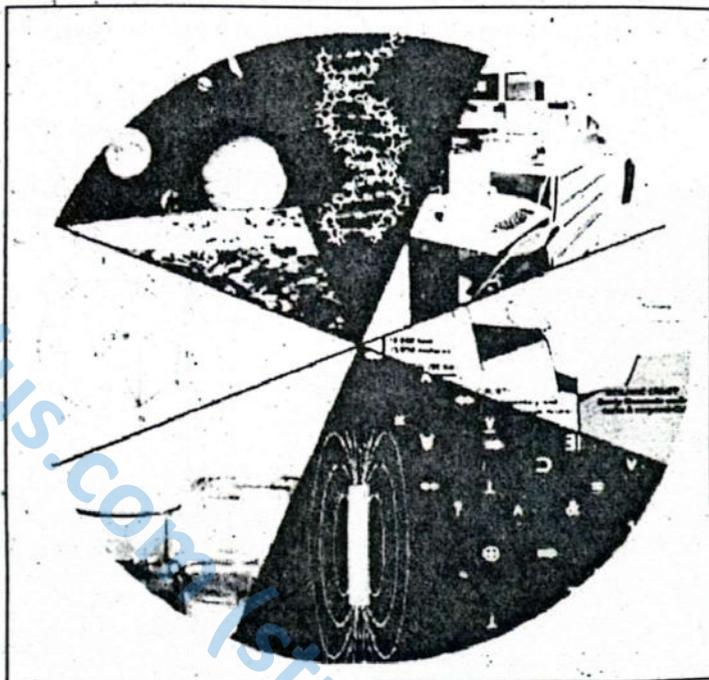


Student Learning Outcomes

After completing this chapter, students will be able to:

- Describe physics as the study of matter, energy, space, time and their mutual connections and interactions
- Explain with examples that physics has many sub-fields, and in today's world involves interdisciplinary fields. (Students should be able to distinguish in terms of the broad subject matter that is studied between the fields:

- Biophysics
- Astronomy
- Astrophysics
- Cosmology
- Thermal Physics
- Optics
- Classical Mechanics
- Quantum Mechanics
- Relativistic Mechanics
- Nuclear Physics
- Particle Physics
- Electromagnetism
- Acoustics
- Computational Physics
- Geophysics
- Climate Physics



- Explain with examples how Physics is a subset of the Physical Sciences and of the natural sciences
- Brief with examples that science is a collaborative field that requires interdisciplinary researchers working together to share knowledge and critique ideas
- Understand the terms 'hypothesis', 'theory' and 'law' in the context of research in the physics
- Explain, with examples in Physics, falsifiability as the idea that a theory is scientific only if it makes assertions that can be disproven
- Differentiate the terms 'science', 'technology' and 'engineering' with suitable examples

Subject Questions & Answers

Introduction

Q. Define science. Into how many disciplines a nature can be classified?

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

Disciplines:

The study of nature basically into two main disciplines.

- i. The biological sciences which deal with the living things.
- ii. The physical sciences which are about the study of non-living things.

Physics is an important and basic part of physical sciences beside other discipline such as chemistry and geology.

9.1

Scope of Physics

Q.1. Define Physics. What is the scope of physics in our daily life?

Ans. Physics:

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

Explanation:

It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies. We have studied some of the basic properties of matter, energy and their mutual inter-relationship. Briefly, the space is the three-dimensional extent in which all objects and events occur. It provides framework to define positions and motions of various objects under some force.

Importance of Time:

The time measures the sequence and durations of events. It is considered fourth dimension.

Oscillating motion:

For example, Oscillating motion such as that of a swinging pendulum relies on the time interval that determine frequency of oscillations.

Time dilation:

Another example is the time dilation which is a phenomenon discussed by special theory of relativity where time passes slowly for an observer moving at ultra-high speed compared to one relatively at rest.

Do You Know



This toy which worked by steam in the 3rd century was invented by Kero, from Alexandria. However, the people did not think of using such things for luxury and comfort in those days.

Fundamental concept:

Physics explores how these fundamental concepts are inter-connected.

Theory of relativity:

For example, the theory of relativity explains how space and time are not absolute quantities but are related to each other. It describes the relationship between space and time and how they are influenced by gravity and speed, for example, the bending of light around massive objects like stars.

