9 CHAPTER

NATURE OF SCIENCE

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SCIENCE

SHORT QUESTIONS

Q.1 Define science? Describe its brief history.

SCIENCE

Definition:

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

Explanation:

Science is to know about everything in nature. Science is the study of physical nature and its aspects. It contains imagination, experimentation and deduction." Humans has been gained knowledge about Science through experiments, observations and trials conducted on the surrounding matters. The organized knowledge collected through several sources has formed a huge pool, which is so vast today that it has been divided into many branches.

Q.2 Define natural philosophy and write its branches.

Ans: **Natural Philosophy:**

Such study of nature gave birth to a single discipline, known as Natural Philosophy now known as science.

(i) Biological Sciences:

"The study of life is referred to as the biological sciences."

Example:

It includes branches like Botany, Zoology, Genetics, Medicine etc.

(ii) Physical Sciences:

"The science about the study of non-living objects is referred to as the physical sciences."

Example:

It majorly includes the branches like Physics, Chemistry, Geology, Geography etc. In this book we will see the impact that physics will have on our life and career.

9.1 SCOPE OF PHYSICS

LONG QUESTIONS

Q.1 Define Physics. Describe the scope of physics in our daily life.

PHYSICS

Definition:

"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."

SCOPE

It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies. We will discuss in detail the concept of space and time in the higher classes.

Third Dimension:

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.

Fourth Dimension:

The time measures the sequence and durations of events. It is considered fourth dimension. For example, oscillating motion such as that of a swinging pendulum relies on the time interval that determine frequency of oscillations.

Theory of Relativity:

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. Physics explores how these fundamental concepts are interconnected. For example, the theory of relativity explains how space and time are not absolute quantities but is 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 mechanics, explains the behavior 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.1 Write a note on Branches of Physics.

Ans:

BRANCHES OF PHYSICS

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

- ***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.*
- ***Heat and thermo dynamics:*** *It deal with the thermal energy possessed by the materials and it is used when it flows from one body to another.*
- ***Acoustics:*** *It deals with the nature and physical aspects of audible sound energy.*
- ***Optics:*** *It deals with the physical aspects of visible light.*
- ***Electromagnetism:*** *It is the study of electromagnetic phenomenon and mutual relationship between electric current and magnetic field.*
- ***Quantum Mechanics:*** *It explains the behavior of particles at the atomic and sub atomic level.*
- ***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.*
- ***Nuclear Physics:*** *It is the study of the properties of nuclei of the atoms.*
- ***Particle Physics:*** *It is the study of subatomic particles and elementary particles which are basic building blocks of matter.*
- ***Astronomy:*** *It is study of distribution of celestial bodies like planets, stars and galaxies.*
- ***Cosmology:*** *It explores the large structure and evolution of the universe.*
- ***Solid State Physics:*** *It is the study of some specific properties of matter in solid form.*

9.4 INTERDISCIPLINARY NATURE OF PHYSICS

LONG QUESTIONS

Q.1 Discuss the different field of physics.

Ans:

DIFFERENT FIELD OF PHYSICS

It 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:

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.

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.

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.

GEOPHYSICS:

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

CLIMATE PHYSICS:

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

COMPUTATION PHYSICS:

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

INTER DISCIPLINARY RESEARCH:

Q.1 What is the Role of Interdisciplinary research in the development of science?

Ans: ROLE OF INTERDISCIPLINARY RESEARCH

Collaboration and interdisciplinary nature of science is essential for addressing the complex issues and challenges of today. By working together and sharing knowledge, scientist 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 requires multi facet 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 note merge 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 another 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 researchers 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.

Interdisciplinary research and collaboration leads to a more holistic understanding of challenging issues by interacting with different perspectives such as that of environment and space exploration.

9.5 SCIENTIFIC METHOD

LONG QUESTION

Q.1 Discuss in detail the Scientific Method:

Ans: SCIENTIFIC METHOD

Introduction:

Scientific method is a systematic approach used to search for truth of an issue and problem solving regarding natural and physical world. It is based on the following steps.

