

**** 1. State in your own words, what is science? Write its two main groups.**

*Science is a **collective knowledge** about the natural phenomena, processes, and events occurring around us.*

It begins by asking questions about how and why things behave the way they do.

Science is divided into two main branches:

1. **Biological Science:** The biological sciences which deals the living things.
2. **Physical Science:** The physical science which is about the study of non-living things.

Natural Philosophy: Natural Philosophy is the *study of nature* that gave birth to a single discipline, now known as science.

**** 2. What is the scope of physics in everyday life? Give some examples.**

*Physics is the fundamental science that deals with the constituents of the universe—matter, energy, space, time, and their **mutual relationships and interactions**.*

It explains how the universe works, from subatomic particles to stars and galaxies.

***Space** is the three-dimensional extent in which all objects and events occur. It provides the framework to define positions and motions of various objects under some force.*

***Time** measures the sequence and duration of events. It is considered the fourth dimension.*

Examples:

- **Oscillating motion** (like a swinging pendulum) depends on time intervals to determine frequency.
- **Time dilation** is a phenomenon explained by the special theory of relativity, where time passes slowly for an observer moving at ultra-high speed compared to one at rest.

Physics connects these concepts:

- **Theory of relativity** explains that **space and time are not absolute**, but are related to each other and are influenced by gravity and speed.
- **Quantum mechanics** explains the behavior of particles at the atomic and subatomic levels.

Physics helps understand phenomena from daily life (motion, heat) to extreme cosmic events.

**** 3. What are the main branches of Physics and their definitions?**

1. **Mechanics:** It is a study of motion and the physical effects which influence motion. It is based on

Newton's laws of motion and gravitation and is often called classical mechanics.

2. **Heat and Thermodynamics:** It deal with the thermal energy possessed by the materials and it is used when it flows from one body to another.
3. **Acoustics:** It deals with the nature and physical aspects of audible sound energy.
4. **Optics:** It deal with the physical aspects of visible light.
5. **Electromagnetism:** It is the study of electromagnetic phenomenon and mutual relationship between electric current and magnetic field.
6. **Quantum Mechanics:** It explains the behavior of particles at the atomic and subatomic level.
7. **Relativistic Mechanics:** It explains how space and time are not absolute quantities but related to observer. It describes the relationship between them and how they are influenced by gravity and speed.
8. **Nuclear Physics:** It is the study of the properties of nuclei of the atoms.
9. **Particle Physics:** It is the study of subatomic particles and elementary particles which are basic building blocks of matter.
10. **Astronomy:** It is study of distribution of celestial bodies like planets, stars and galaxies.
11. **Cosmology:** It explores the large structure and evolution of the universe.
12. **Solid State Physics:** It is the study of some specific properties of matter in solid form.

**** 4. What is meant by interdisciplinary nature of Physics? Explain its branches with examples.**

Interdisciplinary nature of Physics refers to integration and interaction of Physics with various other fields of study.

Physics, being fundamental science, provides essential principles, techniques and methods that are applicable across a wide range of disciplines. Some of these are:

1. **Biophysics:** *Some biological systems and processes are described using the principles and technique of physics under this field of Study.*

For example, the mechanics of biological structures, physical properties of cells, tissues and organs.

2. **Medical Physics:** *It applies physical principles to develop techniques and technologies for health diagnosis and treatment.*

For example, imaging techniques such as X-rays, ultrasound, MRI and CT scan, and radiation therapy for cancer treatment.

3. **Astrophysics:** *It deals with the physical properties and processes of celestial bodies and phenomena.*

For example, the interaction between matter and energy in space to understand the universe as a whole.

4. **Geophysics:** It applies physical principle to the study of internal structure of the Earth, its magnetic and gravitational fields, seismic activity, volcanoes, etc.

For example, studying earthquakes and volcanoes.

5. **Climate Physics:** It includes the study of physical processes in the environment, including atmospheric dynamics, climate change and weather conditions.

For example, studying tornadoes and climate change.

6. **Computational Physics:** It is about the use of computational techniques and methods to solve complex physical problems.

For example, using computer simulations to model physical systems.

5. What is interdisciplinary research and why is collaboration important in science?

Interdisciplinary Research: Interdisciplinary research involves collaboration between different scientific disciplines to address complex issues and challenges. It leads to greater breakthroughs and a deeper understanding of the natural and physical world. Collaboration is important because:

(i) **Solutions to complex issues require multifaceted expertise:** Problems like climate change, disease prevention, and sustainable energy are diverse and require knowledge from multiple fields.