Quantum mechanics:

Another branch of physics, the quantum mechanic, explains the behaviour of particles at the atomic and subatomic levels. It is how the physics has applied its principles to wide variety of phenomena, from everyday occurrences such as related to motion and heat to the extreme conditions found in the universe.

9.2

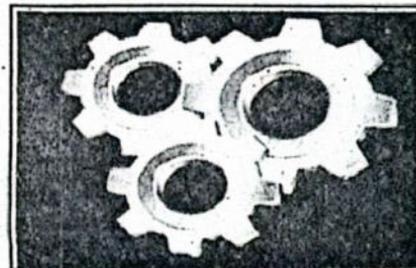
Branches of Physics

Q.2. Explain different branches of physics.

Ans. Due to expanding scope of research in Physics, it is usually divided into following branches:

1. Mechanics:

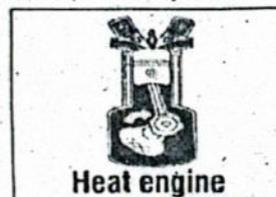
It is a study of motion and the physical effects which influence motion. It is based on Newton's laws of motion and gravitation and is often called classical mechanics.



Gears in a mechanical system

2. Heat and thermodynamics:

It deals with the thermal energy possessed by the materials and it is used when it flows from one body to another.



Heat engine

3. Acoustics:

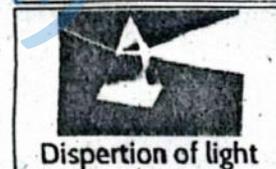
It deals with the nature and physical aspects of audible sound energy.



Pressure horn

4. Optics:

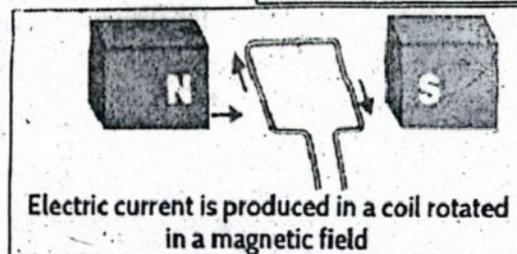
It deals with the physical aspects of visible light.



Dispersion of light

5. Electromagnetism:

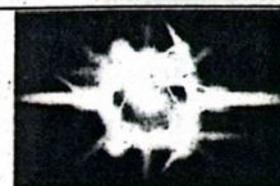
It is the study of electromagnetic phenomenon and mutual relationship between electric current and magnetic field.



Electric current is produced in a coil rotated in a magnetic field

6. Quantum Mechanics:

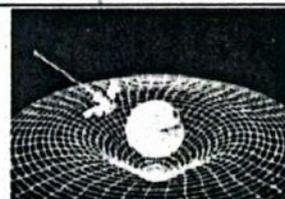
It explains the behaviour of particles at the atomic and subatomic level.



Excited states of atom

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.



Einstein view of gravity as space time curvature

8. Nuclear Physics:

It is the study of the properties of nuclei of the atoms.



Nuclear atom

9. Particle physics:

It is the study of subatomic particles and elementary particles which are basic building blocks of matter.



Einstein view of gravity as space time curvature

10. Astronomy:

It is study of distribution of celestial bodies like planets, stars and galaxies.



Extended Universe

11. Cosmology:

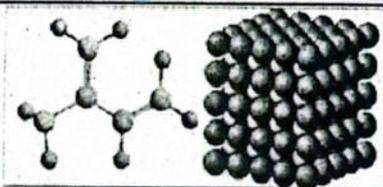
It explores the large structure and evolution of the universe.



Study of exploring universe

12. Solid State Physics:

It is the study of some specific properties of matter in solid form.



Electrical bonding of solids

Q 3. Explain how physics interact with other branches of sciences.

Ans. Physics, being fundamental science, provides essential principles, techniques and

methods that are applicable across a wide range of disciplines. Some of these are:

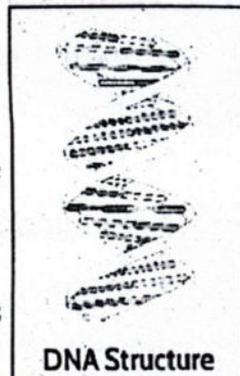
1. Biophysics
2. Medical Physics
3. Astrophysics
4. Geophysics
5. Climate Physics
6. Computation Physics

1. Biophysics:

Some biological systems and processes are described using the principles and technique of physics under this field of study.