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

Some key steps are elaborated here.

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.

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.

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. If any of these cards is displaced, we cannot see light passing through. Thus, this experiment proves that light travels in a straight line.

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.

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.

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.

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 behavior 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.

The theories or laws of physics are manmade 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.

9.6 SCIENTIFIC BASE OF TECHNOLOGIES AND ENGINEERING

LONG QUESTION

Q.1 Write a note on scientific base of Technologies and Engineering.

Ans: **Introduction:**

Technology:

Technology refers to the methods and techniques developed by using scientific knowledge. It may be a machine technology or a software program of information technology. Science or to be more specific, physics plays a vital role being the core of each invention based on physical laws and principles.

For example:

- *Automobile technology is based on the principles of the thermodynamics.*
- *Radar technology is based on the detection and reflection principles of electromagnetic waves.*
- *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:

Definition:

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:

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

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.

SUMMARY

Physics	Physics is the branch of science that describes the matter, energy and their mutual relationship.
Hypothesis	A hypothesis is a tentative assumption or explanation made before any research that can be verified by further investigation.
Theory	A theory explains how nature behaves under specific conditions.
Law	A law is a statement that summarises an observed regularity or pattern in nature and gives the relationship between variables.
Technology	Technology is tools, including methods, that assist people in accomplishing tasks.
Engineering	Engineering is the process of studying and developing technology.

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

Q.1 Choose the best possible option.

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 test able *(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

12. ***The colour of a door is brown. It is an example of:***

(a) observation (b) hypothesis

(c) prediction (d) law

SHORT ANSWER QUESTIONS

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

Ans: **Definition:**

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

Natural Philosophy:

Such study of nature gave birth to a single discipline, known as Natural Philosophy now known as science.

(i) **Biological Sciences:**

"The study of life is referred to as the biological sciences."

Example:

It includes branches like Botany, Zoology, Genetics, Medicine etc.

(ii) **Physical Sciences:**

"The science about the study of non-living objects is referred to as the physical sciences."

Example:

It majorly includes the branches like Physics, Chemistry, Geology, Geography etc. In this book we will see the impact that physics will have on our life and career.

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

Ans: **PHYSICS**

Definition:

"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."

SCOPE

It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies. We will discuss in detail the concept of space and time in the higher classes.

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

Ans: **INTERDISCIPLINARY FIELDS OF PHYSICS**

It 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:

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.

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.

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.

GEOPHYSICS:

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

CLIMATE PHYSICS:

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

COMPUTATION PHYSICS:

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

9.4 List the main steps of scientific method.

Ans: Main steps of a scientific method are:

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

9.5 What is a hypothesis? Give an 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, 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.

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.

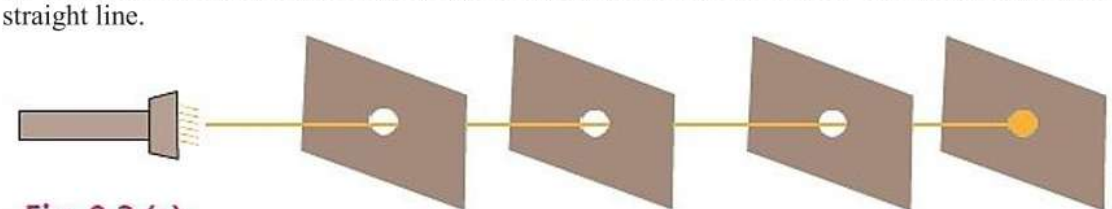

Fig. 9.2 (a)

