

resistance of the second lamp, $r_2 = \dfrac{V^2}{P} = \dfrac{(220)^2}{60} = 806.7\,\Omega$

Since the two lamps are connected in parallel, the equivalent resistance is given by

$$\frac{1}{R_p} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{r_2 + r_1}{r_1 r_2}$$

or $R_p = \dfrac{r_2 r_1}{r_1 + r_2} = \dfrac{484 \times 806.7}{484 + 806.7} = \dfrac{390442.8}{1290.7} = 302.5\ \Omega$

Current drawn from the line, i.e.,

$I = \dfrac{V}{R_p} = \dfrac{220V}{302.6\,\Omega} = 0.73$ A

ON YOUR TIPS

- Charge is the fundamental property of a matter that exhibits electrostatic attraction or repulsion over other matter. Any material body which has unequal number of positive and negative charges is considered as an electrically charged body.

- Materials can be classified according to the ability of the charge to move through them as conductors and insulators.

- Conductors are the materials in which the charge is free to move and hence it's a good conductor of electricity. For example: silver, copper, gold, water etc.

- Insulators are the materials through which the charge cannot move freely. For example: rubber, plastic, glass etc.

- Electric charge has following properties:

  (i) Additive nature: total charge of the system is equal to the sum of electric charges located in a system.

  (ii) Conservation of charge: The total charge of an isolated system always remains conserved.

  (iii) Quantization of charge: Electric charge of any system is always an integral multiple of the least amount of charge.

  (iv) Invariance of charge: Charge is invariant of speed, it remains constant.

- SI unit of charge is coulomb denoted by C.

- The term polarization means to separate into opposites that is when two sides of the object gain opposite charge, the object is said to be polarized.

- The property of any charge to be present in only separate group or bundle of specific minimum charge is known as a quantized charge.

- The rate at which charge, either negative or positive, flow through a given cross sectional area or surface from higher potential is termed as electric current.

- Any circuit which is not complete is considered as open circuit. Current does not flow in this type of circuit.

- Any circuit which is complete and hence potential difference is created across it, hence leading to the current flow.

- The potential difference is defined as the amount of work done (W) by external agent in moving a unit charge (Q) from one point to another.

- Electric potential is defined as the energy per unit charge (Le., per coulomb) at a point in a field

- The SI unit of Electric Potential Difference is Volt (V).

- The Dimensions of electric potential difference are $ML^2T^{-3}A^{-1}$.

- If I is the current flowing through the conductor and V is the voltage or potential difference across its ends, then:

  Which is the same as:

  $$I \propto V$$

  $$V \propto I$$

  $$V = R \times I$$

  This is known as "Ohm's law."

- Common electrical components are resistor, capacitor, inductor, galvanometer, voltmeter, ammeter, rheostat, variable capacitor.

- Factors which affect the resistance are length of the material, cross sectional area of the conductor, nature of material, temperature.

- When a voltage applied across the ends of the metallic wire, the free electrons begin to move and collide with the atoms. The concept behind heating of the electrical devices is the increase in internal energy due to the collision between the valence electrons which are responsible for the conduction. This is known as heating effect of electric current.

- Heat produced is directly proportional to the square of I, resistor R and time t. Where H is in calories, time in seconds and resistor is in ohm. This is known as Joule's law.

- Heating effect of electric current is used in electric bulbs, electric fuse.

- There are two ways by which an electric current can flow through a conductor (like wire). One way is a direct current (DC) and the other way is an alternating current (AC).

- An electric current that flows uniformly in the same single direction is called direct current or DC.

- The household wiring is of two types: Tree system, ring system.

- Electric fuse is a safety device, it is used to protect an electric circuit against electric shock, fire, damage to an electric appliance due to short-circuit and overloading.

NCERT QUESTIONS WITH SOLUTION

1. What does an electric circuit mean ?

Sol. An electric circuit is a closed and continuous path consisting of many devices like resistors, electric bulbs, etc. through which an electric current flows.

2. Define the unit of current.

Sol. The SI unit of current is ampere (A). Current flowing through a conductor is said to be 1 ampere if 1 coulomb of charge flows through it in 1 second.

3. Calculate the number of electrons constituting one coulomb of charge.

Sol. Number of electrons constituting 1 coulomb is given by,

$n = \dfrac{Q}{e}$, where, Q = 1 C and e = charge of a single electron = 1.6×10^{-19} C

or $n = \dfrac{1C}{1.6 \times 10^{-19}C}$ = 6.25×10^{18} electrons.

4. Name a device that helps to maintain a potential difference across a conductor.

Sol. A battery can be used to maintain a potential difference across a conductor.

5. What is meant by saying that the potential difference between two points is 1 V ?

Sol. Potential difference between two points is 1 volt if 1 joule of work is done to carry a charge of 1 coulomb from one point to the other.

6. On what factors does the resistance of a conductor depend?

Sol. The resistance (R) of a conductor depends upon

(i) its length (ℓ): $R \propto \ell$

(ii) its cross-sectional area (A): $R \propto \dfrac{1}{A}$

(iii) Nature of material i.e., resistivity (ρ) of its material: $R \propto \rho$

(iv) Temperature: more the temperature, more will be its resistance.

7. How much energy is given to each coulomb of charge passing through a 6V battery?

Sol. Work done, W = QV Where, Q = 1C; V = 6V
W = 1C × 6V = 6J

8. Does current flow more easily through a thick wire or a thin wire of the same material when connected to the same source? Why?

Sol. The current flows more easily through a thick wire than through a thin wire. This is because the resistance R of a thick wire (large area of cross-section) is less than that of a thin wire (small area of cross-section) as $R \propto \dfrac{1}{A}$.

9. Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half its former value. What change will occur in the current through it?

Sol. We know that I = V/R, when potential difference becomes V/2, and resistance remains constant, then, current becomes 1/2 of its former value.

10. Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Sol. This is because (i) resistivity of an alloy is generally higher than that of pure metals (ii) an alloy has a high melting point and it does not oxidise at high temperatures.

11. (a) which among iron and mercury is a better conductor? Given, $\rho_{iron} = 10.0 \times 10^{-8}$ Ωm and $\rho_{mercury} = 94.0 \times 10^{-8}$ Ωm.
(b) Which material is the best conductor?

Sol. (a) Iron is a better conductor than mercury as resistivity (ρ) for iron is less than that for mercury.
(b) Silver is the best conductor because its resistivity (ρ) is least.

12. Draw a schematic diagram of a circuit consisting of a battery of three cells of 2V each, a 5 ohm resistor, an 8 ohm resistor, and a 12 ohm resistor, and a plug key, all connected in series.

Sol.
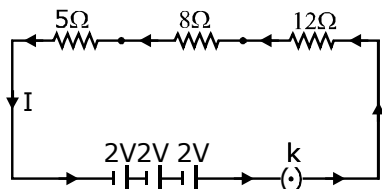
13. Redraw the circuit of Q. 12, putting in an ammeter to measure,the current through the resistors and a voltmeter to measure the voltage across the 12 ohm resistor. What would be the reading in the ammeter and the voltmeter?
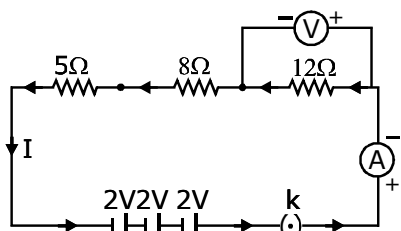
Sol. Since all the three resistances are in series, total resistance in the circuit,

R = 5 + 8 + 12 = 25Ω

Current in the circuit,

$I = \dfrac{V}{R} = \dfrac{2+2+2}{25} = \dfrac{6}{25} = 0.24\,A$,

thus, ammeter will read 0.24 A.

Potential difference across 12 ohm resistor,

V = I × R = 0.24 × 12 = 2.88 V

14. Judge the equivalent resistance when the following are connected in parallel (a) 1Ω and $10^6Ω$ (b) 1Ω, $10^3Ω$ and $10^6Ω$.

Sol. (a) Approx. 1 Ω(slightly less than 1Ω) as other one ($10^6Ω$) is very large as compared to 1Ω. In parallel combination of resistors, the equivalent resistance is lesser than the least resistance (in this case, 1Ω).

(b) Again, resistance is approx. 1Ω(slightly less than 1Ω).

15. An electric lamp of 100Ω, a toaster of resistance 50Ω and a water filter of resistance 500Ω are connected in parallel to a 220V source. What is the resistance of an electric iron connected to the same source that takes as much current as in three appliances and what is current through it?

Sol. Resistance of the electric lamp, R_1 = 100 Ω; resistance of toaster, R_2 = 50Ω; resistance of water filter, R_3 = 500Ω

Since R_1, R_2 and R_3 are connected in Parallel, their equivalent resistance (R_p) is given by

$$\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} = \dfrac{1}{100} + \dfrac{1}{50} + \dfrac{1}{500} = \dfrac{5+10+1}{500} = \dfrac{16}{500} = \dfrac{4}{125}$$

$$R_p = \dfrac{125}{4}$$

Current through the three appliances, i.e.,

$$I = \dfrac{V}{R_p} = \dfrac{220}{(125/4)} = 7.04\,A$$

Since the electric iron drawing the same current when connected to the same source (220 V), its resistance must be equal to R_p. Thus, resistance of the electric iron,

$$\dfrac{125}{4} = 31.25\,Ω$$

Current through the electric iron, I = 7.04 A

16. What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series.

Sol. (a) In case of devices in parallel. if one device gets damaged (or open), all other will work as usual as the whole circuit does not break. This is not with the devices connected in series because when one device fails, the circuit breaks and all devices stop working.

(b) Since potential difference across all devices is same in parallel Circuit, they will draw required current according to their resistances. This is not so in series circuit where same current flows through all the devices, irrespective of their resistances.

---

17. How can three resistors of resistances 2Ω, 3Ω and 6Ω be connected to give a total resistance of (a) 4Ω (b) 1Ω ?

Sol. (a) The get a total resistance of 4Ω from resistors of resistance 2Ω, 3Ω and 6Ω, the resistors are joined as shown below.
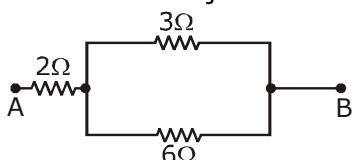

The resistors having resistances 3Ω and 6Ω are connected in parallel. This combination is connected in series with the resistor of resistance 2Ω. Let us check it mathematically, equivalent resistance of 3Ω and 6Ω resistors is,

$$R_1 = \frac{3 \times 6}{3 + 6} = \frac{3 \times 6}{9} = 2\,\Omega$$

Now, R_1 and 2Ω resistors are in series, their equivalent resistance is $R_e = R_1 + 2$ $= 2 + 2 = 4\Omega$.

(b) To get a resistance of 1Ω from three given resistors of resistance 2Ω, 3Ω, 6Ω, are joined as shown below.
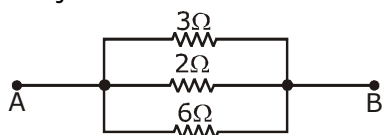
They all are connected in parallel. Their equivalent resistance is given by,

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3 + 2 + 1}{6} = \frac{6}{6} = 1$$

$$\therefore R = 1\Omega$$

18. What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4Ω, 8Ω, 12Ω, 24Ω?

Sol. (a) The highest resistance is secured when all the resistors are connected in series. The equivalent resistance is given by,
    $R_e = 4\Omega + 8\Omega + 12\Omega + 24\Omega = 48\Omega$.

(b) The lowest resistance is secured when all the four coils are connected in parallel.

The equivalent resistance is given by,

$$\frac{1}{R_e} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{6 + 3 + 2 + 1}{24} = \frac{12}{24} = \frac{1}{2}$$

or $R_e = 2\Omega$

19. Why does the cord of electric heater not glow while the heating element does?

Sol. The cord of an electric heater is made of thick copper wire and has much lower resistance than the heating element. For the same current (I) flowing through the cord and the element, heat produced in the element is much more than that produced in the cord. As a result, the element becomes very hot and glows whereas the cord does not become hot and as such does not glow.

20. Compute the heat generated while transferring 96000 coulombs of charge in one hour through a potential difference of 50 V.

Sol. Here, charge, $Q = 96000C$; time, $t = 1$ hr potential difference, $V = 50V$.
Heat produced, $H = V\,I\,t = V \times q\ [\because q = I\,t]$
$= 96000C \times 50V = 4.8 \times 10^6$ J.

21. An electric iron of resistance 20Ω takes a current of 5A. Calculate the heat developed in 30s.

Sol. Here, resistance, $R = 20\Omega$, current, $I = 5A$, time, $t = 30$ s.
Heat produced, $H = I^2\,R\,t = (5)^2\ 5\ 20 \times 30$
$= 1.5 \times 10^4$ J.

22. What determines the rate at which energy is delivered by a current?

**Sol.** Electric power determines the rate at which energy is delivered by a current.

23. An electric motor takes 5A from a 220V. Determine the power and energy consumed in 2Hr.

Sol. Here, current, $I = 5A$; potential difference, $V = 220V$; time,
$t = 2hr = 2 \times 60 \times 60 = 7200$
Power $= 220 \times 5 = 1100$ W
Energy consumed $= P \cdot t = 1100 \times 7200$
$= 7.92 \times 10^6$ J

EXERCISE - I

MULTIPLE CHOICE QUESTIONS

1. Two particles having charges q_1 & q_2 when kept at a certain distance exert force F on each other. If distance is reduced to half, force between them becomes :

(A) $\dfrac{F}{2}$ (B) 2F

(C) 4F   (D) $\dfrac{F}{4}$

2. All the following statements are correct except:
(A) A body is said to be positively charged when it has got excess of electrons
(B) When a body is charged positively, some electron escape from it
(C) The presence of moisture in the air reduces the conductivity of charge
(D) Both (A) and (C)

3. $\dfrac{4}{25}$ coulomb of charge contains _____ electrons:
(A) 10^{15} (B) 10^{18}
(C) 10^{20} (D) none of these

4. Assuming that the charge of an electron is 1.6×10^{-19} C, the number of electrons passing through a section of wire per second, when the wire carries a current of 1 A is :
(A) 6.25×10^{18} (B) 1.6×10^{19}
(C) 1.6×10^{19} (D) 0.625×10^{17}

5. If a charged body attracts another body, the charge on the other body :-
(A) must be negative
(B) must be positive
(C) must be zero
(D) may be negative or positive or zero

6. Current between two points will not be flowing if :
(A) Both the points have same potentials
(B) Circuit is open

(C) Potential difference between the point is zero
(D) All of them

7. If 'I' is the current through a wire and e is the charge of electron, then the number of electrons in t second will be given by :

(A) $\dfrac{Ie}{t}$ (B) Ite

(C) $\dfrac{e}{It}$ (D) $\dfrac{It}{e}$

8. A wire of resistance R is cut into n equal parts. These parts are then connected in parallel. The equivalent resistance of combination will be :
(A) nR   (B) R/n
(C) n/R   (D) R/n^2

9. Three resistance each of 8Ω are connected to a triangle. The resistance between any two terminals :
(A) 12Ω (B) 2Ω

(C) 6Ω (D) $\dfrac{16}{3}\Omega$

10. The smallest resistance that can be obtained from a combination of 'n' identical resistors each of resistance R is :

(A) $\dfrac{R}{n}$ (B) $\dfrac{R}{n^2}$

(C) nR   (D) $n^2 R$

11. A man has five resistors each of value $\dfrac{1}{5}\Omega$. What is the maximum resistance he can obtain by connecting them ?
(A) 1Ω (B) 5Ω

(C) $\dfrac{1}{2}\Omega$ (D) $\dfrac{2}{5}\Omega$

12. The filament of an electric bulb is made of tungsten because :
(A) Its resistance is negligible
(B) It is cheaper
(C) Its melting point is high
(D) Its filament is easily made

13. In the circuit shown in Fig., the reading of the voltmeter V will be

12V

100Ω 200Ω

(V)
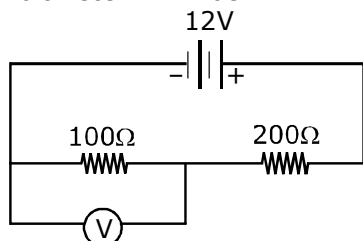
(A) 4 V (B) 2 V
(C) 6 V (D) 3V

14. An electric heater can boil a certain amount of water in 10 minute and another heater can do it in 15 minute, both working at the same voltage. If the two heaters are connected in parallel across the same voltage as before how much time will they take to boil the same amount of water?
(A) 9min (B) 12.5min
(C) 7.5min (D) 6min

15. An electric iron of heating element of resistance 88 Ω is used at 220 volt for 2 hours. The electric energy spent, in unit, will be :
(A) 0.8 (B) 1.1
(C) 2.2 (D) 8.8

16. Correct power rating of a bulb used in our country (India):
(A) 100 volt (B) 100 volt
(C) 100 W-220 volt (D) 10 volt

17. Number of Joules in 1 kWh is :
(A) 3.6×10^7 J (B) 3.6×10^6 J
(C) 3.6×10^5 J (D) 3.6×10^4 J

18. Two indentical heater wires are first connected in series and then in parallel with a source of electricity. The ratio of heat produced in the two cases is :
(A) 2:1 (B) 1:2
(C) 4:1 (D) 1 :4

19. You are given three bulbs 25 W, 40 W and 60 W. Which of them has the lowest resistance?
(A) 25 watt bulb (B) 40 watt bulb
(C) 60 watt bulb (D) insufficient data

20. When two electric bulbs of 40 W and 60 W are connected in parallel with a source, then the :
(A) bulb of 40 watt gives more light
(B) intensity of both bulbs are same
(C) intensity depends on the type of electric source (A.C. or D.C.)
(D) bulb of 60 watt gives more light

21. The current flowing through a resistor connected in an electrical circuit and the potential difference developed across its ends are shown in the following diagrams.

mV   mA

The value of resistance of the resistor in ohms is -
(A) 100 (B) 150
(C) 200 (D) 250

22. To determine the equivalent resistance of a series combination of two resistors R_1 and R_2, a student arranges the following set up:

+ –   (•) R_1 R_2

+ –
(A)

(V)
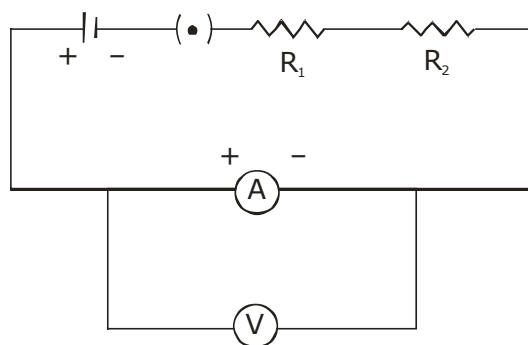
This circuit gives
(A) incorrect reading for current I as well as potential difference V
(B) correct reading for current I but incorrect reading for potential difference V
(C) correct reading for potential difference V but incorrect reading for current I

(D) correct reading for both current I as well as potential difference V

23. To determine the equivalent resistance of two resistors R_1 and R_2 when connected in series, a student arranged the circuit components as shown in the diagram. But he did not succeed to achieve the objectives.
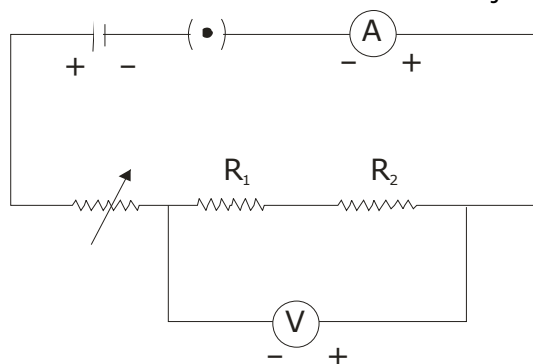

Which of the following mistakes has been committed by him in setting up the circuit ?

(A) Position of ammeter is incorrect

(B) Position of voltmeter in incorrect

(C) Terminals of voltmeter are wrongly connected

(D) Terminal of ammeter are wrongly connected

24. The correct set up for determining in equivalent resistance of two resistors R_1 and R_2 when connected in parallel is-

(A)

(B)

(C)

(D)
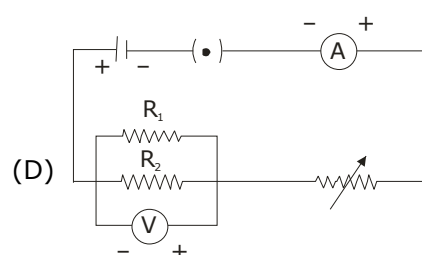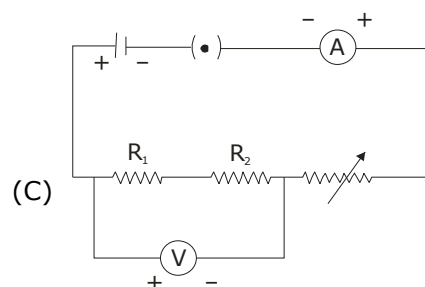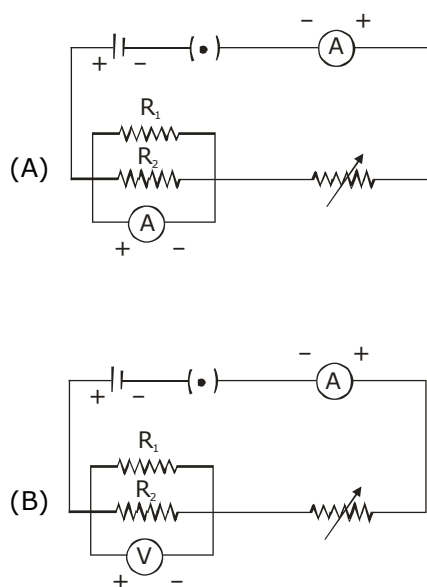
25. The plotted points correctly showing the dependence of the current I on potential difference V across a resistors R for linear resistor is -

(A)

(B)

(C)

(D)
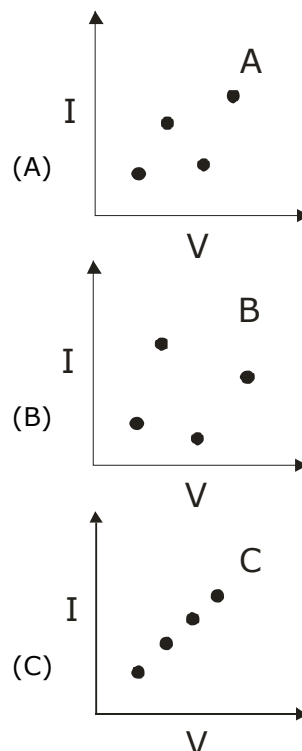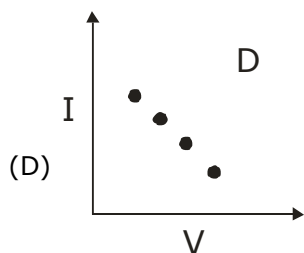
ASSERTION - REASON

The following questions consist of two statements, Assertion and Reason. While responding to these questions choose any one correct option.

(A)   If both assertion and reason are true and the reason is correct explanation of assertion.

(B)   If both assertion and reason are true but reason is not a correct explanation of assertion.

(C)   If assertion is true and reason is false.

(D)   If assertion is false and reason is true.

1.   **Assertion :** If there is current in a wire, potential drop has to be there.
    Reason : If potential drop is zero, the resistance may be zero.

2.   **Assertion :** A voltmeter is an inherently inaccurate instrument.
    Reason : A voltmeter is always connected in parallel in a circuit.

3.   **Assertion :** Two bulbs of 25W and 100W rated 200V are connected in series across 200V supply. Ratio of powers of both the bulbs in the series is 2:1.
    Reason : In series, current in both bulbs is the same; therefore power depends on the resistance of the bulb.

4.   **Assertion :** For zero value of R in circuit, power transfer in external resistance will be maximum.
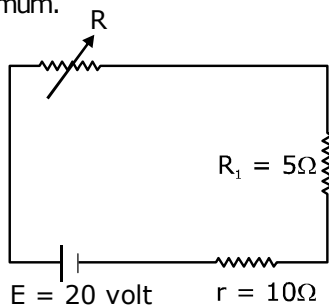

Reason : Since $R_1 < r$ in the given circuit. So, power transfer in external resistance will be maximum when R = 0.

5.   **Assertion :** Since all the current coming to our house returns to the power house. (Since current travels in a closed loop), so there is no need to pay the electricity bill.
    Reason : The electricity bill is paid for the power used, not for the current used.

TRUE OF FALSE

1.   A coulomb is the same as (ampere × second).

2.   In metals, the electric current is mainly due to the movement of free electrons.

3.   Free electrons move to the right in a certain wire. This indicates that current is towards the right in the wire.

4.   Ohm's law is applicable to all conductors of electricity.

5.   The V-I graph for two metallic wires A and B are shown below. Here, resistance of wire A is greater than resistance of wire B.
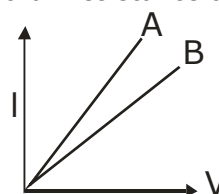
6.   A current of 0.5 A exists in a 60-ohm lamp. The applied potential difference is 30 V.

7.   It is not possible to construct wires of the same length, one of iron and the other of aluminum, such that they have the same resistance at the same temperature.

VERY SHORT ANSWER TYPE

1.   What causes the potential difference between the two terminals of a cell?

2.   You have two metallic wires of resistances 6Ω and 3Ω. How will you connect these wires to get the effective resistance of 2Ω?

3.   What happens to the other bulbs in series circuit, if one bulb blows off?

4.   How can an ammeter be converted into a voltmeter?

5. Resistance of an incandescent filament of a bulb is comparatively much more than that when it is at room temperature. Why?

6. Name and define the smallest commercial unit of electricity.

7. What do you understand by the term fuse in an electric circuit?

8. In how much time will a bulb of 100W consume an energy of 2 kWh?

9. Write S.I unit of resistivity.   **[CBSE 2015]**

SHORT ANSWER TYPE

1. Draw a circuit diagram to show experimental set up for verification of Ohm's law.

2. An electrician puts a fuse of rating 5A in that part of domestic electrical circuit in which an electric heater of rating 1.5 kW, 220V is operating. What is likely to happen in this case and why?

3. Why does the cord of an electric heater not glow while the heating element does?

4. 320 J of heat is produced in 10s in a 2Ω resistor. Find the amount of current flowing through the resistor.

5. An electric bulb is rated 220V and 100W. Calculate the power consumed when it is operated on 110V.

LONG ANSWER TYPE

1. Define charge. What do you understand by positive and negative charge ? Write down the expression for force between two charges.

2. State Ohm's law. How it can be verified experimentally?   **[CBSE 2009, 2015]**

3. Two resistances when connected in parallel give resultant value of 2Ω, when connected in series the value becomes 9Ω. Calculate the value of each resistance.

4. A electric iron consumes energy at a rate of 840 W when heating is at the maximum rate and 360 W when the heating is at the minimum rate. The applied voltage is 220V. What is the value of current and the resistance in each case?

5. A battery E is connected to three identical lamps P, Q and R as shown in figure. Initially the switch S is kept open and the lamp P and Q are observed to glow with some brightness. Then, switch S is closed.
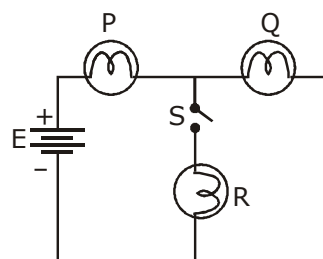

How will the brightness of glow of bulbs P and Q will change? Justify your answer.

6. A metal wire has diameter of 0.25mm and electrical resistivity of 0.8×10^{-8} Ω-m.
(i) What will be the length of this wire to make a resistance 5Ω?
(ii) How much will the resistance change, if the diameter of the wire is doubled?
    [CBSE 2016]

7. Show how would you join three resistance's, each of resistance 9Ω so that the equivalent resistance of combination is: **[CBSE 2018]**
(i) 13.5 Ω (ii) 6 Ω

EXERCISE - II

MULTIPLE CHOICE QUESTIONS

1. Two metal spheres are at different electric potentials and they are joined by a conducting wire as shown in figure given below. Which of the following statements is correct related to the figure shown below ?
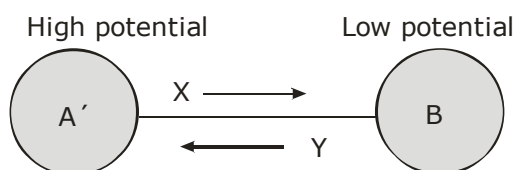

(A) X represents electric current while Y represents electron

(B) X represents proton while Y represents electron.

(C) X represents electron while Y represents electric current

(D) X represents electric current while Y represents proton.

2. A voltmeter and an ammeter are connected in series to an ideal cell of emf E. If the voltmeter reading is V, and the ammeter reading is l. Then - **[NSO]**

I. V < E

II. The voltmeter resistance is V/I.

III. The potential difference across the ammeter is E – V.

IV. Voltmeter resistance + ammeter resistance = E / l

(A) I and II only   (B) II and III only

(C) III and IV   (D) I, II, III, IV

3. An air conditioner is rated 260 V, 2.0 kW. The air conditioner is switched on for 10 hours each day. What is electrical energy consumed in 30 days ? **[NSO]**

(A) 20 kW h   (B) 2000 kW h

(C) 600 kW h   (D) 420 kW h

4. According to Coulomb's law, which of the following is correct, for the diagram given below ?

(A) $q_1 q_2 < 0$ (B) $q_1 q_2 > 0$

(C) $q_1 q_2 = 0$ (D) $q_1 q_2 > 100$ C

5. If 50 joule of work must be done to move an electric charge of 2 C from a point, where potential is –10 V to another point where potential is V volt. Then, the value of V is -

(A) 5 V   (B) – 15 V

(C) + 15 V   (D) +10 V

6. Three resistances of magnitude 2, 3 and 5 ohm are connected in parallel to a battery of 10 volts and of negligible resistance. The potential difference across 3Ω resistance will be- **[IAO-Stage-1/2012]**

(A) 2V   (B) 3V

(C) 5V   (D) 10V

7. Which of the following is not true about an electric charge ?

(A) Charge on a body is always an integral multiple of the charge on an electron

(B) Charge is a scaler quantity

(C) Net charge on an isolated system is always conserved

(D) Charge can be converted into energy and energy can be converted into charge.

8. In case of the circuit shown below, which of the following statement is/are/true ?
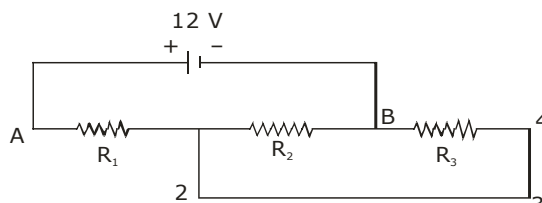
(A) R_1, R_2 and R_3 are in series
(B) R_2 and R_3 are in series
(C) R_2 and R_3 are in parallel
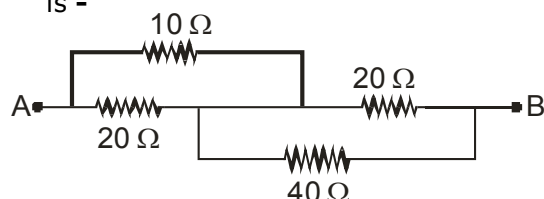(D) The equivalent resistance of the circuit is $\dfrac{R_1 R_3}{R_2 + R_3}$

9. Two metal wires of identical dimensions are connected in series. If σ_1 and σ_2 are the conductivity of the metal wires respectively, the effective conductivity of the combination is -

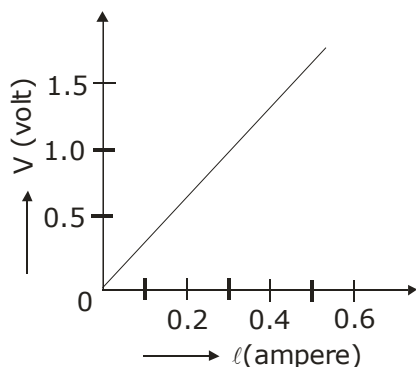(A) $\dfrac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2}$ (B) $\dfrac{\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$

(C) $\dfrac{2\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$ (D) $\dfrac{\sigma_1 + \sigma_2}{2\sigma_1 \sigma_2}$

10. The equivalent resistance between A and B is -

(A) 10 Ω (B) 50 Ω
(C) 20 Ω (D) 30 Ω

11. Following graph was plotted between V and I values, across a metal wire. Which of the following statement(s) is/are correct regarding this ?

(A) Value of ratio $\dfrac{V}{I}$ when the potential difference is 0.8 V is not equal to the value of ratio $\dfrac{V}{I}$

(B) This graph illustrates the non-ohmic law
(C) While plotting this graph, the temperature remains constant
(D) All of these

12. An electric bulb rated 220 V, 60 W is working at full efficiency. Another identical bulb is connected in the same circuit having power supply of 220 V.   **[NSO]**
(i) If both the bulbs are connected in series then the total power consumption will be 60 W.
(ii) If only one bulb is connected then the total power consumption will be 30 W
(iii) If the both bulbs are connected in parallel then the total power consumption will be 120 W.
Which of the above statement(s) is/are correct regarding the circuit ?
(A) Only (i) and (ii)   (B) Only (ii) and (iii)
(C) Only (iii)   (D) Only (i)

13. What is the potential difference across 2 Ω in the given circuit ?   **[NSO]**
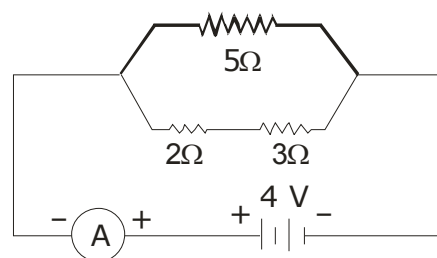

(A) 2.5 V   (B) 1 V
(C) 1.6 V   (D) 5 V

14. In the circuit shown here, the ammeter A reads 5 A and the voltmeter V reads 20 V. The correct value of resistance R is (Assume the voltmeter is not ideal).   **[NSEP-Stage-1/2014]**
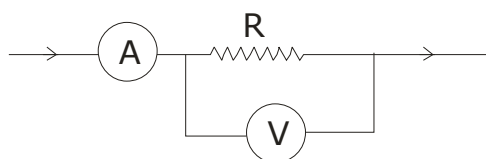
(A) Exactly 4 Ω
(B) Slightly greater than 4 Ω
(C) Slightly less than 4 Ω
(D) Zero.

15. A ring is made of wire having a resistance R_0 = 12Ω. Find the points A and B, as shown in the figure, at which a current carrying conductor should be connected so that the resistance R of the sub-circuit between these points is equal to $\frac{8}{3}$ Ω.
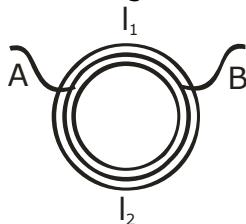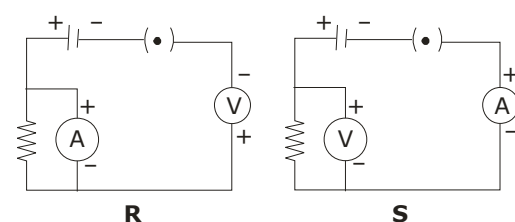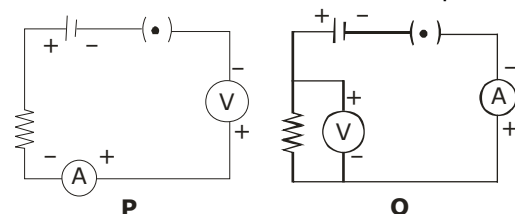

(A) $\frac{\ell_1}{\ell_2} = \frac{5}{8}$ (B) $\frac{\ell_1}{\ell_2} = \frac{1}{3}$

(C) $\frac{\ell_1}{\ell_2} = \frac{3}{8}$ (D) $\frac{\ell_1}{\ell_2} = \frac{1}{2}$

16. Two batteries, one of emf 18 volts and internal resistance 2 Ω and the other of emf 12 volts and internal resistance 1Ω, are connected as shown. The voltmeter V will record a reading of:
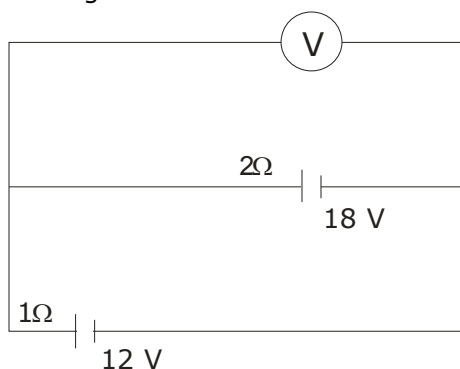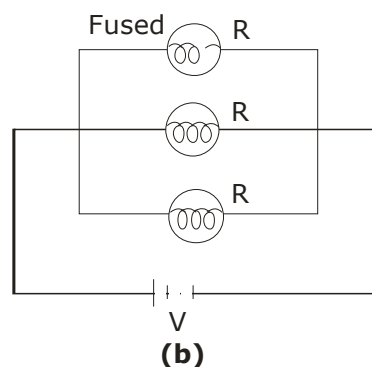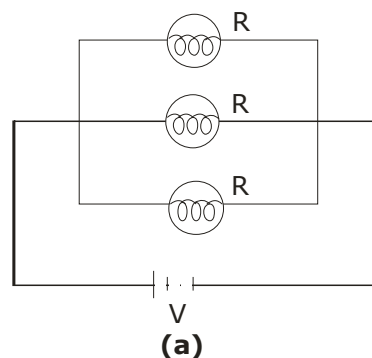

(A) 30 volt   (B) 18 volt
(C) 15 volt   (D) 14 volt

17. Which one of the below circuit is properly connected with the electrical components :
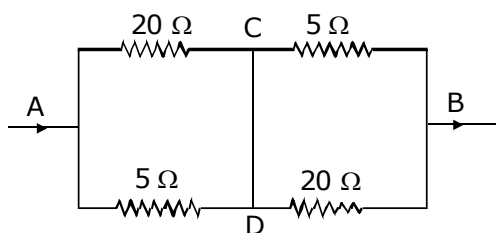

(A) P   (B) Q
(C) R   (D) S

18. Three identical bulbs are connected in parallel with a battery. The current drawn from the battery is 6A. If one of the bulbs gets fused, what will be the total current drawn from the battery?

(a)

(b)

(A) 4 A   (B) 1 A

(C) 3 W   (D) 2 A

19. When some potential difference is maintained between A and B, current I enters the network at A and leaves at B. Which of the following is incorrect.


(A) The equivalent resistance between A and B is 8 Ω.

(B) C and D are at the same potential.

(C) No current flows between C and D.

(D) Current $(3\ell/5)$ flows D to C.

20. A bulb draws 24 W when connected to a 12 V supply. Find the power if it is connected to a 6 V supply. (Neglect resistance change due to unequal heating in the two cases.)

(A) 5 W   (B) 4 W

(C) 6 W   (D) 3 W

21. If 6.4 A current flows continuously for 4 seconds through a circuit, find the number of electrons flowing :

(A) 4.8×10^{-19} (B) 4.8×10^{19}

(C) 1.6×10^{-19} (D) 16×10^{19}

22. Two wires that are made up of two different materials, whose specific resistances are in the ratio 3 : 2, length 4 : 3 and area 5 : 4. The ratio of their resistances is -

[NTSE/STAGE-1/2018]

(A) $\dfrac{5}{8}$ (B) $\dfrac{8}{5}$ (C) $\dfrac{10}{8}$ (D) $\dfrac{8}{10}$

23. If a copper wire is stretched to make it 0.1% longer, then the percentage change in its resistance is approximately

(A) 0.1%   (B) 0.2%

(C) 0.4%   (D) 0.8%

24. Find the current through the resistor R_4 if $R_1 = R_2 = R_3 = 20\ \Omega$, $R_4 = 40\ \Omega$. The emf of the battery is 4 V.
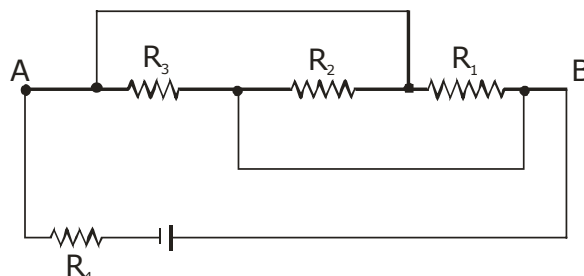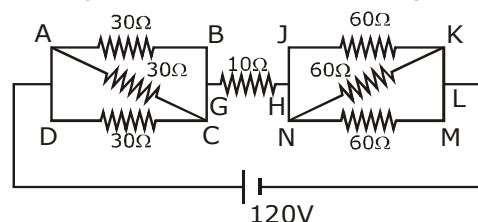

(A) 0.08 A   (B) 0.16 A

(C) 1 A   (D) 2 A

25. In the circuit shown below, the ammeter A reads 5A and the voltmeter V reads 20 V (Fig.). The correct value of resistance R is:- **[NSEP Stage-I 2014]**
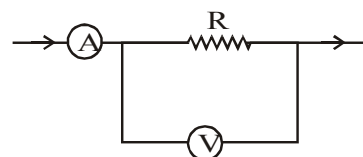

(A) exactly 4Ω

(B) slightly greater than 4Ω

(C) slightly less than 4Ω

(D) zero

26. In the adjacent circuit what is the current flowing from N to K? **[IJSO/Stage-I/2017]**

(A) 3A   (B) 2A   (C) 1A   (D) 0.5A

27. In the given circuit. The voltmeter reads 117 V and ammeter reads 0.13A. If the resistance of voltmeter and ammeter are 9 k Ω and 0.015 Ω respectively, the value of R is _____.

[IJSO/Stage-I/2018]
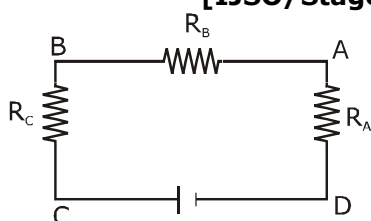
(A) 500Ω   (B) 1kΩ

(C) 1.5kΩ   (D) 2kΩ
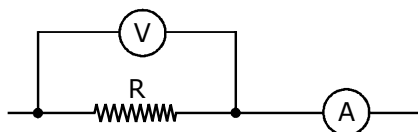
28. In the adjacent circuit, the voltages across AD, BD and CD are 2 V, 6 V and 8 V respectively. If resistance R_A = 1 kΩ, then the values of resistance R_B and R_C _____ and _____ respectively.

[IJSO/Stage-I/2019]

(A) 4 kΩ and 6 kΩ

(B) 2 kΩ and 1 kΩ

(C) 1 kΩ and 2 kΩ

(D) data insufficient as battery voltage is not given

29. Two bulbs 60 W, 220 V and 100 W, 220 V are connected in series to a 440 V supply. Which of the two bulbs fuses ? What happens if these bulbs are connected in parallel ?

[NTSE/STAGE-1/2017]

(A) 60 W bulb fuses when connected in series both bulbs fuses when connected in parallel.

(B) 100 W bulb fuses when connected in series both bulbs fuses when connected in parallel.

(C) 100 W bulb fuses when connected in parallel both bulbs fuses when connected in parallel

(D) 60 W bulb fuses when connected in series, no bulbs fuses when connected in parallel

30. What is the equivalent resistance between points P and Q in the given circuit diagram ?

(A) 4 Ω   (B) 10 Ω

(C) 5 Ω   (D) $\dfrac{10}{3}$ Ω
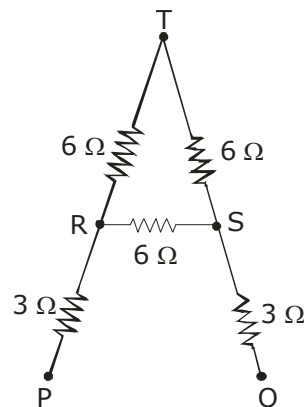
31. When a 3 Ω resistance coil is connected across the terminals of a battery, the current is 1.5 A. When a 5 Ω resistance is connected across the same battery, the current is 1 A. Find the internal resistance of the battery.

(A) 1 Ω   (B) 2 Ω

(C) 3 Ω   (D) 4 Ω

32. In the given circuit, find the power dissipated in the 6 Ω resistance.
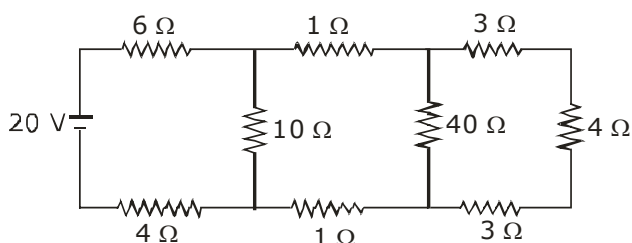
(A) 18 W   (B) 9 W

(C) 10 W   (D) 20 W

33. An electric current of 5 amperes is divided into three branches, along three wires of same material with same cross-section but with their lengths in the proportion of 1 : 2 : 3. Then the current in the middle branch will be: **[NTSE-Stage-1]**

(A) $\dfrac{30}{11}$ A   (B) $\dfrac{10}{11}$ A

(C) $\dfrac{15}{11}$ A   (D) 2.5 A

34. A 500 W bulb and a 500 W heater operate at their rated voltages. Which of the following is true ? **[NTSE-Stage-1]**

(A) Filament of bulb reaches a much higher temperature then heater

(B) Filament of heater reaches a much higher temperature then bulb

(C) Both filament attain same temperature

(D) Nothing can be predicted

35. If current through a resistance is increased by 100% simulaneously reducing resistance value to 25%, the new power dissipated will be - **[NTSE-Stage-1]**

(A) No change

(B) Increased by 100%

(C) Decreased by 400%

(D) Increased by 400%

EXERCISE - III

1. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at room temperature, 100 W, 60 W and 40 W bulbs have filament resistances R_{100}, R_{60} and R_{40}, respectively the relation between these resistance is -

(A) $\dfrac{1}{R_{100}} = \dfrac{1}{R_{40}} + \dfrac{1}{R_{60}}$ (B) $R_{100} = R_{40} + R_{60}$

(C) $R_{100} > R_{60} > R_{40}$ (D) $\dfrac{1}{R_{100}} > \dfrac{1}{R_{60}} > \dfrac{1}{R_{40}}$

2. Consider a thin square sheet of side x and thickness y made of a material of resistivity ρ. The resistance between two opposite faces, shown by the shaded areas in the figure is -
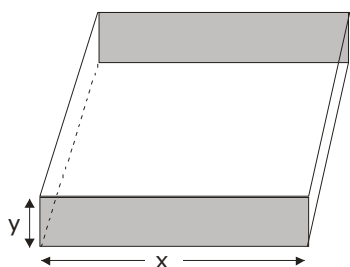
(A) Directly proportional to x
(B) Directly proportional to y
(C) Independent of x
(D) Independent of y

3. Find the current supplied by the source in figure. The resistors are mounted in a cylindrical form.
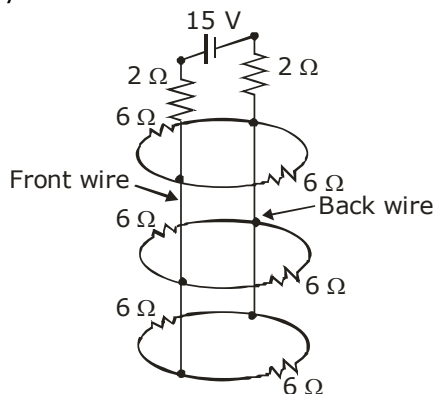
(A) $\dfrac{14}{13}$ A (B) 2 A

(C) 3 A (D) 1.75 A

4. The plot represents the flow of current through a wire at three different time intervals. The ratio of charges flowing through the wire at different intervals is -
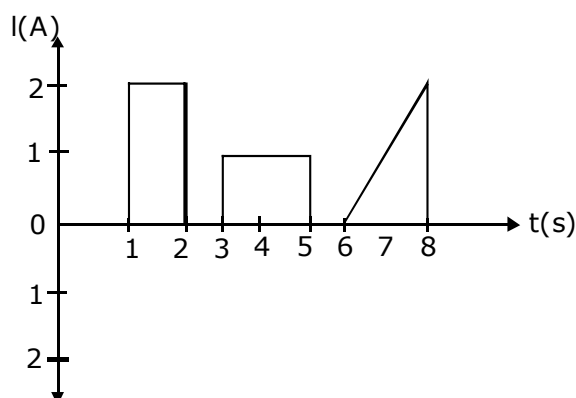
(A) 1 : 2 : 3 (B) 1 : 1 : 1
(C) 3 : 2 : 2 (D) 2 : 3 : 3

5. The resistors R_1, R_2, R_3 and R_4 in the given circuit are all equal in value and connected with a negligible resistance wire. Which of the following is correct relationship between the voltmeters readings V_1, V_2 and V_3 ?
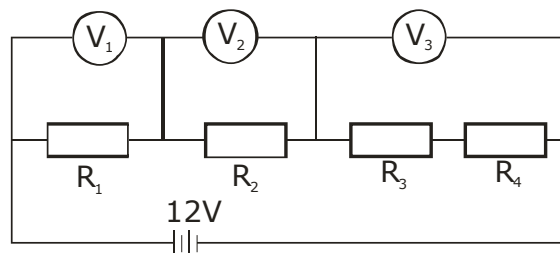
(A) $V_1 = V_2 = V_3$ (B) $V_1 = V_2 > V_3$
(C) $V_1 < V_2 < V_3$ (D) $V_1 = V_2 < V_3$

6. In the network shown the potential difference between A and B is (R=r_1=r_2=r_3=1 Ω, E_1=3V, E_2=2 V, E_3= 1V)
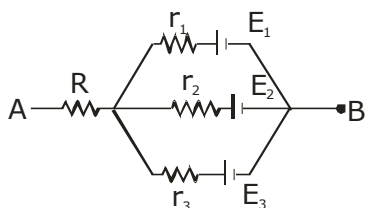
(A) 1 V   (B) 2 V   (C) 3 V   (D) 4 V

7. An electric iron uses a power of 1320 W when set to higher temperature. If set to lower temperature on third of higher temperature current is used. If iron is connected to a potential of 220V, then power used to lower temperature is _____ .
(A) 220 W   (B) 440 W
(C) 660 W   (D) 880 W

8. Graphs shows the number of units consumed by a family for six months. Find the cost of energy for four months from March to June if M.S.E.B. increased its unit rate from Rs. 3.50 to Rs. 4.50 for April and May and again decreased by Rs. 2 for June :
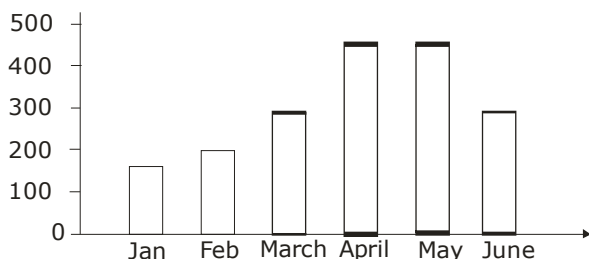
(A) Rs. 6000   (B) Rs. 6,030
(C) Rs. 6,300   (D) Rs. 6,200

9. Consider the circuit shown in figure. The voltmeter on the left reads 10 V and that one the right reads 8 V. Find (a) the current through the resistance R, (b) the value of R, and (c) the potential difference across the battery.
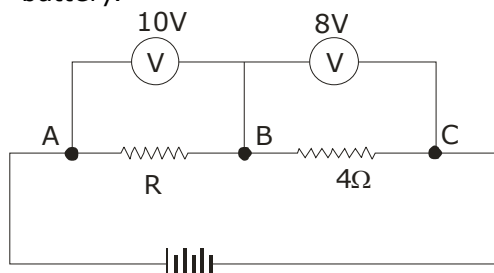
(A) 19 V   (B) 10 V   (C) 18 V   (D) 17 V

10. In the circuit shown below find the current (I) supplied by the battery.
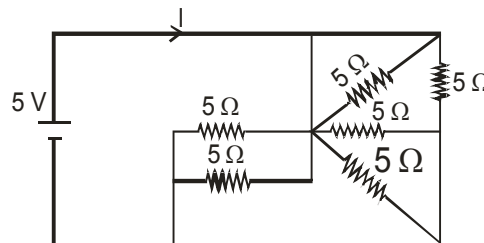
(A) 5 A   (B) 10 A
(C) 2.5 A   (D) 0.6 A

11. In the circuit diagram shown below, what is the reading of ideal Ammeter (A) ?
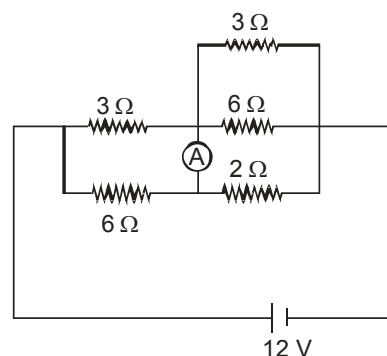
(A) $\dfrac{1}{3}$ A   (B) $\dfrac{2}{3}$ A

(C) $\dfrac{1}{2}$ A   (D) $\dfrac{1}{3}$ A

12. Find equivalent resistance between the points P and Q.
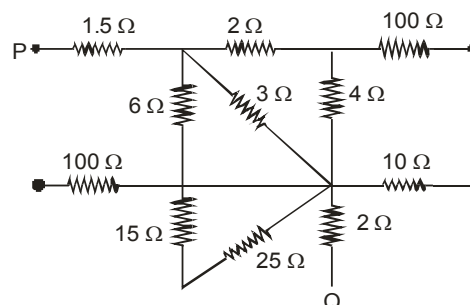
(A) 1 Ω   (B) 4 Ω
(C) 3 Ω   (D) 5 Ω

13. The resistance of all the wires between any two adjacent dots is R. Then equivalent resistance between A and B as shown in figure is :
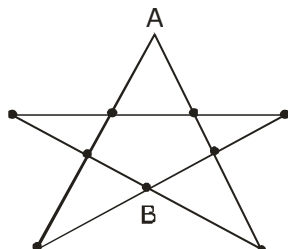
(A) 7/3 R   (B) 7/6 R
(C) 14/8 R   (D) None of these

14. In the box shown, current i enters at H and leaves at C.

If $i_{AB} = \dfrac{i}{6}, i_{DC} = \dfrac{2i}{3}, i_{HA} = \dfrac{i}{2}, i_{GF} = \dfrac{i}{6}, i_{HE} = \dfrac{i}{6}$, choose the branch in which current is zero.
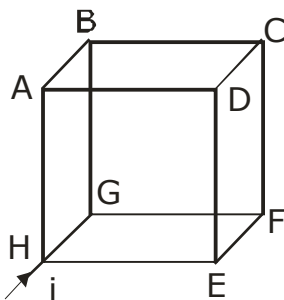
(A) BG   (B) FC
(C) ED   (D) None of these

15. n identical cells are joined in series with its two cells A and B in the loop with reversed polarities. EMF of each cell is E and internal resistance r. Potential difference across cell A or B is (here n > 4).

