

CLASS-XI
SUBJECT-PHYSICS

Chapter -1
Physical World

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1. GIST OF PHYSICAL WORLD

SCIENCE

Science is the systematized and organized knowledge about the various natural phenomena which is obtained by careful experimentation, keen observation, and accurate reasoning. It has two main branches

- Physical science
- Biological science

PHYSICS

The word physics comes from a Greek word which means nature. Physics is the study of the natural laws and their manifestation in the natural phenomena. It deals with the concept of space, time, motion, matter, energy, radiation, etc.

SCIENTIFIC ATTITUDE

Scientific attitude requires a flexible, open-minded approach towards solving problems in which other important points of view are not neglected.

SCIENTIFIC METHOD

The step by step approach used by a scientist in studying natural phenomena and establishing laws which govern these phenomena, is called scientific method. It involves the steps like

- I. experimentation and observation
- II. formation of hypothesis
- III. verification of hypothesis
- IV. theoretical predictions

SCIENTIFIC THEORY

Theory is the name given to a set of a limited number of laws in terms of which the behavior of a physical system can be explained.

Physics is an exact science it is because of high precision and accuracy obtainable in the measurement of physical quantities.

Physics is a basic science because of its important role played in the development of life science, medicine, technology and industry, physics is considered as the most basic of all sciences.

Mathematics has proved to be the most important tool in the development of physics.

Mechanics it deals with the slow motion or equilibrium of material bodies.

Optics it deals with the nature and propagation of light.

Thermodynamics it deals with the change in internal energy, temperature, entropy at etc, of the macroscopic systems through external work and heat

Electrodynamics it deals with electric and magnetic phenomena associated with charged and magnetic bodies.

Quantum mechanics it deals with the mechanical behavior of atoms, molecules and nuclei.

Relativity it deals with the particles having speeds comparable to the speed of light. It is the theory of invariance in nature.

Physics, technology and society sometimes physics generates new technology at other times technology gives rise to new physics. Both have a direct impact on society

Scope of physics It the scope of physics is truly vast. It covers a wide range of magnitudes of physical quantities such as mass, length, time and energy.

Basic quest of physics (i) unification (ii) reductionism

Fundamental forces in nature there are four fundamental forces:

- (i) Gravitational force
- (ii) Electromagnetic force
- (iii) Strong nuclear force
- (iv) Weak nuclear force

Law of conservation of energy it states that the total energy of an isolated system remains constant it follows from the nature's symmetry called homogeneity of time.

Law of conservation of linear momentum it states that if no external force acts on a system, then its total linear momentum remains constant. It follows from nature's symmetry called homogeneity of space.

Law of conservation of angular momentum it states that if no external torque acts on a system, then its angular momentum remains constant. It follows from nature's symmetry called isotropy of space.

Law of conservation of charge it states that the total charge of an isolated system remains constant.

2. NOTES ON PHYSICAL WORLD

Science and its origin

Science is a systematic understanding of natural phenomena in detail so that it can be predicted, controlled and modified. Science involves exploring, experimenting and speculating phenomena happening around us.

- The word Science is derived from a latin verb Scientia meaning ‘to know’.
- Scientific method is a way to gain knowledge in a systematic and in-depth way. It involves:
 - a) Systematic observations
 - b) Controlled experiments
 - c) Qualitative and Quantitative reasoning
 - d) Mathematical modeling
 - e) Prediction and verification (or falsification) of theories
 - f) Speculation or Prediction
- Science does not have any final theory. The improved observations, accurate tools keep improving the knowledge and perspective. Johannes Kepler used Tycho Brahe’s research on planetary motion to improve Nicolas Copernicus theory.
- Quantum mechanics was developed to deal with atomic and nuclear phenomena. Work of Ernest Rutherford on nuclear model of atom became basis of quantum theory given by Niels Bohr. Antiparticle theory of Paul Dirac led to the discovery of anti-electron (positron) by Carl Anderson.

Natural Sciences

Natural science is a branch of science concerned with the description, prediction, and Understanding of natural phenomena, based on observational and empirical evidence. It consists of following disciplines:

- Physics
- Chemistry
- Biology

Physics

Physics is a study of basic laws of nature and their manifestation in different natural phenomena. Physics is the study of physical world and matter and its motion through space and time, along with related concepts such as energy and force.

- Word Physics is derived from a Greek word phusiké meaning nature.
- Two principal types of approaches in Physics are:

1. Unification: This approach considers all of the world’s phenomena as a collection of universal laws indifferent domains and conditions. Example, law of gravitation applies both

to a falling apple from a tree as well as motion of planets around the sun. Electromagnetism laws govern all electric and magnetic phenomena.

2. Reduction: This approach is to derive properties of complex systems from the properties and interaction of its constituent parts. Example, temperature studied under thermodynamics is also related to average kinetic energy of molecules in a system (kinetic theory).

Impact and uses of Physics:

- It can explain a phenomena happening over a large magnitude with a simple theory.
- Experiments and observations are used to develop new theories for unidentified phenomena and improve old theories for existing phenomena.
- Development of devices using laws of physics.