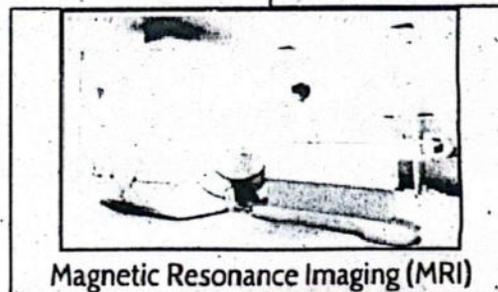
Examples:

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



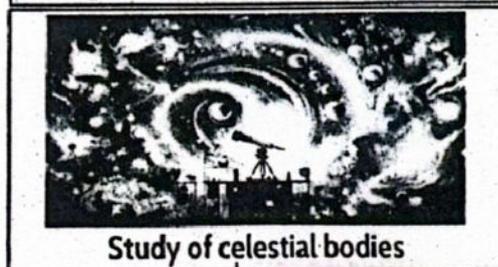
2. Medical Physics:

It applies physical principles to develop techniques and technologies for health diagnosis and treatment. The examples include imaging techniques, such as X-rays; ultra sound, MRI and CT scan and also radiation therapy for cancer treatment.



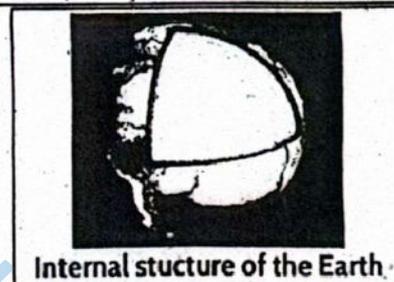
3. Astrophysics:

It deals with the physical properties and processes of celestial bodies and phenomena. For example, the interaction between the matter and energy in space to understand the universe as a whole.



4. Geophysics:

It applies physical principles to the study of internal structure of the Earth, its magnetic and gravitational fields, seismic activity (earthquake) and volcanoes etc.



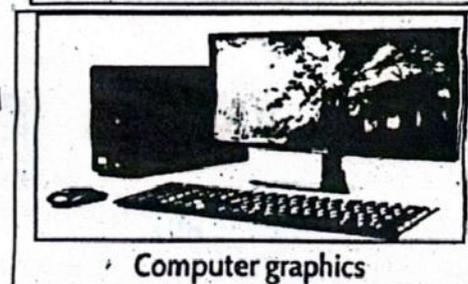
5. Climate Physics:

It includes the study of physical processes in the environment, including atmospheric dynamics, climate change and weather conditions.



6. Computation Physics:

It is about the use of computational techniques and methods to solve complex physical problems.



Q 4. What is meant by Interdisciplinary fields of physics? Give three examples.

Ans. Collaboration and interdisciplinary nature of science is essential for addressing the complex issues and challenges of today. By working together and sharing knowledge, scientists can achieve more significant breakthrough and contribute to a deeper understanding of the natural and physical world around us. It allows us to contribute to advance in technology, healthcare, environmental issues and many other areas. We need collaborated efforts because:

(i) Solution of complex issues require multifacet expertise.

Many challenging issues, such as climate change, disease prevention and treatment, sustainable energy solution are of diverse nature. It is difficult for one discipline to address them adequately. Such as understanding and mitigating climate change require knowledge for meteorology, oceanography, physics, chemistry, biological and environmental sciences. Similarly, the health care issues such as recent Covid epidemic involved combined efforts of expertise from biology, chemistry, physics, medical technologies and data science to combat this challenge.

(ii) Interdisciplinary approaches foster innovation:

Combined different perspectives and methodologies evolve innovation or out of box solutions. This approach can lead to novel insight and breakthroughs that might not emerge working in isolation. For example, nano technology is a blend of physics, chemistry, material science and engineering to create materials and devices at the nano-scale with unique applications in medical, energy and electronics. In an other field of "Artificial Intelligence" the development involves computer science, mathematical logic, neuroscience etc. The collaboration across these fields enhanced the development of intelligence systems and their applications.

(iii) Rapid sharing of knowledge and information across the globe.

Sharing and collaboration of knowledge across the globe brings rapid advances in science. The online internet information exchanges, conferences and workshops provide platforms bringing together researches from different fields to share their fresh findings, discussion and brainstorming new approaches. Collaborated research projects and research journals are also means of collaborate research.

