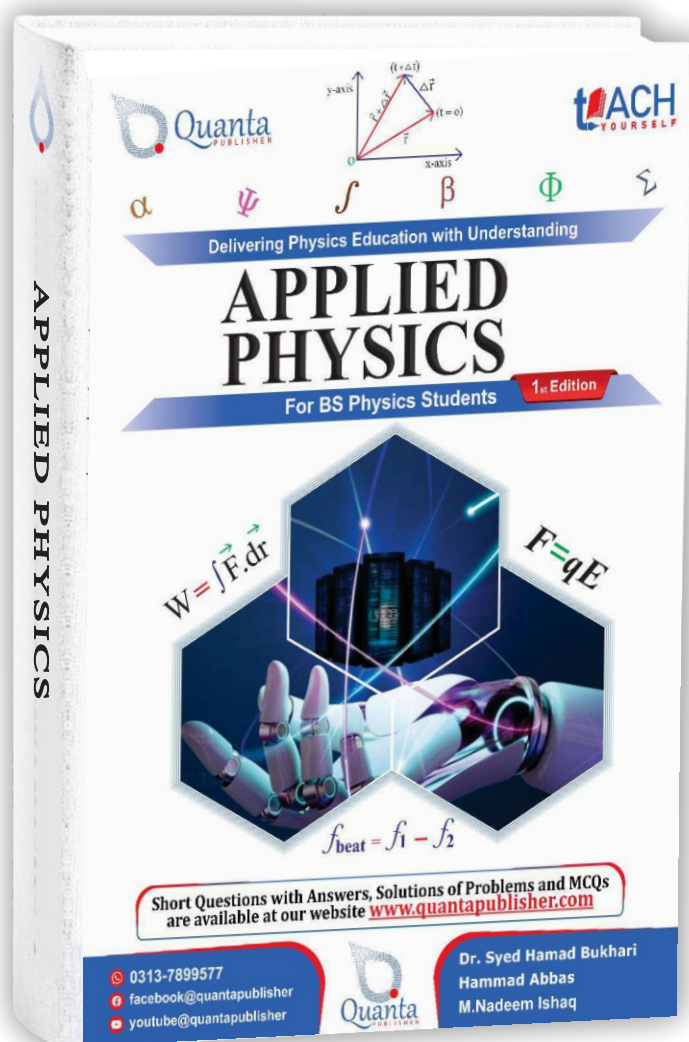




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**Quanta** Publisher, 2660/6C Raza Abad, Shah Shamas, Multan.

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# Chapter 1

## Electric Charge and Electric Force

The electromagnetic force is one of the basic force in the nature that is responsible for the structure of atoms and for the binding of atoms in molecules and solids. Many properties of materials that we have studied so far are electromagnetic in their nature, such as the elasticity of solids and the surface tension of liquids. The spring force, friction, and the normal force all originated with the electromagnetic force between atoms. In open words, all the shapes of objects in nature are stable due to electromagnetic force. In this chapter, we begin with a discussion of electric charge, their electric field, some properties of charged bodies, and the fundamental electric force between two charged bodies.

### 1.1 Electric Charge

*The physical entity which is responsible for all the electromagnetic properties of the matter and also experiences a force when placed in electromagnetic field is known as charge.* For example after you pass a plastic comb through your hair a few times, you will find that the comb can exert a force on individual strands of your hair. You may also observe that, once the strands of hair are attracted to the comb and come into contact with it, they may no longer be attracted to it. It seems reasonable to conclude that the attraction between the comb and the hair is a result of some physical entity being transferred from one to the other when they rub together, with the same physical entity being transferred back again to neutralize the attraction when they come into contact. This physical entity is called electric charge, and today we understand this transfer on the basis of electrons that can be removed from the atoms of one object and attached to the atoms of the other object. Note the net electric charge of an object is usually represented by the symbol  $q$ . The charge is a scalar quantity. It can be positive or negative, depending on whether the object has a net positive or negative charge. Electric charge is measured in units of Coulombs ( $C$ ).

# Chapter 2

# Electric Potential and Electric Current

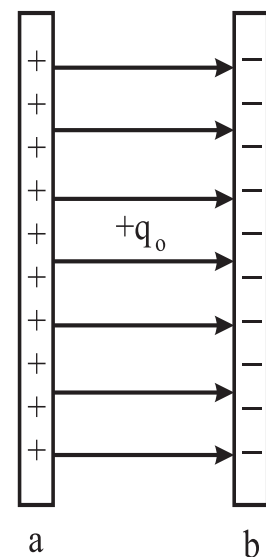
## 2.1 Electric Potential Energy Difference

The potential energy difference between two points is equal to negative of work done by electrostatic force (conservative) in moving charge  $q$  between two points, in an electric field, keeping constant velocity. Change in electrostatic P.E. is given by work energy principle.

$$U = W \tag{2.1}$$

If test charge  $q$  moves in electric field  $E$  from point  $a$  to  $b$  under the action of electrostatic force  $F = q E$  then by Eq. (2.1),

$$U = \int_a^b F dr$$
$$U_b - U_a = q \int_a^b E dr$$
$$U_b - U_a = q \int E dr \tag{2.2}$$



**Fig. 2.1.** A positive test charge is placed between two oppositely charged plates.

Because electric force is conservative, the integral is independent of path and depends only on initial position  $a$  and final position  $b$ . If electric field is produced due to positive point charge  $q$ , then by Eq.(2.2),

## Chapter 3

# Electromagnetic Induction and Maxwells Equation

### 3.1 Magnetic Field

The space around a permanent magnet or current carrying conductor or moving charge where another magnet experience a magnetic force is called magnetic field . A moving electric charge or an electric current sets up a magnetic field  $B$  which can then exert a magnetic force on other moving charges or current.