Scope of Physics

Scope of Physics is vast as it covers quantities with length magnitude as high as 10^{40} m or more (astronomical studies of universe) and as low as 10^{-14} m or less (study of electrons, protons etc). Similarly the range of time scale goes from 10^{-22} s to 10^{18} s and mass from 10^{-30} kg to 10^{55} kg. Physics is broadly divided into two types based on its scope - Classical Physics and Modern Physics. Classical physics deal with the macroscopic phenomena while the modern physics deals with the microscopic phenomena.

Macroscopic Domain

Macroscopic domain includes phenomena at large scales like laboratory, terrestrial and astronomical. It includes following subjects:

1. Mechanics – It is based on Newton's laws on motion and the laws of gravitation. It is concerned with motion/equilibrium of particles, rigid and deformable bodies and general system of particles. Examples,

- a. Propulsion of rocket by ejecting gases
- b. Water/Sound waves
- c. Equilibrium of bent rod under a load

2. Electrodynamics – It deals with electric and magnetic phenomena associated with charged and magnetic bodies. Examples,

- a. motion of a current-carrying conductor in a magnetic field
- b. the response of a circuit to an ac voltage (signal)
- c. the propagation of radio waves in the ionosphere

3. Optics – It deals with phenomena involving light. Examples,

- a. Reflection and refraction of light

b. Dispersion of light through a prism

c. Colour exhibited by thin films

4. Thermodynamics – It deals with systems in macroscopic equilibrium and changes in internal energy, temperature, entropy etc. of systems under application of external force or heat. Examples,

a. Efficiency of heat engines

b. Direction of physical and chemical process

Microscopic Domain

Microscopic domain includes phenomena at minuscule scales like atomic, molecular and nuclear. It also deals with interaction of probes like electrons, photons and other elementary particles. Quantum theory has been developed to handle these phenomena.

Factors responsible for progress of Physics

- Quantitative analysis along with qualitative analysis.
- Application of universal laws in different contexts.
- Approximation approach (complex phenomena broken down into collection of basic laws).
- Extracting and focusing on essential features of a phenomenon.

Hypothesis, Axiom and Models

a) Hypothesis is a supposition without assuming that it is true. It may not be proved but can be verified through a series of experiments.

b) Axiom is a self-evident truth that it is accepted without controversy or question.

c) Model is a theory proposed to explain observed phenomena.

d) Assumption is the basis of physics, where a number of phenomena can be explained. These assumptions are made from experiments, observation and a lot of statistical data.

Technological applications of Physics

Several examples where Physics and its concepts have led to discoveries/inventions are listed below.

- Steam engine was developed from the industrial revolution in eighteenth century.
- Wireless communication was developed after discovery of laws of electricity and magnetism.
- Neutron-induced fission of uranium, done by Hahn and Meitner in 1938, led to the formation of nuclear power reactors and nuclear weapons.
- Conversion of solar, wind, geothermal etc. energy into electricity.

Fundamental Forces in nature

The forces which we see in our day to day life like muscular, friction, forces due to compression and elongation of springs and strings, fluid and gas pressure, electric, magnetic, inter-atomic and intermolecular forces are derived forces as their originations are due to a few fundamental forces in nature. A few fundamental forces are:

Gravitational Force:

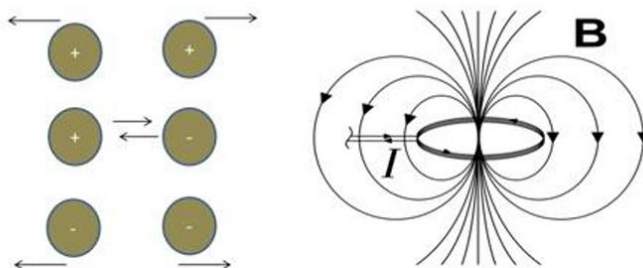
It is the force of mutual attraction between any two objects by virtue of their masses. It is a universal force as every object experiences this force due to every other object in the universe.



The gravitational force causes the apple to fall as well as planets to revolve around the sun.

2. Electromagnetic Force:

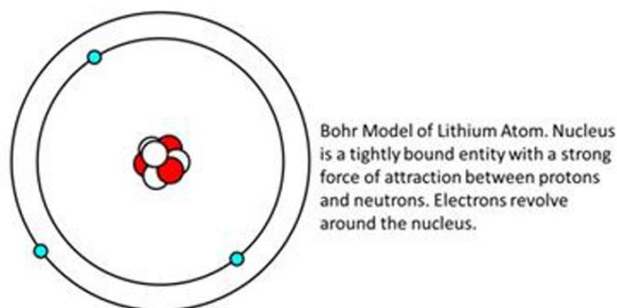
It is the force between charged particles. Charges at rest have electric attraction (between unlike charges) and repulsion (between like charges). Charges in motion produce magnetic force. Together they are called Electromagnetic Force.



The unlike charges attract each other while like charges repel each other. A current carrying wire generates magnetic field around it, giving rise to electromagnetism.