Q 5. What is scientific method? Explain.

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

Explanation: 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.
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.

Q.6. Describes the main stages of scientific method with examples.

Ans. Some key stages are elaborated here:

1. 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 (Fig.9.1).

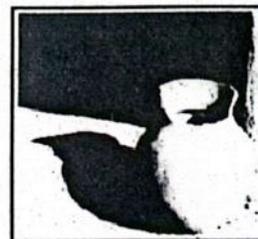


Fig. 9.1

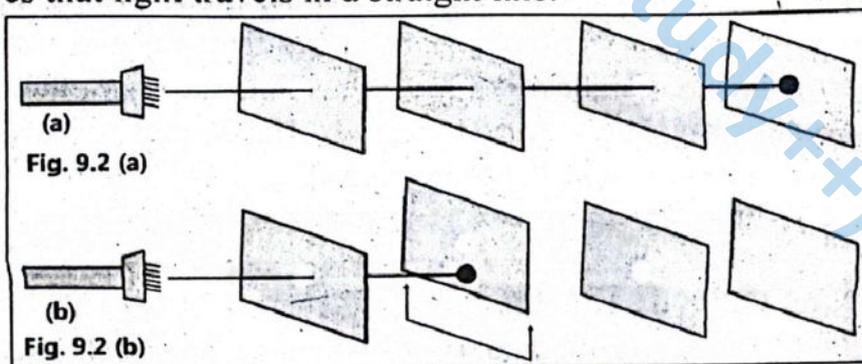
2. Hypothesis:

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.

3. 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 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. (9.2-a). If any of these cards is displaced, we cannot see light passing through. (Fig. 9.2-b). Thus, this experiment proves that light travels in a straight line.



4. 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.

5. Prediction:

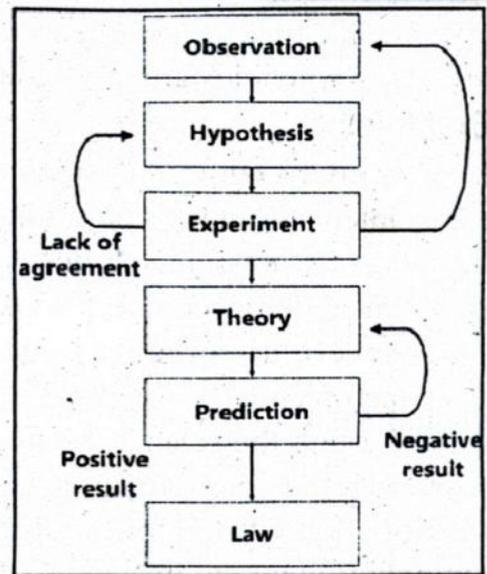
After the careful analysis of a theory, we can make predictions about certain unknown aspects of nature. To verify the prediction, experiments are designed to test the theory over and over again. If test result do not agree, hypothesis is changed or rejected.

6. 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.

7. 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.



9.6

Scientific Base of Technologies and Engineering

Q.7. How scientific base of technologies and engineering plays an important role?

Ans. Role in scientific base of technologies: Science or to be more specific, Physics plays a vital role being the core of each invention based on physical laws and principles. Technology refers to the methods and techniques developed for using scientific knowledge. It may be a machine technology or a software program of information technology.

Examples:

- 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. It is also used extensively for military purpose.

Role in 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:

- 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.

Though the science, technology and engineering fields seem distinct but 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.

Additional MCQs

1. _____ is important and basic part of Physical Sciences.
(a) Physics (b) Chemistry (c) Geology (d) all of these

9.1 Scope of Physics

2. The branch of physics which deals with the behaviour of particles at atomic and subatomic level is called _____.
(a) Biological Science (b) Physics
(c) Quantum Physics (d) Mechanic Physics

9.2 Branches of Physics

3. Into how many branches in Physics is divided?
(a) 10 (b) 12 (c) 13 (d) 11
4. The branch which is based on Newton's law and Gravitation is often called _____.
(a) Mechanics (b) Acoustics (c) Optics (d) Nuclear Physics
5. Mechanics is divided into _____ types.
(a) two (b) three (c) four (d) five
6. The branch which deals with the nature and physical aspects of audible sound energy is called _____.
(a) Optics (b) Nuclear Physics (c) Acoustics (d) Cosmology

