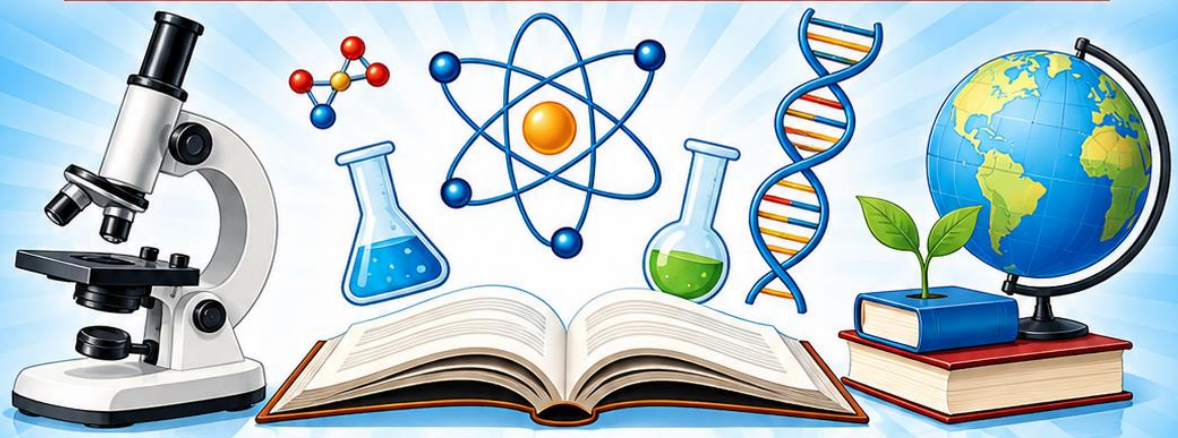
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JALALABAD (W)

205

Pedagogy of Science Education



LALA JAGAT NARYAN EDUCATION COLLEGE
JALALABAD WEST

D.El.Ed 2ND YEAR

NOTES

Unit 1: Understanding science

1.1 Meaning & nature of science

1.2 Why do we teach Science ?

1.3 Scientific Attitude -- Meaning & development

1.4 What do scientist look like ?

1.5 Brief life history & contribution of some eminent Scientists ---- C.V. Raman , J.C. Boss , Bimla Buti , Albert Einstein, Marie Curie

Unit 2: Revisiting school science concepts

2.1The World of the Living: Cell –Structure & function , Animal Tissues: Types(Epithelial, Muscular, connective and Nervous)
2.2 Matter : Structure of Atom- Electron , Proton ,Neutron .Atomic models –Thomson ,Rutherford & Bohar's model .Symbols, Aomic Number ,Mass Number ,Valency & Electronic configuration of first 20 elements.

2.3Natural Phenomena: - - Gravitation:-- Newton's Universal Law of Gravitation , relation between g & G ,Mass & Weight , variation of g with altitude & due to shape of earth. - Magnetism :--Magnet & its properties ,Magnetic field ,magnetic lines of forces , Magnetic materials, different ways of Magnetising a magnetic material. --Current Electricity :-- Charge ,current ,potential difference, Ohm's Law , Sources of

current – Volta cell ,Lechlanche cell , Dry cell. --- Light :--- Nature of light, laws of reflection of light ,Refraction of light ,laws of refraction ,refractive index,refraction through a glass slab, Optical phenomena in nature – Mirage & Twinkling of stars , Optical Instruments – Human Eye & Compound Microscope.

Unit 3: Planning for Teaching

3.1 Need of planning

3.2 Identification & organization of concepts - Need, Basic Principles and Factors that need to be considered for organization of concepts.

3.3. Science lesson design (lesson – plan) - Elements & Structure

3.4 Planning Laboratory work

3.5 Improvisation of apparatus - Meaning, Importance, examples of improvised apparatus (at least 5 examples with required material, construction , working and concepts which can be discussed)

Unit 4: Science for all

4.1 4.2 Issues of gender, language and culture in science classes Science as a tool for Equity

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4.3 Democratising Science learning : Critical Pedagogy ,Role of teacher in Critical Pedagogy

4.4 Introduction to science and society interface - Science for Environment - - Science for Health Sciene for Peac

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Complete Study Notes – Units 1 to 4

These notes are prepared in medium-detail English, using simple language, definitions, explanations, practical examples, important points and mind maps. They are suitable for D.El.Ed. examination preparation.

UNIT 1: UNDERSTANDING SCIENCE

1.1 Meaning and Nature of Science

Meaning of Science

The word Science comes from the Latin word *Scientia*, which means knowledge. Science is a systematic study of the natural world through observation, experimentation, investigation and logical reasoning.

Science helps us understand how and why things happen around us.

Definitions of Science

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1. **Science is an organized body of knowledge based on facts and experiments.**
2. **Science is a systematic process of discovering knowledge about the universe.**
3. **Science is a way of thinking, questioning and finding answers through evidence.**

Examples:

- **We observe that plants grow towards sunlight.**
- **We investigate why ice melts when heated.**
- **We study why objects fall towards the Earth.**
- **We understand how electricity operates household appliances.**

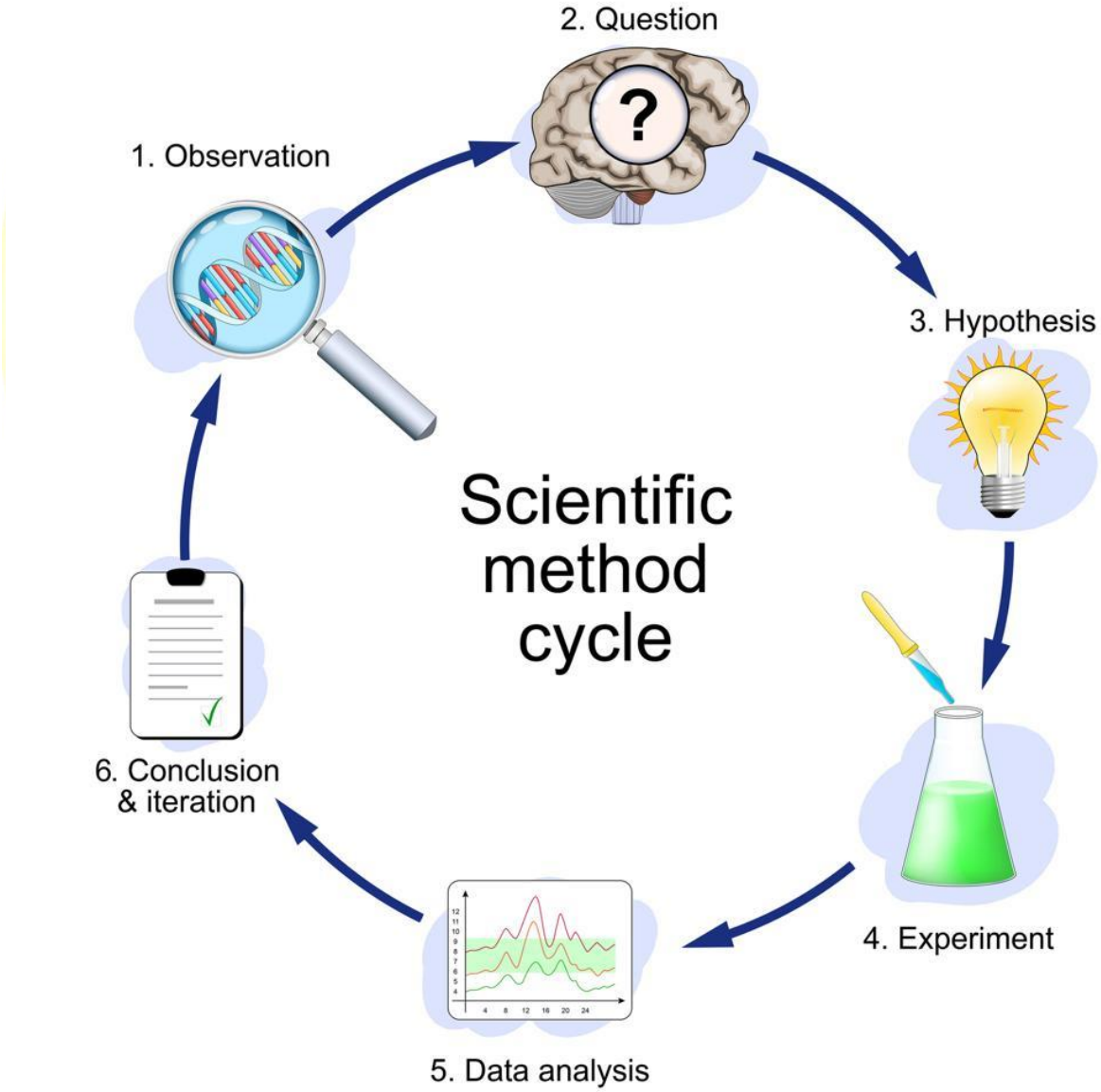
Nature and Characteristics of Science

1. **Scientific: Science is based on systematic investigation.**
2. **Empirical: Scientific knowledge is based on observation and experience.**
3. **Objective: Scientific conclusions depend on evidence rather than personal opinions.**
4. **Systematic: Scientific knowledge is developed through organized methods.**
5. **Logical: Science uses reasoning to explain natural events.**
6. **Experimental: Scientific ideas can be tested through experiments.**
7. **Dynamic: Scientific knowledge changes when new evidence is discovered.**
8. **Universal: Scientific principles apply under the same conditions everywhere.**

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9. **Predictive: Science helps predict future events.**
10. **Problem-solving: Science provides solutions to everyday problems.**

Example: When a student wants to know whether plants need sunlight, the student can grow two similar plants under different light conditions and compare their growth.





Mind Map: Nature of Science

SCIENCE

Observation

Experimentation

Logical Thinking

Evidence

Objectivity

Systematic Study

Prediction

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Problem-Solving

1.2 Why Do We Teach Science?

Science is an important subject in school education because it develops knowledge, understanding, skills and scientific attitudes among students.

Main Objectives of Teaching Science

1. Development of Scientific Knowledge: Students learn about plants, animals, human beings, matter, energy and the universe.

2. Development of Scientific Attitude: Science develops curiosity, honesty, patience, open-mindedness and logical thinking.

3. Development of Observation Skills: Students learn to observe objects, events and natural phenomena carefully.

4. Problem-Solving Ability: Science teaches students how to identify problems and find suitable solutions.

5. Practical Skills: Students learn to use scientific instruments and perform experiments.

6. Environmental Awareness: Science develops understanding of pollution, conservation, climate and natural resources.

7. Health Awareness: Students learn about nutrition, hygiene, diseases and healthy living.

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8. Preparation for Future Careers: Science provides a foundation for careers in medicine, engineering, agriculture, research and technology.

9. Development of Creativity: Students develop new ideas and learn to create useful models and devices.

10. Application in Daily Life: Science helps students understand cooking, electricity, transportation, communication and household activities.

Examples:

- **Learning about germs encourages students to maintain personal hygiene.**
- **Learning about plants helps students understand the importance of trees.**
- **Learning about electricity teaches students to use electrical appliances safely.**
- **Learning about water conservation encourages responsible use of water.**

Importance of Science Teaching

- **Develops rational thinking.**
- **Removes superstitions and misconceptions.**
- **Encourages experimentation.**
- **Develops environmental responsibility.**
- **Promotes national development.**
- **Makes students independent learners.**

1.3 Scientific Attitude – Meaning and Development

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Meaning of Scientific Attitude

Scientific attitude refers to a person's habit of thinking logically, questioning facts, accepting evidence and making decisions without prejudice or superstition.

It helps individuals understand situations through reasoning and investigation.

Characteristics of Scientific Attitude

1. **Curiosity: Desire to know and understand things.**
2. **Open-mindedness: Willingness to accept new ideas.**
3. **Objectivity: Making decisions based on facts.**
4. **Honesty: Reporting experimental results truthfully.**
5. **Critical Thinking: Examining information carefully.**
6. **Patience: Waiting for proper results.**
7. **Skepticism: Not accepting claims without sufficient evidence.**
8. **Cooperation: Working with others during scientific activities.**
9. **Creativity: Finding new ways to solve problems.**
10. **Respect for Evidence: Accepting conclusions supported by facts.**

Development of Scientific Attitude Among Students

- **Encourage students to ask questions.**
- **Organize classroom experiments.**
- **Arrange science exhibitions.**
- **Encourage observation of natural objects.**
- **Provide opportunities for group discussions.**
- **Organize educational visits to science centres.**

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- **Encourage students to prepare science projects.**
- **Develop the habit of recording observations.**
- **Discuss scientific discoveries.**
- **Encourage students to verify information.**

Example: If a student hears that plants grow faster when music is played, the teacher can encourage the student to investigate the claim scientifically rather than accepting it immediately.



1.4 What Do Scientists Look Like?

There is no particular physical appearance, dress, age, gender or personality that defines a scientist.

A scientist can be a man or woman, young or old, and can belong to any country, culture or community.

Qualities of a Scientist

1. **Curious and questioning.**
2. **Creative and imaginative.**
3. **Hardworking and dedicated.**
4. **Patient and disciplined.**
5. **Honest and responsible.**
6. **Logical and analytical.**
7. **Open to new ideas.**
8. **Interested in discovering new things.**
9. **Willing to learn from mistakes.**
10. **Committed to society and humanity.**

What Does a Scientist Do?

- **Observes natural phenomena.**
- **Identifies scientific problems.**
- **Develops research questions.**
- **Collects information.**
- **Performs experiments.**
- **Analyses results.**
- **Draws conclusions.**
- **Shares discoveries with others.**

Important Educational Point: Teachers should explain that science is not limited to people wearing laboratory coats. Farmers, doctors, engineers, environmental researchers and many other people use scientific thinking in their work.

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Example: A farmer who observes soil conditions, studies rainfall and experiments with different seeds is also applying scientific methods.



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1.5 Life History and Contributions of Eminent Scientists

1. C. V. Raman (1888–1970)

Full Name: Chandrasekhara Venkata Raman

Born: 7 November 1888

Birthplace: Tiruchirappalli, Tamil Nadu, India

Field: Physics

Life History:

- **C. V. Raman was a famous Indian physicist.**
- **He showed great interest in science from childhood.**
- **He studied at Presidency College, Madras.**
- **He conducted important research in the field of light.**
- **He became the first Asian scientist to receive the Nobel Prize in Physics.**

Major Contributions:

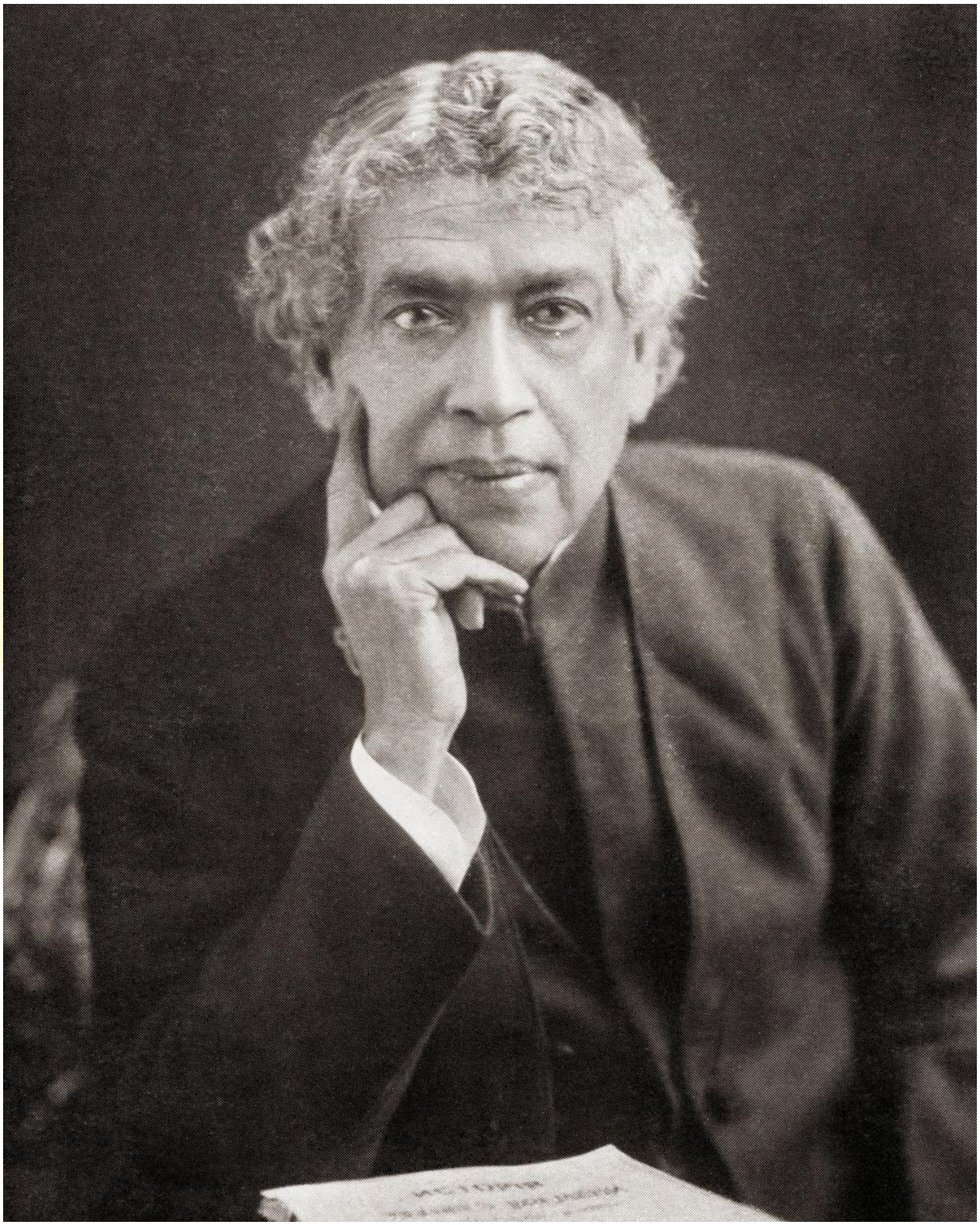
1. **Discovered the Raman Effect in 1928.**
2. **Explained the scattering of light when it passes through transparent materials.**
3. **His discovery became important in molecular and material analysis.**
4. **Received the Nobel Prize in Physics in 1930.**
5. **Bharat Ratna was awarded to him in 1954.**

Example: The Raman Effect is used in modern scientific instruments to study the composition of different substances.

Important Day: National Science Day is celebrated in India on 28 February to commemorate the discovery of the Raman Effect.