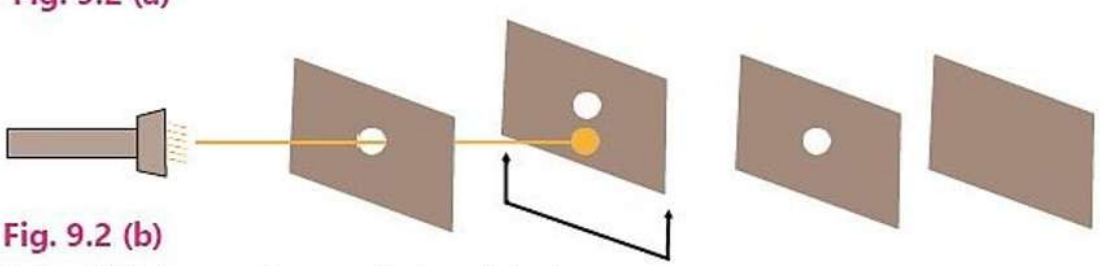

Fig. 9.2 (b)

9.6 Distinguish between a theory and a law of physics.

Ans: **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.

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 behavior 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.

The theories or laws of physics are manmade 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.

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

Ans: **SCIENCE**

Definition:

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

Explanation:

Science is to know about everything in nature. Science is the study of physical nature and its aspects. It contains imagination, experimentation and deduction." Humans has been gained knowledge about Science through experiments, observations and trials conducted on the surrounding matters. The organized knowledge collected through several sources has formed a huge pool, which is so vast today that it has been divided into many branches.

Technology:

Technology refers to the methods and techniques developed by using scientific knowledge. It may be a machine technology or a software program of information technology. Science or to be more specific, physics plays a vital role being the core of each invention based on physical laws and principles.

For example:

- *Automobile technology is based on the principles of the thermodynamics.*
- *Radar technology is based on the detection and reflection principles of electromagnetic waves.*
- *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:

Definition:

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:

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

9.8 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.

9.9 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 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.

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

Ans:

SCOPE

It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies. We will discuss in detail the concept of space and time in the higher classes.

Third Dimension:

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.

Fourth Dimension:

The time measures the sequence and durations of events. It is considered fourth dimension. For example, oscillating motion such as that of a swinging pendulum relies on the time interval that determine frequency of oscillations.

CONSTRUCTED RESPONSE QUESTIONS

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

Ans: The theory of science is not considered an ultimate truth. Instead, it is a framework for understanding the natural world based on evidence, experimentation, and reasoning. Science is constantly evolving as new information and discoveries emerge. Scientific theories are often revised or replaced as our understanding deepens or as new technologies and methods allow us to observe the world in ways we couldn't before. Therefore, science is more about developing the best possible understanding of reality, subject to change as we learn more, rather than providing an absolute or ultimate truth.

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

Ans: Yes, it's possible that the existing laws of nature may need to be adjusted or refined in the future. While the laws we have, such as Newton's laws of motion or the laws of thermodynamics, have been extremely successful in explaining many phenomena, they are not considered complete. For example, quantum mechanics and general relativity are both incredibly accurate in their respective domains, but they are not fully compatible with each other. New discoveries or insights, like those in particle physics or cosmology, could reveal deeper layers of reality that might require a revision of our current laws, or even a unification of existing theories. Science is always open to new evidence, and as we expand our understanding, it's possible that our conception of nature's laws could change.

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

Ans: *Here are three jobs that rely on scientific knowledge:*

- ***Medical Doctor****: Medical doctors use scientific knowledge to diagnose, treat, and prevent illnesses. They rely on biology, chemistry, and physics to understand the human body, prescribe medications, and recommend treatments based on scientific research and evidence.*
- ***Environmental Scientist****: Environmental scientists use scientific principles to study and solve environmental issues. They apply knowledge from biology, chemistry, and earth science to analyze pollution, climate change, and conservation efforts, working to protect ecosystems and public health.*
- ***Engineer****: Engineers apply scientific principles to design, build, and improve structures, machines, and technology. Whether they specialize in civil, mechanical, electrical, or aerospace engineering, they use physics, mathematics, and material science to solve problems and innovate in various fields like construction, transportation, and electronics.*

9.2 Describe when a theory is rejected or need its modification?

Ans: A theory is typically rejected or modified when new evidence or observations contradict its predictions or fail to support it.