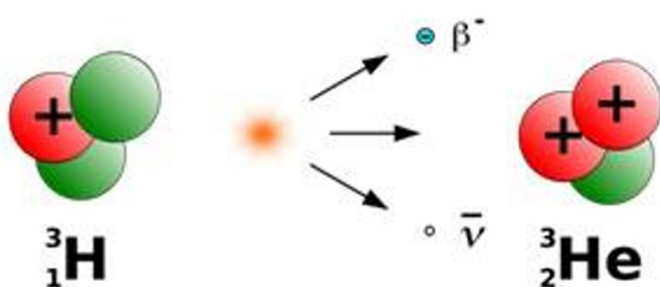
3.Strong Nuclear Force :

It is the attractive force between protons and neutrons in a nucleus. It is charge independent and acts equally between a proton and a proton, a neutron and a neutron, and a proton and a neutron. Recent discoveries show that protons and neutrons are built of elementary particles, quarks



4. Weak Nuclear Force:

This force appears only in certain nuclear processes such as the β decay of a nucleus, in β decay the nucleus emits an electron and an uncharged particle called neutrino. This particle was first predicted by Wolfgang Pauli in 1931.



B-decay of a nucleus.

Below table shows difference between the above forces.

NAME	RELATIVE STRENGTH	RANGE	OPERATES AMONG
Gravitational force	10^{-39}	Infinite	All objects in the universe
Weak nuclear force	10^{-13}	Very short, Sub-nuclear size (10^{-15}m)	Some elementary particles, particularly electron and neutrino
Electromagnetic force	10^{-2}	Infinite	Charged particles
Strong nuclear force	1	Short, nuclear size ($\sim 10^{-15}\text{m}$)	Nucleons elementary particles

5. Unification of Forces: There have been physicists who have tried to combine a few of the above fundamental forces. These are listed in table below.

Name of Physicist	Year	Achievement in Unification
Isaac Newton	1687	Unified celestial and terrestrial mechanics.
Hans Christian Oersted and Michael Faraday	1820 and 1830 respectively	Unified electric and magnetic phenomena to give rise to electromagnetism.
James Clerk Maxwell	1873	Unified electricity, magnetism and optics to show that light is an electromagnetic wave.
Sheldon Glashow, Abdus Salam, Steven Weinberg	1979	Gave the idea of electro-weak force which is a combination of electromagnetic and weak nuclear force.
Carlo Rubia, Simon Vander Meer	1984	Verified the theory of electro-weak force.

Conserved Quantities

Physics gives laws to summarize the investigations and observations of the phenomena occurring in the universe.

- Physical quantities that remain constant with time are called conserved quantities. Example, for a body under external force, the kinetic and potential energy change over time but the total mechanical energy (kinetic + potential) remains constant.
- Conserved quantities can be scalar (Energy) or vector (Total linear momentum and total angular momentum).



A ball in air falling to ground has some Potential energy and zero Kinetic energy. As soon as it touches the ground the potential energy gets converted into kinetic energy. The total Mechanical energy remains same.

Conservation Laws

A conservation law is a hypothesis based on observation and experiments which cannot be proved. These can be verified via experiments.

Law of conservation of Energy

- According to the general Law of conservation of energy, the energies remain constant over time and convert from one form to another.
- The law of conservation of energy applies to the whole universe and it is believed that the total energy of the universe remains unchanged.
- Under identical conditions, the nature produces symmetric results at different time.

Law of conservation of Mass

This is a principle used in analysis of chemical reactions.

- A chemical reaction is basically a rearrangement of atoms among different molecules.
- If the total binding energy of the reacting molecules is less than the total binding energy of the product molecules, the difference appears as heat and the reaction is exothermic.
- The opposite is true for energy absorbing (endothermic) reactions.
- Since the atoms are merely rearranged but not destroyed, the total mass of the reactants is the same as the total mass of the products in a chemical reaction.
- Mass is related to energy through Einstein theory, $E = mc^2$, where c is the speed of light in vacuum

Law of conservation of linear momentum

- Symmetry of laws of nature with respect to translation in space is termed as law of conservation of linear momentum.
- Example law of gravitation is same on earth and moon even if the acceleration due to gravity at moon is 1/6th than that at earth.

Law of conservation of angular momentum

- conservation Isotropy of space (no intrinsically preferred direction in space) underlies the law of conservation of angular momentum.

3. MULTIPLE CHOICE QUESTIONS

Question 1.

The word Science originates from the Latin verb Scientia meaning

- (a) to know
- (b) to see
- (c) to experience
- (d) to observe

Question 2.

Atomic and molecular phenomena are dealt with by

- (a) Newtonian Mechanics
- (b) fluid Mechanics
- (c) applied Mechanics
- (d) Quantum Mechanics

Question 3.

Wave picture of light failed to explain.

- (a) The photoelectric effect
- (b) polarization of light
- (c) diffraction of light
- (d) interference of light

Question 4.

Heliocentric theory proposed by Nicolas Copernicus was

- (a) replaced by circular orbits to fit the data better
- (b) replaced by elliptical orbits to fit the data better
- (c) replaced by elliptical orbits to fit the taste of new rulers of Italy
- (d) replaced by parabolic orbits to fit the data better

Question 5.

Just as a new experiment may suggest an alternative theoretical model, a theoretical advance may suggest what to look for in some for in some experiments. Which of the following experiments can be considered to support this claim?

- (a) Davisson and Germer Experiment
- (b) experimental discovery of positron
- (c) scattering of alpha particle or the gold foil experiment
- (d) Michelson Morley experiment

Question 6.