(A) $\dfrac{2E}{n}$ (B) $2E\left(1 - \dfrac{1}{n}\right)$

(C) $\dfrac{4E}{n}$ (D) $2E\left(1 - \dfrac{2}{n}\right)$

16. In the circuit shown in figure, all wires have equal resistance r. Find the equivalent resistance between A and B.
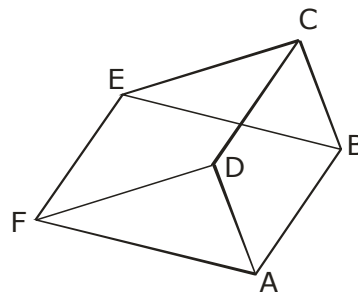
(A) $\dfrac{3r}{5}$ (B) $\dfrac{3r}{4}$
(C) $\dfrac{4r}{5}$ (D) $\dfrac{5}{3r}$

17. Figure shown three resistors configurations R_1, R_2 and R_3 connected to 3V battery. If the power dissipated by the configuration R_1, R_2 and R_3 is P_1, P_2 and P_3, respectively, then

[JEE-2008]
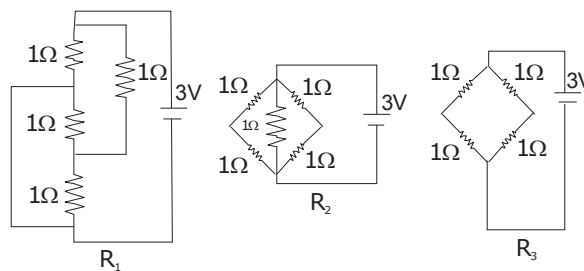
(A) $P_1 > P_2 > P_3$ (B) $P_1 > P_3 > P_2$
(C) $P_2 > P_1 > P_3$ (D) $P_3 > P_2 > P_1$

18. Cost of coal is Rs. 5 per kg and can produce energy of 20MJ/kg. If a power station used coal to produce electricity with 25% efficiency, then the cost of coal for producing 1 unit (1 kw/h) of electricity in Rs.
(A) 0.9   (B) 3.6
(C) 9.0   (D) 36.0

19. Electric power of a heater is 1200 W when connected to a 240 V supply. The resistivity and area of cross section of the coil are 10^{-5} Ω m and 0.4 mm^2, respectively. If the radius of each turn is 7mm, find the number of turns present in the coil.
(A) 22   (B) 44
(C) 11   (D) 40

20. Three batteries with emf E_1, E_2 and E_3 are connected as shown in the figure. If their terminal voltages are 4 V, 2 V and 6 V, respectively, then find the ratio of their internal resistance.

$E_1 = 10V$ $E_2 = 6V$

r_1 r_2

r_3

$E_3 = 2V$
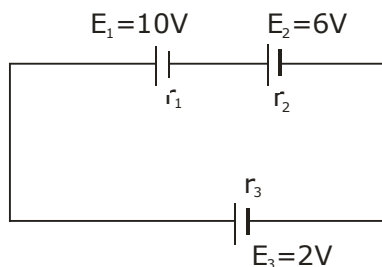
(A) 1 : 1 : 1   (B) 3 : 2 : 1
(C) 1 : 3 : 1   (D) 3 : 2 : 2

21. Two bulbs A and B are connected to a 200 V supply. The maximum current that can flow through A and B is 0.5 A and 1.2 A, respectively. The effective resistance of the two bulbs in series and parallel is 280.0 Ω and 60.0 Ω, respectively.

Which of the two bulbs, the one with high wattage or low wattage will fuse when connected in series ?
(A) The bulb with low wattage will fuse
(B) The bulb with high wattage will fuse
(C) Both bulb will fuse
(D) None of these

22. Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage error in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is - **[JEE-Main 2012]**
(A) 6%   (B) zero
(C) 1%   (D) 3%

23. The supply voltage to a room is 120 V. The resistance of the lead wires is 6Ω. A 60W bulb is already switched on. What is the decrease in voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb ?   **[JEE-Main 2013]**
(A) 13.3 Volt   (B) 10.4 Volt
(C) zero Volt   (D) 2.9 Volt

24. When two identical batteries of internal resistance 1Ω each are connected in series across a resistor R, the rate of heat produced in R is J_1. When the same batteries are connected in parallel across R, the rate is J_2. If $J_1 = 2.25 J_2$, then the value of R in Ω is -
[JEE-2010]
(A) 1 Ω (B) 2 Ω
(C) 3 Ω (D) 4 Ω

25. Two batteries of different emfs and different internal resistance are connected as shown. The voltage across AB in volts is -**[JEE-2011]**
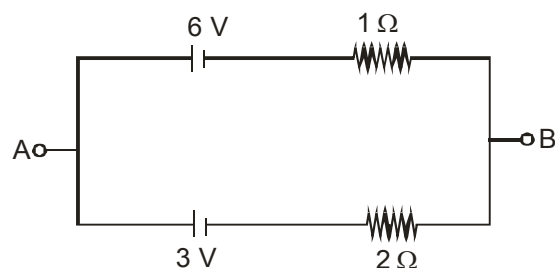

6 V   1 Ω

A○   ○B

3 V   2 Ω

(A) 4.5 V   (B) 3 V
(C) 5 V   (D) 4.9 V

26. A physics student is doing an experiment with a heating element by immersing it in a water beaker. If the resistance offered by it is 150 Ω, the current in it is 5 A for 5 minute and rise in the temperature of water is 15°C, then find the mass of water heated.
Take specific heat capacity of water as 1 cal g^{-1}°C^{-1}.
(A) 17.05 kg   (B) 17.65 kg
(C) 17.85 kg   (D) 18 kg

27. An ice block of mass 4 kg at 0°C temperature is completely converted into water at 0°C at the end of 5 minute when it is in contact with a heating coil. If 220-volt potential difference is applied to the coil, then find out the current passing through it.
(A) 20.4 A   (B) 19 A
(C) 20 A   (D) 21 A

28. A rectangular metal plate, shown in the adjacent figure has a charge of 420 μC assumed to be uniformly distributed over it.

Then how much is the charge over the shaded area ? No part of metal plate is cut. (Circle and the diagonal are shown for clarity only. $\pi = 22/7$)

14 cm

28 cm
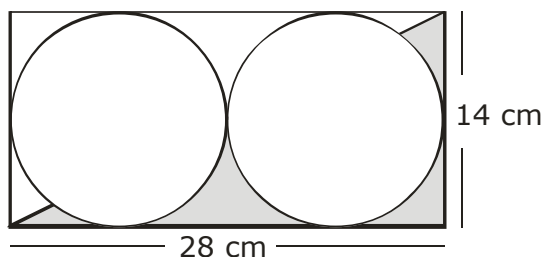
(A) 45 μC   (B) 450 μC
(C) 15 μC   (D) 150 μC

29. A piece of wire P and three identical cells are connected in series. An amount of heat is generated in a certain time interval in the wire due to passage of current. Now the circuit is modified by replacing P with another wire Q and N identical cells, all connected in series Q is four times longer in length than P. The wire P and Q are of same material and have the same diameter. If the heat generated in second situation is also same as before in the same time interval, the find N. **[IJSO/Stage-I/2019]**
(A) 1   (B) 6
(C) 16   (D) 36

30. A heating element in the form of a wire with uniform circular cross sectional area has a resistance of 310 Ω and can bear a maximum current of 5.0 A. The wire can be cut into pieces of equal length. The number of pieces, arranged suitably, so as to draw maximum power when connected to a constant voltage of 220V, is **[IJSO/Stage-I/2020]**
(A) 7   (B) 8
(C) 44   (D) 62

31. An average human adult radiates about 100W energy mainly in infra-red region of the electromagnetic spectrum 50 persons are sitting in a hall with an air conditioning system which is 50% efficient. How much electricity must be used to maintain temperature of the hall at 25°c for 4 hours?**[IJSO/Stage-I/2021]**
(A) 5 units   (B) 10 units
(C) 20 units   (D) 40 units

CHEMISTRY

CLASS - X
BOOKLET - 1

Motion®

METALS AND NON-METALS

ANSWER KEY

CHEMICAL REACTIONS AND EQUATIONS

Physical Change ← **INTRODUCTION** → Chemical Change

Definition ← **CHEMICAL REACTION** → Characteristics with examples

CHEMICAL EQUATION

- Definition
- Types of Chemical Equation
  - Word Equation
  - Symbol Equation
- Writing of a Chemical Equation
- Unbalanced & balanced chemical Equations
  - Balancing of chemical equation

EFFECT OF OXIDATION REACTION IN EVERYDAY LIFE

- Corrosion
- Rancidity

TYPES OF CHEMICAL REACTIONS

- Combination Reaction
- Decomposition Reaction
- Displacement Reaction
- Double Displacement Reaction
- Redox Reaction
  - Oxidation
  - Reduction

INTRODUCTION

Chemistry is defined as that branch of science which deals with the composition and properties of matter and the changes that matter undergoes by various interactions.

A chemical compound is formed as a result of a chemical change and in this process different types of energies such as heat, electrical energy, radiation etc. are either absorbed or evolved. The total mass of the substance remains the same throughout the chemical change.

We observe many changes taking place in our daily life. The milk turns sour if kept for a long time at room temperature, freezing of water, melting of candle wax, milk changes to curd, rusting, digestion of food in our body etc. are all examples of changes we come across in our day to day life. These changes can be categories into two depending upon whether a new substance is formed in them or not.

1.   **PHYSICAL CHANGE :–** A change in which the physical properties of the substance changes but the chemical composition does not change i.e. no new substance is formed. The substance is restored to its original state as soon as the cause of change is withdrawn.
      Example: Freezing, Melting, Boiling, Condensation etc.

2.   **CHEMICAL CHANGE :–** In a chemical change, reacting substances change into a new substances with a different composition. The new substances cannot be changed back to the original substance even if the cause of change is withdrawn. In such changes, the nature and the properties of the substance changes and we say a chemical reaction has taken place.
      Example: Rusting of iron, buring of candle, calcination of lime stone etc.

DIFFERENCE BETWEEN PHYSICAL & CHEMICAL CHANGE

| S.No	Physical change	Chemical change
1	The identity of the substance is maintained.	The identity of the original substance is completely lost.
2	The change is temporary, the substance returns to its original state as the cause of change is withdrawn.	The change is permanent.
3	No new substance is produced.	A new substance is always produced.
4	Heat change may or may not occur.	Heat change always occur.
5	Only the physical state or some of the physical properties of the substances are changed. Eg. Iron tawa is left exposed to air, melting of wax.	The substance after the change can not come back to its original state even when the cause of change is withdrawn. Eg. Fermentation of rice, breathing, curding of milk.

CHEMICAL REACTION

The processes, in which a substance or substances undergoes a chemical change to produce new substance or substances, with entire new properties, are known as chemical reactions.

The nature and identity of products is totally different from those of the reactants.

1. **IMPORTANT CHARACTERISTICS OF CHEMICAL REACTIONS**
    Whenever a chemical change that is a chemical reactions occurs, one of the following is most likely to occur, indicating the occurrence of the reaction.
   **Example**:

    $$\underbrace{H_2 + O_2}_{\text{Reactants}} \rightarrow \underbrace{H_2O}_{\text{Product}}$$
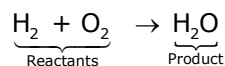
(A) **Change in state:** The physical state of the substances normally changes.
    e.g   (i) Formation of solid MgO from solid Mg and gaseous O_2.
    (ii) Formation of solid PbI_2 (ppt) from liquid solutions of $Pb(NO_3)_2$ and KI.
    (iii) Formation of H_2 gas from the reaction of solid Zn with liquid H_2SO_4.
    (iv) Two volumes of hydrogen gas react with one volume of oxygen gas to form two volume of water.

    $$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$$
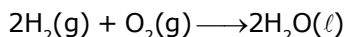
    or when electric current is passed through water it splits into its elements

    $$2H_2O(\ell) \xrightarrow{\text{Electric current}} 2H_2(g) + O_2(g)$$
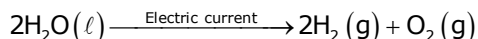
(B) **Change in colour :** In some of the chemical reactions change in colour can be observed.
    e.g.   (i) Formation of brown rust on black iron nails.
    (ii) Formation of yellow ppt. of lead iodide from colourless solution of $Pb(NO_3)_2$ and KI.
    (iii) When copper carbonate (green) is heated strongly it leaves behind a black residue.

    $$\underset{\substack{\text{Copper} \\ \text{carbornate} \\ \text{(green)}}}{CuCO_3(s)} \xrightarrow{\text{heat}} \underset{\substack{\text{Copper oxide} \\ \text{(Black)}}}{CuO(s)} + \underset{\substack{\text{Carbon} \\ \text{dioxide}}}{CO_2(g)}$$
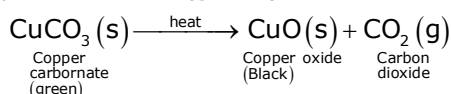
(C) **Evolution of a gas:** In some cases, a gas may be evolved.
    e.g.   (i) Evolution of H_2 gas, in the reaction between Zn and dil HCl
    (ii) Evolution of CO_2 gas, during burning of any fuel, which contains carbon.
    (iii) Heating a mixture of potassium chlorate ($KClO_3$) and manganese dioxide (MnO_2) gives oxygen gas.

    $$\underset{\text{Potassium chlorate}}{2KClO_3(s)} \xrightarrow[MnO_2]{\text{heat}} \underset{\text{Potassium chloride}}{2KCl(s)} + \underset{\text{Oxygen gas}}{3O_2(g)}$$
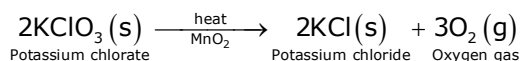
    Note: MnO_2 is used as a catalyst in this reaction.
    This reaction is used for the preparation of oxygen in the laboratory.

(D) **Change in temperature:** All the reactions are accompanied by temperature change. i.e. increase or decrease in temperature. On this basis, reactions can be categorised as :

(i) **Endothermic reaction :** A chemical reaction which is accompanied by the absorption of energy is called as endothermic reactions.

    $$C(s) + 2S(s) \xrightarrow{\text{Heat}} CS_2(\ell)$$

    $$N_2(g) + O_2(g) \xrightarrow{\text{Heat}} 2NO(g)$$
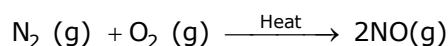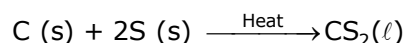
> **Info Bubble**
> The decomposition of vegetable matter into compost is also an example of an exothermic reaction.

(ii)   **Exothermic reaction :** A chemical reaction which is accompanied by the release of energy is called exothermic reaction.

$$Mg\ (s) + O_2\ (g) \xrightarrow{\text{Heat}} 2MgO\ (s) + Energy$$
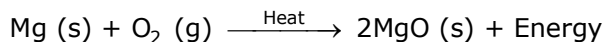
Some example, that chemical reaction is taking place.

(i) Burning of wood: When we burn wood, we obtain ash as a residue.

(ii) Digestion of food: Any food we eat, undergoes several chemical reactions to produce required amount of energy and essential contents of body needs.

(iii) Rusting of iron: A flaky mass originates over iron metal when exposed to air and water over a period of time.

ACTIVITY – 1

●   Clean a magnesium ribbon about 2 cm long by rubbing it with sandpaper.

●   Hold it with a pair of tongs. Burn it using a spirit lamp or burner and collect the ash so formed in a watch-glass as shown in Fig. 1.1. Burn the magnesium ribbon keeping it as far as possible from your eyes.
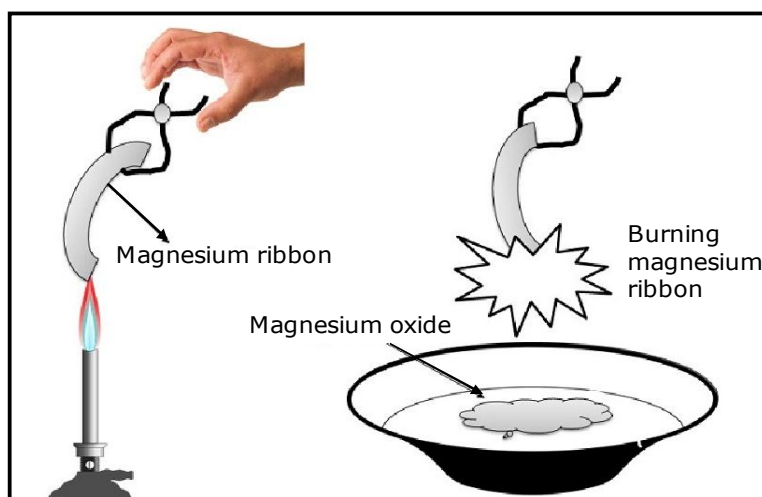
●   What do you observe?

Ans.   We observe that magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide. It is formed due to the reaction between magnesium and oxygen present in the air.

$$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$$
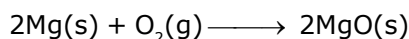
ACTIVITY – 2

●   Take lead nitrate solution in a test tube.

●   Add potassium iodide solution to this.

●   What do you observe?

Ans.   We observe that both the substances react together and the following reaction takes palce :

$$Pb(NO_3)_2(aq) + 2KI(aq) \longrightarrow 2KNO_3(aq) + PbI_2$$
$$\text{(yellow ppt)}$$

We observed that in this reaction between soluble lead nitrate and Potassium Iodide. to form the insoluble salt Lead Iodide. $PbI_2(s)$; which precipitates out as a bright yellow solid.

CHEMICAL EQUATION

A chemical reaction is represented through names or symbols and formulae of the substances involved in the reaction. This representation is called a chemical equation. The substance or substances which takes part in a chemical reaction are called **reactants.**

The new substance or substances formed as a result of a chemical reaction are called **products.** A chemical equation may be a word equation or a symbol equation.

Word equation : A chemical equation represents a chemical reaction briefly in words, writing complete names of reactants and products is called a word equation.

Example : Sodium + water $\longrightarrow$ Sodium hydroxide + Hydrogen

In the above reaction sodium & water are reactants and sodium hydroxide & hydrogen are products.

Symbol Equation : When symbols and chemical formulae of the reactants and products are used then it is called symbol equation.

Example : $Na + H_2O \longrightarrow NaOH + H_2$

1.   **RULES FOR WRITING A WORD EQUATION**

(A)   The substances taking part in chemical reaction, reactants are always written on the left hand side of arrow.

(B)   The substances formed after the chemical reaction, products are always written on the right hand side of arrow.

(C)   A plus sign (+) is put in between the reactants or between the products if their number is two or more.

(D)   An arrow ($\longrightarrow$) is put between the reactants and products. The arrow shows the direction in which the reaction proceeds. The arrow is read as **"to yield" or "to form".**

A symbol equation is more convinient, time saving and informative as compared to a word equation. Chemical equations may also be categories as balanced and unbalanced equations :

Unbalanced equations : In an unbalanced equation, the number of atoms of different elements on both sides of the equation are not equal. For example, in the equation give below, the number of Mg atoms on both sides of the equation is one (same), but the number of oxygen atoms are not equal. It is known as an unbalanced equation.

$Mg + O_2 \longrightarrow MgO$
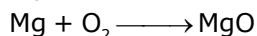
Balanced equations : In a balanced equation, the number of atoms of different elements on both sides of the equation are always equal. The balanced equation for the burning of magnesium ribbon in oxygen is written as :

$2Mg + O_2 \longrightarrow 2MgO$
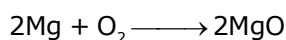
> **Info Bubble**
>
> A chemical equation that conserves the amount of all elements and electrical charges, is said to be balanced.

Is it necessary to balance chemical equations ?

The number of atoms of elements on both sides of a chemical equation should be equal in accordance with the law of conservation of mass.

2.   STEPS IN BALANCING OF CHEMICAL EQUATIONS

A number of steps are involved in balancing a chemical equation, e.g.,

(I)   Na + H$_2$O $\longrightarrow$ NaOH + H$_2$
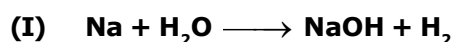
Step 1 :

Examine the number of atoms of different elements present in unbalanced equation.

	Number of atoms in reactants	Number of atom in products
Na	1	1
H	2	3
O	1	1

Step 2:

Pick an element to balance the equation. In the above equation Na and O are balanced, Hydrogen is not.

Step 3:

To balance Hydrogen on both sides we need to multiply H$_2$O by 2 which makes Hydrogen atoms equal to 4 on the reactants' side. To make Hydrogen 4 on the product's side, multiply NaOH by 2. Now oxygen has become 2 on both sides. But Sodium atom has become two on the product's side. Multiply Na by 2 on the reactant's side so that they become equal on both sides. The steps are as follows :

(i)   Na + 2H$_2$O $\longrightarrow$ NaOH + H$_2$

(ii)   Na + 2 H$_2$O $\longrightarrow$ 2 NaOH + H$_2$

(iii)   2 Na + 2 H$_2$O $\longrightarrow$ 2 NaOH + H$_2$
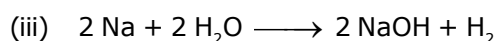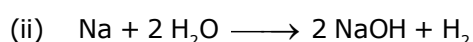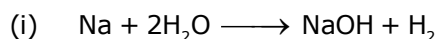
The equation is now balanced.

(II) Fe + H$_2$O $\longrightarrow$ Fe$_3$O$_4$ + H$_2$
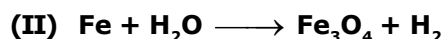
> **Info Bubble**
>
> It must be kept in mind that we can put coefficients but we cannot change the subscripts in the formula, i.e., to balance Oxygen atoms, we can put the coefficient 4 as 4 H$_2$O and not H$_2$O$_4$ or (H$_2$O)$_4$.

Step 1 :

Element	Number of atoms in reactants	Number of atoms in products
Fe	1	3
H	2	2
O	1	4

Step 2 :

Pick up the compound which has the maximum number of atoms whether a reactant or a product, and in that compound select the element which has the highest number of atoms, e.g., we select Fe$_3$O$_4$ in the above equation :

To balance oxygen atoms,

	In reactant	In product
Initial	1 (in H_2O)	4 (in (Fe_3O_4)
To balance	1 × 4	4 × 1

To equalise the number of atoms, we put the coefficient on the left side of the formula. A coefficient is a small whole number, like coefficients used in algebraic equations. The partly balanced equation becomes as follows :

$$Fe~(s) + 4~H_2O~(g) \longrightarrow Fe_3O_4~(s) + H_2~(g) \qquad \text{(Partly balanced)}$$
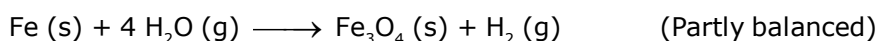
Step 3 :

Pick up the second element to balance this partly balanced equation. Let us try to balance hydrogen atoms. In partly balanced equation, atoms of hydrogen are :

	In reactants	In products
Initial	8 (in $4H_2O$)	2 (in H_2)
To balance	8 × 1	2 × 4

To equalise the number of Hydrogen atoms, we use 4 as the coefficient of H_2 in the products.

$$Fe~(s) + 4H_2O~(g) \longrightarrow Fe_3O_4~(s) + 4H_2(g)$$
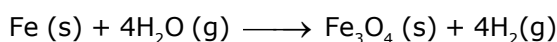
Step 4 :

Pick up the third element to be balanced. The element which is left to be balanced is Fe.

Atoms of Iron	In reactants	In products
Initial	1 (in Fe)	3 (in Fe_3O_4)
To balance	1 × 3	3 × 1

To equalise iron, we use 3 as coefficient of Fe in reactants.

$$3~Fe + 4~H_2O \longrightarrow Fe_3O_4 + 4H_2$$
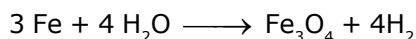
Step 5 :

Check the correctness of the balanced equation.

Atoms	In reactants	In products
Fe	3	3
H	8	8
O	4	4

The equation is balanced because atoms of all the elements are equal on both sides.

This method of balancing equation is known as hit and trial method.

Examples :

(i) Zinc reacts with dilute sulphuric acid to give zinc sulphate and hydrogen. Write the word & symbol equations for the reaction ?

Ans. The word equation for the reaction is –

Zinc + Sulphuric acid $\longrightarrow$ Zinc sulphate + Hydrogen
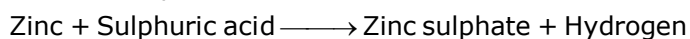
The symbol equation for the reaction is –

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$
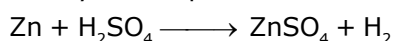
(ii) In order to white wash a house a man mixed 10 kg of quick lime with 30 litres of water. On adding lime, he noticed that the water started boiling even when it was not being heated. Explain what is the reason behind it and write the reaction involved.

Ans. When quick lime (CaO) was added to water, formation of slaked lime [$Ca(OH)_2$] has taken place, with the evolution of a large amount of heat. i.e. its an exothermic reaction, which caused solution to boil.

$$CaO(s) + H_2O(\ell) \longrightarrow Ca(OH)_2(s) + heat$$
Calcium oxide   Calcium hydroxide
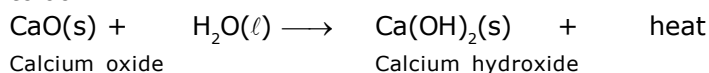
3. **SPECIALITIES OF CHEMICAL EQUATION**

(A) We get the information about the substances which are taking part and formed in the reaction.

(B) We get the information about the number of molecules of elements or compounds which are either taking part or formed in the chemical reaction.

(C) We also get the information of weight of reactants or products.

(D) In a chemical equation if any reactant or product is in gaseous state, then its volume can also be determined.

(E) In a chemical equation with the help of product we can get information about the valency as well.

> **Info Bubble**
> In a balanced chemical equation an integer precedes the formula of each substance. This number is know as stoichiometric coefficient. If no number is there, stoichiometric coefficient is taken as 1.

4. **LIMITATIONS OF CHEMICAL EQUATIONS AND THEIR RECTIFICATIONS**

(A) We do not get information about the physical state of reactants and products.
For example : solid, liquid or gas.

(B) No information about the concentration of reactants and products is obtained.

(C) No information about the speed of reaction and sense of timing can be obtained.

(D) Information regarding the favourable conditions of the reactions such as pressure, temperature, catalyst etc. can't be obtained during the reaction.

(E) We do not get information whether energy is absorbed or evolved during the reactions.

(F) We do not get information whether the reaction is reversible or irreversible.

(G) We do not get information about the necessary precautions to be taken for the completion of reactions.

The above limitations are rectified in the following manner :

(A) The physical state of reactants and products are represented by writing them in bracket.

Writing State Symbols :

The chemical equations or symbol equations which we have enlisted don't mention the physical states of the reactant and product species involved in the reaction.

(A) In order to make the equation more informative, the physical states are also mentioned with the help of certain specific symbols known as state symbols. These symbols are
(s) for solid state
(ℓ) for liquid state
(g) for gaseous sate
(aq) for aqueous solution i.e., solution prepared in water.

> **Info Bubble**
> Energy change (like heat) can be shown by adding it either on reactant side or product side as per if it is absorbed or released respectively

(B) The precipitate formed in the reactions is represented by ↓ symbol and gaseous substance by ↑ symbol. The abbreviation 'ppt' is also used to represent the precipitate, if formed.

(C) To express the concentration, dilute(dil.) or concentrated(conc.) is written below the formula.

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$
$\quad$ (dilute)
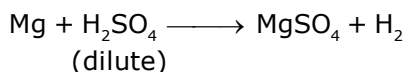
(D) Favourable conditions required for the completion of reaction are written above and below the arrow.

$$N_2 + 3H_2 \xrightarrow[\text{200 atm}]{\text{500° C, Fe/Mo}} 2NH_3$$
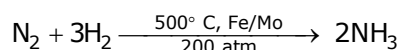
(E) Reversible reaction is represented by ($\rightleftharpoons$) symbol and irreversibe reaction by ($\rightarrow$) symbol.

(F) The heat absorbed in the chemical reaction is written on the right side by putting negative (–) sign and heat evolved in the chemical reaction is written on the right side by putting positive (+) sign.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 + 22400 \text{ Calorie } \text{(Exothermic reactions)}$$

$$N_2 + O_2 \rightleftharpoons 2NO - 43200 \text{ Calorie } \text{(Endothermic reactions)}$$
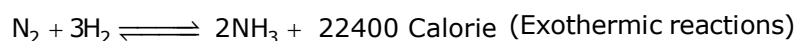
PRACTICE YOUR CONCEPTS

1. Why should a magnesium ribbon be cleaned before burning in air?

Ans. Magnesium ribbon should be cleaned to remove the dust particles present at the upper surface so that the surface comes directly in contact with air.

2. Write the balanced equation for the following chemical reactions :

(i) Hydrogen + Chlorine $\longrightarrow$ Hydrogen chloride

(ii) Barium chloride + Aluminium sulphate $\longrightarrow$ Barium sulphate + Aluminium chloride

(iii) Sodium + Water $\longrightarrow$ Sodium hydroxide+ Hydrogen

Ans. (i) Hydrogen + Chlorine $\longrightarrow$ Hydrogen chloride
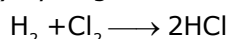
$\quad H_2 + Cl_2 \longrightarrow 2HCl$

(ii) Barium chloride + Aluminium sulphate $\longrightarrow$ Barium sulphate + Aluminium chloride

$\quad 3BaCl_2 + Al_2(SO_4)_3 \longrightarrow 3BaSO_4 + 2AlCl_3$

(iii) Sodium + Water $\longrightarrow$ Sodium hydroxide + Hydrogen

$\quad 2Na + 2H_2O \longrightarrow 2NaOH + H_2$
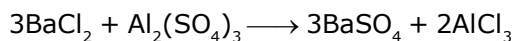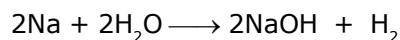
3. Write a balanced chemical equaion with state symbols for the folllowing reactions :

(i) Solutions of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution of sodium chloride.

(ii) Sodium hydroxide solution (in water) react with hydrochloric acid solution (in water) to produce sodium chloride solution and water.

Ans. (i) $BaCl_2(l) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaCl(l)$

(ii) $NaOH(aq) + HCl(aq) \longrightarrow NaCl(l) + H_2O (l)$
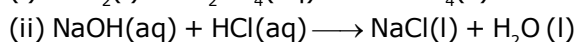
TYPES OF CHEMICAL REACTIONS

Chemical reactions are classified into various categories depending upon the types of changes taking place. The different types of reactions are as follows :

Chemical Reactions

| Combination Reactions | Decomposition Reactions | Displacement Reactions | Double Displacement Reactions | Redox Reactions |
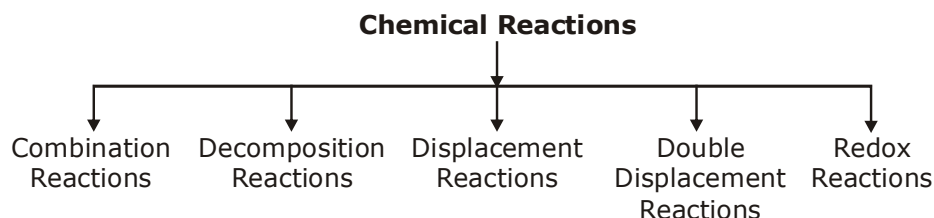
1.   COMBINATION REACTIONS

The reactions in which two or more substances combine to form a single new substance are called combination reactions.

Combination may take place,

(A) Between two or more elements.

(B) Between two or more compounds.

(C) Between elements and compounds.

(A)   Combination of elements :

(i)   Burning of Coal

$C(s)$ + $O_2(g) \longrightarrow$ $CO_2(g)$
Carbon   Oxygen   Carbon dioxide

(ii)   Formation of Water
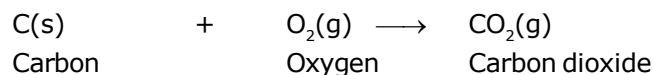
$2H_2(g)$ + $O_2(g) \longrightarrow$ $2H_2O(\ell)$
Hydrogen   Oxygen   Water
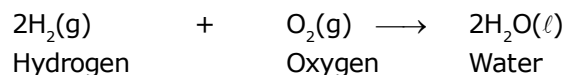
(iii)   Burning of Magnesium in air

$2Mg(s)$ + $O_2(s) \longrightarrow$ $2MgO(s)$
Magnesium   Oxygen   Magnesium oxide
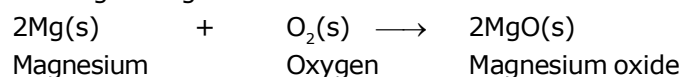
(iv)   Formation of Iron sulphide

$Fe(s)$ + $S(s) \xrightarrow{\Delta} FeS(s)$

Iron   Sulphur   Iron sulphide
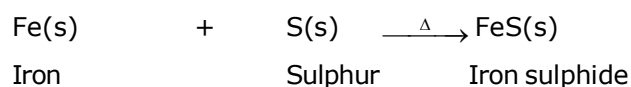
(B)   Combination of compounds :

(i)   Formation of Ammonium chloride

$NH_3(g)$ + $HCl(g) \longrightarrow$ $NH_4Cl(s)$
Ammonia   Hydrogen Chloride   Ammonium Chloride
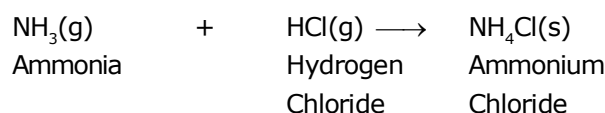
(ii)   Formation of Calcium Carbonate

$CaO(s)$ + $CO_2(g) \longrightarrow$ $CaCO_3(s)$
Calcium oxide (Quick lime)   Carbon dioxide   Calcium carbonate
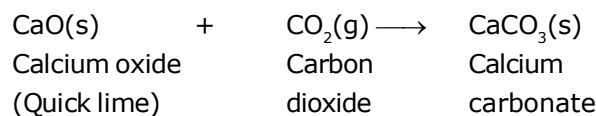
Info Bubble

After white washing of walls Calcium hydroxide reacts slowly with the carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white washing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also $CaCO_3$.
$Ca(OH)_2(aq) + CO_2(g)$ $CaCO_3(s) + H_2O(l)$
(Calcium hydroxide)   (Calcium carbonate)
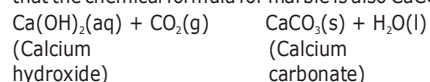
(C) **Combination of an element and a compound**

(i) Reaction of carbon monoxide with oxygen

$$2CO(g) \quad + \quad O_2(g) \longrightarrow \quad 2CO_2(g)$$

(ii) $CH_2=CH_2 + Br_2 \longrightarrow CH_2—CH_2$
    $\quad\quad\quad\quad\quad\quad\quad\quad\quad | \quad\quad |$
    $\quad\quad\quad\quad\quad\quad\quad\quad\quad Br \quad Br$

2. **DECOMPOSITION REACTIONS**

Chemical reactions in which a single compound breaks down to produce two or more simpler substances. i.e. a compound decomposes into simpler substances are called decomposition reactions.

They are opposite to combination reactions.

There are three ways in which decomposition reactions can be carried out, i.e., energy required in decomposition reaction can be supplied in the following ways:

(A) Electricity   (B) Heat   (C) Light

> **Info Bubble**
>
> An important example of decomposition reaction in our body is digestion of food. When we eat rice, wheat or potatoes, the starch gets decomposed to simple sugar and proteins get converted into simple substances called amino acids in our body.

(A) **Electrolysis :** When decomposition reaction is carried out with the help of electric current, the process is called electrolysis ('electro' means electric, 'lysis' means break down), e.g. when electric current is passed through acidified water (water mixed with a few drops of acid so as to make it a good conductor), it decomposes into Hydrogen and Oxygen.

$$2 H_2O \xrightarrow{\text{electric current}} 2 H_2 + O_2$$
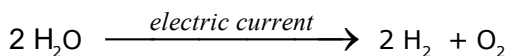
Other examples of electrolysis are:

(i) $2NaCl \xrightarrow{\text{electric current}} 2Na + Cl_2$
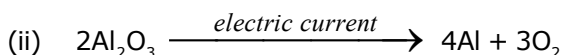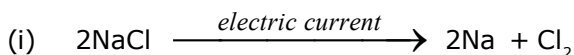
> **Info Bubble**
>
> Decomposition of silver salts is used in black and white photography.

(ii) $2Al_2O_3 \xrightarrow{\text{electric current}} 4Al + 3O_2$

ACTIVITY – 3

⇒ **Aim :** To demonstrate electrolysis of water.

⇒ **Materials Required :** Plastic mug, drilling machine or screw driver, carbon electrodes, 6 volt battery, dil. H_2SO_4, water

⇒ **Procedure :**

1. Take a plastic mug.
2. Drill two holes at the base and insert carbon electrodes as shown in figure.
3. Fill the mug with water to its half and add a few drops of dilute sulphuric acid.
4. Fill a graduated measuring cylinder with water and invert it in the apparatus so that one of the two electrodes is enclosed within it.
5. Fill another graduated cylinder with water and invert it over the second electrode.
6. Allow the current to pass through the voltameter and leave the apparatus undisturbed for some time.

7. Bubble formation starts at both the electrodes.
8. Observe the volume of gases collected in the inverted measuring cylinders.
9. Collect the gases in respective cylinders and test them separately.
10. Bring a match stick near each of the gases in the cylinders and note down the observations and write conclusion about the gas.

Electrolysis of Water
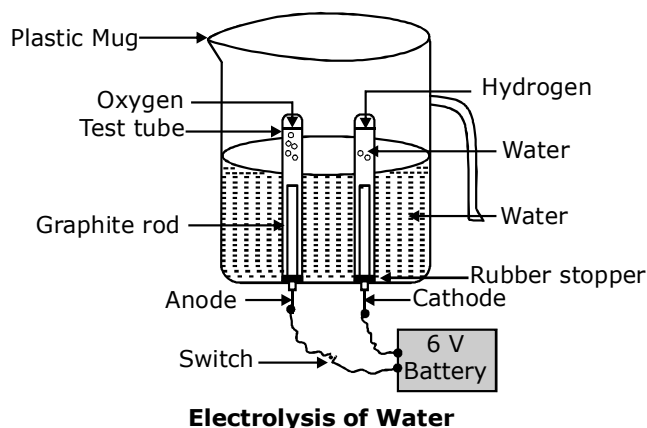
⇒ **Observation :** The volume of one of the gases is twice the volume of other gas. One of the gases catches fire and burns with 'pop' sound whereas in other gas match stick burns brightly.

⇒ **Conclusion :** Water, on electrolysis decomposes to hydrogen gas and oxygen gas. Hydrogen gas burns explosively whereas oxygen gas helps in burning, i.e., hydrogen is highly combustible and oxygen is supporter of combustion.

(B) **Thermal Decompositions:** When decomposition reaction is carried out by heating, it is called thermal decomposition reaction, e.g.,

$$CaCO_3 \text{ (s)} \xrightarrow{\text{heat}} CaO \text{ (s)} + CO_2 \text{ (g)}$$
Limestone   Quick lime

$$FeSO_4 \text{ (s)} \xrightarrow{\text{heat}} Fe_2O_3 \text{ (s)} + SO_2 \text{(g)} + SO_3 \text{(g)}$$
                  Ferric oxide

$$2Pb(NO_3)_2 \text{(s)} \xrightarrow{\text{heat}} 2PbO \text{ (s)} + 4NO_2 \text{(g)} + O_2 \text{(g)}$$

$$ZnCO_3 \text{ (s)} \xrightarrow{\text{heat}} ZnO \text{ (s)} + CO_2 \text{ (g)}$$
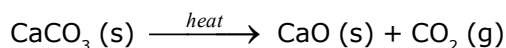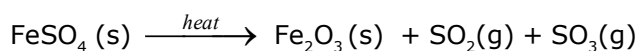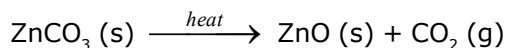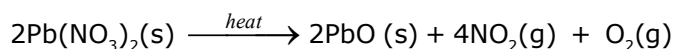
(C) **Photochemical Decomposition :**
Chemical reaction in which a compound decomposes into simpler substances on the absorption of light energy is called photo-decomposition reaction.
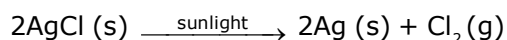
$$2AgCl \text{ (s)} \xrightarrow{\text{sunlight}} 2Ag \text{ (s)} + Cl_2 \text{ (g)}$$
Silver Chloride   Silver   Chlorine
(White)   (Grey in colour)
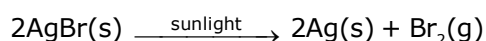
$$2AgBr \text{(s)} \xrightarrow{\text{sunlight}} 2Ag \text{(s)} + Br_2 \text{(g)}$$
Silver Bromide   Silver   Bromine

Other examples of photochemical reactions : Silver bromide and silver iodide also decompose in the same manner.

$$2 \text{ AgI (s)} \xrightarrow{\textit{sunlight}} 2 \text{ Ag (s)} + I_2 \text{ (g)}$$
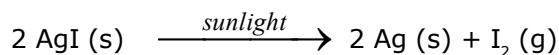
3. DISPLACEMENT REACTIONS

Those reactions in which a more reactive element displaces a less reactive element from a compound are called displacement reactions.

Reactivity or **Activity series** of metals : The arrangement of different metals in the decreasing order of their reactivity is called reactivity or activity series of metals.

Significance of reactivity series: The reactivity series tells us about :

(i)   Feasibility of a displacement reaction.

(ii)   Liberation of hydrogen gas in the reaction.

(iii) Occurrence of a metal in earth's crust

Lithium	Li	Most Reactive
Potassium	K	
Barium	Ba	
Sodium	Na	
Calcium	Ca	
Magnesium	Mg	DECREASING REACTIVITY
Aluminium	Al	
Zinc	Zn	
Iron	Fe	
Nickel	Ni	
Tin	Sn	
Lead	Pb	
Hydrogen	H	
Copper	Cu	
Mercury	Hg	
Silver	Ag	
Gold	Au	
Platinum	Pt	Least Reactive

These reactions mostly occur in solution form, e.g.,

$$\text{Zn (s)} + \text{CuSO}_4 \text{ (aq)} \longrightarrow \text{ZnSO}_4 \text{ (aq)} + \text{Cu (s)}$$

         Blue   Colourless   Reddish brown

$$\text{Pb} + \text{CuSO}_4 \text{ (aq)} \longrightarrow \text{PbSO}_4 \downarrow + \text{Cu (s)}$$

$$\text{Mg} + \text{CuSO}_4 \longrightarrow \text{MgSO}_4 \text{(aq)} + \text{Zn (s)}$$

$$\text{Mg(s) + ZnSO}_4 \text{ (aq)} \longrightarrow \text{MgSO}_4 \text{ (aq) + Zn (s)}$$

$$\text{Mg (s) + FeSO}_4 \text{ (aq)} \longrightarrow \text{MgSO}_4 \text{ (aq) + Fe (s)}$$

$$\text{Zn (s) + FeSO}_4 \text{ (aq)} \longrightarrow \text{ZnSO}_4 \text{ (aq) + Fe (s)}$$
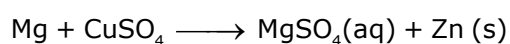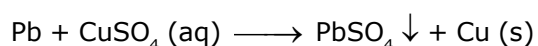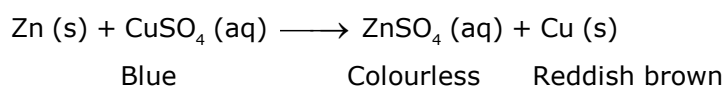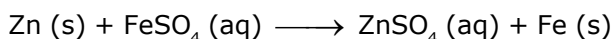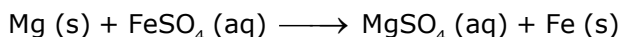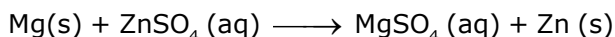
On the basis of the above reactions, we can conclude Mg > Zn >Fe > Pb > Cu > Ag is the order of reactivity.

$$\text{Zn (s) + H}_2\text{SO}_4 \text{ (dil.)} \longrightarrow \text{ZnSO}_4 \text{ (aq) + H}_2 \text{(g)}$$

$$\text{Mg (s) + H}_2\text{SO}_4 \text{ (dil.)} \longrightarrow \text{MgSO}_4 \text{ (aq) + H}_2 \text{ (g)}$$
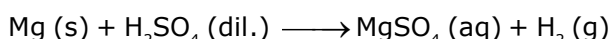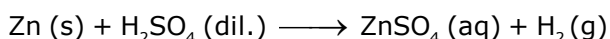
These reactions show that Zn and Mg are more reactive than Hydrogen because they displace Hydrogen from dilute acids.

4. DOUBLE DECOMPOSITION REACTIONS (DOUBLE DISPLACEMENT REACTIONS)

Those reactions in which two different atoms or groups of atoms are displaced by other atoms or groups of atoms, i.e., two compounds exchange their ions are called double displacement reactions.
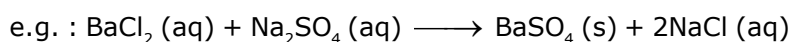
> **Info Bubble**
>
> All precipatation and neutralization reactions are double displacement reactions.

e.g. : $\text{BaCl}_2 \text{ (aq) + Na}_2\text{SO}_4 \text{ (aq)} \longrightarrow \text{BaSO}_4 \text{ (s) + 2NaCl (aq)}$

Other examples of double displacement reactions are :

NaOH (aq)	+ HCl (aq)	$\longrightarrow$	NaCl (aq)	+ H_2O
$AgNO_3$ (aq)	+ NaBr (aq)	$\longrightarrow$	AgBr (s) $\downarrow$	+ $NaNO_3$ (aq)
$AgNO_3$ (aq)	+ KI (aq)	$\longrightarrow$	AgI $\downarrow$	+ KNO_3 (aq)
$FeSO_4$ (aq)	+ 2 NaOH (aq)	$\longrightarrow$	Fe $(OH)_2$ (s) $\downarrow$	+ Na_2SO_4 (aq)
$CuSO_4$	+ H_2S(g)	$\longrightarrow$	CuS (s) $\downarrow$	+ H_2SO_4 (aq)
Pb $(NO_3)_2$	+ 2 HCl (aq)	$\longrightarrow$	$PbCl_2$ (s)	+ 2 HNO_3 (aq)
CH_3COOH	+ NaOH	$\longrightarrow$	CH_3COONa	+ H_2O (l)
CH_3COONa	+ HCl	$\longrightarrow$	CH_3COOH	+ NaCl (aq)
$NaHCO_3$	+ NaOH	$\longrightarrow$	Na_2CO_3	+ H_2O (l)
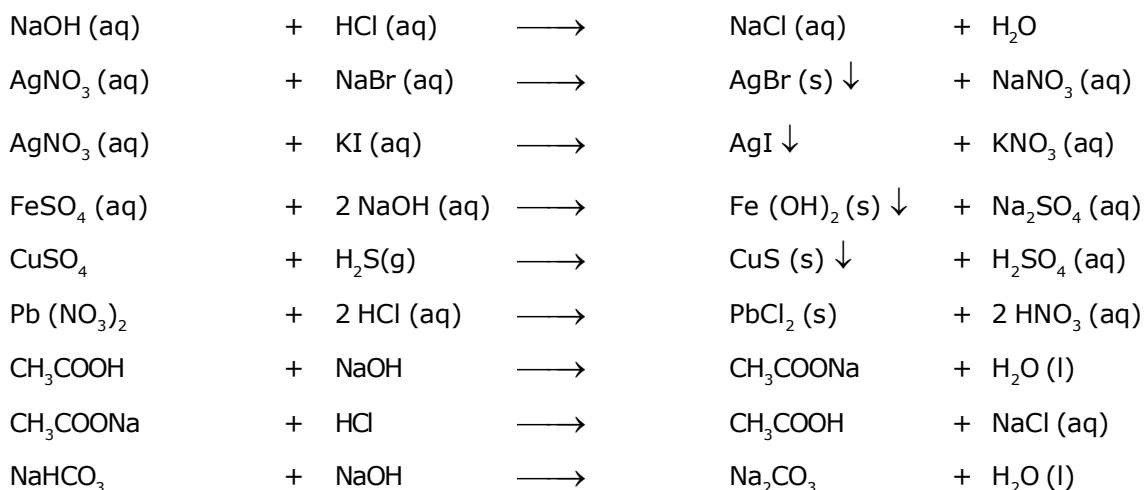
When acidic salts reacts with base to form salt and water, it is also called neutralization reaction.

5. REDOX REACTIONS

Those reactions in which oxidation and reduction take place simultaneously are called redox reactions. To understand redox reactions, we need to know about oxidation and reduction process.

Some examples of redox reactions are :

Oxidation

(i) $MnO_2(s) + 4\ HCl\ (Conc).\ \longrightarrow\ MnCl_2(aq) + Cl_2\ (g) + 2H_2O$

Reduction

Oxidation

(ii) $Cu\ (s) + I_2\ (s)\ \longrightarrow\ CuI_2\ (s)$

Reduction
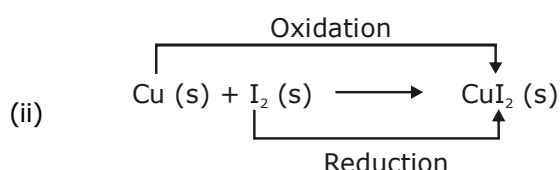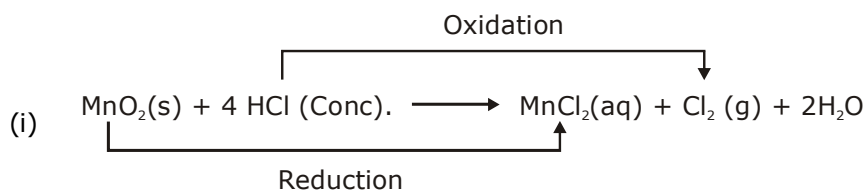
(A)   Oxidation :

(i)   It is a process in which oxygen or an electronegative element is added.

$4Na + O_2\ \longrightarrow\ 2\ Na_2O$ (Addition of oxygen)

$2Mg + O_2\ \longrightarrow\ 2\ MgO$ (Addition of oxygen)

$2\ Fe + 3\ Cl_2\ \longrightarrow\ 2\ FeCl_3$ (Addition of electronegative element)
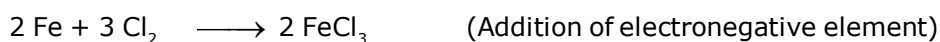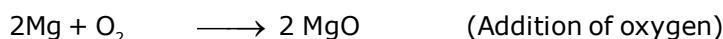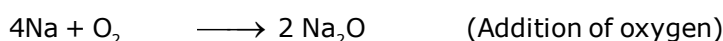
(ii)   It can also be defined as a process in which hydrogen or an electropositive element is removed.

$Hg_2Cl_2\ \longrightarrow\ Hg + HgCl_2$ (Removal of electropositive element)

$CH_3CH_2OH\ \xrightarrow{\ Cu\ \atop 300^oC\ }\ CH_3CHO + H_2$ (Removal of Hydrogen)
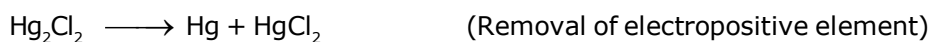
(iii)   In terms of electronic concept, oxidation is a process in which loss of electrons takes place.

$Fe^{2+}\ \longrightarrow\ Fe^{3+} + e^-$ (Loss of electron)

(B)   Reduction.

(i)   It is a process in which addition of Hydrogen or an electropositive element takes place.

$2\ Na\ +\ H_2\ \longrightarrow\ 2NaH$ (Addition of Hydrogen)

$Hg\ +\ HgCl_2\ \longrightarrow\ Hg_2Cl_2$ (Addition of an electropositive element)

$Cu\ +\ CuCl_2\ \longrightarrow\ Cu_2Cl_2$ (Addition of an electropositive element)

$CuO\ +\ H_2\ \longrightarrow\ Cu + H_2O$ (Removal of Oxygen and addition of hydrogen)
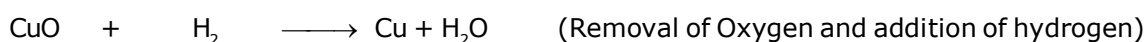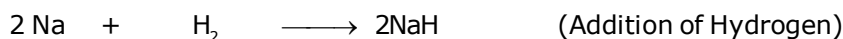
(ii)   It is also defined as a process in which Oxygen or an electronegative element is removed.

$AuCl_3\ \longrightarrow\ AuCl\ +\ Cl_2$ (Removal of an electronegative element)

(iii)   In electronic concept, reduction process involves gain of electrons.

$Fe^{3+}\ +\ e^-\ \longrightarrow\ Fe^{2+}$ (Gain of electron)
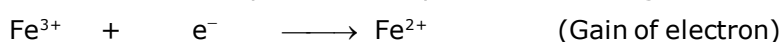
(C) Oxidising and Reducing Agents :

Oxidising Agent : A substance that oxidises the other substance and gets itself reduced is called an oxidising agent. It

(i) Add oxygen or an electronegative element to other materials.

(ii) Remove hydrogen or an electropositive element from other materials.

(iii) Gain electrons.

Reducing Agent. A substance that reduces the other substance and gets itself oxidised is called an reducing agent. It

(i) Add hydrogen or an electropositive element to other materials.

(ii) Remove oxygen or an electronegative element from other materials

(iii) Lose electrons.

Example 1. $Fe + S \longrightarrow FeS$

$Fe \longrightarrow Fe^{2+} + 2e^-$ (Oxidation)

$S + 2e^- \longrightarrow S^{2-}$ (Reduction)
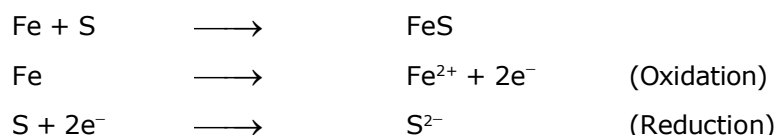
Fe is getting oxidised to Fe^{2+} (Ferrous ion) whereas S gets reduced to S^{2-} (Sulphide ion)

Fe is **losing electrons**, therefore, it acts as a **Reducing agent**.

S is **gaining electrons**, therefore, it acts as an **Oxidising agent**.

Example 2. $Cu\ (s) + 2AgNO_3\ (aq) \longrightarrow Cu\ (NO_3)_2\ (aq) + 2\ Ag\ (s)$

$Cu\ (s) \longrightarrow Cu^{2+} + 2e^-$ (Oxidation)

$2\ Ag^+ + 2e^- \longrightarrow 2\ Ag$ (Reduction)

$Cu\ (s) + 2\ Ag^+\ (aq) \longrightarrow Cu^{2+}\ (aq) + 2\ Ag\ (s)$
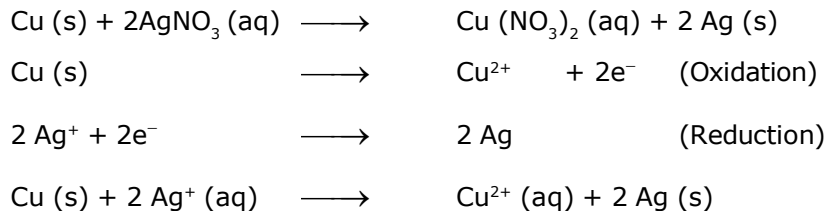
Cu is a reducing agent because it is losing electrons whereas Ag^+ is an oxidising agent.

Example 3. $2\ Na + Cl_2 \longrightarrow 2NaCl$

$2\ Na \longrightarrow 2\ Na^+ + 2e^-$ [Oxidation]

$Cl_2 + 2e^- \longrightarrow 2Cl^-$
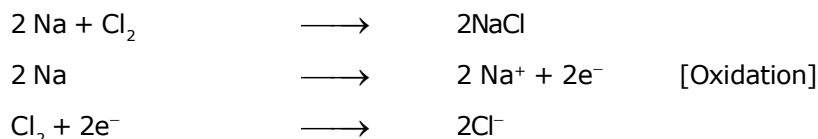
Na is a reducing agent whereas Cl_2 is an oxidizing agent.