2. J. C. Bose (1858–1937)

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Full Name: Jagadish Chandra Bose

Born: 30 November 1858

Birthplace: Mymensingh, Bengal Presidency (now Bangladesh)

Field: Physics and Plant Physiology

Life History:

- **J. C. Bose was a great Indian scientist.**
- **He studied physics at the University of Cambridge.**
- **He made important contributions to wireless communication research.**
- **He also studied the responses of plants to external stimuli.**

Major Contributions:

1. **Conducted pioneering experiments on electromagnetic waves.**
2. **Developed instruments to study plant responses.**
3. **Invented the Crescograph to measure plant growth.**
4. **Demonstrated that plants respond to different environmental conditions.**
5. **Contributed to the development of experimental science in India.**

Example: His Crescograph helped scientists observe and measure very small changes in plant growth.

3. Bimla Buti

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Name: Bimla Buti

Field: Theoretical Physics and Plasma Physics

Nationality: Indian

Life and Contributions:

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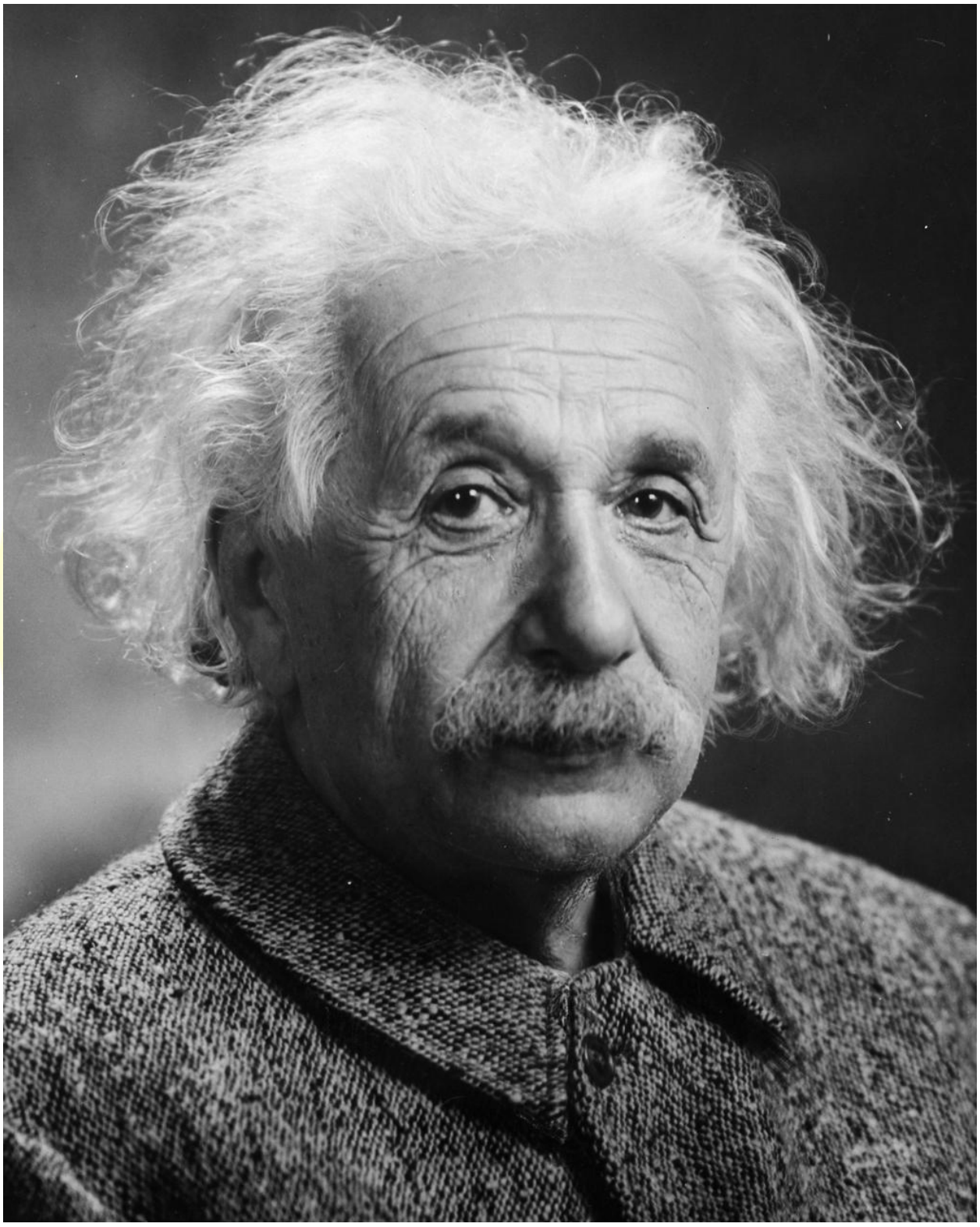
- **Bimla Buti is an Indian woman scientist known for her work in theoretical physics.**
- **She contributed to research in plasma physics.**
- **Her research involved the study of plasma, which is considered the fourth state of matter.**
- **She worked on scientific problems related to plasma behaviour and space physics.**
- **Her achievements represent the contribution of Indian women to scientific research.**

Example: Plasma physics is important in understanding the Sun, stars and other space phenomena.

Note: Detailed biographical dates and personal-history information should be checked against an authoritative scientific biography before using them in an examination.

4. Albert Einstein (1879–1955)

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Born: 14 March 1879

Birthplace: Ulm, Germany

Field: Theoretical Physics

Life History:

- **Albert Einstein was one of the greatest physicists in history.**
- **He developed an interest in mathematics and science at an early age.**
- **He worked in Switzerland and later in the United States.**
- **His scientific theories changed our understanding of space, time and energy.**

Major Contributions:

1. **Developed the Special Theory of Relativity in 1905.**
2. **Developed the General Theory of Relativity in 1915.**
3. **Presented the famous mass-energy equation:**

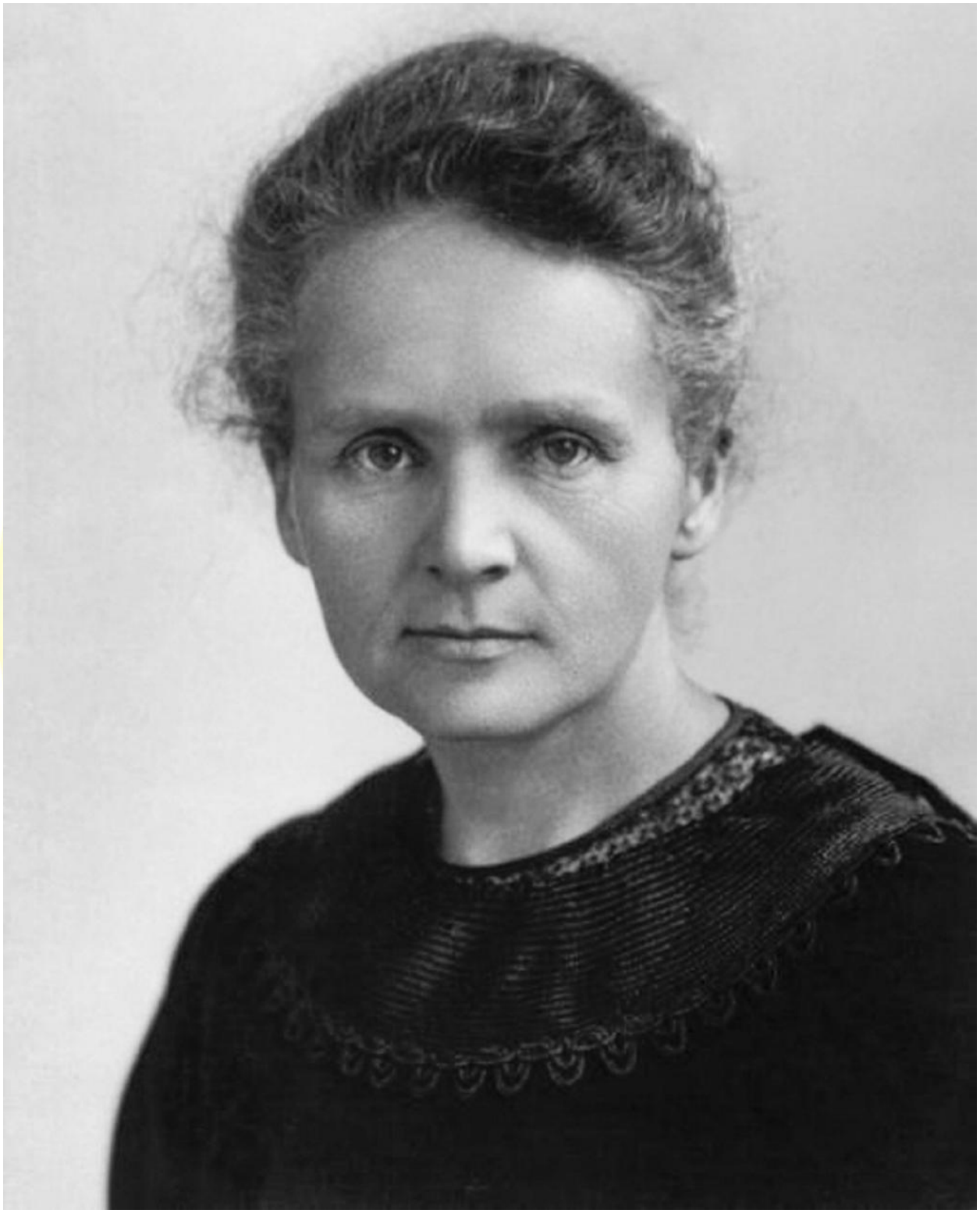
\[E=mc^2 \]

4. **Explained the photoelectric effect.**
5. **Received the Nobel Prize in Physics in 1921 for his explanation of the photoelectric effect.**

Example: Einstein's theories are important in modern physics. Relativity also plays a role in the corrections used in GPS technology.

5. Marie Curie (1867–1934)

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Born: 7 November 1867

Birthplace: Warsaw, Poland

Field: Physics and Chemistry

Life History:

- **Marie Curie was a famous scientist who worked in physics and chemistry.**
- **She faced many difficulties in obtaining higher education.**
- **She moved to Paris for further studies.**
- **She worked with Pierre Curie on radioactivity.**
- **She became the first woman to receive a Nobel Prize.**

Major Contributions:

1. **Conducted pioneering research on radioactivity.**
2. **Discovered the elements Polonium and Radium with Pierre Curie.**
3. **Received the Nobel Prize in Physics in 1903.**
4. **Received the Nobel Prize in Chemistry in 1911.**
5. **Became the first person to win Nobel Prizes in two different scientific fields.**

Example: Her research contributed to the development of medical applications involving radiation, including cancer treatment.

Mind Map: Eminent Scientists

GREAT SCIENTISTS

C. V. Raman

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Raman Effect

J. C. Bose

Wireless research and Crescograph

Bimla Buti

Plasma Physics

Albert Einstein

Theory of Relativity

Marie Curie

Radioactivity

UNIT 2: REVISITING SCHOOL SCIENCE CONCEPTS

This unit deals with important concepts of Biology, Chemistry and Physics that teachers need to understand before teaching science at the elementary level.

2.1 The World of the Living

A. Cell – Structure and Function

Meaning of Cell

A cell is the basic structural and functional unit of life. All living organisms are made up of one or more cells.

The cell was first discovered by Robert Hooke in 1665 when he observed a thin slice of cork under a microscope.

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Types of Cells

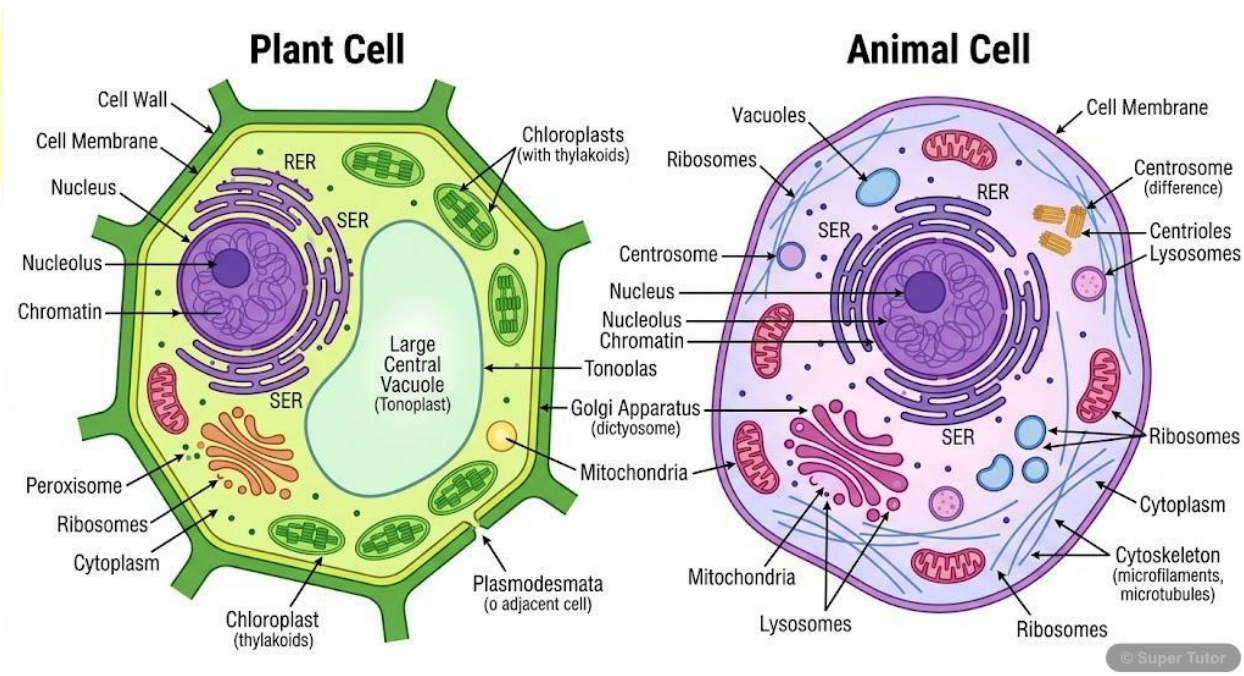
1. Unicellular Organisms: Organisms made up of only one cell.

Examples: Amoeba, Paramecium and bacteria.

2. Multicellular Organisms: Organisms made up of many cells.

Examples: Human beings, animals and plants.

Structure of a Cell



The main parts of a cell are:

1. Cell Membrane: It is the outer covering of the cell. It controls the movement of substances into and out of the cell.

2. Cytoplasm: It is a jelly-like substance present inside the cell. Various cell organelles are found in it.

3. Nucleus: It controls the activities of the cell and contains genetic material (DNA).

4. Mitochondria: It produces energy through cellular respiration. It is called the powerhouse of the cell.

5. Ribosomes: They help in protein synthesis.

6. Endoplasmic Reticulum: It helps in the transportation and production of materials within the cell.

7. Golgi Apparatus: It modifies, packages and transports proteins and other substances.

8. Lysosomes: They contain enzymes that help break down waste materials and unwanted substances.

9. Vacuoles: They store water, food and waste materials. Plant cells usually have a large central vacuole.

10. Chloroplast: It is found in green plant cells and contains chlorophyll, which helps in photosynthesis.

Difference Between Plant Cell and Animal Cell

Plant Cell	Animal Cell
Cell wall is present.	Cell wall is absent.
Chloroplasts are present in green cells.	Chloroplasts are absent.
Usually has a large central	Vacuoles are generally

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vacuole.	**smaller.**
Usually has a fixed shape.	**Shape may be irregular or rounded.**
Stores carbohydrates mainly as starch.	**Stores carbohydrates mainly as glycogen.**

Functions of Cells

- **Provide structure to living organisms.**
- **Produce energy.**
- **Help in growth and development.**
- **Perform metabolic activities.**
- **Help in reproduction.**
- **Carry genetic information.**

Example: Human skin cells protect the body, while nerve cells carry messages from one part of the body to another.

B. Animal Tissues and Their Types

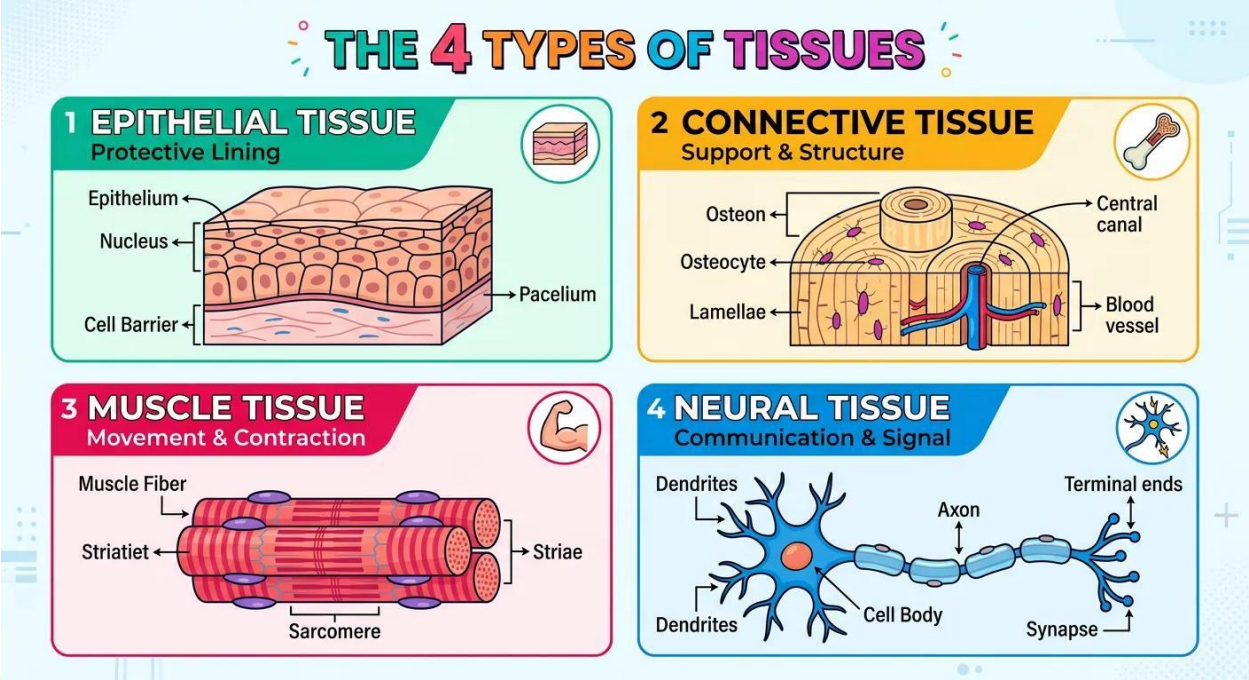
Meaning of Tissue

A tissue is a group of similar cells that work together to perform a particular function.

In multicellular organisms, cells combine to form tissues, tissues form organs, and organs form organ systems.

Four Main Types of Animal Tissues

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1. Epithelial Tissue

Epithelial tissue covers the body surface and lines internal organs and body cavities.