The scientific method is

- (a) a prescribed method for investigating phenomena, acquiring new knowledge...
- (b) A procedure for proposing new hypothesis
- (c) a body of techniques for investigating phenomena, acquiring new knowledge...
- (d) A method for proposing new theories.

Question 7.

A scientific theory

- (a) cannot be changed but can be reformulated
- (b) is fixed once and for all because it is logical
- (c) is changed to suit new fashion among scientists
- (d) can be revised if required to fit new phenomenon or data

Question 8.

Which of the following is a possible first step in applying the scientific method

- (a) Conducting tests
- (b) Formulating a hypothesis
- (c) Formulation of a question
- (d) Building a theory

Question 9.

Which of the following is a possible final step in applying the scientific method

- (a) Formulating a hypothesis
- (b) Building a theory
- (c) Analysis of test results
- (d) Formulation of a question

Question 10.

Physics is a

- (a) Applied Science
- (b) Mathematical Science
- (c) Engineering Science
- (d) Natural Science

Question 11.

Newtonian mechanics could not explain

- (a) fall of bodies on earth
- (b) Some of the most basic features of atomic phenomena.
- (c) movement of planets
- (d) flight of rockets

Question 12

Macroscopic domain includes

- a) Phenomena at the laboratory
- b) Terrestrial scale
- c) Astronomical scales
- d) All of the above

Question13.

The man who is known as the father of Experimental physics is.

- a) Newton
- b) Albert Einstein
- c) Galileo
- d) Rutherford

Question14.

The person who has been awarded the father of physics of 20th century is

- a) Madame curie

- b) Sir C.V. Raman
- c) Neils Bohr
- d) Albert Einstein

Question 15.

Science is exploring ...x.... and....y....from what we see around us. Here x and y refer to

- a) Qualitative, modify
- b) Experiment, predict
- c) Verification, predict
- d) Reasoning, quantitative

Question 16.

The branch of science which deals with nature and natural phenomena is called

- a) Sociology
- b) Biology
- c) Civics
- d) Physics

Question 17. Which of the following is true regarding the physical science?

- a) They deal with the non-living things.
- b) The study of matter is conducted at atomic or ionic level
- c) Both (a) and (b)
- d) None of these

Question 18.

The scientific principle involved in production of ultrahigh magnetic fields is.

- a) Super conductivity
- b) Digital logic
- c) Photoelectric effect
- d) Laws of thermodynamics

Question 19.

Consider the following statements and choose correct one

- I. Optics deal with the phenomena involving light
 - II. Unification means physical phenomena in terms of few Concepts and laws
 - III. Macroscopic domain of physics deals with the constitution and structure of matter at the minute scales of atoms and nuclei
- a) Only I
 - b) Only II
 - c) Only I and II
 - d) Only II and III

Question 20

The aeroplane works on the scientific principle

- (a) Laws of Thermodynamics
- (b) Nuclear Fusion
- (c) Electromagnetic Induction
- (d) Bernoulli's Theorem

Question 21.

Nuclear reactor works on the scientific principle

- (a) Bernoulli's Theorem
- (b) Nuclear Fission
- (c) Electromagnetic Induction
- (d) Laws of Thermodynamics

Question 22.

Who discovered neutron

- (a) Galileo
- (b) Chadwick
- (c) C.V. Raman
- (d) none of them

Question 23.

Wave nature of electron was discovered by

- (a) Roentgen
- (b) Pauli
- (c) de Broglie
- (d) Einstein

Question 24.

Atomicity of charge was discovered by

- (a) Faraday
- (b) Marie Curie
- (c) Maxwell
- (d) R.A. Millikan

Question 25.

Theory of relativity was discovered by

- (a) Maxwell
- (b) Faraday
- (c) Einstein
- (d) Pauli

Question 26.

Electric generator works on the scientific principle

- (a) Laws of Thermodynamics
- (b) Nuclear Fusion
- (c) Bernoulli's Theorem
- (d) Electromagnetic Induction

Question 27.

Size of the nucleus is

- (a) 10^{-10} m
- (b) 10^{-14} m
- (c) 10^{-9} m
- (d) 10^{-12} m

Question 28.

The scientists who discovered natural radioactivity belonged to

- (a) Italy
- (b) Austria
- (c) France
- (d) England

Question 29.

The scientist who discovered x-rays belonged to:

- (a) Germany
- (b) Japan
- (c) England
- (d) France

Question 30.

The scattering of light by molecules was discovered by

- (a) J. Bardeen
- (b) Einstein
- (c) C.V. Raman
- (d) Newton

Question 31.

The scientist who discovered the "Theory of Relativity" belonged to

- (a) India
- (b) France
- (c) Germany
- (d) None of these

Question 32.

Which of the following technology uses Newton's second and third laws of motion

- (a) Electric Generator
- (b) Radio and Television
- (c) Rocket Propulsion
- (d) None

Question 33.

Laws of electromagnetic induction were discovered by:

- (a) Chadwick
- (b) Einstein
- (c) Newton
- (d) Faraday

Question 34.

Heat engine and refrigerator work on scientific principle:

- (a) Electromagnetic Induction
- (b) Bernoulli's Theorem
- (c) Nuclear Fusion
- (d) Laws of thermodynamics

Question 35.

Who discovered cosmic rays

- (a) J.J. Thomson
- (b) Hess
- (c) Lawrence
- (d) Yukawa

Question 36.