Example 4.

$$\overset{\text{Reduction}}{\underset{\text{Oxidation}}{Fe_2O_3\ +\ 2Al\ \longrightarrow\ Al_2O_3\ +\ 2Fe}}$$
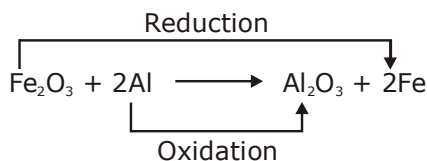
Fe_2O_3 is an oxidizing agent whereas Al is a reducing agent.

Example 5. $Zn + CuSO_4$ $\longrightarrow$ $ZnSO_4 + Cu$

Reduction

$Zn + Cu^{24} \longrightarrow Zn^{2+} + Cu$
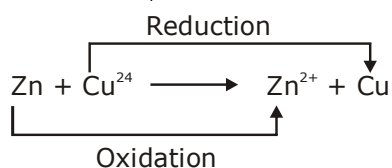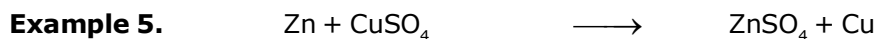
Oxidation

Zn is a reducing agent whereas Cu^{2+} is an oxidizing agent

Reduction

Example 6. $2H_2S + SO_2 \longrightarrow 2H_2O + 3\ S$
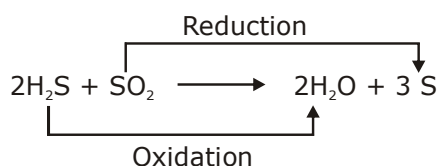
Oxidation

H_2S is a reducing agent whereas SO_2 is an oxidizing agent.
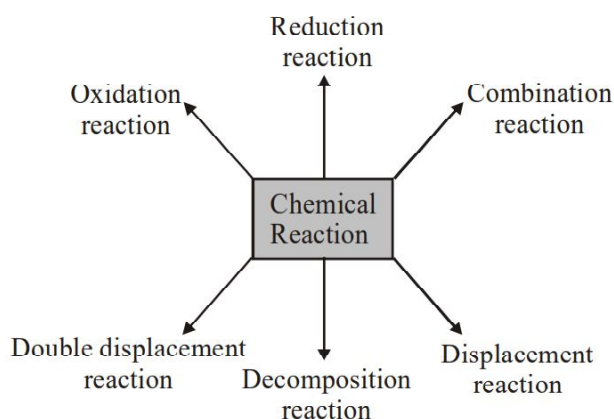
MODERN CONCEPT OF OXIDATION AND REDUCTION

Electronic concept : This concept is applicable when reactants are ionic in nature.

Oxidation is defined as a process in which an atom, ion or molecule looses one or more eletrons.

$$Mg \rightarrow Mg^{2+} + 2e^{\ominus}$$

$$Cu \rightarrow Cu^{2+} + 2e^{\ominus}$$
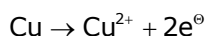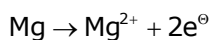
Reduction is defined as a process in which atom, ion or molecule gains one or more electrons.

$$Cl + e^{\ominus} \rightarrow Cl^-$$

$$Zn^{2+} + 2e^{\ominus} \rightarrow Zn$$
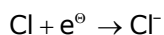
Oxidising agent : A substance i.e. atom, ion or molecule that oxidises other one and in return gets reduced itself by gain of electron is called Oxidising agent.

Examples of Oxidising agent

(i) Non-metals such as halogens and oxygen, ozone are good oxidising agents. Among halogens fluorine is the strongest oxidising agent.

(ii) Oxides of elements such as CaO, MgO, CuO, P_4O_{10}, Na_2O etc.

(iii) Acidified $K_2Cr_2O_7$

$$Cr_2O_7^{2-} + 14H^+ + 6e^\ominus \rightarrow 2Cr^{3+} + 7H_2O$$

(iv) Hydrogen peroxide H_2O_2

$$H_2O_2 + 2H^+ + 2e^\ominus \rightarrow 2H_2O$$
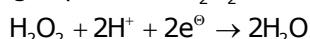
(v) Potassium permangnate $KMnO_4$

(a) In acidic medium

$$MnO_4^- + 8H^+ + 5e^\ominus \rightarrow Mn^{2+} + 4H_2O$$

i.e. $Mn^{7+} + 5e^\ominus \rightarrow Mn^{2+}$

(b) In alkaline medium

$$MnO_4^- + e^\ominus \rightarrow MnO_4^{2-}$$

i.e. $Mn^{7+} + e^\ominus \rightarrow Mn^{6+}$

(c) In neutral medium

$$MnO_4^- + 2H_2O + 3e^\ominus \rightarrow MnO_2 + 4OH^-$$

i.e. $Mn^{7+} + 3e^\ominus \rightarrow Mn^{4+}$
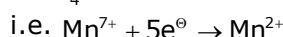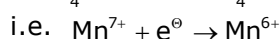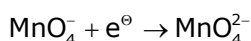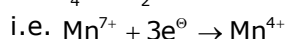
Reducing agent : A substance i.e., atom, ion or molecule which reduces the other one and gets oxidised it self by loss of electrons is called a reducing agent.

Example :

(i) All the metals are strong reducing agents. For e.g. , Na, K, Zn, Al, V, Cr, Fe etc.

(ii) Metallic hydrides such as, CaH_2, NaH, LiH etc.

(iii) Strongest reducing power is shown by Lithium in its solution state.

(iv) Compounds such as $FeSO_4$, HI, HCl, HBr, H_2S, $SnCl_2$, O_3 and H_2O_2 etc. also show strongreducing power.

(v) In the reaction of stannous chloride ($SnCl_2$) and mercuric chloride ($HgCl_2$), stannous chloride acts as a reducing agents as it oxidation state is increased from +2 to +4

$$\overset{\text{Oxidation}}{\overbrace{SnCl_2 + 2HgCl_2 \longrightarrow SnCl_4 + Hg_2Cl_2}}$$

$$\underset{\text{Reduction}}{\underbrace{}}$$

$$Sn^{2+} \rightarrow Sn^{4+} + 2e^- \, (\text{Oxidation})$$
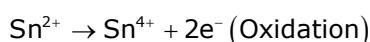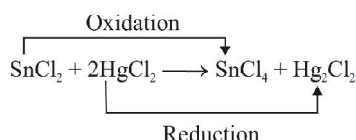
The overall reaction can be written as

$$Sn^{2+} + 2Hg^{2+} \rightarrow 2Hg^{1+} + Sn^{4+}$$

$$\begin{bmatrix} COOH \\ | \\ COOH \end{bmatrix} \rightarrow C_2O_4^{2-} + 2H^+$$

(Oxalic acid)

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$
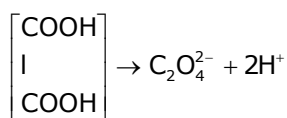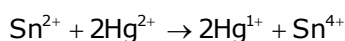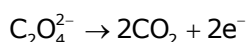
The substance which act as both oxidising and reducing agents are O_3, H_2O_2, H_2SO_3, HNO_2, $NaNO_2$, SO_2, $Na_2S_2O_3$ etc.

VALENCY, OXIDATION STATE AND OXIDATION NUMBER

Valency of an element is defined as number indicating its combining capacity.

For example,

(i) It represents the number of hydrogen atoms which can combine with a given atom.

(ii) It also represents the number of single bonds which an atom can form.

(iii) It is also defined as a number of electrons its atom is able to lend, borrow or share.

(iv) In any case valency is a pure number and has no plus or minus sign associated with it. In ionic compounds the hereby oxidation state of an element is the same as the charge on the ion formed from an atom of the element. For example, in potassium bromide, potassium is said to be in the + 1 oxidation state and bromine in – 1 oxidation state. It ionizes as

$KBr \rightarrow K^+ + Br^-$
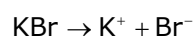
(v) Oxidation state of aluminium in Al_2O_3 is +3 and the total oxidation number of two aluminium atoms is +6.

(vi) Thus oxidation state of an element is its oxidation number per atom.

Difference between the magnitude of valency and the oxidation number :

For example, consider the following compounds of carbon:

CH_4	CH_3Cl	CH_2Cl_2	$CHCl_3$	CCl_4
Methane	Methyl chloride	Methylene chloride	Chloroform	Carbon tetrachloride

In each case one atom of carbon shares a total of 4 pairs of electrons with other atoms. Carbon atom is, therefore, tetravalent in each case.

Oxidation number for carbon in CH_4, CH_3Cl, CH_2Cl_2, $CHCl_3$ and CCl_4 is –4, –2, 0, +2 and +4 respectively.

Oxidation and Reduction in terms of Oxidation Number :

The term oxidation refers to any chemical change involving increase in oxidation number whereas the term reduction applies to any chemical change involving decrease in oxidation number

Consider the following chemical changes :

(i) $2H_2 + O_2 \rightarrow 2H_2O$
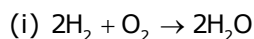
Here in oxidation number of hydrogen changes from 0 (in H_2) to + 1 (in H_2O). It is, therefore, a case of oxidation of hydrogen.

(ii) Sugar ($C_{12}H_{22}O_{11}$) burns to give CO_2 and water. In this oxidation number of carbon increases from 0 (in $C_{12}H_{22}O_{11}$) to +4 in CO_2. The sugar is, therefore, said to have undergone oxidation.

(iii) When oxygen reacts with hydrogen to give water [example (i)] the oxidation number of oxygen decreases from 0 (in O_2) to –2 (in H_2O). It is, therefore, a case of reduction of oxygen.

In the same reaction, oxidation number of hydrogen increases, and that of oxygen decreases,

i.e., hydrogen undergoes oxidation while oxygen undergoes reduction. Thus oxidation and reduction occur together.

An oxidising agent is a substance which brings about oxidation. It contains an atom which undergoes a decrease in oxidation number. It can also be defined as a substance which picks up electrons and thus brings about de-electronation.

Oxidation Number or Oxidation State :

Definition of Oxidation Number : The oxidation number is defined as a positive or negative number that represents a charge that an atom appears to have in a given species when the bonding electrons are counted as per the certain prescribed set of rules.

Rules for assigning oxidation number : Oxidation number for atoms & ions can be assigned using the following set of rules.

Rule 1 : The oxidation number of an atom in an element in its free uncombined state is zero, regardless of whether the element exists as monoatomic or polyatomic molecule. For example, each fluorine atom in F_2, each phosphorus atom in P_4 & the silver atom in Ag,is assigned as oxidation number of zero.

Rule 2 : The oxidation number of a monoatomic ion is same as the charge on the ion. For example, the oxidation number of calcium ion is +2, in sulphur S^{-2} ion has oxidation number of −2.

Rule 3 : Oxidation numbers conventionally assigned to atoms in their chemical compounds are as follows :

(a) Oxygen = −2 (except in peroxides where it is −1). For example, the oxidation state of oxygen in SO_2, $KClO_3$ and $KMnO_4$ is −2. In Na_2O_2 & H_2O_2, the oxidation number of oxygen is −1. In the very rare instance when oxygen is bound to an element that is more electronegative than itself, such as in OF_2, Oxygen exhibits an oxidation number of +2 and in O_2F_2, oxygen shows +1 oxidation number.

(b) Hydrogen = +1 (except in metallic hydrides where it is −1). For example the oxidation number of hydrogen atom in H_2O, H_2O_2,NH_3, CH_3COOH is +1. In LiH, it is −1.

(c) Group IA elements (alkali metals) = +1.

(d) Group IIA elements (alkaline earth elements) = +2.

(e) Halogen atoms in binary ionic compounds (halides) = −1. The halogen atom in NaI,KBr, CsI has an oxidation number of −1.

Rule 4 : The algebraic sum of the positive & negative oxidation numbers in a compound is zero.

The oxidation number of a specified atom in a compound can therefore be determined as illustrated below.

Oxidation number of Mn in $KMnO_4$

Let oxidation number of Mn be x

Oxidation number of oxygen is −2

& Oxidation number of K is +1

∴ +1 + x + 4 (−2) = 0

∴ x = + 7

Therefore, the oxidation number of Mn in $KMnO_4$ is +7

Rule 5 : The algebraic sum of the positive and negative oxidation states or numbers of the atoms in a polyatomic ion is equal to charge on the ion.

(i) Let us find out the oxidation number of chromium in $Cr_2O_7^{-2}$

Let the oxidation number of chromium be x and oxygen as –2,
Sum of oxidation numbers = 2 x + 7 (–2) = – 2
$$2 x – 14 = – 2$$
$$x = + 6$$

Thus the oxidation number of chromium in $Cr_2O_7^{-2}$ ion is +6.

(ii) Oxidation number of S in H_2SO_4 is as,

Let oxidation number of S be x, Hydrogen as +1 and oxygen as –2
Sum of oxidation numbers of various atoms in H_2SO_4

$2x (+1) + x + 4 x (–2) = 0$

$2 + x = 8$

$x – 8 = 2$

$x = 6$

oxidation number of S in H_2SO_4 = +6

(iii) Oxidation number of S in $Na_2S_2O_3$

$2 + 2x – 6 = 0$

$2x – 4 = 0$, we have

$x = +2$

∴ Oxidation number of S in $Na_2S_2O_3$ = +2

(iv) Oxidation state of Mn in Mn_2O_7 is as,

Let the oxidation state of manganese be x.
Sum of oxidation numbers of various atoms in Mn_2O_7 is as,

$2(x) + 7 (–2) = 0$

∴ $2 x = + 14$

$x = +7$

Distinction between valency and oxidation state / oxidation number :

(i) Valency is always a whole number, on the other hand the oxidation number of the element may be a whole number or fractional.

(ii) Valency of the element is never zero except of noble gases but the oxidation number of the element may be zero.

(iii) Valency is the combining power of an element with no plus or minus sign. On the other hand oxidation number is the charge present on the atom of the element while being in combination.

It may have plus or minus sign.

Note : The oxidation number changes with the following cases.

Oxidation → **Oxidation number increases**

Reduction → **Oxidation number decreases**

Oxidizing agent → **Oxidation number decreases**

Reducing agent → **Oxidation number increases**

Oxidation State / Oxidation number in Complex molecules :

(i) Carbon in Glucose ($C_6H_{12}O_6$)

Let the oxidation number of carbon be x, hydrogen +1 and oxygen −2

Sum of oxidation number of various atoms in $C_6H_{12}O_6$ is

$6x + 12\,(+1) + 6\,(-2) = 0$

$6x + 12 - 12 = 0$

$6x = 0$

$x = 0$

In glucose the oxidation state of carbon is zero.

(ii) Ni in $[Ni(CO)_4]$

The oxidation state of CO is zero, hence the oxidation state of nickel will also be zero.

(iii) Sulphur in $(CH_3)_2SO$

i.e., dimethyl sulphoxide.

Let the oxidation state of S be x, oxygen −2, and each methyl group is +1

Sum of oxidation numbers of various atoms in $(CH_3)_2SO$ is

$+2 + x - 2 = 0$

$x = 0$

Thus the oxidation state of sulphur in $(CH_3)_2SO$ is zero.

(iv) Boron in $LiBH_4$

In metal hydrides, the oxidation state of hydrogen is −1 and the metal Lithium is +1

Sum of oxidation number of various atoms in $LiBH_4$ is,

$+1 + x - 4 = 0$

$x = +3$

Thus the oxidation state of B in $LiBH_4$ is +3

Fractional values of Oxidation numbers are possible with the following components :

(i) Hydrazoic acid N_3H

Let the oxidation no. of nitrogen be x and hydrogen +1.

$3x + 1 = 0$

$3x = -1$

$x = -\dfrac{1}{3}$

$x = -0.333$

The oxidation number of N in N_3H is $-1/3$.

(ii) $Na_2S_4O_6$

Let the oxidation no. of sulphur be x, sodium $+1$ and oxygen -2,

$2 + 4x + 6(-2) = 0$

$2 + 4x - 12 = 0$

$4x = + 10$

$x = 10/4 = 2.5$

The oxidation number of S in $Na_2S_4O_6$ is 2½

BALANCING OF REDOX REACTIONS

The redox reactions can be balanced by following methods

(i) Oxidation number method

(ii) Ion-electron method

Balancing by oxidation number method : The various steps involved in balancing a redox equation by oxidation number method are:

(i) Write the skeleton equation.

(ii) Indicate the oxidation numbers of all the atoms involved in the equation above their symbols.

(iii) Identify the elements which undergo change in oxidation number.

(iv) Calculate the increase and decrease in oxidation number per atom with respect to the reactants.

If more than one atom is involved, then multiply with the number of the atoms undergoing the change to calculate the total change in oxidation number.

(v) Equate the increase and decrease in oxidation number on the reactant side by multiplying the formulae of the oxidising and reducing agents suitably.

(vi) Balance the equation with respect to all the atoms except hydrogen and oxygen.

(vii) Finally balance hydrogen and oxygen atoms also.

(viii) In the reactions taking place in the acidic medium, balance the O atoms by adding required number of H_2O molecules to the side deficient in O atoms. Then balance the H atoms by adding H^+ to the side deficient in H atoms.

(ix) In the basic medium, first balance the number of negative charges by adding required number of OH^- ions to the side deficient in the magnitude of the charges. Then add H_2O molecules on the other side in order to balance the OH^- ions added.

Let us try to balance a few chemical equations by oxidation number method.

Example: **Balance the following chemical equations by the oxidation number method**

$$CuO + NH_3 \rightarrow Cu + N_2 + H_2O$$
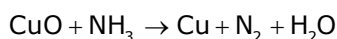
Solution: The balancing is done in the following steps:

1. Write the O.N. of each atom in the skeleton equation

$$\overset{+2}{Cu}\overset{-2}{O}+\overset{-3}{N}\overset{+1}{H_3} \rightarrow \overset{0}{Cu}+\overset{0}{N_2}+\overset{+1}{H_2}\overset{-2}{O}$$
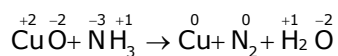
2. Calculate the increase and decrease in O.N. w.r.t. reactant atoms

Increase in O.N. = 3

$$\overset{+2}{Cu}O + \overset{-3}{N}H_3 \longrightarrow \overset{0}{Cu} + \overset{0}{N_2} + H_2O$$
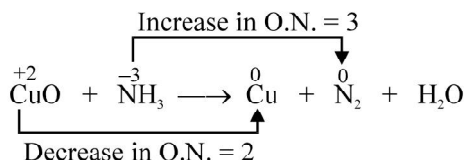
Decrease in O.N. = 2

3. Equate the increase and decrease in O.N. on the reactant side.

$$3CuO + 2NH_3 \rightarrow Cu + N_2 + H_2O$$
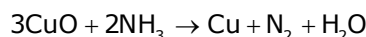
4. Balance the number of Cu and N atoms on both sides of the equation.

$$3CuO + 2NH_3 \rightarrow 3Cu + N_2 + H_2O$$
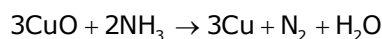
5. Now balance H and O atoms by hit and trial method

$$3CuO + 2NH_3 \rightarrow 3Cu + N_2 + 3H_2O$$
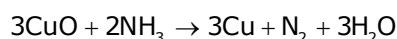
Balancing by Ion-electron method (or half reaction method) :

Balancing can also be done by another method known as ion-electron method. It is based on the principle that the electrons lost during oxidation half reaction in a particular redox reaction is equal to the electrons gained in the reduction half reaction. The method is, therefore, called half reaction method. The balancing is completed in the following steps :

(i) Write the redox reaction in ionic form.

(ii) Find out species which are getting oxidised and also which are getting reduced.

(iii) Split the whole equation into two half reactions i.e. oxidation half reaction and reduction half reaction.

(iv) While balancing each half reaction add electrons for the number of atoms of each element.

(v) In the acidic medium, and neutral medium add water molecules to the side deficient in O and H^+ to the side deficient in hydrogen.

(vi) In the basic medium, for each excess of oxygen, add one water molecule to the same side and two OH^- ions to the other side. If hydrogen is still unbalanced, add on OH^- ion for each excess hydrogen on the same side and one water molecule to the other side.

(vii) Multiply one or both half reactions by suitable number so that the number of electrons become equal in both the equation.

(viii) Add the two balanced half reactions and cancel any term common to both sides.

Example: Balance the following chemical equation by ion-electron method.

$$Cr_2O_7^{2-} + Fe^{2+} + H^+ \rightarrow Cr^{3+} + Fe^{3+} + H_2O$$
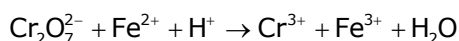
Solution: Step I. Separation of the equation in two half reactions

(i) Write the O.N. of all the atoms involved in the skeleton equation

$$(\overset{+6}{Cr_2}\overset{-2}{O_7})^{2-} + (\overset{+2}{Fe})^{2+} + (\overset{+1}{H})^+ \rightarrow (\overset{+3}{Cr})^{3+} + (\overset{+3}{Fe})^{3+} + \overset{+1}{H_2}\overset{-2}{O}$$
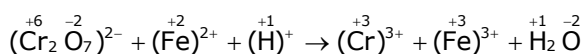
(ii) Identify the atoms which undergo change in O.N.

$$(\overset{+6}{Cr_2}O_7)^{2-} + (\overset{+2}{Fe})^{2+} + (\overset{+1}{H})^+ \rightarrow (\overset{+3}{Cr})^{3+} + (\overset{+3}{Fe})^{3+} + H_2O \cdot$$
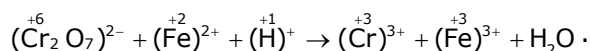
(iii) Find out the species involved in the oxidation and reduction half reactions.
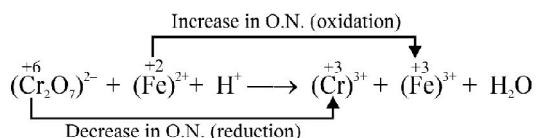
Thus, the two half reactions are:

Oxidation half reaction: $Fe^{2+} \longrightarrow Fe^{3+}$

Reduction half reaction: $(Cr_2O_7)^{2-} \longrightarrow Cr^{3+}$

Step II. Balancing of oxidation half reaction:

The oxidation half reaction is: $Fe^{2+} \longrightarrow Fe^{3+}$

(i) As the increase in O.N. as a result of oxidation is 1, add one e^- on the product side to balance change in O.N.

$$Fe^{2+} \longrightarrow Fe^{3+} + e^-$$
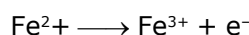
(ii) The charge is already balanced, and thus the equation is alo balanced

$$Fe^{2+} \longrightarrow Fe^{3+} + e^- \qquad \dots\dots(i)$$

Step III. Balancing of reduction half reaction :

The reduction half reaction is: $(\overset{+6}{Cr_2}O_7)^{2-} \rightarrow (\overset{+3}{Cr})^{3+}$

(i) The decrease in O.N. per Cr atom is 3 and the total decrease in O.N. for two Cr atoms is 6. Therefore, add $6e^-$ on the reactant side

$$\left(Cr_2O_7\right)^{2-} + 6e^- \rightarrow Cr^{3+}$$
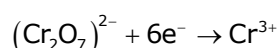
(ii) Balance Cr atoms on both sides of the equation

$$\left(Cr_2O_7\right)^{2-} + 6e^- \rightarrow 2Cr^{3+}$$
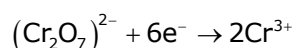
(iii) In order to balance O atoms add seven H_2O molecules on the product side and then to balance H atoms add 14 H^+ on the reactant side.

$$\left(Cr_2O_7\right)^{2-} + 6e^- + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O \qquad \dots\dots(ii)$$
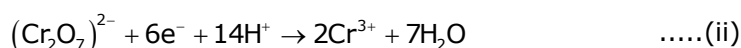
Step IV. Adding the two half reactions :

In order two equate the electrons, multiply the equation (i) by 6 and then add to equation (ii) in order to get the final equation.

$$\left[Fe^{2+} \rightarrow Fe^{3+} + e^-\right] \times 6 = 6\ Fe^{2+} \longrightarrow 6\ Fe^{3+} + 6e^-$$

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$
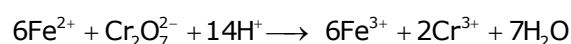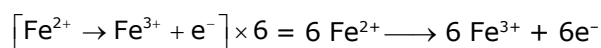
PRACTICE YOUR CONCEPTS

4. Why is the amount of gas collected in one of the test tubes in electrolysis of water, double of the amount collected in the other? Name this gas.

Ans. The gas collected in one of the test tubes is double because it is hydrogen gas and the other test tube contains oxygen. These two gases are formed by the electrolysis of water. The volume of hydrogen is double than that of oxygen in water.

5. What is the difference between displacement and double displacement reaction. Write equations for these reactions.

Ans. In displacement reaction, one element from its salt is displaced by a more reactive element. For example in following reaction, Cu is displaced by Zn from $CuSO_4$ because Zn is more reactive.

$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$
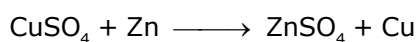
In double displacement reaction, exchange of ions takes palce between two reactants to forms net products.
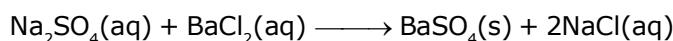
$Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$

6. Explain the following in terms of gain or loss of oxygen with two examples each.

(a) Oxidation   (b) Reduction

Ans. (a) Oxidation : The reactions in which gain of oxygen take place are called oxidation.

Examples : (i) $2Cu + O_2 \longrightarrow 2CuO$ (ii) $2H_2 + O_2 \longrightarrow 2H_2O$
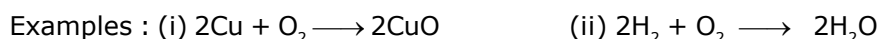
(b) Reduction : The reaction in which loss of oxygen takes place are called reduction.

Examples : (i) $ZnO + C \longrightarrow Zn + CO$ (ii) $CuO + H_2 \longrightarrow Cu + H_2O$

7. A shiny brown coloured element 'X' on heating in air becomes black in colour. Name the element 'X' and the black coloured compound formed.

Ans. The shiny brown coloured element 'X' is copper. When it is heated in air, it becomes black due to the deposit of copper oxide.

$2Cu + O_2 \xrightarrow{\text{Heat}} 2CuO$
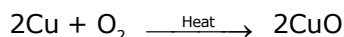
Brown   Black

EFFECTS OF OXIDATION IN EVERYDAY LIFE

Redox reactions play a vital role in our everyday lives. The effect of these reactions is majorily due to the oxidation of the primary substance. The effect is both beneficial as well as harmful.

Beneficial effects of oxidation

(i) Combustion reactions : A chemical reaction in which a substance burns or gets oxidised in the presence of air or oxygen is called combustion reeaction. For example, kerosene, coal, charcoal, wood etc. burn in air and thus, undergo combustion.

(ii) Methane (CH_4) a major constituent of natural gas undergoes combustion in excess of oxygen upon heating.

$CH_4 (g) + 2O_2 (g) \longrightarrow CO_2 (g) + 2H_2O (\ell) + energy$
(Methane)

(iii)   Butane (C_4H_{10}) the main consistuent of L.P.G. also undergoes combustion.

$$2C_4H_{10}\,(g) + 13O_2\,(g) \longrightarrow 8CO_2\,(g) + 5H_2O\,(g) + energy$$
(butane)

(iv)   Carbohydrates such as glucose, fructose, starch etc. are the major source of energy to the human body. They undergo oxidation with the help of oxygen that we inhale to form carbon dioxide and water. For example :

$$C_6H_{12}O_6\,(s) + 6O_2\,(g) \longrightarrow 6CO_2(g) + 6H_2O\,(\ell) + energy$$

Damaging effects of oxidation :

Oxidation has damaging effect on metals as well as on food. The damaging effect of oxidation on metals is studied as corrosion and that on food is studied as rancidity.

1.   CORROSION OF METALS

Corrosion is the process of deterioration of metals as a result of its reaction with air, moisture and acids present in environment surrounding it.

Corrosion causes damage to buildings, bridges, ships and many other articles especially made of iron. Corrosion of iron is the commonest and is called rusting.

Rust : Iron corrode readily when exposed to moisture and gets covered with a brown flaky substance called rust. It is called rusting of iron, Rust is a hydrated Iron (III) oxide, $Fe_2O_3 \cdot xH_2O$

$$4Fe + \underbrace{3O_2 + xH_2O}_{\text{from air}} \longrightarrow 2Fe_2O_3.xH_2O$$
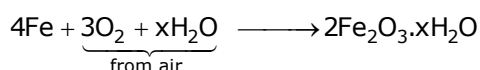
Experiment to show that rusting requires both air and water

We take three test tubes and put one clean iron nail in each of the three test tubes :

(A)   In the first test tube containing iron nail, we put some anhydrous calcium chloride to absorb water (or moisture) from the damp air present in the test tube and make it dry.

(B)   In the second test tube containing iron nail, we put boiled water. Boiled water does not contain any dissolved air or oxygen in it. A layer of oil is put over boiled water in the test tube to prevent the outside air from mixing with boiled water.

(C)   In the third test tube containing an iron nail, we put unboiled water so that about two-third of the nail is immersed in water and the rest is above water exposed to damp air.

         After one week, we observe the iron nails kept in all the three test tubes.
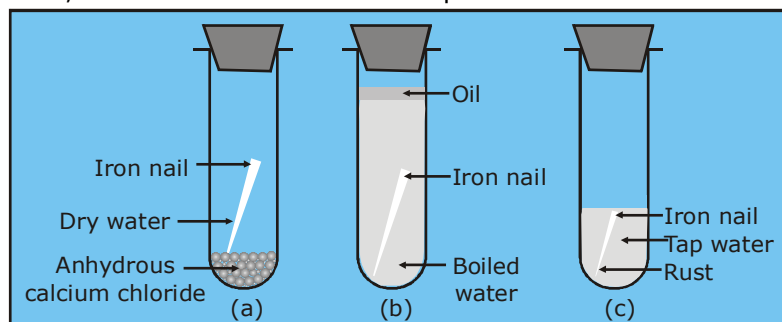
Observation :

(A)   No rust is seen on the surface of iron nail kept in dry air in the first test tube. This tells us that rusting does not takes place in air alone.

(B) No rust is seen on the surface of iron nail kept in air free boiled water in the second test tube. This tells us that rusting does not take place in water alone.

(C) Red brown rust is seen on the surface of iron nail kept in the presence of both air and water in the third test tube. This tells us that rusting takes place in the presence of both air and water together.

Rusting takes place under the following conditions:

(i) Presence of air (or oxygen)

(ii) Presence of water (or moisture).

(iii) Presence of impurities in the metal speed up the rusting process. Pure iron does not rust.

(iv) Presence of electrolytes in water also speeds up the process of rusting.

(v) The position of the metal in the electrochemical series determines the extent of corrosion. More the reactivity of the metal, there will be more possibility of the metal getting corroded.

> **Info Bubble**
> Unreactive metals such as gold, platinum, palladium, titanium etc. corrode negligibly.

Other examples of corrosion are :

(i) Copper reacts with moist carbon dioxide in the air and slowly loses its shiny brown surface and acquires a green coating of basic copper carbonate.

$$2Cu\ (s) + CO_2\ (g) + \underbrace{O_2\ (g) + H_2O}_{moist\ air}\ (\ell) \longrightarrow CuCO_3.Cu(OH)_2\ (green)$$
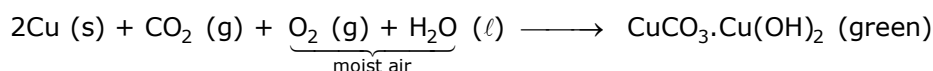
(ii) Silver articles become black after sometime when exposed to air because it reacts with sulphur to form a coating of silver sulphide.

$$2Ag\ (s) + H_2S\ (g) \longrightarrow Ag_2S\ (s) + H_2\ (g)$$
$$\text{from air} \qquad \text{black}$$
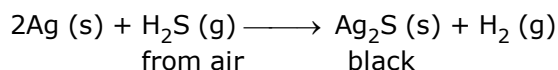
(iii) Lead or stainless steel lose their lusture due to corrosion.

(iv) Unreactive metals such as Gold, Platinum, Palladium, Titanium etc. do not corrode.

Corrosion of Aluminium :

Aluminium objects lose their lustre and become dull after some time. This is due to corrosion of aluminium. When aluminium is exposed to moist air, its surface is covered with a thin impervious (non-penetrable) layer of aluminium oxide (Al_2O_3). This layer does not allow moist air to come in contact with the metal and hence protects the metal underneath from further damage. Thus, a common metal which is highly resistant to corrosion is aluminium.

Prevention of Rusting/ Corrosion :

Rusting/Corrosion can be prevented if objects are not allowed to come in contact with the damp air. Some common methods generally used are given below.

(i) By painting the articles such as window grills, iron gates, steel furniture, railway coaches, bodies of cars, buses etc.

(ii) By greasing and oiling the articles such as mechanical tools, machine parts etc.

(iii) By galavanisation, i.e. coating the surface of iron objects with a thin layer of zinc.

2. RANCIDITY

The oxidation of oils or fats in food, resulting into a bad taste and bad smell is called rancidity. It is caused due to prolonged exposure of food in air. Oxygen present in air oxidises fats/oil present in food to form volatile substances, which have bad odour. The food is said to become rancid.

> **Info Bubble**
>
> Vitamin E and Vitamin C (Ascorbic acid) are the two antioxidants occurring in natural fats.

(A) Prevention of rancidity :–

(i) Rancidity can be prevented by adding antioxidants to foods containing fats and oils. Antioxidants are reducing agents so when they are added to food it do not get oxidised easily and hence do not rancid. The two common anti oxidants are –

(a) BHA (Butylated Hydroxy Anisole)

(b) BHT (Butylated Hydroxy Toluene)

(ii) Rancidity can be prevented by packaging fat and oil containing foods in nitrogen gas.

(iii) It can be retarted by keeping food in refrigerator.

(iv) It can also be retarded by storing food in air tight containers.

(v) It can be retarded by storing foods away from light.

PRACTICE YOUR CONCEPTS

7. Why do we apply paint on iron articles?

Ans. We apply paint on iron articles to prevent them from corrosion. Paint disconnects the reaction between iron and air or water.

8. Oil and fat containing food items are flushed with nitrogen. Why?

Ans. Oil and fat containing food items are flushed with nitrogen to prevent them from damage. When such items come in contact of air, they get oxidised and become rancid. Their smell and taste changes.

9. Explain the following terms with one examples each.

(a) Corrosion   (b) Rancidity

Ans. (a) Corrosion : The process of damaging or chemically eaten up the surface of some metals they are left for some time in moist air is called corrosion.

Conditions of corrosion:

(i) Presence of moisture (water)   (ii) Presence of air

Example : Rusting of iron is a common example of corrosion.

(b) Rancidity : When facts and oils are oxidised, they become rancid and their smell and taste change. This phenomenon is called rancidity.

Example : Fat and oil containing substances are damaged and their taste or smell is changed.

ON YOUR TIPS

- A complete chemical equation representing the reactants products and their physical state symbolicaly.

- Chemical equation is a balanced so that the number of atoms of each type involved in a reaction are the same on the reactant and product sides of the equation.

- In a combination reaction to a more substances combine to form a new single substance.

- Decomposition reaction are opposite to combination reactions. In a decomposition reaction a substance decomposes to give two or more substances.

- Reaction in which energy is absorbed known as endothermic reactions.

- When an element is displaced another element from its compound known as displacement reaction.

- Two different atoms or groups of atoms are exchange known as double displacement reaction.

- Precipitation reaction produce insoluble salts.

- Reaction also involve the gain or loss of oxygen or hydrogen by substances oxidation is the gain of oxygen or loss of hydrogen reduction is loss of oxygen or gain of hydrogen.

- In terms of electronic concept, oxidation is defined as a loss of electrons while reduction is defined as a gain of electrons.

- Corrosion is the slow eating up of metals by the action of air and moisture on their surfaces. Corrosion in case of Iron is known as Rusting.

- Advantages of corrosion: Though corrosion is undesirable, it can be advantageous in case of aluminium which on exposure to air, gets coated with a protective layer of aluminium oxide. This protects the metal underneath from further corrosion and damage.

- Rancidity: When oils and fats or foods containing oils and fats are exposed to air, they get oxidised due to which the food becomes stale and gives a bad taste or smell. This is called Rancidity.

NCERT QUESTIONS WITH SOLUTION

1. Why should a magnesium ribbon be cleaned before it is burnt in air?

Sol. Magnesium is an extremely reactive metal. When stored, it reacts with oxygen to form a layer of magnesium oxide on its surface. This layer of magnesium oxide is quite stable and prevents further reaction of magnesium with oxygen. The magnesium ribbon is cleaned by sand paper for removing this layer so that the underlying metal can be exposed to air.

2. Write the balanced equation for the following chemical reactios.
(i) Hydrogen + Chlorine $\longrightarrow$ Hydrogen chloride
(ii) Barium chloride + Aluminium sulphate $\longrightarrow$ Barium sulphate + Aluminium chloride
(iii) Sodium + Water $\longrightarrow$ Sodium hydroxide + Hydrogen

Sol. (i) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$
(ii) $3BaCl_2(aq) + Al_2(SO_4)_3(aq) \longrightarrow 3BaSO_4(s) + 2AlCl_3(aq)$
(iii) $2Na(s) + 2H_2O(\ell) \longrightarrow 2NaOH(aq) + H_2(g)$

3. Write a balanced chemical equation with state symbols for the following reactions.
(i) Solutions of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution of sodium chloride.
(ii) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride solution and water.

Sol. (i) $BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$
(ii) $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell)$

4. A solution of a substance 'X' is used for white washing.
(i) Name the substance 'X' and write its formula.
(ii) Write the reaction of the substance 'X' with water.

Sol. (i) The substance 'X' is calcium oxide. Its chemical formula is CaO.
(ii) Calcium oxide reacts vigorously with water to form calcium hydroxide (slaked lime).
$CaO(s) + H_2O(\ell) \longrightarrow Ca(OH)_2(aq)$
Calcium oxide   Water   Calcium hydroxide
(Quick lime)   (Slaked lime)
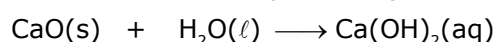
5. Why is the amount of gas collected in one of the test tubes is double of the amount collected in the other? Name this gas.

Sol. Water (H_2O) contains two parts hydrogen and one part oxygen. Therefore, the amount of hydrogen and oxygen produced during electrolysis of water is in a 2 : 1 ratio. During electrolysis, since hydrogen goes to one test tube and oxygen goes to another, the amount of gas collected in one of the test tubes is double of the amount collected in the other.

6. Explain the following terms with one example each.
(a) Corrosion   (b) Rancidity

Sol. **(a) Corrosion:** Corrosion is defined as a process where materials, usually metals, deteriorate as a result of a chemical reaction with air, moisture, chemicals, etc.
For example, iron, in the presence of moisture, reacts with oxygen to form hydrated iron oxide.
$4Fe + 3O_2 + nH_2O \longrightarrow 2Fe_2O_3.nH_2O$
                        Hydrated iron oxide
This hydrated iron oxide is rust.
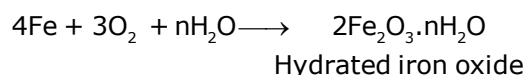
(b) Rancidity: The process of oxidation of fats and oils that can be easily noticed by the change in taste and smell is known as rancidity.

For example, the taste and smell of butter changes when kept for long.

Rancidity can be avoided by:

(1) Storing food in air tight containers

(2) Storing food in refrigerators

(3) Adding antioxidants

(4) Storing food in an environment of nitrogen

7. Give an example of a double displacement reaction other than the one given in Activity.

Sol. Sodium carbonate reacts with calcium chloride to form calcium carbonate and sodium chloride.

$Na_2CO_3(aq) + CaCl_2(aq) \longrightarrow CaCO_3(s) + 2NaCl(aq)$
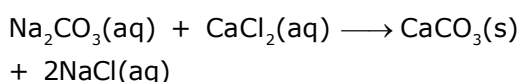
In this reaction, sodium carbonate and calcium chloride exchange ions to form two new compounds. Hence, it is a double displacement reaction.

8. Identify the substances that are oxidised and the substances that are reduced in the following reactions.

(i) $4Na(s) + O_2(g) \longrightarrow 2Na_2O(s) + O_2(g)$

(ii) $CuO(s) + H_2(g) \longrightarrow Cu(s) + H_2O(\ell)$
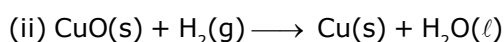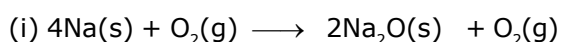
Sol. (i) Sodium (Na) is oxidised as it gains oxygen and oxygen gets reduced.

(ii) Copper oxide (CuO) is reduced to copper (Cu) while hydrogen (H_2) gets oxidised to water (H_2O).

9. Which of the statements about the reaction below are incorrect?

$2PbO(s) + C(s) \longrightarrow 2Pb(s) + CO_2(g)$
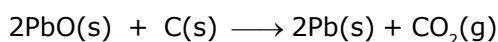
(a) Lead is getting reduced.

(b) Carbon dioxide is getting oxidised.

(c) Carbon is getting oxidised.

(d) Lead oxide is getting reduced.

(1) (a) and (b)   (2) (a) and (c)

(3) (a), (b) and (c)   (4) all

Sol. (1) (a) and (b)

10. $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

The above reaction is an example of a

(1) Combination reaction.

(2) Double displacement reaction.

(3) Decomposition reaction.

(4) Displacement reaction.

Sol. (4) The given reaction is an example of a displacement reaction.

11. What happens when dilute hydrochloric acid is added to iron filings? Tick the correct answer.

(1) Hydrogen gas and iron chloride are produced.

(2) Chlorine gas and iron hydroxide are produced.

(3) No reaction takes place.

(4) Iron salt and water are produced.

Sol. (1) Hydrogen gas and iron chloride are produced. The reaction is as follows:

$Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2 \uparrow$
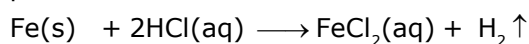
12. What is a balanced chemical equation? Why should chemical equations be balanced ?

Sol. A reaction which has an equal number of atoms of all the elements on both sides of the chemical equation is called a balanced chemical equation. The law of conservation of mass states that mass can neither be created nor destroyed. Hence, in a chemical reaction, the total mass of reactants should, be equal to the total mass of the products. It means that the total number of atoms of

each element should be equal on both sides of a chemical equation. Hence, it is for this reason that chemical equations should be balanced.

13. Translate the following statements into chemical equations and then balance them.

(a) Hydrogen gas combines with nitrogen to form ammonia.

(b) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.

(c) Barium chloride reacts with aluminium sulphate to give aluminium chloride and a precipitate of barium sulphate.

(d) Potassium metal reacts with water to give potassium hydroxide and hydrogen gas.

Sol. (a) $3H_2(g) + N_2(g) \longrightarrow 2NH_3(g)$

(b) $2H_2S(g) + 3O_2(g) \longrightarrow 2H_2O(\ell) + 2SO_2(g)$

(c) $3BaCl_2(aq) + Al_2(SO_4)_3(aq) \longrightarrow 2AlCl_3(aq) + 3BaSO_4(s)$

(d) $2K(s) + 2H_2O(\ell) \longrightarrow 2KOH(aq) + H_2(g)$

14. Balance the following chemical equations.

(a) $HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + H_2O$

(b) $NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$

(c) $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$

(d) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + HCl$

Sol. (a) $2HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + 2H_2O(g)$

(b) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

(c) $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$

(d) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$
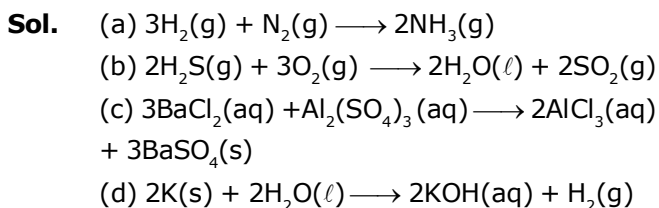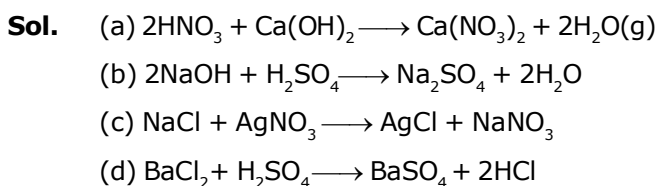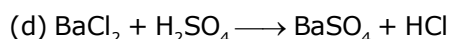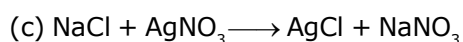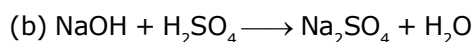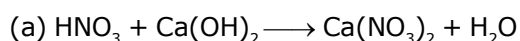
15. Write the balanced chemical equations for the following reactions.

(a) Calcium hydroxide + Carbon dioxide $\longrightarrow$ Calcium carbonate + Water

(b) Zinc + Silver nitrate $\longrightarrow$ Zinc nitrate + Silver

(c) Aluminium + Copper chloride $\longrightarrow$ Aluminium chloride + Copper

(d) Barium chloride + Potassium sulphate $\longrightarrow$ Barium sulphate + Potassium chloride

Sol. (a) $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

(b) $Zn + 2AgNO_3 \longrightarrow Zn(NO_3)_2 + 2Ag$

(c) $2Al + 3CuCl_2 \longrightarrow 2AlCl_3 + 3Cu$

(d) $BaCl_2 + K_2SO_4 \longrightarrow BaSO_4 + 2KCl$
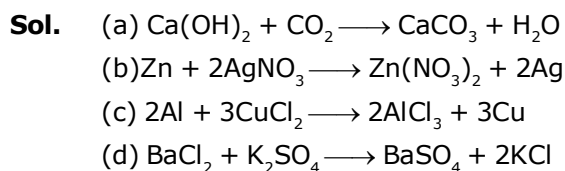
16. Write the balanced chemical equation for the following and identify the type of reaction in each case.

(a) Potassium bromide(aq) + Barium iodide(aq) $\longrightarrow$ Potassium iodide + Barium bromide

(b) Zinc carbonate(s) $\longrightarrow$ Zinc oxide(s) + Carbon dioxide(g)

(c) Hydrogen(g) + Chlorine(g) $\longrightarrow$ Hydrogen chloride(g)

(d) Magnesium(s) + Hydrochloric acid(aq) $\longrightarrow$ Magnesium chloride(aq) + Hydrogen(g)

Sol. (a) $2KBr(aq) + BaI_2(aq) \longrightarrow 2KI(aq) + BaBr_2(s)$; Double displacement reaction

(b) $ZnCO_3(s) \longrightarrow ZnO(s) + CO_2(g)$; Decomposition reaction

(c) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$; Combination reaction

(d) $Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$; Displacement reaction
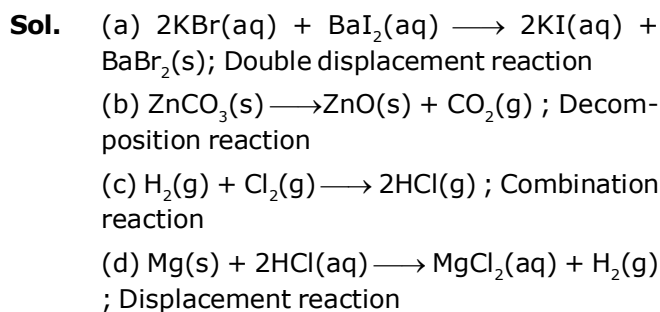
17. What does one mean by exothermic and endothermic reactions? Give examples.

Sol. Chemical reactions that release energy in the form of heat, light, or sound are called exothermic reaction.

Example: Mixture of sodium and chlorine to yield table salt

$Na(s) + \dfrac{1}{2}Cl_2(g) \longrightarrow NaCl(s) + 411$ kJ of energy
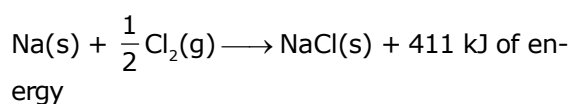
In other words, combination reactions are exothermic.

Reactions that absorb energy or require energy in order to proceed are called endothermic reactions. For example: In the process of photosynthesis, plants use the energy from the sun to convert carbon dioxide and water to glucose and oxygen.

$$6CO_2(g) + 6H_2O(\ell) \xrightarrow{\text{Sunlight}} C_6H_{12}O_6(aq) +$$

$$\text{Glucose}$$

$$6O_2(g)$$
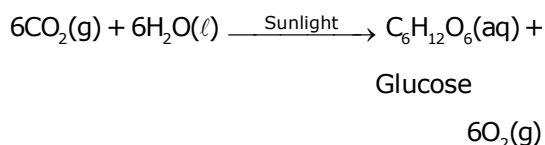
18. Why is respiration considerd as exothermic reaction ? Explain.

Sol. Energy is required to support life. Energy in our body is obtained from the food we eat. During digestion, large molecules of food are broken down into simpler substances such as glucose. Glucose combines with oxygen in the cells and provides energy. The special name of this combustion reaction is respiration. Since energy is released in the whole process, it is an exothermic process.

$$C_6H_{12}O_6(aq) + 6O_2(g) \longrightarrow 6CO_2(g)$$

$$+ 6H_2O(\ell) \qquad + \text{Energy}$$
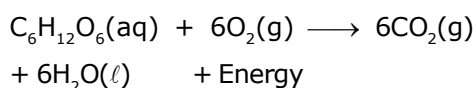
19. Why are decomposition reactions called the opposite of combination reactions? Write equations for these reactions.

Sol. Decomposition reactions are those in which a compound breaks down to form two or more substances. These reactions require a source of energy to proceed. Thus, they are the exact opposite of combination reactions in which two or more substances combine to give a new substance with the release of energy.

Decomposition reaction: AB + Energy $\longrightarrow$ A + B

$$2H_2O(\ell) \xrightarrow{\text{Electrolysis}} 2H_2(g) + O_2(g)$$
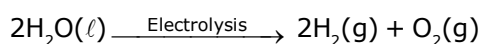
Combination reaction: A + B $\longrightarrow$ AB + Energy

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell) + \text{Energy}$$
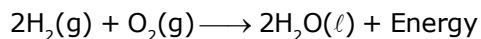
20. Write one equation each for decomposition reactions where energy is supplied in the form of heat, light or electricity.

Sol. (a)   Thermal decomposition:

$$2FeSO_4(s) \xrightarrow{\Delta} Fe_2O_3(g) + SO_2(g) + SO_3(g)$$
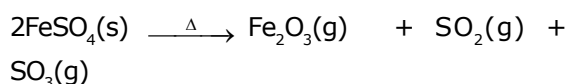
(b)   Decomposition by light:

$$2AgCl(s) \xrightarrow{\text{Light}} 2Ag(s) + Cl_2(s)$$
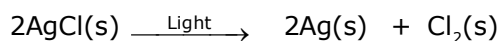
(c)   Decomposition by electricity:

$$2Al_2O_3(aq) \xrightarrow{\text{Electricity}} 4Al(s) + 3O_2(g)$$
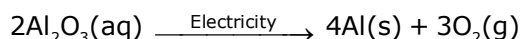
21. What is the difference between displacement and double displacement reactions? Write equations for these reactions.

Sol. In a displacement reaction, a more reactive element replaces a less reactive element from a compound.

A + BX $\longrightarrow$ AX + B; where A is more reactive than B

In a double displacement reaction, two atoms or a group of atoms shift places to form new compounds.

AB + CD $\longrightarrow$ AD + CB

For example:

Displacement reaction:

$$CuSO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + Cu(s)$$

Double displacement reaction:

$$Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$$
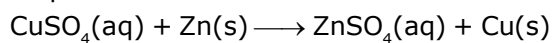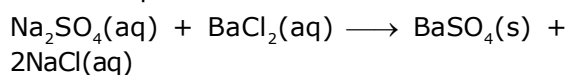
22. In the refining of silver, the recovery of silver from silver nitrate solution. involved displacement by copper metal. Write down the reaction involved.

Sol. $2AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

23. What do you mean by a precipitation reaction? Explain by giving examples.

Sol. A reaction in which an insoluble solid (called precipitate) is formed is called a precipitation reaction.

For example:

$Na_2CO_3(aq) + CaCl_2(aq) \longrightarrow CaCO_3(s) + 2NaCl(aq)$
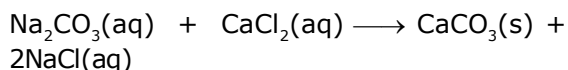
In this reaction, calcium carbonate is obtained as a precipitate. Hence, it is a precipitation reaction. Another example of precipitation reaction is:

$Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$
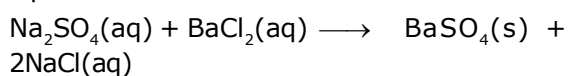
In this reaction, barium sulphate is obtained as a precipitate.

24. Explain the following in terms of gain or loss of oxygen with two examples each.

(a) Oxidation   (b) Reduction

Sol. (a) Oxidation is the gain of oxygen.

For example:

(i) $\underset{\text{Addition of oxygen-oxidation}}{\underline{CO_2 + H_2 \longrightarrow CO + H_2O}}$

(ii) $\underset{\text{Gain of oxygen - oxidation}}{\underline{2Cu + O_2 \longrightarrow 2CuO}}$
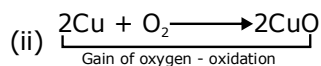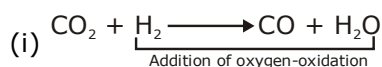
In equation (i), H_2 is oxidized to H_2O and in equation (ii), Cu is oxidised to CuO.

(b) Reduction is the loss of oxygen.

For example:

(i) $\underset{\text{Removal of oxygen - reduction}}{\underline{CO_2 + H_2 \longrightarrow CO + H_2O}}$

(ii) $\underset{\text{Loss of oxygen - reduction}}{\underline{CuO + H_2 \xrightarrow{\Delta} Cu + H_2O}}$
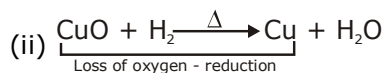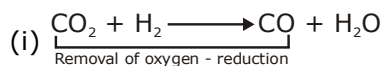
in equation (i), CO_2 is reduced to CO and in equation (ii), CuO is reduced ro Cu.

25. A shiny brown-cloured element 'X' on heating in air becomes black in colour. Name the element 'X' and the black coloured compound formed.

Sol. 'X' is copper (Cu) and the black-coloured compound formed is copper oxide (CuO). The equation of the reaction involved on heating copper is given below.

$2Cu + O_2 \xrightarrow{\text{Heat}} 2CuO$

(Shiny brown in colour)   (Black in colour)

26. Why do we apply paint on iron articles?

Sol. Iron articles are painted because it prevents them from rusting. When painted, the contact of iron articles from moisture and air is cut off. Hence, rusting is prevented. Their presence is essential for rusting to take place.

27. Oil and fat containing food items are flushed with nitrogen. Why?

Sol. Nitrogen is an inert gas and does not easily react with these substances. On the other hand, oxygen reacts with food substances and makes them rancid. Thus, bags used in packing food items are flushed with nitrogen gas to remove oxygen inside the pack. When oxygen is not present inside the pack, rancidity of oil and fat containing food items is avoided.

OTHER SOLVED EXAMPLE

1. What happens chemically when quick lime is added to water ?

Sol. Calcium hydroxide (or slaked lime) is formed accompanied by a hissing sound. So much heat is evolved during the reaction that the reaction mixture starts boiling. The chemical equation for the reaction is :

$CaO(s) + H_2O(aq) \longrightarrow Ca(OH)_2(s) + heat$

(Quick lime)   (Slaked lime)

2. What is an oxidation reaction ? Identify in the following reactions :

(i) the substance oxidised

(ii) the substance reduced.