7. The branch which deals with the Physical aspects of visible light is called _____
- (a) Cosmology (b) Optics
(c) Nuclear Physics (d) Thermodynamics
8. The study of electromagnetism phenomenon and mutual relationship between electric current and magnetic field is called _____
- (a) Astronomy (b) Cosmology
(c) Nuclear Physics (d) Electromagnetism
9. Which branch of physics explains the behaviour of particles at the atomic and subatomic level?
- (a) Relativistic Mechanics (b) Quantum Mechanics
(c) Classical Mechanics (d) None of these
10. Which branch describes the relationship between space and time and how they are influenced by gravity and speed?
- (a) Nuclear Physics (b) Astronomy
(c) Cosmology (d) Relativistic Mechanics
11. The study of properties of nuclei of the atoms is called _____
- (a) Astronomy (b) Nuclear Physics
(c) Cosmology (d) Particle Physics
12. The study of subatomic particles and elementary particles which are basic building blocks of matter is called _____
- (a) Particle Physics (b) Nuclear Physics
(c) Astronomy (d) Cosmology
13. The study of distribution of celestial bodies like planets, stars, and galaxies is called _____
- (a) Cosmology (b) Mechanics
(c) Astronomy (d) Particle Physics
14. Which branch explores the large structure and evolution of the universe?
- (a) Cosmology (b) Particle
(c) Nuclear Physics (d) Astronomy

9.3

Interdisciplinary Nature of Physics

15. Which techniques are used in Medical Physics?
- (a) X-Rays (b) MRI (c) CT scan (d) All of these
16. How many disciplines nature of physics have?
- (a) Two (b) Three (c) Five (d) Six
17. The study of internal structure of the Earth, is magnetic and gravitational fields, seismic activity and volcanoes etc is called _____
- (a) Geophysics (b) Biophysics (c) Medical Physics (d) Astronomy
18. The study of climate change and weather conditions is called _____
- (a) Computation Physics (b) Biophysics
(c) Climate Physics (d) Geophysics

19. Techniques and methods to solve complex physical problems is called _____
(a) Geophysics (b) Computation Physics
(c) Climate Physics (d) Biophysics

9.4 Interdisciplinary Research

20. Understanding and mitigating climate change requires knowledge of _____
(a) Meteorology (b) Oceanography
(c) Chemistry (d) All of these

9.5 Scientific Method

21. Who presented the theory of relativity?
(a) Newton (b) Albert Einstein (c) J.J Thomson (d) Goldstein
22. The first step in scientific method is:
(a) Experiment (b) Hypothesis (c) Observation (d) Prediction
23. How many steps does scientific method have?
(a) Two (b) Five (c) Six (d) Three
24. In scientific method, if predictions that can be tested and potentially proven false is known as:
(a) Hypothesis (b) Falsifiability (c) Observations (d) Prediction
25. After the careful analysis of a theory we can make:
(a) Hypothesis (b) Observation (c) Prediction (d) Experiment
26. If test result do not agree, hypothesis is:
(a) Rejected (b) Changed (c) Accepted (d) Both a and b
27. In which century, Albert Einstein declared that mass and energy, the two concerns of Physics, are forms of each other?
(a) 18th (b) 19th (c) 20th (d) 21st

ANSWERS:

- | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (c) | 3. (b) | 4. (a) | 5. (a) | 6. (c) | 7. (b) |
| 8. (d) | 9. (b) | 10. (d) | 11. (b) | 12. (a) | 13. (c) | 14. (a) |
| 15. (d) | 16. (d) | 17. (a) | 18. (c) | 19. (b) | 20. (d) | 21. (b) |
| 22. (c) | 23. (c) | 24. (b) | 25. (c) | 26. (d) | 27. (c) | |

Conceptual MCQs

1. Mechanics is based on:
(a) Newton's law of motion (b) Gravitation
(c) Both a and b (d) Heat energy
2. Artificial Intelligence involved which fields?
(a) Computer science (b) Mathematical logic
(c) Neuroscience (d) All of these