Functions:

- **Protects the body.**
- **Helps in absorption.**
- **Helps in secretion.**
- **Helps in filtration.**

Types:

- **Squamous epithelium.**
- **Cuboidal epithelium.**
- **Columnar epithelium.**
- **Ciliated epithelium.**

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- **Glandular epithelium.**

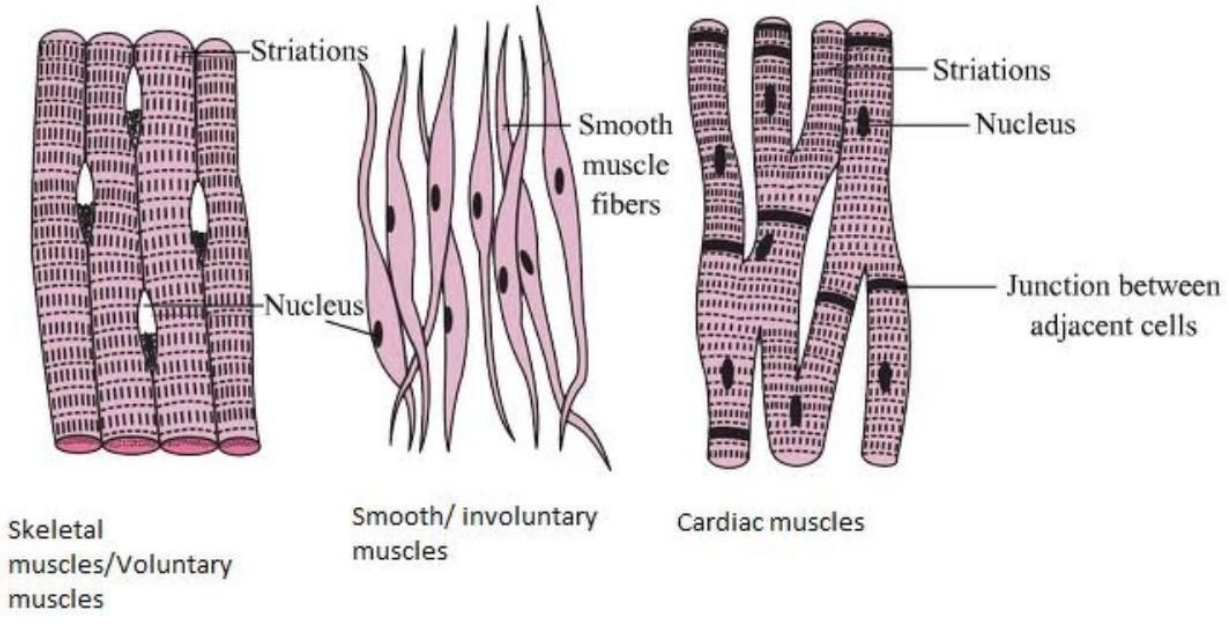
Examples: Skin, lining of the mouth and lining of the intestine.

2. Muscular Tissue

Muscular tissue is made up of special cells that contract and relax to produce movement.

Types:

- **Striated Muscles: These are voluntary muscles found attached to bones. Example: Muscles of arms and legs.**
- **Smooth Muscles: These are involuntary muscles found in internal organs. Example: Intestine and stomach.**
- **Cardiac Muscles: These are found only in the heart and help pump blood.**



Functions:

- **Help in body movement.**
- **Maintain posture.**
- **Pump blood.**
- **Move food through the digestive system.**

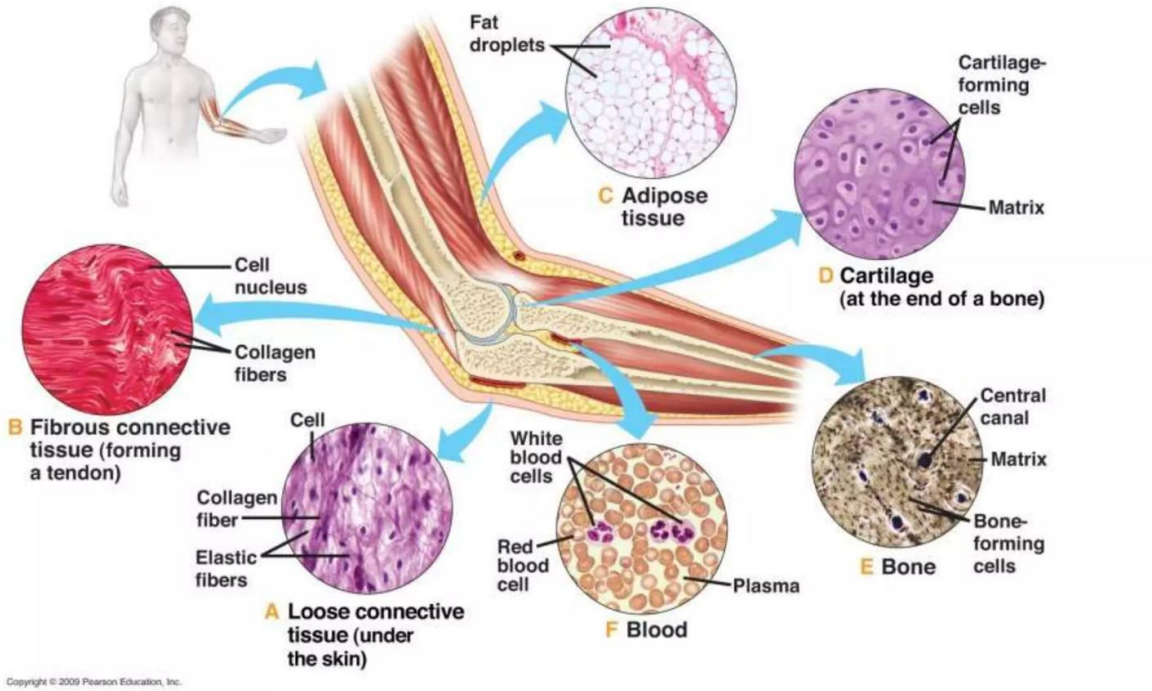
3. Connective Tissue

Connective tissue connects, supports, binds and protects different parts of the body.

Types and Examples:

- **Blood: Transports oxygen, nutrients and waste materials.**
- **Bone: Provides support and protection.**
- **Cartilage: Provides flexible support.**
- **Tendons: Connect muscles to bones.**
- **Ligaments: Connect bones to bones.**
- **Adipose Tissue: Stores fat and provides insulation.**

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4. Nervous Tissue

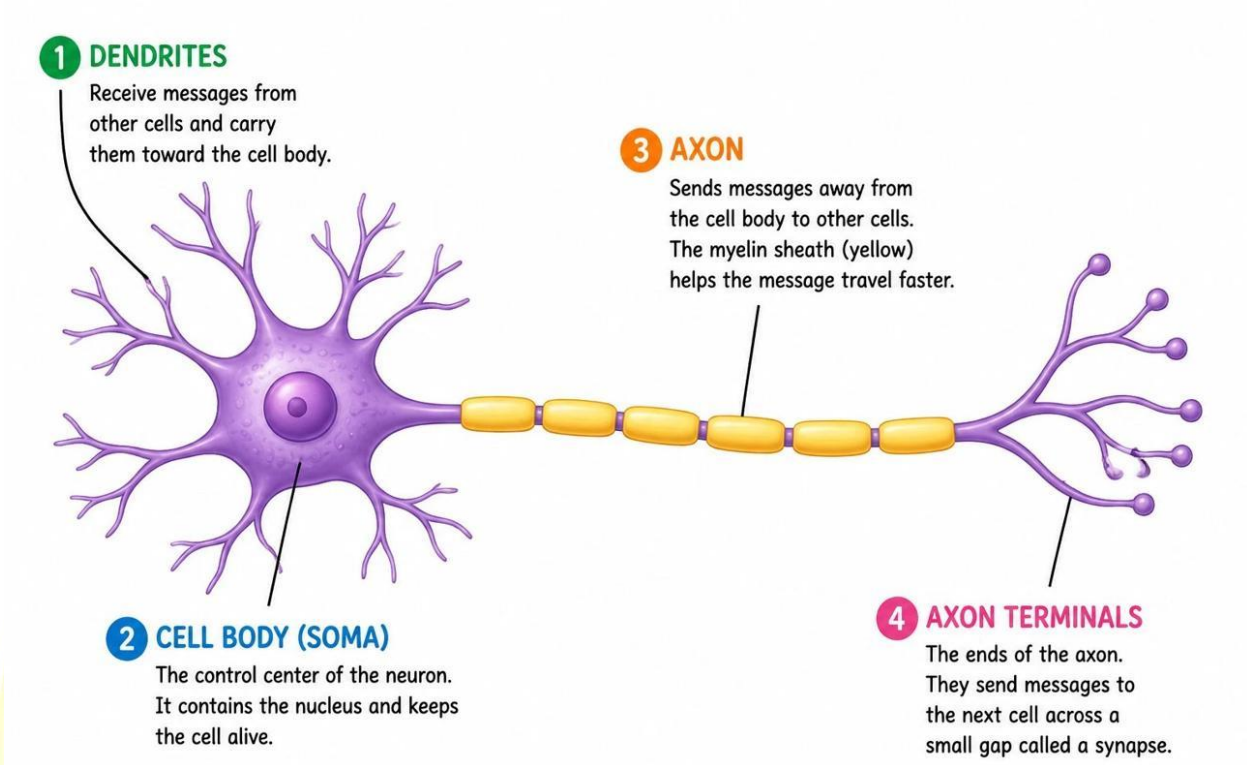
Nervous tissue is responsible for receiving and transmitting messages throughout the body.

It is mainly found in the brain, spinal cord and nerves.

Main Parts of a Neuron:

- **Dendrites: Receive messages.**
- **Cell Body: Contains the nucleus.**
- **Axon: Carries nerve impulses away from the cell body.**
- **Axon Terminals: Pass messages to other cells.**

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Functions:

- **Controls body activities.**
- **Receives sensory information.**
- **Transmits nerve impulses.**
- **Helps in thinking, learning and memory.**

Mind Map: The World of the Living

THE WORLD OF THE LIVING

CELL

Cell Membrane

Cytoplasm

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Nucleus

Organelles

ANIMAL TISSUES

EpithelialProtection

MuscularMovement

ConnectiveSupport

NervousControl

2.2 Matter: Structure of Atom

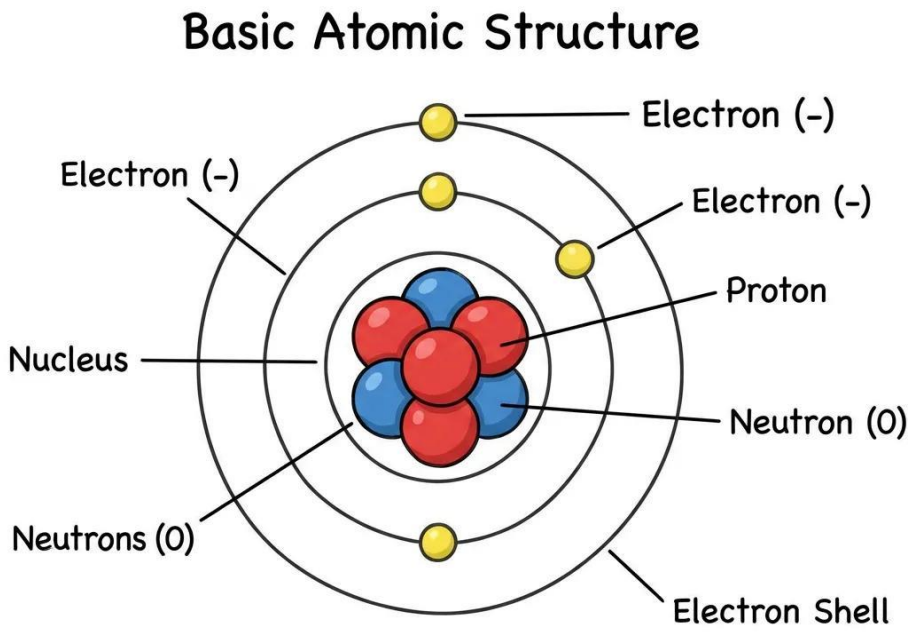
A. Structure of an Atom

Meaning of Atom

An atom is the smallest unit of an element that retains its chemical properties.

All matter is made up of atoms. Atoms contain three main subatomic particles: electrons, protons and neutrons.

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Three Fundamental Particles

Particle	Charge	Location
Electron	Negative (-1)	Outside nucleus
Proton	Positive (+1)	Inside nucleus
Neutron	No charge (0)	Inside nucleus

1. Electron

- **Discovered by J. J. Thomson in 1897.**
- **It has a negative charge.**
- **It is present outside the nucleus.**
- **It has very small mass compared with a proton.**

2. Proton

- **Identified through the work of Ernest Rutherford.**
- **It has a positive charge.**

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- **It is present inside the nucleus.**
- **Its mass is approximately one atomic mass unit.**

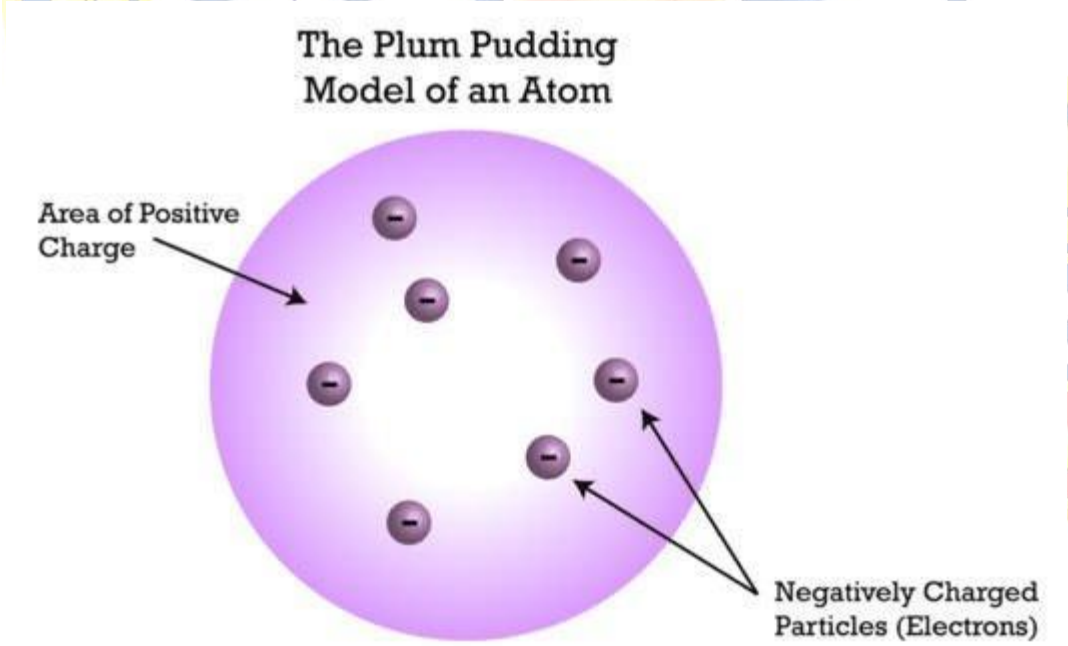
3. Neutron

- **Discovered by James Chadwick in 1932.**
- **It has no electrical charge.**
- **It is present inside the nucleus.**
- **Its mass is approximately one atomic mass unit.**

B. Atomic Models

Scientists developed different atomic models to explain the structure of an atom.

1. Thomson's Atomic Model (1904)

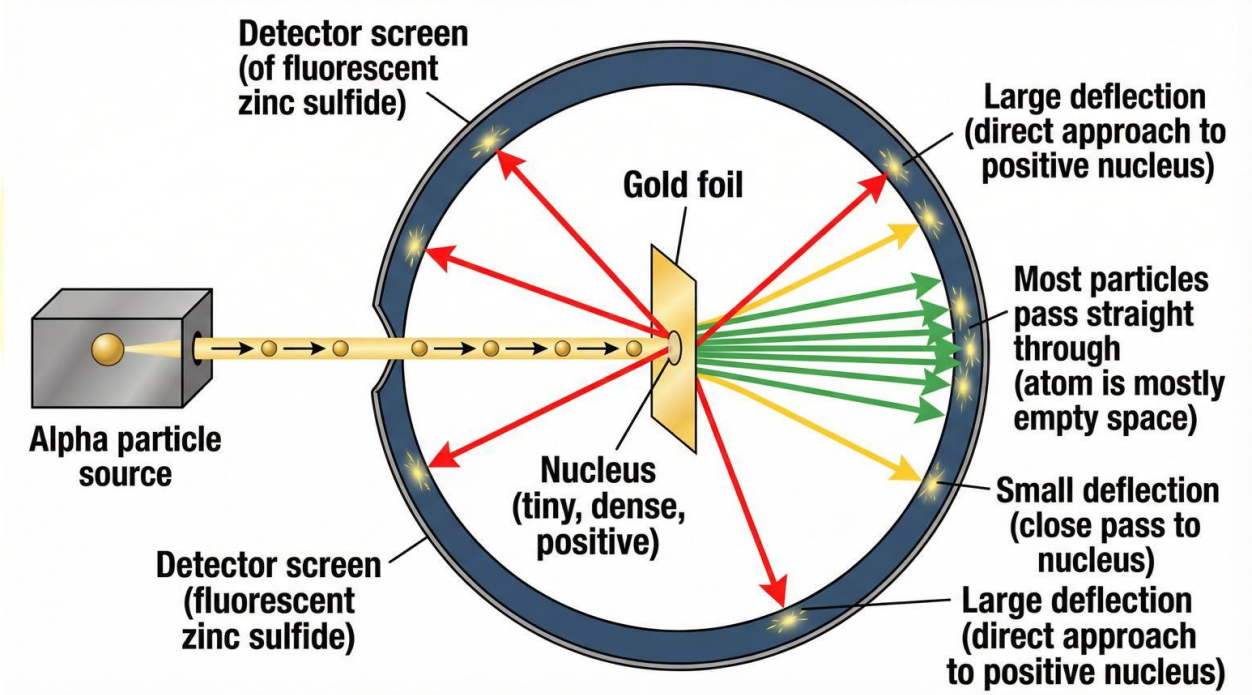


- **Proposed by J. J. Thomson.**

- **Also called the Plum Pudding Model.**
- **An atom was considered a positively charged sphere.**
- **Electrons were embedded in this positive sphere.**
- **The atom was considered electrically neutral.**

Limitation: It could not explain the results of Rutherford's alpha-particle scattering experiment.