$ZnO + C \longrightarrow Zn + CO$

Sol. Oxidation involves the addition of oxygen or the removal of hydrogen in a chemical reaction while reduction involves the addition of hydrogen or removal of oxygen.

In the given reaction :

(i) Carbon (C) is oxidised to carbon monoxide (CO).

(ii) Zinc oxide (ZnO) is reduced to zinc (Zn)

3. Which gas is evolved when dilute hydrochloric acid reacts with zinc ? Write the molecular formula of the gas.

Sol. Hydrogen gas is evolved. Its molecular formula is H_2.

4. State any two observation in an activity which may suggest that a chemical reaction has taken place. Give examples in support of your answer.

Sol. (i) In a tube take small amount of solid sodium carbonate (Na_2CO_3). To this add a few drops of hydrochloric acid.

(ii) A colourless and odourless gas will evolve which shows that a chemical reaction has taken place. The gas will turn lime water milky when passed through it.

5. Identify the type of reaction in the following examples :

(i) $Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$

(ii) $Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$

(iii) $2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell)$

Sol. (i) It is an example of double displacement reaction.

(ii) It is an example of displacement reaction.

(iii) It is an example of combination reaction.

6. Solid calcium oxide was taken in a container and water was added slowly to it

(i) State two observations made in the experiment.

(ii) Write the name of the chemical formula of the product.

Sol. (i) Water will start boiling and hissing noise will be produced.

(ii) Calcium hydroxide (slaked lime) will be formed.

$CaO(s) + H_2O(aq) \rightarrow Ca(OH)_2(s) + heat$

Calcium oxide   Calcium hydroxide

7. A house wife wanted her house to be white washed. She bought 10 kg of quick lime from the market and dissolved in 30 litres of water. On adding lime to water, she noticed that the water started boiling even when it was not being heated. Give reason for her observation. Write the corresponding equation and name the product formed.

Sol. A supension of slaked lime also called calcium hydroxide is formed when water is added to quick lime.

$$CaO(s) + H_2O(\ell) \longrightarrow Ca(OH)_2(s) + heat$$
$$\text{(Slaked lime)}$$
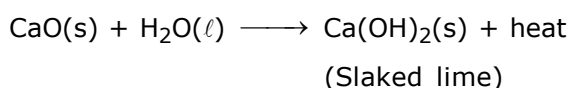
Since the reaction is highly exothermic, the solution started although it was not being heated. The suspension of slaked lime is allowed to cool for sometime, preferably overnight. It is then decanted and the liquid obtained is used for white washing.

EXERCISE – I

MULIPLE CHOICE QUESTIONS

1. Which of the following is/are exothermic processes

(i) Sublimation of NH_4Cl

(ii) Quick lime is added to water

(iii) Evaporation of water

(iv) Dilution of an acid

(A) (i) and (ii)   (B) (ii) and (iii)

(C) (iii) and (iv)   (D) (ii) and (iv)

2. $Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$, is a

(i) combination reaction

(ii) Displacement reaction

(iii) redox reaction

(iv) Double displacement reaction

(A) (i) and (ii)   (B) (ii) and (iii)

(C) (iii) and (iv)   (D) (ii) and (iv)

3. Silver Bromide, On exposure to sunlight turns grey due to

(A) Formation of silver by its decomposition

(B) Oxidation of silver Bromide

(C) Sublimation of silver Bromide

(D) Decomposition of bromine gas from silver bromide

4. Water on electrolysis decomposes to hydrogen and oxygen. the mole ratio of H_2 and O_2 is

(A) 1 : 2   (B) 1 : 1

(C) 2 : 1   (D) 4 : 1

5. 50 ml of water was taken in a beaker A, B and C. A small amount of $CuSO_4$, NaOH and NaCl were added to beaker A, B and C respectively. The temperature of beaker A and B increased where in beaker c decreases. The correct statement (s) is/are

(i) In beaker C exothermic process has occurred.

(ii) In beaker A and B exothermic process has occurred.

(iii) In beaker A and B endothermic process has occurred.

(iv) In beaker C endothermic process has occured.

(A) (i) and (ii)   (B) (ii) and (iii)

(C) (iii) and (iv)   (D) (ii) and (iv)

6. Which of the following is a double displacement reaction?

(A) $2H_2 + O_2 \longrightarrow 2H_2O$

(B) $FeSO_4 + Zn \longrightarrow ZnSO_4 + Fe$

(C) $CH_4 + 2O_2 \longrightarrow 2H_2O + CO_2$

(D) $Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2NaCl$

7. Which of the following is not a decomposition reaction?

(A) $CaCO_3 \longrightarrow CaO + CO_2$

(B) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(C) Digestion of food in the body

(D) $H_2 + Cl_2 \longrightarrow 2HCl$

8. Which of the following represent a double displacement reaction?

(A) $2H_2 + O_2 \longrightarrow 2H_2O$

(B) $2Mg + O_2 \longrightarrow 2MgO$

(C) $AgNO_3 + NaCl \longrightarrow AgCl \downarrow + NaNO_3$

(D) $H_2 + Cl_2 \longrightarrow 2HCl$

9. Which of the following is a displacement reaction?

(A) $CaCO_3 \longrightarrow CaO + CO_2$

(B) $CaO + 2HCl \longrightarrow CaCl_2 + H_2O$

(C) $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$

(D) $NaOH + HCl \longrightarrow NaCl + H_2O$

10. The reaction $H_2 + Cl_2 \longrightarrow 2HCl$ is a –

(A) Decomposition reaction

(B) Combination reaction

(C) Double displacement reaction

(D) Displacement reaction

11. Which of the following is a decomposition reaction?

(A) NaOH + HCl $\longrightarrow$ NaCl + H_2O

(B) $NH_4CNO \longrightarrow H_2NCONH_2$

(C) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(D) $H_2 + I_2 \longrightarrow 2HI$

12. Which of the following statement is incorrect?

(A) In oxidation, oxygen in added to a substance.

(B) In reduction, hydrogen is added to a substance.

(C) Oxidizing agent in oxidized.

(D) Reducing agent is oxidized.

13. Which of the following is a combustion reaction–

(A) Boiling of water

(B) Melting of wax

(C) Burning of petrol

(D) None of these

14. Which of the following is a redox reaction?

(A) $CaCO_3 \longrightarrow CaO + CO_2$

(B) $H_2 + Cl_2 \longrightarrow 2HCl$

(C) CaO + 2HCl $\longrightarrow CaCl_2 + H_2O$

(D) NaOH + HCl $\longrightarrow$ NaCl + H_2O

15. Which statement is correct about the following reaction?

$$ZnO + CO \longrightarrow Zn + CO_2$$

(A) ZnO is being oxidized

(B) CO is being reduced

(C) CO_2 is being oxidized

(D) ZnO is being reduced

16. The reaction C + $O_2 \longrightarrow CO_2$ + Heat is a –

(A) Combination reaction

(B) Oxidation reaction

(C) Exothermic reaction

(D) All of the above

17. Conversion of $CaCO_3$ in to CaO as per following reaction is an example of –

$$CaCO_3 \longrightarrow CaO + CO_2$$

(A) Decomposition reaction

(B) Reduction reaction

(C) Oxidation reaction

(D) None of these

18. Fe_2O_3 + 2Al $\longrightarrow Al_2O_3$ + 2Fe This reaction is an example of –

(A) Combination reaction

(B) Double displacement reaction

(C) Decomposition reaction

(D) Displacement reaction

19. In reaction $SO_2 + 2H_2S \longrightarrow 2H_2O$ + 3S the reducing agent is –

(A) SO_2 (B) H_2S

(C) H_2O (D) S

20. What happens when dil hydrochloric acid is added to iron fillings?

(A) Hydrogen gas and Iron chloride are produced.

(B) Chlorine gas and Iron hydroxide are produced.

(C) No reaction takes place

(D) Iron salt and water are produced.

21. When Iron nails are added to an aqueous solution of copper sulphate, a chemical change occurs, which of the following is not true about this reaction?

(A) Blue colour of the solution fades.

(B) Iron nails becomes brownish in colour.

(C) It is a displacement reaction.

(D) Iron nails dissolves completely.

22. When in a chemical reaction, a product is obtained as a precipitate, it is shown by the following sign :

(A) ↑   (B) ↓

(C) →   (D) ←

23. When dilute sulphuric acid is added in a conical flask containing zinc granules, then:
(A) SO_2 gas is evolved
(B) SO_3 gas is evolved
(C) H_2 gas is evolved
(D) Zinc sulphate and H_2 gas are produced

24. Food items after exposed to atmosphere become rancid due to the process of :
(A) oxidation   (B) reduction
(C) corrosion   (D) hydrogenation

25. What is not true in a balanced chemical equation?
(A) number of atoms of different elements on both sides are equal
(B) mass of both sides are equal
(C) number of charged ions on both sides are equal
(D) total of charges on both sides are equal

26. Which one of the following changes is not oxidation?
(A) combination   (B) decomposition
(C) corrosion   (D) rancidity

27. The reaction between aqueous solutions of sodium chloride and silver nitrate is
(A) Displacement reaction
(B) Synthesis reaction
(C) Double displacement reaction
(D) Analysis reaction

28. $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ reaction is an example of-
(A) Synthetic   (B) Analytical
(C) Displacement   (D) Neutralisation

29. A brown and bright element "x" when heated in presence of air turns into black substance "y". If Hydrogen gas is passed over this heating material again "x" is obtained. "x" and "y" are
(A) Cu & CuO   (B) S & SO_2
(C) C & CO_2 (D) Na & NaH

30. $H_2S(g) + Cl_2(g) \longrightarrow 2HCl(g) + S(s)$
The reaction is interpreted as :
(A) H_2S is getting oxidised and Cl_2 is getting reduced
(B) H_2S is getting reduced and Cl_2 is getting oxidised
(C) Only H_2S is oxidised
(D) Both H_2S and Cl_2 are reduced

31. What is the oxidation number of sulphur in peroxy mono sulphuric acid (H_2SO_5) ?

(A) 8   (B) 6
(C) 5   (D) 4

32. Oxidation is defined as :
(A) loss of electron
(B) gain of electron
(C) loss of proton
(D) gain of proton

33. From the following metals whose nitrate produces NO_2 gas on heating
(A) Na   (B) K
(C) Pb   (D) None of these

34. The equation given below indicates NaCl + $AgNO_3 \rightarrow AgCl + NaNO_3$:
(A) Chemical decomposition
(B) Chemical combination
(C) Chemical displacement
(D) Chemical double displacement

35. From the given reactions which is a redox reaction ?
(A) $CuO(s) + H_2O(g) \rightarrow Cu(s) + H_2O(\ell)$
(B) $2Cu(s) + O_2(g) \rightarrow 2CuO(s)$
(C) $C(s) + 2H_2(g) \rightarrow CH_4(g)$
(D) All of the above

36. Displacement reaction is :

    (A) $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2$ (aq)

    (B) $Pb(s) + CuCl_2(aq) \rightarrow PbCl_2(aq) + Cu(s)$

    (C) $MnO_2(s) + 4HCl(l) \rightarrow MnCl_2(s) + 2H_2O(l) + Cl_2(g)$

    (D) $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

37. What is the instrument called for water electrolysis process ?

    (A) Voltameter   (B) Voltmeter

    (C) Hydrometer   (D) Lactometer

38. Which of the following is endothermic reaction ?

    (A) $C(s) + O_2(g) \rightarrow CO_2(g)$

    (B) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

    (C) $2H_2(g) + O2(g) \rightarrow 2H_2O(l)$

    (D) $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$

39. What is the color of the solution of copper sulphate?

    (A) Green   (B) Light green

    (C) Blue   (D) Pink

40. Which type of reaction takes place when an iron nail is dipped in a solution of copper sulphate?

    (A) Combination

    (B) Displacement

    (C) Double displacement

    (D) Decomposition

41. $BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

    The types of reaction are :

    (A) Displacement   (B) Precipitation

    (C) Combination

    (D) Double displacement

    (A) (a) & (c)   (B) (a), (b), & (c)

    (C) (b) & (c)   (D) (b) & (d)

42. The chemical reaction $HNO_3 + KOH \rightarrow KNO_3 + H_2O$ is an example of -

    (A) neutralization

    (B) double displacement

    (C) neutralization and double displacement

    (D) combination

43. Which one is a double displacement reaction?

    (A) $BaCl_2 + Na_2SO_4 \longrightarrow BaSO_4 + 2NaCl$
    (B) $CaO + H_2O \longrightarrow Ca(OH)_2$
    (C) $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$
    (D) $Zn + 2AgNO_3 \longrightarrow Zn(NO_3)_2 + 2Ag$

44. The heating of ferrous sulphate is an example of _____ reaction and the reaction between iron and copper sulphate is an example of _____ reaction.

    (A) displacement, decomposition

    (B) decomposition, displacement

    (C) combination, displacement

    (D) combination, decomposition

45. A black mass is obtained on strongly heating a mixture of iron fillings and sulphur powder. When this black mass was treated with dilute sulphuric acid a gas with smell of rotten eggs is liberated. The gas is -

    (A) SO_3

    (B) SO_2

    (C) a mixture of SO_2 and SO_3

    (D) H_2S

46. Following is the reactivity series in decreasing order of their reactivity -

    Magnesium > Zinc > Iron > Lead > Copper > Silver > Gold

    Which one of the following metals can displace copper from copper sulphate solution?

    (A) Zn   (B) Ag

    (C) Au   (D) None

ASSERTION-REASON

In the following questions , a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(A) If both assertion and reason are true and reason is the correct explanation of assertion.

(B) If both assertion and reason are true but reason is not a correct explanation of assertion.

(C) If assertion is true and reason is false.

(D) If both assertion and reason are false.

1. **Assertion :** $CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}$. It is a redox reaction.
Reason : In a redox reaction, reductant is reduced by accepting electrons and oxidant is oxidised by losing electrons.

2. **Assertion :** When a zinc rod is dipped in a solution of copper sulphate, zinc rod dissolves partially and its surface is coated with copper metal.
Reason : This reaction is due to the presence of sulphate ions.

3. **Assertion :** $2H_2S_{(g)} + O_{2(g)} \rightarrow 2S_{(s)} + 2H_2O_{(l)}$. It is a redox reaction.
Reason : Oxidation involves removal of hydrogen while reduction involves addition of hydrogen.

4. **Assertion :** SO_2 and Cl_2 both are bleaching agents.
Reason : Both are reducing agents.

5. **Assertion :** Corrosion of iron is commonly known as rusting.
Reason : Corrosion of iron occurs in presence of water and air.

TRUE-FALSE

1. Rusting of iron is physical change.

2. Unbalanced chemical equation is against the law of conservation of mass.

3. When water containing dil. H_2SO_4 is electrolysed, H_2 gas is obtained at positive electrode (anode).

4. Oxidizing agent gets oxidized in a chemical reaction.

5. The reaction of zinc with copper chloride gases are mixed, then the chemical change occuring is type of decomposition reaction.

6. The form: $X + YX \longrightarrow XZ + Y$ is combination reaction.

7. When oxygen is added to copper, then it gets oxidized to cupric oxide.

VERY SHORT ANSWER QUESTIONS

1. Why does not a wall immediately acquire a white colour when a coating of slaked lime is applied on it?

2. What is rust?

3. What is the difference b/w the following 2 reactions?
(a) $Mg + 2HCl \longrightarrow MgCl_2 + H_2$
(b) $NaOH + HCl \longrightarrow NaCl + H_2O$

4. Which chemical process is used for obtaining a metal from its oxide?

5. What is the role of oxidising agent in a reaction?

6. What is meant by a skeletal chemical equation?

7. On what basis is a chemical equation balanced?

8. Balance following chemical equation:-
$Pb(NO_3)_2(s) \xrightarrow{\text{Heat}} PbO(s) + NO_2(g) + O_2(g)$

9. Write a balanced chemical equation to represent the following equation:- Iron reacts with steam to form Iron (II, III) oxide and Hydrogen gas.

10. Balance the following chemical equation.
(i) $FeCl_2 + H_2S \longrightarrow HCl + FeS$
(ii) $HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + H_2O$

11. What happens chemically when Quick lime is added to water?

12. Give one example of each exothermic reaction and endothermic reaction?

13. In the reaction $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$. Identify which one is reduced and which one is oxidized?

14. Complete the equation:-

$Fe_2O_3 + 2Al \longrightarrow$

15. Take a small amount of calcium oxide or quick lime in a beaker and slowly add water to this. Is there any change in temperature?

SHORT ANSWER TYPE QUESTIONS

1. Write balance chemical equation "during respiration combustion of glucose takes place producing carbon dioxide water and energy".

2. A zinc rod is left for nearly 20 minutes in a copper sulphate solution. What change would you observe in zinc rod?

3. Name a reducing agent that can be used to obtain manganese from manganese dioxide. Write balanced chemical equation for the reaction?

4. Give reason, silver articles become black after sometime when exposed to air?

5. What is the role of catalyst in a chemical reaction?

6. Name 2 salts which are used in black and white photography?

7. State the essential requirement for rusting?

8. Identify the type of reaction

(i) $CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$

(ii) $BaCl_2 + ZnSO_4 \longrightarrow BaSO_4 + ZnCl_2$

(iii) $NH_4Cl \xrightarrow{\text{Heat}} NH_3 + HCl$

(iv) $HgCl_2 + SnCl_2 \longrightarrow HgCl_2 + SnCl_4$

(v) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(vi) $2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2Fe$

9. Balance the following equation

(i) $H_2SO_4 + NaOH \longrightarrow Na_2SO_4 + H_2O$

(ii) $KCN + H_2SO_4 \longrightarrow K_2SO_4 + HCN$

(iii) $HgCl_2 + SnCl_2 \longrightarrow Hg_2Cl_2 + SnCl_4$

(iv) $Al_2O_3 + H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_2O$

(v) $Al_2(SO_4)_3 + NaOH \longrightarrow Al(OH)_3 + Na_2SO_4$

10. Identify the type of reaction

(i) $2H_2O \xrightarrow{\text{Electrolysis}} 2H_2 + O_2$

(ii) $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$

(iii) $AgNO_3 + Nacl \longrightarrow NaNO_3 + Agcl$

(iv) $Zn + 2AgNO_3 \longrightarrow Zn(NO_3)_2 + 2Ag$

(v) $Ni(NO_3)_2 + 2NaOH \longrightarrow Ni(OH)_2\uparrow + 2NaNO_3$

(vi) $MgO(s) + C(s) \longrightarrow CO(g) + Mg(s)$

LONG ANSWER TYPE QUESTIONS

1. When a water insoluble substance "X" is added to dil. Hydrochloric acid, a colourless, odourless gas is evolved. When the gas is passed through lime water, it turns milky. Write the formula of gas evolved and balanced chemical equation of the reaction.

2. **(a)** Write one equation each for decomposition reaction when energy is supplied in the form of (i) Heat (ii) Light.

(b) Account for following:-

(i) Paint is applied on Iron articles.

(ii) Oil and fat containing food items are flushed with nitrogen.

3. A green coloured hydrated salt of Iron loses its water of crystallisation and smell of burning sulphur is given. Identify the salt and write chemical equation.

4. (a) Why cannot a chemical change be normally reversed?

(b) Why is it always essential to balance a chemical equation?

(c) Why do diamond and graphite, 2 forms of carbon evolve different amounts of heat on combustion?

(d) Why does milkiness disappear when CO_2 is passed through lime water in excess?

(e) Can rusting of Iron take place in distilled water?

6. $X + YSO_4 \longrightarrow XSO_4 + Y$

$Y + XSO_4 \longrightarrow$ No reaction

and of the 2 elements "X" and "Y" which is more reactive and why?

7. (a) Can a combination reaction be an oxidation reaction?

(b) How will you test whether the gas evolved in a reaction is hydrogen?

(c) Why does copper not evolve hydrogen on reacting with dilute sulphuric acid?

8. A brown substance "X" on heating in air forms a substance "Y". When hydrogen gas is passed over heated "Y". It again changes back into "X". (i) Name the substance X and Y.

(ii) Name the chemical processes occuring during both changes.

(iii) Write chemical equations?

9. Explain why:-

(i) Respiration is an Exothermic reaction.

(ii) When blue salt of $CuSO_4$ is heated it becomes colourless?

10. In electrolysis of water

(i) Name the gas collected at the cathode and anode respectively.

(ii) Why is the volume of one gas collected at one electrode double that at the other? Name this gas?

(iii) How will you test the evolved gases?

ACTIVITY BASED QUESTIONS

1. The marble statues slowly get corroded when kept in open for a long time. Give suitable explanation?

2. **(a)** Based on reactions given below, arrange the metals invloved in these reactions in decreasing order of reactivity. Give suitable explanation.

(i) $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$

(ii) $Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$

(iii) $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$

(iv) $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$
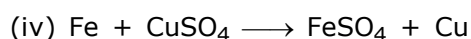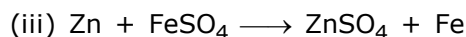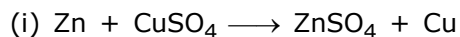
(b) What is the nature of reactions?

3. A, B and C are 3 elements which undergo chemical reactions according to following equations:-

$$A_2O_3 + 2B \longrightarrow B_2O_3 + 2A$$

$$3CSO_4 + 2B \longrightarrow B_2(SO_4)_3 + 3C$$

$$3CO + 2A \longrightarrow A_2O_3 + 3C$$
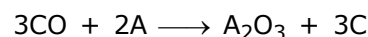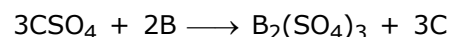
Answer the following Questions

(a) Which element is more reactive?

(b) Which element is least reactive?

4. You are given following materials:-

(i) Marble chips (ii) Dil. HCl acid (iii) zinc granules

Identify type of reaction when marble chips and zinc granules are added separately to acid taken in two tubes. Write chemical equation in each case.

5. 2gm of $FeSO_4$ Crystals were heated in a hard glass test tube and observations recorded.

(a) What was the successive colour change?

(b) Identify liquid droplets collected on cooler part of test tube.

(c) What type of odour is observed on heating $FeSO_4$ Crystals?

EXERCISE – II

MULIPLE CHOICE QUESTIONS

1. When water is added in a vessel containing lumps of quick lime, it is observed that

   (A) the vessel becomes hot

   (B) a hissing sound is produced

   (C) lump of quick lime breaks and dissolves partially in water

   (D) All the above.

2. The colour changes observed when the ferrous sulphate crystals are heated in a dry boiling tube is

   (A) green $\longrightarrow$ orange $\longrightarrow$ brown

   (B) green $\longrightarrow$ white $\longrightarrow$ brown

   (C) blue $\longrightarrow$ green $\longrightarrow$ white

   (D) green $\longrightarrow$ brown $\longrightarrow$ black

3. A student heated small amount of ferrous sulphate in a test tube. She made the following observations:

   (i) Ferrous sulphate colour changes to brown

   (ii) A gas having a smell of burning sulphur is evolved

   (iii) Water droplets collect on the upper side of the test tube

   (iv) Brown coloured gas is evolved.

   The correct set of observation is

   (A) (i), (ii), (iv)

   (B) (i), (ii), (iii)

   (C) (i), (iii), (iv)

   (D) (ii), (iii), (iv)

4. Four groups of the students were assigned separately the experiment of interaction of iron nail with a solution of copper sulphate. Each group recorded the observations as given below in the table. Which group of students recorded all the observations correctly?

Group of Change Students	Initial colour of solution	Final colour of solution	Change in the iron nail
(A)	Blue	Colourless	Grey coat
(B)	Green	Green	Brown coat
(C)	Blue	Blue	Brown coat
(D)	Blue	Light green	Brown coat

5. Four students were asked to study the reaction between aqueous solutions of barium chloride and sodium sulphate. They reported that their experiment as follows. On mixing the solutions of the two salts in a test tube
   (i) the colour of the mixture becomes brown
   (ii) the solutions form separate layer
   (iii) a colourless mixture is obtained
   (iv) a white substance settles at the bottom.
   The correct report is
   (A) (i)   (B) (ii)
   (C) (iii)   (D) (iv)

6. Which of the following pairs of reactions is not opposite to each other.
   (A) Combination - decomposition
   (B) Displacement - Double displacement
   (C) Reduction - Oxidation
   (D) Endothermic - Exothermic

7. Which of the following is not correct about the balanced chemical equation ?
   (A) Short hand representation of a chemical reaction
   (B) How much amount of reactants required to produce the given amount of products.
   (C) How much amount of product will be obtained from given reactants.
   (D) Rate of reactions can be known by chemical equation

8. In which of the following, heat energy is not released ?

(A) $C + O_2 \longrightarrow CO_2$

(B) $CaO + H_2O \longrightarrow Ca(OH)_2$

(C) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

(D) $NH_4OH \longrightarrow NH_3 + H_2O$

9. Chemical equation for the combustion of methanol is as follows :
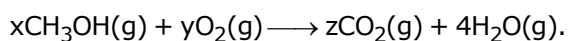
$xCH_3OH(g) + yO_2(g) \longrightarrow zCO_2(g) + 4H_2O(g)$. What is the value of 'x, y and z" in the equation, respectively ?

(A) 1, 2 and 3   (B) 1, 2 and 4

(C) 2, 3 and 4   (D) 2, 3 and 2

10. Magnesium ribbon is rubbed with sand paper before making it to burn. The reason of rubbing the ribbon is to

(A) remove moisture condensed over the surface of ribbon.

(B) generate heat due to exothermic reaction.

(C) remove magnesium oxide formed over the surface of magnesium.

(D) Mix silicon from sand paper (silicon dioxide) with magnesium for lowering ignition temperature of the ribbon.

11. Match the following :

Column I		Column II
(a)	Neutralisation	(i)	$2Mg+O_2 \rightarrow 2MgO$
(b)	Precipitation	(ii)	$H_2SO_4+NaOH \rightarrow Na_2SO_4+H_2O$
(c)	Gas-formation	(iii)	$ZnS+2HCl \rightarrow ZnCl_2+H_2S\uparrow$
(d)	Oxidation	(iv)	$PbNO_3+Na_2SO_4 \rightarrow PbSO_4+2NaNO_3$.

(A) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

(B) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

(C) (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

(D) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

12.

Column I		Column II
(a)	Neutralisation	(i)	$CuO + H_2 \xrightarrow{heat} Cu + H_2O$
(b)	Decomposition	(ii)	$Na_2SO_4(aq) + BaCl_2$ $\rightarrow BaSO_4(aq) + 2NaCl(aq)$
(c)	Precipitation	(iii)	$CaCO_3 \xrightarrow{heat} CaO + CO_2$
(d)	Redox	(iv)	$NaOH + HCl \rightarrow NaCl + H_2O$

(A) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

(B) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

(C) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

(D) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

13. Which of the following reactions takes place in respiration?

(A) $CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$

(B) $6CO_2(aq) + 6H_2O(l) \xrightarrow{\text{sun light}}$ $C_6H_{12}O_6(aq) + 6O_2(aq)$

(C) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6H_2O + 6CO_2 + E$

(D) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + H_2O(l)$
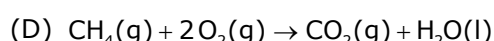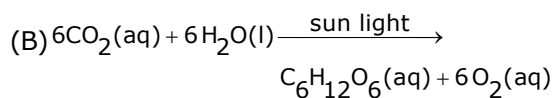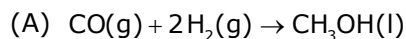
14. Find the incorrect match

(A) Decomposition of vegetable matter   – Exothermic reaction

(B) Respiration   – Exothermic reaction

(C) Decomposition of calcium carbonate   – Exothermic reaction

(D) Burning of natural gas   – Exothermic reaction

15. Identify the balance equation.

(A) $C_6H_{12}O_6 + 3O_2 + 4H_2O \rightarrow$ $5CO_2 + H_2O + energy$

(B) $C_6H_{12}O_6 + 6O_2 + 6H_2O \rightarrow$ $12CO_2 + 6H_2O + energy$

(C) $C_6H_{12}O_6 + 6O_2 + 6H_2O \rightarrow$ $5CO_2 + 6H_2O + energy$

(D) $C_6H_{12}O_6 + 6O_2 + 6H_2O \rightarrow$ $6CO_2 + 12H_2O + energy$
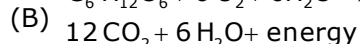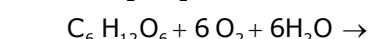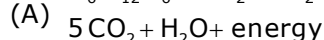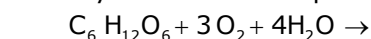
16. Which of the following is a balanced chemical equation?

(A) $Al + 2H^+ \rightarrow Al^{3+} + H_2$

(B) $Al + 6H^+ \rightarrow 2Al^{3+} + H_2$

(C) $2Al + 6H^+ \rightarrow 2Al^{3+} + 3H_2$

(D) $Al + 3H^+ \rightarrow Al^{3+} + H_2$
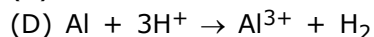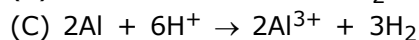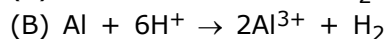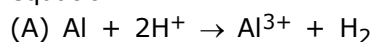
17. Identify which among the following is/are mismatched regarding the product formed during corrosion of the metal surface and choose the correct option.

(i) Fe – $Fe_2O_3.xH_2O$

(ii) Cu – CuO

(iii) Ag – Ag_2S

(A) Only (i)   (B) Only (ii)

(C) Only (iii)   (D) Both (ii) and (iii)
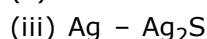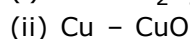
18. The change in the oxidation state of iron in the given redox reaction is
$FeO + CO \rightarrow Fe + CO_2$
(A) 0 to +3   (B) +3 to 0
(C) +2 to 0   (D) 0 to +2

19. The colour of the precipitate obtained during the reaction of potassium iodide and lead nitrate is
(A) White   (B) Blue
(C) Yellow   (D) Grey

20. A small amount of calcium oxide (quick lime) is taken in a beaker. Water is slowly added to this.
Which of the following observations is/are incorrect about the activity?
(i) The beaker becomes hot because it is an endothermic reaction.
(ii) A clear solution is obtained at the top after the reaction gets over.
(iii) This reaction is a combination reaction in which quick lime (CaO) is converted into slaked lime, $Ca(OH)_2$
(A) (i), (ii) and (iii)
(B) (ii) and (iii) only
(C) (i) Only
(D) (i) and (iii) only

21. Observe the given reaction carefully and identify (i), (ii), (iii) and (iv).**[NSO-2016]**
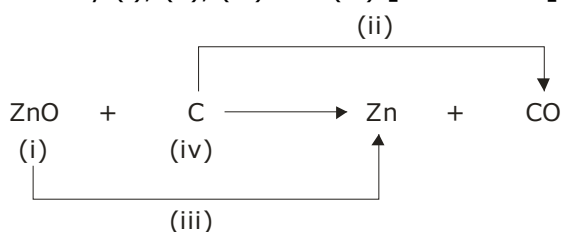
	(i)	(ii)	(iii)	(iv)
(A)	Undergoes oxidation	Oxidation	Reduction	Undergoes reduction
(B)	Reducing agent	Reduction	Oxidation	Oxidising agent
(C)	Oxidising agent	Oxidation	Reduction	Reducing agent
(D)	Undergoes reduction	Reduction	Oxidation	Undergoes oxidising

22. Select the incorrect match(es).
(i) Burning of magnesium ribbon-Combination reaction.
(ii) Action of carbon dioxide on quick lime-combination reaction.
(iii) Exposure of silver bromide to light-Decomposition reaction
(iv) Addition of zinc to dilute sulphuric acid - Double displacement reaction.
(V) Addition of an acid to a base to form a salt single displacement reaction.
(A) (i) and (iii) only
(B) (ii), (iii) and (v) only
(C) (v) Only
(D) (iv) and (v) only

23. A student wrote three statements about rancidity:
(i) When fats and oils are reduced, they become rancid.
(ii) Chips manufactures usually flush chips bags with oxygen to prevent rancidity.
(iii) Rancidity is prevented by adding substances called antioxidants to food.
Choose the correct statement(s)
(A) (i) only
(B) (ii) and (iii) only
(C) (iii) Only
(D) (i), (ii) and (iii)

24. x, y and z in the given reaction are respectively
$$xKClO_{3(s)} \xrightarrow[MnO_2]{heat} yKCl_{(s)} + zO_{2(g)}$$
(A) 2, 3 and 3
(B) 3, 3 and 1
(C) 2, 2 and 3
(D) 1, 3 and 2
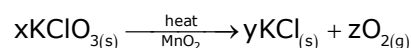
25. 5 mL of sodium sulphate solution is taken in a test tube and 5 mL of barium chloride solution is taken in another test tube. When the two solutions are mixed slowly and the test tube is left undisturbed for some time, a white precipitate is formed. **[NSTSE-2016]** Which of the following statements is correct about the above reaction?

(A) It is a double displacement reaction since exchange of ions occurs between the two reactants.

(B) It is combination reaction since barium ions combine with sulphate ions to give barium sulphate.

(C) It is a displacement reaction since chloride ions are replaced by sulphate ions.

(D) It is a neutralisation reaction since an acid reacts with alkali to give a salt.

26. Which of the following reactions are exothermic in nature?

(i) Evaporation of water

(ii) Dissolution of sodium hydroxide in water

(iii) Dilution of sulphuric acid

(iv) Dissolution of ammonium chloride in water

(v) Combustion of methane gas

(A) (i), (iv) and (v) only

(B) (ii), (iii) and (v) only

(C) (i), (ii) and (iv) only

(D) (i), (iii) and (iv) only

27. Observe the given figure carefully. Which of the following observation(s) is/are correct?
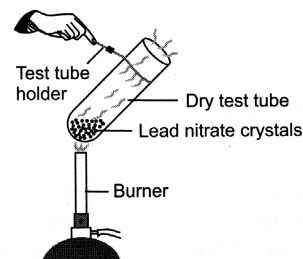
(i) A double decomposition reaction takes place.

(ii) Brown fumes of NO_2 are evolved.

(iii) Red residue is left behind in the test tube.

(A) (i) and (iii) only   (B) (ii) and (iii) only

(C) (i) and (ii) only   (D) (ii) only

EXERCISE – III

MULIPLE CHOICE QUESTIONS

1. A metal 'M' produces white ash of 'N' and dazzling white light on burning in the presence of oxygen gas. The metal 'M' and ash 'N' would be **[NSEJS-2017]**

   (A) magnesium oxide, manganese respectively

   (B) manganese dioxide, magnesium respectively

   (C) magnesium, magnesium oxide respectively

   (D) magnesium carbonate, magnesium respectively

2. Chemical equation for the formation of hydrogen sulphide gas is

   $ZnS + xHCl \longrightarrow ZnCl_2 + yH_2S\uparrow$.
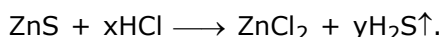
   What is the value of "x and y" in the equation, respectively ?

   (A) 2 and 1   (B) 1 and 2

   (C) 2 and 2   (D) 3 and 1

3. Which of the following is not an exothermic reaction?

   (A) $CaCO_3 \longrightarrow CaO + CO_2$

   (B) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

   (C) $HCl + NaOH \longrightarrow NaCl + H_2O$

   (D) $N_2 + 3H_2 \longrightarrow 2NH_3$

4. The reaction that releases energy is

   (A) $2FeSO_4(s) \xrightarrow{\Delta} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

   (B) $3Pb(NO_3)_2(s) \xrightarrow{\Delta} 2PbO(s) + 4NO_2(g) + O_2(g)$

   (C) $2AgBr(s) \xrightarrow{Sunlight} 2Ag(s) + Br_2(g)$

   (D) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$

5. Column II gives type of reaction mention in column I, match them correctly.

Column-I	Column-II
(A) $C + O_2 \longrightarrow CO_2$	(1) Displacement
(B) $AgBr \xrightarrow{light} Ag + Br$	(2) Combination
(C) $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$	(3) Decomposition
(D) $CH_3CH_2OH \xrightarrow{Cu} CH_3CHO + H_2$	(4) Oxidation

   (A) A-2, B-3, C-1, D-4

   (B) A-1, B-3, C-2, D-4

   (C) A-3, B-4, C-2, D-1

   (D) A-2, B-4, C-3, D-1

6. A green coloured crystalline solid 'X' when heated first becomes colourless and then on further heating, it becomes brown. During this process two gases with the smell of burning sulphur are also evolved. The brown coloured compound is

   (A) $FeSO_4$

   B) FeO

   (C) $Fe_2(SO_4)_3$

   (D) Fe_2O_3

7. Match the following:

Coloumn-I		Coloumn-I	
(a)	$A \longrightarrow A^+ + e^-$	(i)	Exothermic reaction
(b)	$A + e^- \longrightarrow A^-$	(ii)	Exothermic reaction
(c)	$A + B \rightarrow C + Energy$	(iii)	Oxidation reaction
(d)	$A + B \rightarrow C - Energy$	(iv)	Reduction reaction

   (A) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

   (B) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

   (C) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

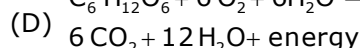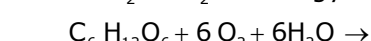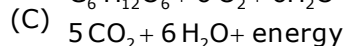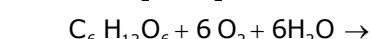   (D) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

8. Corrosion and rancidity are due to and respectively.

(A) oxidation; oxidation

(B) oxidation; reduction

(C) reduction; oxidation

(D) reduction; reduction

9. A small amount of a light green coloured compound X is heated in a test tube. In the beginning, it loses some water and then gas(es) Z with suffocating smell come(s) out. The vapours of gas(es) are collected and dissolved in water The solution turn blue litmus red. The residue Y left in the test tube turns reddish brown. X, Y and Z could be respectively.

(A) $PbSO_4$, Pb_2O_3 and SO_3

(B) $FeSO_4, \cdot 7H_2O$, Fe_2O_3 and SO_2, SO_3

(C) $Na_2SO_4 \cdot 10H_2O$, Na_2SO_4 and SO_2

(D) $Pb(NO_3)_2$, PbO_2 and NO_2, N_2O_4

10. Metal X is found in earth's crust. This metal forms a reddish brown substance when exposed to moist air. When a blue coloured solution Y is stored in a container made of X, the solution turns green and a reddish brown metal Z gets deposited on the container.

X, Y and Z are respectively

(A) Cu, $CuSO_4$, Fe

(B) Zn, $ZnSO_4$, Fe

(C) Fe, $CuSO_4$, Cu

(D) Cu, $FeSO_4$, Fe

11. Two colourless solutions X and Y were mixed together. On mixing, a yellow precipitate Z was fomed. Which of the following statements is correct regarding X, Y and Z ?

(A) X and Y were lead nitrate and potassium iodide solutions respectively. The yellow precipitate Z was lead iodide.

(B) X and Y were potassium chloride solution and water respectively. The yellow precipitate Z was of chloride ions.

(C) X and Y were sodium hydroxide solution and hydrochloric acid respectively and the yellow precipitate Z was sodium chloride.

(D) Z and Y were potassium hydroxide solution and nitric acid respectively and the yellow precipitate Z was potassium nitrate.

12. Four test tubes were taken and marked 1, 2, 3 and 4 respectively. 2 mL of aqueous solution of aluminium sulphate, $Al_2(SO_4)_2$ was filled in each test tube. A peice of metal zinc was placed in test tube 1, iron in test tube 2, copper in test tube 3 and aluminium in test tube 4. Mark the correct change in colour in the four test tube.

	1	2	3	4
(A)	Colour-less	Green	Blue	Colour-less
(B)	Light green	Green	Blue	Pale yellow
(C)	Light blue	Colour-less	Colour-less	Light blue
(D)	Colour-less	Colour-less	Colour-less	Colour-less

13. Marble chips or calcium carbonate react with hydrochloric acid as:

$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
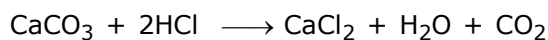
The reaction is carried out twice and following graphs were obtained: **[NSEJS-2018]**
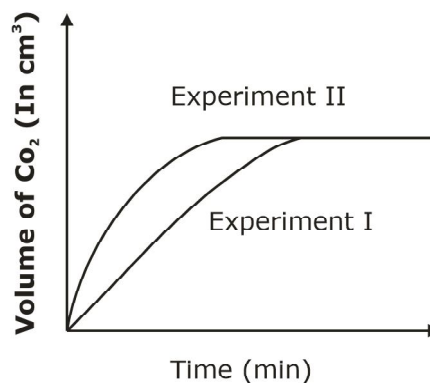
Which of the following statements is incorrect?

(A) Reaction is faster in experiment II.

(B) Marble chips taken in experiment II are smaller in size than marble chips taken in experiment I.

(C) Same amount of marble chips and hydrochloric acid is used for both the experiments.

(D) None of these.

14. Four students P, Q, R and S noted the initial colour of the solutions kept in beakers I, II, III and IV. After inserting zinc rods in each solution and leaving them undistrubed for two hours, the colour of each solution was again noted in the form of table given below:
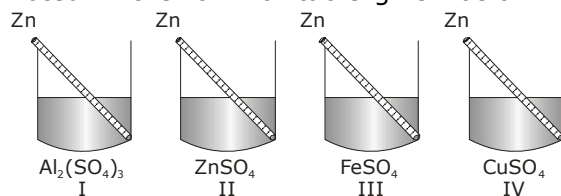
Student	Colour of the solution	I	II	III	IV
P	Initial	Colour less	Colour less	Light Green	Blue
	Final	Colour less	Colour less	Colour less	Colour less
Q	Initial	Colour less	Light Yellow	Light Green	Blue
	Final	Colour less	Colour less	Light Green	Colour less
R	Initial	Colour less	Colour less	Light Green	Blue
	Final	Light Blue	Colour less	Colour less	Light Blue
S	Initial	Light Green	Colour less	Light Green	Blue
	Final	Colour less	Colour less	Dark green	Colour less

Which student noted the colour change in all the four beakers correctly?

(A) P　　　　　　(B) Q

(C) R　　　　　　(D) S

15. Rupali, a class 10 student has set up the apparatus as shown in the figures.
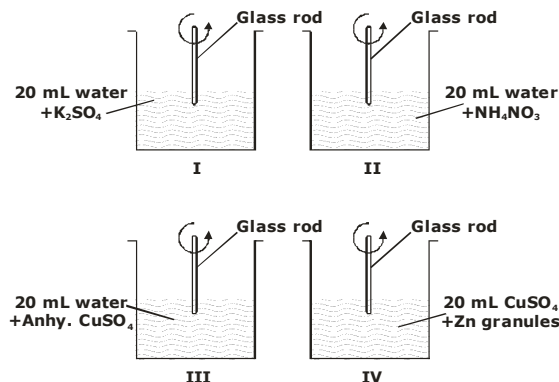
Which of the following observation is correct?

(A) Temperature of beakers I, II and III will be raised as dissolution of salts is an exothermic process.

(B) Temperature of beakers III and IV will be raised while temperature of beakers I and II will fall.

(C) Temperature will rise only in beaker IV as redox reactions are exothermic.

(D) None of these.

16. Identify the following type of reaction

$$2KClO_3 \xrightarrow[\text{catalyst}]{\text{heat}} 2KCl_{(s)} + 3O_{2(g)}$$

(A) It is combination reaction

(B) It is a decomposition reaction and is accompanied by release of heat.

(C) It is Photo Chemical decomposition reaction by release of heat

(D) It is a decomposition reaction and is endothermic in nature.

17. Which information is not conveyed by a balance chemical equation ?

(A) Physical quantity of reactants and products.

(B) Symbols and formula of all the substances involved in a particular reaction

(C) No of atoms/molecules of the reactants and products formed.

(D) Whether a particular reaction is actually feasible or not.

18. When the reaction

$$Pb(NO_3)_2 \rightarrow 2PbO + NO_2 + O_2$$
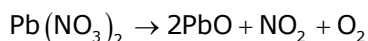
is balanced the coefficients of the reactants and products in the balanced reaction will be

(A) 4, 2, 1, 2   (B) 2, 2, 4, 1

(C) 2, 4, 1, 2   (D) 4, 2, 2, 2, 1

19. Match List - I(Position of the metal in the activity series) with the list-II(Related redcution process) and select the correct option using the codes given below:

List I (Positon of the Metal in the Activity Series)		List II (Related Redcution Process)	
(a)	The bottom of the series	(i)	Electrolysis
(b)	The top of the series	(ii)	Reduction by heat alone
(c)	The lower regions of the series	(iii)	Found in native state
(d)	The middle of the serise	(iv)	Reducion using carbon or some other reducing agent

(A) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

(B) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

(C) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

(D) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

20. Potassium permanganate reacts with concentrated hydrochloric acid based on the equation given below: **[NTSE Stage 2-2017]**

$$aKMnO_4 + bHCl \rightarrow cKCl + dMnCl_2 + eH_2O + fCl_2$$
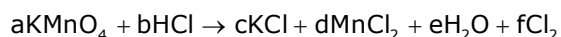
The value of 'f' when the above chemical equation is balanced is:

(A) 3   (B) 4

(C) 5   (D) 6

21. Match chemical reactions given in the List-I with the type of chemical reactions given in List-II and select the correct answer using the options given below:

List I (Chemical reactions)		List II (Types of chemical reactions)	
(a)	Formation of NH_3 form N_2 and H_2	(i)	Decomposition
(b)	Calcination of zinc carbonate	(ii)	Double displacement
(c)	Reaction of aqueous $BaCl_2$ solution with dilute H_2SO_4	(iii)	Combination
(d)	Rancidity of oils	(iv)	Redox
		(v)	Displacement

(A) (a)-(i), (b)-(v), (c)-(iii), (d)-(iv)

(B) (a)-(iii), (b)-(iv), (c)-(v), (d)-(i)

(C) (a)-(iv), (b)-(iii), (c)-(v), (d)-(i)

(D) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

22. The values of stoichiometric coefficients m, x, y and z in the following reaction after balancing are respectively.

$$m(NH_4)_2 Cr_2O_4 \xrightarrow{\Delta} xCr_2O_3 + yN_2 + zH_2O$$
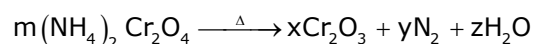
(A) 2, 1, 1, 2

(B) 2, 2, 2, 4

(C) 1, 1, 1, 4

(D) 2, 2, 1, 2

23. Which of the following is not a redox reaction?

(A) $2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$

(B) $Ca(OH)_{2(aq)} + 2HNO_{3(aq)} \rightarrow$ $Ca(NO_3)_{2(aq)} + 2H_2O_{(l)}$

(C) $2Pb(NO_3)_{2(s)} \rightarrow PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$

(D) $Cl_{2(g)} + H_2O_{(l)} \rightarrow HCl_{(aq)} + HClO_{(aq)}$

24. Study the given experimental set-up
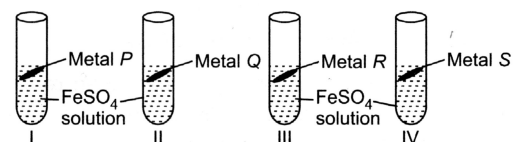
If in test tubes I and III, black residue was obtained and in test tubes II and IV, no change was observed, then metals P, Q, R and S could be respectively

(A) Al, Cu, Pb, Ag   (B) Pb, Cu, Ag, Al

(C) Pb, Al, Cu, Ag   (D) Zn, Cu, Al, Ag

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BIOLOGY
CLASS - X
BOOKLET - 1

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RESPIRATION

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Nutrition  Respiration  Transportation  Excretion  Control &
                                                   Coordination
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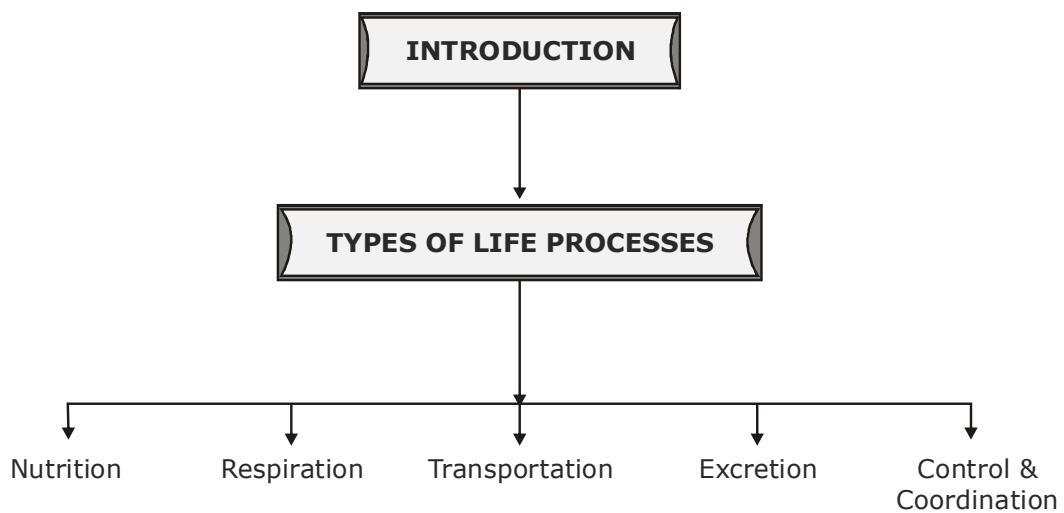
INTRODUCTION

- Living organisms require oxygen, water and food for their various activities to sustain life.

- The various processes essential for maintenance of life are called life processes, which are Nutrition, Respiration, Transportation and Excretion.

- Energy is continuously required by living organisms to carry out various life processes. This energy is liberated due to intake as well as utilisation of nutrients and also by respiration of an organism.

- Organisms can be classified into two groups - Autotrophic and Heterotrophic.

- Respiration is the process in which food is oxidised to release energy, which can be aerobic or anaerobic. The first step in respiration is called breathing.

- Animals have evolved different organs for the uptake of Oxygen from the surroundings and for release of Carbon dioxide.

- In human beings, the transport of materials like Oxygen, Carbon dioxide, food and excretory products is a function of the circulatory system.

- The circulatory system consists of heart, blood and blood vessels.

- In higher plants, transport of water, minerals, food and other materials is a function of the vascular tissue which consists of conducting tissues, xylem and phloem.

- All plants and animals produce harmful substances due to a number of metabolic activities occurring in their body tissues. These substances are to be eliminated from the body as they are toxic in nature.

- In human beings, excretory products in the form of soluble Nitrogen compounds are removed by the nephrons in the kidneys. Plants use a variety of techniques to get rid of waste materials; which are stored in the cell-vacuoles, removed by the falling of leaves thus, excreted into the surrounding soil.

NUTRITION

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                      ┌─────────────────┐
                      │    NUTRITION    │
                      └─────────────────┘
              ┌───────────────┴───────────────────────┐
       ┌─────────────┐                                 │
       │ AUTOTROPHIC │                                 │
       └─────────────┘                                 │
        ┌──────┴──────────┐                            │
┌──────────────────┐ ┌──────────────────┐              │
│ PHOTOAUTOTROPHIC │ │ CHEMOAUTOTROPHIC  │             │
└──────────────────┘ └──────────────────┘              │
  eg - All Producers   eg - Sulphur Bacteria           │
                                            ┌────────────────┐
                                            │  HETEROTROPHIC │
                                            └────────────────┘
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Parasitic	Symbiotic	Saprotrophic	Holozoic
eg. Liver fluke, Tape Worm etc	eg. Lichens	eg. Decomposers	eg. Amoeba, Humans
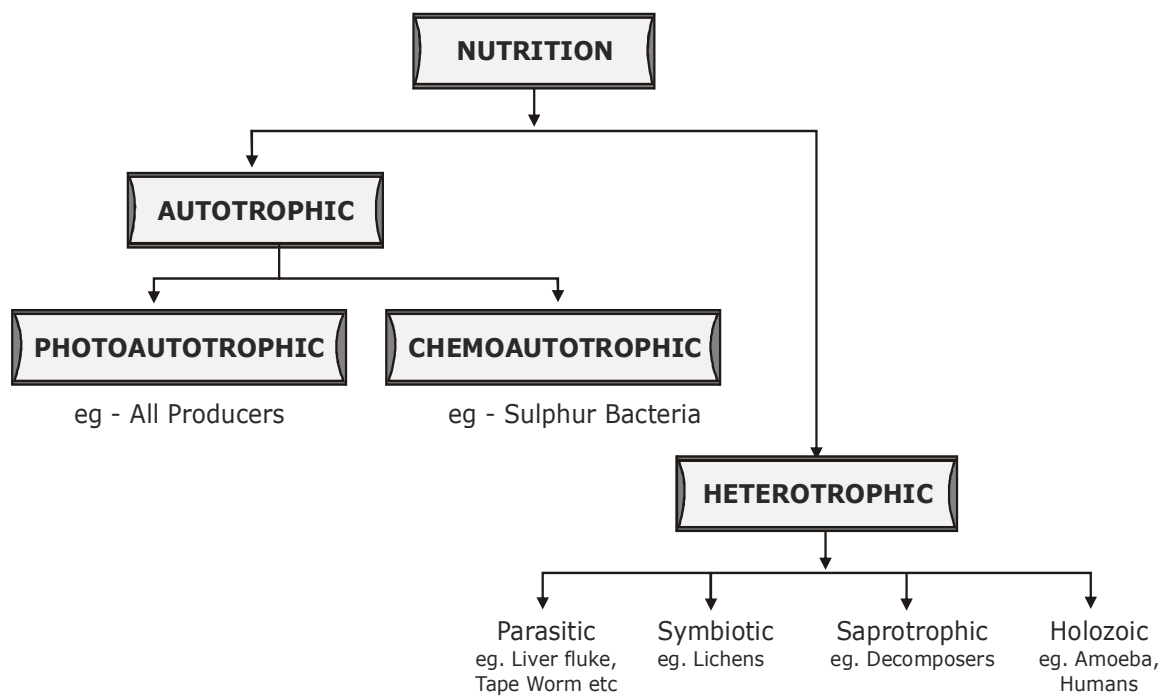
NUTRITION

It is the method of obtaining nutrients from the environment. It can be defined as the process by which the organism ingests, digests, absorbs, transports and utilises nutrients and disposes off their end products.

NUTRIENT

The different component of food that have distinct functions like providing energy, materials for body building, maintenance & regulation of metabolism are called nutrient.

For example-Proteins, Minerals, Vitamin, Carbohydrates, fats.

MODES OF NUTRITION

Mode of nutrition
- Autotrophic nutrition
- Heterotrophic nutrition
  - Holozoic nutrition
  - Saprotrophic nutrition
  - Parasitic nutrition
  - Symbiotic nutrition
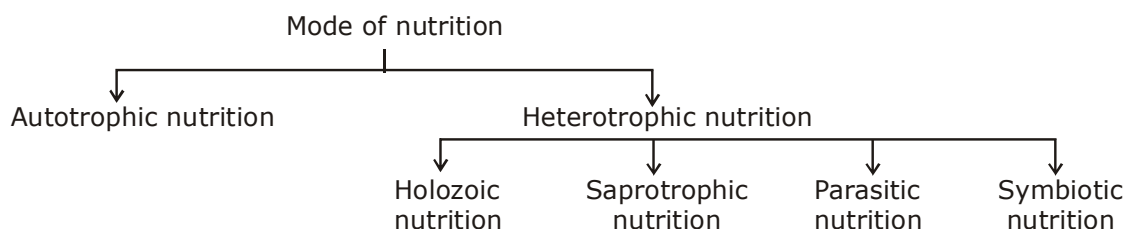
1. AUTOTROPHIC NUTRITION

In this type of nutrition, organisms synthesise the organic materials they require, from inorganic sources. All green plants are autotrophic and use light as a source of energy for the synthesis.