- Example: **Climate change** needs input from meteorology, oceanography, physics, chemistry, biology, and environmental sciences.

- Example: The **COVID-19 pandemic** required expertise from biology, chemistry, physics, medical technologies, and data science.

(ii) **Interdisciplinary approaches foster innovation:** Combining knowledge from different fields leads to innovative and novel solutions.

- Example: **Nanotechnology** blends physics, chemistry, materials science, and engineering to create nanoscale materials with medical and electronic applications.

- Example: **Artificial intelligence** combines computer science, logic, and neuroscience, leading to smart systems with wide-ranging uses.

(iii) **Rapid sharing of knowledge across the globe:** Global collaboration through the internet, conferences, and workshops allows scientists to share findings, discuss ideas, and cooperate on new approaches.

- Research journals and joint projects promote global cooperation in science.

Conclusion: Interdisciplinary research and collaboration provide a holistic understanding of complex problems, benefiting fields like environmental science and space exploration.

6. What is scientific method? Explain its main steps with the help of an example.

Scientific method is a systematic approach used to search for truth of an issue and problem solving regarding natural and physical world.

Some key steps are elaborated here:

- (i) **Observation:** The first step in scientific method is to make observations of natural processes and to collect the data about them. This may be done either by ordinary observations or by obtaining the results from different experiments.

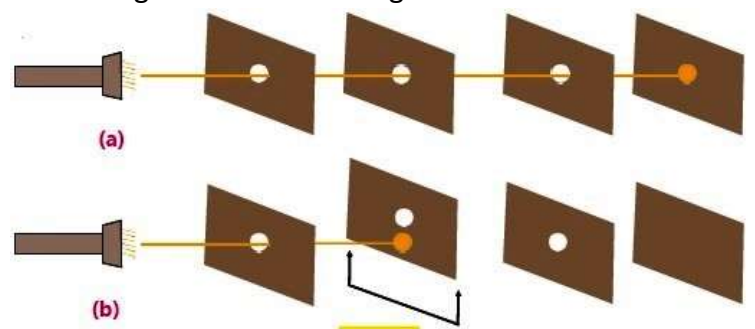
For example, it is our common observation that shadow of an opaque object is formed when it is placed in the path of light coming from the Sun or a lamp.

- (ii) **Hypothesis:** On the basis of the data collected through observations or experimentation, we can develop a hypothesis. This is done in order to test its logical results, i.e., it is assumed that nature will act in a particular way under certain specific circumstances.

From the above example, we assume that shadows of opaque objects are formed when they come in the path of light because light travels in a straight line.

- (iii) **Experiment:** Experiment is an organized repeatable process which is used to test the truth of a hypothesis.

To verify the assumption made in the above example, four cardboards, each with a hole, are placed in a straight line, such that the hole in the 1st card is in front of a torch. When we see through the hole in cards, we can see the light of the torch (Fig. a). If any of these cards is displaced, we cannot see light passing through (Fig. b). Thus, this experiment proves that light travels in a straight line.



- (iv) **Theory:** After the successful verification of an assumption and with the help of careful experimentation, it becomes a theory and is applicable to similar phenomena.

With the help of the above experiment, the assumption has been proved that light travels in a

straight line. So, it then becomes a theory. It is a logical explanation of the causes and effects of an issue or an event that occurs in nature.

(v) **Prediction:** After the careful analysis of a theory we can make predictions about certain unknown aspects of nature. To verify the prediction, experiments are designed to test the theory over and over again. If test results do not agree, hypothesis is changed or rejected.

(vi) **Falsifiability:** It is a concept introduced that suggests a theory to be considered scientific if it also makes predictions that can be tested and potentially proven false. The requirement of falsifiability ensures that theories are not based on vague, non-specific or untestable claims. It distinguishes scientific theories from false or pretended beliefs that cannot be experimentally tested.

(vii) **Law:** When a theory has been tested many times and generally accepted as true, it is called a law. The law is such a statement regarding the behaviour of nature which explains the observations and experiments of the past and can predict about other aspects of nature.

From the fact that light travels in a straight line, we can predict that shadow of an opaque object, similar in shape, is formed whenever it is placed in the path of light.

