Physical world

1. **Science**
   Science is a systematic and organised attempt to acquire knowledge about the surroundings through observations, experiments and verifications.
2. **Scientific Method**
   Several inter-related steps are involved in scientific method. Some of the most significant steps are as follows:
   - The systematic observations
   - Controlled experiments
   - Qualitative and Quantitative Reasoning
   - Mathematical modelling
   - Theoretical prediction(verification and falsification of theory)
3. **Physics**
   Physics is a fundamental science concerned with understanding the natural phenomena that occur in our universe.
   It has many branches such as Mechanics, Electromagnetism, Thermodynamics, Modem Physics, etc. Between 1600 and 1900, three broad areas were developed, which is together called Classical Physics. These three areas of study are classical mechanics, thermodynamics and electromagnetism. But by 1905 it became apparent that classical ideas failed to explain several phenomena. Then some new theories were developed in what is called Modem Physics such as Special Relativity, Quantum Mechanics, etc.
4. **Scope and Excitement of Physics**
   The scope of Physics is very broad and covers a wide range of magnitude of physical quantities such as length, mass, time,r energy, etc.
   It deals with the macroscopic world like galaxies and universe as well as microscopic world like nucleus of an atom and fundamental particles like electrons, protons, neutrons etc.
   Immense excitement is involved in the study of physics since it explains every naturally occuring phenomena with a set of rules, so that clear understanding can be achieved. The challenge to carry out imaginative new experiments to unlock the secrets of nature, to verify or refute theories, is really exciting.
5. **Physics in Relation to Other Sciences**
   Physics is a very significant branch of science which plays a crucial role in understanding the developments pertaining to the other branches of science such as Chemistry, Biology etc.
   (i) Physics in relation to Mathematics. Study of physical variables led to the idea of differentiation, integration and differential equation. Meaningful interpretation of Mathematics becomes Physics.
   (ii) 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.

Understanding the bonding and the chemical structure of substances is easy with the help of the concept of interactions between various particles.
(iii) Physics in relation to Astronomy. Optical telescopes of reflecting and refracting type enabled man to explore the space around. Discoveries like radio telescopes have revolutionised the study of Astronomy.
(iv) Physics in relation to Biology. The conceptual study of pressure and its measurement has helped us to know blood pressure and hence the functioning of heart. Invention of X-rays developed the field of diagnosis. Electron and optical microscopic designs have revolutionised the study of medical science.
(v) Physics in relation to Meteorology. The discoveries regarding the study of pressure variations help us to forecast the weather.
Various other inventions of physics have opened new vistas of study in the field of sciences and social sciences.

6. **Physics in Relation to Technology and Society**
Advancement in physics has led to new technologies and vice-versa. Sometimes technology gives rise to new dimension of physics; at other times physics generates new technology. In fact, the technological development is closely related to the application of science and physics in particular. Physics has a dominant influence on society. It has helped the human being to develop its ideas. Development of digital communication systems, rapid mass transport system, lasers making bloodless surgeries, etc., has made human life easy and pleasant.
    - There are four fundamental forces in nature that govern the diverse phenomena of the microscopic and macroscopic world. These are
    - the 'gravitational force',
    - the 'electromagnetic force';
    - the 'strong nuclear force',
    - the 'weak nuclear force

Ordered from **strongest** to **weakest**, the **forces** are 1) the strong nuclear **force**, 2) the electromagnetic **force**, 3) the weak nuclear **force**, and 4) gravitational force .

Unification of forces is a basic quest in physics. The electromagnetic and the weak nuclear forces have now been qqunified and are seen as aspects of a single 'electro-weak' force. Attempts are being made to unify electro-weak and the strong force.

- Conservation of energy, momentum, angular momentum, charge, etc., are considered to be the fundamental laws in physics. Conservation laws have a deep connectionn with

symmetries of nature. Symmetries of space and time, and other types of symmetries play a central role in modem theories of fundamental forces in nature.

7. **IMPORTANT TABLES**

Table 1.1 Some Physicists from Different Countries of the World and their Major Contributions

Name	*Major contribution/discovery*	*Country of Origin*
Archimedes	Principle of buoyancy; Principle of the lever	Greece
Galileo Galilei	Law of inertia	Italy
Christiaan Huygens	Wave theory of light	Holland
Isaac Newton	Universal law of gravitation; Laws of motion; Reflecting telescope	U.K.