2. Rutherford's Atomic Model (1911)

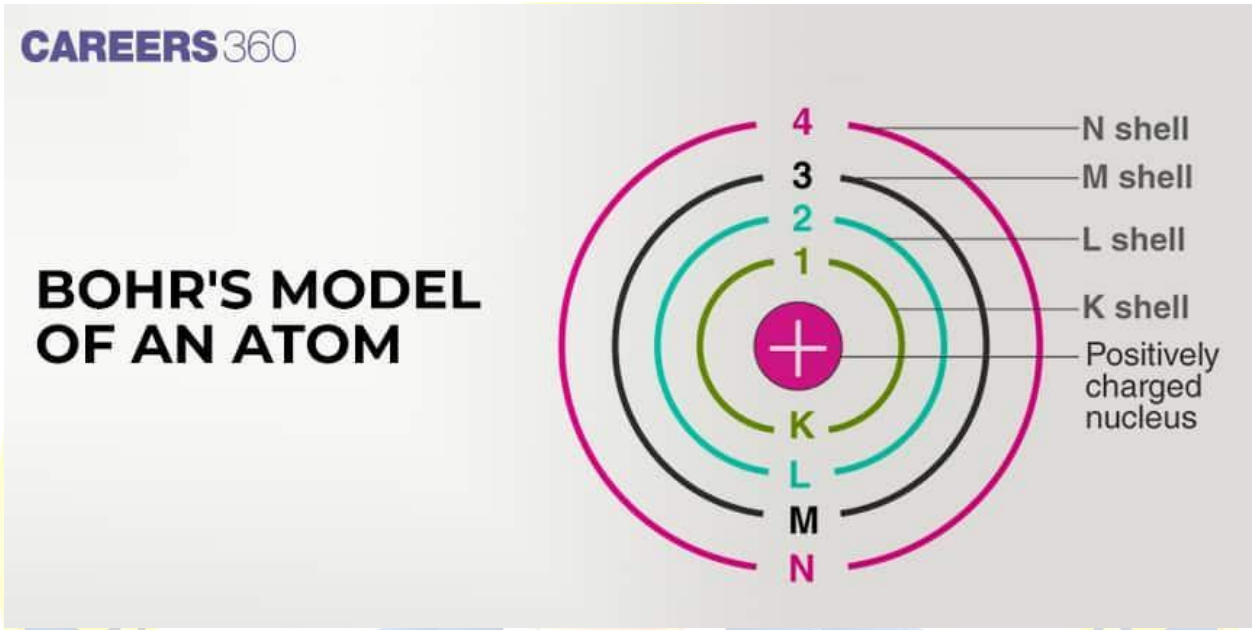


- **Proposed by Ernest Rutherford.**
- **An atom contains a small, dense and positively charged nucleus.**
- **Most of the mass is concentrated in the nucleus.**
- **Electrons move around the nucleus.**
- **Most of the atom is empty space.**

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Limitation: It could not explain the stability of atoms according to classical physics.

3. Bohr's Atomic Model (1913)



- **Proposed by Niels Bohr.**
- **Electrons move in certain permitted energy levels or shells.**
- **These shells are represented by K, L, M and N.**
- **Electrons absorb or release energy when they move between energy levels.**
- **It explained the hydrogen atomic spectrum.**

Limitation: It could not fully explain the spectra of atoms containing many electrons.

C. Atomic Number and Mass Number

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Atomic Number (Z)

Atomic number is the total number of protons present in the nucleus of an atom.

For a neutral atom:

Atomic Number = Number of Protons = Number of Electrons.

Example: Sodium has 11 protons, so its atomic number is 11.

Mass Number (A)

Mass number is the total number of protons and neutrons present in the nucleus.

\[A = \text{Protons}+\text{Neutrons} \]

Example: Sodium has 11 protons and 12 neutrons.

Mass number = 11 + 12 = 23.

D. Symbols of Elements

A chemical symbol is a short form used to represent an element.

Examples:

- **Hydrogen – H**
- **Oxygen – O**
- **Carbon – C**
- **Sodium – Na**
- **Iron – Fe**

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- **Calcium – Ca**

E. Valency

Meaning: Valency is the combining capacity of an atom. It indicates how many electrons an atom loses, gains or shares while forming chemical bonds in elementary examples.

Examples:

- **Hydrogen – 1**
- **Oxygen – 2**
- **Nitrogen – 3**
- **Carbon – 4**
- **Sodium – 1**
- **Magnesium – 2**

F. Electronic Configuration of First 20 Elements

Electronic configuration means the arrangement of electrons in different shells of an atom.

For the first 20 elements, the basic shell distribution follows 2, 8, 8, 2.

Atomic No.	Element	Symbol	Electronic Configuration	Valency
1	Hydrogen	H	1	1
2	Helium	He	2	0
3	Lithium	Li	2,1	1
4	Beryllium	Be	2,2	2
5	Boron	B	2,3	3

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6	**Carbon**	**C**	**2,4**	**4**
7	**Nitrogen**	**N**	**2,5**	**3**
8	**Oxygen**	**O**	**2,6**	**2**
9	**Fluorine**	**F**	**2,7**	**1**
10	**Neon**	**Ne**	**2,8**	**0**
11	**Sodium**	**Na**	**2,8,1**	**1**
12	**Magnesium**	**Mg**	**2,8,2**	**2**
13	**Aluminium**	**Al**	**2,8,3**	**3**
14	**Silicon**	**Si**	**2,8,4**	**4**
15	**Phosphorus**	**P**	**2,8,5**	**3**
16	**Sulphur**	**S**	**2,8,6**	**2**
17	**Chlorine**	**Cl**	**2,8,7**	**1**
18	**Argon**	**Ar**	**2,8,8**	**0**
19	**Potassium**	**K**	**2,8,8,1**	**1**
20	**Calcium**	**Ca**	**2,8,8,2**	**2**

Note: The valencies shown are the common elementary values; some elements have variable valencies.

Mind Map: Structure of Atom

ATOM

ProtonPositive

NeutronNeutral

ElectronNegative

Atomic Concepts

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Atomic Number

Mass Number

Valency

Electronic Configuration

Atomic Models

Thomson → Rutherford → Bohr

2.3 Natural Phenomena

A. Gravitation

Meaning of Gravitation

Gravitation is the universal force of attraction between any two objects having mass.

The gravitational force keeps planets in their orbits and makes objects fall towards the Earth.

Newton's Universal Law of Gravitation

Newton stated that every object in the universe attracts every other object with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

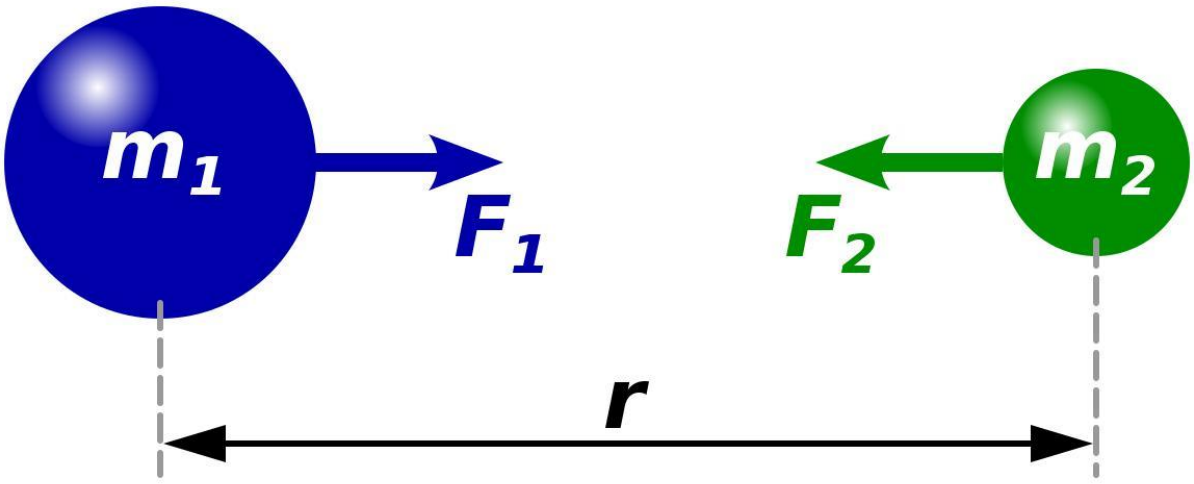
Mathematical formula:

\[F=\frac{Gm_1m_2}{r^2} \]

Where:

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- **F = Gravitational force**
- **G = Universal gravitational constant**
- **m_1 and m_2 = Masses of two objects**
- **r = Distance between their centres**



$$F_1 = F_2 = G \frac{m_1 \times m_2}{r^2}$$

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Relation Between g and G

The acceleration due to gravity is represented by small g.

\[g=\frac{GM}{R^2} \]

Where:

- **G = Universal gravitational constant**
- **M = Mass of Earth**
- **R = Radius of Earth**

The average value of g near Earth's surface is approximately 9.8 m/s^2.

Difference Between Mass and Weight

Mass	Weight
Amount of matter in an object.	Gravitational force acting on an object.
SI unit is kilogram (kg).	SI unit is newton (N).
Remains constant at different places.	Changes with gravity.
Measured using a balance.	Measured using a spring balance.
Scalar quantity.	Vector quantity.

Formula:

\[W=mg \]

Variation of g with Altitude

As altitude increases, the distance from the Earth's centre increases. Therefore, the value of g decreases.

Example: The value of gravity at the top of a high mountain is slightly less than at sea level.

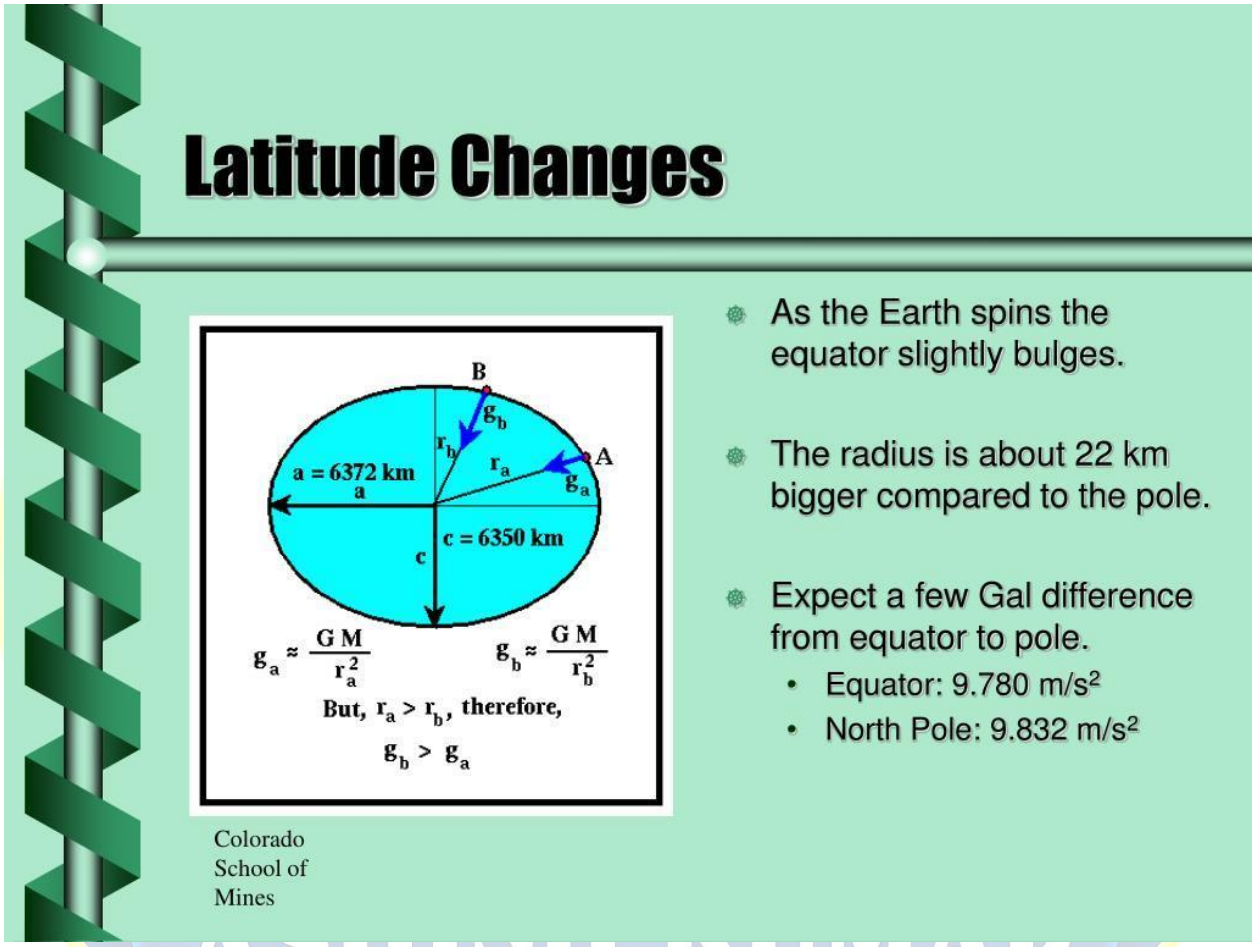
Variation of g Due to Shape of Earth

The Earth is not a perfect sphere. It is slightly flattened at the poles and bulging at the equator.

- **Earth's radius is smaller at the poles.**

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- **Earth's radius is larger at the equator.**
- **The value of g is greater at the poles.**
- **The value of g is smaller at the equator.**

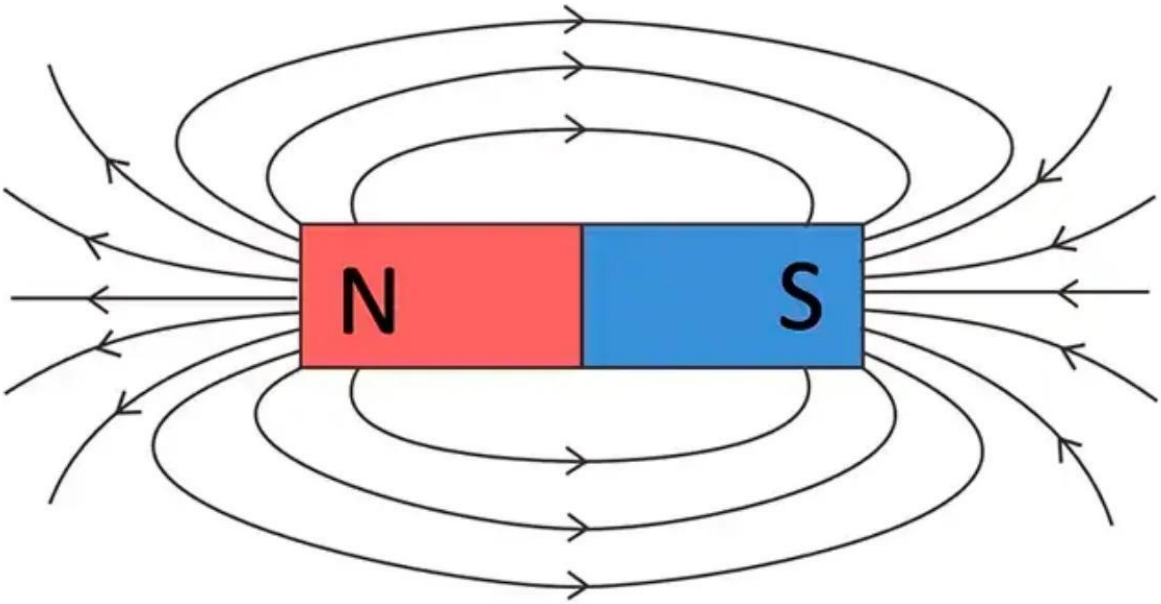


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B. Magnetism

Meaning of Magnet

A magnet is an object that attracts magnetic materials such as iron, nickel and cobalt.



Properties of Magnets

1. **A magnet has two poles – North and South.**
2. **Like poles repel each other.**
3. **Unlike poles attract each other.**
4. **Magnetic force is strongest near the poles.**
5. **A freely suspended magnet points approximately in the north-south direction.**
6. **Magnetic poles always occur in pairs in ordinary magnets.**
7. **A magnet attracts certain magnetic materials.**

Magnetic Field

The region around a magnet where its magnetic force can be experienced is called a magnetic field.

Magnetic Lines of Force

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These are imaginary lines used to represent the direction and strength of a magnetic field.

Properties:

- **Outside a magnet, they go from North to South.**
- **Inside a magnet, they go from South to North.**
- **They form closed curves.**
- **They never intersect.**
- **Closer lines indicate a stronger magnetic field.**

Magnetic Materials

Materials that are strongly attracted by magnets are called ferromagnetic materials.

Examples: Iron, cobalt, nickel and steel (depending on composition).

Some other materials, such as copper and aluminium, are not strongly attracted to ordinary magnets.

Different Ways of Magnetising a Magnetic Material

1. **Stroking Method: A magnetic material can be magnetised by repeatedly stroking it in one direction with a magnet.**
2. **Electrical Method: A coil of insulated wire carrying direct current can produce a magnetic field that magnetises a suitable material.**
3. **Induction Method: A magnetic material may become temporarily magnetised when placed near a magnet.**

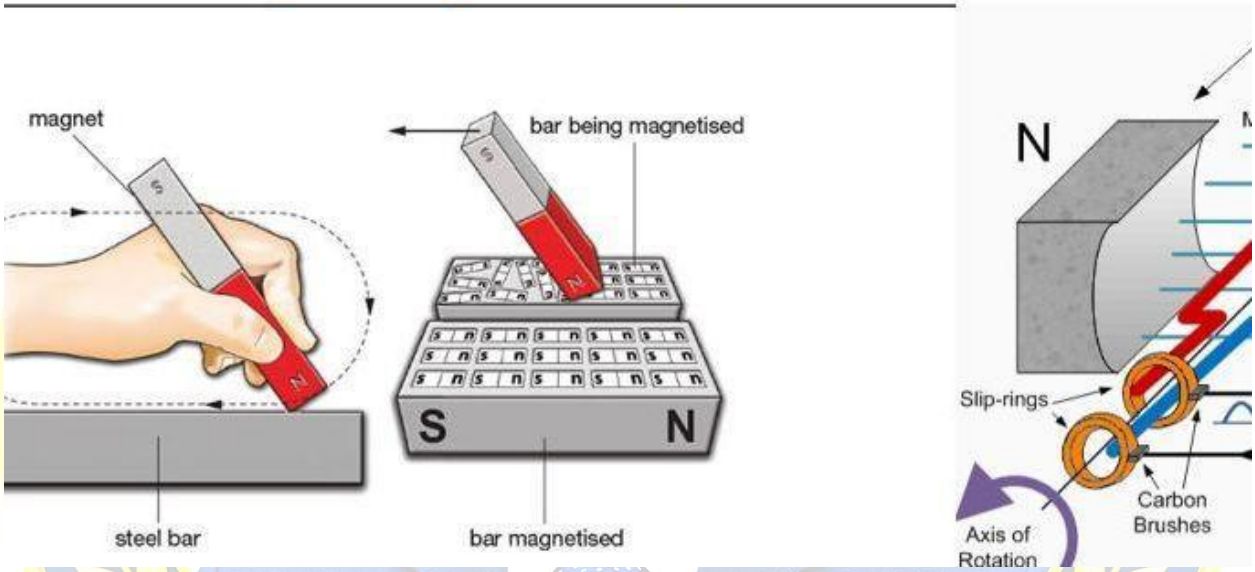
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acher Explains

How to Induce Magnetism

You can make induce magnetism in some materials through several meth

- Stroking them with a magnet (in one direction!)
- Use of d.c. in a coil
- Hammering in a magnetic field (in the north-south orientati



Example: A compass uses a small magnetised needle to indicate direction.