Autotrophs

The organisms which make their own food from raw materials like carbon dioxide and water in the presence of sunlight and chlorophyll are called Autotrophs. These organisms are also called **producers** and include green plants and some bacteria.

Photosynthesis

It is the process by which green parts of the plant synthesise organic food in the form of carbohydrates from CO_2 and water in the presence of sunlight.

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$$
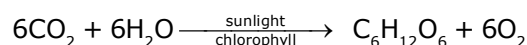
In plants and most algae photosynthesis occurs in the **chloroplasts** and there are two principal reactions:

(i) **Light reaction (light-dependent)** requires the **presence of light energy** from the sunlight which is obtained by photosynthetic pigments, *i.e.,* chlorophyll and used to bring about the photolysis of water.

$$H_2O \rightarrow 2H^+ + 2e^-$$
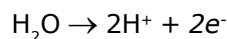
(ii) **Dark reaction (light-independent)** *i.e.,* this reaction is **not dependent on light** and during this reaction carbon dioxide is reduced to carbohydrate in a metabolic pathway known as the **Calvin cycle**.

Site of Photosynthesis

Photosynthesis occurs in green parts of the plants like leaves and green stems.

Anatomically, the leaf has outermost epidermal layers (on both surface) which are covered by waxy cuticle. The internal layers of the leaf are made up of mesophyll cells rich in **chloroplast**.

Chloroplast are the cell organelles that perform photosynthesis. Structurally chloroplasts are double membrane bound cell organelles containing sac-like structure called **thylakoids**. These are present in the stroma of chloroplast either in a stacked manner to form **granum** (plural : grana) or singly. **Stroma lamellae** connect the two grana. The thylakoid membranes contain green pigment molecule called **chlorophyll**, which absorbs the light energy and converts it into chemical energy.
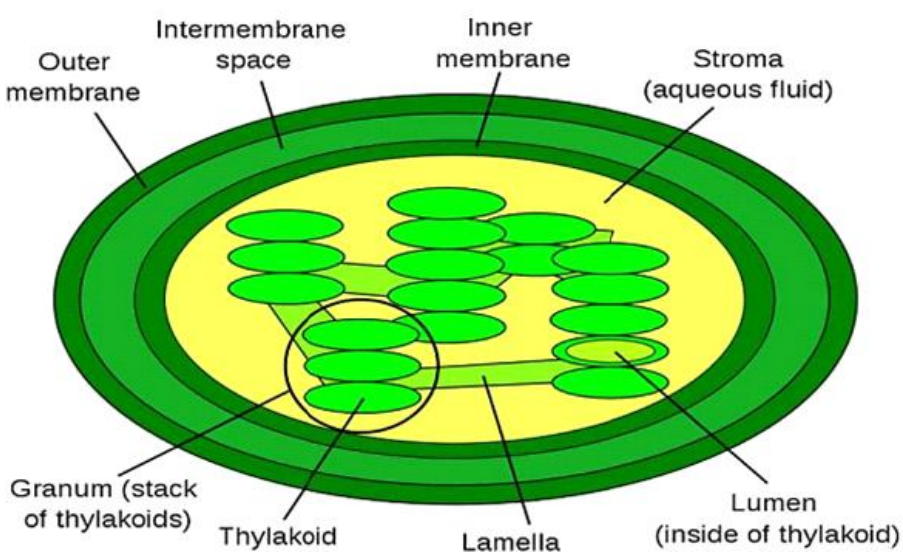
Difference between light and dark reactions

Features	Light reaction	Dark reaction
Requirement of light	Required	Not required
Takes place inside	Grana part of the chloroplast	The stroma region of chloroplast
ATP and NADPH$_2$	ATP and NADPH$_2$ are produced by the conversion of light energy into chemical energy	ATP and NADPH$_2$ formed during light reaction are used for the fixation of CO$_2$ into carbohydrate
Sugar formation	No sugar formation takes place	Sugar formation takes place
Release of oxygen	Oxygen is released	No oxygen is released

2.   VARIOUS COMPONENTS OF PHOTOSYNTHESIS

Various components necessary for the process of photosynthesis are :

(A)   Chlorophyll

(B)   Carbon dioxide

(C)   Sunlight

(D)   Water

This can be demonstrated with the help of various experiments.

(A)   Chlorophyll

Chlorophyll is a green pigment present in the green leaves, stems etc.

ACTIVITY - 1

To prove that chlorophyll is essential for photosynthesis.

Apparatus

Plant with variegated leaves, Apparatus for starch test i.e., Iodine solution, beaker, test tubes.
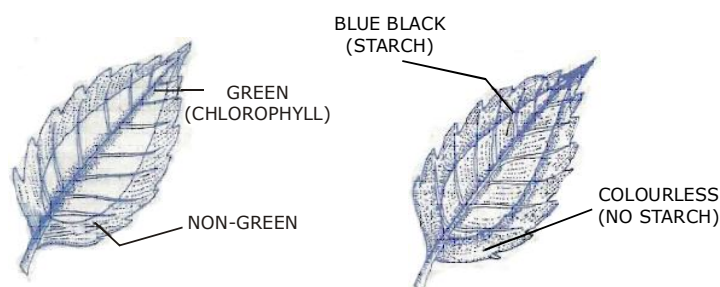
Apparatus to show that chlorophyll is essential for photosynthesis

Procedure

1. A potted plant with variegated leaf (Coleus, Croton) is kept in darkness for two days to make the leaves starch-free.

2. A plant is then kept in sunlight for few hours.

3. A leaf is removed from the plant and tested with Iodine for starch, after decolourising it first with water and then alcohol.

Conclusion

It is seen that the portions of leaves which are devoid of chlorophyll remain colourless (starch free) whereas the rest of the leaf turns blue-black due to the presence of starch.

(B)   Carbon-Dioxide

*   Photosynthesis has been found to takes place in a very wide range of CO_2 concentration.
*   Within the range, the rate of photosynthesis will decrease or increase with decrease or increase in CO_2 concentration, provided other factors are not limiting.
*   Relatively high concentration of CO_2, reduces the rate of photosynthesis and if given for a considerable period of time, has detrimental effect on the process itself.

ACTIVITY - 2

To prove that carbon dioxide is necessary for the process of photosynthesis.

Apparatus

Two healthy potted plants, Potassium hydroxide (KOH), 2 bell jars, watch-glass, vaseline, 2 glass plates, Iodine solution, H_2O and alcohol.

Procedure
1. Take two healthy potted plants of same size.
2. Destarch them by keeping in a dark room for 3-4 days.
3. Now place these potted plants on separate glass sheets.
4. Place watch glass containing KOH by the side of one of the plants. KOH has the property to absorb carbon dioxide.
5. Now cover these potted plants with bell jars.
6. To make the apparatus air tight use vaseline to seal the bottom of the jars to glass plates.
7. Keep this experimental setup in sunlight for 3 to 4 hours.
8. Pluck one leaf from each plant.
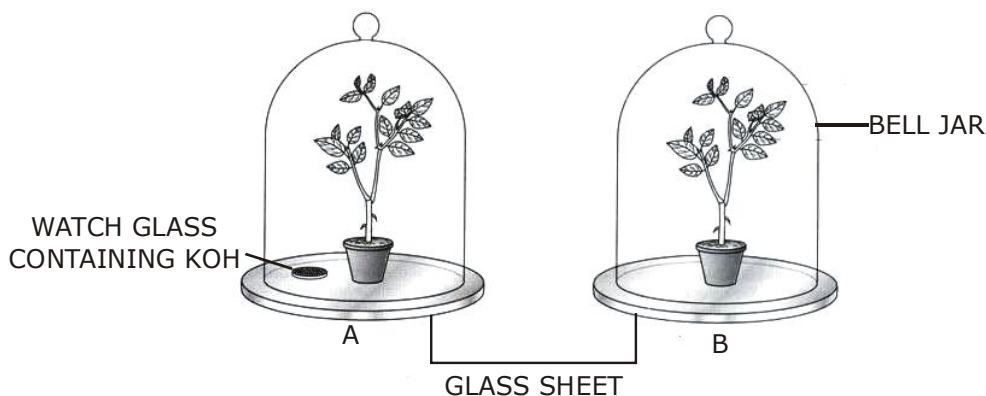
Apparatus to show that CO₂ is necessary for the process of photosynthesis

9. Perform starch test for both the leaves by decolourizing leaf first in water, then in alcohol and finally testing with Iodine solution.
10. Leaf which was within bell jar with KOH solution gives a negative test whereas other one gives positive test.

Conclusion

The experiment clearly proves the fact that Carbon dioxide is absolutely essential for photosynthesis. The part of the leaf which could not show iodine test positive or manufacture starch had all the requirements for photosynthesis except CO_2, which was absorbed by KOH in the bottle.

Info Bubble

The light intensity where in the photosynthesising organs neither takes CO_2 nor release the same is called compensation point.

(C)   Sunlight

Plants do photosynthesis by trapping sunlight using chlorophyll.

ACTIVITY – 3

To prove that light is necessary for photosynthesis-Starch Printing Test.

Apparatus

Ganong's light screen or two strips of black paper. A destarched plant, Apparatus for starch test.

Procedure

1. Take a Ganong's light screen or, you can even use two black paper strips to cover the leaf.
2. A potted plant is kept in the dark for two days to make the leaves starch free.
3. A leaf is partly covered with a piece of black paper or by a Ganong's light screen.
4. The pot is then kept in the sunlight for few hours.
5. The leaf is then tested with Iodine solution for starch.

Conclusion

It is seen that the starch is formed only in the exposed portion of the leaf whereas covered portion remains starch-free because light was not available to such patches for photosynthesis.
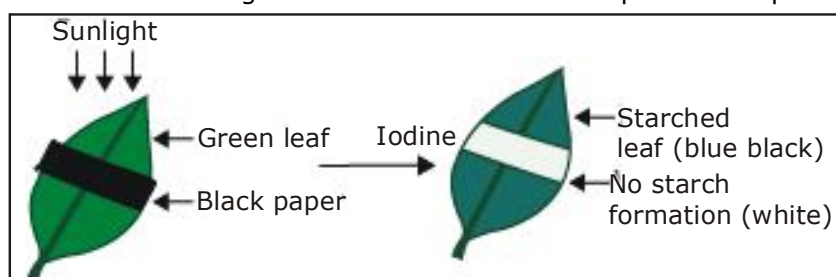
To show that light is required for photosynthesis

(D)   Water

(i)   Plants absorb water from the soil with the help of root system. The effect of water deficiency on the rate of photosynthesis is indirect one.

(ii)   Decrease in H_2O content of the leaves may cause partial or complete closure of stomatal opening, and hence a reduction in the rate of diffusion of CO_2.

(iii) A partial drying of the cell walls cause decrease in its permeability to CO_2, another indirect effect of water deficiency is that the accumulation of sugar within the cells increases the rate of respiration and thus decreases apparent photosynthesis.

PRACTICE YOUR CONCEPTS

1. In plants, the carbohydrates which are not utilised are stored in the form of
(A) Glycogen   (B) Starch   (C) Glycolipid   (D) Phospholipid

2. In terrestrial plants, water used in photosynthesis is taken up by the
(A) Flowers   (B) Roots   (C) Aerial leaves   (D) Green stems

3. Micro-organisms that do not show any molecular movement in them, until they infect some cells are
(A) Viruses   (B) Bacteria   (C) Archaebacteria   (D) Eubacteria

4. Identify the correct matching pair of form of organic food synthesized, stored and transported in plants, from the following.

Form of food synthesized	Form of food stored	Form of food transported
(A) Sucrose	Glucose	Starch
(B) Glucose	Starch	Sucrose
(C) Glucose	Sucrose	Starch
(D) Sucrose	Glycogen	Glucose

5. Which of the following events does not occur exclusively during light reaction of photosynthesis ?
(A) Photolysis of water
(B) Conversion of light energy into chemical energy
(C) Absorption of solar energy
(D) Reduction of CO_2

[Ans. 1. (B), 2. (B), 3. (A), 4. (B), 5. (D)]

2. HETEROTROPHIC NUTRITION

The type of nutrition in which organisms derive their food (nutrients) from other living organisms. In heterotrophic nutrition, **the energy is derived from the intake and digestion of the organic substances, normally of plant or animal tissue**.

Heterotrophs : The organisms which **cannot make their own food** and depend directly or indirectly on autotrophs for their survival are called heterotrophs. These organisms include animals and fungi.

Heterotrophic mode of nutrition are of different types :

(A) **Saprotrophic Nutrition**

It refers to the mode of nutrition in which organisms obtain nutrients from the dead and decaying organic matter, *e.g.,* fungi, yeast and bacteria are called **saprophytes.**

(B) **Parasitic Nutrition**

It refers to the mode of obtaining food synthesised by others. The organism which obtains food is called the '**parasite**' and the organism from which food is absorbed is called the 'host'. This nutrition is observed in fungi, bacteria, a few plants like *Cuscata* and some animals like *Plasmodium* and roundworm.

(C) **Symbiotic Nutrition (Mutualistic)**

The mutualistic nutrition can be defined as the **interdependent nutrition** in which each organism is dependent mutually on the other.

Ex. The lichens share mutualistic nutrition between a fungus and a cyanobacterium.

(D) **Holozoic Nutrition**

It refers to the mode of nutrition in which the complex organic matter in the form of solid food is ingested, digested and then absorbed into the cells and utilised, *e.g.* amoeba, frog, human beings.

Depending upon the source of food, holozoic organisms are of three types – **Herbivores, carnivores, omnivores**.

Herbivores :

(L.*herba*-plant, *vorare*-to eat)

They are holozoic organisms which feed on plants or plant parts, e.g., cow, buffalo, deer, goat, rabbit, grasshopper, elephant, squirrel, hippopotamus.

Carnivores : They are animals which feed on other animals. Carnivores are also called **predators.** They hunt, kill and feed on their preys, e.g. lion, tiger, leopard, snake, hawk.

Omnivores : (L.*omnis*-all, *vorare*-to eat)

They are holozoic organisms which feed on both plant and animal materials, e.g. cockroach, ant, pig, crow, rat, bear, dog, humans.

3. **NUTRITION IN AMOEBA (HOLOZOIC)**

Protozoan (protists) carry out holozoic nutrition through **intracellular digestion.**

Steps of Nutrition in amoeba

(i) Ingestion : Food is taken in with help of pseudopodia.

(ii) Digestion : Intracellular with help of enzymes present in lysosomes.

(iii) Absorption : The digested food then diffuses into the cytoplasm.

(iv) Assimilation : The absorbed food is utilised to meet the energy requirements of Amoeba.

(v) Egestion : Undigested food thrown out.

Food particle

Nucleus Contractile vacuole

A

B

Ingested food particle   Lysosome

Fresh food vacuole

Old food vacuole

C

D

Food vacuole   Undigested particles

E

HOLOZOIC NUTRITION IN AMOEBA
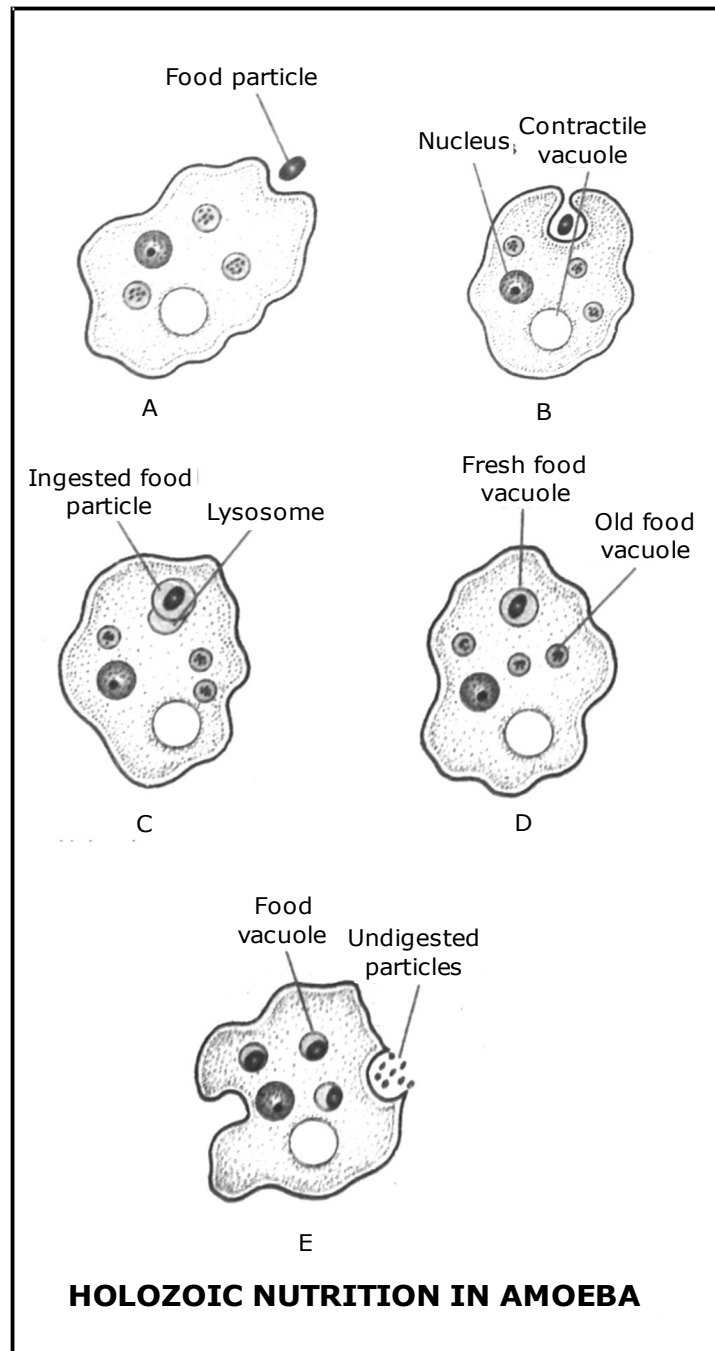
4.   DIGESTIVE SYSTEM OF HUMAN

The organs which are responsible for **ingestion, digestion, absorption, assimilation and egestion** constitute the digestive system. The digestive system comprises of the alimentary canal and associated digestive glands.

Digestive system

Alimentary canal   Digestive Glands

→ Salivary Glands

→ Liver

→ Gastric Glands

→ Pancreas

Mouth   Buccal   Oesophagus   Stomach   Intestine
         cavity

Small Intestine   Large Intestine

Duodenum   Jejunum   Ileum   Caecum   Colon   Rectum
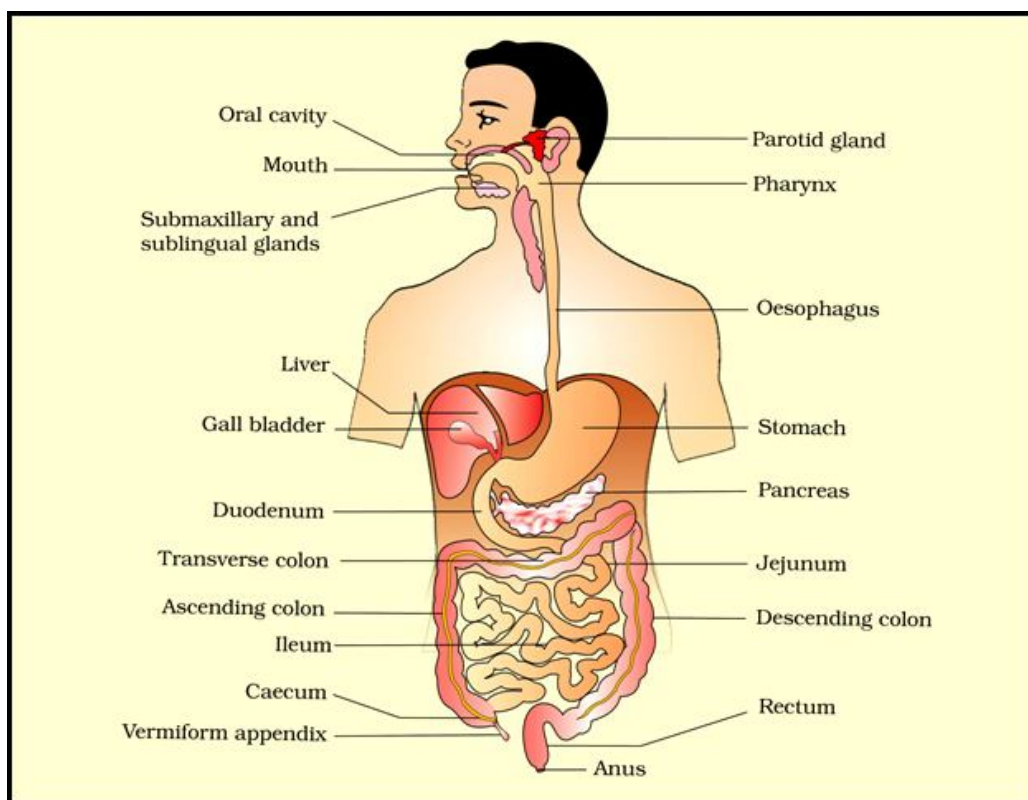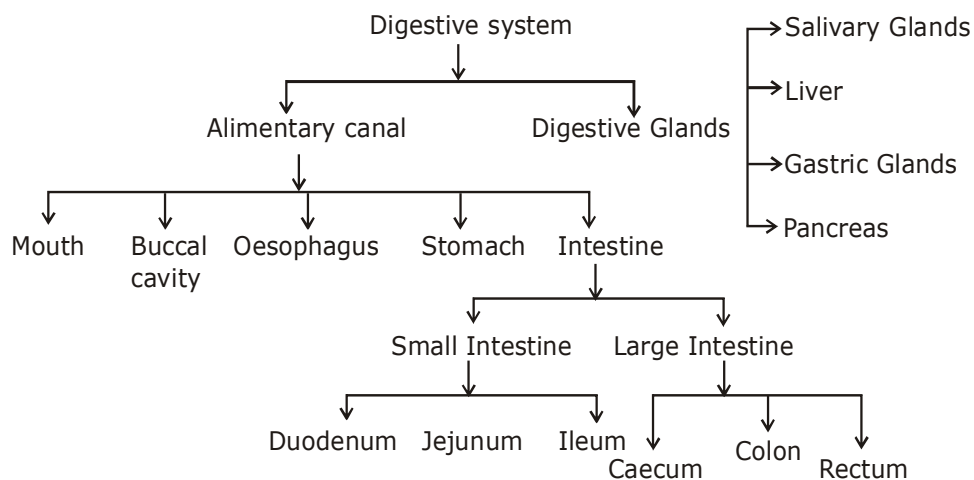
(A)   Alimentary canal

The alimentary canal is basically a **long tube extending from the mouth to the anus**.
It is differentiated into following parts.

(i)   Mouth : It is a transverse slit bounded by movable lips. The lips serve to close and open the mouth. Holding the food in between and also helps in speaking.

Anterior view
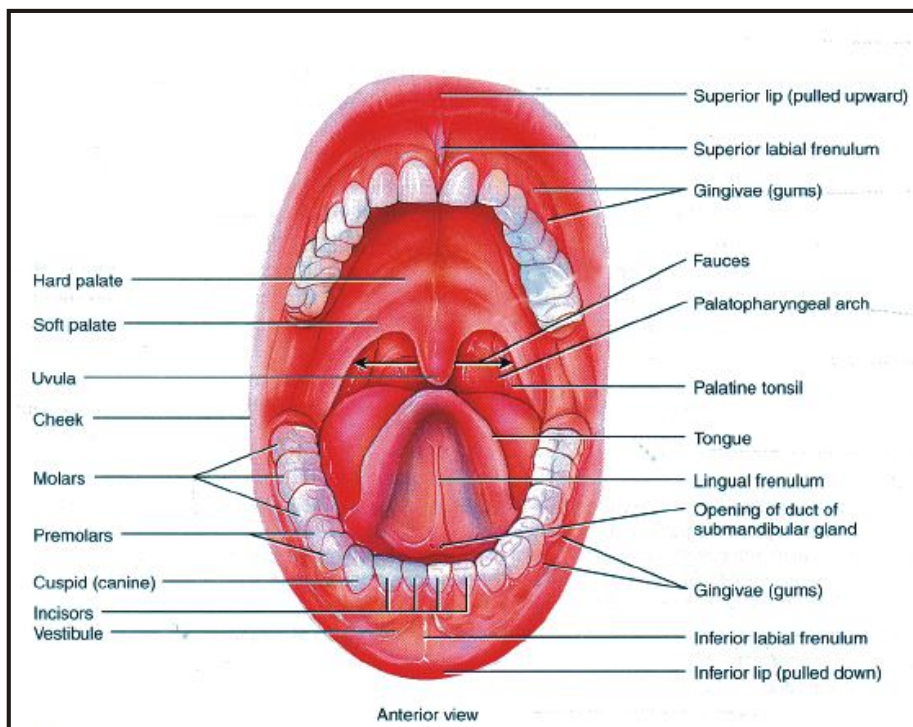
Teeth

Man possess teeth on both the jaws. There are **32 teeths** of four different types, namely **incisors, canines, premolars and molars**.

Types of teeth	Milk teeth	Permanent teeth
Incisor	8	8
Canine	4	4
Premolar	0	8
Molar	8	12
Total number of teeth	**20**	**32**

MORE TO KNOW

Definition in human beings:
(i)   **Heterodont** having different types of teeth like canine, incisors, premolars and molars.
(ii) **Diphyodont** teeth grow twice in life. Out of 32, 20 teeth are diphyodont and 12 are monophyodont (Teeth which grows only once in life).
(iii) **Thecodont** teeth have well-developed roots embedded in deep bony sockets.
(iv) Molars of milk teeth are shed off and premolars of permanent teeth take their place.
(v)   Upper incisors of the elephant are modified into tusk.

Dental Caries

The hard, outer covering of a tooth is called Enamel. **Tooth enamel is the hardest material in our body.** It is even harder than bones. The part of tooth below enamel is called **dentine**. Dentine is similar to bone. Inside the dentine is pulp cavity. The pulp cavity contains nerves and blood vessels. **The formation of small cavities (or holes) in the teeth due to the action of acid-forming bacteria and improper dental care is called dental caries**.

When we eat sugary food, the bacteria in our mouth act on sugar to produce acids. These acids first dissolve the calcium salts from the tooth enamel and then from dentine forming small cavities (or holes) in the tooth over a period of time. The formation of cavities reduces the distance between the outside of the tooth and the pulp cavity which contains nerves and blood vessels. The acids produced by bacteria irritate the nerve endings inside the tooth and cause toothache. If the cavities caused by dental decay are not cleaned and filled by a dentist, the bacteria will get into the pulp cavity of tooth causing inflammation and infection leading to severe pain.

If the teeth are not cleaned regularly, they become covered with a sticky, yellowish layer of food particles and bacteria cells called **'dental plaque'**. Since plaque covers the teeth forming a layer over them, the alkaline saliva cannot reach the tooth surface to neutralise the acid formed by bacteria and hence tooth decay sets in. Brushing the teeth regularly, after eating food, removes the plaque before bacteria produces acids. This will prevent dental carries or tooth decay.

section of a mandibular (lower) molar
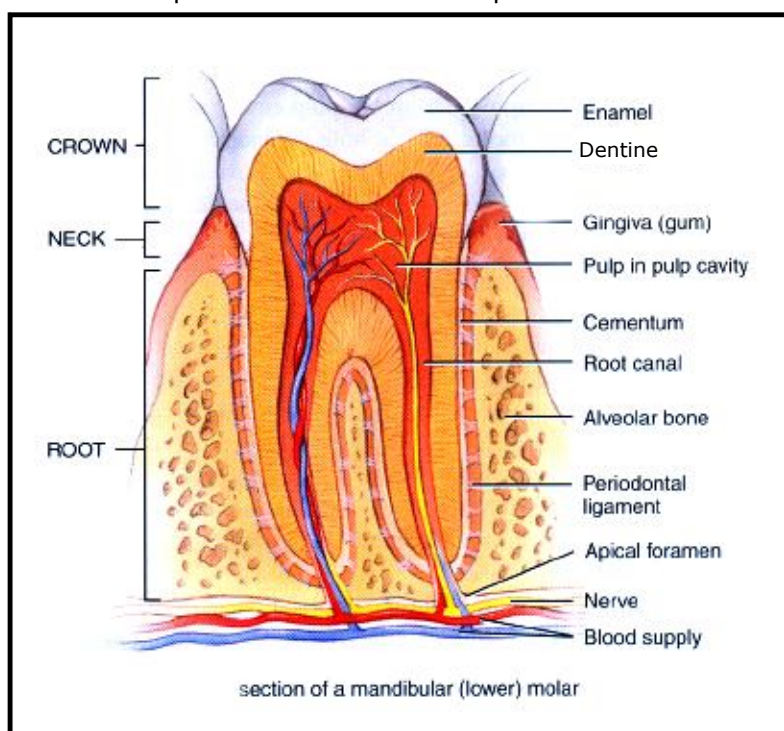
Info Bubble

It is the tooth decay which involves destruction of the enamel layer of the tooth by acids produced by the action of bacteria on sugar. If dental caries is not treated, it can spread to the dentine and pulp of the tooth, causing inflammation and infection of the tooth.

Digestion in oral cavity

• **In humans, digestion starts first in oral cavity.**

• In the in oral cavity, food gets mixed up with saliva secreted by salivary glands.

• Saliva contains an enzyme ptyalin which breaks polysaccharide starch into disaccharide maltose.

$$Starch \xrightarrow[\text{(Salivary anylase)}]{\text{Ptyalin}} Maltose$$
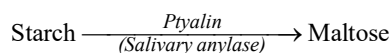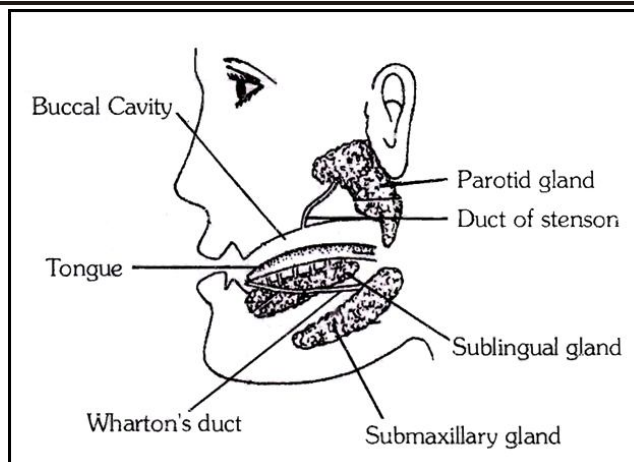
- The food from the mouth cavity passes into the stomach through the oesophagus.

Info Bubble

Apart from the presence of food, the sight, smell or even touch of one's favourite food can initiate secretion of gastric juices.

(ii)   Pharynx
It is a short, conical region that lies after the mouth cavity. The pharynx is divided into two parts — the **nasopharynx** which lies behind the nasal cavities and the **oropharynx** which lies behind the mouth.
Two apertures are found in central part of buccopharyngeal cavity.

*   Ventral or lower aperture is called **glottis** which is related to the larynx. Which is guarded by epiglottis.
*   The dorsal and upper aperture is called **gullet** which opens into oesophagus.

(iii) Oesophagus (food pipe)
It is a long, narrow, muscular tube which leads to the stomach. The oesophagus is a collapsible muscular tube leading from pharynx to stomach. There are no digestive glands but mucus glands are present.

(iv)   Stomach
It is a thick, muscular and J shaped sac present on the left side of upper part of abdomen. Gastric glands are present in the wall of stomach. These releases gastric juice or digestive juice, which contains mucus, hydrochloric acid and a protein digesting enzyme called **pepsin**. Mucus lubricates the food and protects the inner linning of the stomach from the action of HCl.
HCl creates an acidic medium, which facilitates the action of enzyme pepsin and kills the bacteria present in food.
Pepsin breaks down proteins into peptides.
Spinchter muscles regulate the exit of food from stomach into intestine due to peristaltic waves of stomach.

Human Stomach
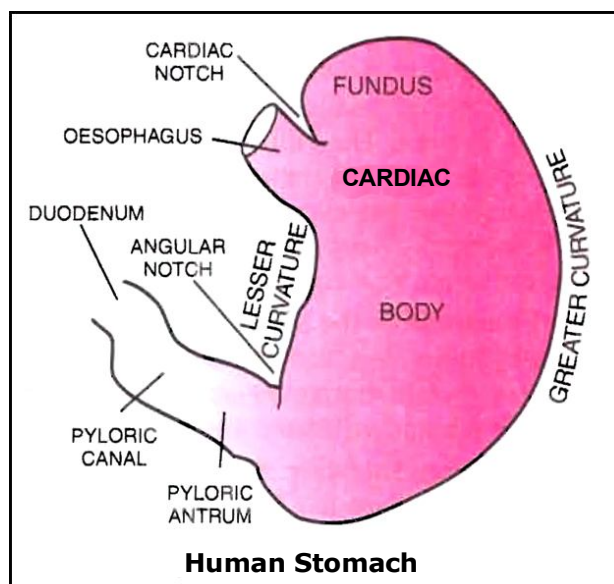
(v) Intestine

It is the **largest part of alimentary canal** which is fitted into a compact space because of extensive coiling. It is distingushed into small intestine and large intestine.

- **Small intestine**

  The small intestine is the **site of the complete digestion** of carbohydrates, proteins and fats. It receives the secretions of the liver and pancrease for digestion.

  Food is mixed with three digestive juices (**bile juice, pancreatic juice and intestinal juice**)

  Bile juice (**from the liver**) provide alkaline medium and emulsifies fats (conversion of larger fat globules into smaller fat droplets) but it is **non-enzymatic** digestive juice so it has no chemical action on food.

  Pancreatic juice (from the **pancreas**) contains **trypsin, pancreatic amylase and pancreatic lipase,** which digest the peptons, starch and fats into peptides, maltose and fatty acids and glycerol respectively.

  The wall of intestine secretes **intestinal juice** which contains enzymes for complete digestion of proteins into amino acids, carbohydrates into glucose and fats into fatty acid and glycerol.

  The inner lining of the small intestine has numerous finger like projections called **villi** which increase the surface area for absorbtion of digested food.

  These are richly supplied with blood vessels.

- **Large Intestine**

  It is much shorter and wider than small intestine and is differentiated into three regions *viz.,* **caecum**, which is small rounded blind sac from which **vermiform appendix** arises; **colon** is the inverted U-shaped tube and the **rectum** opens to exterior through **anus**.

(vi) Anus

The rest of the material is removed from the body via anus. The exit of waste material is regulated by anal spinchter.

(B) Digestive Glands

Various glands associated with alimentary canal are :

Info Bubble

On eating food of our interest, watering starts in our mouth. This water is basically the saliva which is secreted by salivary glands that get activated by eating and even seeing or thinking of good food.

(i) **Salivary Glands**

The salivary glands secrete the first of the digestive juices, the saliva which aids in digestion of carbohydrate, keeps your mouth moist and supports healthy teeth. There are three pairs of salivary glands, namely the **parotid, sub-maxillary and sublingual glands**.

(ii) **Gastric Glands**

They are branched tubular glands which lie in the mucus membranes of the stomach. They secrete gastric juice, which is clear, acidic (containing HCl), enzymes and mucus.

(iii) **Liver**

It is the **largest gland in man** and lies below diaphragm in the right upper part of abdomen. Liver comprises of two lobes, right and left, where the right lobe is much larger than the left lobe. The cells of liver, *i.e.,* **hepatic cells produce bile juice** which flows out of liver through hepatic ducts forming common bile duct and opens into duodenum. Bile juice then flows into gall bladder through the cystic ducts.

(iv) **Pancreas**

It is a soft lobulated gland present in between the loops of duodenum. It secretes pancreatic juice containing enzymes which is poured into duodenum with the help of pancreatic duct.

The duct systems of liver, gall bladder and pancreas
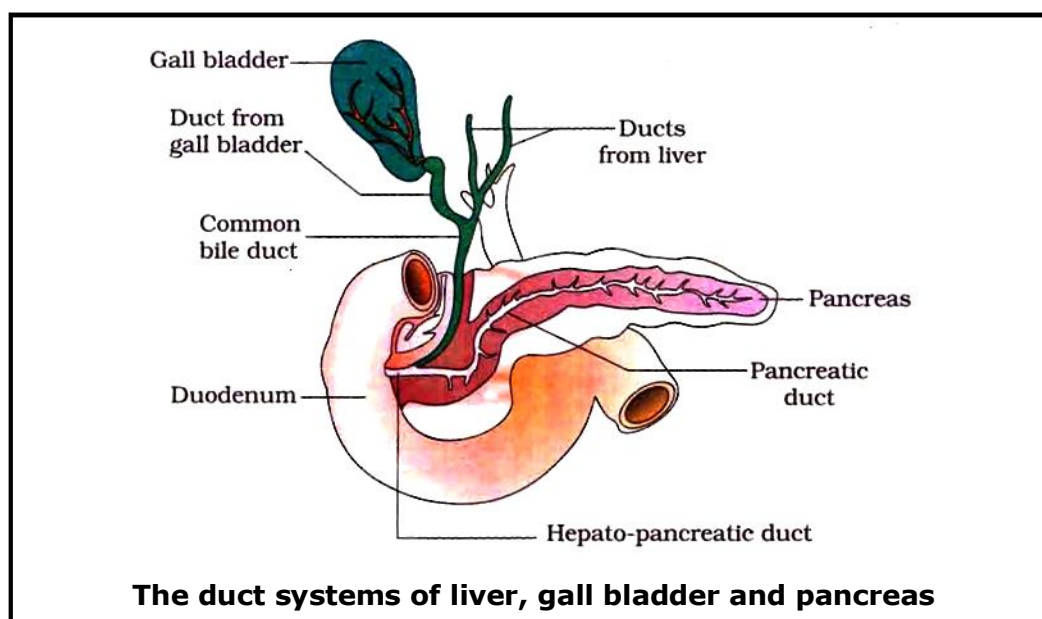
PRACTICE YOUR CONCEPTS

6. What are dental caries and how are they caused?

Ans. It is the tooth decay which involves destruction of the enamel layer of the tooth. It begins when bacteria acting on sugars produce acids that softens or demineralises the enamel, masses of bacterial cells together with food particle stick to the teeth to form dental plaque. If the dental caries are not treated, it can spread to the dentine and pulp of the tooth, causing infection and inflammation of the tooth.

7. Why are villi richly supplied with blood vessels?

Ans. The blood vessels take the absorbed food to each and every cell of the body, where it is utilised for obtaining energy, building up new tissues and the repair of old tissues.

8. It is said that, 'small intestine is the site of the complete digestion'. Why is it so?

Ans. The small intestine receives the secretions of the liver and pancreas which helps in the complete digestion of carbohydrates, proteins and fats.

ON YOUR TIPS

- **Emulsification :-** Emulsification is the phenomenon of physically breaking of large sized fat globules into small sized fat droplets by the bile-salts of the bile juice. This increases the surface area for digestion of fats by the lipase enzyme.
- **Enzymes are classified into 3 groups :-**
  - (a) Amylolytic enzymes   –   Carbohydrate digestion
  - (b) Proteolytic enzymes   –   Protein digestion
  - (c) Lipolytic enzymes   –   Lipid digestion
- **Alimentary Canal :-** The digestive canal where the entire process of digestion is accomplished, called alimentary canal.
  - * It is the site for ingestion, digestion, absorption and egestion of food material.
  - * In man it is about 7–8 meters long.
  - * The alimentary canal of herbivores is longer than the alimentary canal of carnivores, because herbivores have to digest the cellulose, which is difficult to digest.
- **Mucus in stomach :-** Mucus is a viscous secretion. The mucus also forms a thick coating over the mucosal cells and prevents them from the harmful effects of HCl and pepsin.
- Pepsin is the chief proteolytic enzyme.
- **Castle's Intrinsic factor :-** This intrisic factor is secreted by fundic glands of the stomach mucosa. It combines with vitamin B_{12} [which is known as extrinsic factor].
  The vitamin B_{12} from this combined complex can easily be extracted and absorbed by the intestinal mucosa. Intrinsic factor, thus, helps in the absorption of vitamin B_{12}.
- **Colitis :-** An inflammation of the colon and rectum is called colitis. Inflammation of the mucosa reduces absorption of water and salts, producing watery, bloody faces and in severe cases, dehydration and salt depletion.
- Digestion of proteins in man starts from stomach. In buccal cavity there is no digestion of proteins because saliva contains no proteolytic (protein digesting) enzyme.

NCERT QUESTIONS WITH SOLUTION

1. Why is diffusion insufficient to meet the oxygen requirement of multicellular organisms like humans?

Sol. In humans, the body organisation is multicellular and complex. The living cells are not in direct contact with environment because they are generally covered by dead cells. Air containing intracellular spaces are also absent so quick diffusion cannot occur. Cell to cell diffusion is very slow process and if it takes place in humans then passage of oxygen in whole body will take about years. Thus, diffusion is insufficient to deliver oxygen to all parts of a multicellular organisms like humans.

2. What criteria do we use to decide whether something is alive?

Sol. The main criteria that is used to decide whether something is alive, is cellular movement. Movements may be of different types like locomotion (running, walking), moving body parts, breathing movements, growth movements and movement of molecules in various metabolic reactions. Besides movements, other qualities found in living beings are self-built body organisation, presence of protoplasm, self repair, various vital life processes like metabolism, growth, nutrition, respiration, excretion and reproduction.
All living organisms have a definite lifespan and particular life cycle.

3. What processes would you consider essential for maintaining life?

Sol. The processes essential for maintaining life are nutrition, metabolism, respiration, circulation/transportation and excretion.

4. What are the differences between autotrophic nutrition and heterotrophic nutrition?

Sol. In autotrophic mode of nutrition, organisms (green plants, some protists and bacteria) prepare their own food from inorganic raw materials with the help of energy obtained from sunlight whereas in heterotrophic mode of nutrition, organisms obtain food prepared by autotrophs or from other organic sources as they cannot synthesise their own food. Heterotrophic nutrition may be saprophytic, parasitic and holozoic.

5. Where do plants get each of the raw materials required for photosynthesis?

Sol. The raw materials required for photosynthesis are carbon dioxide and water. Plants obtain water from the soil through roots and carbon dioxide from the atmosphere through stomata present on leaves.

6. What is the role of the acid in our stomach?

Sol. Hydrochloric acid (HCl) is secreted inside the stomach. The main functions of HCl are to
(i) stop the action of salivary amylase
(ii) kill the microbes present in the food
(iii) provide acidic medium necessary for the activation of the enzyme pepsin
(iv) make food soft
(v) convert pepsinogen and prorennin into active forms of pepsin and rennin.

7. What is the function of digestive enzymes?

Sol. Digestive enzymes are hydrolytic in nature which help in digestion of carbohydrates, proteins and fats. They bring about hydrolytic splitting of complex organic substances into simple soluble and absorbable substances. For example, by the action of digestive enzymes, proteins are converted into amino acids.

8. How is the small intestine designed to absorb digested food?

Sol. Small intestine is a long, tubular structure. Its inner wall is lined by epithelium which possess numerous finger-like projections called villi. These villi not only increase the surface area for absorption but also reach deep into the lumen of intestine for maximum absorption of digested food. Villi possess blood capillaries and lymph vessels (lacteals) for quick transport of absorbed food.

EXERCISE - I

MULTIPLE CHOICE QUESTIONS

1. CO_2 and O_2 balance in atmosphere is due to
(A) Photorespiration (B) Photosynthesis
(C) Respiration (D) Leaf anatomy

2. During photosynthesis the oxygen in glucose comes from
(A) Water
(B) Carbon dioxide
(C) Both from water and carbon dioxide
(D) Oxygen in air

3. With regards to natural eating habits, a human is
(A) A herbivore (B) A carnivore
(C) An omnivore (D) A granivore

4. Muscular contractions of alimentary canal are
(A) Circulation (B) Deglutition
(C) Peristalsis (D) Churning

5. Which of the following regions of the alimentary canal of man does not secrete a digestive enzyme ?
(A) Oesophagus (B) Stomach
(C) Duodenum (D) Mouth

6. Saliva has the enzyme
(A) Pepsin (B) Ptyalin
(C) Trypsin (D) Rennin

7. Pepsin digests
(A) Proteins in stomach
(B) Carbohydrates in duodenum
(C) Proteins in duodenum
(D) Fats in ileum

8. If the stomach did not produce any hydrochloric acid, which enzyme will not function?
(A) Ptyalin (B) Trypsin
(C) Pepsin (D) Collagenase

9. Chief function of bile is
(A) To digest fat by enzymatic action
(B) To emulsify fat for digestion
(C) To eliminate waste product
(D) To regulate process of digestion

10. Where is bile produced ?
(A) In gall bladder (B) In blood
(C) In liver (D) In spleen

11. Largest gland in human body is
(A) Liver (B) Pancreas
(C) Pituitary (D) Thyroid

12. The original function of the vertebrate stomach was
(A) Storage (B) Digestion
(C) Absorption (D) Enzyme secretion

13. Dental formula of an adult man is -

(A) $\dfrac{2,1,2,3}{2,1,2,3}$ (B) $\dfrac{2,1,2,3}{2,1,2,2}$

(C) $\dfrac{2,1,2,3}{2,1,2,4}$ (D) $\dfrac{2,1,3,2}{2,1,3,2}$

14. Which of the following is a common passage in swallowing food and breathing
(A) Pharynx (B) Larynx
(C) Glottis (D) Gullet

15. The hardest constituent of the tooth is-
(A) Enamel (B) Dentine
(C) Bone (D) Pulp

16. Nasal chambers and buccal cavity are separated by-
(A) By uvula (B) By palate
(C) By palatine (D) None of these

17. The structure which prevents entry of food into wind pipe during swallowing in mammals is-
(A) Larynx (B) Glottis
(C) Epiglottis (D) Pharynx

18. In which part of stomach mainly digestion occurs-
(A) Cardiac region (B) Fundic region
(C) Pyloric region (D) All of the above

19. Hydrochloric acid is secreted by the :-
(A) Paneth cells (B) Goblet cells
(C) Chief cells (D) Parietal cells

20. In human teeth, which help in cutting
(A) Canine   (B) Incisor
(C) Molar   (D) Premolar

21. In both chordates and non-chordates intestine develops from :-
(A) Pharyngeal pouch (B) Ectoderm
(C) Endoderm   (D) Mesoderm

22. Ptyalin is secreted by-
(A) Stomach   (B) Salivary gland
(C) Pancreas   (D) Bile

23. Ptyalin, an enzyme work in saliva in -
(A) Alkaline medium
(B) almost neutral medium
(C) Acidic medium
(D) all mediums

24. Parotid salivary gland are present :
(A) Below the tongue
(B) In front and just below the ear
(C) Below the eye orbit
(D) In the angle between two jaws

25. In order to destarch the leaves for an experiment to show that sunlight is necessary for photosynthesis, the:
(a) Leaves are kept in alcohol and boiled in a water bath
(b) leaves are soaked in iodine for two hours
(c) plant with the leaves is kept in dark room for 48 hours
(d) plant with the leaves is exposed to light of a lamp, a night before the experiment

26. Which one of the following is the correct combination of relevant materials required for setting up an experiment to show that light is necessary for photosynthesis?
(a) destarched leaves, strips of black paper, starch solution, and iodine crystals
(b) a potted plant, strips of coloured paper, starch solution, iodine and potassium iodide
(c) destarched leaves, strips of black paper, starch solution and potassium iodide
(d) destarched leaves, strips of black paper and iodine solution.

27. A portion of destarched leaf of a potted plant was covered with a black strip of paper. The plant was then exposed to sunlight for six hours and then tested for starch. It was observed that:
(a) both covered and uncovered parts of leaf turned blue-black
(b) both covered and uncovered parts of leaf turned yellowish-brown
(c) only the uncovered part of leaf turned blue-black
(d) only the covered part of leaf turned blue-black

28. In the sketch of the stomatal apparatus given alongside, the parts I, II, III and IV were labelled differently by four students. The correct labelling is shown in:
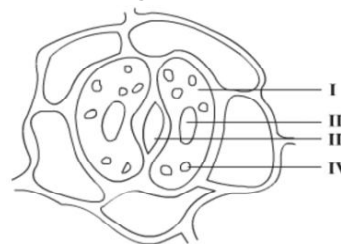
(A) (I) guard cells, (II) stoma, (III) starch granule, (IV) nucleus
(B) (I) guard cells, (II) starch, (III) nucleus, (IV) stoma
(C) (I) cytoplasm, (II) nucleus, (III) stoma, (IV) chloroplast
(D) (I) cytoplasm, (II) chloroplast, (III) stoma, (IV) nucleus

ASSERTION-REASON

In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:
(A) If both assertion and reason are true and reason is the correct explanation of assertion.
(B) If both assertion and reason are true but reason is not the correct explanation of assertion.
(C) If assertion is true but reason is false.
(D) It both assertion and reason are false.

1. **Assertion :-** Bile helps in emulsification of fats.
   Reason:- During emulsification fat is brokendown into fatty acid and glycerol.
2. **Assertion :-** Acid which reach intestine does not damage it.
   Reason:- The mucous along with the bicarbonates from the pancreas protects the intestinal mucosa.
3. **Assertion :-** Maximum absorption of food occur in jejunum.
   Reason:- Villi & microvilli abundantly present in small intestine.
4. **Assertion :-** The second largest digestive gland in our body is pancreas.
   Reason:- Pancreas function both as an exocrine & endocrine gland.
5. **Assertion :-** Vitamins are essential for healthy life.
   Reason:- Vitamins regulate metabolism.
6. **Assertion :-** Digestion does not take place in large intestine.
   Reason:- Undigested food gets converted to faeces in large intestine.
7. **Assertion :-** Bile juice helps in digestion of food in small intestine.
   Reason:- Bile juice contains sodium salts.

TRUE OR FALSE

1. In photosynthesis chemical energy converts into light energy.
2. Oxygen and water are the raw material for photosynthesis.
3. Guard cells regulate the opening and closing of stomata.
4. Rate of photosynthesis is maximum in green light.
5. CO_2 is released as a byproduct of light reaction.
6. Enzymes are biological catalysts.
7. The tongue helps in mixing food with saliva.
8. Digestion of starch starts in the stomach.
9. Liver is gland associated with the digestive system.
10. The gall bladder temporarily stores bile.

VERY SHORT ANSWER TYPE QUESTIONS

1. Define heterotrophic nutrition.
2. What are heterotrophs?
3. Which types of organisms are called consumers?
4. What is saprophytic nutrition?
5. Define holozoic mode of nutrition.
6. Define a hervivore.
7. What is carnivore?
8. Which type of animal is called omnivore?
9. What is the mode of nutrition in Amoeba?
10. What type of digestion occurs in Paramoecium?

SHORT ANSWER TYPE QUESTIONS

1. How do saprophytic organisms obtain their nourishment?
2. What is the importance of saprophytes?
3. What is the action of hydrochloric acid of gastric juice?
4. Name a digestive juice that has no enzymes. What is the role of this juice?
5. Name the various parts of large intestine. What is the role of large intestine?
6. Differentiate between autotrophic and heterotrohic nutrition.
7. Distinguish saprophytes from parasites.
8. Differentiate between photosynthetic and holozoic nutrition.

LONG ANSWER TYPE QUESTIONS

1. Explain the mechanism of nutrition of Amoeba with the help of suitable diagram.
2. Describe the various types of heterotrophic nutrition.
3. Briefly describe the digestive system of humans.
4. What happens to food in the small intestine?
5. Why chlorophyll is needed for photosynthesis.

ACTIVITY / PRACTICAL BASED QUESTIONS

1. One day Mohan had a severe toothache. His father took Mohan to a dentist. The dentist examined all the teeth of Mohan very carefully and said that he had tiny holes in his two teeth. He also told Mohan that all his teeth were covered with a sticky, yellowish layer. The dentist performed a certain procedure on his two teeth having tiny holes and also gave him some medicines.
   Mohan's toothache disappeared gradually.
   (a) What are the tiny holes in the teeth known as?
   (b) How are the tiny holes formed in the teeth?
   (c) What kind of procedure was performed by dentist on Mohan's two teeth?
   (d) What is the sticky, yellowish layer on Mohan's teeth known as?
   (e) How is the sticky, yellowish layer formed on the teeth?
   (f) What advice will you give to Mohan to avoid such dental problems in future?

2. If the teeth are not cleaned regularly, they become covered with a sticky yellowish layer of food particles and bacteria. Since layer covers the teeth, the alkaline liquid X secreted by glands Y inside the mouth cannot reach the teeth surface to neutralise the acid formed by the action of organisms Z on sugar food, and hence tooth decay sets in.
   (a) What is W known as?
   (b) What is (i), X and (ii) Y?
   (c) What are organisms Z?
   (d) State one way of removing layer W from the teeth.

3. There are four organisms A, B, C and D. The organisms A eats only the flesh of other animals as food. The organisms B can eat grains, fruits and vegetables as well as meat and fish. The organisms C can make the food itself from simple inorganic substances present in the environment by utilising sunlight energy. On the other hand, organism D eats only plants and their products as food.
   (a) Which organism is (i) omnivore (ii) herbivore, and (ii) carnivore?

4. X is a wild animal which eats only the flesh of other animals whereas Y is a domestic animal which feeds mainly on green grass.
   (a) What are animals like X known as?
   (b) What are animals like Y known as?
   (c) Which animal, X or Y, has a longer small intestine? Why?
   (d) Name one animal which is like X.
   (e) Name one animal which is like Y.

EXERCISE - II

MULTIPLE CHOICE QUESTIONS

1. Which of the following elements is not required by plants for their normal healthy growth
   (A) Calcium   (B) Magnesium
   (C) Lead   (D) Iron

2. Plant ash is an indication of
   (A) Mineral salts absorbed by the plants
   (B) Organic matter of the plant
   (C) Only mineral salts
   (D) None of the above

3. How the mineral contents of the plant is known
   (A) Titrimetric method
   (B) Calorimetric method
   (C) Ash analysis
   (D) All

4. Bacteriochlorophyll differs from chlorophyll 'a' in having:
   (A) One pyrrole nucleus with one hydrogen
   (B) One pyrrole nucleus with two hydrogen
   (C) One pyrrole nucleus with three hydrogen
   (D) One pyrrole nucleus with four hydrogen

5. C_4 plants are adapted to:
   (A) Hot and dry climate
   (B) Temperate climate
   (C) Cold and dry climate
   (D) Hot and humid climate

6. Photosynthetically active radiation is represented by the range of wavelength of:
   (A) 340-450 nm   (B) 400-700 nm
   (C) 500-600 nm   (D) 400-950 nm

7. Study the figure showing graph of light intensity on the rate of photosynthesis
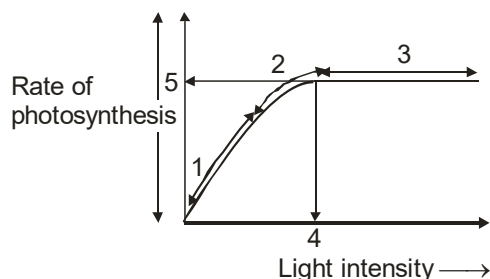
	Column-I		Column-II
A.	(1) Limiting factor in region	I.	Some factor other than light intensity is be coming the limiting factor
B.	(2) represents to	II.	Light is no longer
C.	(3) represents to	III.	Light intensity
D.	(4) represents to	IV.	Maximum rate of photosynthesis
E.	(5) represents to	V.	Saturation point for light intensity

(A)	A-I;	B-II;	C-III;	D-IV;	E-V
(B)	A-III;	B-I;	C-II;	D-V;	E-IV
(C)	A-IV;	B-II;	C-V;	D- III;	E I
(D)	A-V;	B-IV;	C-III;	D-II;	E-I

8. The innermost layer of the digestive tract is the:
   (A) Serosa membrane
   (B) Mucosa membrane
   (C) Submucosa membrane
   (D) Lumen

9. The sphincter of Oddi is present between:
   (A) Oesophagus and cardiac stomach.
   (B) Pyloric stomach and duodenum.
   (C) Hepatic duct and cystic duct.
   (D) Hepatopancreatic duct and duodenum.

