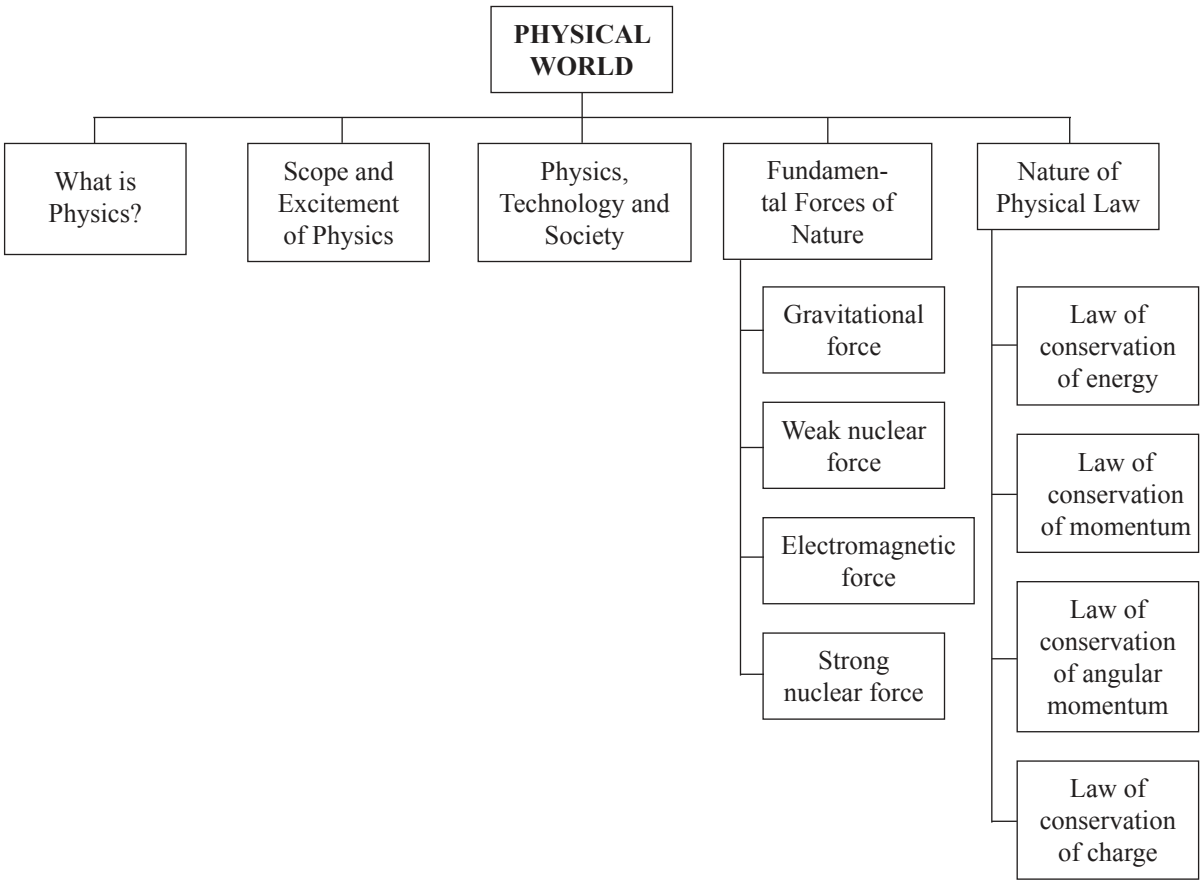
CHAPTER 1

Physical World

Syllabus

- **What is physics?**
- **Scope and excitement of physics**
- **Physics, technology, and society:** Physics related to society; Physics related to technology.
- **Fundamentals forces of nature:** Gravitational force; Electromagnetic force; Strong nuclear force; Weak nuclear force.
- **Nature of physical laws:** Conservation of laws.

MIND MAP



Mind Map: Classification of Physical World

RECAP

What is Physics?

- The word *'Physics'* comes from the Greek word '*phusika'* which means '*knowledge' of nature* and in general, this field of study aims to analyse and understand the natural phenomena of the universe.
- Physics is the study of the basic laws of nature and their manifestation. Physics is all about explaining diverse physical phenomena with the help of concepts and laws.
- Aninon pls. Chck : Mesoscopic domain addresses fund a mental problems that occur when a mecroscopic objcet is miniatured. The scale of materials can be describe as being between now scale size of quantity of atoms and of materials measuring in micrometers.