The scientist who discovered cosmic rays belonged to

- (a) America
- (b) Austria
- (c) India
- (d) France

Question 37.

The physical sciences deal with the study of:

- (a) Living things
- (b) Non-living things
- (c) Both
- (d) None

Question 38.

The branch of science which deals with the study of stars is called

- (a) Astronomy
- (b) Geology
- (c) Meteorology
- (d) Seismology

Question 39.

The idea of calculus was given by

- a) Newton
- b) Einstein
- c) Marconi
- d) Planck

Question 40.

Which of the following principles is being used in Sonar Technology?

- a) Reflection of ultrasonic waves
- b) Newton's laws of motion
- c) Reflection of electromagnetic waves
- d) Laws of thermodynamics

Question 41. Which of the following is wrongly matched?

- a) Barometer-Pressure
- b) Lactometer-Milk
- c) Coulomb's law-Charge
- d) Humidity-Calorimeter

Question 42.

C.V.Raman got Nobel Prize for his experiment

- a) Dispersion of light
- b) Reflection of light
- c) Deflection of light
- d) Scattering of light

Question 43.

The discoverer of loudness and intensity of sound is

- a) Newton
- b) Bell
- c) Laplace
- d) Edison

Question 44.

It has been postulated that there may be some particles moving with speed greater than the speed of light. Such particles are known as

- a) Electrons
- b) Neutrons
- c) Nucleons
- d) Tachyons

Question 45.

A superposition that is put forward as a probable solution to a natural phenomenon is called a

- a) Hypothesis
- b) Theory
- c) Law
- d) Relief

Question 46.

The book "Pisces of physics" has been written by

- a) Einstein
- b) Newton
- c) Archimedes
- d) Galileo

Question 47.

It is more important to have beauty in the equations of physics than to have them agree with experiments'

The scientist who made this statement is

- a) Dirac
- b) Raman
- c) Faraday
- d) Maxwell

Question 48.

Chandrasekhar, Indian scientist was awarded Nobel Prize in Physics on subject concerning

- a) Geophysics
- b) Superconductivity
- c) Laser technology
- d) Astronomy

Question 49.

The relative strength of fundamental forces is

- a) $F_G : F_W : F_E : F_S = 1 : 10^{19} : 10^{30} : 10^{35}$
- b) $F_G : F_W : F_E : F_S = 1 : 10^{22} : 10^{34} : 10^{38}$
- c) $F_G : F_W : F_E : F_S = 1 : 10^{25} : 10^{36} : 10^{38}$
- d) $F_G : F_W : F_E : F_S = 1 : 10^{15} : 10^{31} : 10^{36}$

Question 50.

Law of conservation of angular momentum follows which symmetry?

- a) Homogeneity of space
- b) Isotropy of space
- c) Homogeneity of time
- d) Isotropy of time

4. Assertion Reasoning Questions

Question: - In the following questions (1- 20), a statement of assertion is followed by a statement of reason. Mark the correct choice as

- A) If both assertion and reason are true and the reason is the correct explanation of the assertion.**
- B) If both assertion and reason are true but reason is not the correct explanation of the assertion.**
- C) If assertion is true but reason is false.**
- D) If the assertion and reason both are false.**
- E) If assertion is false but reason is true.**

1. **Assertion: -** The Coulomb force is dominating force in the universe.

Reason: - The Coulomb force is weaker than the gravitational force.

2. **Assertion: -** unlike electric force and gravitational forces, nuclear forces has limited range.

Reason: - Nuclear force does not obey inverse square law.

3. **Assertion: -** The concept of energy is Central to Physics and expression for energy can be written for every physical system.

Reason: - Law of conservation of energy is not valid for all forces and for any kind of transformation between different forms of energy.

4. **Assertion: -** The basic laws of electromagnetism govern all electric and magnetic phenomena.

Reason:-The attempts to unify fundamental force of nature reflect the quest for unification.

5. **Assertion:-**The elastic spring force arises due to the net attraction or repulsion between the neighboring atom of the spring when it is elongated or compressed.

Reason: - The laws of derived forces such as spring force, friction force are independent of the laws of fundamental forces in nature.

6. **Assertion:-**In a nuclear process mass gets converted into energy.

Reason:-According to Einstein mass energy equivalence relation, mass m is equivalent to energy given by the relation $E = mc^2$ where c is the speed of light in vacuum.

7. **Assertion:-**If we perform an experiment in our laboratory today and repeat the same experiment on the same object under identical conditions after a year the results are found to be same.

Reason: - The laws of nature do not change with time.