10. The common bile duct in human is formed by the joining of:
    (A) Pancreatic duct and bile duct
    (B) Cystic duct and hepatic duct
    (C) Cystic duct and pancreatic duct
    (D) Hepatic duct and pancreatic duct

11. How does a gastrovascular cavity differ from an alimentary canal? The gastrovascular cavity
    (A) Stores food but does not digest it.
    (B) Is usually much larger.
    (C) Has only one opening.
    (D) Functions in digestion but not absorption.

12. True stomach in cud-chewing animals is:
(A) Abomasum   (B) Reticulum
(C) Omasum   (D) Rumen

13. How would you expect the digestive system of a hawk, a carnivore, to be compared with that of a sparrow, a seed-eater?
(A) The hawk would have a larger gastro-vascular cavity.
(B) The sparrow's digestive system would be longer.
(C) The hawk would have a gizzard, but the sparrow would not.
(D) The hawk's digestive system would be longer.

14. Hydroponics is a method of
(A) Study of the development of soil
(B) Study of soil protection
(C) Growth of plants in liquid culture medium
(D) Growing plants in laboratory

15. The number of essential elements required for normal growth of plant is -
(A) 10   (B) 16
(C) 20   (D) 25

16. The deficiency of which vitamin is known to cause abortion in early pregnancy of rat?
(A) Retinol   (B) Calciferol
(C) Cobalamin   (D) Napthoquinone

17. Glottis is a structure which:
(A) Prevents entry of food into windpipe during swallowing food.
(B) Allows food to pass into oesophagus.
(C) Produces sound as air is forced through it.
(D) Allows air to enter in trachea.

18. Which of the following food reserves would be first used in a starving person?
(A) Muscle proteins
(B) Skin adipose tissue
(C) Liver glycogen
(D) Liver proteins

19. When gall bladder of a man is removed:
(A) Fat digestion is not possible.
(B) Acidity continues in duodenum.
(C) Effect of pancreatic juice upon food is impaired.
(D) All of the above

20. When a piece of bread is chewed, it tastes sweet because:
(A) The sugar contents are drawn out.
(B) Saliva converts starch into maltose.
(C) It does not taste sweet.
(D) The taste buds are stimulated by chewing.

21. Herbivorous animals can digest cellulose because:
(A) Their molar and premolar teeth can crush and grind the food.
(B) Bacteria present in their caecum help in digestion of cellulose.
(C) Gastric juice has a digestive enzyme for cellulose digestion.
(D) Alimentary canal is very long.

22. Duct leading from parotid gland and opening into vestibule is:
(A) Wharton's duct   (B) Stensen's duct
(C) Wolffian duct   (D) Infra-orbital

EXERCISE - III

MULTIPLE CHOICE QUESTIONS

1. Complete digestive juice having enzymes to digest all types of organic materials is secreted by - **[NSEJS/Stage-I/2010-11]**
(A) salivary gland and pancreatic gland.
(B) gastric gland and pancreatic gland.
(C) salivary gland and intestinal gland.
(D) pancreatic gland and intestinal gland

2. Consider the following statements. Choose the correct option.
(i) The portion of spectrum between 500 nm and 800 nm is also referred to as photosynthetically active radiation (PAR).
(ii) Magnesium, calcium and chloride ions play prominent roles in the photolysis of water.
(iii) In cyclic photophosphorylation, oxygen is not released (as there is no photolysis of water) and NADPH is also not produced.
(A) (i) is true but (ii) and (iii) are false
(B) (i) and (ii) are false but (iii) is true
(C) (ii) is true but (i) and (iii) are false
(D) (i) and (ii) are true but (iii) is false

3. Organism that does not evolve O_2 during photosynthesis is:
(A) Funaria   (B) Anabaena
(C) Rhodospirillum   (D) Nostoc

4. The diagram below shows ATP synthesis through chemiosmosis. Which option shows the correct labelling of 1, 2, 3 and 4 in the diagram ?

(A) 1 - F_1, 2 - Thylakoid membrane, 3 - Photosystem-I, 4 - Photosystem-II
(B) 1 - F_0, 2 - Thylakoid membrane, 3 - Photosystem-I, 4 - Photosystem-II
(C) 1 - F_1 2 - Thylakoid membrane, 3 - Photosystem-II, 4 - Photosystem-I
(D) 1 - F_0, 2 - Thylakoid membrane, 3 - Photosystem-II, 4 - Photosystem-I

5. Which of the following statements are correct?
(i) Photorespiration is favoured by high O_2 low CO_2, rise in temperature, high light intensity.
(ii) Chloroplasts of cells of bundle sheath of C_4 plants are granal, have PEP Co PEP Case but no RuBis Co.
(iii) Chloroplasts of mesophyll cells of C_4 plant are granal, have PEP Co PEP Case but no RuBis Co.
(iv) Maize and Sorghum are C_4 plants.
(A) All are correct except (ii)
(B) (i) and (iv)
(C) (ii) and (iii)
(D) Only (iv)

6. Accumulation of food in assimilatory cells results in:
(A) Increase in the rate of photosynthesis
(B) Decrease in the rate of photosynthesis
(C) No effect
(D) May increase or decrease.
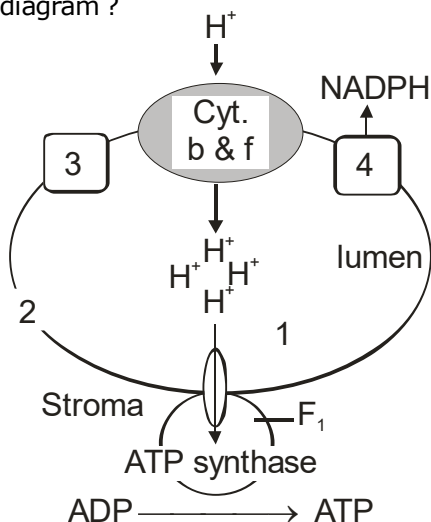
7. The graph below shows the result of experiment in which isotopes of oxygen were used to distinguish between oxygen absorbed by plants and oxygen given out. A mixture of the oxygen istopes $^{16}O_2$ and $^{18}O_2$ was supplied to a suspension of the unicellular alga Chlorella which had previously been exposed to $^{16}O_2$ only. During the following hour changes in the concentration of these gases in the suspension were measured. The $^{18}O_2$ concentration fell in light because it was:
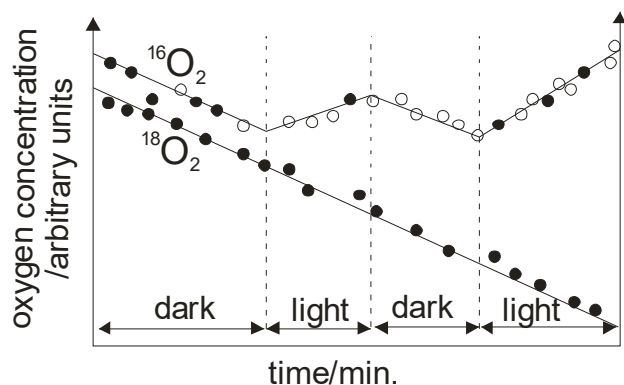
(A) Undergoing radioactive decay to from $^{16}O_2$
(B) Absorbed in respiration but was not being produced in photosynthesis.
(C) Absorbed in respiration slower than it was being produced in photosynthesis.
(D) Absorbed as C $^{18}O_2$ in photosynthesis.

8. Assume a thylakoid is somehow punctured so that the interior of the thylakoid is no longer separated from the stroma. This damage will have the most direct effect on which of the following processes?
    (A) The splitting of water.
    (B) The absorption of light energy by chlorophyll.
    (C) The flow of electrons from photosystem II to photosystem I.
    (D) The synthesis of ATP.

9. The rate of photosynthesis of a freshwater plant is measured using five spectral colours. Which sequence of colours would give an increasing photosynthetic response?
    smallest → largest response
    (A) Blue → Green → Yellow → Orange → Red
    (B) Green → Yellow → Orange → Red → Blue
    (C) Red → Orange → Yellow → Green → Blue
    (D) Yellow → Green → Orange → Blue → Red

10. DNase and RNase are enzymes secreted by:
    (A) Pancreas   (B) Stomach
    (C) Gall bladder   (D) Intestine

11. Diastema is a toothless gap in the jaws of rabbit between:
    (A) Premolars and molars
    (B) Incisors and molars
    (C) Canines and molars
    (D) Incisors and premolar

12. The part of the digestive system that digests lipids in the food is :
    [NSEJS/Stage-I/2009-10]
    (A) stomach   (B) duodenum
    (C) ileium   (D) large intestine

13. The below diagram represents a section of small intestinal mucosa showing villi. Identify 1, 2, 3 and 4.
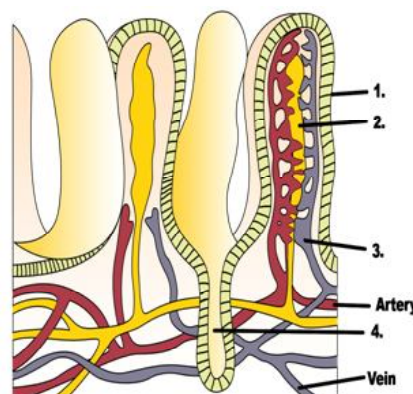
    (A) 1-Villi, 2-Lacteal, 3-Capillaries, 4-Crypts
    (B) 1-Lacteal, 2-Villi, 3-Capillaries, 4-Crypts
    (C) 1-Villi, 2-Lacteal, 3-Crypts, 4-Capillaries
    (D) 1-Crypts, 2-Lacteal, 3-Capillaries, 4-Villi

14. Which of the following is/are correct statements regarding beri-beri?
    (i)   A crippling disease prevalant among the native population of sub-Saharan Africa.
    (ii) A deficiency disease caused by lack of thiamine (vitamin B_1).
    (iii) A nutritional disorder in infants and young children when the diet is persistently deficient in essential protein.
    (iv) Occurs in those countries where the staple diet is polished rice.

(v) The symptoms are pain, paralysis, muscle, cramps, progressive oedema, mental deterioration and finally heart failure.

(A) (i), (ii) and (v)   (B) (i), (ii) and (iv)

(C) (i), (iii) and (v)   (D) (ii), (iv) and (v)

15. If the chyme of a person who had orally consumed only starch as food is analysed before it enters the duodenum, it will show the presence of:

(A) Maltose and glucose

(B) Dextrin and maltose

(C) Starch, dextrin and maltose

(D) Starch, dextrin and glucose

16. Two groups isolated thylakoids are placed in an acidic bathing solution so that H^+ diffuse into the thylakoids. They are then transferred to a basic bathing solution, and one group is placed in the light, while the other group is kept in the dark. Select the choice given below that describes what you expect each group of thylakoids to produce.

(A)
In Light	In Dark
ATP only	Nothing

(B)
ATP, O_2	ATP only

(C)
ATP, O_2 Glucose	ATP, O_2

(D)
ATP, O_2	O_2

17. The ointment prescribed for burns usually contains, among other ingredients,

[NSEJS/Stage-I/2010-11]

(A) vitamin A   (B) vitamin B

(C) vitamin D   (D) vitamin E

18. In the leaves of C_4 plants, malic acid formation during CO_2 fixation occurs in the cells of:

(A) Epidermis   (B) Mesophyll

(C) Bundle Sheath (D) Phloem

19. Unsaturated fatty acids contain

[NSEJS/Stage-I/2011-12]

(A) atleast one double bond

(B) two double bonds

(C) more than two double bonds

(D) no double bond

20. A child having protruding belly, bulging eyes, thin and curved legs and peeling skin is likely to be suffering from

[NSEJS/Stage-I/2010-11]

(A) kwashiorkor   (B) rickets

(C) marasmus   (D) xerophthalmia

21. Ampulla of Vater is guarded by:

(A) Sphincter of Oddi

(B) Pyloric sphincter

(C) Cardiac sphincter

(D) Anal sphincter

22. Excessive stimulation of vagus nerve in humans may lead to:

(A) Hoarse voice

(B) Peptic ulcers

(C) Efficient digestion of proteins

(D) Irregular contractions of diaphragm

23. The given diagram shows the duct systems of liver, gall bladder and pancreas in which few structures are marked as A, B, C and D. On the basis of this figure, answer the questions.
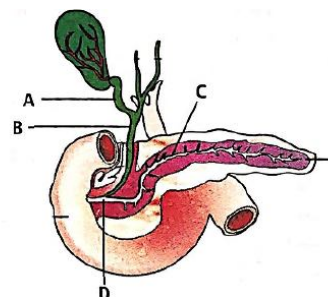
Sphincter of Oddi controls the flow of digestive juice by guarding which duct?

(A) A   (B) B

(C) D   (D) C

MATHEMATICS

CLASS - X
BOOKLET - 1

ARITHMETIC PROGRESSIONS

TRIANGLE

COORDINATE GEOMETRY

INTRODUCTION TO TRIGONOMETRY

ANSWER KEY

1

REAL NUMBERS

- **CLASSIFICATION OF NUMBERS**
- **EUCLIDS DIVISION LEMMA**
- **EUCLIDS DIVISION ALGORITHM**
- **THEOREM ON RATIONAL NUMBER**
- **FUNDAMENTAL THEOREM OF ARITHMETIC**
- **PROOF OF IRRATIONALITY**

INTRODUCTION

In the previous class, we have learnt about real numbers which are not rational numbers and hence the existence of irrational numbers such as, $\sqrt{2}, \sqrt{3}, \sqrt{5}$, etc. In this chapter, we will learn some more properties of the positive real numbers. We will introduce two very important properties of positive integers. Euclid's division algorithm and the Fundamental Theorem of Arithmetic. We will also learn about some of their applications. With the help of the Fundamental Theorem of Arithmetic, we will establish (i) the irrationality of the numbers, like $\sqrt{2}, \sqrt{3}$ and $\sqrt{5}$ and (ii) the nature of the decimal expansion of a rational number of the form $\frac{p}{q}(q \neq 0)$, i.e., when will the decimal expansion of $\frac{p}{q}$ is terminating and when will it be non-terminating recurring (repeating). For example, decimal expansion of $\frac{2}{5}$ is 0.4 which is terminating whereas the decimal expansion of $\frac{1}{3}$ is 0.3333... which is non-terminating recurring. In this chapter, we will learn the logical reason for this behaviour of the rational numbers of the form $\frac{p}{q}(q \neq 0)$.

BASIC CONCEPTS AND IMPORTANT DEFINITIONS

(A) **Natural numbers :** Counting numbers are called natural numbers. We start counting from 1, so 1 is the smallest natural number. A set of natural numbers is denoted by N. Thus,

N = {1, 2, 3, ...}

(B) **Whole numbers :** Natural numbers together with zero are called whole numbers. A set of whole numbers is denoted by W. Thus,

W = {0, 1, 2, 3, ...}

All natural numbers are whole numbers but all whole numbers are not natural numbers. Only the difference between whole numbers and natural numbers is the number zero (0).

(C) **Integers :** All natural numbers and negatives of natural numbers together with zero are called integers. A set of integers denoted by Z or I. Thus,

Z = {.... − 6, − 5, − 4, −3, − 2, −1, 0, 1, 2, 3, 4, 5, 6 ....}

(D) **Rational numbers :** A number of the form $\dfrac{p}{q}$, where p and q are integers and q ≠ 0 is called a rational number. For example, $\dfrac{2}{7}$, $\dfrac{-3}{8}$, 2, 0, etc., are rational numbers.

The decimal expansion of a rational number is either terminating or non-terminating repeating one.

(E) **Irrational numbers :** A number which is not a rational number, i.e., which cannot be written in the form $\dfrac{p}{q}$, p and q ∈ Z or I and q ≠ 0, is known as an irrational number. For example, $\sqrt{2}$, $-\sqrt{3}$, $7\sqrt{5}$, $\dfrac{1}{\sqrt{2}}$, $1 + \sqrt{6}$, etc., are irrational numbers.

The decimal expansion of an irrational number is non-terminating and non-repeating one.

(F) **Real numbers :** All rational and irrational numbers together make up a collection, called real numbers.

Note : *All natural numbers, integers, rational numbers and irrational numbers are real numbers.*

(G) **Prime Numbers :** All natural numbers that have one and itself only as their factors are called prime number i.e. prime numbers are exactly divisible by 1 and themselves e.g. 2, 3, 5, 7, 11, 13, 17, 19, 23.....etc.If P is the set of prime number then P = {2, 3, 5, 7,.......}

(H) **Composite Numbers :** All natural numbers, which are not prime are composite numbers. If C is the set of composite number then C = {4, 6, 8, 9, 10, 12, ...}.

1 is neither prime nor composite number.

Co-prime Numbers : If the H.C.F. of the given numbers (not necessarily prime) is 1 then they are known as co-prime numbers e.g. 4, 9 are co-prime as H.C.F. of (4, 9) = 1.

Any two consecutive natural numbers will always be co-prime.

EUCLID'S DIVISION LEMMA

For any two given positive integers a and b, there exist unique whole numbers q and r such that:

a = b × q + r, where 0 ≤ r < b

$$2\overline{\smash{\big)}\,5}\ \big(2$$
$$\underline{-\ 4}$$
$$1$$

$$b\overline{\smash{\big)}\,a}\ \big(q$$
$$\underline{-qb}$$
$$r$$

Here, a is called the dividend, b the divisor, q the quotient and r is called the remainder. For example, when we divide 5 by 2, we get 2 as quotient and 1 as remainder

Here $5 = 2 \times 2 + 1$

∴   Dividend = Divisor × Quotient + Remainder

Info Bubble

- In the relation $a = b \times q + r$, $0 \leq r < b$, q and r are unique whole numbers corresponding to the given pair of positive integers a and b.
- Although Euclid's division lemma is stated for only positive integers a and b but it is also true when a and $b \neq 0$ are any kind of integers. However, we shall restrict our discussion to only positive integers.

Info Bubble

- Every even integer is of the form 2m, where m is some integer.
- Every odd integer is of the form $2m + 1$, where m is some integer.
- 0 is neither even nor odd generally but it is considered as even many times.

Properties of Euclid's Division Lemma :

(i)   If an integer c be a divisor of each of the two given integers a and b, then we say that c is a common factor of both a and b.

(ii)   Let P be a prime number and if a,b, are integers such that $\dfrac{ab}{P}$ is an integer, then either P is a factor of a or b or both.

Info Bubble

- If a prime number divides a product of integers, then it necessarily divides either of the integers.
- If a prime P divides a^2, then it divides a also.

EUCLID'S DIVISION ALGORITHM

If 'a' and 'b' are positive integers such that $a = bq + r$, then every common divisor of 'a' and 'b' is a common divisor of 'b' and 'r', and vice-versa.

Step I : Apply Euclid's division lemma to a and b and obtain whole numbers q and r such that

$a = bq + r$, $0 \leq r < b$.

Step II : If r = 0, b is the HCF of a and b.

Step III : If r ≠ 0, apply Euclid's division lemma to b and r and continue this process till r = 0.

The divisor at this stage is HCF of a and b.

PRACTICE YOUR CONCEPTS

1. Prove that square of any odd integer is of the form 8k + 1, Where k an integer.

Ans. For any odd integer is of the form 2m + 1 and $(2m + 1)^2 = 4m^2 + 4m + 1$

= 4 m (m + 1) + 1

Now, m (m + 1) is alwyas even, say 2k, hence 4m(m + 1) = 4 × 2k

⇒ $(2m + 1)^2 = 8k + 1$

2. Show that any positive odd integer is of the form 6q + 1. or 6q + 3. or 6q + 5. where q is some integer.

Ans. Let a be any positive integer and b = 6

∴ by Euclid's division lemma

a = bq + r, 0 ≤ r < b

and q be any integer, q ≥ 0

∴ a = 6q + r

where r = 0, 1, 2, 3, 4, 5,

because 0 ≤ r < 6.

If a is of the form 6q, 6q + 2, 6q + 4, then a is an even integer.

As,   a = 6q = 2(3q),

or   a = 6q + 2 = 2(3q + 1),

or   a = 6q + 4 = 2(3q + 2).

∴ a is an even integer.

but if a = 6q + 1

      = 2(3q) + 1 = 2n + 1,

or   a = 6q + 3 = 6q + 2 + 1,

      = 2(3q + 1) + 1 = 2n + 1,

or   a = 6q + 5 = 6q + 4 + 1

      = 2(3q + 2) + 1 = 2n + 1,

then a is an odd positive integer.

3. Prove that $n^2 - n$ is divisible by 2 for every positive integer n.

Ans. We know that any positive integer is of the form 2q or 2q + 1, for some integer q.

So, following cases arise.

Case I When n=2q

In this case, we have

⇒ $n^2 - n = (2q)^2 - 2q = 4q^2 - 2q = 2q (2q - 1)$

⇒ $n^2 - n = 2r$, where r = q (2q - 1)

$n^2 - n$ is divisible by 2

Case II When n = 2q + 1

In this case, we have

$n^2 - n = (2q + 1)^2 - (2q + 1) = (2q + 1)(2q + 1)(2q + 1 - 1) = 2q(2q + 1)$

$n^2 - n = 2r$, where $r = q(2q + 1)$

$n^2 - n$ is divisible by 2.

Hence, $n^2 - n$ is divisible by 2 for every positive interger n.

4. Use Euclid's division algorithm to find the HCF of 210 and 55.

Ans. Given integers are 210 and 55. Clearly, 210 > 55. Applying Euclid's division lemma to 210 and 55, we get

$210 = 55 \times 3 + 45$

$$\begin{array}{r} \because\ 55\overline{)210}(3 \\ 165 \\ \hline 45 \end{array}$$

Since the remainder $45 \neq 0$. So, we apply the division lemma to the divisior 55 and remainder 45 to get

$55 = 45 \times 1 + 10$

$$\begin{array}{r} \because\ 45\overline{)55}(1 \\ 45 \\ \hline 10 \end{array}$$

Now, we apply division lemma to the new divisor 45 and new remainder 10 to get

$45 = 10 \times 4 + 5$

$$\begin{array}{r} \because\ 10\overline{)45}(4 \\ 40 \\ \hline 5 \end{array}$$

We now consider the new divisor 10 and the new remainder 5, and apply division lemma to get

$10 = 5 \times 2 + 0$

$$\begin{array}{r} \because\ 5\overline{)10}(2 \\ 10 \\ \hline 0 \end{array}$$

The remainder at this stage is zero. So, the divisor at this stage or the remainder at the previous stage i.e. 5 is the HCF of 210 and 55.

5. Use Euclid's algorithm to find the HCF of 4052 and 12576.

Ans. Using $a = bq + r$, where $0 \leq r < b$.

Clearly, 12576 > 4052   [a = 12576 , b = 4052]

$\Rightarrow$ $12576 = 4052 \times 3 + 420$

$\Rightarrow$ $4052 = 420 \times 9 + 272$

$\Rightarrow$ $420 = 272 \times 1 + 148$

$\Rightarrow$ $272 = 148 \times 1 + 124$

$\Rightarrow$ $148 = 124 \times 1 + 24$

$\Rightarrow$ 124 = 24 × 5 + 4

$\Rightarrow$ 24 = 4 × 6 + 0

The remainder at this stage is 0. So, the divisor at this stage, i.e., 4 is the HCF of 12576 and 4052.

6. Find the HCF of 1848, 3058 and 1331.

Ans. Two numbers 1848 and 3058, where 3058 > 1848

3058	=	1848 × 1 + 1210
1848	=	1210 × 1 + 638 [Using Euclid's division algorithm to the given number 1848 and 3058]
1210	=	638 × 1 + 572
638	=	572 × 1 + 66
572	=	66 × 8 + 44
66	=	44 × 1 + 22
44	=	22 × 2 + 0

Therefore HCF of 1848 and 3058 is 22.

HCF (1848 and 3058) = 22

Let us find the HCF of the numbers 1331 and 22.

1331 = 22 × 60 + 11

22 = 11 × 2 + 0

∴   HCF of 1331 and 22 is 11

$\Rightarrow$ HCF (22, 1331) = 11

Hence the HCF of the three given numbers 1848, 3058 and 1331 is 11.

HCF (1848, 3058, 1331) = 11

7. What is the largest number that divides 626, 3127 and 15628 and leaves remainders of 1, 2 and 3 respectively.

Ans. Clearly, the required number is the H.C.F. of the numbers 626 − 1 = 625, 3127 − 2 = 3125 and 15628 − 3 = 15625.

Using Euclid's division lemma to find the H.C.F. of 625 and 3125.

3125 = 625 x 5 + 0

Clearly, H.C.F. of 625 and 3125 is 625.

Now, H.C.F. of 625 and 15625

15625 = 625 x 25 + 0

So, the H.C.F. of 625 and 15625 is 625

Hence, H.C.F. of 625, 3125 and 15625 is 625.

Hence, the required number is 625.

FUNDAMENTAL THEOREM OF ARITHMETIC

Every composite number can be expressed as a product of primes and this factorization is unique, apart from the order in which the prime factors occur.

Note : *Any number of the form a^n will end with the digit zero if prime factors of a^n would contain 5 and 2 as prime factors, where $n \in N$.*

> **Info Bubble**
>
> - If $a = p \times p \times \ldots \ldots \times p$, where p is a prime, then no prime number other than p can divide a.
>
> - If $a = p_1 \times p_2 \times \ldots \ldots \times p_n$ where $p_1, p_2 \ldots., p_n$ are primes such that $p_1 \leq p_2 \leq \ldots \ldots \leq p_n$ and $a = q_1 \times q_2 \times \ldots \ldots,$ where $q_1, q_2, \ldots \ldots$ are primes such that $q_1 \leq q_2 \leq \ldots \ldots$
>
>   Then there will be exactly n primes $q_1, q_2, \ldots., q_n$ in the second expression and also $q_1 = p_1, q_2 = p_2, \ldots., q_n = p_n$

Ex.1 **Determine the prime factorization of each of the following numbers:**
(i) 13915   **(ii) 556920**

Sol. (i) Using the prime factrorization tree, we have
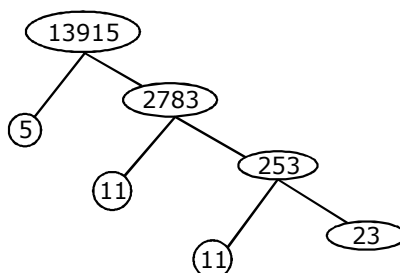
$\therefore$ 13975 = 5 × 11 × 11 × 23 = 5 × 11^2 × 23

(ii) Using the prime factrorization tree, we have
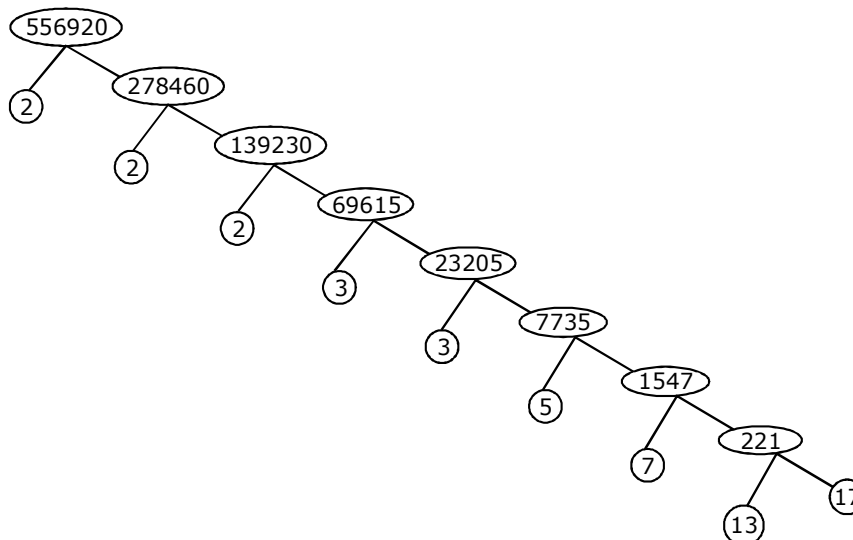
$\therefore$ 5256920 = 2 × 2 × 2 × 3 × 3 × 5 × 7 × 13 × 17 = 2^3 × 3^2 × 5 × 7 × 13 × 17

Ex.2 Prove that there is no natural number n for which 4^n ends with the digit zero.

Ans. We know that any positive integer ending with the digit zero is divisible by 5 and so its prime factorization must contain the prime 5.

We have,

$$4^n = (2^2)^n = 2^{2n}$$

The only prime in the factorization of 4^n is 2.

There is no other primes in the factorization of $4^n = 2^{2n}$

5 does not occur in the prime factorization of 4^n for any n.

4^n does not end with the digit zero for any natural number n.

THEOREMS ON RATIONAL NUMBERS

(i) Let x be a rational number whose decimal expansion terminates. Then x can be expressed in the form $\frac{p}{q}$, where p and q are co-prime, and the prime factorization of q is of the form $2^n 5^m$, where n, m are non-negative integers.

(ii) Conversely, Let $x = \frac{p}{q}$ be a rational number, such that the prime factorization of q is of the form $2^n 5^m$, where n, m are non-negative integers. Then x has a decimal expansion which terminates.

(iii) Let $x = \frac{p}{q}$ be a rational number such that the prime factorization of q is not of the form $2^n 5^m$, where n, m are non-negative integers. Then x has a decimal expansion which is non-terminating repeating (recurring).

Note : (i) HCF(p, q) × LCM (p, q) = (p × q), where p and q are positive integers.

(ii) HCF(p, q, r) × LCM(p, q, r) ≠ (p × q × r), where p, r and q are positive integers.

$$LCM(p, q, r) = \frac{p \times q \times r.HCF(p,q,r)}{HCF(p,q).HCF(q,r).HCF(p,r)}$$

$$HCF(p, q, r) = \frac{p \times q \times r.LCM(p,q,r)}{LCM(p,q).LCM(q,r).LCM(p,r)}$$

> **Info Bubble**
>
> - The product of two positive integers is equal to the product of their HCF and LCM, but the same is not true for three or more positive integers.
> - HCF is a factor of LCM.

PRACTICE YOUR CONCEPTS

8. Find the HCF of 96 and 404 by prime factorization method. Hence, find their LCM.

Ans. We have,

$96 = 2^5 \times 3$ and $404 = 2^2 \times 101$

$\therefore$ HCF = 2^2 = 4

Now, HCF × LCM = 96 × 404

$\Rightarrow$ LCM = $\dfrac{96 \times 404}{\text{HCF}} = \dfrac{96 \times 404}{4}$ = 96 × 101 = 9696

9. There is a circular path around a sports field. Priya takes 18 minutes to drive one round of the field, while Ravish takes 12 minutes for the same. Suppose they both start at the same point and at the same time, and go in the same direction. After how many minutes will they meet again at the starting point ?

Ans. Required number of minutes is the LCM of 18 and 12.

We have,

18 = 2 × 3^2 and 12 = 2^2 × 3

$\therefore$ LCM of 18 and 12 is 2^2 × 3^2 = 36

Hence, Ravish and Priya will meet again at the starting point after 36 minutes.

10. Rahul, Navin and Vinay have pieces of lands in the form of circles of diameters 10m, 12m and 16m. With the help of ropes each of them calculates the ratio of the circumference to length of diameters of their respective fields.

(a) Calculate the HCF of their ratios.

(b) What values are shown?

Ans. (a) Their HCF is π. The HCF of their ratios will be π because ratio of circumference to diameter is knwon as π and value of π don't varies circles to circle.

Values

- Concept of π i.e. definition of π.
- Reason why π is an irrational number.
- Each irrational number is not π.

11. A class of 20 boys and 15 girls is divided into n groups so that each group has x boys and y girls. Find x, y and n. What values are referred in a class.

Ans. HCF of 20 and 15 = 5

So n = 5 groups

no. of students in one group = $\dfrac{20 + 15}{5} = \dfrac{35}{5} = 7$

Total number of girls in each group x = $\dfrac{20}{5}$ = 4

no. of boys in each group = $\dfrac{15}{5}$ = 3

Values

- Promote coeducation.
- Promote and help to educate girl child.
- Role of activity in groups.
- Increasing healthy and friendly environment at school level.

PROVING IRRATIONALITY OF NUMBERS

In class IX, we have learnt about irrational numbers and their propeties. We have also learnt about the existence of irrational numbers and their representation on the number line. Recall that a number is an irrational number if it cannot be written in the form $\frac{p}{q}$, where p and q are integers and $q \neq 0$. For example, $\sqrt{2}, \sqrt{3}, \sqrt{7}, \frac{\sqrt{2}}{\sqrt{5}}, \pi$ etc. are irrational numbers. In this section, we will prove that $\sqrt{2}, \sqrt{3}, \sqrt{5}$ etc. are irrational numbers by using the Fundamental Theorem of Arithmetic.

In fact, for any prime number p, $\sqrt{p}$ is an irrational number. In proving the irrationality of these numbers, we will use the result that if a prime p divides a^2, then it divides a also. We will prove the irrationality of numbers by using the method of contradiction. In class IX, we have also learnt that the sum or difference of a rational and and irrational number is an irrational number. Also, the product and quotient of a non-zero rational number and an irrational number is an irrational number.

PRACTICE YOUR CONCEPTS

12. Prove that $\sqrt{2}$ is an irrational number.

Ans. Let assume on the contrary that $\sqrt{2}$ is a rational number.

Then, there exists positive integer a and b such that

$\sqrt{2} = \frac{a}{b}$ where, a and b are coprimes i.e. their HCF is 1.

$\Rightarrow \quad \left(\sqrt{2}\right)^2 = \left(\frac{a}{b}\right)^2 \quad \Rightarrow \quad 2 = \frac{a^2}{b^2}$

$\Rightarrow \quad a^2 = 2b^2$ |

$\Rightarrow \quad a^2$ is a multiple of 2

$\Rightarrow \quad a$ is a multiple of 2   ....(i)

a = 2c for some integer c.

$\Rightarrow \quad a^2 = 4c^2$

$\Rightarrow \quad 2b^2 = 4c^2$

$\Rightarrow \quad b^2 = 2c^2$

$\Rightarrow \quad b^2$ is a multiple of 2

$\Rightarrow \quad b$ is a multiple of 2   ....(ii)

For (i) and (ii), a and b have at least 2 as a common factor. But this contradicts the fact that a and b are co-prime. This means that $\sqrt{2}$ is an irrational number.

13. Show that $5 - \sqrt{3}$ is an irrational number.

Ans. Suppose $5 - \sqrt{3}$ is a rational number (say p)

Then $5 - \sqrt{3} = p$

$\Rightarrow \qquad 5 - p = \sqrt{3}$

Since p is a rational number and 5 is also a rational number.

$\therefore$ 5 – p being the difference of two rational numbers is a rational number because the set of rational numbers is closed w.r.t. the operation of subtraction.

So, $\sqrt{3}$ should be a rational number But, it is an irrational number

$\Rightarrow \qquad$ Our supposition is wrong. Hence $5 - \sqrt{3}$ is irrational number.

14. If n is any positive integer, then prove that $\sqrt{n+1} + \sqrt{n-1}$ is an irrational number.

Ans. Let us suppose that $\sqrt{n+1} + \sqrt{n-1}$ is rational, we can write

$$\sqrt{n+1} + \sqrt{n-1} = \frac{p}{q} \qquad \qquad \ldots\text{(i)}$$

where p and q are integers and $q \neq 0$.

Certainly $p \neq 0 \qquad \left(\because \sqrt{n+1} \neq \sqrt{n-1} \right)$

Taking reciprocals on both sides of (i), we obtain

$$\frac{1}{\sqrt{n+1} + \sqrt{n-1}} = \frac{q}{p}$$

$$\Rightarrow \qquad \frac{\sqrt{n+1} - \sqrt{n-1}}{(\sqrt{n+1} + \sqrt{n-1})(\sqrt{n+1} - \sqrt{n-1})} = \frac{q}{p} \qquad \text{(rationalising)}$$

$$\Rightarrow \qquad \frac{\sqrt{n+1} - \sqrt{n-1}}{n+1 - (n-1)} = \frac{q}{p}$$

$$\Rightarrow \qquad \sqrt{n+1} - \sqrt{n-1} = \frac{2q}{p} \qquad \qquad \ldots\text{(ii)}$$

Adding (i) and (ii), we get

$$2\sqrt{n+1} = \frac{p}{q} + \frac{2q}{p} = \frac{p^2 + 2q^2}{pq}$$

$$\Rightarrow \qquad \sqrt{n+1} = \frac{p^2 + 2q^2}{2pq} \qquad \qquad \ldots\text{(iii)}$$

Subtracting (ii) from (i), we get

$$2\sqrt{n-1} = \frac{p}{q} - \frac{2q}{p} = \frac{p^2 - 2q^2}{pq}$$

$$\Rightarrow \qquad \sqrt{n-1} = \frac{p^2 - 2q^2}{2pq} \qquad \qquad \ldots\text{(iv)}$$

Now (iii) and (iv) show that $\sqrt{n+1}$ and $\sqrt{n-1}$ are rationals [$\because$ RHS in either case is rational]

and $n+1 = \left(\dfrac{p^2 + 2q^2}{2pq}\right)^2$, $n-1 = \left(\dfrac{p^2 + 2q^2}{2pq}\right)^2$ are perfect squares of positive integers.

($\because$ Square of a non-integral rational number is always non-integral)
which is not possible as n + 1 and n − 1 differ by 2 and squares of any two positive integers must differ atleast by 3.
($\because$ $(m + 1)^2 - m^2 = 2m + 1 \geq 3$ for any positive integer m)

Hence, our supposition is wrong and $\sqrt{n+1} + \sqrt{n-1}$ cannot be rational for any positive integer n.

15. Prove that $\sqrt{p} + \sqrt{q}$ is irrational, where p, q are primes.

Ans. Let $\sqrt{p}$ is rational so that it can be written in the form of $\dfrac{a}{b}$.

$\sqrt{p} = \dfrac{a}{b}$ (where a and b are coprimes)

Squaring both sides, $p = \dfrac{a^2}{b^2}$

a^2 has a factor p.
$\qquad pb^2 = a^2$ ...(i)
So, a also has a factor p.
So,   a = pc
$\qquad a^2 = p^2c^2$
Put the value of a^2 in equation (i).
$\qquad pb^2 = p^2c^2$
$\qquad b^2 = pc^2$
b^2 has a factor p, $\because$ b has a factor p
Now, a and b have common factor p.
But as stated earlier a, b are coprimes.
So, our supposition is wrong.

$\sqrt{p}$ must be irrational number. (where p is prime number)

we can prove $\sqrt{q}$ is also an irrational number. (where q is prime number)

Sum of two irrational numbers is irrational if both are prime numbers.

So, $\sqrt{p} + \sqrt{q}$ is an irrational number. (Hence proved)

16. Without actually performing the long division, state whether $\dfrac{\mathbf{13}}{\mathbf{3125}}$ will have a terminating decimal expansion or a non-terminating repeating decimal expansion:

Ans. (i) $\dfrac{13}{3125}$

prime factorisation of

$3125 = 5 \times 5 \times 5 \times 5 \times 5 = 5^5$

$\therefore \dfrac{13}{3125} = \dfrac{13}{5^5}$

$\therefore \dfrac{13}{3125}$ has terminating decimal expansion because prime factorisation of 3125 is of the form 5^5 or $2^n \times 5^m$.

$\therefore \dfrac{13}{3125}$ has terminating decimal expansion.

17. Check whether $43.\overline{123456789}$ is rational or not. If it is rational, and of the form $\dfrac{p}{q}$, what can you say about the prime factors of q?

Ans. $43.\overline{123456789}$

Let $x = 43.\overline{123456789}$ ...(i)

$\Rightarrow 1000000000x$

$= 43123456789.\overline{123456789}$ ...(ii)

Subtracting equation (i) from (ii), we get
$99999999x = 43123456746$

$\Rightarrow x = \dfrac{43123456746}{999999999}$

$= \dfrac{4791495194}{111111111}$

Prime factorisation of 111111111 is $= 3^2 \times 37 \times 333667$
So, it is rational having non-terminating decimal expansion.

ON YOUR TIPS

- Euclid's division lemma : Given positive integers a and b, there exists unique whole numbers q and r satsfying $a = bq + r$, $0 \le r < b$.
- HCF is highest common factor of any two or more numbers (or algebraic expressions).
- LCM is least common multiple of any two or more numbers (or algebraic expressions).
- Multiplication of LCM and HCF of two numbers is equal to multiplication of two numbers.

- LCM of $\left(\dfrac{a}{b}, \dfrac{p}{q}, \dfrac{\ell}{m}\right) = \dfrac{\text{LCM of } (a, p, \ell)}{\text{HCF of } (b, q, m)}$

- HCF of $\left(\dfrac{a}{b}, \dfrac{p}{q}, \dfrac{\ell}{m}\right) = \dfrac{\text{HCF of } (a, p, \ell)}{\text{LCM of } (b, q, m)}$

- LCM of a rational and an irrational number is not defined.

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NCERT QUESTIONS WITH SOLUTIONS

EXERCISE 1.1

1. Use Euclid's division algorithm to find the HCF of:

(i) 135 and 225

(ii) 196 and 38220

(iii) 867 and 255

Sol. (i) Given numbers are 135 and 225. On applying Euclid's Division Algorithm, we have

225 =135 x 1 + 90

135 =90 x 1 + 45

90 =45 x 2

So, HCF of 135 and 225 is 45. Notice that

45 = HCF (90, 45)

= HCF (90, 135)

= HCF (225, 135).

(ii) Given numbers are 196 and 38220.

On applying Euclid's Division Algorithm,

38220 =196 x 195 + 0

So, HCF of 196 and 38220 is 196.

(iii) Given numbers are 867 and 255.

On applying Euclid 's Division Algorithm,

867 =255 x 3 + 102

255 =102 x 2 + 51

102 =51 x 2 + 0

So, HCF of 867 and 255 is 51.

51 = HCF (102, 51)

= HCF (255, 102)

= HCF (867, 255).

2. Show that any positive odd integer is of the form 6q + 1, or 6q + 3, or 6q + 5, where q is some integer.

Sol. Let a be any positive integer and b = 6. Then, by Euclid's algorithm, a = 6q + r, for some integer q $\geq$ 0, and r = 0, 1, 2, 3, 4, 5, because 0 $\leq$ r < 6. Now substituting the value of r, we get, If r = 0, then a = 6q Similarly, for r= 1, 2, 3, 4 and 5, the value of a is 6q+1, 6q+2, 6q+3, 6q+4 and 6q+5, respectively. If a = 6q, 6q+2, 6q+4, then a is an even number and divisible by 2. A positive integer can be either even or odd Therefore, any positive odd integer is of the form of 6q+1, 6q+3 and 6q+5, where q is some integer.

3. An army contingent of 616 members is to march behind an army band of 32 members in a parade. The two groups are to march in the same number of columns. What is the maximum number of columns in which they can march?

Sol. Maximum number of columns = HCF of (616, 32). No. of members in army contingent = 616. No. of members in an army band = 32. By Euclid's division lemma

616 = 32 x 19 + 8

32 = 8 x 4 + 0

$\therefore$ HCF (616, 32) =8

They can march in 8 columns

4. Use Euclid's division lemma to show that the square of any positive integer is either of the form 3m or 3m + 1 for some integer m.

[Hint: Let x be any positive integer then it is of the form 3q. 3q + 1 or 3q + 2. Now square each of these and show that they can be rewritten in the form 3m or 3m + 1.]

Sol. Let a be any positive integer and b = 3, then by Euclid's division lemma,

a = 3q + r, where q $\geq$ 0 and 0 $\leq$ r < 3

$\therefore$ a =3q, 3q + 1, 3q + 2

Square of these numbers are

$$a^2 = (3q^2) \text{ or } (3q + 1)^2 \text{ or } (3q + 2)^2$$

$$\Rightarrow a^2 = 9q^2 \text{ or } 9q^2 + 1 + 6q$$

$$\text{or } 9q^2 + 4 + 12q$$

These can be rewritten in the form

$$a^2 = 3(3q^2) \text{ or } 3(3q^2 + 2q) + 1$$

$$\text{or} \quad = 3(3q^2 + 4q + 1) + 1$$

$$a^2 = 3m \text{ or } 3m + 1$$

where m is integer

5. Use Euclid's division lemma to show that the cube of any positive integer is of the form 9m, 9m + 1 or 9m + 8.

Sol. Let a be any positive integer and b = 9. Then by Euclid's division lemma,

a = 9q + r where q ≥ 0 and 0 ≤ r < 9

So, a = 9q, 9q + 1, 9q + 2, 9q + 3, 9q + 4,

9q + 5, 9q + 6, 9q + 7, 9q + 8

All these numbers can be expressed as

a = 9q = 3(3q) = 3n, where n = 3q is any integer

$$a = 9q + 1 = 3(3q) + 1 = 3n + 1$$
$$a = 9q + 2 = 3(3q) + 2 = 3n + 2$$

Similarly,

a = 9q + 3 = 3(3q + 1) = 3n

where n = 3q + 1 is any integer.

$$a = 9q + 4 = 3(3q + 1) + 1 = 3n + 1$$
$$a = 9q + 5 = 3(3q + 1) + 2 = 3n + 2$$

Also,

a = 9q + 6 = 3(3q + 2) = 3n

where n = 3q + 2 is any integer

$$a = 9q + 7 = 3(3q + 2) + 1 = 3n + 1$$
$$a = 9q + 8 = 3(3q + 2) + 2 = 3n + 2$$

So, all numbers; a = 9q, 9q + 1, 9q + 2, 9q + 3, 9q + 4, 9q + 5, 9q + 6, 9q + 7 and 9q + 8 are expressed as 3n, 3n + 1, 3n + 2.

So, a = 3n, 3n + 1, 3n + 2

Cube of all these numbers.

$$a^3 = (3n)^3 = 9(3n^3) = 9m$$

where m = $3n^3$ is any integer.

Similarly,

$$a^3 = (3n + 1)^3$$
$$= (3n)^3 + 1^3 + 3(3n)(3n + 1)$$
$$= 9(3n^3 + 3n^2 + n) + 1$$
$$= 9m + 1,$$

where m = $3n^3 + 3n^2 + n$ is any integer.

Also,

$$a^3 = (3n + 2)^3$$
$$= (3n)^3 + (2)^3 + 3(3n)(2)(3n + 1)$$
$$= 9(3n^3 + 6n^2 + 4n) + 8$$

$$\Rightarrow a^3 = 9m + 8$$

where m = $3n^3 + 6n^2 + 4n$ is any integer.

So, the cube of any positive integer is of the form 9m, 9m + 1 and 9m + 8.

EXERCISE 1.2

1. Express each number as a product of its prime factors:

(i) 140   (ii) 156

(iii) 3825   (iv) 5005

(v) 7429

Sol. (i) 140

2	140
2	70
5	35
	7

∴   140 = 2 × 2 × 5 × 7

Product of prime factors are

$$= 2^2 \times 5 \times 7$$

(ii) 156

2	156
2	78
3	39
	13

∴   156 = 2 × 2 × 3 × 13

Product of prime factors are

$$= 2^2 \times 3 \times 13$$

(iii) 3825

5	3825
5	765
3	153
3	51
	17

∴   3825 = 5 × 5 × 3 × 3 × 17

Product of prime factors are

     = $5^2 × 3^2 × 17$

(iv) 5005

5	5005
7	1001
11	143
	13

∴   5005 = 5 × 7 × 11 × 3

Product of prime factors are

     = 5 × 7 × 11 × 13

(v) 7429

17	7429
19	437
	23

∴   7429 = 17 × 19 × 23

Product of prime factors are

     = 17 × 19 × 23

2.   Find the LCM and HCF of the following integers and verify that LCM x HCF = product of the two numbers.

(i) 26 and 91

(ii) 510 and 92

(iii) 336 and 54

Sol. (i) Numbers are 26 and 91.

    Prime factorisation of 26 and 91 are

       26 = 2 x 13

       91 = 7 x 13

So, HCF = 13

and LCM = 2 x 7 x 13 = 182

Verification :

LCM x HCF

=   Product of two numbers.

⇒   (2 x 7 x 13) x 13 = 26 x 91

⇒   2 x 13 x 7 x 13 = 26 x 91

⇒   26 x 91 = 26 x 91   Hence verified.

(ii) Numbers are 510 and 92.

    Prime factorisation of 510 and 92 are

    510 = 2 x 3 x 5 x 17

    92 = 2 x 2 x 23

    HCF = 2

    LCM = 2 x 2 x 3 x 5 x 17 x 23

       = $2^2 × 3 × 5 × 17 × 23$

∴   LCM = 23460

Verification :

LCM x HCF

=   Product of two numbers

⇒   23460 x 2 = 510 x 92

    46920 = 46920   Hence verified.

(iii) Numbers are 336 and 54.

    Prime factorisation are

    336 = 2 x 2 x 2 x 2 x 3 x 7

    54 = 2 x 3 x 3 x 3

    HCF = 2 x 3 = 6

    LCM = 2 x 3 x 2 x 2 x 2 x 3 x 3 x 7

    = $2^4 × 3^3 × 7 = 3024$

Verification :

LCM x HCF

=   Product of two numbers

    3024 x 6 = 336 x 54

    18144 = 18144   Hence verified.

3.   Find the LCM and HCF of the following integers by applying the prime factorisation method.

(i) 12, 15 and 21 (ii) 17, 23 and 29

(iii) 8, 9 and 25

Sol. (i) Numbers are 12, 15 and 21.

Prime factorisation of 12, 15 and 21 are

12 = 2 x 2 x 3

15 =3 x 5

21 = 3 x 7

HCF = 3

LCM = 2 x 2 x 3 x 5 x 7

$= 2^2 \times 3 \times 5 \times 7 = 420$

(ii) Numbers are 17, 23 and 29

Prime factorisation of 17, 23 and 29 are

17=17 x 1

23 =23 x 1

29 = 29 x 1

HCF = 1

LCM = 17 x 23 x 29 =11339

(iii) Numbers are 8, 9 and 25

Prime factorisation of 8, 9 and 25 are

8 = 2 x 2 x 2

9 = 3 x 3

25 = 5 x 5

HCF = 1

LCM = 2 x 2 x 2 x 3 x 3 x 5 x 5

$= 2^3 \times 3^2 \times 5^2 = 1800$

4. Given that HCF (306, 657) = 9, find LCM (306, 657).

Sol. HCF (306, 657) = 9   LCM = ?

We know that,

LCM x HCF = Product of two numbers.

$\Rightarrow$ LCM x 9 = 306 x 657

$\therefore$ $LCM = \dfrac{306 \times 657}{9} = 22338$

$\therefore$ LCM is 22338.

5. Check whether 6^n can end with the digit 0 for any natural number n.

Sol. If the number 6^n for any integer n ends with the digit zero, then it should be divisible by 5.

$\therefore$ Prime factorisation of 6^n must contain prime number 5.

But prime factorisation of 6^n are

$6^n = (2 \times 3)^n = 2^n \times 3^n$

It only contains prime numbers 2 and 3 in its prime factorisation.

Hence by uniqueness of Fundamental Theorem, there is no other prime number in the factorisation of 6^n.

So, there is no natural number n for which 6^n ends with the digit zero.

6. Explain why 7 x 11 x 13 + 13 and 7 x 6 x 5 x 4 x 3 x 2 x 1 + 5 are composite numbers.

Sol. Numbers are 7 x 11 x 13 + 13 and 7 x 6 x 5 x 4 x 3 x 2 x 1 + 5

I[st] number

= 7 x 11 x 13 + 13 = 13 (7 x 11 + 1)

= multiple of 13.

IInd number

= 7 x 6 x 5 x 4 x 3 x 2 x 1 + 5

= 5 (7 x 6 x 4 x 3 x 2 x 1 + 1)

= multiple of 5.

I[st] number is multiple of 13 and IInd number is multiple of 5.

Hence, both numbers are not prime numbers because prime numbers have only two factors, one and itself.

Therefore, they are composite numbers because they have more factors other than one and itself.

7. There is a circular path around a sports field. Sonia takes 18 minutes to drive one round of the field, while Ravi takes 12 minutes for the same. Suppose they both start at the same point and at the same time, and go

in the same direction. After how many minutes will they meet again at the starting point?

Sol. Sonia takes 18 minutes to drive one round.

Prime factorisation of 18 = 2 x 3 x 3

Ravi takes 12 minutes for the same.

Prime factorisation of 12 = 2 x 2 x 3

Time when they will meet at starting point

= LCM of 18 and 12 = 2 x 3 x 3 x 2

= 36 minutes.

EXERCISE 1.3

1. Prove that $\sqrt{5}$ is an irrational.

Sol. Let $\sqrt{5}$ is a rational number.

∴ $\sqrt{5} = \dfrac{a}{b}$, where a and b are co-primes and b ≠ 0.

Squaring both sides, we have

$5 = \dfrac{a^2}{b^2}$

⇒ $a^2 = 5b^2$ ⇒ 5 divides a^2.

Hence, 5 divides a.

Let a = 5c

So, $(5c)^2 = 5b^2$ ⇒ 25 $c^2 = 5b^2$

⇒ $5c^2 = b^2$

⇒ 5 divides b^2 and hence b.

∴ 5 is a common factor of a and b.

This is not possible as a and b are co-primes.

∴ our supposition is wrong.

Hence, $\sqrt{5}$ is an irrational.

2. Prove that $3 + 2\sqrt{5}$ is an irrational.

Sol. Let $3 + 2\sqrt{5}$ is a rational number.

∴ $3 + 2\sqrt{5} = \dfrac{a}{b}$; where a, b ∈ Z, b ≠ 0,

⇒ $2\sqrt{5} = \dfrac{a}{b} - 3$

⇒ $2\sqrt{5} = \dfrac{a - 3b}{b}$

⇒ $\sqrt{5} = \dfrac{a - 3b}{2b}$

But this is not possible because $\sqrt{5}$ is an irrational and $\dfrac{a - 3b}{2b}$ is rational

∴ our supposition is wrong.

Hence, $3 + 2\sqrt{5}$ is an irrational.

3. Prove that the following are irrationals.

(i) $\dfrac{1}{\sqrt{2}}$ (ii) $7\sqrt{5}$ (iii) $6 + \sqrt{2}$

Sol. (i) $\dfrac{1}{\sqrt{2}}$ can be written as $\dfrac{\sqrt{2}}{2}$.

Let $\dfrac{\sqrt{2}}{2}$ is rational.

Let $\dfrac{\sqrt{2}}{2} = \dfrac{a}{b}$; a, b ∈ Z

where a and b are co-primes and b ≠ 0.