Scope and Excitement of Physics

- Scope of physics is explained in two domains of interest, macroscopic, and microscopic.
- Macroscopic domain is that domain which includes phenomena at the laboratory, terrestrial, and astronomical scales. Whereas microscopic domain is that domain which includes atomic, molecular, and nuclear phenomena.
- However, a third domain of interest between macroscopic domain and microscopic domain exists it is, named mesoscopic is also there. In this domain scientists deal with a few tens or hundreds of atoms, it has emerged as an exciting field of research.
- Theories of these domains are further categorised as: Classical physics and Quantum theory.
- Classical physics is the study of macroscopic phenomena, which includes subjects like:
  - Mechanics
  - Electrodynamics
  - Thermodynamics
  - Optics
- Quantum Theory is the framework for explaining microscopic phenomena as classical physics can't explain phenomenon at microscopic level (or smaller dimensions like atoms, nuclei, etc.)
- The study of physics exists in many ways. For example:
  - Live transmission of events as it explain us the reason behind several intresting features like. Thousands of kilometers away on the television.
  - STD, ISD, Fax, Cellular phone etc.
  - The speed and memory of the fifth generation of computers.
  - Use of robots for many purposes.
  - Technological advances in health care and medical science.
  - Lasers and their ever-increasing applications.

Physics, Technology and Society

- There are number of examples in the world which shows close relation between physics, technology and society. Such as, the steam engine is inseparable from the *Industrial Revolution* in England in the 18th century, which had great impact on the course of human civilisation. Wireless communication, nano technology and computers are some other examples.

Physics Related to Society

- Most of the developments in physics have a direct impact on the society. For example:
  - The development of telephone, telegraph, telex have enabled us to transmit important messages instantly.
  - The development of radio, television, satellites have increased the means of communication.
  - Advances in electronics, computers, lasers have greatly enriched the society.
  - Rapid means of transport have increased the pace of transportation through air, water, and land.

Physics Related to Technology

- Technology is the application of the principles of physics for practical purposes.
- Technology and physical principles are inter-related quantities.
- Technology gives rise to new principles in physics and vice-versa.

Fundamental Forces of 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, interatomic and intermolecular forces are **derived forces** as their originations are due to a few fundamental forces in nature:
  Some key fundamental forces are :
  - Gravitational Force
  - Electromagnetic Force
  - Strong Nuclear Force
  - Weak Nuclear Force
- **Gravitational Force**: The force of attraction between any two material particles is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them. It acts along the line joining the two particles.
- **Electromagnetic Force:** It is a fundamental force it nature, the electromagnetic force acts between charged particles and is the combination of all electrical and magnetic force. The electromagnetic force can be attractive or repulsive.
- **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.
- **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.

Table: Fundamental forces and their relative strength

Force	Particles Experiencing	Range	Relative Strength
Gravity (acts between objects with mass)	All particles with mass	Infinity	much weaker ⋮
Weak Force (governs particle decay)	Quarks and leptons	Very short range	⋮
Electromagnetism (acts between electrically charged particles)	Electrically charged	Infinity	⋮
Strong Force (binds quarks together)	Quarks and gluons	Short range	▼ much stronger

Nature of Physical Laws

Conservation Laws in Physics

- The physical quantities that remain unchanged in a process are called conserved quantities. Some of the general conservation laws in nature include the laws of conservation of energy, mass, linear momentum, angular momentum, charge, parity, etc. Some conservation laws are true for one fundamental force but not for the other.
  - **Law of conservation of energy:** Sum of all kinds of energy in this universe remains constant.
  - **Law of conservation of linear momentum:** In the absence of an external force, the linear momentum of a system remains unchanged.
  - **Law of conservation of angular momentum:** If the total external torque acting on a system is zero, then the angular momentum of the system remains constant.
  - **Law of conservation of charge:** Charges can neither be created nor be destroyed but can be transferred from one body to another.
- These conservation laws have a deep connection with symmetries of nature. Symmetries of space and time, and other types of symmetries play a central role in modern theories of fundamental forces in nature.

PRACTICE TIME

What is Physics?