8. **Assertion:**-Electrons do not experience strong nuclear force.
Reason: - Strong nuclear force is charge independent force.
9. **Assertion:**-Gravitational force is always attractive in nature while electromagnetic force can be attractive or repulsive.
Reason: - Electromagnetic force dominates Terrestrial phenomena.
10. **Assertion:**-In physics we attempt to derive the properties of bigger more complex system from the properties and interaction of its constituent simpler parts.
Reason: - This approach is called unification and is at the heart of physics.
11. **Assertion:**-The microscopic domain of physics deals with the constitution and structure of matter at the minute scale of atoms and nuclei.
Reason: - Classical physics is adequate to deal with the microscopic domain of physics.
12. **Assertion:**-The acceleration due to gravity on the moon is $1/6$ that of the earth.
Reason: - The law of Gravitation is the same on both the moon and earth.
13. **Assertion:** - Stone and a feather dropped from the same height do not reach the ground at the same time.
Reason: - Acceleration due to gravity is dependent on the mass of the object.
14. **Assertion:** - Radar is used to detect an aero plane in the sky.
Reason: - Radar works on the principle of reflection of waves.
15. **Assertion:** - Physics is the heart and technology is the body of science.
Reason: - Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.
16. **Assertion:** - The theories and concepts of Physics lead to the development of various mathematical tools like differential equations, equations of motion, etc.
Reason: - Physics is the science-based on imagination and intuition which can be tested experimentally and mathematically.
17. **Assertion:** - According to the principle of conservation of energy all heat can be converted into mechanical work
Reason: - Due to various losses, it is impossible to convert all heat into mechanical work.
18. **Assertion:** - A scientific theory cannot be changed but can be reformulated.
Reason: - The theory is approved by a panel of people after studying the theory only.
19. **Assertion:** - Scientific theory is accepted if predictions of the theory are confirmed by experiments.

Reason: - Scientific method involves Systematic observations, controlled experiments, qualitative and quantitative reasoning, mathematical modeling, prediction and verification.

20. **Assertion:** - Nuclear forces between proton and proton, a neutron and a neutron and a proton and a neutron are nearly equally strong.

Reason: - The strong nuclear force does not depend on the charge of the nucleons.

5. Case Study Based Questions

Case Study 1

From walking on the street, to launching a rocket into space, to sticking a magnet on your refrigerator, physical forces are acting all around us. But all the forces that we experience every day (and many that we don't realize we experience every day) can be whittled down to just four fundamental forces:

1. Gravitational force
2. Electromagnetic force
3. Strong nuclear force
4. Weak nuclear force

These are called the four fundamental forces of nature, and they govern everything that happens in the universe.

Name	Relative Strength	Range	Operates among
Gravitational force	10^{-39}	Infinite	All objects in the universe
Weak nuclear force	10^{-13}	Very short, Sub-nuclear size ($\sim 10^{-16}$ m)	Some elementary particles, particularly electron and neutrino
Electromagnetic force	10^{-2}	Infinite	Charged particles
Strong nuclear force	1	Short, nuclear size (10^{-15} m)	Nucleons, heavier elementary particles

1. Rank the four fundamental forces of nature in order from weakest to strongest:

- a) Electromagnetism, Gravity, Strong Nuclear, Weak Nuclear
- b) Weak Nuclear, Gravity, Electromagnetism, Strong Nuclear
- c) Gravity, Weak Nuclear, Electromagnetism, Strong Nuclear
- d) Weak Nuclear, Electromagnetism, Gravity, Strong Nuclear

2. Gravity has a range that is _____.

- a) Short
- b) Long
- c) Infinite
- d) Variable

3. _____ can be either a force of attraction or repulsion while _____ is only a force of attraction.

- a) Gravity; Electromagnetism
- b) Electromagnetism; Gravity
- c) Gravity; Strong nuclear force
- d) Magnetism; Electricity

4. When an atom undergoes radioactive decay, the energy that is released is due to:

- a) Gravity
- b) Strong Nuclear
- c) Electromagnetism
- d) Weak Nuclear

5. Range of Nuclear forces is

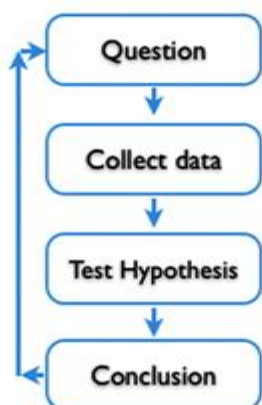
- a) $< 10^{-14}\text{m}$
- b) $> 10^{-14}\text{m}$
- c) $< 10^{-10}\text{m}$
- d) $< 10^{-10}\text{m}$

Case Study 2

The word Science originates from the Latin verb Scientia meaning ‘to know’. The Sanskrit word Vijnan and the Arabic word Ilm convey similar meaning, namely ‘knowledge’. Science is a systematic attempt to understand natural phenomena in as much detail and depth as possible, and use the knowledge so gained to predict, modify and control phenomena. Science is exploring, experimenting and predicting from what we see around us.

The Scientific method is a process with the help of which scientists try to investigate, verify, or construct an accurate and reliable version of any natural phenomena. They are done by creating an objective framework for the purpose of scientific inquiry and analyzing the results scientifically to come to a conclusion which either supports or contradicts the observation made at the beginning.

SCIENTIFIC METHOD STEPS:



1. The word Science originates from the Latin verb Scientia meaning

- a) to know
- b) to see
- c) to experience
- d) to observe

2. The scientific method is

- a) a prescribed method for investigating phenomena, acquiring new knowledge.
- b) A procedure for proposing new hypothesis
- c) a body of techniques for investigating phenomena, acquiring new knowledge
- d) A method for proposing new theories.