∴ $\sqrt{2} = \dfrac{2a}{b}$

But this is not possible as $\sqrt{2}$ is irrational and 2, a and b are integers, and $\dfrac{2a}{b}$ is rational.

∴ Our supposition is wrong.

Hence, $\dfrac{1}{\sqrt{2}}$ or $\dfrac{\sqrt{2}}{2}$ is irrational

(ii) Let $7\sqrt{5}$ is a rational.

$\therefore 7\sqrt{5} = \dfrac{a}{b}; a, b \in Z$

where a and b are co-primes and $b \neq 0$.

$\therefore \sqrt{5} = \dfrac{a}{7b}$

But this is not possible as $\sqrt{5}$ is an irrational

and $\dfrac{a}{7b}$ is rational.

$\therefore$ Our supposition is wrong

Hence, $7\sqrt{5}$ is irrational.

(iii) Let $6 + \sqrt{2}$ is rational.

$\therefore 6 + \sqrt{2} = \dfrac{a}{b}; a, b \in Z$

where a and b are co-primes and $b \neq 0$.

$\therefore 6 + \sqrt{2} = \dfrac{a}{b} \Rightarrow \sqrt{2} = \dfrac{a - 6b}{b}$

which is impossible because $\sqrt{2}$ is an irrational

and $\dfrac{a - 6b}{b}$ is a rational.

$\therefore$ Our supposition is wrong.

Hence, $6 + \sqrt{2}$ is irrational.

EXERCISE 1.4

1. Without actually performing the long division, state whether the following rational numbers will have a terminating decimal expansion or a non-terminating repeating decimal expansion:

(i) $\dfrac{17}{8}$ (ii) $\dfrac{64}{455}$ (iii) $\dfrac{15}{1600}$

(iv) $\dfrac{29}{343}$ (v) $\dfrac{23}{2^3 5^2}$ (vi) $\dfrac{129}{2^2 5^7 7^5}$

Sol. (i) $\dfrac{17}{8} = \dfrac{17}{2 \times 2 \times 2} = \dfrac{17}{2^3}$

Prime factorisation of 8 is of the form 2^3 or $x \ 2^n \times 5^m$.

Hence $\dfrac{17}{8}$ is rational having terminating decimal expansion.

(ii) $\dfrac{64}{455} = \dfrac{64}{5 \times 7 \times 13}$

Prime factorisation of 455 is of the form $5 \times 7 \times 13$ which is not of the form $2^n \times 5^m$.

$\therefore \dfrac{64}{455}$ is rational having non-terminating repeating decimal expansion.

(iii) $\dfrac{15}{1600} = \dfrac{15}{2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 5 \times 5}$

$= \dfrac{15}{2^6 \times 5^2}$

$\therefore \dfrac{15}{600}$ is rational having terminating decimal expansion.

Because prime factorisation of 1600 is of the form

$2^6 \times 5^2$ or $2^n \times 5^m$.

(iv) $\dfrac{29}{343} = \dfrac{29}{7 \times 7 \times 7} = \dfrac{29}{7^3}$

$\therefore \dfrac{29}{343}$ is rational with non-terminating repeating decimal expansion because prime factorisation of 343 is not of the form of $2^n \times 5^m$.

(v) $\dfrac{23}{2^3 5^2}$, rational having terminating decimal expansion because its denominator is of the form $2^n \times 5^m$.

(vi) $\dfrac{129}{2^2 5^7 7^5}$, rational having non-terminating repeating decimal expansion because its denominator is not the form of $2^n \times 5^m$.

2. Write down the decimal expansions of those rational numbers in Question 1 above which have terminating decimal expansions.

Sol. Numbers having terminating decimal expansions in Q.16 are

(i) $\dfrac{17}{8} = \dfrac{17}{2^3} = \dfrac{17 \times 5^3}{2^3 \times 5^3} = \dfrac{17 \times 5^3}{10^3}$

$= \dfrac{17 \times 5 \times 5 \times 5}{1000} = \dfrac{2125}{1000} = 2.125$

(ii) $\dfrac{15}{1600} = \dfrac{15}{2^6 \times 5^2} = \dfrac{3 \times 5}{2^6 \times 5^2}$

$= \dfrac{3}{2^6 \times 5^1} = \dfrac{3 \times 5^5}{2^6 \times 5^6} = \dfrac{3 \times 3125}{(10)^6}$

$= \dfrac{9375}{1000000} = 0.009375$

(iii) $\dfrac{23}{2^3 \times 5^2} = \dfrac{23 \times 5^1}{2^3 \times 5^3} = \dfrac{115}{(10)^3}$

$= \dfrac{115}{1000} = 0.115$

3. The following real numbers have decimal expansions as given below. In each case, decide whether they are rational or not. If they are rational, and of the form $\dfrac{p}{q}$, what can you say about the prime factors of q?
(i) 43.123456789
(ii) 0.120120012000120000 …

Sol. (i) 43.123456789

This can be written as

$= \dfrac{43123456789}{1000000000} = \dfrac{43123456789}{(10)^9}$

$= \dfrac{43123456789}{(2 \times 5)^9} = \dfrac{43123456789}{2^9 \times 5^9}$

Prime factorisation of q is of the type $2^9 \times 5^9$.

So, it is rational having terminating decimal expansion.

(ii) 0.120120012000120000 ....

The given number is non terminating non-repeating.

∴ it is an irrational number.

EXERCISE – I

MULTIPLE CHOICE QUESTIONS

1. Which of the following statements is false?

(A) Every fraction is a rational number

(B) Every rational number is a fraction

(C) Every integer is a rational number

(D) All the above

2. An irrational number is :

(A) a terminating and non-repeating decimal

(B) a non-terminating and non-repeating decimal

(C) a terminating and repeating decimal

(D) a non-terminating and repeating decimal

3. HCF of two numbers is 113, their LCM is 56952. If one number is 904, the other number is :

(A) 7719   (B) 7119   (C) 7791   (D) 7911

4. Expressing $0.3\overline{58}$ as a rational number, we get:

(A) $\dfrac{358}{100}$ (B) $\dfrac{358}{999}$

(C) $\dfrac{355}{990}$ (D) None of these

5. Missing numbers in the following factor tree are :
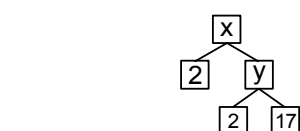
(A) x = 34, y = 68

(B) y = 34, x = 68

(C) y = 34, x = 34

(D) y = 68, x = 68

6. Express $0.\overline{75}$ as rational number.

(A) $\dfrac{75}{90}$ (B) $\dfrac{25}{33}$

(C) $\dfrac{3}{4}$ (D) None

7. A rational number in its standard from can be expressed as a terminating decimal, if the denominator has factors :

(A) 2 or 5   (B) 2, 3 or 5

(C) 3 or 5   (D) None of these

8. $5+\sqrt{6}$ is :

(A) a rational number

(B) an irrational number

(C) can't say

(D) both (A) and (B)

9. 0.1010010001 …… is :

(A) a rational number

(B) a repeating decimal number

(C) an irrational number

(D) both (A) and (C)

10. Set of natural numbers is a subset of

(A) set of even numbers

(B) set of odd numbers

(C) set of composite numbers

(D) set of real numbers

11. The sum of two rational numbers is always

(A) an irrational number

(B) a rational number

(C) a fraction

(D) none of these

12. The product of a rational and an irrational number is always :

(A) a irrational number

(B) a rational number

(C) a fraction

(D) none of these

13. If m is an integer, then square of any positive integer is of the form :

(A) 2m + 1 (B) 2 m or 3m

(C) 3m or 3m + 1 (D) 2m + 1 or 3m + 1

14. The value of $1.\overline{34} + 4.1\overline{2}$ is

(A) $\dfrac{133}{99}$ (B) $\dfrac{371}{90}$

(C) $\dfrac{5411}{990}$ (D) $\dfrac{541}{99}$

15. 7 × 11 × 13 + 13 and 7 × 6 × 5 × 4 × 3 × 2 × 1 + 5 are

(A) composite numbers

(B) whole number

(C) prime numbers

(D) none of these

16. If q is some integer, then an positive odd integer is of the form :

(A) q – 1

(B) 2q

(C) 4q + 1 or 4q – 1

(D) 4q + 1 or 4q + 3

17. In a morning walk three persons steps off together. Their steps measures 80 cm, 85 cm and 90 cm respectively. The minimum distance each should walk so that they can cover the distance in complete steps is.

(A) 122 m 40 cm (B) 132 m 60 cm

(C) 125 m 31 cm (D) 120 m 40 cm

18. Two tankers contain 850 litres and 680 litres of petrol respectively. The maximum capacity of a container which can measure the petrol of either tanker in exact number of times is :

(A) 160 litres (B) 168 litres

(C) 170 litres (D) 180 litres

(Direction: Q.19 to 23)

To enhance the reading skills of grade X students, the school nominates you and two of your friends to set up a class library. There are two sections- section A and section B of grade X. There are 32 students in section A and 36 students in section B.
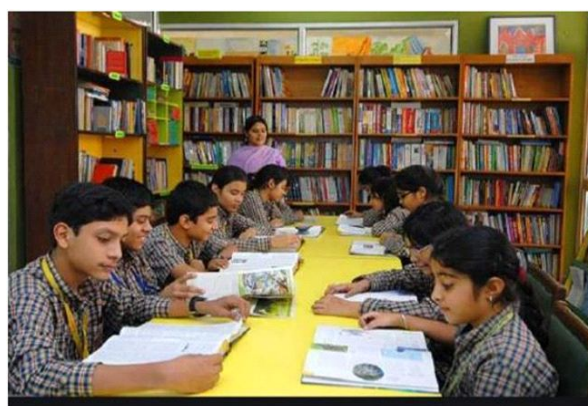
19. What is the minimum number of books you will acquire for the class library, so that they can be distributed equally among students of Section A or Section B?

(A) 144 (B) 128

(C) 288 (D) 272

20. If the product of two positive integers is equal to the product of their HCF and LCM is true then, the HCF (32 , 36) is

(A) 2 (B) 4

(C) 6 (D) 8

21. 36 can be expressed as a product of its primes as

(A) $2^2 \times 3^2$ (B) $2^1 \times 3^3$

(C) $2^3 \times 3^1$ (D) $2^0 \times 3^0$

22. $7 \times 11 \times 13 \times 15 + 15$ is a

(A) Prime number

(B) Composite number

(C) Neither prime nor composite

(D) None of the above

23. If p and q are positive integers such that p = ab^2 and q = a^2b, where a, b are prime numbers, then the LCM (p, q) is

(A) ab   (B) a^2b^2

(C) a^3b^2 (D) a^3b^3

ASSERTION & REASON

24. If x : Every whole number is a natural number and y : 0 is not a natural number, Then which of the following statement is true?

(A) x is false and y is the correct explanation of x.

(B) x is true and y is the correct explanation of x.

(C) x is true and y is false.

(D) Both x and y are true.

25. If R : Every fraction is a rational number and T : Every rational number is a fraction, then which of the following is correct?

(A) R is True and T is False.

(B) R is False and T is True.

(C) Both R and T are True.

(D) Both R and T are False.

SUBJECTIVE QUESTIONS

Very Short Answer Type Questions

1. Find the largest number which divides 70 and 125, leaving remainders 5 and 8, respectively.

2. If two positive integers a and b are written as a = x^3y^2 and b = xy^3; x, y are prime numbers, then find the HCF (a, b).

3. Without actually performing the long division, state whether $\dfrac{13}{3125}$ has terminating decimal expansion or not.

4. What can you say about the prime factorization of the denominators of the following rationals :

(i) 43.123456789   (ii) $43.\overline{123456789}$

5. Show that the denominator of the rational number must be in the form 2^m5^n (where m and n are non-negative integers) so as to have the decimal expansion of that rational number as terminating?

Short Answer Type Questions

1. Without actually performing the long division, find if $\dfrac{987}{10500}$ will have terminating or non-terminating (repeating) decimal expansion. Give reason for your answer.

2. Prove that $3 - \sqrt{5}$ is an irrational number.

3. Prove that $2 + \sqrt{3}$ is irrational.

4. If n is an odd integer, then show that $n^2 - 1$ is divisible by 8.

5. Using Euclid's division algorithm, find the largest number that divides 1251, 9377 and 15628 leaving remainders 1, 2 and 3 respectively.

6. On a morning walk, three persons step off together and their steps measure 40 cm, 42 cm and 45 cm, respectively. What is the minimum distance each should walk so that each can cover the same distance in complete steps?

Long Answer Type Questions

1. Show that the cube of a positive integer of the form $6q + r$, q is an integer and r = 0, 1, 2, 3, 4, 5 is also of the form $6m + r$.

2. Prove that one of any three consecutive positive integers must be divisible by 3.

3. Show that cube of any positive integer is of the form 4m, 4m + 1 or 4m + 3, for some integer m.

4. Prove that $2 + 5\sqrt{3}$ is an irrational number, given that $\sqrt{3}$ is an irrational number.

CASE BASED STUDY QUESTIONS

A Mathematics Exhibition is being conducted in your School and one of your friends is making a model of a factor tree. He has some difficulty and asks for your help in completing a quiz for the audience.

Observe the following factor tree and answer the following:
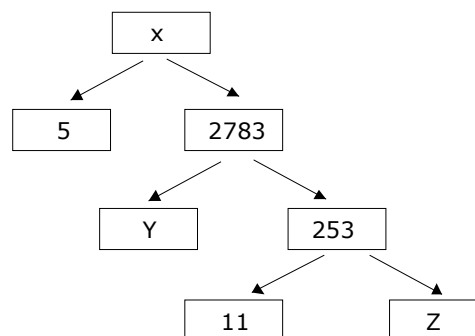
1. What will be the value of x?

2. What will be the value of y?

3. What will be the value of z?

4. According to Fundamental Theorem of Arithmetic 13915 is a

5. The prime factorisation of 13915 is
(A) $5 \times 11^3 \times 13^2$
(B) $5 \times 11^3 \times 23^2$
(C) $5 \times 11^2 \times 23$
(D) $5 \times 11^2 \times 13^2$

EXERCISE – II

NTSE STAGE-I AND OTHER OLYMPIAD

1. If $(1^2 + 2^2 + 3^2 + \dots + 12^2) = 650$, then the value of $(2^2 + 4^2 + 6^2 + \dots + 24^2)$ is

[NTSE Rajasthan 2015-16]

(A) 1300   (B) 2600

(C) 2500   (D) 42250

2. The value of $\sqrt{5-2\sqrt{6}}$ is

[NTSE WEST-BENGAL 2016]

(A) $\pm(\sqrt{3}-\sqrt{2})$ (B) $\sqrt{3}-\sqrt{2}$

(C) $\sqrt{2}-\sqrt{3}$ (D) All of the above

3. Among the numbers 2^{250}, 3^{200}, 4^{150} and 5^{100}, the greatest is -

[NTSE WEST-BENGAL 2016]

(A) 2^{250} (B) 3^{200}

(C) 4^{150} (D) 5^{100}

4. The sum of a number and its reciprocal is 4. What is their difference?

[NTSE KERALA 2017]

(A) $\sqrt{2}$ (B) $\sqrt{3}$

(C) $2\sqrt{2}$ (D) $2\sqrt{3}$

5. $3^9 + 3^{12} + 3^{15} + 3^n$ is a perfect cube, $n \in N$, then the value of n = ……..

[NTSE ANDHRA PRADESH-2017]

(A) 18   (B) 17

(C) 14   (D) 16

6. A four digit number has the following properties

(i) It is a perfect square

(ii) Its first two digits are equal to each other

(iii) Its last two digits are equal to each other

Then the four digit number is ….

[NTSE ANDHRA PRADESH-2017]

(A) 5566   (B) 7744

(C) 2288   (D) 3399

7. A number when divided by 5, 3 and 2 leaves remainders 4, 2 and 1 respectively. Out of all three digit numbers find the total such numbers   **[NTSE HARYANA 2018]**

(A) 28   (B) 29

(C) 30   (D) 31

8. **Statement-I** : If $\sqrt{5+\sqrt{24}} = \sqrt{x}+\sqrt{y}$ then $x + y = 5$ and $xy = 24$.

Statement-II : The square root of $(5-\sqrt{24})$ is $(\sqrt{3}-\sqrt{2})$.   **[NTSE KARNATKA 2018]**

(A) Both statement-I and II are wrong

(B) Statement I is wrong, but statement-II is right

(C) Both statement-I and II are right

(D) Statement-I is right, but statement-II is wrong

9. If If $\dfrac{3+2\sqrt{3}}{3-\sqrt{3}} = a+\sqrt{3}b$, then the value of $\sqrt{a+b}$ where a and b are rational numbers is-   **[NTSE RAJASTHAN 2018]**

(A) 5   (B) 8

(C) 2   (D) 16

10. Which is unit digit of $6^{18} - 5^{10}$?

[NTSE RAJASTHAN 2018]

(A) 5   (B) 8   (C) 1   (D) 9

11. Choose false statement from following:

[NTSE MADHYA-PRADESH 2019]

(A) All equilateral triangles are isosceles triangle

(B) Some rational numbers are integers

(C) All integers are not rational number

(D) Some Isosceles triangles are equilateral triangles

12. The decimal expansion of the number $\frac{14588}{8750}$

will **[NTSE HARYANA 2019]**

(A) terminate after two decimal places

(B) terminate after three decimal places

(C) terminate after four decimal place

(D) not terminate

13. Which of the following statements are not true? **[NTSE TAMILNADU 2019]**

(a) Sum of two irrational numbers is always irrational

(b) Difference between two irrational numbers is irrational

(c) Product of two irrational numbers is irrational

(d) Quotient of two irrational numbers is irrational

(A) (a) and (b) only

(B) (a), (b), (c) and (d)

(C) (a), (b) and (c) only

(D) None of the above

14. $\sqrt{a\sqrt{b\sqrt{c\sqrt{d}}}} =$ **[NTSE WEST–BENGAL 2020]**

(A) $a^{1/2}b^{1/4}c^{1/8}d^{1/16}$ (B) $(abcd)^{1/16}$

(C) $(abcd)^{1/8}$ (D) $a^{1/2}b^{1/2}c^{1/2}d^{1/2}$

15. If two positive integers 'a' and 'b' are expressible in the form of $a = p^3q^2$ and $b = p^2q^4$, p and q being prime numbers, then LCM (a,b) is - **[NTSE ANDHRA-PRADESH 2020]**

(A) p^3q^3 (B) p^2q^4

(C) p^3q^4 (D) p^2q^3

16. If p, q, r and s are distinct prime numbers such that p + q + r = 72, p + r + s = 74, q + r + s = 89. The largest of these p, q, r and s is **[NTSE DELHI 2020]**

(A) r = 53 (B) q = 53

(C) s = 53 (D) s = 49

17. Which of the following is a true statement?

[NTSE TAMILNADU 2021]

(A) any real number is either rational or irrational.

(B) 0 is not real number.

(C) Any real number is either prime or composite.

(D) $\sqrt{9}$ is an irrational number

18. If 'a' and 'b' are any two positive integers and $a^b \times b^a = 72$, then the values of a and b are : **[NTSE TAMILNADU 2021]**

(A) 2, 3 (B) 3, 2

(C) 2, 3 or 3, 2 (D) 3, 3

19. n is an odd number. Which of the following statement is true?

[NTSE MAHARASHTRA 2021]

(A) $(2^n + 1)$ is divisible by 5

(B) $(2^n + 1)$ is divisible by 3

(C) $(2^n - 1)$ is divisible by 5

(D) $(2^n - 1)$ is divisible by 3

20. Which of the following statement is incorrect?
[NTSE TAMILNADU 2022]

(A) Every natural number is a whole number

(B) Every integer is a rational number

(C) Every rational number is an integer

(D) Every rational number is a real number

21. The product of the additive inverse and multiplication inverse of 6 is :

(A) −6   (B) 1

(C) −1   (D) 6

22. The value of $\sqrt{3\sqrt{3\sqrt{3\sqrt{3\sqrt{3\sqrt{3.......}}}}}}$ .... is :

(A) 0

(B) 3

(C) Both 0 and 3

(D) Can't be determined

23. Which of the following statements is correct?

(A) 0 is called the additive identity for rational numbers.

(B) 1 is called the multiplicative identity for rational numbers.

(C) The additive inverse of 0 is zero itself.

(D) All the above.

24. Which of the following is rational number?
[IMO-2016]

(A) Sum of $(2 + \sqrt{3})$ and its reciprocal

(B) Square root of 18

(C) Square root of $7+4\sqrt{3}$

(D) None of these

25. The number $3^{11} - 3^8$ is divisible by prime numbers:

(A) 2 and 3 only   (B) 2, 3 and 11 only

(C) 311 only   (D) 2, 3 and 13 only

26. Find the unit digit in $132^{74} - (3498)^{49}$:

(A) 6   (B) 0

(C) 4   (D) 2

27. Which of the following alternatives is wrong? Given that :

(i) Difference of two rational numbers is a rational number.

(ii) Subtraction is commutative on rational numbers

(iii) Addition is not commutative on rational numbers.

(A) (ii) & (iii)   (B) (i) only

(C) (i) & (iii)   (D) All the above

28. The average of the middle two rational numbers if $\frac{2}{5}$, $\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{7}$ are arranged in ascending order is :

(A) $\frac{5}{4}$ (B) $\frac{9}{10}$

(C) $\frac{39}{35}$ (D) $\frac{17}{28}$

29. Which is smallest among :

$10 - 3\sqrt{11}$, $18 - 5\sqrt{13}$ and $51 - 10\sqrt{26}$

(A) $10 - 3\sqrt{11}$ (B) $18 - 5\sqrt{13}$

(C) $51 - 10\sqrt{26}$ (D) All are equal

30. The greater between $\sqrt{19} - \sqrt{14}$ and $\sqrt{12} - \sqrt{7}$

(A) $\sqrt{19} - \sqrt{14}$ (B) $\sqrt{12} - \sqrt{7}$

(C) Both are equal   (D) Can't say

31. The smallest among $\sqrt[2]{2}$, $\sqrt[3]{4}$ and $\sqrt[4]{3}$ is :

(A) $\sqrt[2]{2}$ (B) $\sqrt[4]{3}$

(C) $\sqrt[3]{4}$ (D) Can't compare

32. A number that has to be added to 9247653140 in order to make it divisible by 8 is :

(A) 2   (B) 8

(C) 6   (D) 4

33. In order that the six digit number 1x0x3x be divisible by 11, the digit x should be :

(A) 2   (B) 1

(C) 4   (D) 5

34. What are the values of x and y if 15×0468913y is divisible by 8 and 11, where x and y are single digit integers?

(A) x = 3, y = 6   (B) x = 6, y = 9

(C) x = 9, y = 12   (D) x = 0, y = 3

35. What is the complete solution to the equation : |3 − 4x| = 13 ?

(A) $x = \dfrac{5}{2}$, x = 4   (B) $x = \dfrac{5}{2}$, x = − 4

(C) $x = -\dfrac{5}{2}$, x = 4   (D) $x = -\dfrac{5}{2}$, x = − 4

EXERCISE – III

NTSE STAGE-II AND JEE LEVEL

1. On dividing a natural number x by 11 ,the remainder is 3 , and on dividing x by 17 , the remainder is 9 . If the number x lies between 300 and 400 , then the remainder on dividing x by 21 is - **[NTSE STAGE-II-2020]**
(A) 9 but not 11　　(B) 11 but not 9
(C) both 9 and 11　　(D) neither 9 nor 1

2. If $m = n^2 - n$ where n is an integer, then $m^2 - 2m$ is divisible by
[NTSE STAGE-II-2019]
(A) 20　　　　　(B) 24
(C) 30　　　　　(D) 16

3. Given that $\frac{1}{7} = 0.\overline{142857}$, which is a repeating decimal having six different digits. If x is the sum of such first three positive integers n such that $\frac{1}{n} = 0.\overline{abcdef}$ where a,b,c,d, e and f are different digits, then the value of x is **[NTSE STAGE-II-2018]**
(A) 20　　　　　(B) 21
(C) 41　　　　　(D) 42

4. Which of the following digits is ruled out in the units place of $12^n + 1$ for every positive integer n ? **[NTSE STAGE-II-2018]**
(A) 1　　　　　(B) 3
(C) 5　　　　　(D) 7

5. On dividing 2272 as well as 875 by a 3 - digit number N, we get the same remainder in each case. The sum of the digits of N is
[NTSE STAGE-II-2017]
(A) 10　(B) 11　(C) 12　(D) 13

6. The value of $\sqrt{97 \times 98 \times 99 \times 100 + 1}$ is equal to **[NTSE STAGE-II-2019]**
(A) 9901　　　　(B) 9891
(C) 9801　　　　(D) 9701

7. If a, b, c are real, then a (a – b) + b (b – c) + c (c – a) = 0, only if
(A) a + b + c = 0
(B) a = b = c
(C) a = b or b = c or c = a
(D) a – b – c = 0

8. If x, y are rational numbers such that
$(x + y) + (x - 2y) \sqrt{2} = 2x - y + (x - y - 1) \sqrt{6}$ then
(A) x = 1, y = 1
(B) x = 2, y = 1
(C) x = 5, y = 1
(D) x & y can take infinitely many values

9. Find the value of the expression
$\frac{2}{\log_4 (2000)^6} + \frac{3}{\log_5 (2000)^6}$.
(A) 6　　　　　(B) $\frac{1}{6}$
(C) 5　　　　　(D) $\frac{1}{5}$

10. Greatest integer less than or equal to the number $\log_2 15 . \log_{1/6} 2 . \log_3 1/6$ is
(A) 4　　　　　(B) 3
(C) 2　　　　　(D) 1

11. The ratio $\frac{2^{\log_{2^{1/4}} a} - 3^{\log_{27} (a^2 +1)^3} - 2a}{7^{4\log_{49} a} - a - 1}$ simplifies to
(A) $a^2 - a - 1$　　(B) $a^2 + a - 1$
(C) $a^2 - a + 1$　　(D) $a^2 + a + 1$

12. If $\log_x \log_{18}(\sqrt{2} + \sqrt{8}) = \dfrac{1}{3}$. Then the value of

1000 x is equal to
(A) 8　　　　　　　(B) 1/8
(C) 1/125　　　　　(D) 125

13. Number of real solution (x) of the equation

$|x - 3|^{3x^2 - 10x + 3} = 1$ is

(A) exactly four　　(B) exactly three
(C) exactly two　　(D) exactly one

14. How many digits are contained in the number
2^{75} ?
(A) 21　　　　　　(B) 22
(C) 23　　　　　　(D) 24

15. Let 'm' be the number of digits in 3^{40} and 'p'
be the number of zeroes in 3^{-40} after decimal
before starting a significant digit the (m +
p) is　(log3 = 0.4771)
(A) 40　　　　　　(B) 39
(C) 41　　　　　　(D) 38

16. If P is the number of integers whose
logarithms to the base 10 have the
characteristic p , and Q the number of integers
the logarithms of whose reciprocals to the
base 10 have the characteristic
$-q$, Find value of $\log_{10} P - \log_{10} Q$ is :
(A) p + q − 1　　　(B) p − q + 1
(C) p + q + 1　　　(D) p − q − 1

17. If a, b, c are real and distinct numbers, then

the value of $\dfrac{(a - b)^3 + (b - c)^3 + (c - a)^3}{(a - b)(b - c)(c - a)}$ is

(A) 1　　　　　　(B) a b c
(C) 2　　　　　　(D) 3

18. The number of ordered pairs (x, y) satisfying
the equation $x - y = (\log_2 y - \log_2 x)(2 + xy)$
and
$x^3 + y^3 = 16$
(A) 1　　　　　　(B) 2
(C) 3　　　　　　(D) 0

19. Let A = {x l x is a prime number and x < 30}.
The number of different rational numbers
whose numerator and denominator belong
to A is
(A) 90　　　　　　(B) 180
(C) 91　　　　　　(D) 181

20. The number of zeros immediately after the
decimal in 3^{-100}
(A) 50　　　　　　(B) 47
(C) 48　　　　　　(D) 49

21. If $4^A + 9^B = 10^C$,
where A = $\log_{16} 4$, B = $\log_3 9$ & C = $\log_x 83$,
then find x.
(A) 11　　　　　　(B) 10
(C) 9　　　　　　(D) 12

22. Number of real x satisfying the equation
$|x - 1| = |x - 2| + |x - 3|$ is
(A) 1　　　　　　(B) 2
(C) 3　　　　　　(D) more than 3

Motion

CONTENTS

बड़े भाई साहब

लेखक – प्रेमचन्द्र

I. लेखक–परिचय

प्रश्नः हिंदी के कहानीकार प्रेमचंद का परिचय निम्नलिखित शीर्षकों के अंतर्गत दीजिए –

जीवन–परिचय, रचनाएँ, साहित्यिक विशेषताएँ, भाषा–शैली।

उत्तरः **जीवन–परिचय–** हिंदी के सर्वश्रेष्ठ कहानीकार प्रेमचंद का जन्म वाराणसी के निकट लमही नामक गाँव में सन् 1880 में हुआ। उनकी आरंभिक शिक्षा गाँव में हुई। छुटपन में ही उनके पिता का देहांत हो गया। इसलिए घर की जिम्मेदारी असमय ही अनके कंधों पर आ पड़ी। वे दसवीं पास करके प्राइमरी स्कूल के शिक्षक बन गए। नौकरी में रहकर ही उन्होंने बी.ए. पास किया। इसके बाद वे शिक्षा–विभाग में सबडिप्टी–इंस्पेक्टर–ऑफ–स्कूल्स के रूप में नियुक्त हो गए।

सन् 1920 में वे गाँधी जी के आह्वान पर असहयोग आंदोलन में कूद पड़े। उन्होंने साहित्य–लेखन द्वारा देशसेवा करने का संकल्प किया। उनका वास्तविक नाम धनपत राय था। पहले वे नवाबराय के नाम से उर्दू में लिखते थे। बाद में हिंदी में प्रेमचंद के नाम से लिखने लगे। उन्होंने अपना छापाखाना खोला तथा 'हंस' नामक पत्रिका का संपादन किया। सन् 1936 में उनका देहांत हो गया।

रचनाएँ– मुंशी प्रेमचंद ने 350 कहानियाँ और 11 उपन्यास लिखे। उनके कहानियाँ **'मानसरोवर'** नाम से आठ भागों में संकलित हैं। उनके प्रसिद्ध उपन्यास हैं – सेवासदन, प्रेमाश्रम, रंगभूमि, निर्मला, गबन, कर्मभूमि और गोदान। 'कर्बला' और 'प्रेम का वेदी' नामक उनके दो नाटक भी हैं। उनके द्वारा लिखित निबंध 'कुछ विचार' और 'विविध प्रसंग' नामक संकलनों में संकलित हैं।

साहित्यिक विशेषताएँ– मुंशी प्रेमचंद के साहित्य का सबसे प्रमुख विषय है – राष्ट्रीय जगरण और समाज–सुधार। देशभक्ति के प्रबल स्वर के कारण उनके कहानी–संग्रह 'सोजे वतन' को अंग्रेज सरकार ने जब्त कर लिया था। मुंशी प्रेमचंद ने दीन–हीन किसानों, ग्रामीणों और शोषितों की दलित अवस्था का मार्मिक चित्रण किया। उनकी कफन, पूस की रात, गोदान आदि रचनाएँ शोषण के विरुद्ध विद्रोह की आवाज उठाती है। उन्होंने समाज में व्याप्त अन्य बुराईयों–दहेज, अनमेल विवाह, नशाखोरी, शोषण, बहु–विवाह, छुआछुत, ऊँच–नीच आदि पर भी प्रभावशाली साहित लिखा।

भाषा–शैली– मुंशी प्रेमचंद अपनी सरल, मुहावरेदार भाषा के लिए विख्यात हैं। उन्होंने लोकसभा को साहित्यिक भाषा बनाया। उनकी भाषा आम जनता के बहुत निकट है। वे अपने पात्र, वातावरण और मनोदशा के अनुसार शब्दों का चुनाव करते हैं। वास्तव में एक व्यक्ति जिस वातावरण में अपने पद–स्थान के अनुसार जिस परिस्थिति में जो भाषा बोलता है, उसी को व्याकरण के नियमों में ढालकर उन्होंने प्रस्तुत कर दिया है। वे मानव–मन में उठ रहे मनोभावों को प्रकट करने में बहुत कुशल हैं।

II. कहानी का सार

प्रश्न— प्रेमचंद द्वारा रचित 'बड़े भाई साहब' नामक कहानी का सारांश लिखिए।

उत्तर— 'बड़े भाई साहब' मनोवैज्ञानिक कहानी है। इसमें दिखाया गया है कि किस प्रकार आयु में बड़े भाई को अपने बड़े होने की चाह परेशान किए रखती है। उसमें बड़े होने के योग्य गुण चाहे बिल्कुल न हों, फिर भी वह किस प्रकार बड़प्पन के रास्ते निकाल लेता है। कहानी का सार इस प्रकार है —

बड़े भाई साहब का परिचय — लेखक का बड़ा भाई 14 वर्ष का था और लेखक नौ वर्ष का। बड़ा भाई दो साल फेल हो चुका था। इसलिए वह अब लेखक से केवल तीन दरजे आगे था। वह पढ़ाई में चाहे कैसा भी हो लेकिन बड़ा होने के नाते लेखक से डाँट–डपट करना और उस पर निगरानी रखना अपना धर्म समझता था। लेखक देखता था कि उसका बड़ा भाई अकसर किताब खोले बैठा रहता था। परंतु उसका दिमाग कहीं और होता था। वह अपनी कापियों और किताबों पर चिड़ियों, कुत्तों की तस्वीरें बनाता रहता था या एक–ही नाम कई बार लिखता रहता था। इन बेतुकी बातों का कोई अर्थ नहीं होता था न ही लेखक बड़े भाई से इनका अर्थ पूछने की हिम्मत रखता था।

बड़े भाई की नसीहतें— लेखक का मन पढ़ाई में बहुत कम लगता था। इसलिए वह मौका पाते ही होस्टल से निकल कर मैदान में आ जाता था और खूल खेलता था। कभी दोस्तों में गप्पें, कभी झूलने का मजा। परंतु कमरें में पहुँचते ही बड़े भाई पूछते थे– कहाँ थे? उनका रूद्र रूप देखकर लेखक काँप जाता था। वह मौन धारण कर लेता था। इस पर बड़ा भाई स्नेह और रोष–भरा उपदेश दिया करता था– 'अंग्रेजी पढ़ना हँसी–खेल नहीं है। मैं रात–दिन आँखे फोड़ता हूँ, तब जाकर वह विद्या आती है। बड़े–बड़े विद्वान भी शुद्ध अंग्रेजी नहीं लिख पाते। मुझे देखो, मैं कोई खेल–तमाशा नहीं देखता। फिर भी एक क्लास में दो–तीन साल लगते है। तुम यों ही खेलते रहे तो उम्र बीत जाएगी। इससे तो अच्छा है कि घर चले जाओ। दादा की मेहनत की कमाई यों ही बरबाद न करो।'

लेखक का टाइम–टेबल बनाना — भाई साहब की कड़ी बातें सुनकर लेखक खूब रोता–पछताता। भाई ऐसी–ऐसी चुभती बातें कहता कि लेखक का कलेजा काँप जाता। वह निरोश हो जाता। परंतु कुछ देर बाद फिर–से हिम्मत लौट आती। वह पढ़ाई में जी लगाने का इरादा करता। वह नए सिरे से टाइम–टेबल बनाता। रोज की दिनचर्या बनाता। उसमें खेलने का समय बिल्कुल भी न रखता। परंतु पहले ही दिन से उस टाइम–टेबल की अनदेखी शुरू हो जाती। मैदान की खुली हवा, फुटबाल और बॉलीबाल देखते ही वह फिर–से मैदान की तरफ दौड़ पड़ता। परिणामस्वरूप उसे फिर से भाई साहब की नसीहतें और झिड़कियाँ सुननी पड़तीं। उसके लिए भाई का सामना होना नंगी तलवार जैसा प्रतीत होता था। परंतु वह क्या करे, उससे खेलों का तिरस्कार न हो पाता था।

भाई साहब का फिर–से फेल होना— वार्षिक परीक्षा हुई। भाई साहब फिर–से फेल हो गए। लेखक अपनी कक्षा में प्रथम आया। लेखक के मन में आया कि बड़े भाई को खूब सुनाए। पूछे कि तुमने पढ़–लिख कर क्या कमा लिया। परंतु मुंह से शब्द न निकला। हाँ, अब वह बड़े अधिकार से खेलने जाने लगा। बड़े भाई लेखक की निडरता भाँप ली। आखिर एक दिन उसके संयम का बाँध टूट पड़ा।

लेखक सुबह से दोपहर तक गुल्ली–डंडा खेलकर भोजन के लिए आया। बड़े भाई ने उसे आड़े हाथों लिया। उसने कहा– देख रहा हूँ, इस साल कक्षा में प्रथम आ गए हो तुम्हें घमंड हो गया है। परंतु रावण का भी घमंड नहीं रहा। जानते हो, रावण चक्रवर्ती राजा था। आज के अंग्रेज भी चक्रवर्ती नहीं हैं। रावण को सभी राजा कर देते थे। मगर फिर भी उसका घमंट टूटा। शैतान हो या शाहेरूम–सबका अहंकार नष्ट हुआ था। तुमने एक दरजा क्या पास कर लिया है, तुम्हें घमंड हो गया है। यह पास होना भी अंधे के हाथ बटेर लगना है। परंतु यह बटेर बार–बार हाथ नहीं लगेगी।

पाठ्यक्रम की मुश्किलें गिनाना — भाई साहब बोले– मेरे फेल होने पर न जाओ। मेरी कक्षा में पहुँचोगे तो दाँतो पसीना आ जाएगा। इंगलिस्तान का इतिहार पढ़ना पड़ेगा जिसमें आठ–आठ हेनरी हुए है, दर्जनों जेम्स हुए है, दर्जनों विलियम, कोडियों चार्ल्स।

इस सबके किस्से याद रखते–रखते चक्कर आने लगते हैं। जामेट्री बनाने वाले तो व्यर्थ में छात्रों का खून पीते हैं। बताओ अ ब ज की जगह अ ज ब लिख दिया तो क्या हुआ? परंतु नहीं, इसी रटंत का नाम है शिक्षा। अब रेखा पर लंब निराने का छात्रों से क्या वास्ता? परंतु परीक्षा पास करने के लिए यह सब खुराफात करनी ही पड़ती है।

अब बताइए 'समय की पाबंदी' पर चार पन्नों का निबंध लिखने को कहा जाता है। पूछो, यह हिमाकत है कि नहीं। जो बात एक ही वाक्य में कही जा सकती है, उस पर इतने पन्नें क्यों खराब करें? यह छात्रों पर सरासर अत्याचार है। अभी तो यह निबंध संक्षेप में है। वरना शायद सौ–दो–सौ पन्नों में लिखवाते। इन अध्यापकों को जरा भी तमीज नहीं है और लाला–मेरे दरजे में आओगे तो ये सारे पापड़े बेलने पड़ेंगे। मैं लाख फेल हो गया हूँ। परंतु अनुभव में तुमसे बड़ा हूँ।

भाई साहब के ये तिरस्कार–वचन सुनकर लेखक को भोजन बहुत बेस्वाद लगा। वह ऊँचे दरजे की पढ़ाई का भयंकर चित्र सुनकर भयभीत हो उठा। परंत फिर भी उसकी रुचि पुस्तकों की ओर न बन सकी। अब वह चोरी–चोरी खेलने जाने लगा।

अगले साल बड़े भाई फिर फेल– अगले साल बड़ा भाई फिर फेल हो गया, जबकि लेखक दरजे में प्रथम आया। बड़े भाई ने इस बार दिन–रात मेहनत की थी। एक–एक शब्द चाट गया था। फिर भी फेल हो गया। परिणाम सुनकर वह रो पड़ा। लेखक भी रो पड़ा। उसे भाई पर दया आने लगी। अब दोनों में बस एक ही कक्षा का अंतर रह गया। लेखक के मन में विचार आया कि कहीं बड़ा भाई अगले साल भी फेल हो गया तो दोनों एक ही दरजे में बनाएँगे। फिर यह कहाँ से मेरी फजीहत करेगा।

फेल होने के बाद बड़ा भाई नरम पड़ गया। उसे समझ आ गया कि अब उसका लेखक को डाँटने का अधिकार नहीं रहा। लेखक की स्वच्छंदता बढ़ने लगी। अब उसे कनकौए उड़ाने का शौक लग गया। वह पूरा दिन पतंगबाजी के खेल में लगाने लगा। हाँ, वह यह बराबर ध्यान रखता था कि कहीं उसका भाई उसे देख न ले। वह उनका अदब और सम्मान पूरा बनाए रखता था।

पतंग लूटते हुए पकड़े जाना – एक संध्या का लेखक होस्टल से दूर कनकौआ लूटने दौड़ा जा रहा था। आँखे आसमान की ओर थीं। बालकों की सेना झाड़ूदार बाँस और लग्गी उठाए हुए बेतहाशा दौड़ी जा रही थी। सहसा बड़े भाई ने लेखक को देख लिया। उसने लेखक का हाथ पकड़ लिया। बोले–इन बाजारी लौंडों के साथ धेले का कनकौआ लूटते तुझे शर्म नहीं आती? आठवीं में पढ़ते हो। कुल अपनी पोजीशन का भी ख्याल करो। एक जमाना था, जब आठवीं पास लोग नायब तहसीलदार, डिप्टी मैजिस्ट्रेट या सुपरिडेंट हो जाते थे। आजकल कितने ही मिडलची अखबारों के संपादक हैं। और तुम! इनके साथ कानकौए लूटने भागे जा रहे हो। माना कि तुम जहीन हो और कल को यह भी हो सकता है कि तुम मेरी जमात में आ जाओ या मुझसे आगे निकल जाओ। फिर भी यह न समझना कि मुझे तुम्हें कुछ कहने का हक नहीं है।

तजुर्बे का तर्क– भाई बोला– मैं तुमसे पाँच साल बड़ा हूँ। तुम मेरे तजुर्बे की बराबरी नहीं कर सकते। तुम चाहे एम.ए., डी.फिल. और डी.लिट क्यों न हो जाओ। पर समझ किताबें पढ़ने से नहीं आती। हमारे दादा और अम्माँ कोई अधिक पढ़े–लिखे नहीं हैं। फिर भी हमें–पढ़ों–लिखों को समझाने का हक उनका है। भगवान न करें, मैं बीमार हो जाऊँ। तुम्हारे हाथ–पाँव फूल जाएँगे। तुम दादा का तार करने के सिवा कुछ न करोगे। परंतु तुम्हारी जगह दादा हों तो बिल्कुल न घबराएँ। वे खुद मरज पहचानकर इलाज कर लेंगे या डॉक्टर को बुलाएँगें। हम–तुम तो महीने–भर के खर्च का हिसाब–किताब भी नहीं जानते। परंतु दादा ने हमारे खर्च से भी आधे में अपनी उम्र का बड़ा भाग नेकनामी से बिता दिया है। हमारे हेडमास्टर को ही लो। वह पढ़ा–लिखा है। एक हजार से भी अधिक पैसे कमाता है। किंतु उसका घर–खर्च उसकी माँ ही चलाती है। इसलिए भाईजान! गरूर को दिल से निकाल डालो। मैं तुझे बेराह न चलने दूँगा। यदि न माना तो थप्पड़ भी रसीद कर दूँगा।

लेखक को बड़े भाई की यह नई युक्ति बहुत अच्छी लगी। वह उसके सामने झुक गया। उसे सचमुच लघुता का अनुभव हुआ। बोला–आपको कहने का पूरा अधिकार है। यह सुनते ही बड़े भाई ने लेखक को गले से लगा लिया। बोला–मैं कनकौए उड़ाने को मना नहीं करता। मेरा भी जी ललचाता है। पर क्या करूँ? खुद बेराह चलूँ तो तुम्हारी रक्षा कैसे करूँ? तभी एक कटा हुआ कनकौआ ऊपर से गुजरा। बड़े भाई ने लपककर उसे पकड़ लिया। वह बेतहाशा होस्टल की तरफ दौड़ा। लेखक भी पीछे–पीछे दौड़ने लगा।

III. अर्थग्रहण संबंधी प्रश्नोत्तर

प्रश्न– निम्नलिखित गद्यांशों से संबंधित प्रश्नों के उत्तर दीजिए–

1. मेरा जी पढ़ने में बिलकुल न लगता था। एक घंटा भी किताब लेकर बैठना पहाड़ था। मौका पाते ही होस्टल से निकलकर मैदान में आ जाता और कभी कंकरियाँ, कभी कागज की तितलियाँ उड़ाता और कहीं कोई साथी मिल गया, तो पूछना ही क्या। कभी चारदीवारी पर चढ़कर नीचे कूद रहे हैं। कभी फाटक पर सवार, उसे आगे–पीछे चलाते हुए मोटरकार का आनंद उठा रहे हैं, लेकिन कमरे में आते ही भाई साहब का वह रूद्र–रूप देखकर प्राण सुख जाते। उनका पहला सवाल यह होता– ''कहाँ थे''? हमेशा यही सवाल इसी ध्वनि में हमेशा पूछा जाता था और इसका जवाब मेरे पास केवल मौन था। न जाने मेरे मुँह से यह बात क्यों न निकलती कि जरा बाहर खेल रहा था। मेरा मौन कह देता था कि मुझे अपना अपराध स्वीकार है और भाई साहब के लिए उसके सिवा और कोई इलाज न था कि स्नेह और रोष से मिले हुए शब्दों में मेरा सत्कार करें।

प्रश्न. (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) प्रसंग स्पष्ट कीजिए।

(ग) लेखक का दिल पढ़ाई में क्यों नही लगता था?

(घ) लेखक को किस चीज में आनंद मिलता था?

(ड.) लेखक कमरे में आकर भयभीत क्यों हो जाता था?

(च) लेखक के बड़े भाई लेखक को देखकर क्रोध में क्यों आ जाते थे?

(छ) लेखक बड़े भाई के सामने मौन क्यों रह जाता था?

(ज) लेखक को मौन देखकर बड़ा भाई कैसा व्यवहार करता था?

उत्तर – (क) कहानी – बड़े भाई साहब

कहानीकार – प्रेमचंद

(ख) लेखक और उसका बड़ा भाई दोनों छात्रावास में पढ़ते थे तथा एक ही कमरे में रहते थे। लेखक अपने बड़े भाई से पाँच साल छोटा था परंतु कक्षा में केवल तीन दरजे ही कम था। कारण यह था कि बड़ा भाई दो बार फेल हो चुका था। फिर भी वह गंभीरता से पढ़ता रहता था तथा छोटे भाई को खेलता देखकर डाँट लगाता था।

(ग) लेखक का दिल पढ़ाई में बिलकुल नहीं लगता था। कारण यह कि उसकी रूचि खेलों तथा मनोरंजन की गतिविधियों में अधिक रहती थी। वह निश्चित होकर मटरगश्ती करता रहता था। उसके मन में पढ़ाई का कोई हौवा भी नहीं था।

(घ) लेखक को पढ़ाई की बजाय खेलने–कूदने और मटरगश्ती करने में आनंद आता था। इसलिए वह मौका पाते ही होस्टल से बाहर आ जाता था। कभी कंकरियाँ उछालने लगता था। कभी कागज की तितलियाँ उड़ाने लगता था। कभी किसी साथी के साथ गप्पें हाँकने लगता था। कभी फाटक पर सवार होकर झूलने लगता था।

(ड.) लेखक के मन में अपने बड़े भाई का डर रहता था। उसे लगता था कि उसका बड़ा भाई उससे सवाल–जवाब करेगा। वह उससे एक–एक मिनट का हिसाब माँगेगा। वह उसे आवारा घूमने और खेलने के लिए डाँट लगाएगा।

(च) लेखक का बड़ा भाई लेखक को देखते ही क्रोध में आ जाता था। वह जानता था कि लेखक पढ़ने–लिखने की बजाय आवारागर्दी करके आया है। बड़ा भाई होने के नाते उसे यह सब सहन नहीं था। वह उसे सदा पढ़ता हुआ और उसकी आज्ञा मानता हुआ देखना चाहता था।

(छ) लेखक बड़े भाई साहब के सामने अपनी सफाई देना चाहता था। परंतु बड़े भाई का आतंक इतना अधिक होता था कि वह सफाई में कुछ भी नहीं कह पाता था। भाई का तीखा गुस्सा उसे अंदर तक भयभीत कर देता था।

(ज) लेखक को अपने सामने मौन देखकर बड़ा भाई मान लेता था कि छोटे भाई ने अपना अपराध स्वीकार कर लिया है। तब वह स्वयं को सफल मानकर उससे स्नेह भरी वाणी में बात करने लगता था। वह एक प्रकार से भाई का सत्कार होता था।

बहुविकल्पी प्रश्नोत्तर

1. **'मैं' कौन है?**

(क) प्रेमचंद (ख) कोई भी नालायक बालक

(ग) प्रेमचंद का बड़ा भाई (घ) कथानायक

2. **लेखक को किताब पढ़ना पहाड़ क्यों लगता था?**

(क) पढ़ाई में रुचि न होने के कारण (ख) किताबें ऊबाऊ होने के कारण

(ग) समझ न आने के कारण (घ) खेल–कूद में रुचि होने के कारण

3. **'प्राण सूख जाते' का आशय है –**

(क) मृत्यु हो जाती (ख) आनंद आ जाता (ग) निराशा हो जाती (घ) घबराहट हो जाती

4. **बड़े भाई साहब किस ध्वनि में प्रश्न पूछते थे?**

(क) स्नेहपूर्ण (ख) व्यंग्यपूर्ण (ग) रोषपूर्ण (घ) कर्तव्यपूर्ण

5. **'सत्कार करें' का आशय है –**

(क) स्वागत करें (ख) सम्मान करें (ग) दुत्कारें–पीटें (घ) डाँटें–डपटें

उत्तर – 1. (क) 2. (घ) 3. (घ) 4. (ग) 5. (घ)

2. ''इस तरह अंग्रेजी पढ़ोगे, तो जिंदगी–भर पढ़ते रहोगे और एक हर्फ न आएगा। अंग्रेजी पढ़ना कोई हँसी–खेल नहीं है कि जो चाहे, पढ़ ले, नहीं ऐरा–गैरा नत्थू–खैरा सभी अंग्रेजी के विद्वान हो जाते। यहाँ रात–दिन आँखें फोड़नी पड़ती है और खून जलाना पड़ता है, तब कहीं यह विद्या आती है। और आती क्या है, हाँ कहने को आ जाती है। बड़े–बड़े विद्वान भी शुद्ध अंग्रेजी नहीं लिख सकते, बोलना तो दूर रहा। और मैं कहता हूँ, तुम कितने घोंघा हो कि मुझे देखकर भी सबक नहीं लेते। मैं कितनी मेहनत करता हूँ, यह तुम अपनी आँखों से देखते हो, अगर नहीं देखते, तो यह तुम्हारी आँखों का कसूर है, तुम्हारी बुद्धि का कसूर है। इतने मेले–तमाशे होते हैं, मुझे तुमने कभी देखने जाते देखा है? रोज ही क्रिकेट और हॉकी मैच होते है। मैं पास नहीं फटकता। हमेशा पढ़ता रहता हूँ। उस पर भी एक–एक दरजे में दो–दो, तीन–तीन साल पड़ा रहता हूँ, फिर भी तुम कैसे आशा करते हो कि तुम यों खेल–कूद में वक्त गँवाकर पास हो जाओगे? मुझे तो दो ही तीन साल लगते हैं, तुम उम्र–भर इसी दरजे में पड़े सड़ते रहोगे? अगर तुम्हें इस तरह उम्र गँवानी है, तो बेहतर है, घर चले जाओ और मजे से गुल्ली–डंडा खेलो। दादा की गाढ़ी कमाई के रूपये क्यों बरबाद करते हो?''

प्रश्न– (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) प्रसंग स्पष्ट कीजिए।

(ग) बड़े भाई ने लेखक को किसलिए डाँटा?

(घ) बड़े भाई ने लेखक को किस–किस चीज का डर दिखलाया?

(ङ) बड़ा भाई क्या सोचकर अपना उदाहरण देता है? क्या यह उदाहरण सही है?

(च) बड़ा भाई घनघोर मेहनत करके भी उत्तीर्ण क्यों नहीं होता? उसका और अपना मत लिखिए।

(छ) बड़ा भाई लेखक को उम्र भर एक दरजे में पड़े रहने का डर क्यों दिखाता है?

(ज) बड़ा भाई लेखक को किस–किस चीज का वास्ता देकर पढ़ने के लिए प्रेरित करता है?

उत्तर: (क) कहानी   –   बड़े भाई साहब

कहानीकार   –   प्रेमचंद

(ख) बड़ा भाई और लेखक दोनों छात्रावास में रहते थे। बड़ा भाई दो साल फेल होकर भी छोटे भाई को पढ़ने का उपदेश देने से नहीं चूकता था। छोटा भाई पढ़ाई में तेज किंतु खेलने–कूदने का शौकीन था। एक दिन जब वह यूँ ही मटरगश्ती करके कमरे में आया तो बड़े भाई ने उसे बुरी तरह डाँटा।

(ग) बड़े भाई ने लेखक को उसकी लापरवाही, मटरगश्ती और पढ़ाई न करने के लिए डाँटा। लेखक आठवीं का छात्र था। वह होस्टल से बाहर यों ही मस्ती करके और गप्पें मारकर कमरे में घुसा था। परंतु उसका बड़ा भाई बड़ी गंभीरता से पढ़ता रहा था। उस पर छोटे भाई को समझाने की भी जिम्मेदारी थी। इसलिए उसने लेखक को डाँटा।

(घ) बड़े भाई ने लेखक को पढ़ाई की ओर मन लगाने के लिए निम्नलिखित डर दिखाए–

● अंग्रेजी की पढ़ाई बहुत कठिन होती है।

● लोग मेहनत के बावजूद बार–बार फेल हो जाते हैं।

● दादा की मेहनत की कमाई को बेकार में न बहाओ।

बहुविकल्पी प्रश्नोत्तर

1. इस कथन का वक्ता कौन है?

(क) लेखक   (ख) बड़ा भाई   (ग) अध्यापक   (घ) हैडमास्टर

2. 'हँसी–खेल होने' का आशय है–

(क) मजाक   (ख) आसान काम   (ग) कठिन काम   (घ) मनोरंजक काम

3. बड़े भाई के फेल होने का आप क्या कारण मानते है?

(क) खेलों में लगे रहना   (ख) ठीक से मेहनत न करना   (ग) मेहनत में कमी रखना   (घ) रट्टू तोता होना

4. बड़ा भाई खेल–कूद और मनोरंजन में रुचि क्यों नहीं लेता?

(क) रुचि न होने के कारण   (ख) परीक्षाओं के तनाव के कारण

(ग) अध्यापकों के रोकने के कारण   (घ) छोटे भाई को सीख देने की इच्छा से

5. बड़ा भाई लेखक को क्या भय दिखाता है?