C. Current Electricity

Electric Charge

Electric charge is a basic property of matter responsible for electrical forces.

There are two types of electric charges:

- **Positive charge.**
- **Negative charge.**

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SI unit: Coulomb (C).

Electric Current

Electric current is the rate of flow of electric charge through a conductor.

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

Where I = Current, Q = Charge and t = Time.

SI unit: Ampere (A).

Potential Difference

Potential difference is the work done per unit charge to move a charge between two points.

$$V=\frac{W}{Q}$$

SI unit: Volt (V).

Ohm's Law

Ohm's Law states that the current flowing through a conductor is directly proportional to the potential difference across its ends, provided its temperature and other physical conditions remain constant.

$$V=IR$$

Where:

- **V = Potential difference**
- **I = Current**

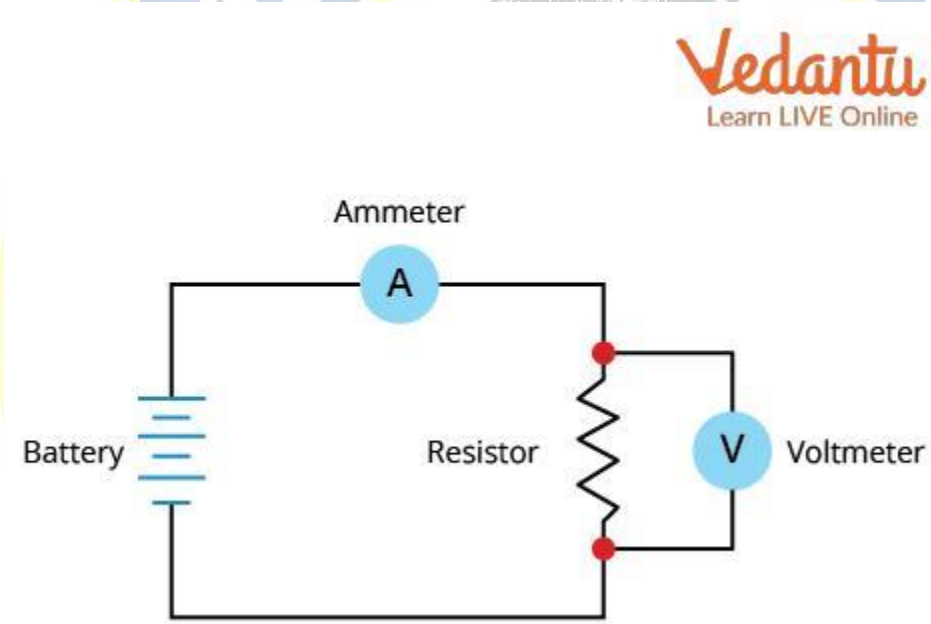
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- **R = Resistance**

Example:

If a resistor has resistance of 5 ohms and current is 2 amperes:

\[V=5\times2=10V \]



Sources of Electric Current

1. Voltaic Cell

- **Invented by Alessandro Volta.**
- **It was one of the earliest practical sources of continuous electric current.**
- **It uses two different electrodes and an electrolyte.**
- **Chemical energy is converted into electrical energy.**

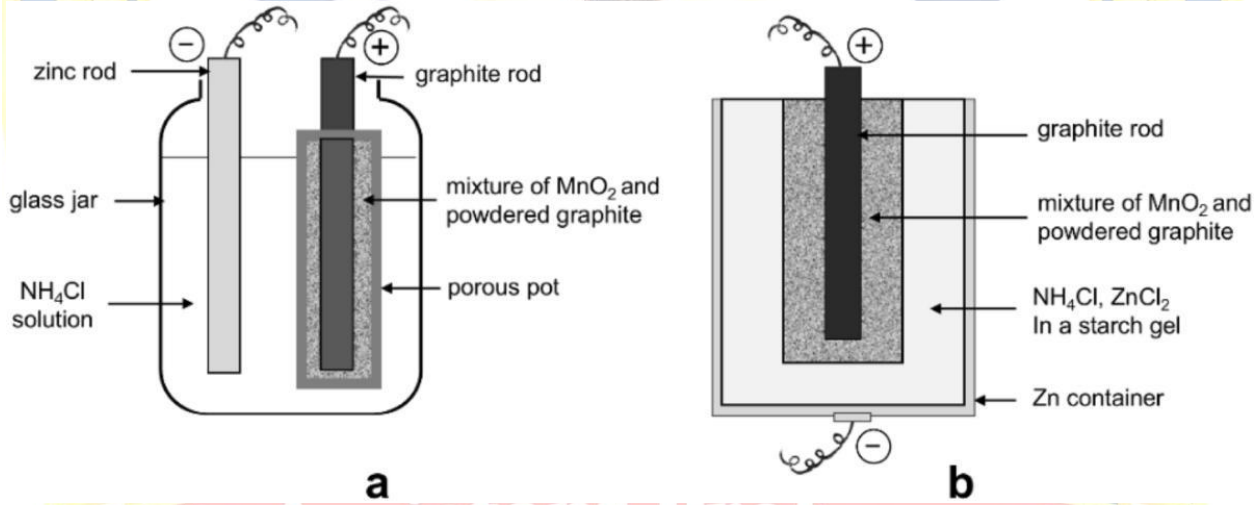
2. Leclanché Cell

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- **Developed by Georges Leclanché.**
- **It uses zinc and carbon electrodes.**
- **Its electrolyte is an ammonium chloride solution or paste.**
- **It was an important early type of primary cell.**

3. Dry Cell

- **A commonly used primary cell.**
- **Zinc container acts as the negative electrode.**
- **Carbon rod acts as the positive current collector.**
- **Electrolyte is in paste form.**
- **Chemical energy is converted into electrical energy.**



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D. Light

Nature of Light

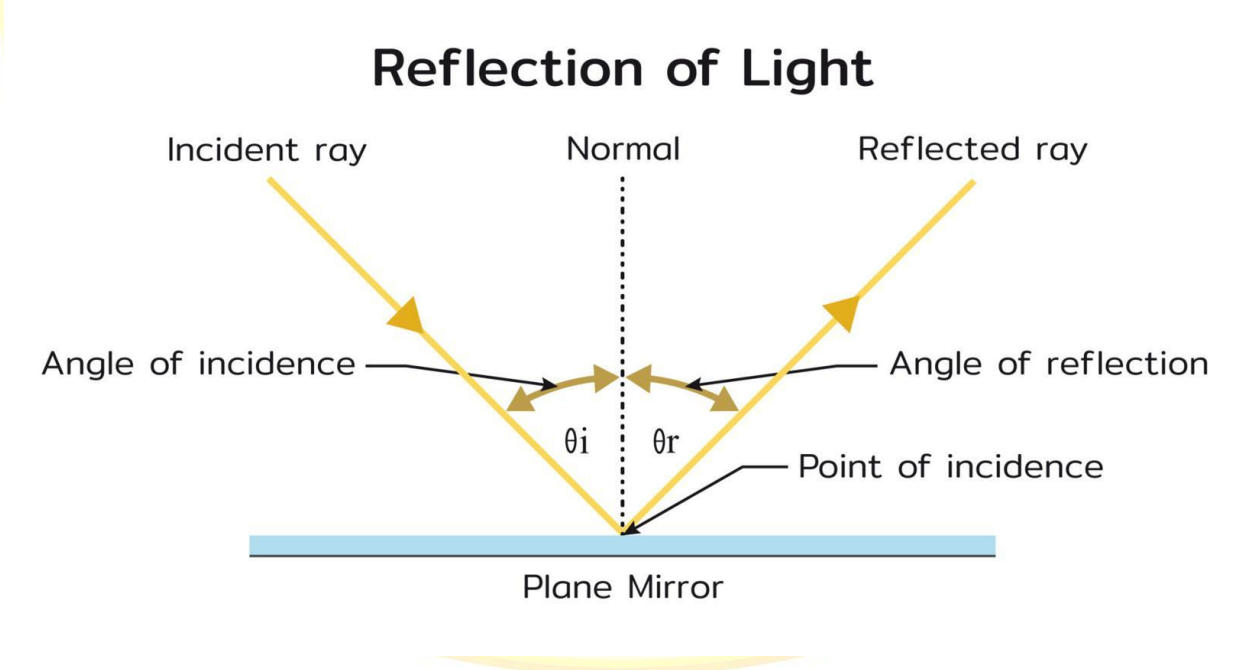
Light is a form of electromagnetic radiation that enables us to see objects.

Characteristics:

1. **Light travels in straight lines in a uniform transparent medium.**
2. **Light can travel through a vacuum.**
3. **Its speed in vacuum is approximately \(3\times10^8\) m/s.**
4. **Light can be reflected and refracted.**
5. **Light can be dispersed into different colours.**
6. **Light exhibits both wave and particle properties.**

Reflection of Light

Reflection is the bouncing back of light into the same medium after striking a surface.



Laws of Reflection

1. **The angle of incidence is equal to the angle of reflection.**

2. **The incident ray, reflected ray and normal all lie in the same plane.**

$$\angle i=\angle r$$

Refraction of Light

Refraction is the bending of light when it travels from one transparent medium to another because its speed changes.

Laws of Refraction

1. **The incident ray, refracted ray and normal lie in the same plane.**
2. **For a given pair of media and a given colour of light, the ratio of sine of angle of incidence to sine of angle of refraction is constant.**

This is called Snell's Law.

$$\frac{\sin i}{\sin r}=n_{21}$$

Refractive Index

The refractive index of a medium indicates how much light slows down in that medium compared with vacuum.

$$n=\frac{c}{v}$$

Where:

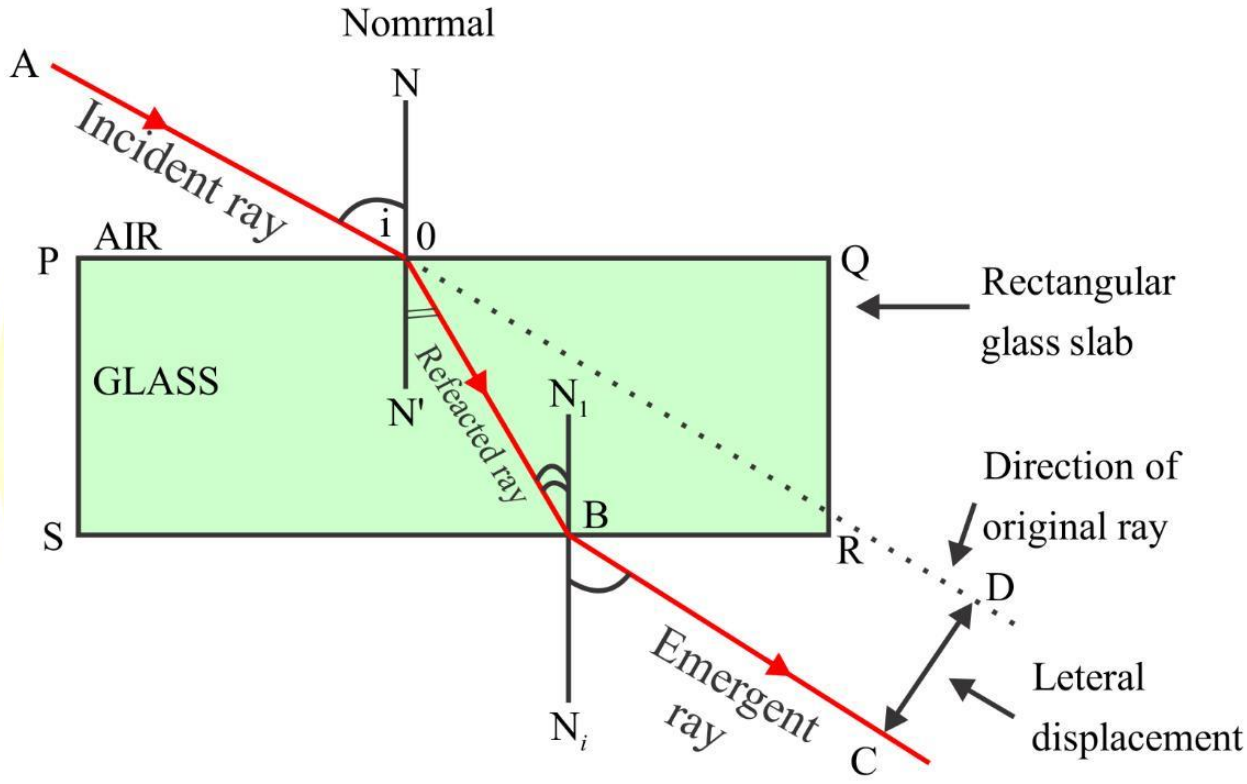
- **c = Speed of light in vacuum.**
- **v = Speed of light in the medium.**

Refraction Through a Glass Slab

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When light passes through a rectangular glass slab:

- **It bends towards the normal on entering glass from air.**
- **It bends away from the normal on leaving glass.**
- **The emergent ray is parallel to the incident ray.**
- **A lateral displacement occurs.**



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Optical Phenomena in Nature

1. Mirage

A mirage is an optical phenomenon commonly seen on hot roads or in deserts. It occurs because light bends through layers of air having different temperatures and refractive indices.

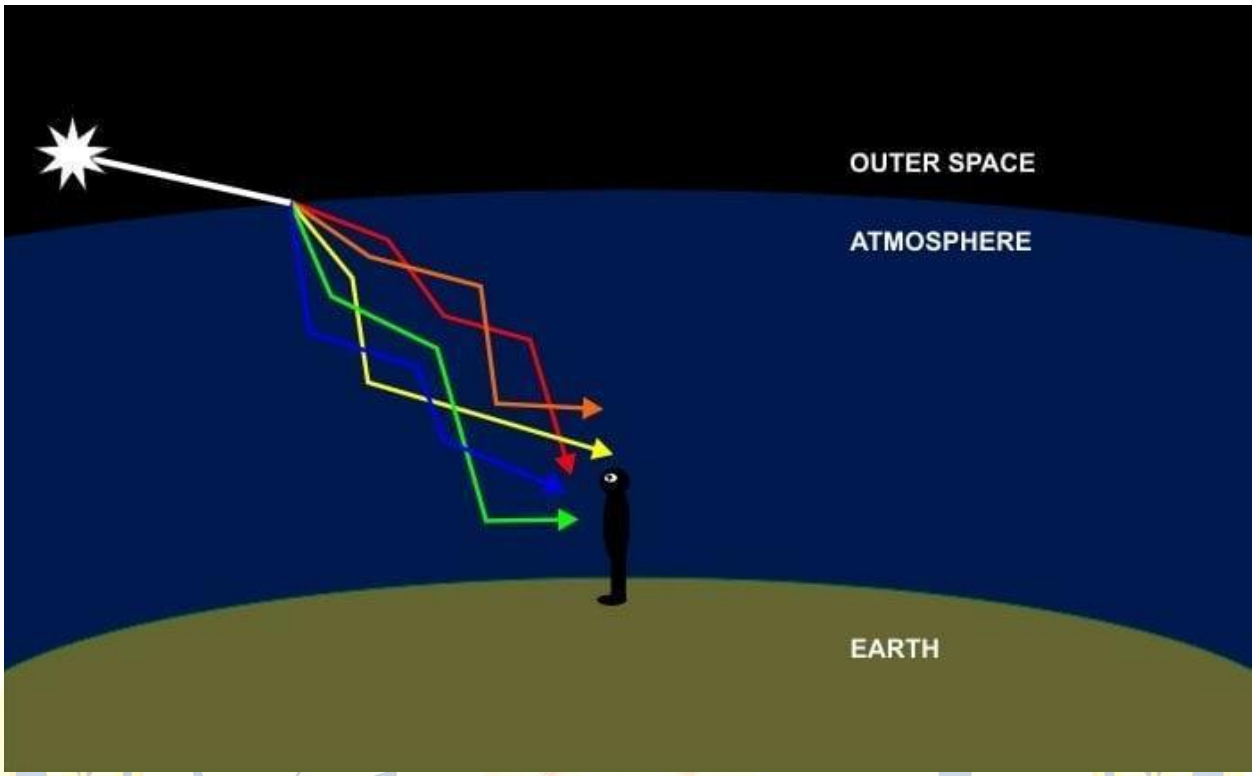
It may create the appearance of water on a distant road.



2. Twinkling of Stars

Stars appear to twinkle because their light passes through different layers of Earth's atmosphere. These layers have changing refractive indices, causing variations in the apparent position and brightness of stars.

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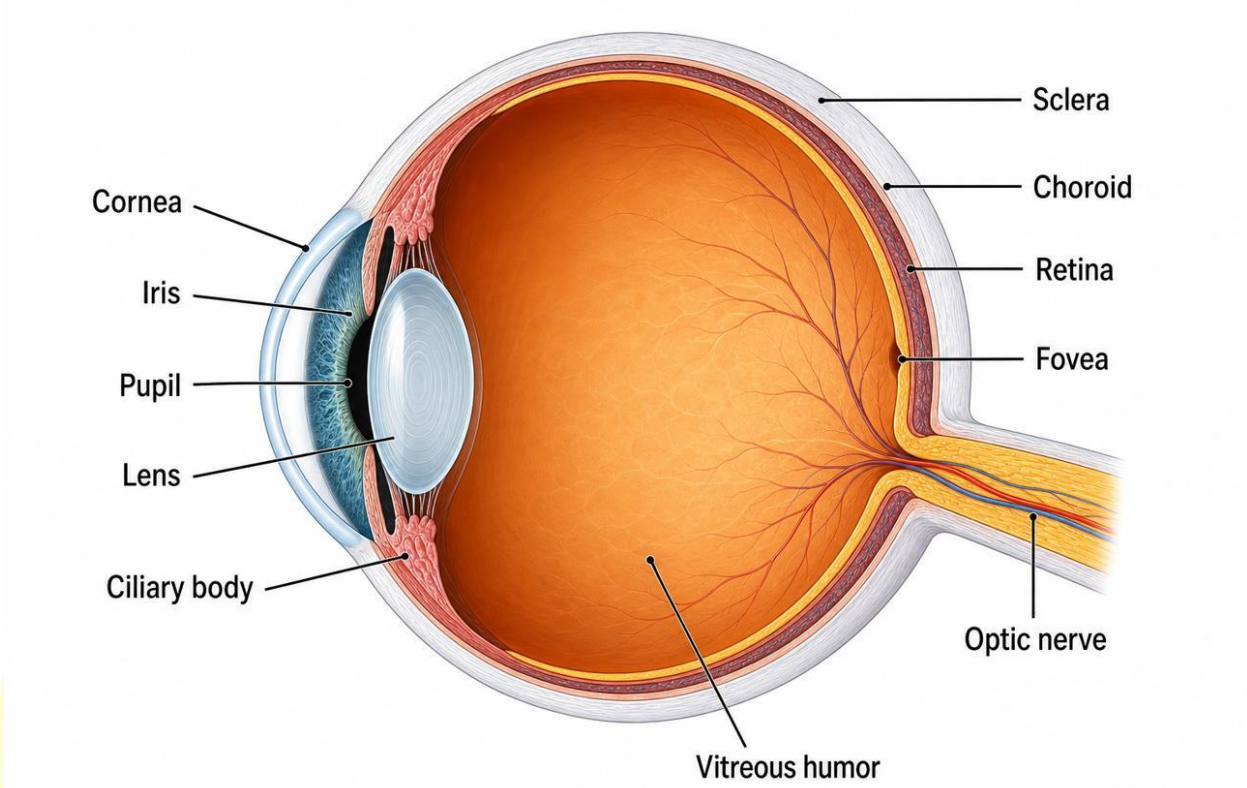


E. Optical Instruments

1. Human Eye

The human eye is a natural optical instrument that helps us see objects.

