Chapter 1 : PHYSICAL WORLD

SCIENCE:

The word science has been derived from a Latin word *'scientia'* which means 'to know'. *Hence, science may be defined as the systematic study of facts, events and happenings around us is called science.*

PHYSICS:

The word physics has been derived from a Greek word 'fusis' which means 'nature'. Hence, *physics may be defined as the branch of science which deals with the study of nature and natural phenomena.*

SCIENTIFIC METHOD:

To know fully about anything we have to use the following steps:

1. Systematic observations
2. Controlled experiments
3. Qualitative and quantitative reasoning
4. Mathematical modeling
5. Prediction and verification of theories

These steps taken together are known as scientific method.

UNIFICATION

Effort to explain different physical phenomena *in terms of a few concepts and laws in physics is known as unification.*

For example, the same law of gravitation (given by Newton) describes the fall of an apple to the ground, the motion of the moon around the earth and the motion of planets around the sun.

REDUCTION

Effort is to derive the properties of a bigger, more complex, system from the properties and interactions of its basic simpler parts is called reduction or reductionism.

For example, the subject of thermodynamics, developed in the nineteenth century, deals with bulk systems in terms of macroscopic quantities such as temperature, internal energy, entropy, etc.

SCOPE OF PHYSICS

The idea of scope of physics can be obtained by study of following three domains (fields) in physics:

1. Macroscopic domain: It deals with the study of large bodies and their phenomena. E.g. astronomical phenomena and terrestrial phenomena.
2. Microscopic domain: it deals with the study of very small particles like electron, protons, neutrons, α-particles and structure of atom.
3. Mesoscopic domain: It deals with the study of a few tens or hundreds of atoms.

It covers a very large range of magnitude of physical quantities like length, mass, time, energy, etc.
e.g. range of length is from 10^{-14}m (study of electrons etc.) to 10^{26}m (size of universe).Range of time is from 10^{-22}s (time taken by light to cross nuclear diameter) to 10^{18}s (age of sun).The range of masses goes from, 10^{-30} kg (mass of an electron) to 10^{55} kg (mass of known observable universe)

EXCITEMENT OF PHYSICS

Physics is exciting in many ways as-

1. A large number of complex phenomena of nature can be explained on the basis of some fundamental laws of physics.
2. Physics has opened and detected many secrets of nature.

Except these reason for excitement of physics can vary from person to person.

HYPOTHESIS, AXIOMS AND MODELS

A hypothesis is a supposition without assuming that it is true. It cannot be proved but it can be verified. e.g. The universal law of gravitation, because it cannot be proved. It can be verified and substantiated by experiments and observations.

An axiom is a self-evident truth

Model is a theory proposed to explain observed phenomena.
For example Behr's model of hydrogen atom, in which Bohr assumed that an electron in the hydrogen atom follows certain rules

PHYSICS, TECHNOLOGY AND SOCIETY

Technology is the application of the laws in physics for practical purposes.

The invention of steam engine, nuclear reactors, Production of electricity from solar energy and geothermal energy had a great impact on human civilization.

Also, physics giving rise to technology is the integrated chip(IC) and processors which grew the computer industry greatly in the last two decades. Computers have improved production techniques and lower production costs.

The lawful purpose of technology is to serve people. Our society is becoming more and more science-oriented. We can become better members of society by understanding of the basic laws of physics.

LINK BETWEEN TECHNOLOGY AND PHYSICS

Technology	Scientific principle(s)
Aeroplane	Bernoulli.s principle in fluid dynamics
Computers	Digital logic
Electric generator	Faraday.s laws of electromagnetic induction
Electron microscope	Wave nature of electrons
Hydroelectric power	Conversion of gravitational pot. energy into electrical energy
Lasers	Light amplification by stimulated emission of radiation
Non-reflecting coatings	Thin film optical interference
Nuclear reactor	Controlled nuclear fission
Optical fibres	Total internal reflection of light
Particle accelerators	Motion of charged particles in electromagnetic fields
Photocell	Photoelectric effect
Production of ultra high magnetic fields	Superconductivity
Radio and Television	Generation, propagation and detection of e.m. waves