3. Which of the following is a possible first step in applying the scientific method

- a) Conducting tests
- b) Formulating of a question
- c) Formulation a hypothesis
- d) Building a theory

4. Which of the following is a possible final step in applying the scientific method

- a) Formulating a hypothesis
- b) Building a theory
- c) Analysis of test results
- d) Formulation of a question

5. A scientific theory

- a) cannot be changed but can be reformulated
- b) is fixed once and for all because it is logical
- c) is changed to suit new fashion among scientists
- d) can be revised if required to fit new phenomenon or data

Case Study 3

Physics is so important branch of science that without the knowledge of physics, other branches of science cannot make any progress. This can be seen from the following:

(i) Physics in relation to Chemistry: The concept of X-ray diffraction and radioactivity has helped to distinguish between the various solids and to modify the periodic table.

(ii) Physics in relation to Biology: The concept of pressure and its measurement has helped us to know the blood pressure of a human being. The discovery of X-rays has made it possible to diagnose the various diseases in the body and fracture in bones. Skin disease and cancer can be cured with the help of high energy radiation like X-rays, ultraviolet rays.

(iii) Physics in relation to Geology: The internal structure of various rocks can be known with the study of crystal structure. Age of rocks and fossils can be known easily with the help of radioactivity, i.e., with the help of carbon dating.

(iv) Physics in relation to Astronomy: Optical telescope has made it possible to study the motion of various planets and satellites in our solar system.

(v) Physics in relation to Meteorology: The variation of pressure with temperature leads to forecast the weather.

(vi) Physics in relation to Seismology: The movement of earth's crust and the types of waves produced help us in studying the earthquake and its effect.

1. The branch of science which deals with the study of stars is called

- a) Astronomy
- b) Geology
- c) Meteorology
- d) Seismology

2. The physical sciences deal with the study of:

- a) Living things
- b) Non-living things
- c) Both
- d) None

3. The study of the biological specimens are conducted at:

- a) Atomic level
 - b) Ionic level
 - c) Molecular level
 - d) None
- 4. The concept of interaction between various particles leads to understand the bonding in the chemical structure of a substance belongs to which subject?**
- a) Astronomy
 - b) Geology
 - c) Biology
 - d) Chemistry
- 5. What is the correct sequence of events: technology gives rise to new sciences or new sciences gives rise to technology?**
- a) Science can give rise to technology.
 - b) Technology and Science are independent.
 - c) Both can happen technology gives rise to new sciences and new sciences gives rise to technology
 - d) Technology can give rise to new sciences.

Case Study 4

The two main principal thrusts in physics are: Unification and Reduction.

Unification is the act of unifying the different laws valid for different phenomena in to a single theory that explains all the different phenomena.

Example: Electricity, magnetism and light are different phenomena and have different laws of physics for each of them. These are unified under theory of electromagnetism; all these three phenomena can be explained from this theory of electromagnetism.

The law of gravitation explains falling of objects on earth, planetary motion, motion of moon, etc.

Reductionism is breaking down of a complex system in to simple constituent systems so that laws of physics can be applied on these systems and we can understand the working of the complex system. For example, temperature of a system is reduced to average kinetic.

- 1. What is the two principal thrust in physics?**
- a) Unification and Reduction
 - b) Unification and Oxidation
 - c) Magnification and Reduction
 - d) Simplification and Reduction
- 2. Explaining diverse physical phenomena in terms of a few concepts and laws is**
- a) unification
 - b) reduction
 - c) law
 - d) fact
- 3. Deriving the properties of a bigger, more complex system from the properties and interaction of its constituent simple parts is**
- a) unification
 - b) reduction
 - c) law

- d) Fact
4. **Logical possibility that an assertion, hypothesis or theory can be contradicted by an observation or the outcome of a physical experiment is**
- a) falsifiability
 - b) fact
 - c) hypothesis
 - d) law
5. **Which of the following statements is/are correct**
- a) Both
 - b) universal law of gravitation is an assumption or hypothesis
 - c) universal law of gravitation can be verified
 - d) none of this

Case Study 5

Physics is a study of basic laws of nature and their manifestation in different natural phenomena. Physics is the study of physical world and matter and its motion through space and time, along with related concepts such as energy and force.

Word Physics is derived from a Greek word fisis meaning nature.

Factors responsible for progress of Physics:

- Quantitative analysis along with qualitative analysis.
- Application of universal laws in different contexts.
- Approximation approach (complex phenomena broken down into collection of basic laws).
- Extracting and focusing on essential features of a phenomenon.

Hypothesis, Axiom and Models:

- Hypothesis is a supposition without assuming that it is true. It may not be proved but can be verified through a series of experiments.
- Axiom is a self-evident truth that it is accepted without controversy or question.
- Model is a theory proposed to explain observed phenomena.
- Assumption is the basis of physics, where a number of phenomena can be explained. These assumptions are made from experiments, observation and a lot of statistical data.

1. What is Central to the growth of Physics?

- a) Qualitative descriptions
- b) conjectural descriptions
- c) speculative descriptions
- d) quantitative measurement

2. Physics is a

- a) Applied Science
- b) Mathematical Science
- c) Engineering Science
- d) Natural Science

3. Origin of the word 'Physics' is from

- a) French word 'Fusis'
- b) Latin word 'Fusis'
- c) Greek word 'Fusis', which means 'Nature'
- d) Greek word 'Fusis', which means 'Physical'

4. A theory proposed to explain observed phenomena is

- a) Postulate
- b) Hypothesis
- c) Law
- d) Model

5. A truth, which is self-evident is a/an

- a) Axiom
- b) Postulate
- c) Either (1) or (2)
- d) Hypothesis

6. ANSWERS

MULTIPLE CHOICE QUESTIONS

1(a) to know

2(d) Quantum Mechanics

3(a) the photoelectric effect

4(b) replaced by elliptical orbits to fit the data better

5(b) experimental discovery of positron

6(c) a body of techniques for investigating phenomena, acquiring new knowledge...