3. **Successful verification of an assumption with the help of experimentation, it becomes.**
(a) Prediction (b) Hypothesis (c) Law (d) Theory
4. **When a theory has been tested many times, it becomes:**
(a) Hypothesis (b) Law (c) Experimentation (d) Observation
5. **Moving magnet produces:**
(a) Light (b) Heat (c) Current (d) Steam
6. **Solution of complex issues requires:**
(a) Experimentation (b) Deep study
(c) Multifactor expertise (d) Collaboration
7. **Combat against Covid epidemic involved:**
(a) Multifacet expertise (b) Collaboration
(c) Innovation (d) Sharing of knowledge
8. **$E = mc^2$ the equation deals with:**
(a) Theory of relativity (b) Theory of Big Bang
(c) Theory of cyclic model (d) Theory of static
9. **Which of the following best describes the nature of scientific knowledge?**
(a) Absolute and unchangeable (b) Tentative and subject to revision
(c) Based on personal opinions (d) Determined solely by cultural values
10. **A hypothesis in science is"**
(a) A proven fact (b) An untestable guess
(c) A tentative explanation that can be tested
(d) A theory that has been confirmed
11. **Science is limited to studying phenomena that are:**
(a) Observable and measurable (b) Controlled by humans
(c) Philosophical in nature (d) Proven beyond doubt
12. **Which of the following is not a characteristic of scientific theories?**
(a) They are based on evidence.
(b) They can be disproved with new evidence.
(c) They are guesses without supporting evidence.
(d) They provide explanations for natural phenomena.
13. **The process of peer review in science ensures that:**
(a) Scientific ideas are always correct. (b) Scientists agree with one another.
(c) All experiments produce the same results.
(d) Research is evaluated for quality and validity by other experts.
14. **What role does mathematics play in Physics?**
(a) It is unrelated to the study of physical phenomena.
(b) It serves as a language to describe and quantify physical laws and relationships
(c) It is only used to validate theories
(d) It replaces experimental observations.
15. **Which of the following is a valid reason for rejecting a scientific theory?**
(a) It disagrees with common sense.

- (b) It is inconsistent with new experimental evidence
(c) It has been around for a long time (d) It is too complex to understand

ANSWERS:

1. (c) 2. (d) 3. (d) 4. (b) 5. (c) 6. (c) 7. (a)
8. (a) 9. (b) 10. (c) 11. (a) 12. (c) 13. (d) 14. (b)
15. (b)

Additional Short Questions

1. What is science (Natural Philosophy)? Write the types of Science.

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

Classification: The study of nature is basically into two main parts.

- (i) The biological sciences which deal with the living things.
(ii) The physical sciences which are about the study of non-living things.

9.1 Scope of Physics

2. Define physics. Name some branches of it.

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

Branches of Physics.

- (i) Mechanics (ii) Optics (iii) Electromagnetism

3. What is the theory of relativity?

Ans. Relativity is a theory formulated by Albert Einstein, which states that space and time are relative and all motion must be relative to a frame of reference.

4. Define quantum mechanics.

Ans. The quantum mechanics is the branch of Physics which explains the behavior of particles at the atomic and subatomic levels.

9.2 Branches of Physics

5. Define Mechanics.

Ans. 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.

6. Define acoustics.

Ans. It deals with the nature and physical aspects of audible sound energy. The wide range of applications of sound properties are studied in the field of acoustics.

7. Differentiate between Quantum mechanics and Relativistic Mechanics.

Ans.	Quantum Mechanics	Relativistic Mechanics
	It explains the behaviour of particles at the atomic and subatomic level.	It explain 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. Differentiate between Nuclear Physics and Particle Physics.

Ans.	Nuclear Physics	Particle Physics
	It is the study of the properties of nuclei of the atoms.	It is the study of subatomic particles and elementary particles which are basic building blocks of matter.

9. How do Astronomy and Cosmology differ from each other?

Ans.	Astronomy	Cosmology
	It is study of distribution of celestial bodies like planets, stars and galaxies.	It explores the large structure and evolution of the universe.

9.3 Interdisciplinary Nature of Physics

10. Define geophysics.

Ans. It applies physical principle to the study of internal structure of the Earth, its magnetic and gravitational fields, seismic activity (earthquake) and volcanoes etc.

11. Differentiate between biophysics and medical Physics.

Ans.	Biophysics	Medical Physics
	Some biological systems and processes are described using the principles and technique of physics, under this field of Study. Examples include the mechanics of biological structures, physical properties of cells, tissues and organs.	It applies physical principles to develop techniques and technologies for health diagnosis and treatment. The examples include imaging techniques, such as X-rays; ultra sound, MRI and CT scan and also radiation therapy for cancer treatment.