1. Physics is a/an
(a) engineering science
(b) mathematical science
(c) applied science
(d) natural science

2. Among the following which is not the branch of physics?
(a) Electrodynamics (b) Optics
(c) Cytogenetics (d) Mechanics

Scope and Excitement of Physics

3. Proper framework for explaining microscopic phenomena is
(a) quantum theory (b) theory of relativity
(c) Maxwell's theory (d) classical physics

4. What is the range of masses we study in physics?
(a) 10^{-27} kg to 10^{60} kg (b) 10^{-27} kg to 10^{55} kg
(c) 10^{-30} kg to 10^{55} kg (d) 10^{-30} kg to 10^{60} kg
[***Hint:*** *Mass of electron* = $9.10938356 \times 10^{-31}$ *kilograms*]

5. Which of the following is not included in classical physics?
(a) Mechanics (b) Light
(c) Heat (d) Elementary Particles

6. The microscopic domain of physics deals with
(a) the constitution and structure of matter at the scales of atoms and nuclei and their interaction with different elementary particles.
(b) the constitution and structure of matter at the scales of atoms and nuclei and their interaction with different bodies on the Earth.
(c) the constitution and structure of matter at the scales of stars and planets and their interaction with different elementary particles.
(d) None of these

Physics, Technology and Society

7. Technology strives
(a) to use science for application
(b) to fulfil a human need such as faster cooking or sewing etc
(c) to perfect science
(d) to invent better rat traps

8. What is centre to the growth of Physics?
(a) Qualitative descriptions
(b) Conjectural descriptions
(c) Speculative descriptions
(d) Quantitative measurement

9. One example where technology predates science is
(a) television (b) steam engine
(c) radio (d) laser surgery

10. Technology started with
(a) invention of printing press
(b) invention of power loom
(c) the conversion of natural resources into simple tools
(d) invention of steam engine

11. _____ was declared as International Year of Physics.
(a) 2002 (b) 2003
(c) 2005 (d) 2007

12. C.V. Raman has majorly contributed in
(a) measurement of electronic charge.
(b) inelastic scattering of light by molecules.
(c) nuclear model of atom.
(d) model of hydrogen atom.

13. Who discovered lighting?
(a) Ohm (b) Thomson
(c) Franklin (d) Faraday

14. Electron microscope uses electron for their which property?
(a) Spin (b) Wave nature
(c) Negative charge (d) None of these

15. Which of the following waves emitted by SONAR?
(a) Radio waves (b) Micro waves
(c) Ultrasonic wave (d) Gamma rays

16. Who was the inventor of cyclotron?
(a) James Chadwick
(b) James Clerk Maxwell
(c) Michael Faraday
(d) Ernest Orlando Lawrence

Fundamental Forces of Nature

17. Which of the following is not the fundamental force in nature?
(a) Gravitational force (b) Strong nuclear force
(c) Tension (d) Electromagnetic force

18. The fundamental force which is the weakest force is
(a) gravitational force
(b) weak nuclear force
(c) strong nuclear force
(d) electromagnetic force

19. The range of the gravitational force is given by_____.
(a) 10^{-2} m (b) 10^{-15} m
(c) Infinite
(d) 10^{-10} m

20. Which of the following force follows the inverse square law of distance?
(a) Gravitational forces
(b) Electromagnetic forces
(c) Both (a) and (b)
(d) None of these

21. The Sun releases energy, which is coming from_____
(a) weak electrical forces
(b) gravitational forces
(c) electromagnetic waves
(d) nuclear forces

22. Select the correct statement.
(a) Weak nuclear force is responsible for holding the constituents of the nucleus together.
(b) Weak nuclear force is responsible for holding the electrons of the nucleus together.
(c) Weak nuclear force is responsible for holding the electrons and the nucleus together.
(d) Weak nuclear force is responsible for a common form of radioactivity called beta decay.

23. What is the difference between nuclear forces and electromagnetic forces?
(a) Nuclear forces have longer range compared to electromagnetic forces.
(b) Nuclear forces are mediated by photons for electromagnetic forces.
(c) Nuclear forces do not depend on charge.
(d) Nuclear forces are weaker compared to electromagnetic forces.

Nature of Physical Laws

24. Under the principle of conservation_____
(a) a physical quantity like mass is converted into energy
(b) a physical quantity changes to a form of energy
(c) a physical quantity for example total momentum does not change in a phenomenon. The quantity has the same value before and after the phenomenon
(d) a physical quantity like energy is converted into mass

25. The magnitude of acceleration due to gravity on the moon is
(a) same that of the Earth
(b) (1/6)th that of the Earth
(c) (1/9)th that of the Earth
(d) (1/10)th that of the Earth

26. What is the meaning of the statement 'basic laws of physics are universal'?
(a) The same laws apply in widely different contexts.
(b) The same laws do not apply on mars and stars.
(c) The same laws apply in similar contexts.
(d) The same laws apply in different contexts only.

