

# Chapter - 1 Physical World

- The word Science originates from the Latin verb Scientia meaning 'to know'
- 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.

## THE STEPS IN SCIENTIFIC METHOD

- Systematic observations
- controlled experiments
- qualitative and quantitative reasoning
- mathematical modelling
- Prediction and verification or falsification of theories.

## PHYSICS

- Physics is a basic discipline in the category of Natural Sciences.
- Physics as a study of the basic laws of nature and their manifestation in different natural phenomena.
- In Physics, we attempt to explain diverse physical phenomena in terms of a few concepts and laws.
- The two approaches of physics are unification and reductionism.
- Attempting to explain diverse physical phenomena with a few concepts and laws is unification.
- An attempt to explain a macroscopic system in terms of its microscopic constituents is reductionism.

## SCOPE OF PHYSICS

### Macroscopic domain

- The macroscopic domain includes phenomena at the laboratory, terrestrial and astronomical scales.
- Classical Physics deals mainly with macroscopic phenomena and includes subjects like Mechanics, Electrodynamics, Optics and Thermodynamics.
- Mechanics -founded on Newton's laws of motion

- Electrodynamics – deals with electric and magnetic phenomena associated with charged and magnetic bodies.
- Optics – deals with the phenomena involving light
- Thermodynamics. – it deals with systems in macroscopic equilibrium and is concerned with changes in internal energy, temperature, entropy, etc., of the system through external work and transfer of heat.

### Microscopic domain

- The microscopic domain includes atomic, molecular and nuclear phenomena.
- Quantum Theory is currently accepted as the proper framework for explaining microscopic phenomena.

### Link between technology and physics

| Technology                              | Scientific principle                                           |
|-----------------------------------------|----------------------------------------------------------------|
| Steam engine                            | Laws of thermodynamics                                         |
| Nuclear reactor                         | Controlled nuclear fission                                     |
| Radio and TV                            | Generation, propagation and detection of electromagnetic waves |
| Computers                               | Digital logic                                                  |
| Lasers                                  | Light amplification by stimulated emission of radiation        |
| Production of ultrahigh 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 in to 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                                   |
| Electron microscope   | Wave nature of electrons                                             |
| Photocell             | Photoelectric effect                                                 |

## FUNDAMENTAL FORCES IN NATURE

- Gravitational force
- Electromagnetic force
- Strong nuclear force
- Weak Nuclear force

### Gravitational force

- Force of mutual attraction between two weak bodies due to their masses.
- It is a universal force.
- It is a non-contact force.
- Obeys inverse square law.
- Weakest force of all forces.
- Long range force.
- Independent of intervening medium.

### **Electromagnetic force**

- The force between charged particles.
- May be repulsive or attractive.
- Depends on the intervening medium.
- Large compared to gravitational force.
- Acts over large distances.
- Electric force between two protons, for example, is  $10^{36}$  times the gravitational force between them, for any fixed distance.
- The forces like 'tension', 'friction', 'normal force', 'spring force', etc. are electromagnetic.

### **Strong nuclear force**

- The strong nuclear force binds protons and neutrons in a nucleus.
- Attractive in nature.
- Strongest force in nature-about 100 times the electromagnetic force in strength.
- It is charge-independent and acts equally between a proton and a proton, a neutron and a neutron, and a proton and a neutron.
- Short range force-about nuclear dimensions.

### **Weak nuclear force**

- Appears only in certain nuclear processes such as the  $\beta$ -decay of a nucleus.
- In  $\beta$ -decay, the nucleus emits an electron and an uncharged particle called neutrino.
- The electron and neutrino interacts through weak force.
- not as weak as the gravitational force, but much weaker than the strong nuclear and electromagnetic forces.
- The range of weak nuclear force is exceedingly small, of the order of  $10^{-16}\text{m}$ .

**Ratio of strengths of forces**

**Strong force > electromagnetic > force > gravitational**

**The ratio of strengths is 1:  $10^{-2}$ :  $10^{-13}$ :  $10^{-39}$**