12. How physics helps to understand the relation between matter and energy?

Ans. It deals with the physical properties and processes of celestial bodies and phenomena. For example, the interaction between the matter and energy in space to understand the universe as a whole.

9.4 Interdisciplinary Research

13. Define nanotechnology.

Ans. Nanotechnology is a blend of physics, chemistry, material science and engineering to create materials and devices at the nano-scale with unique applications in medical, energy and electronics.

14. What is hypothesis? Give an example.

Ans. 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.

For 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.

15. Differentiate the form, Science, technology and engineering with examples.

(1) Science (2) Technology (3) Engineering

Ans. (1) Science: Science is a collective knowledge about the natural Phenomena, processes and events occurring around us.

(2) Technology: Technology refers to the methods and techniques developed for using scientific knowledge.

(3) 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.

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.

16. List few examples of technology.

Ans. 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. It is also used extensively for military purpose.

Conceptual Short Questions

1. How gravitational force plays a vital role?

Ans. Following are the key roles which gravitational force plays.

(i) The revolving of Earth around the sun

(ii) The revolving of moon around the earth

(iii) It keeps the atmosphere and oceans fixed to the surface of the Earth.

2. Why study of basic interaction of nature is necessary?

Ans. Study of interactions among matter energy, space and time give us basic understanding of forces and fields that governs the universe.

3. Why bodies fall downward on Earth?

Ans. That is because of gravitational force.

4. Why atomic nuclear resides in an atom?

Ans. It holds the atomic nuclei together by binding the protons and neutrons in the nucleus over coming repulsive electromagnetic force between positively charged protons. It is also a short-range force with the order of 10^{-14}m .

5. How different fields collaborate to enhance the development of Artificial Intelligence?

Ans. "Artificial Intelligence" the development involves computer science, mathematical logic, neuroscience etc. The collaboration across these fields enhanced the development of intelligence systems and their applications.

Exercise Questions

A Multiple Choice Questions

Tick (✓) the correct answer:

- 9.1. Physics is a branch of:
(a) social science (b) life science
(c) physical science (d) biological science
- 9.2. Which branch of science plays vital role in technology and engineering?
(a) Biology (b) Chemistry (c) Geology (d) Physics
- 9.3. Automobile technology is based on:
(a) acoustics (b) electromagnetism
(c) optics (d) thermodynamics
- 9.4. A user friendly software application of smart phone use:
(a) laser technology (b) information technology
(c) medical technology (d) electronic technology
- 9.5. The working of refrigeration and air conditioning involves:
(a) electromagnetism (b) mechanics
(c) climate science (d) thermodynamics
- 9.6. What is the ultimate truth of a scientific method?
(a) Hypothesis (b) Experimentation (c) Theory (d) Law
- 9.7. The statement "If I do not study for this test, then I will not get good grade" is an example of:
(a) theory (b) observation (c) prediction (d) law
- 9.8. Which of the following are methods of investigation?
(a) Observation (b) Experimentation (c) Research (d) All of these
- 9.9. A hypothesis:
(a) may or may not be testable (b) is supported by evidence
(c) is a possible answer to a question (d) all of these
- 9.10. A graph of an organized data is an example of:
(a) collecting data (b) forming a hypothesis
(c) asking question (d) analyzing data
- 9.11. The colour of a door is brown. It is an example of:
(a) observation (b) hypothesis (c) prediction (d) law

Answers:

1. (c) 2. (d) 3. (d) 4. (b) 5. (d) 6. (d) 7. (c)
8. (d) 9. (c) 10. (d) 11. (a)

B Short Answer Questions

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

Ans. Science: Science is a collective knowledge about the natural phenomena, processes

and events occurring around us.

Classification: The study of nature basically into two main part.

- (i) The biological sciences which deal with the living things.
- (ii) The physical sciences which are about the study of non-living things.

9.2 What is physics all about? Name some of its branches.

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

- (i) Mechanics
- (ii) Optics
- (iii) Nuclear physics

Explanation: It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies.

9.3 What is meant by interdisciplinary fields? Give a few examples.

Ans. Interdisciplinary fields combine knowledge and methods from multiple disciplines to solve complex problems.

Examples include biophysics (biology and physics), astrobiology (astronomy and biology), environmental science (biology, chemistry, geology), etc.