Technology	Scientific principle(s)
Rocket propulsion	Newton.s laws of motion
Sonar	Reflection of ultrasonic waves
Steam engine	Laws of thermodynamics

LIST OF PHYSICISTS FROM DIFFERENT COUNTRIES AND THEIR CONTRIBUTIONS

Name	Major contribution/discovery	Country of Origin
Abdus Salam	Unification of weak and electromagnetic interactions	Pakistan
Albert Einstein	Explanation of photoelectric effect;Theory of relativity	Germany
Archimedes	Principle of buoyancy; Principle of the lever	Greece
C.H. Townes	Maser; Laser	U.S.A.
C.V. Raman	Inelastic scattering of light by molecules	India
Christiaan Huygens	Wave theory of light	Holland
Edwin Hubble	Expanding universe	U.S.A.
E. Fermi	Controlled nuclear fission	Italy
E. O. Lawrence	Cyclotron	U.S.A.
E. Rutherford	Nuclear model of atom	New Zealand
Galileo	Galilei Law of inertia	Italy
H. R. Hertz	Generation of electromagnetic waves	Germany
Hideki Yukawa	Theory of nuclear forces	Japan
Homi Jehangir Bhabha	Cascade process of cosmic radiation	India
Isaac Newton	Universal law of gravitation; Laws of motion etc	U.K.
J.C. Bose	Ultra short radio waves	India
J.J. Thomson	Electron	U.K.
James Chadwick	Neutron	U.K.
J. C. Maxwell	Electromagnetic theory	U.K.
John Bardeen	Transistors; Theory of super conductivity	U.S.A.
L. V. de Borglie	Wave nature of matter	France
M.N. Saha	Thermal ionisation	India
Marie Sklodowska Curie	radium and polonium; Studies on natural radioactivity	Poland
Michael Faraday	Laws of electromagnetic induction	U.K.
Niels Bohr	Quantum model of hydrogen atom	Denmark
Paul Dirac	Relativistic theory of electron; Quantum statistics	U.K.
R.A. Millikan	Measurement of electronic charge	U.S.A.
S. Chandrasekhar	Chandrasekhar limit, structure & evolution of stars	India
S.N. Bose	Quantum statistics	India
V. F. Hess	Cosmic radiation	Austria
W.K. Roentgen	X-rays	Germany
Werner Heisenberg	Quantum mechanics; Uncertainty principle	Germany
Wolfgang	Pauli Exclusion principle	Austria

FUNDAMENTAL FORCES IN NATURE

Sir Issac Newton was the first who give an exact definition for force.*"Force is the external agency applied on a body to change its state of rest and motion".*

There are four basic forces in nature.

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

1. Gravitational force

Newton's law of gravitation, the gravitational force of attraction between any two bodies in universe is directly proportional to the product of the masses and inversely proportional to the square of the distance between them.

Porperties:

- It is the force between any two objects in the universe.
- It is an attractive force by virtue of their masses.
- By Gravitational force is the weakest force among the fundamental forces of nature but control the structure of universe
- Unlike the other forces, gravity works universally on all matter and energy, and is universally attractive.

2. Electromagnetic force

It is the force between charged particles such as the force between two electrons, or the force between two current carrying wires.

Porperties:

- It is attractive for unlike charges and repulsive for like charges.
- The electromagnetic force obeys inverse square law.
- It is very strong compared to the gravitational force.
- It is the combination of electrostatic and magnetic forces.

3. Strong nuclear force

This force holds the protons and neutrons together in the nucleus of an atom.

It is the strongest of all the basic forces of nature. It, however, has the shortest range, of the order of 10^{-15} m.

4. Weak nuclear force

Weak nuclear force is important in certain types of nuclear process such as β-decay. This force is stronger than the gravitational force but much weaker than strong nuclear force.