*For example, the shadow of a ball will be round whereas the shadow of a rectangular block will be a rectangle. After testing the theory under different situations, this becomes a **law of science that light travels in a straight line.***

Conclusion: The theories or laws of physics are man-made ideas about the way the things work. They are liable to be disproved or modified with the future advances in science which brings fresh facts and new insights about the natural and physical world.

OR

Scientific method is a **systematic approach** used to search for the truth of an issue and to solve problems related to the **natural and physical world**.

It is based on the following steps:

1. **Observation:** The first step is to observe natural processes and collect data. This can be done by simple observation or through experiments.

Example: We commonly observe that a **shadow is formed** when an opaque object is placed in the path of light from the Sun or a lamp.

2. **Hypothesis:** A hypothesis is a possible explanation or guess based on observations. It is made to test logical results.

Example: From the above observation, we assume that shadows are formed **because light travels in a straight line**.

3. **Experiment:** An experiment is a repeatable process used to test the truth of a hypothesis.

Example: Take four cardboards with holes and arrange them in a straight line in front of a torch. Light passes through all holes when aligned. If one cardboard is moved, the light is blocked. This proves that **light travels in a straight line**.

4. **Theory:** After successful experiments, the hypothesis becomes a **theory**. A theory explains the causes and effects of a natural event.

Example: The above experiment proves that light travels in a straight line, so this assumption becomes a **theory**.

5. **Prediction:** Based on the theory, we can make predictions about other natural events.

Example: We can predict that a ball will make a round shadow and a block will make a rectangular shadow when placed in light.

6. **Falsifiability:** A theory must make predictions that can be tested and possibly proven wrong. This helps to check if the theory is truly scientific and not based on vague ideas.

7. **Law:** After many successful tests and wide acceptance, a theory becomes a **law**.

Example: The theory that light travels in a straight line becomes the **law of rectilinear propagation of light**.

7. What did Einstein declare about mass and energy?
In the 20th century, Albert Einstein declared that mass and energy, the two concerns of Physics, are forms of each other. His theory of relativity altered man's views of the universe.

**** 8. Differentiate the terms, science, technology and engineering with examples.**

Science: Science or to be more specific, physics plays a vital role being the core of each invention based on physical laws and principles.

Technology: Technology refers to the methods and techniques developed by using **scientific knowledge**. It may be a machine technology or a software programme of information technology.

For example:

(i) **Automobile technology** is based on the principles of the thermodynamics.

(ii) **Radar technology** is based on the detection and reflection principles of electromagnetic waves.

(iii) **Laser technology** is based on the principles of atomic physics. It is widely used in medical diagnosis and

treatment, metallurgy, industry, telecommunication and space exploration.

Engineering: Engineering is the process of applying various technologies and scientific principles to design various instruments, tools and build things that help to meet specific needs in every walk of life. Engineers also consider factors like **cost effectiveness and safety measures** when designing various products.

Examples include:

- (i) A **civil engineer** designs a bridge that can withstand strong winds, earthquakes, intense weather conditions and heavy traffic.
- (ii) A **software engineer** designs a user friendly application of a smartphone.
- (iii) An **aviation engineer** looks for lighter material which can withstand sudden and severe disturbances and extreme weather conditions during the flight of an aeroplane.

Interdependence: Though the science, technology and engineering fields seem distinct, they often **work together**.

Scientific discoveries lead to new technologies and engineers rely on scientific knowledge for our benefits and comforts.

They are the potent for change in the outlook of mankind in shaping life style and influencing our way of thinking.

**** 9. List the main steps of scientific method.**

It is based on the following steps:

- 1. Identify or recognize an issue or a problem.
- 2. Gather information through observations of its various aspects.
- 3. Propose an explanation or a guess work known as hypothesis.
- 4. Perform experiment or collect evidences to test the hypothesis.
- 5. Record, organize and analyze gathered data, plotting and interpreting graphs to reach at a conclusion which is called a theory.
- 6. Repeated tests of the theory to wide range of similar issues then lead towards the formulation of a law.

**** 10. What is falsifiability concept? How is it important?**

Falsifiability means that a scientific idea or theory can be tested to show whether it is right or wrong.

It is important because only those theories that can be proven false by experiments are considered truly scientific. This helps separate real science from fake beliefs that cannot be tested.

**** 11. What is the basis of laser technology?**

Laser technology is based on principle of atomic physics. It is widely used in medical diagnosis and treatment, metallurgy, and space exploration.