27. Einstein's mass energy equation is given by_____.
(a) $E = mc$
(b) $E = mc^2$
(c) $E = m^2c$
(d) $E = 2mc$

28. There is no law of conservation of _____.
(a) energy
(b) linear momentum
(c) force
(d) mass

29. For motion under an external conservative force
(a) the potential energy of a body is a constant.
(b) the sum of kinetic and potential energy of a body is a constant only if there is no motion.
(c) the sum of kinetic and potential energy of a body is a constant.
(d) the kinetic energy of a body is a constant.

HIGH-ORDER THINKING SKILL

Physics, Technology, and Society

1. Correctly match the following names with corresponding inventions

	Column I		Column II
A	Archimedes	(i)	Electromagnetic theory of Light
B	W K Roentgen	(ii)	X-Rays
C	Albert Einstein	(iii)	Theory of Relativity
D	James Clerk Maxwell	(iv)	Principle of Buoyancy

(a) A-(iv), B-(ii), C-(iii), D-(i)
(b) A-(ii), B-(iv), C-(iii), D-(i)
(c) A-(iv), B-(ii), C-(i), D-(iii)
(d) A-(iv), B-(iii), C-(ii), D-(i)

2. What is the scientific principle involved in electron microscope?

(a) Magnification by electromagnetic fields
(b) Magnification by optical lenses
(c) Magnification by X-ray
(d) Magnification by ultrasonic waves

3. Wave picture of light failed to explain
(a) the photoelectric effect
(b) polarisation of light
(c) diffraction of light
(d) interference of light

4. Which of the following was not explained by Newtonian mechanics :
(a) Fall of bodies on earth
(b) Some of the most basic features of atomic phenomena
(c) Movement of planets
(d) Flight of rockets

5. 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

Fundamental Forces of Nature

6. Which of the following is the correct decreasing order of the strengths of four fundamental forces of nature?
(a) Electromagnetic force > weak nuclear force > gravitational force > strong nuclear force
(b) Strong nuclear force > weak nuclear force > electromagnetic force > gravitational force
(c) Gravitational force > electromagnetic force > strong nuclear force > weak nuclear force
(d) Strong nuclear force > electromagnetic force > weak nuclear force > gravitational force

7. Which of the following statements is/are correct?
(i) Strong nuclear force binds protons and neutrons in a nucleus.
(ii) In twentieth century, silicon chip triggered a revolutionary change in technology of computer system.
(iii) The fossil fuels of the planet are dwindling fast and there is urgent need to discover new source of energy.
(a) Only (i)
(b) Only (iii)
(c) (i) and (ii)
(d) (i), (ii) and (iii)

8. When we hold a book in our hand, we are balancing the gravitational force on the book due to
(a) normal force provided by our hand
(b) friction force provided by the book
(c) both (a) and (b)
(d) None of these

ASSERTION AND REASONS

Directions: In the following questions, 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 reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

What is Physics?

1. **Assertion:** In physics the microscopic domain is that domain which includes the study of properties of atomic, molecular, and nuclear phenomena.
Reason: Macroscopic domain deals with matter and objects that are measurable and can be observed by the haked eye.

2. **Assertion:** The properties of a bigger and complex system are derived from the properties and interactions of its constituent simple part in physics.
Reason: This methodology is known as unification which is the core of physics.

Fundamental Forces of Nature

3. **Assertion:** The magnitude of acceleration due to gravity on the moon is one-sixth that on the Earth.
Reason: The law of gravitation is the same for the whole universe.

4. **Assertion:** The basic laws of electromagnetism govern all electric and magnetic phenomena.
Reason: The attempts to unify fundamental forces of nature reflect the quest for unification.

5. **Assertion:** Strong nuclear forces cannot be experienced by electrons.
   Reason: Strong nuclear forces are always charge independent force.
6. **Assertion:** The nature of gravitational force is always attractive, whereas electromagnetic forces can be attractive or repulsive in nature.
   Reason: Electromagnetic force always dominates the terrestrial phenomena.
7. **Assertion:** During the nuclear process mass gets converted into energy.
   Reason: Einstein's mass energy equation $E = mc^2$ explains that mass m is converted in to energy, where c is the speed of light in vacuum.
8. **Assertion:** When a spring is elongated or compressed then the elastic spring force arises due to the net attraction or repulsion between the neighbouring atoms of the spring.
   Reason: The laws of derived forces are independent of the laws of fundamental forces in nature.