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Main Parts and Their Functions

1. **Cornea: Transparent front part that bends incoming light.**
2. **Iris: Controls the size of the pupil.**
3. **Pupil: Opening through which light enters the eye.**
4. **Eye Lens: Focuses light on the retina.**
5. **Retina: Light-sensitive layer where the image is formed.**
6. **Optic Nerve: Carries visual information to the brain.**
7. **Ciliary Muscles: Change the shape of the lens for focusing.**

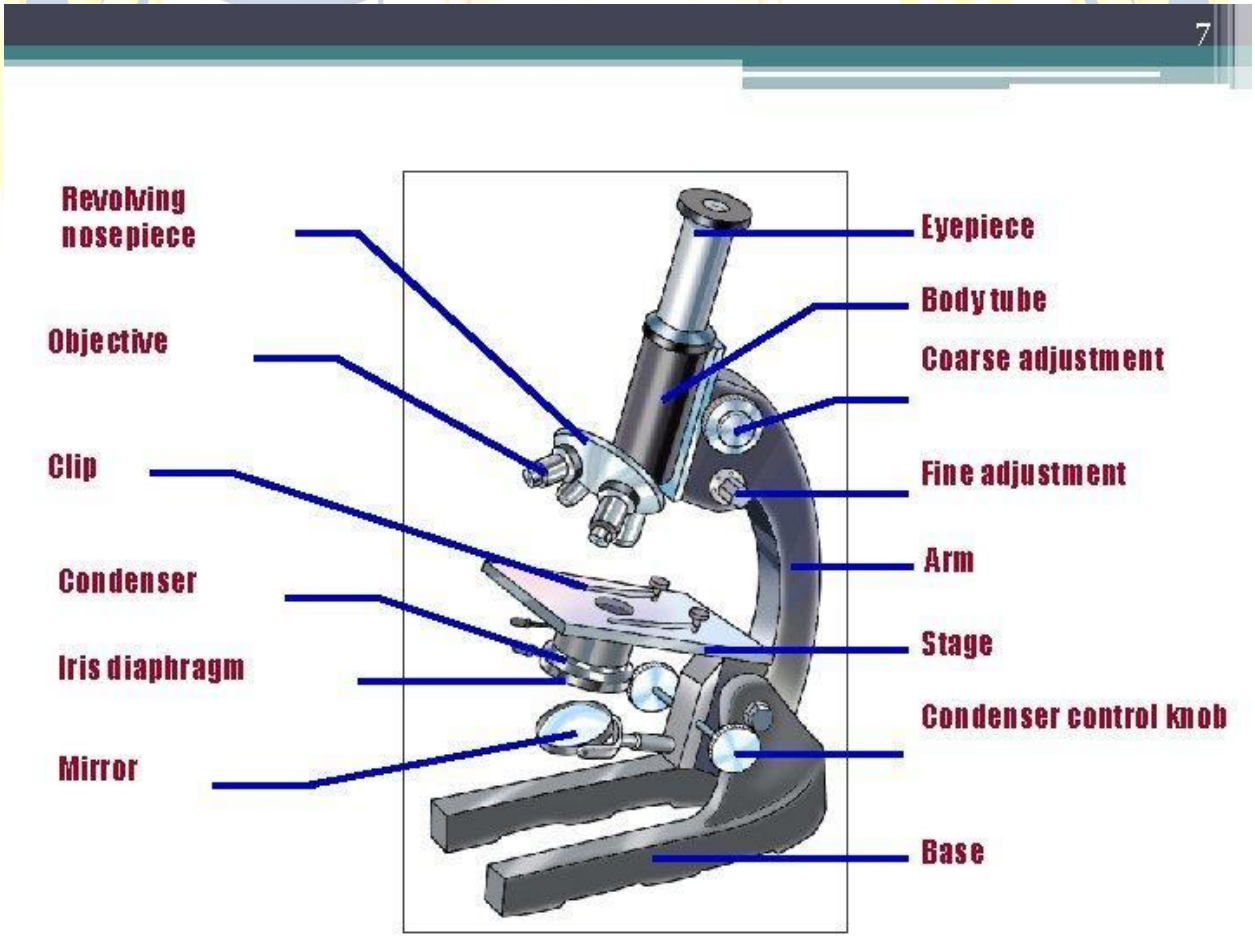
Working of Human Eye

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- **Light enters through the cornea.**
- **It passes through the pupil and lens.**
- **The lens focuses light on the retina.**
- **An image is formed on the retina.**
- **The optic nerve carries signals to the brain.**
- **The brain interprets the information and enables vision.**

2. Compound Microscope

A compound microscope is an optical instrument used to observe very small objects that cannot be seen clearly with the naked eye.



Main Parts

- **Eyepiece lens.**
- **Objective lens.**
- **Body tube.**
- **Stage.**
- **Mirror or illuminator.**
- **Coarse adjustment knob.**
- **Fine adjustment knob.**
- **Arm and base.**

Working

1. **Light passes through the specimen.**
2. **The objective lens produces an enlarged intermediate image.**
3. **The eyepiece magnifies this image further.**
4. **The observer sees a highly magnified image.**

Uses

- **Observing plant cells.**
- **Studying microorganisms.**
- **Examining tissue samples.**
- **Studying bacteria and other tiny structures.**

Mind Map: Natural Phenomena

NATURAL PHENOMENA

Gravitation

Newton's Law, g, G, Mass, Weight

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Magnetism

Magnets, poles, field and magnetisation

Current Electricity

Charge, current, voltage and Ohm's Law

Light

Reflection, refraction and optical effects

Optical Instruments

Human eye and compound microscope

UNIT 3: PLANNING FOR TEACHING

3.1 Need of Planning

Meaning of Planning

Planning is a systematic process of deciding in advance what is to be taught, how it will be taught, what teaching materials will be used and how students' learning will be evaluated.

In science teaching, planning helps teachers organize lessons, experiments, activities and classroom discussions effectively.

Need and Importance of Planning

1. **Clear Objectives: Planning helps teachers decide what students should learn.**
2. **Proper Organization: It arranges scientific concepts in a logical sequence.**

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3. **Time Management: It helps teachers complete the syllabus within the available time.**
4. **Selection of Teaching Methods: Teachers can choose suitable methods such as demonstration, discussion and experimentation.**
5. **Use of Teaching Aids: Planning helps teachers select charts, models, apparatus and digital resources.**
6. **Student Participation: It encourages students to participate in practical activities.**
7. **Individual Differences: Teachers can plan activities according to students' abilities and learning needs.**
8. **Classroom Management: It helps maintain discipline and an effective learning environment.**
9. **Evaluation: It provides opportunities to assess students' understanding.**
10. **Achievement of Learning Outcomes: It ensures that teaching activities are connected with educational objectives.**

Example:

If a teacher plans to teach the topic "Parts of a Plant", the teacher may arrange:

- **Real plants and leaves.**
- **A labelled plant diagram.**
- **Group observation activities.**
- **Questions about roots, stems and leaves.**
- **A short worksheet.**

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3.2 Identification and Organization of Concepts

Meaning of Concept

A concept is a general idea or understanding developed by observing common characteristics among different objects, events or phenomena.

Examples: Plants, animals, force, energy, matter, light and electricity.

Identification of Concepts

Identification of concepts means selecting the important scientific ideas that students need to learn from a particular topic or chapter.

Steps for Identification

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1. **Study the science syllabus.**
2. **Read the prescribed textbook.**
3. **Identify important scientific terms.**
4. **Identify basic and advanced concepts.**
5. **Understand the relationship between different concepts.**
6. **Select concepts according to the age and level of students.**
7. **Identify concepts that require practical activities.**

Example:

Topic: Water

Important concepts:

- **Sources of water.**
- **Properties of water.**
- **States of water.**
- **Water cycle.**
- **Water conservation.**
- **Water pollution.**

Meaning of Organization of Concepts

Organization of concepts refers to arranging scientific ideas in a meaningful and logical sequence so that students can understand them easily.

Need for Organization of Concepts

- **Makes learning systematic.**
- **Avoids confusion.**
- **Connects previous and new knowledge.**

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- **Develops clear understanding.**
- **Helps in remembering scientific facts.**
- **Encourages meaningful learning.**

Basic Principles of Organization of Concepts

1. **Simple to Complex: Teach easy concepts before difficult ones.**
2. **Known to Unknown: Begin with students' existing knowledge.**
3. **Concrete to Abstract: Start with real objects before introducing abstract ideas.**
4. **Particular to General: Begin with examples and develop general rules.**
5. **Whole to Part: Introduce an overall idea and then explain its parts where appropriate.**
6. **Logical Sequence: Arrange topics according to their relationships.**
7. **Activity-Based Learning: Give opportunities for practical experiences.**
8. **Correlation: Connect science with mathematics, social science and daily life.**
9. **Continuity: Connect present learning with previously learned concepts.**
10. **Age Appropriateness: Select concepts according to students' developmental levels.**

Factors to Be Considered While Organizing Concepts

- **Age and mental ability of students.**
- **Previous knowledge.**
- **Nature of the subject matter.**

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- **Learning objectives.**
- **Available time.**
- **Availability of teaching aids.**
- **Classroom environment.**
- **Individual differences.**
- **Local environment and experiences.**
- **Practical importance of concepts.**

Example: Teaching the Concept of Water

WATER

Introduction: Water used in daily life
Properties of Water
States: Solid, Liquid, Gas
Water Cycle
Conservation of Water
Evaluation and Activities

3.3 Science Lesson Design (Lesson Plan)

Meaning of Lesson Plan

A lesson plan is a written outline prepared by a teacher before teaching a particular topic. It includes objectives, teaching methods, teaching aids, classroom activities and evaluation.

A good lesson plan makes teaching systematic, interesting and effective.

Importance of Lesson Planning

- **Provides direction to teaching.**

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- **Saves classroom time.**
- **Improves teacher confidence.**
- **Encourages active participation.**
- **Helps achieve learning objectives.**
- **Makes evaluation easier.**
- **Ensures proper use of teaching aids.**

Elements of a Science Lesson Plan

1. **General information.**
2. **Previous knowledge.**
3. **General objectives.**
4. **Specific learning outcomes.**
5. **Teaching-learning materials.**
6. **Introduction of the lesson.**
7. **Statement of the topic.**
8. **Presentation and explanation.**
9. **Student activities.**
10. **Blackboard work.**
11. **Recapitulation.**
12. **Evaluation.**
13. **Homework or follow-up activity.**

Structure of a Science Lesson Plan

Step	Teacher's Activity	Students' Activity
Introduction	Asks questions about the topic.	Answer questions.
Announcement	Announces the lesson topic.	Listen carefully.

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Presentation	**Explains concepts using models and examples.**	**Observe and participate.**
Demonstration	**Performs a simple experiment.**	**Observe the experiment.**
Discussion	**Asks questions and explains results.**	**Discuss findings.**
Blackboard Work	**Writes important points.**	**Copy key points.**
Evaluation	**Asks questions and gives exercises.**	**Answer questions.**
Homework	**Gives an activity or assignment.**	**Complete the work.**

Example of a Science Lesson Plan

Sample Lesson Plan

Science – Elementary Level

Particulars	**Details**
Subject	**Science**
Topic	**Parts of a Plant**
Class	**Class V**
Duration	**35–40 minutes**
Teaching Method	**Demonstration and Discussion**
Teaching Aids	**Real plant, chart, blackboard**
Previous Knowledge	**Students know about plants.**

General Objective

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To develop scientific understanding and observation skills among students.

Specific Learning Outcomes

Students will be able to:

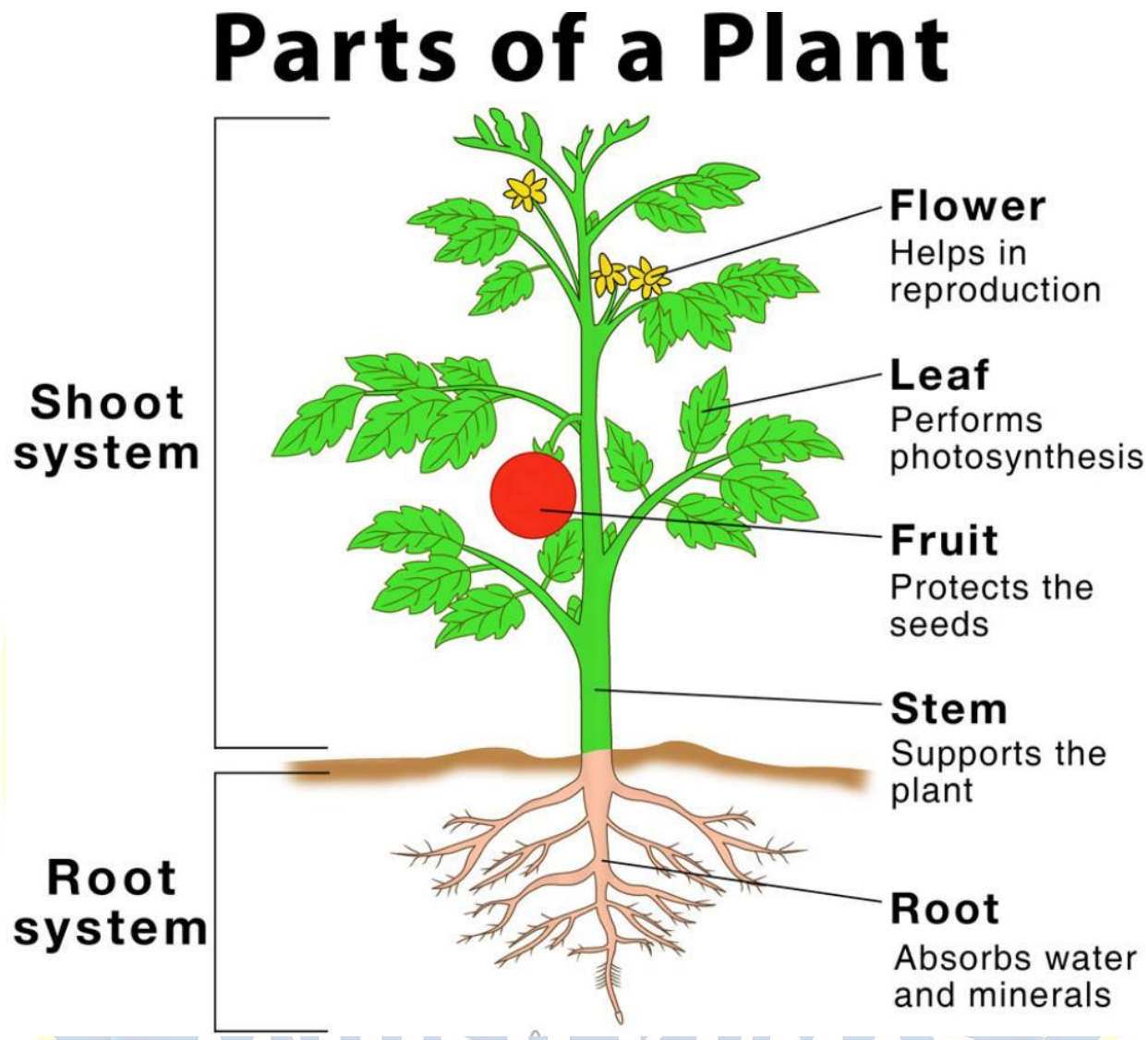
- **Identify different parts of a plant.**
- **Explain the functions of roots, stems and leaves.**
- **Draw a labelled diagram of a plant.**

Introduction Questions

1. **Where do we see plants?**
2. **What do plants need to grow?**
3. **Which part of a plant absorbs water?**

Presentation

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Plant Part	Function
Root	Absorbs water and minerals.
Stem	Supports the plant and transports materials.
Leaves	Prepare food through photosynthesis.
Flower	Helps in reproduction.
Fruit	Protects seeds.

Student Activity

Students observe a real plant and identify its parts.

Evaluation Questions

1. **What is the function of roots?**
2. **Which part prepares food?**
3. **What is the function of the stem?**

Homework

Draw a labelled diagram of a plant and write the functions of its parts.

3.4 Planning Laboratory Work

Meaning of Laboratory Work

Laboratory work refers to practical activities and experiments performed by students in a science laboratory or classroom to understand scientific concepts through direct experience.

It connects theoretical knowledge with practical learning.