7(d) can be revised if required to fit new phenomenon or data

8(c) Formulation of a question

9(c) Analysis of test results

10(d) Natural Science

11(b) some of the most basic features of atomic phenomena.

12 (d) All of the above

13 (c) Galileo

14 (d) Albert Einstein

15 (b) experiment, predict

16 (d) Physics

17 (c) Both (a) and (b)

18 (a) Super conductivity

19 (c) only I and II

20 (d) Bernoulli's Theorem

21 (b) Nuclear Fission

22 (b) Chadwick

23 (c) de Broglie

24 (d) R.A. Millikan

25 (c) Einstein

- 26 (d) Electromagnetic Induction
- 27 (b) 10^{-14}m
- 28 (c) France
- 29(a) Germany
- 30 (c) C.V. Raman
- 31 (c) Germany
- 32 (c) Rocket Propulsion
- 33 (d) Faraday
- 34 (d) Laws of Thermodynamics
- 35 (b) Hess
- 36 (b) Austria
- 37 (b) Non-living things
- 38 (a) Astronomy
- 39 (a) Newton
- 40 (a) Reflection of ultrasonic waves
- 41 (d) Humidity-Calorimeter
- 42 (d) Scattering of light
- 43 (b) Bell
- 44 (d) Tachyons
- 45 (a) Hypothesis
- 46 (a) Einstein
- 47 (a) Dirac
- 48 (d) Astronomy
- 49 (c) $F_G : F_W : F_E : F_S = 1 : 10^{25} : 10^{36} : 10^{38}$
- 50 (d) Isotropy of space

ASSERTION AND REASONING ANSWERS

Answer 1: - D) if both assertion and reason are false statements.

Gravitational force is the dominating force in nature and not Coulomb force. Gravitational force is the weakest force. Also, Coulomb's force \gg Gravitational force.

Answer 2: - B) if both assertion and reason are true but reason is not the correct explanation of assertion.

Gravitational force: - Weakest force, but infinite range

Weak Nuclear force: - Next weakest but short range

Electromagnetic force: - Stronger, with infinite range

Strong Nuclear force: - Strongest but short range.

Answer 3: - C) Assertion is correct but the reason is incorrect.

Answer 4:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 5:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 6:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 7:- A) Both assertion and reason are correct and the reason is the correct explanation for the assertion.

Answer 8:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 9:- C) Assertion is correct but the reason is incorrect

Answer 10:- C) Assertion is correct but the reason is incorrect

Answer 11:- C) Assertion is correct but the reason is incorrect

Answer 12:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 13:- C) Assertion is correct but the reason is incorrect

Answer 14:- A) Both assertion and reason are correct and the reason is the correct explanation for the assertion

As Radar is most accurate instrument used to detect aero plane in the sky based on the principle of reflection of waves.

Answer 15:- A) Both assertion and reason are correct and the reason is the correct explanation for the assertion

Answer 16:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

Answer 17:- B) Both Assertion and Reason are true but reason is not correct explanation of Assertion.

According to the law of conservation of energy, energy can neither be created nor can it be destroyed. Thus, it is physically possible to convert all of heat into mechanical work. But due to various energy losses, this cannot be achieved practically ever.

Answer 18: - D) if both assertion and reason are false statements.

Answer 19: - A) Both assertion and reason are correct and the reason is the correct explanation for the assertion.

Answer 20:- A) Both assertion and reason are correct and the reason is the correct explanation for the assertion.

ANSWERS OF CASE STUDY

Case Study 1

Answer 1: c) Gravity, Weak Nuclear, Electromagnetism, and Strong Nuclear

Answer 2: c) Infinite

Answer 3: b) Electromagnetism; Gravity

Answer 4: b) Strong Nuclear

Answer 5: a) $< 10^{-14}\text{m}$

Case Study 2

Answer 1: (a) to know

Answer 2: (c) a body of techniques for investigating phenomena, acquiring new knowledge.

Answer 3: (b) Formulation of a question

Answer 4: (c) Analysis of test results

Answer 5: (d) can be revised if required to fit new phenomenon or data

Case Study 3

Answer 1: (a) Astronomy

Answer 2: (b) Non-living things

Answer 3: (c) Molecular level

Answer 4: (d) Chemistry

Answer 5: (c) Both can happen technology gives rise to new sciences and new sciences gives rise to technology

Case Study 4

Answer 1:- (a) Unification and Reduction

Answer 2: - a) unification

Answer 3: - b) reduction

Answer 4: - a) falsifiability

Answer 5: - a) both

Case Study 5

Answer 1:- (d) quantitative measurement

Answer 2:- (d) Natural Science

Answer 3:- (c) Greek word 'Fusis', which means 'Nature'

Answer 4: - (d) Model

Answer 5: - (c) Either (1) or (2)