Nature of Physical Laws

9. **Assertion:** While performing an experiment in the laboratory today and repeating it after five years on same object under identical conditions, we can get the same results.
   Reason: The fundamental laws of nature do not change with time.
10. **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.

ANSWER KEYS

Practice Time

1	(d)	2	(c)	3	(a)	4	(c)	5	(d)	6	(a)	7	(b)	8	(d)	9	(b)	10	(c)
11	(c)	12	(b)	13	(c)	14	(b)	15	(c)	16	(d)	17	(c)	18	(a)	19	(c)	20	(c)
21	(d)	22	(d)	23	(c)	24	(c)	25	(c)	26	(a)	27	(b)	28	(c)	29	(b)		

High-Order Thinking Skill

1	(a)	2	(a)	3	(a)	4	(b)	5	(c)	6	(d)	7	(d)	8	(a)

Assertion and Reasons

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

HINTS AND EXPLANATIONS

Practice Time

1 (d) The natural sciences seek to understand how the world and universe around us works. There are five major branches: Chemistry, astronomy, earth science, physics and biology. Physics is a natural science.

2 (c) Cytogenetics is the study of inheritance in relation to the structure and function of chromosomes. It is the branch of biology, not of physics.

3 (a) Quantum mechanics (also known as quantum physics or quantum theory) is a branch of physics which deals with physical phenomena at nanoscopic scales where the action is on the order of the Planck constant. It departs from classical mechanics primarily at the quantum realm of atomic and subatomic length scales.

4 (c) The range of masses is from 10^{-30} kg to 10^{55} kg. It is from the mass of an electron to the mass of known universe.

5 (d) Elementary particles are included in quantum physics, not in classical its physics.

6 (a) Microscopic domain includes atomic, molecular, and nuclear phenomena. It can be said as the

study of matter. It includes the study of structure and configuration of atom, nucleus and the constitute particles of atom-electron, proton, neutron, and interaction with elementary particles like electron, photon etc.

7 (b) Science and technology will continue to generate all sorts of new enhancers, and the quest for enhancement is not necessarily unfair or unethical. We humans are inveterate enhancers, striving to increase our intelligence and to improve our memory and powers of perception.

8 (d) Quantitative measurement is centre to the growth of physics because laws of nature happen to be expressible in more precise mathematical equations.

9 (b) Thomas Newcomen's atmospheric engine was the first commercial true steam engine which was used with a piston and further used in 1712 for pumping in a mine. Watt's 10 horsepower engines enabled a wide range of manufacturing machinery to be powered. The steam engines can be sited anywhere in such a way that water, coal, and wood fuel can be obtained. The steam engines became popular for mining and 104 engines were in use by 1733, eventually over 2,000 of engines were installed, thus steam engine is the example where technology predates science.

10 (c) The history of technology is the history of the invention of tools and techniques and is like other sides of the history of humanity. Technology can refer to methods ranging from as simple as language and stone tools to the complex genetic engineering and information technology that has emerged since the 1980s.

11 (c) The United Nations has declared 2005 to be the International Year of Physics. This declaration coincides with the 100^{th} anniversary of physicist Albert Einstein's 'miraculous year'.

12 (b) C.V. Raman helped the growth of science. He received the Nobel Prize for physics in 1930 for the discovery that when light passes through a transparent material, some of the light changes its wavelength. This phenomenon is now called Raman scattering.

13 (c) The kite experiment is a scientific experiment in which a kite with a pointed, conductive wire attached to its apex is flown near thunder clouds to collect electricity from the air and conduct it down the wet kite string to the ground. It was proposed and may have been conducted by Benjamin Franklin with the assistance of his son William Franklin.

14 (b) Electron microscope uses electron for their wave nature.

The electron microscope is a type of microscope that uses a beam of electrons to create an image of the specimen. It is capable of much higher magnifications and has a greater resolving power than a light microscope, allowing it to see much smaller objects in finer detail.

15 (c) SONAR emits ultrasonic waves to navigate, communicate with or detect objects on or under the surface of the water.

16 (d) In 1929, Ernest Orlando Lawrence invented the cyclotron, a device for accelerating nuclear particles to very high velocities without the use of high voltages.

17 (c) Tension is not a fundamental force of nature.

18 (a) Gravitational force is the weakest but has an infinite range.

19 (c) Gravitational force has an infinite range.

20 (c) Gravitational forces and electromagnetic forces follow the inverse square law of distance.