Need and Importance of Laboratory Work

1. **Develops practical knowledge.**
2. **Improves observation skills.**
3. **Encourages scientific thinking.**
4. **Develops problem-solving abilities.**
5. **Helps verify scientific principles.**
6. **Creates interest in science.**
7. **Develops cooperation and teamwork.**
8. **Teaches proper handling of scientific apparatus.**

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9. **Improves accuracy and measurement skills.**
10. **Connects classroom learning with real-life experiences.**

Principles of Planning Laboratory Work

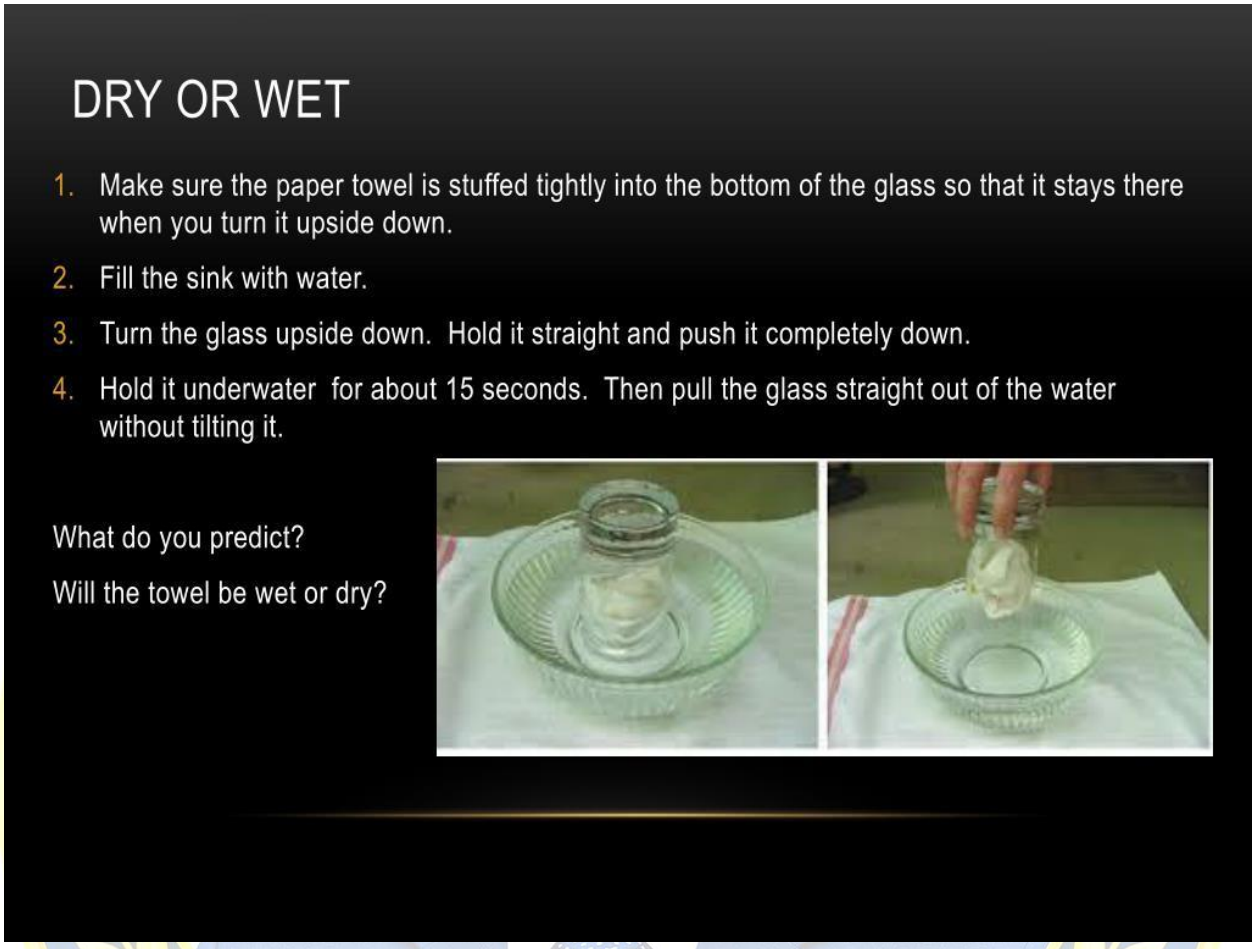
- **Select experiments according to learning objectives.**
- **Ensure the activity is suitable for the age of students.**
- **Arrange all materials before the lesson.**
- **Explain instructions clearly.**
- **Ensure proper laboratory safety.**
- **Provide equal opportunities to students.**
- **Encourage students to record observations.**
- **Discuss results after the experiment.**
- **Evaluate students' understanding.**

Steps for Planning Laboratory Work

1. **Select the topic.**
2. **Decide the objectives.**
3. **Choose the experiment.**
4. **Prepare the required apparatus.**
5. **Arrange the laboratory.**
6. **Explain safety rules.**
7. **Demonstrate the procedure.**
8. **Allow students to perform the activity under supervision.**
9. **Record observations.**
10. **Discuss conclusions.**

Example: Experiment to Show That Air Occupies Space

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Materials Required:

- **Transparent glass.**
- **Bowl of water.**
- **Small piece of tissue paper.**

Procedure:

1. **Put the tissue paper inside the bottom of the glass.**
2. **Turn the glass upside down.**
3. **Push the glass vertically into a bowl of water.**
4. **Remove the glass carefully.**
5. **Observe the tissue paper.**

Observation: The tissue paper remains dry because the air trapped inside the glass prevents water from entering.

Conclusion: Air occupies space.

Learning Outcomes:

- **Students understand that air is matter.**
- **Students learn observation skills.**
- **Students understand the properties of air.**

Safety: Perform the activity carefully using an unbroken glass and a shallow container.

3.5 Improvisation of Apparatus

Meaning of Improvisation of Apparatus

Improvisation of apparatus means preparing simple and low-cost teaching-learning materials or scientific instruments using locally available and easily accessible resources when standard laboratory equipment is unavailable.

It makes science education economical, practical and interesting.

Importance of Improvisation

1. **Reduces the cost of laboratory equipment.**
2. **Makes science learning activity-based.**
3. **Encourages creativity among students.**
4. **Develops practical skills.**
5. **Makes difficult concepts easier to understand.**

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6. **Encourages the use of local resources.**
7. **Supports learning in rural and resource-limited schools.**
8. **Promotes environmental awareness through reuse of materials.**
9. **Encourages students to work in groups.**
10. **Develops scientific curiosity.**

Five Examples of Improvised Apparatus

1. Simple Periscope



Required Materials:

- **Cardboard box or thick cardboard.**
- **Two small plane mirrors.**
- **Scissors.**
- **Adhesive tape.**
- **Pencil and ruler.**

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Construction:

- **Prepare a long rectangular cardboard tube.**
- **Make two openings near opposite ends.**
- **Place mirrors at approximately 45-degree angles.**
- **Keep the mirrors parallel to each other.**
- **Secure them with tape.**

Working:

Light from an object reflects from the upper mirror to the lower mirror and then reaches the observer's eye.

Concepts Discussed:

- **Reflection of light.**
- **Laws of reflection.**
- **Multiple reflection.**
- **Uses of periscopes.**

Applications: Understanding how periscopes help people see objects over or around obstacles.

2. Simple Electroscope

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Required Materials:

- **Transparent glass jar.**
- **Cardboard lid.**
- **Metal wire.**
- **Aluminium foil strips.**
- **Adhesive tape.**

Construction:

- **Make a small hole in the cardboard lid.**
- **Pass a metal wire through it.**
- **Attach two thin aluminium foil strips to the lower end.**
- **Place the assembly over the jar.**

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Working:

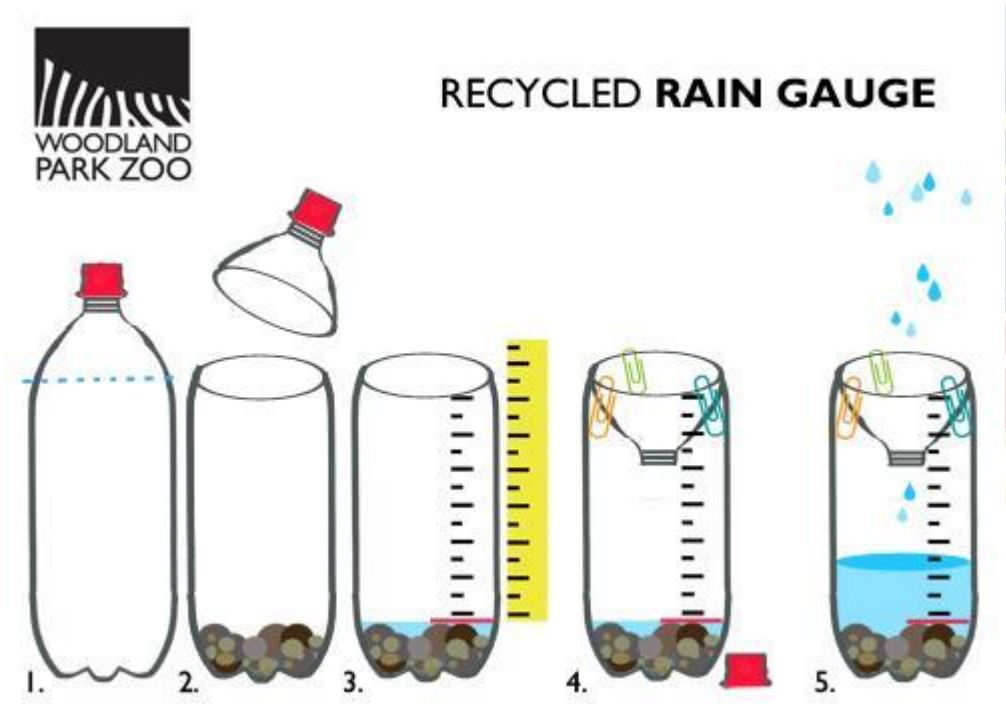
When a charged object is brought near or touches the metal terminal, electric charges are redistributed. The foil strips acquire similar charges and repel each other.

Concepts Discussed:

- **Electric charge.**
- **Electrostatic force.**
- **Repulsion of similar charges.**
- **Detection of electric charge.**

Safety: Use only simple static-electricity demonstrations. Do not connect this apparatus to mains electricity.

3. Simple Rain Gauge



Required Materials:

- **Transparent plastic bottle.**
- **Scissors.**
- **Ruler.**
- **Permanent marker.**
- **Small stones.**

Construction:

- **Cut the upper part of the bottle.**
- **Put a few stones at the bottom for stability.**
- **Invert the cut upper part to form a funnel.**
- **Mark measurement divisions on the bottle.**
- **Place it in an open area.**

Working:

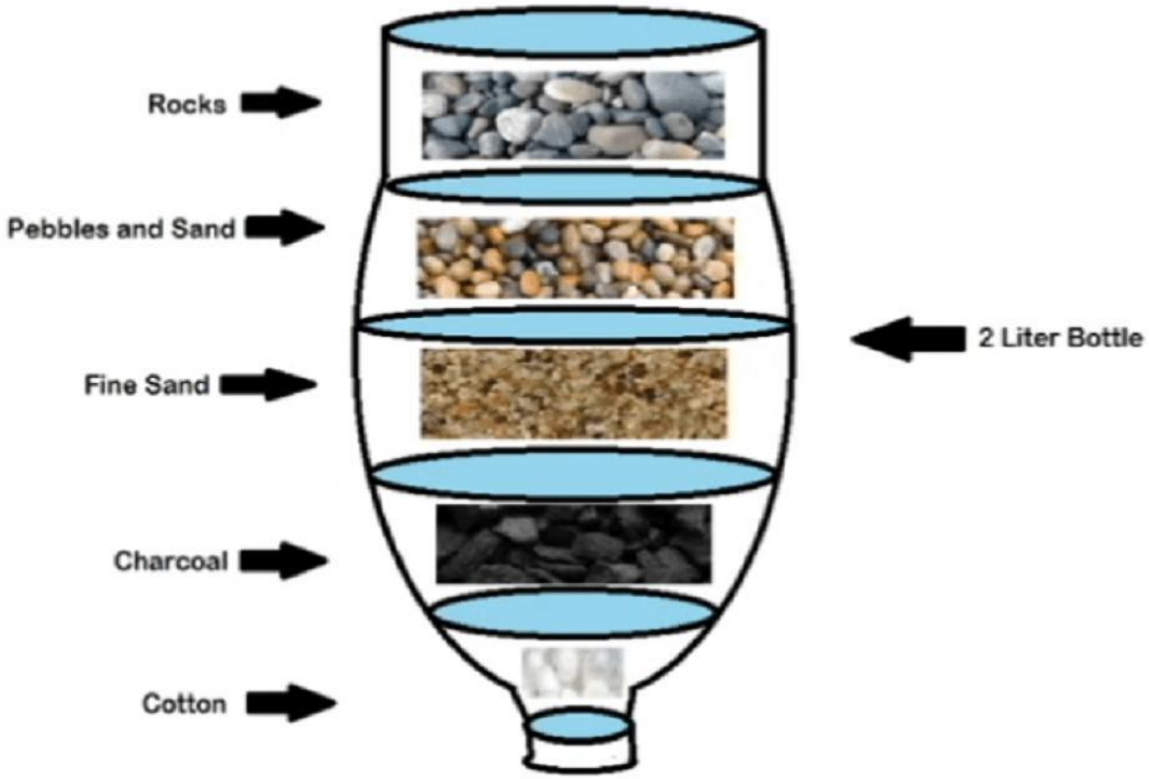
Rainwater enters through the funnel and collects inside the bottle. Students measure the collected water using the marked scale.

Concepts Discussed:

- **Rainfall measurement.**
- **Weather and climate.**
- **Water cycle.**
- **Observation and measurement.**

4. Simple Water Filter Model

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Required Materials:

- **Transparent plastic bottle.**
- **Cotton.**
- **Clean gravel.**
- **Clean sand.**
- **Activated charcoal.**
- **Collection container.**

Construction:

- **Prepare a cut plastic bottle as a demonstration funnel.**
- **Place cotton at the outlet.**
- **Add separate layers of clean sand, charcoal and gravel.**

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- **Keep a container below to collect the filtered water.**

Working:

When muddy water passes through the layers, some suspended particles are trapped.

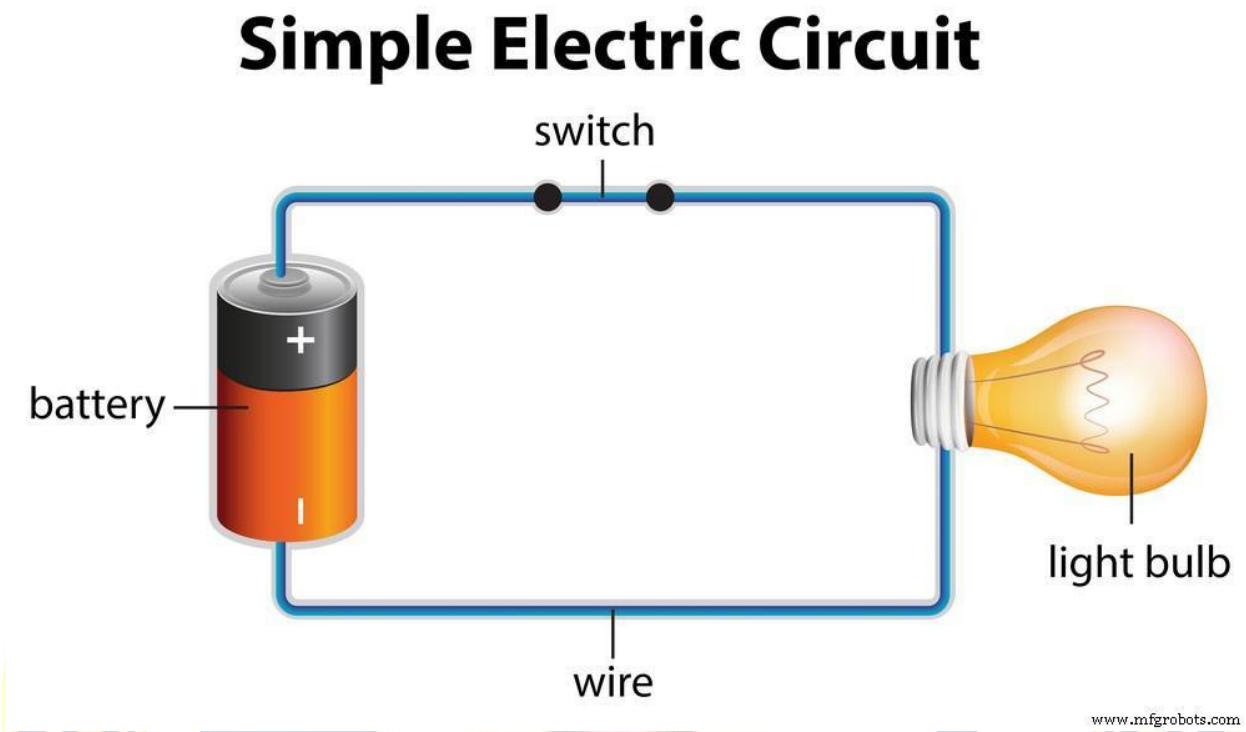
Concepts Discussed:

- **Filtration.**
- **Separation of mixtures.**
- **Water pollution.**
- **Water purification.**

Important: This model demonstrates basic filtration only. The collected water is not necessarily safe to drink because microorganisms and dissolved contaminants may remain.

5. Simple Electric Circuit Model

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Required Materials:

- **Low-voltage battery.**
- **Small torch bulb and suitable holder.**
- **Insulated connecting wires.**
- **Small switch.**

Construction:

- **Connect one battery terminal to the bulb.**
- **Connect the other bulb terminal to the switch.**
- **Connect the switch back to the remaining battery terminal.**
- **Ensure all connections are secure.**

Working:

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When the switch is closed, the circuit becomes complete and the bulb glows. When the switch is opened, the circuit breaks and the bulb goes off.

Concepts Discussed:

- **Electric current.**
- **Electric circuit.**
- **Conductors and insulators.**
- **Open and closed circuits.**

Safety: Use only an appropriate low-voltage battery. Never connect a classroom model to household electricity.

Comparison of Five Improvised Apparatus

Apparatus	Main Concept
Periscope	Reflection of light
Electroscope	Electric charge
Rain Gauge	Rainfall measurement
Water Filter	Filtration
Electric Circuit	Current electricity

Mind Map: Planning for Teaching

PLANNING FOR TEACHING

Need of Planning

Objectives, time and organization

Concept Organization

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Simple to complex, known to unknown

Lesson Plan

Introduction, presentation and evaluation

Laboratory Work

Experiments and practical activities

Improvisation

Low-cost and locally available materials

UNIT 4: SCIENCE FOR ALL

Introduction

Science is a subject for everyone, irrespective of gender, language, culture, religion, economic background or social status.

Science education should provide equal opportunities to all students. Every child should have the opportunity to ask questions, perform experiments, develop scientific thinking and participate in scientific activities.

The main purpose of Science for All is to make science education inclusive, equal, accessible and useful for society.

4.1 Issues of Gender, Language and Culture in Science Classes

Science classrooms include students from different social, cultural and linguistic backgrounds. Teachers should

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understand these differences and provide equal learning opportunities.

A. Gender Issues in Science Classes

Meaning of Gender Issues

Gender issues refer to inequalities, discrimination and stereotypes related to boys and girls in education and society.

Sometimes people believe that science, mathematics, engineering and technology are more suitable for boys than girls. Such beliefs create barriers to equal participation.

Major Gender Issues

1. **Gender Stereotypes: The belief that boys are naturally better at science and mathematics.**
2. **Unequal Opportunities: Girls may receive fewer opportunities to handle scientific equipment.**
3. **Lack of Encouragement: Girls may not receive sufficient encouragement to choose scientific careers.**
4. **Representation: Women scientists are sometimes less represented in textbooks.**
5. **Social Expectations: Traditional social roles may discourage girls from pursuing science.**
6. **Classroom Discrimination: Teachers may unintentionally give more attention to boys during science activities.**

Role of Teacher in Removing Gender Discrimination

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- **Give equal opportunities to boys and girls.**
- **Encourage all students to participate in experiments.**
- **Introduce students to successful women scientists.**
- **Avoid gender-based stereotypes.**
- **Distribute laboratory responsibilities equally.**
- **Use inclusive language.**
- **Encourage girls to participate in science exhibitions and competitions.**

Example: During an experiment on electricity, the teacher should allow both boys and girls to connect the circuit, operate the switch and record observations.