Michael Faraday	Laws of electromagnetic induction	U.K.
James Clerk Maxwell	Electromagnetic theory; Light-an electromagnetic wave	U.K.
Heinrich Rudolf Hertz	Generation of electromagnetic waves	Germany
J.C. Bose	Ultra short radio waves	India
W.K. Roentgen	X-rays	Germany
J.J. Thomson	Electron	U.K.
Marie Sklodowska Curie	Discovery of radium and polonium; Studies on natural radioactivity	Poland
Albert Einstein	Explanation of photoelectric effect; Theory of relativity	Germany
Victor Francis Hess	Cosmic radiation	Austria
R.A. Millikan	Measurement of electronic charge	U.S.A.
Ernest Rutherford	Nuclear model of atom	New Zealand
Niels Bohr	Quantum model of hydrogen atom	Denmark
C.V. Raman	Inelastic scattering of light by molecules	India
Louis Victor de Broglie	Wave nature of matter	France
M.N. Saha	Thermal ionisation	India
S.N. Bose Wolfgang Pauli	Quantum statistics Exclusion principle	India Austria

Enrico Fermi	Controlled nuclear fission	Italy
Werner Heisenberg	Quantum mechanics; Uncertainty principle	Germany
Paul Dirac	Relativistic theory of electron; Quantum statistics	U.K.
Edwin Hubble	Expanding universe	U.S.A.
Ernest Orlando Lawrence	Cyclotron	U.S.A.
James Chadwick	Neutron	U.K.
Hideki Yukawa	Theory of nuclear forces	Japan
Homi Jehangir Bhabha	Cascade process of cosmic radiation	India
Lev Davidovich Landau	Theory of condensed matter; Liquid helium	Russia
S. Chandrasekhar	Chandrasekhar limit, structure and evolution of stars	India
John Bardeen	Transistors; Theory of super-conductivity	U.S.A.
C.H. Townes	Maser; Laser	U.S.A.
Abdus Salam	Unification of weak and electromagnetic interactions	Pakistan

Table 1.2. Link between technology and physics

Technology	*Scientific principle(s)*
Steam engine	Laws of thermodynamics
Nuclear reactor	Controlled nuclear fission
Radio and Television	Generation, propagation and detection of electromagnetic waves
Computers	Digital logic
Lasers	Light amplification by stimulated emission of radiation
Production of ultra-high magnetic fields	Superconductivity
Rocket propulsion	Newton's laws of motion
Electric generator	Faraday's laws of electromagnetic induction
Hydroelectric power	Conversion of gravitational potential energy into electrical energy
Aeroplane	Bernoulli's principle in fluid dynamics
Particle accelerators	Motion of charged particles in electromagnetic fields
Sonar	Reflection of ultrasonic waves
Optical fibres	Total internal reflection of light
Non-reflecting coatings	Thin film optical interference
Electron microscope	Wave nature of electrons
Photocell	Photoelectric effect
Fusion test reactor (Tokamak)	Magnetic confinement of plasma
Giant Metrewave Radio Telescope (GMRT)	Detection of cosmic radio waves
Bose-Einstein condensate	Trapping and cooling of atoms by laser beams and magnetic fields.

Table 1.3. Fundamental forces of nature

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 ($\sim 10^{-15}$m)	Nucleons, heavier elementary particles

Table 1.4. Progress in unification of different forces/domains in nature

Name of the physicist	*Year*	*Achievement in unification*
Isaac Newton	1687	Unified celestial and terrestrial mechanics; showed that the same laws of motion and the law of gravitation apply to both the domains.
Hans Christian Oersted Michael Faraday	1820 1830	Showed that electric and magnetic phenomena are inseparable aspects of a unified domain: electromagnetism.
James Clerk Maxwell	1873	Unified electricity, magnetism and optics; showed that light is an electromagnetic wave.
Sheldon Glashow, Abdus Salam, Steven Weinberg	1979	Showed that the 'weak' nuclear force and the electro-magnetic force could be viewed as different aspects of a single electro-weak force.
Carlo Rubia, Simon Vander Meer	1984	Verified experimentally the predictions of the theory of electro-weak force.