21 (d) This reaction known as **nuclear fusion** converts hydrogen atoms into helium. The by-product of nuclear fusion in the Sun's core is a massive volume of energy that gets released and radiates outward toward the surface of the Sun and then into the solar system beyond it.

22 (d) The weak nuclear force stops a neutron from decaying into a proton and an electron. When this happens, an electron leaves the atom. This is known as β-decay.

23 (c) The nuclear force is nearly independent of whether the nucleons are neutrons or protons. This property is called **charge independence.** The force depends on whether the spins of the nucleons are parallel or antiparallel.

24 (c) In physics, a conservation law states that a particular measurable property of an isolated physical system does not change as the system evolves over time. Exact conservation laws include conservation of energy, conservation of linear momentum, conservation of angular momentum, and conservation of electric charge.

25 (c) The acceleration due to gravity is 1.62 m/s^2 on Moon. This is approximately 1/6th that of the acceleration due to gravity on the Earth (9.81 m/s^2).

26 (a) Laws of nature as expressed in physics as laws and theories are often said to be universal. This means that, so far as we have been able to test them, they apply everywhere and at every time, past, present, and future.

27 (b) $E = mc^2$ is the correct relation given by Einstein.

Where, E stands for energy, m for mass and c for the speed of light (squared).

This was first demonstrated by Albert Einstein's Theory of Special Relativity and famously expressed in his iconic equation.

28 (c) There is no law of conservation of force.

29 (b) Mechanical energy is the sum of the potential and kinetic energies in a system. The principle of the conservation of mechanical energy states that the total mechanical energy in a system (i.e., the sum of the potential and kinetic energies) remains constant as long as the only forces acting are conservative forces.

High-Order Thinking Skill

1 (a) (i) Archimedes – Principle of buoyancy
(ii) W K Roentgen – X-Rays
(iii) Albert Einstein − Theory of Relativity
(iv) James Clerk Maxwell – Electromagnetic theory of Light.

2 (a) In electron microscope the magnification is obtained by electromagnetic fields.

3 (a) Wave picture of light do not explain the photoelectric effect. It was explained by particle theory of light.

4 (b) Some of the most basic features of atomic phenomena were explained by quantum mechanics.

5 (c) Formulating a hypothesis is a possible final step in applying the scientific method.

6 (d) Gravitational force-weakest force; strong nuclear force-strongest force.

7 (d) In a nucleus, strong nuclear force (strongest fundamental force) binds protons and neutrons. The silicon 'chip' triggered the computer revolution in the last three decades of the twentieth century. A most significant area to which physics has and will contribute is the development of alternative energy resources. The fossil fuels of the planet are dwindling fact and there is an urgent need to discover new and affordable sources of energy.

8 (a) When we hold a book in our hand, we are balancing the gravitational force on the book due to the huge mass of the Earth by the 'normal force' provided by our hand.

Assertion and Reasons

1 (c) The study of properties and structure of matter at the small scales of atoms and nuclei and their interaction with different particles is done in the microscopic domain of physics.

2 (c) The mentioned method is called reductionism. Unification is the attempt to explain diverse physical phenomena in terms of a few concepts and laws.

3 (b) The fundamental laws of nature are the same everywhere, whereas the phenomena may be different for various places because of different geographical conditions at different locations.

4 (b) Physics explains diverse physical phenomena in terms of few concepts and laws. The aim is to understand the physical world as manifestation of various universal laws in different domains.

5 (b) Strong nuclear force does not dependent on charge. Strong nuclear force acts equally between two protons, two neutrons, and two electrons. Although electrons are situated outside the nucleus. That is why, electron do no experience strong nuclear force.

6 (c) Mass is always positive, there is no negative mass but the electric charge can be of two types, i.e. positive or negative, so the gravitational force is always attractive and electromagnetic force can be attractive and repulsive. Gravitation force dominates terrestrial phenomena and electric force is largely zero because most of the time matter is electrically neutral by nature.

7 (b) During the nuclear reaction like fission, the difference in mass between the original nucleus and the product nuclei gets converted to energy at a rate governed by the Einstein mass energy equation.

8 (c) The law of derived forces depend on the law of fundamental forces in nature. So, the reason of given assertion is false.

9 (a) Laws of nature like 'law of conservation of energy' etc. do not change with time. So, the reason of assertion is correct.

10 (c) The concept of energy is central to physics and the expressions for energy can be written for every physical system. When all forms of energy e.g. heat, mechanical energy, electrical energy etc., are counted, it turns out that energy is conserved. The general law of conservation of energy is true for all forces and for any kind of transformation between different forms of energy.