B. Language Issues in Science Classes

Meaning

Language issues refer to difficulties students face in understanding scientific concepts because of differences between their home language, classroom language and the language used in textbooks.

Science contains many technical terms that may be unfamiliar to students.

Major Language Issues

1. **Difficulty understanding scientific vocabulary.**
2. **Differences between home language and school language.**
3. **Use of difficult English terminology.**
4. **Lack of science books in local languages.**
5. **Difficulty expressing scientific ideas.**
6. **Misunderstanding scientific concepts due to translation.**

Role of Teacher

- **Use simple and understandable language.**
- **Explain difficult scientific terms.**
- **Use pictures, charts and models.**
- **Allow students to discuss concepts in their home language.**
- **Connect scientific terms with everyday examples.**
- **Encourage students to explain observations in their own words.**
- **Use bilingual teaching materials where appropriate.**

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Example: While teaching evaporation, a teacher can explain the concept in simple English and also use familiar Punjabi expressions to help students understand how water changes into vapour.

C. Cultural Issues in Science Classes

Meaning

Cultural issues refer to differences in students' beliefs, traditions, customs, lifestyles and experiences that may influence their understanding of science.

Major Cultural Issues

1. **Different traditional beliefs about natural phenomena.**
2. **Superstitions and misconceptions.**
3. **Differences in food habits and health practices.**
4. **Different environmental experiences.**
5. **Unequal access to scientific resources.**
6. **Differences in family and community practices.**

Role of Teacher

- **Respect all cultures and traditions.**
- **Encourage scientific questioning.**
- **Explain scientific facts through evidence.**
- **Avoid insulting students' beliefs.**
- **Connect science with local experiences.**
- **Promote cooperation among students.**
- **Develop a scientific attitude.**

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Example: While teaching eclipses, the teacher should explain the scientific reasons behind solar and lunar eclipses through diagrams and models instead of making fun of traditional beliefs.



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4.2 Science as a Tool for Equity

Meaning of Equity

Equity means providing fair opportunities, resources and support according to the needs of individuals so that everyone can achieve educational success.

Equality means giving everyone the same opportunities, whereas equity means providing opportunities and support according to individual needs.

Meaning of Science as a Tool for Equity

Science is a powerful tool for reducing social inequalities and improving people's quality of life.

Science education should be accessible to every child, including girls, children from disadvantaged communities, rural students and children with disabilities.

Importance of Science for Equity

1. **Equal Educational Opportunities: Science education should be available to all children.**
2. **Women Empowerment: Science develops confidence and career opportunities among girls.**
3. **Social Development: Scientific knowledge helps people make informed decisions.**
4. **Health Awareness: Science provides knowledge about nutrition, hygiene and diseases.**
5. **Environmental Protection: It helps communities understand environmental problems.**
6. **Technological Development: Technology can improve access to education and information.**
7. **Removal of Superstitions: Scientific thinking promotes rational decisions.**
8. **Rural Development: Science improves agriculture, sanitation and water management.**

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9. **Support for Children with Disabilities: Assistive technologies help children participate in education.**
10. **Economic Development: Scientific knowledge creates opportunities for employment and innovation.**

Examples of Science as a Tool for Equity

- **Solar energy provides electricity to remote areas.**
- **Water purification technologies improve access to clean water.**
- **Online educational resources help students access knowledge.**
- **Assistive devices support children with disabilities.**
- **Agricultural science helps farmers improve productivity.**
- **Vaccination programmes protect communities against diseases.**

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Role of Science Teacher in Promoting Equity

- **Provide equal learning opportunities.**
- **Use low-cost teaching aids.**
- **Encourage all students to perform experiments.**
- **Provide additional support to students who need it.**
- **Use accessible learning materials.**
- **Respect diversity.**
- **Encourage critical thinking.**
- **Develop scientific awareness in society.**

4.3 Democratising Science Learning

Meaning of Democratising Science Learning

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Democratising science learning means making science education accessible, inclusive and participatory for every student.

It ensures that all students get equal opportunities to ask questions, express opinions, perform experiments and participate in scientific discussions.

It also means that science learning should not remain limited to textbooks, laboratories or privileged groups.

Characteristics of Democratising Science Learning

1. **Equal participation of all students.**
2. **Freedom to ask questions.**
3. **Respect for different opinions.**
4. **Learning through activities and experiments.**
5. **Equal opportunities for boys and girls.**
6. **Respect for local knowledge and experiences.**
7. **Development of critical thinking.**
8. **Cooperative learning.**
9. **Accessible teaching materials.**
10. **Learning connected with social problems.**

Importance

- **Promotes equality in education.**
- **Develops independent thinking.**
- **Encourages active participation.**
- **Removes fear of questioning.**
- **Develops scientific attitude.**
- **Promotes social responsibility.**
- **Makes science meaningful and practical.**

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A. Critical Pedagogy

Meaning of Critical Pedagogy

Critical pedagogy is an educational approach that encourages students to question existing ideas, examine social inequalities and develop independent and critical thinking.

It believes that education should not be limited to memorising facts. Students should understand their surroundings, identify problems and think about possible solutions.

Brazilian educator Paulo Freire is one of the most important thinkers associated with critical pedagogy.

Main Principles of Critical Pedagogy

1. **Dialogue: Teachers and students should learn through discussion.**
2. **Critical Thinking: Students should question and examine information.**
3. **Equality: Every student should have equal opportunities.**
4. **Participation: Students should actively participate in learning.**
5. **Problem-Based Learning: Learning should be connected with real-life problems.**
6. **Freedom of Expression: Students should be able to express their views.**
7. **Social Awareness: Students should understand social and environmental issues.**

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8. **Reflection: Students should think about their experiences and learning.**

Example of Critical Pedagogy in Science

Topic: Water Pollution

The teacher asks students:

- **Why are rivers becoming polluted?**
- **What are the causes of water pollution?**
- **How does polluted water affect human health?**
- **Who is responsible for protecting water resources?**
- **What can students and communities do to prevent pollution?**

Students discuss the questions, collect local information and suggest solutions.

This approach develops critical thinking and social responsibility.

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B. Role of Teacher in Critical Pedagogy

The teacher acts as a facilitator, guide and co-learner rather than only a provider of information.

Main Roles

1. **Encouraging Questions: Motivate students to ask questions about scientific concepts.**
2. **Creating Dialogue: Organize meaningful discussions.**
3. **Promoting Equality: Give every student opportunities to participate.**
4. **Developing Critical Thinking: Encourage students to examine facts and evidence.**
5. **Connecting Learning with Life: Relate science to everyday experiences.**
6. **Encouraging Group Work: Organize cooperative learning activities.**
7. **Respecting Opinions: Listen to students' views.**
8. **Developing Scientific Attitude: Encourage evidence-based thinking.**
9. **Removing Discrimination: Ensure equal participation.**
10. **Promoting Social Responsibility: Encourage students to solve community problems.**

Example: Instead of simply teaching the causes of air pollution, the teacher can ask students to observe pollution in their locality, identify its causes and suggest preventive measures.

4.4 Introduction to Science and Society Interface

Meaning of Science and Society Interface

Science and society interface refers to the relationship between scientific knowledge, technological development and human society.

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Science influences our daily life, while society provides problems and needs that encourage scientific research and innovation.

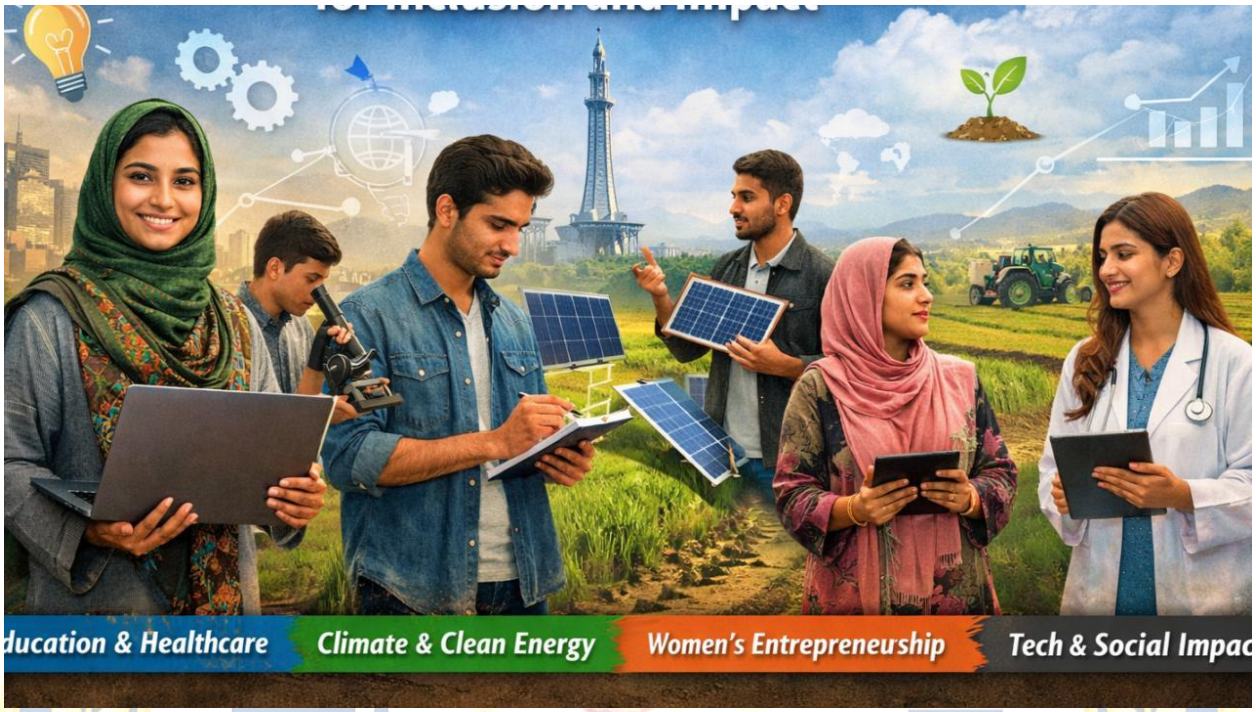
Relationship Between Science and Society

1. **Science improves human health.**
2. **Science promotes agricultural development.**
3. **Science improves communication.**
4. **Science supports transportation.**
5. **Science provides environmental solutions.**
6. **Science improves education.**
7. **Science supports industrial development.**
8. **Science contributes to national development.**

Examples:

- **Mobile phones have changed communication.**
- **Medical science has improved healthcare.**
- **Agricultural technology has improved farming.**
- **Renewable energy supports sustainable development.**
- **Computers have changed teaching and learning.**

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A. Science for Environment

Meaning

Science for the environment refers to the application of scientific knowledge and technology to understand, protect and improve the natural environment.

The environment includes air, water, land, plants, animals and human beings.

Importance of Science for Environment

1. **Helps identify causes of pollution.**
2. **Promotes conservation of natural resources.**
3. **Helps control air and water pollution.**
4. **Supports wildlife conservation.**

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5. Helps understand climate change.
6. Encourages renewable energy.
7. Promotes waste management.
8. Supports sustainable development.
9. Helps conserve biodiversity.
10. Develops environmental awareness.

Major Environmental Problems

- Air pollution.
- Water pollution.
- Soil pollution.
- Deforestation.
- Global warming.
- Climate change.
- Loss of biodiversity.
- Excessive use of natural resources.

Role of Science in Environmental Protection

1. Pollution Control: Scientific methods help monitor and reduce pollution.

2. Renewable Energy: Solar, wind and hydropower reduce dependence on fossil fuels.

3. Water Conservation: Rainwater harvesting and water treatment help conserve water.

4. Waste Management: Recycling and composting reduce waste.

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5. Forest Conservation: Scientific research helps protect forests and wildlife.

6. Climate Monitoring: Scientific instruments help study weather and climate.



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Role of Science Teacher in Environmental Protection

- **Organize tree plantation activities.**
- **Teach students about pollution.**
- **Encourage water conservation.**
- **Organize cleanliness campaigns.**
- **Promote recycling.**
- **Arrange nature walks.**
- **Develop environmental clubs.**
- **Encourage students to avoid unnecessary waste.**

Example: Students can prepare a rainwater harvesting model to understand how rainwater can be collected and stored for future use.

B. Science for Health

Meaning

Science for health refers to the use of scientific knowledge, research and technology to maintain good health, prevent diseases and improve the quality of human life.

Science helps us understand the human body, nutrition, hygiene, medicines and disease prevention.

Importance of Science for Health

1. **Develops awareness about personal hygiene.**
2. **Helps prevent infectious diseases.**
3. **Improves nutrition and food habits.**
4. **Promotes vaccination.**
5. **Supports medical diagnosis.**
6. **Develops awareness about sanitation.**
7. **Improves maternal and child healthcare.**
8. **Promotes mental and physical well-being.**
9. **Helps people make healthy lifestyle choices.**
10. **Improves life expectancy and quality of life.**

Applications of Science in Health

1. Medical Technology: X-rays, ultrasound and other diagnostic technologies help doctors identify health problems.

2. Vaccination: Vaccines help protect people against certain infectious diseases.

3. Medicines: Scientific research helps develop medicines to treat diseases.

4. Nutrition: Nutritional science explains the importance of balanced diets.

5. Sanitation: Scientific knowledge promotes clean drinking water and proper waste disposal.

6. Hygiene: Science explains the importance of handwashing and cleanliness.





Role of Science Teacher in Health Education

- **Teach students about personal hygiene.**
- **Explain the importance of balanced diets.**
- **Promote safe drinking water.**
- **Develop awareness about communicable diseases.**
- **Encourage physical activity.**
- **Teach the importance of sanitation.**
- **Organize health-awareness activities.**
- **Promote healthy habits.**

Example: A teacher can demonstrate the correct handwashing technique and explain how it helps reduce the spread of germs.

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C. Science for Peace

Meaning

Science for peace refers to the use of scientific knowledge and technology for human welfare, international cooperation, development and peaceful purposes.

Science should be used to improve human life rather than create conflict, destruction or inequality.

Importance of Science for Peace

1. **Promotes international cooperation.**
2. **Supports peaceful development.**
3. **Improves communication between countries.**
4. **Helps solve environmental problems.**
5. **Supports disaster management.**
6. **Promotes scientific cooperation.**
7. **Improves healthcare and education.**
8. **Encourages responsible use of technology.**
9. **Supports sustainable development.**
10. **Promotes understanding among communities.**

Role of Science in Promoting Peace

1. International Cooperation: Scientists from different countries work together to solve global problems.

2. Healthcare: Medical research helps protect human life.

3. Environmental Protection: Scientific cooperation helps address climate change and pollution.

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4. Disaster Management: Science helps predict and prepare for natural disasters.

5. Communication: Modern technology connects people across the world.

6. Education: Science education develops rational thinking and understanding.

7. Responsible Technology: Scientific knowledge should be used ethically and for human welfare.



Role of Science Teacher in Promoting Peace

- **Develop scientific temper among students.**

- **Encourage cooperation and teamwork.**
- **Promote respect for different cultures.**
- **Teach the peaceful use of technology.**
- **Encourage students to solve problems through discussion.**
- **Develop environmental responsibility.**
- **Promote honesty and human values.**
- **Explain the importance of science for humanity.**

Example: Students from different communities can work together on a project about clean drinking water. This develops cooperation, mutual respect and social responsibility.

Important Mind Maps – Unit 4

1. Science for All

SCIENCE FOR ALL

GenderEqual participation

LanguageSimple and bilingual teaching

CultureRespect for diversity

EquityFair opportunities

Inclusive Science Education

2. Democratising Science Learning

DEMOCRATISING SCIENCE LEARNING

Critical Pedagogy

Student Participation

Dialogue and Discussion

Critical Thinking

Freedom of Expression

Equality and Inclusion

Social Awareness

Goal: Independent thinking and responsible citizenship

3. Science and Society Interface

SCIENCE AND SOCIETY

EnvironmentConservation

HealthWell-being

PeaceCooperation

Human Welfare and Sustainable Development

Important Examination Questions

These questions are useful for revision and preparation.

Unit 1: Understanding Science

1. **Define science and explain its nature and characteristics.**
2. **Why do we teach science at the elementary level?**

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3. **What is scientific attitude? Explain the ways of developing it among students.**
4. **What are the qualities of a good scientist?**
5. **Explain the life and contributions of C. V. Raman.**
6. **Discuss the contributions of J. C. Bose and Marie Curie.**
7. **Write short notes on Albert Einstein and Bimla Buti.**

Unit 2: Revisiting School Science Concepts

1. **Define cell and explain its structure and functions.**
2. **Explain the four major types of animal tissues.**
3. **Explain the structure of an atom.**
4. **Describe Thomson's, Rutherford's and Bohr's atomic models.**
5. **Differentiate between atomic number and mass number.**
6. **Explain the electronic configuration of the first 20 elements.**
7. **State Newton's Universal Law of Gravitation.**
8. **Differentiate between mass and weight.**
9. **Explain the properties of magnets and magnetic field lines.**
10. **State Ohm's Law with an example.**
11. **Explain the laws of reflection and refraction.**
12. **Explain mirage and twinkling of stars.**
13. **Describe the structure and working of the human eye.**
14. **Explain the working of a compound microscope.**

Unit 3: Planning for Teaching

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1. **What is planning? Explain its need and importance in science teaching.**
2. **Explain the principles of organization of concepts.**
3. **What is a science lesson plan? Explain its elements and structure.**
4. **Explain the importance of laboratory work in science teaching.**
5. **What is improvisation of apparatus? Explain its importance.**
6. **Describe any five improvised science apparatus with materials, construction, working and concepts.**

Unit 4: Science for All

1. **Explain gender, language and cultural issues in science classrooms.**
2. **Discuss science as a tool for equity.**
3. **What is democratising science learning?**
4. **Define critical pedagogy and explain its principles.**
5. **Explain the role of a teacher in critical pedagogy.**
6. **Discuss the relationship between science and society.**
7. **Explain the importance of science for environmental protection.**
8. **Discuss the contribution of science to human health.**
9. **Explain the role of science in promoting peace.**

Final Revision: Complete Syllabus Mind Map

205

PEDAGOGY OF SCIENCE EDUCATION

D.El.Ed. Second Year

Unit 1

UNIT 1 – UNDERSTANDING SCIENCE

Meaning • Nature • Need • Scientific Attitude • Scientists

Unit 2

UNIT 2 – SCHOOL SCIENCE CONCEPTS

Cell • Tissues • Atom • Gravitation • Magnetism • Electricity • Light

Unit 3

UNIT 3 – PLANNING FOR TEACHING

Planning • Concept Organization • Lesson Plan • Laboratory • Improvisation

Unit 4

UNIT 4 – SCIENCE FOR ALL

Gender • Language • Culture • Equity • Critical Pedagogy • Environment • Health • Peace

FINAL GOAL

Scientific Knowledge + Practical Skills + Scientific Attitude + Social Responsibility

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