9.4 List the main steps of scientific method.

Ans. The main steps of the scientific method are observation, question, hypothesis, prediction, experiment, analysis, conclusion and communication.

9.5 What is a hypothesis? Give one example.

Ans. 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,

For 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.

9.6 Distinguish between a theory and a law of physics.

Ans. After the successful verification of an assumption and with the help of careful experimentation, it becomes a theory and is applicable to similar phenomena.

When a theory has been tested many times and generally accepted as true, it is called a law.

9.7 What is the basis of laser technology?

Ans. 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. It is also used extensively for military purpose.

9.8 What is falsifiability concept? How is it important?

Ans. Falsifiability: It is a concept introduced that suggests a theory to be considered scientific if it also make 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.

Importance: It distinguishes scientific theories from false or pretended beliefs that cannot be experimentally tested.

9.1 Is the theory of science an ultimate truth? Describe briefly.

Ans. No, the theory of science is not the ultimate truth. Scientific theories are based on current evidence and understanding, but they are subject to revision or replacement as new data or better explanations emerge as new discoveries are made, and theories are refined to better explain observations and phenomena.

9.2 Do you think that the existing laws of nature may need a change in future? Describe briefly.

Ans. Yes, the laws of nature may need to be revised in the future. Current laws are based on existing evidence, but new discoveries could reveal situations where these laws don't fully apply, as seen with quantum mechanics and general relativity. Science involves and our understanding may change over time.

9.3 Describe three jobs that need the use of scientific knowledge.

Ans. 1. Medical Scientist: Conducts research to improve health care develop new treatments, and understand diseases.

2. Environmental Scientist: Studies the environment and works on solutions to protect natural resources and address issues like pollution and climate change.

3. Forensic scientist: Uses scientific techniques to analyze evidence from crime scenes helping solve criminal cases.

9.4 Describe when a theory is rejected or needs its modification.

Ans. A theory is rejected or needs modification when new evidence contradicts its predictions, or it fails to explain. Certain phenomena or observations that arise. If a theory cannot accommodate new findings or better explanations are developed, it may be revised or replaced.

9.5 Comment on the statement. "A theory is capable of being proved right but not being proved wrong is not a scientific theory".

Ans. The statement is incorrect. A scientific theory must be testable and falsifiable meaning it must be capable of being proven wrong. If a theory can't be disproven, it isn't a valid scientific theory.

9.6 What has been the general reaction to new ideas about established truths?

Ans. New ideas about established truths are often met with skepticism and resistance. Over time, if supported by evidence, they may be accepted, leading to a shift in understanding. However, this process usually occurs gradually.

9.7 If a hypothesis is not testable, is the hypothesis wrong? Explain.

Ans. The hypothesis is not "wrong" if it is not testable, but it is not scientifically useful. Science relies on testable hypotheses to gather evidence and draw conclusions. If a hypothesis cannot be tested or falsified it cannot be proven true or false, making it outside the realm of scientific inquiry.

9.8 Explain how a small amount of data cannot prove that a prediction is always correct but can prove it is not always correct.

Ans. A small amount of data can't prove a prediction is always correct, as it may not cover all scenarios. However, it can show the prediction is not always correct if even one instance contradicts it. More data is needed to prove a prediction true in all cases.

9.9 What is the relationship between an experiment and a hypothesis?

Ans. An experiment tests a hypothesis. The hypothesis is a prediction or explanation that can be tested through experimentation. The experiment collects data to confirm or refute the hypothesis, helping to determine whether (if) it is supported by evidence.

9.10 Describe why the solution of complex problems need interdisciplinary research and collaboration.

Ans. Complex problems often involve multiple factors across different fields, such as science, technology and social aspects. Interdisciplinary research and collaboration bring together expertise from various disciplines, allowing for a more comprehensive understanding and effective solutions. By combining diverse perspectives and knowledge interdisciplinary teams can tackle problems more holistically and develop innovative approaches that wouldn't be possible within a single field.

D Comprehensive Questions

9.1 What are the main branches of physics? State briefly.

Ans. For answer see Q # 2

9.2 What is meant by interdisciplinary fields of physics? Give three examples.

Ans. For answer see Q # 4

9.3 What is scientific method? Describe its main steps with examples.

Ans. For answer see Q # 5

9.4 Differentiate the terms, science, technology and engineering with examples.

Ans. For answer see Q # 7

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

Ans. For answer see Q # 1