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

Ans: A theory that cannot be proven wrong is not scientific because it does not allow for testing or challenging in a meaningful way. For example, if a theory is framed in such a way that no observation or experiment could ever contradict it, then it isn't open to the scrutiny that defines scientific inquiry.

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

Ans: The general reaction to new ideas about established truths is often a complex process of resistance, testing, and, if the evidence is compelling, eventual integration into the accepted scientific framework. This is a fundamental part of how science evolves and refines its understanding of the world.

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

Ans: *A hypothesis that is not testable is not necessarily "wrong," but it is not scientifically useful. For a hypothesis to be meaningful in the context of scientific inquiry, it must be testable—which means that it must be possible to design an experiment or make observations that could potentially support or contradict it. If a hypothesis is untestable, it cannot be examined through empirical evidence, and therefore, it cannot be evaluated scientifically. This does not mean the hypothesis is wrong—it may simply be outside the scope of current scientific methods, or it may deal with concepts that cannot be measured or observed directly.*

9.2.4 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 sample can provide a clear example where a prediction fails, but it can't provide definitive proof that the prediction is always true, because it doesn't account for all possibilities or variations.

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

Ans: The hypothesis guides the design of the experiment, and the experiment provides the data to evaluate the hypothesis. Together, they form a cycle of testing, learning, and refining scientific knowledge.

9.2.6 Describe why the solution of complex problems need interdisciplinary research and collaboration?

Ans: Solving complex problems is rarely the work of a single field. By bringing together different perspectives and expertise, interdisciplinary research and collaboration help address the full scope of the issue, leading to more effective, innovative, and sustainable solutions.

COMPREHENSIVE QUESTIONS

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

Ans: **SCOPE**

It strives to understand how the universe works, from the smallest subatomic particles to the largest star and galaxies. We will discuss in detail the concept of space and time in the higher classes.

Third Dimension:

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.

Fourth Dimension:

The time measures the sequence and durations of events. It is considered fourth dimension. For example, oscillating motion such as that of a swinging pendulum relies on the time interval that determine frequency of oscillations.

Theory of Relativity:

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. Physics explores how these fundamental concepts are interconnected. For example, the theory of relativity explains how space and time are not absolute quantities but is 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 mechanics, explains the behavior 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.

BRANCHES OF PHYSICS

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

- ***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.*
- ***Heat and thermo dynamics:*** *It deal with the thermal energy possessed by the materials and it is used when it flows from one body to another.*
- ***Acoustics:*** *It deals with the nature and physical aspects of audible sound energy.*
- ***Optics:*** *It deals with the physical aspects of visible light.*
- ***Electromagnetism:*** *It is the study of electromagnetic phenomenon and mutual relationship between electric current and magnetic field.*
- ***Quantum Mechanics:*** *It explains the behavior of particles at the atomic and sub atomic level.*
- ***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.*
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- ***Cosmology:*** *It explores the large structure and evolution of the universe.*
- ***Solid State Physics:*** *It is the study of some specific properties of matter in solid* form.

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

Ans: It 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:

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.

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.

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.

GEOPHYSICS:

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

CLIMATE PHYSICS:

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

COMPUTATION PHYSICS:

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

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

Ans: **SCIENTIFIC METHOD**

Introduction:

Scientific method is a systematic approach used to search for truth of an issue and problem solving regarding natural and physical world. It is based on the following steps.

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

Some key steps are elaborated here.

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.

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.

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. If any of these cards is displaced, we cannot see light passing through. Thus, this experiment proves that light travels in a straight line.

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.

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.

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.

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 behavior 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.

The theories or laws of physics are manmade 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.

TEXT BOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

ANSWER KEY

1	2	3	4	5	6	7	8	9	10	11
C	D	D	B	D	D	C	D	D	D	A