(क) पिटने का   (ख) माता–पिता के क्रोध का

(ग) जीवन–भर फेल होने का   (घ) माता–पिता की कमाई नष्ट होने का

उत्तर –1.   (ख)   **2.**   (ख)   **3.**   (घ)   **4.**   (ख)   **5.**   (ग)

3. मैं यह लताड़ सुनकर आँसू बहाने लगता। जवाब ही क्या था। अपराध तो मैंने किया, लताड़ कौन सहे? भाई साहब उपदेश की कला में निपुण थे। ऐसी–ऐसी लगती बातें कहते, ऐसे–ऐसे सूक्ति–बाण चलाने कि मेरे जिगर के टुकड़े–टुकड़े हो जाते और हिम्मत टूट जाती। इसी तरह जान तोड़कर मेहनत करने की शक्ति मैं अपने में न पाता था और उस निराशा में जरा देर के लिए मैं सोचने लगता– 'क्यों न घर चला जाऊँ। जो काम मेरे बूते के बाहर है, उसमें हाथ डालकर क्यों अपनी जिंदगी खराब करूँ।' मुझे अपना मूर्ख रहना मंजूर था, लेकिन उतनी मेहनत से मुझे तो चक्कर आ जाता था, लेकिन घंटे–दो घंटे के बाद निराशा के बादल फट जाते और मैं इरादा करता कि आगे से खूब जी लगाकर पढ़ूँगा। चटपट एक टाइम–टेबल बना डालता। बिना पहले से नक्शा बनाए कोई स्कीम तैयार किए काम कैसे शुरू करूँ। टाइम–टेबल में खेलकूद की मद बिलकुल उड़ जाती।

प्रश्न– (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) लेखक को किस कसूर पर लताड़ सुननी पड़ती थी?

(ग) लेखक की हिम्मत टूटने के क्या कारण थे?

(घ) निराशा में लेखक क्या सोचने लगता है?

(ङ) लेखक घर वापस जाने की बात क्यों सोचने लगता था?

(च) लेखक को कौन–सा काम बहुत कठिन और असंभव प्रतीत होता था?

(छ) निराशा के बादल फट जाने का क्या परिणाम होता है?

(ज) लेखक टाइम–टेबल क्यों बनाता था? उसकी खास विशेषता बताओ।

उत्तर: (क)   कहानी   –   बड़े भाई

कहानीकार   –   प्रेमचंद

(ख) लेखक का मन खेलने–कूदने में अधिक लगता था। वह प्रायः कमरे में बैठकर पढ़ाने की बजाय होस्टल से बाहर जाकर मटरगश्ती करता रहता था। उसका बड़ा भाई उसकी इसी लापरवाही से नाराज होकर लताड़ सुनाता था।

(ग) लेखक का बड़ा भाई छोटे भाई को उपदेश देते समय बहुत चुभती हुई बातें कहता था। वह जान–बूझ कर ऐसी तीखी–तीखी बातें और चोट करने वाली सूक्तियाँ कहा करता था कि लेखक का कलेजा टूक–टूक हो जाता था। उसकी हिम्मत टूट जाती थी।

(घ) बड़े भाई की बातें सुनकर लेखक को मानसिक चोट पहुँचती थी। उसका दिल टूट जाता था। हिम्मत जवाब दे जाती थी। प्रायः वह रोने लगता था। कभी–कभी मन में यह आता था कि वह पढ़ाई छोड़कर घर चला जाए।

(ङ) लेखक का बड़ा भाई लेखक को बुरी तरह डाँटता और लताड़ता था। वह डाँट–डपट में यही बताता था कि अगर उसने जी–तोड़ मेहनत न की, दिन–रात पढ़ाई न की, तो वह पास नहीं हो पाएगा। इतनी मेहनत की बात सुनकर लेखक निराश हो जाता था। उसे इतनी मेहनत करना अपने बस की बात नहीं लगती थी। इसलिए वह होस्टल छोड़कर घर वापस जाने की बात सोचने लगता था।

(च) दिन–रात पढ़ाई करना और पुस्तकों से आँखें फोड़ना लेखक को बहुत कठिन काम लगता था। वह अपने लिए इतनी मेहनत करना असंभव मानता था।

(छ) जब निराशा समाप्त हो जाती थी तो लेखक मन में लगनपूर्वक पढ़ाई करने का निश्चय करता था। तब वह एक टाइम–टेबल तैयार तैयार करता था, जिसके अनुसार वह पढ़ाई कर सके।

(ज) लेखक सोचता था कि वह जो भी मेहनत करे, वह सोची–समझी योजना के अनुसार हो। इसके लिए वह पढ़ाई का एक टाइम–टेबल तैयार करता था। उसकी सबसे बड़ी विशेषता यह होती थी कि उसमें खेलकूद का समय बिल्कुल नहीं होता था।

बहुविकल्पी प्रश्नोत्तर

1. 'सूक्ति–बाण' का क्या आशय है–

(क) लक्ष्य पर लगने वाले बाण   (ख) अच्छे–अच्छे नीति–वाक्य

(ग) लक्ष्य पर लगने वाले बचन   (घ) आहत करने वाले व्यंग्य–वचन

2. कौन–सा मुहावरा निराशा–हताशा को प्रकट नहीं करता–

(क) जिगर के टुकड़े–टुकड़े होना   (ख) हिम्मत टूटना   (ग) चक्कर आना   (घ) बूते के बाहर होना

3. लेखक आँसू क्यों बहाने लगता था–

   (क) अपने फेल होने की कल्पना करके   (ख) बड़े भाई की लताड़ सुनकर

   (ग) जीवन बर्बाद होने की कल्पना करके   (घ) अध्यापक से मार खाने की सोचकर

4. बड़े भाई साहब किस कला में कुशल थे?

   (क) पढ़ाई की   (ख) खेल से बचने की

   (ग) उपदेश देने की   (घ) उपदेशों का पालन करने की

5. लेखक अपने टाइम टेबल में किस बात का ध्यान रखता था?

   (क) सभी विषयों की पढाई हो सके   (ख) उसमें खेल–कूद का भी स्थान हो।

   (ग) एक भी मिनट बेकार न जाए।   (घ) उसमें खेल–कूद का स्थान न हो।

उत्तर – 1.   (घ)   2.   (घ)   3.   (ख)   4.   (ग)   5.   (घ)

4. मगर टाइम–टेबिल बना लेना एक बात है, उस पर अमल करना दूसरी बात। पहले ही दिन उसकी अवहेलना शुरू हो जाती। मैदान की वह सुखद हरियाली, हवा के हलके–हलके झोंके, फुटबाल की वह उछल–कूद, कबड्डी के वह दाँव–घात, वॉलीबाल की वह तेजी और फुरती, मुझे अज्ञात और अनिवार्य रूप से खींच ले जाती और वहाँ जाते ही मैं सब कुछ भूल जाता। वह जानलेवा टाइम–टेबिल, वह आँखफोड़ पुस्तकें, किसी की याद न रहती और भाई साहब को नसीहत और फजीहत का अवसर मिल जाता। मैं उनके साये से भागता, उनकी आँखों से दूर रहने की चेष्टा करता, कमरे में इस तरह दवे पाँव आता कि उन्हें खबर न हो। उनकी नजर मेरी ओर उठी और मेरे प्राण निकले। हमेशा सिर पर एक नंगी तलवार–सी लटकती मालूम होती। फिर भी जैसे मौत और विपत्ति के बीच भी आदमी मोह और माया के बंधन में जकड़ा रहता है, मैं फटकर और घुड़कियाँ खाकर भी खेल–कूद का तिरस्कार न कर सकता था।

प्रश्न– (क) अकसर टाइम–टेबल बनाना व्यर्थ क्यों हो जाता है?

                              अथवा

        टाइम–टेबल बना लेने पर भी, उस पर अमल क्यों नहीं हो पाया?

        (ख) लेखक का मन किस चीज में अधिक रमता था?

        (ग) लेखक टाइम–टेबल और पुस्तकों को क्यों भूल जाता था?

        (घ) लेखक के भाई को लेखक की फजीहत करने का अवसर किस कारण मिलता था?

        (ङ) लेखक अपने कमरे में दबे पाँव क्यों आता था?

        (च) अपने भाई को कमरे में पाकर लेखक कैसा अनुभव करता था?

        (छ) खेलकर वापस आने पर छोटे भाई की क्या प्रतिक्रिया होती।

        (ज) लेखक स्वयं को किस बंधन में जकड़ा पाता है और क्यों?

उत्तर: (क) अकसर टाइम–टेबल बड़े जोश में या डॉट–डपट से प्रभावित होकर या अयथार्थ होकर बनाए जाते हैं। लड़का टाइम–टेबल बनाते समय अपनी रूचि, खेल–कूद आदि सब भूल जाता है। ऐसा टाइम–टेबल व्यावहारिक नहीं होता। इस कारण अकसर उसका बनना व्यर्थ हो जाता है। छात्रा उसके अनुसार चल नहीं पाता।

(ख) लेखक का मन खेल–कूद, सैर–सपाटा, गप्प–शप्प में अधिक रमता था। मैदान की हरियाली, हवा के सुखद झोंके, फुटबाल, कबड्डी, वॉलीबाल के खेल बरबस उसे अपनी ओर खींच लेते थे।

(ग) लेखक का मन खेल–कूद और सैर–सपाटे का अधिक रसिया था। जब वह फुटबाल की उछल–कूद और वॉलीबाल की फुर्ती देखता था तो देखता ही रह जाता था। इसी प्रकार हरे–भरे मैदान और हवा के ठंडे–ठंडे झोंके उसे अपनी ओर खींचते थे। इनके आकर्षणों में वह टाइम–टेबल और पुस्तकों को बिल्कुल भूल जाता था। उसे पुस्तकों में बिल्कुल भी रुचि नहीं थी।

(घ) लेखक टाइम–टेबल बनाकर भी उसका पालन नहीं करता था। वह दिन भर पढ़ाई करने की बजाय खेल–कूद में लगा रहता था। उसका बड़ा भाई दिन–रात पढ़ता रहता था। वह छोटे भाई की देखभाल करना भी अपना कर्तव्य समझता था। इस कारण उसे छोटे भाई की फजीहत करने का अवसर मिल जाता था।

(ङ) लेखक टाइम–टेबल बनाकर भी पढ़ता–लिखता नहीं था। वह, खेलने–कूदने और सैर–सपाटे में समय बिता देता था। इसलिए जब वह कमरे में वापस पहुँचता था, तो उसे बड़े भाई से डर लगता था। इसलिए वह कमरें में दबे पाँव प्रवेश करता था।

(च) अपने बड़े भाई को कमरे में पाकर लेखक ऐसा अनुभव करता था मानो उसके सिर पर नंगी तलवार लटकी हुई हो। वह उनके साये से भी भागता था। वह उनसे भयभीत रहता था।

(छ) जब लेखक खेलकूद कर वापस कमरे में आता था तो उसके बड़े भाई साहब बहुत नाराज होते थे। वे उसे खेलकूद और लापरवाही के लिए डाँटते–डपटते थे। वे उसे अनुत्तीर्ण होने का हौवा दिखाते थे।

(ज) लेखक स्वयं को खेलकूद और मस्ती की जकड़ में जकड़ा हुआ पाता था। उसे पता होता था कि खेलने में समय गँवाने के बाद उसके बड़े भाई उसे डाँटेंगे। अपने भाई की डाँट नंगी तलवार के समान उसके सिर पर लटकी रहती थी। फिर भी वह खेलों के आनंद को ठुकरा नहीं पाता था।

बहुविकल्पी प्रश्नोत्तर

1. 'अवहेलना' का अर्थ है–

   (क) ठीक से पालन करना
   (ख) सम्मान करना
   (ग) उपेक्षा करना
   (घ) तोड़–फोड़ करना

2. लेखक टाइम–टेबल की उपेक्षा क्यों कर देता था–

   (क) खेलों में रुचि के कारण
   (ख) पुस्तकों में अरुचि हाने के कारण
   (ग) भाई साहब को भूलने के कारण
   (घ) पढ़ाई की बातें भूलने के कारण

3. टाइम–टेबल को जानलेवा क्यों कहा गया है? क्योंकि

   (क) वह बहुत सख्त था।
   (ख) उसमें खेल–कूद के लिए समय नहीं था।
   (ग) उसमें ऊब ही ऊब थी।
   (घ) वह लेखक की रुचि के विपरीत था।

4. लेखक अपने बड़े भाई के साये से क्यों भागता था?

   (क) मार से बचने के कारण
   (ख) उनके उपदेशों से बचने की इच्छा से
   (ग) डाँट–डपट से बचने के कारण
   (घ) शर्म के कारण

5. 'सिर पर नंगी तलवार लटकने' का आशय है–

   (क) मरने का भय
   (ख) उपदेशों का भय
   (ग) पास न होने का भय
   (घ) पढ़ाई का भय

उत्तर – 1. (ग)   2. (क)   3. (ख)   4. (ग)   5. (ख)

5. शैतान का हाल भी पढ़ा ही होगा। उसे यह अभिमान हुआ था कि ईश्वर का उससे बढ़कर सच्चा भक्त कोई है ही नहीं। अंत में यह हुआ कि स्वर्ग से नरक में ढकेल दिया गया। शाहेरूम ने भी एक बार अहंकार किया था। भीख माँग–माँगकर मर गया। तुमने तो अभी केवल एक दरजा पास किया है और अभी से तुम्हारा सिर फिर गया, तब तो तुम आगे पढ़ चुके। यह समझ लो कि तुम अपनी मेहनत से नहीं पास हुए, अंधे के हाथ बटेर लग गई। मगर बटेर केवल एक बार हाथ लग सकती है, बार–बार नहीं लग सकती। कभी–कभी गुल्ली–डंडे में भी अंधा–चोट निशाना पड़ जाता है। इससे कोई सफल खिलाड़ी नहीं हो जाता। सफल खिलाड़ी वह है, जिसका कोई निशाना खाली न जाए।

प्रश्न— (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) शैतान का क्या हाल हुआ और क्यों?

(ग) बड़े भाई ने लेखक को शैतान का उदाहरण क्यों दिया?

(घ) शाहेरूम की क्या दशा हुई और क्यों?

(ङ) बड़े भाई ने किस तर्क के आधार पर लेखक को असफल खिलाड़ी कहा?

(च) बड़े भाई ने छोटे भाई की सफलता पर क्या टिप्पणी की?

(छ) वक्ता की मनःस्थिति का वर्णन कीजिए।

(ज) बड़ा भाई लेखक को किसलिए कटु उपदेश दे रहा है?

उत्तर: (क)   कहानी   —   बड़े भाई साहब

                कहानीकार   —   प्रेमचंद

(ख) शैतान को स्वर्ग से नरक में ढकेल दिया गया था।क्यों–उसे यह अभिमान हो गया था कि वही ईश्वर का सबसे बड़ा भक्त और चहेता है।

(ग) बड़े भाई ने लेखक को शैतान का उदाहरण घमंड से दूर रहने की चेतावनी देने के लिए दिया। इस उदाहरण का सीधा–सा अर्थ था कि अगर लेखक घमंड के कारण पढ़ना–लिखना छोड़ देगा और उसकी बात नहीं मानेगा तो उसे नरक के समान कष्ट भोगने पड़ेंगे।

(घ) शाहेरूम को भीख माँगनी पड़ी। अहंकार के कारण वह भीख माँगते–माँगते मर गया।

(ङ) बड़े भाई ने लेखक को असफल खिलाड़ी इसलिए कहा क्योंकि उसने यह सफलता मेहनत करके नहीं, यों ही तुक्के–से प्राप्त की थी। उसके शब्दों में– ''यह समझ लो तुम अपनी मेहनत से पास नहीं हुए, अंधे के हाथ बटेर लग गई।''

(च) बड़े भाई ने छोटे भाई की सफलता पर कहा–तुम अपनी मेहनत से नहीं पास हुए हो। यह तो तुक्का लग गया है। अंधे के हाथ बटेर बार–बार नहीं लगा करती।

(छ) वक्ता बड़ा भाई है। वह अपमान और उपेक्षा से पीड़ित है। साथ ही उसके मन में अपने छोटे भाई के प्रति कर्तव्य–बोध भी है। बार–बार असफल होने की कुंठा, छोटे भाई को कहने में न रख पाने की हताशा, छोटे भाई की मौज–मस्ती सफलता और ईर्ष्या आदि से उसका चित उद्भ्रांत है।

(ज) बड़ा भाई लेखक की मौज–मस्ती और मनमानी से पीड़ित है। वह उसे अपना कहना मानने और पढ़ाई करने के लिए मजबूर करना चाहता है। इस कारण वह कटु होकर उपदेश देता है।

बहुविकल्पी प्रश्नोत्तर

1. बड़ा भाई किस कारण दुःखी है?

(क) छोटे भाई के खेल–कूद से

(ख) छोटे भाई के सामने घटते सम्मान से

(ग) छोटे भाई की सफलता से

(घ) अपने फेल होने से

2. भीख माँगने और मरने का भय दिखाकर बड़ा भाई क्या करना चाहता है?

(क) छोटे भाई को रास्ते पर लाना चाहता है।

(ख) छोटे भाई को अहंकार से मुक्ति दिलाना चाहता है।

(ग) छोटे भाई पर अपना दबदबा बनाना चाहता है।

(घ) छोटे भाई को डराना चाहता है।

3. 'अंधे के हाथ बटेर लगना' का आशय है–

(क) बिना मेहनत के सफलता मिलना

(ख) अचानक प्राप्ति होना

(ग) घमंड करना

(घ) डींग हाँकना

4. 'सिर फिरना' का आशय है–

(क) बुद्धि भ्रष्ट होना

(ख) घमंड होना

(ग) बुद्धि में परिवर्तन होना

(घ) बुद्धि–बल बढ़ना

5. बड़ा भाई छोटे भाई की सफलता में किसका योगदान मानता है?

(क) मेहनत का   (ख) ईश्वर–कृपा का   (ग) संयोग का   (घ) बुद्धि का

उत्तर – 1.   (ख)   2.   (ग)   3.   (क)   4.   (ख)   5.   (ग)

6. स्कूल का समय निकट था, नहीं ईश्वर जाने यह उपदेश–माला कब समाप्त होती। भोजन आज मुझे निःस्वाद–सा लग रहा था। जब पास होने पर यह तिरस्कार हो रहा है, तो फेल हो जाने पर तो शायद प्राण ही ले लिए जाएँ। भाई साहब ने अपने दरजे की पढ़ाई का जो भयंकर चित्रा खींचा था, उसने मुझे भयभीत कर दिया। स्कूल छोड़कर घर नहीं भागा, यही ताज्जुब है, लेकिन इतने तिरस्कार पर भी पुस्तकों में मेरी अरुचि ज्यों–की–त्यों बनी रही। खेल–कूद का कोई अवसर हाथ से न जाने देता। पढ़ता भी, मगर बहुत कम। बस, इतना कि रोज टास्क पूरा हो जाए और दरजे में जलील न होना पड़े। अपने ऊपर जो विश्वास पैदा हुआ था, वह फिर लुप्त हो गया और फिर चोरों का–सा जीवन कटने लगा।

प्रश्न– (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) प्रसंग स्पष्ट कीजिए।

(ग) लेखक को भोजन बेस्वाद क्यों लग रहा था?

(घ) लेखक भयभीत क्यों हो गया?

(ङ) लेखक का आत्मविश्वास क्यों समाप्त होने लगा?

(च) चोरों–सा जीवन कटने का क्या आशय है? लेखक के साथ ऐसा क्यों हुआ?

(छ) लेखक के भाई ने लेखक को क्यों लज्जित किया और डराया?

(ज) लेखक पर भाई की लताड़ का क्या असर हुआ?

उत्तर: (क) कहानी — बड़े भाई साहब

कहानीकार — प्रेमचंद

(ख) लेखक पिछले साल खेल–कूद कर भी कक्षा में प्रथम आ गया। बड़ा भाई पढ़–पढ़ कर भी फेल हो गया। इस कारण अब लेखक बड़े विश्वास से खेलने–कूदने में समय लगाने लगा। यह देखकर बड़े भाई से रहा न गया। उसने नए तरीके से लेखक को डाँट पिलाई। इस गद्यांश में उस लताड़ का प्रभाव दिखाया गया है।

(ग) लेखक को भोजन बेस्वाद इसलिए लग रहा था क्योंकि उसके बड़े भाई ने उसे अभी–अभी लताड़ा था। लेखक स्वयं को बेकसूर मानता था। और बड़े भाई से फालतू की डाँट नहीं सुनना चाहता था। फिर भी उसे जली–कटी बातें सुननी पड़ी। इस अकारण अपमान के कारण उसे भोजन बेस्वाद प्रतीत हुआ।

(घ) लेखक के भाई ने बड़ी कक्षा की पढ़ाई को बहुत भयंकर बनाकर पेश किया। इससे लेखक बहुत भयभीत हो गया। वह भाई से मिले तिरस्कार से भी भयभीत हुआ।

(ङ) लेखक का आत्मविश्वास अपने बड़े भाई की अकारण डाँट–फटकार सुनकर समाप्त होने लगा। उसे लगा कि वह कक्षा में प्रथम आकर भी बड़े भाई को संतुष्ट नहीं कर पा रहा है। फिर अगर फेल हो गया तो क्या होगा? जब भाई ने बड़ी कक्षा की पढ़ाई का भयंकर चित्र खींचा तो उसका आत्मविश्वास और अधिक डगमगा गया।

(च) चोरों–सा जीवन कटने का आशय है– छिप–छिप कर रहना, मन में अपराध धारण करके जीना। लेखक पहले अपने बड़े भाई से निडर हो गया था। अब उसने उसे कस कर लताड़ा, उसके सामने आगे की पढ़ाई की भयंकरता का चित्र खींचा तो वह फिर–से दबाव में आ गया।

(छ) लेखक का भाई अपनी उपेक्षा से बहुत दुखी था। उसे मन–ही–मन लगता था कि उसका छोटा भाई उसकी अनदेखी करता है। वह उसे फिर–से अपना आज्ञाकारी बनाना चाहता था तथा पढ़ाई की ओर लगाना चाहता था। इस कारण उसने मौका देखकर उसे लज्जित किया और डराया।

(ज) लेखक पर अपने भाई की लताड़ का बहुत गहरा असर हुआ। वह दबाव में आ गया। उसे आगे की पढ़ाई बहुत भयानक प्रतीत होने लगी। उसका आत्मविश्वास डगमगाने लगा। उसका दिल किया कि वह स्कूल छोड़कर घर भाग जाए।

बहुविकल्पी प्रश्नोत्तर

1. **लेखक को भोजन बेस्वाद क्यों लगने लगा?**

   (क) पढ़ाई की कठिनाइयाँ जानकर   (ख) रोज–रोज पढ़ाई करने की बात सोचकर

   (ग) भाई साहब की डाँट–फटकार सुनकर   (घ) अपनी करतूतों को जानकर

2. **'ताज्जुब' का अर्थ है–**

   (क) गनीमत   (ख) अच्छा   (ग) हैरानी   (घ) महत्त्वपूर्ण

3. **बड़े भाई का तिरस्कार पाकर खेल–कूद के बारे में लेखक ने क्या प्रतिक्रिया की?**

   (क) उसने खेलना छोड़ दिया।   (ख) उसे खेलने से डर लगने लगा।

   (ग) उसने खेलना अधिक कर दिया।   (घ) उसने खेल–कूद जारी रखे।

4. **तिरस्कार से लेखक के मन पर क्या प्रभाव हुआ?**

   (क) उसका आत्मविश्वास बढ़ा।   (ख) वह ठीक हो गया।

   (ग) उसका आत्मविश्वास घटा।   (घ) वह भाई का विरोधी हो गया।

5.   लेखक का जीवन चोरों–सा क्यों कटने लगा?

(क) मन में अपराध–भाव आ गया था।   (ख) उसे भाई साहब से बचना होता था।

(ग) मन में ग्लानि–भाव आ गया था।   (घ) वह खेलों को बुरा मानने लगा था।

उत्तर – 1.   (ग)   2.   (ग)   3.   (घ)   4.   (ग)   5.   (ख)

6.   फिर सालाना इम्तिहान हुआ और कुछ ऐसा संयोग हुआ कि मैं फिर पास हुआ और भाई साहब फिर फेल हो गए। मैंने बहुत मेहनत नहीं की, पर न जाने कैसे दरजे में अव्वल आ गया। मुझे खुद अचरज हुआ। भाई साहब ने प्राणांतक परिश्रम किया। कोर्स का एक–एक शब्द चाट गए थे, दस बजे रात तक इधर, चार बजे भोर से उधर, छः से साढ़े नौ तक स्कूल जाने के पहले। मुद्रा कांतिहीन हो गई थी, मगर बेचारे फेल हो गए। मुझे उन पर दया आती थी। नतीजा सुनाया गया, तो वह रो पड़े और मैं भी रोने लगा। अपने पास होने की खुशी आधी हो गई। मैं भी फेल हो गया होता, तो भाई साहब को इतना दुःख न होता, लेकिन विधि की बात कौन टाले!

मेरे और भाई साहब के बीच में अब केवल एक दरजे का अंतर और रह गया। मेरे मन में एक कुटिल भावना उदय हुई कि कहीं भाई साहब एक साल और फेल हो जाएँ, तो मैं उनके बराबर हो जाऊँ, फिर वह किस आधार पर मेरी फजीहत कर सकेंगे, लेकिन मैंने इस विचार को दिल से बलपूर्वक निकाल डाला। आखिर वह मुझे मेरे हित के विचार से ही तो डाँटते हैं। मुझे इस वक्त अप्रिय लगता है अवश्य, मगर यह शायद उनके उपदेशों का ही असर है कि मैं दनादन पास हो जाता हूँ और इतने अच्छे नंबरों से।

प्रश्न–   (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) आपकी दृष्टि में बड़ा भाई फेल क्यों हो गया?

(ग) बड़े भाई ने पढ़ाई के लिए किस प्रकार परिश्रम किया?

(घ) लेखक को बड़े भाई पर दया क्यों आई?

(ङ) बड़े भाई को किस–किस बात का दुख था?

(च) लेखक के पास होने की खुशी आधी क्यों हो गई?

(छ) लेखक के मन में कौन–सी कुटिल भावना उदित हुई और क्यों?

(ज) लेखक ने मन में आई कुटिलता को क्यों दबा लिया?

उत्तर: (क)   कहानी   –   बड़े भाई साहब

कहानीकार   –   प्रेमचंद

(ख) मेरी दृष्टि में बड़ा भाई तनाव, भय और रटंत शैली के कारण फेल हो गया। उसके लिए पास होना हौव्वा बन चुका था। उसके मन में डर बैठ चुका था कि वह इस बार फिर–से फेल होगा। इस कारण वह ज्ञान को तसल्ली से मन में बिठाने की बजाय शब्दों को रटता था। वह कोर्स का एक–एक शब्द चाट गया था। परंतु ऐसी रटंत विद्या परीक्षा में काम नहीं आती।

(ग) बड़े भाई ने पढ़ाई के लिए दिन–रात परिश्रम किया। उसने न दिन देखा, न रात। वह रात को दस बजे तक पड़ा। फिर सुबह चार बजे उठकर पढ़ा। स्कूल जाने से पहले छः से साढ़े नौ तक पढ़ा। पढ़ते–पढ़ते उनका मुख निस्तेज हो गया, किंतु वह कोर्स का एक–एक शब्द चाट गया।

(घ) लेखक को अपने बड़े भाई पर दया इसलिए आई क्योंकि वह दिन–रात रट–रट कर भी चौथी बार फेल हो गया। उसका मुख निस्तेज हो गया। सबसे बड़ी बात तो यह हो गई कि वह छोटे भाई की तुलना में हीन सिद्ध हो गया। अब उनमें केवल एक ही कक्षा का अंतर रह गया।

(ङ) बड़े भाई को चौथी बार फेल हो जाने का दुख तो था ही; उसे अपनी तुलना में छोटे भाई के अव्वल आने का भी दुख था।

(च) लेखक कक्षा में प्रथम आया था। परंतु उसकी यह खुशी इसलिए आधी रह गई क्योंकि उसका बड़ा भाई चौथी बार फेल हो गया था।

(छ) लेखक के मन में एक कुटिल भावना उठी। उसने सोचा कि अगर उसका बड़ा भाई अगले साल भी फेल हो जाए तो वे दोनों एक ही कक्षा में हो जाएँगे। तब बड़ा भाई बात–बात पर उसका अपमान नहीं कर सकेगा।

(ज) लेखक के मन में यह कुटिल विचार आया कि काश! भाई अगले साल भी फेल हो जाए। तब वे दोनों एक ही कक्षा में आ जाएँगे। परंतु उसने यह कुविचार तुरंत ही दबा लिया। उसे मन–ही–मन पाप–बोध हुआ। उसे लगा कि यह विचार पापपूर्ण है। हो सकता है, बड़े भाई की नसीहतें और फजीहतें सुन–सुनकर ही वह दनादन पास हो जाता हो।

बहुविकल्पी प्रश्नोत्तर

1. **बड़े भाई की असफलता का क्या कारण था?**

   (क) बहुत अधिक मेहनत   (ख) परीक्षा का तनाव

   (ग) बिना समझे पढ़ना   (घ) लगातार पढ़ना

2. **लेखक को बड़े भाई पर दया क्यों आती थी?**

   (क) उनकी दुर्दशा को देखकर   (ख) उनकी मेहनत को देखकर

   (ग) उनकी असफलता को देखकर   (घ) उनके अपमान को देखकर

3. **लेखक को अपने पास होने पर खुशी क्यों नहीं हुई?**

   (क) क्योंकि उसने मेहनत नहीं की थी।   (ख) क्योंकि अंक अपेक्षा से कम आए थे।

   (ग) क्योंकि भाई साहब को खुशी नहीं हुई थी। (घ) क्योंकि बड़े भाई फेल हो गए थे।

4. **लेखक के मन में अपने बड़े भाई के एक साल और फेल होने की कल्पना क्यों आई?**

   (क) मजा लेने के लिए   (ख) बदला लेने के लिए

   (ग) तिरस्कार से बचने के लिए   (घ) उनके साथ एक कक्षा में पढ़ने के लिए

5. **आपके विचार से लेखक दनादन पास क्यों हो जाता है?**

   (क) मेहनत करके   (ख) परीक्षा की योग्य तैयारी करके

   (ग) समझदारी पूर्वक परीक्षा देने के कारण   (घ) बड़े भाई के उपदेशों से डर के

उत्तर – 1.   (ख)   2.   (क)   3.   (घ)   4.   (ग)   5.   (ग)

8.   एक जमाना था कि लोग आठवाँ दरजा पास करके नायब तहसीलदार हो जाते थे। मैं कितने ही मिडिलचियों को जानता हूँ, जो आज अव्वल दरजे के डिप्टी मैजिस्ट्रेट या सुपरिटेंडेंट हैं। कितने ही आठवीं जमात वाले हमारे लीडर और समाचारपत्रों के संपादक हैं। बड़े–बड़े विद्वान उनकी मातहती में काम करते हैं और तुम उसी आठवें दरजे में आकर बाजारी लौंडों के साथ कनकौए के लिए दौड़ रहे हो। मुझे तुम्हारी इस कम अक्ली पर दुःख होता है। तुम जहीन हो, इसमें शक नहीं, लेकिन वह जेहन किस काम का जो हमारे आत्मगौरव की हत्या कर डाले। तुम अपने दिल में समझते होगे, मैं भाई साहब से महज एक दरजा नीचे हूँ और अब उन्हें मुझको कुछ कहने का हक नहीं है, लेकिन यह तुम्हारी गलती है। मैं तुमसे पाँच साल बड़ा हूँ और चाहे आज तुम मेरी ही जमात में आ जाओ और परीक्षकों का यही हाल है, तो निस्संदेह अगले साल तुम मेरे समकक्ष हो जाओगे और शायद एक साल बाद मुझसे आगे भी निकल जाओ, लेकिन मुझमें और तुममें जो पाँच साल का अंतर है, उसे तुम क्या, खुदा भी नहीं मिटा सकता।

प्रश्न— (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) प्रसंग स्पष्ट कीजिए।

(ग) बड़ा भाई लेखक की प्रतीभा को क्यों व्यर्थ मानता है।

(घ) बड़ा भाई आठवीं कक्षा की महिमा कैसे गाता है?

(ङ) बड़ा भाई किस तर्क के आधार पर अपने छोटे भाई पर अपना हक जमाता है?

(च) बड़ा भाई किस तर्क के आधार पर अपने छोटे भाई पर अपना हक जमाता है?

(छ) बड़ा भाई अपने फेल होने के लिए किसे दोषी मानता है?

(ज) भाई के अनुसार लेखक अपने आत्मगौरव की हत्या किस प्रकार करता है?

उत्तरः (क)   कहानी   –   बड़े भाई साहब

कहानीकार   –   प्रेमचंद

(ख) लेखक का बड़ा भाई स्वयं कई बार फेल हो चुका था। लेखक कई बार कक्षा में प्रथम आ चुका था। फिर भी बड़ा भाई छोटे भाई पर अपना नियन्त्रण रखना चाहता था। वह उसे खेल–कूद और पतंगबाजी से रोकना चाहता था। लेखक बार–बार कक्षा में प्रथम आकर निडर और आजाद हो चुका था। ऐसे में एक बार बड़े भाई ने लेखक को सड़क पर पतंग लूटने के लिए भागता देख लिया। इस अवसर पर उसने यह प्रताड़ना दी।

(ग) बड़ा भाई लेखक को बाजारी लौंडों के साथ गलियों में दौड़ने–भागने के लिए डाँटता है। उसका आरोप है कि लेखक ऐसा करके अपना स्तर गिरा रहा है। आठवीं पास करने वाले तो नायब तहसीलदार, डिप्टी मैजिस्ट्रेट या सुपरिडेंट तक बर सकते है। ऐसी महत्त्वपूर्ण कक्षा में पढ़कर भी वह पतंग लूटता फिर रहा है– यह अपने स्तर को गिराने का लक्षण है।

(घ) बड़ा भाई कहता है कि आठवीं पास करने का बहुत बड़ा मूल्य है। पहले लोग आठवीं पास करके नायब तहसीलदार बन जाते थे। आज कितने ही मिडलची अव्वल दर्जे के डिप्टी मैजिस्ट्रेट या सुपरिडेंट हैं। कितने ही आठवीं पास लीडर और संपादक बन चुके हैं। बड़े–बड़े विद्वान उनके अधीन काम करते हैं।

(ङ) बड़ा भाई लेखक को प्रतिभाशाली अर्थात् जहीन तो मानता है किंतु उसे व्यर्थ कहता है। कारण यह है कि वह अपनी प्रतिभा का मूल्य नहीं जानता। वह अपने जेहन का सम्मान नहीं करता। वह बाजारी लौंडों के साथ सड़कों–गलियों पर पतंग लूटता फिरता है। इससे आत्मगौरव नष्ट होता है।

(च) बड़ा भाई लेखक को कहता है कि वह पढ़ाई में उससे कमजोर है। हो सकता है, वह अगले साल फिर–से फेल हो जाए। तब वे दोनों बराबर हो जाएँगे। किंतु फिर भी उम्र के कारण वह छोटे भाई से सदा बड़ा बना रहेगा। इस कारण उसे छोटे भाई को डाँटने का अधिकार भी रहेगा। इस अंतर को कोई नहीं झुठला सकता।

(छ) बड़ा भाई अपने फेल होने के लिए परीक्षकों को दोषी मानता है। वह कहता है– ''और परीक्षकों का यही हाल है, तो निस्संदेह अगले साल तुम मेरे समक्ष हो जाओगे।''

(ज) बड़े भाई के अनुसार, बाजारी लौंडों के साथ सड़कों और गलियों पर पतंग लूटने के लिए दौड़ना अपने आत्मगौरव की हत्या करना है। आठवीं पास व्यक्ति तो बड़े–बड़े सम्माननीय पदों तक पहुँच जाता है। फिर आठवीं कक्षा में पहुँचकर पतंग लूटना और बाजारी लौंडों के साथ संगति करना सरासर अपने सम्मान को गिराना है।

बहुविकल्पी प्रश्नोत्तर

1. बड़ा भाई छोटे भाई पर किस कारण दबदबा बनाता है?

(क) योग्यता के कारण (ख) बड़प्पन के कारण

(ग) उम्र में बड़ा होने के कारण (घ) कर्तव्यबोध के कारण

2. बड़ा भाई छोटे भाई को उपदेश क्यों झाड़ता है?

(क) उसे दबाने के लिए (ख) उसे पढ़ाई में लगाने के लिए

(ग) उसके अहंकार को कुचलने के लिए (घ) अपना महत्त्व बनाए रखने के लिए

3. 'जहीन' का अर्थ है–

(क) जलील (ख) दुष्ट (ग) प्रतिभाशाली (घ) भाग्यशाली

4. बड़ा भाई अपने फेल होने का कारण किसे मानता है?

(क) किस्मत को (ख) आजकल के परीक्षकों को

(ग) गलत परीक्षा–प्रणाली को (घ) अपनी बुद्धिहीनता को

5. बड़ा भाई किस गुण में बहुत आगे है?

(क) बातें बनाने में (ख) उपदेश देने में (ग) दबदबा बनाने में (घ) तीनों में

उत्तर – 1. (ग) 2. (घ) 3. (ग) 4. (ख) 5. (घ)

9. मैं तुमसे पाँच साल बड़ा हूँ और हमेशा रहूँगा। मुझे दुनिया का और जिंदगी का जो तजुरबा है, तुम उसकी बराबरी नहीं कर सकते, चाहे तुम एम.ए. और डी. फिल् और डी. लिट् ही क्यों न हो जाओ। समझ किताबें पढ़ने से नहीं आती, दुनिया देखने से आती है। हमारी अम्माँ ने कोई दरजा नहीं पास किया और दादा भी शायद पाँचवी–छठी जमात के आगे नहीं गए, लेकिन हम दोनों चाहे सारी दुनिया की विद्या पढ़ लें, अम्माँ और दादा को हमें समझाने और सुधारने का अधिकार हमेशा रहेगा केवल इसलिए नहीं कि वे हमारे जन्मदाता हैं, बल्कि इसलिए कि उन्हें दुनिया का हमसे ज्यादा तजुरबा है और रहेगा। अमेरिका में किस तरह की राज–व्यवस्था है, और आठवें हेनरी ने कितने ब्याह किए और आकाश में कितने नक्षत्र हैं, यह बातें चाहे उन्हें न मालूम हों, लेकिन हजारों ऐसी बातें हैं, जिनका ज्ञान उन्हें हमसे और तुमसे ज्यादा है।

प्रश्न– (क) कहानी तथा कहानीकार का नाम लिखिए।

(ख) प्रसंग स्पष्ट कीजिए।

(ग) इस गद्यांश में बड़ा भाई क्या सिद्ध करना चाहता है?

(घ) लेखक बड़े भाई पर क्या व्यंग्य करना चाहता है?

(ङ) अधिक मूल्य किस बात का है– पढ़ाई का, बड़े होने का या अनुभव का?

(च) अम्माँ और दादा को सबको समझाने का अधिकार क्यों है?

उत्तरः (क) कहानी – बड़े भाई साहब

कहानीकार – प्रेमचंद

(ख) लेखक का बड़ा भाई स्वयं कई बार फेल हो चुका था। लेखक कई बार कक्षा में प्रथम आ चुका था। फिर भी बड़ा भाई छोटे भाई पर अपना नियंत्रण रखना चाहता था। वह उसे खेल–कूद और पतंगबाजी से रोकना चाहता था।

लेखक बार–बार कक्षा में प्रथम आकर निडर और आजाद हो चुका था। ऐसे में एक बार बड़े भाई ने लेखक को सड़क पर पतंग लूटने के लिए भागता देख लिया। इस अवसर पर उसने यह प्रताड़ना दी।

(ग) इस गद्यांश में बड़ा भाई यह सिद्ध करना चाहता है कि जीवन में पढ़ाई–लिखाई से अधिक महत्त्वपूर्ण है– बड़ी उम्र और जीवन का अनुभव। इन दोनों में वह अपने छोटे भाई से आगे है। इसलिए उसे उसका सम्मान करना चाहिए, उसकी बात माननी चाहिए।

(घ) लेखक बड़े भाई पर यह व्यंग्य करना चाहता है कि उसे बड़प्पन का रोग है। वह किसी भी सूरत में अपने छोटे भाई की उपेक्षा सहन नहीं कर सकता। इसलिए वह कोई–न–कोई युक्ति भिड़ाकर स्वयं को बड़ा सिद्ध करके रहेगा और छोटे भाई पर शासन करता रहेगा।

(ङ) इस गद्यांश में पढ़ाई, उम्र और अनुभव–तीनों की तुलना है। लेखक ने पढ़ाई की तुलना में उम्र और अनुभव दोनों को अधिक महत्त्व दिया है। उसने बड़ी उम्र से भी अधिक महत्त्वपूर्ण तजुर्बे को अर्थात जीवन–अनुभव को माना है।

(च) अम्माँ और दादा कम पढ़े–लिखे हैं, किंतु उन्हें जीवन का अनुभव अधिक है। इसलिए वे अधिक समझदार है। अतः उन्हें अपने सुशिक्षित बच्चों को भी समझाने का पूरा–पूरा अधिकार है।

बहुविकल्पी प्रश्नोत्तर

1. 'मैं' कौन है?

   (क) लेखक   (ख) बड़ा भाई   (ग) अध्यापक   (घ) पिता

2. बड़ा भाई लेखक से किस चीज में आगे है?

   (क) अनुभव में   (ख) पढ़ाई में   (ग) सफलता में   (घ) योग्यता में

3. बड़ा भाई अनुभव को महत्त्व क्यों देता है?

   (क) लेखक को लताड़ने के लिए   (ख) लेखक को खेल–कूद से रोकने के लिए

   (ग) अपना दबदबा बनाने के लिए   (घ) अनुभव का महत्त्व समझाने के लिए

4. बड़ा भाई किताबों को महत्त्व क्यों नही देता?

   (क) किताबें न समझ पाने के कारण   (ख) अनपढ़ होने के कारण

   (ग) किताबों की व्यर्थता जानने के कारण   (घ) अनुभव–ज्ञान को सच्चा ज्ञान मानने के कारण

5. 'तजुरबा' का तात्पर्य है–

   (क) अनुभव   (ख) अहसास   (ग) जीवन   (घ) समझ

उत्तर – 1.   (ख)   2.   (क)   3.   (ग)   4.   (क)   5.   (क)

V. पाठ्य–पुस्तक के प्रश्न–अभ्यास

मौखिक

निम्नलिखित प्रश्नों के उत्तर एक–दो पंक्तियों में दीजिए–

प्रश्न.1 दूसरी बार पास होने पर छोटे भाई के व्यवहार में क्या परिवर्तन आया?

उत्तरः दूसरी बार पास होने पर छोटा भाई स्वच्छंद हो गया। उसने पढ़ना–लिखना बिल्कुल छोड़ दिया और पतंगबाजी में मन लगा लिया।

प्रश्न.2 बड़े भाई साहब दिमाग को आराम देने के लिए क्या करते थे?

उत्तरः बड़े भाई साहब दिमाग को आराम देने के लिए कापी या किताब पर इधर–उधर की व्यर्थ की बातें बार–बार लिखा करते थे या कोई चित्र बना डालते थे।

लिखित

निम्नलिखित प्रश्नों के उत्तर (25-30 शब्दों में) लिखिए–

प्रश्न.1 छोटे भाई ने अपनी पढ़ाई का टाइम–टेबिल बनाते समय क्या–क्या सोचा और फिर उसका पालन क्यों नहीं कर पाया?

उत्तर: छोटे भाई ने अपनी पढ़ाई का टाइम–टेबल बनाते समय सोचा कि वह नियम बनाकर दिन–रात पढ़ा करेगा तथा खेलकूद बिल्कुल छोड़ देगा। परंतु खेलकूद में गहरी रुचि तथा पुस्तकों में अरुचि होने के कारण वह इसका पालन न कर सका।

प्रश्न.2 बड़े भाई साहब छोटे भाई को क्या सलाह देते थे और क्यों?

उत्तर: बड़े भाई साहब छोटे भाई को दिन–रात पढ़ने तथा खेल–कूद में समय न गँवाने की सलाह देते थे। वे बड़ा होने के कारण उसे राह पर चलाना अपना कर्तव्य समझते थे।

निम्नलिखित प्रश्नों के उत्तर (50-60 शब्दों में) लिखिए–

प्रश्न.1 बड़े भाई साहब के अनुसार जीवन की समझ कैसे आती है?

उत्तर: बड़े भाई साहब के अनुसार जीवन की समझ पुस्तकें पढ़ने से नहीं, अपितु दुनिया देखने से आती है। जिसे जीवन जीने का अनुभव अधिक है, वही समझदार माना जाता है। इसीलिए माँ–बाप, दादा–दादी, कम पढ़–लिखकर भी अधिक ज्ञान और समझ रखते हैं। वे घर–खर्च, बीमारी और अन्य प्रबंध करने में पढ़े–लिखों से भी अधिक कुशल होते हैं। हेडमास्टर से भी अधिक कुशल उनकी बूढ़ी माँ थीं जिन्होंने अपने सुशिक्षित पुत्र की अव्यवस्था को सँभाल लिया।

प्रश्न.2 बड़े भाई की स्वभावगत विशेषताएँ बताइए?

अथवा

कहानी के आधार पर बड़े भाई साहब के स्वभाव की तीन विशेषताओं पर प्रकाश डालिए।

उत्तर: बड़ा भाई महत्त्वकांक्षी है। वह बड़ा होने का सम्मान चाहता है। वह अपने–आपको अपने छोटे भाई का संरक्षक सिद्ध करने के लिए जी–जान लगा देता है।

घोर परिश्रमी और धुनी– बड़ा भाई चाहे पढ़ाई करने की ठीक विधि न जानता हो, किंतु उसके परिश्रम और धुन में कोई कोर–कसर नहीं रहती। वह तीन–तीन बार फेल होकर भी उसी धुन से पढ़ता रहता है। वह दिन–रात पढ़ता है। उसकी तपस्या बड़े–बड़े तपस्वियों को भी मात करती है।

वाक्पटु– बड़ा भाई उपदेश देने और बातें बनाने में बहुत कुशल है। वह अपने–आपको बड़ा सिद्ध करने के लिए हर तर्क जुटा लेता है। कभी वह घमंडियों के नाश की बात कहता है। कभी बड़ी कक्षा की पढ़ाई को कठिन बताता है, कभी परीक्षकों को बुरा कहता है, कभी पढ़ाई–लिखाई को बेकार कहता है, कभी अपनी समझदारी की डींग हाँकता है, और कभी उम्र और अनुभव को महत्त्वपूर्ण कहता है। परंतु वह स्वयं को बड़ा सिद्ध करके ही मानता है।

प्रश्न.3 बड़े भाई साहब ने जिंदगी के अनुभव और किताबी ज्ञान में से किसे और क्यों महत्त्वपूर्ण कहा है?

उत्तर: बड़े भाई साहब ने जिंदगी के अनुभव और किताबी ज्ञान में से जिंदगी के अनुभव को अधिक महत्त्वपूर्ण माना है। उसके अनुसार, अनुभव से ही जीवन की सही समझ विकसित होती है। उसी से जीवन के सारे महत्त्वपूर्ण काम सधते हैं। बीमारी हो, घर–खर्च चलाना हो या घर के अन्य प्रबंध करने हों, इसमें उम्र और अनुभव काम आता है, पढ़ाई–लिखाई नहीं। लेखक की अम्माँ, दादा और हेडमास्टर साहब की बूढ़ी माँ के उदाहरण सामने हैं। वहाँ उम्र और अनुभव काम आते हैं, पढ़ाई–लिखाई नहीं।

VI. अन्य महत्वपूर्ण परीक्षोपयोगी प्रश्नोत्तर

विचार/संदेश संबंधी प्रश्नोत्तर

प्रश्न.1 'बड़े भाई साहब' नामक कहानी से आपको क्या प्रेरणा मिलती है?

उत्तरः 'बड़े भाई साहब' कहानी हमें यह प्रेरणा देती है कि हम अपनी स्थिति, शक्ति और सीमा को समझें। दूसरे शब्दों में, अपनी औकात को जानें। उसी के अनुरूप व्यवहार करें। यदि हम स्वयं अपने गिरेबान में नहीं झाँकते किंतु औरों से उम्मीदें करते है, तो हम हँसी के पात्र बन जाते हैं। यदि हम स्वयं योग्य नहीं हैं, सफल नहीं हैं तो हम किसी को उपदेश देने का अधिकार भी खो बैठते हैं।

इस कहानी से हमें यह प्रेरणा भी मिलती है कि हम पढ़ाई को सहज रूप से करें। हम उसका हौव्वा न खड़ा करें। हम परीक्षा के तनाव में चौबीसों घंटे किताबों में न घुसे रहें। इससे हमारा दिमाग बंद हो जाता है और पढ़ाई व्यर्थ हो जाती है।

इस कहानी से तीसरी प्रेरणा यह मिलती है कि पढ़ाई को रटने की बजाय उसे समझने की कोशिश करें। अपनी समझ को विकसित करें। चौथा संदेश यह मिलता है कि खेल–कूद पढ़ाई के विरोधी नहीं हैं। ये पढ़ाई में सहायक हो सकते हैं।

प्रश्न.2 बड़ा भाई छोटे भाई से कैसे संबंध चाहता है? उसकी समस्या क्या है?

उत्तरः बड़ा भाई छोटे भाई के लिए बड़ा और मार्गदर्शक बना रहना चाहता है। उसकी समस्या यह है कि वह मार्गदर्शक बनने योग्य नहीं है। वह भाई को जिस मार्ग पर चलाना चाहता है, उसमें वह स्वयं फिसड्डी है। अतः उसका मार्गदर्शन एक अंधे का मार्गदर्शन है। परंतु जैसे धृतराष्ट्र अयोग्य होने पर भी राजगद्दी नहीं छोड़ता, उसी तरह बड़ा भाई भी अपने बड़प्पन की लीक नहीं छोड़ता। वह जैसे–तैसे उस पर अपनी श्रेष्ठता का रौब लादना चाहता है।

विषय–बोध संबंधी प्रश्नोत्तर

प्रश्न.1 बड़ा भाई छोटे भाई पर शासन करने के लिए कौन–कौन सी युक्तियाँ अपनाता है?

उत्तरः बड़ा भाई छोटे भाई पर शासन करने के लिए निम्नलिखित युक्तियाँ अपनाता है–

- वह हमेशा छोटे भाई के खेल–कूद और स्वच्छंदता पर नियंत्रण रखता है। उससे रोज सवाल पूछता है कि वह कहाँ गया था?
- वह भाई द्वारा न पढ़ने पर और खेलने में मन लगाने पर लंबे–लंबे भाषण देता है। उस भाषण में अपने फेल होने का, पढ़ाई के कठिन होने का, स्वयं के खेल–कूद से दूर रहने का उदाहरण देता है।
- स्वयं फेल होने पर वह सफलता की बजाय बुद्धि के विकास को महत्त्वपूर्ण बताता है। फिर वह अपने ज्ञात की डींग हाँककर उस पर हावी होता है।
- लेखक द्वारा मनमानी करने पर वह उसे घमंड न करने की सीख देता है। वह रावण, शैतान, शाहरूम जैसे बड़े–बड़े अभिमानियों की फजीहत के उदाहरण देता है।
- वह इतिहास, अलजबरा और निबंध–लेखन की शिक्षा को व्यर्थ बताता है।
- वह आचरण की महिमा और गौरव को महत्त्वपूर्ण बताकर छोटे भाई को अपमानित करता है।
- वह किताबी शिक्षा की बजाय जीवन के अनुभव को अधिक काम की चीज बताता है।

प्रश्न.2 बड़ा भाई घमंड का विरोध क्यों करता है? उसके लिए किन–किन के उदाहरण देता है?

उत्तरः बड़ा भाई अपने छोटे भाई को नियंत्रण में रखने के लिए उसे घमंडी कहता है। फिर वह घमंड को बहुत बुरी बीमारी कहता है। इसके लिए वह रावण, शैतान और शाहरूम के उदाहरण देता है। रावण अंग्रेजों से भी बड़ा राजा था। फिर भी उसका अभिमान चकनाचूर हो गया। शैतान को भी नरक भोगना पड़ा। शाहरूम भीख माँग–माँग कर मर गया। बड़ा भाई कहता है कि अधिक घमंड करने पर उसे भी तिल–तिल कर मरना पड़ेगा।

प्रश्न.3 बड़ा भाई किस कारण लेखक पर निगरानी का अधिकार समझता था?

उत्तर: बड़ा भाई उम्र में बड़ा होने के कारण यह अपना जन्मसिद्ध अधिकार समझता था कि वह छोटे भाई पर निगरानी रखे, उसे बेराह न होने दे। उसे पढ़ने के लिए प्रेरित करे तथा समय नष्ट करने से बचाए।

प्रश्न.4 वह स्वभाव से अध्ययनशील थे– इसमें क्या व्यंग्य है?

उत्तर: इस टिप्पणी में गहरा व्यंग्य है। बड़ा भाई प्रकट रूप में बहुत अध्ययनशील जान पड़ता था। जब भी देखो, वह किताबों में घुसा रहता था। यहाँ तक कि उसने पढ़–पढ़ कर अपना चेहरा तेजहीन कर डाला था। किंतु उसका अध्ययन एक नाटक था। वह समझता तो कुछ था नहीं। वह केवल रटता था। जब रटते–रटते बोर हो जाता था तो किताबों और कापियों पर बेकार की आड़ी–तिरछी लकीरें खींचने लगता था।

प्रश्न.5 बड़े भाई द्वारा छोटे भाई को अपना उदाहरण देना कहाँ तक ठीक है?

उत्तर: समानता हमेशा समान गुण वालों में होती है। बड़ा भाई पढ़ाई में फिसड्डी है। वह रट्टूपीर है। इसलिए हर साल फेल हो जाता है और पढ़ाई को बहुत कठिन हौव्वा समझता है। वह अपनी क्षमता के आधार पर अपने छोटे भाई को उपदेश देने लगता है। गलती से वह अपनी मेहनत का तथा अपने फेल होने का उदाहरण देता है। यह तुलना अनुचित है। इससे तुलना करने वाला हँसी का पात्र बनता है।

प्रश्न.6 बड़ा भाई अनुभव को महत्त्वपूर्ण बताने के लिए कौन–कौन से उदाहरण देता है और क्यों?

उत्तर: बड़ा भाई अनुभव को महत्त्वपूर्ण सिद्ध करने के लिए अपनी अम्माँ, दादा तथा हेडमास्टर की बूढ़ी माँ के उदाहरण देता है। ये तीनों अधिक पढ़े–लिखे नहीं हैं। फिर भी इन्हें जिंदगी का अनुभव अधिक है। इसलिए ये समझदारी से प्रबंध करते हैं, कुशलता से घर–खर्च चलाते हैं और अच्छी तरह देखभाल कर पाते हैं।

प्रश्न.7 आदर्श स्थिति बनाए रखने के लिए बड़े भाई साहब का बचपना कैसे तिरोहित हो जाता है?

उत्तर: परिवार में आदर्श स्थिति यह है कि बड़ा भाई छोटे भाई का संरक्षक हो। यह काम बहुत ही टेढ़ा है। इस कहानी का बड़ा भाई स्वयं भी नवयुवक है। उसका दिल बात–बात पर मचलता है। परंतु उसकी मजबूरी यह है कि उसे छोटे भाई के सामने स्वयं को बड़ा सिद्ध करना है। इसके लिए वह बात–बात पर उसे उपदेश देता है, डाँटता है तथा बड़े संरक्षकों की भाँति व्यवहार करता है। परिणामस्वरूप उसका बचपना गायब हो जाता है। वह छोटे को संयमित रखने के लिए अपनी मस्ती त्याग देता है।