#### Magnetic Field Lines

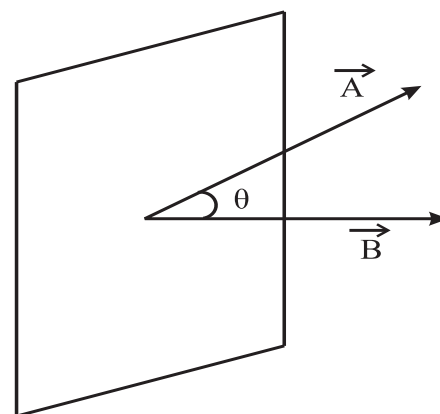
The line or path along which isolated north-pole moves in magnetic field is called line of magnetic force .

It is directed away from north-pole and is directed towards south-pole.

The tangent to the magnetic line at any point gives direction of magnetic induction  $B$  at that point.

The inter spacing between magnetic field lines at any point gives an idea about strength of magnetic field at that point.

If magnetic field lines are close, field will be strong and if lines are apart, field will be weak.



**Fig. 3.1.** The schematic picture of magnetic flux.



# Chapter 4

## Electronics

### 4.1 Semi-conductors

*A semiconductor is an element with electrical properties between those of a conductor and an insulator. In term of energy bands, the semiconductor may be defined as those materials, which at room temperature, have*

**Partially filled valence band,**

**Partially filled conduction band,**

**A very narrow (forbidden) energy gap ( $E_g \approx 1eV$ ) between conduction and valence bands.** A small energy gap means that a small amount of energy is required to free the electrons by moving them from the valence band into the conduction band. Common examples of semiconductors are Silicon and Germanium which have forbidden energy gaps of  $0.72 eV$  and  $1.1 eV$ , respectively.

#### Temperature Effect on Conductivity of Semiconductors

*A pure semiconductor behaves as insulator at  $0 K$  but the conductivity of semiconductor increases with the increase in temperature. The electric conductivity of semiconductors is in the range of  $10^{-3}$  to  $10^{-6} \text{ cm}^{-1}$ .*

As the temperature rises, electrons gain energy and leave the valence band to rise up to the conduction band. When an electron gains enough energy, greater than the band gap energy, and jumps to the upper band, it is free to move, becoming a carrier and therefore increasing the conductivity of the semiconductor. When electrons leave the valence band they leave behind a hole which can move about the crystal, also adding to the conductivity. So, conduction electrons are freely flow in conduction band and positive holes flow in the valence band.

## Chapter 5

# Modern and Nuclear Physics

### 5.1 Bohrs Theory of Hydrogen Atom

At the beginning of the 20th century, scientists were perplexed by the failure of classical physics to explain the characteristics of atomic spectra. Why did atoms of a given element exhibit only certain spectral lines? Furthermore, why did the atoms absorb only those wavelengths that they emitted? In 1913, Niels Bohr provided an explanation of atomic spectra that includes some features of the currently accepted theory. Bohrs theory contained a combination of ideas from Plancks original quantum theory, Einsteins photon theory of light, early models of the atom, and Newtonian mechanics. Using the simplest atom, hydrogen, Bohr described a model of what he thought must be the atoms structure. His model of the hydrogen atom contains some classical features, as well as some revolutionary postulates that could not be justified within the framework of classical physics.

The basic ideas of the Bohr theory as it applies to the hydrogen atom are as follows:

1. The electron moves in circular orbits around the proton under the influence of the Coulomb force of attraction.
2. Only certain electron orbits are stable. These stable orbits are ones in which the electron does not emit energy in the form of radiation. Hence, the total energy of the atom remains constant, and classical mechanics can be used to describe the electrons motion. Note that this representation is completely different from the classical model of an electron in a circular orbit. According to classical physics, the centripetally accelerated electron should continuously emit radiation, losing energy and eventually spiraling into the nucleus.

# Chapter 6

## Waves and Oscillations

### 6.1 Interference

Superposition of two waves having same frequency, same wavelength and moving in the same direction will result in the phenomenon of interference. Interference is of two types.

#### **1. Constructive Interference**

If the two waves reach a point in phase i.e. crest of one wave falls on the crest of the other wave and trough of one wave falls on the trough of the other wave then the two waves reinforce each other and the net wave effect increases i.e. the net intensity is greater than the intensity of individual wave. Such interference is called constructive interference.

#### **2. Destructive Interference**

If the two waves reach a point out of phase i.e. crest of one wave falls on the trough of the other, then the two waves cancel each others effect and the net intensity is less than the intensity of individual wave. This type of interference is called destructive interference.

#### **Coherence Source**

Coherent source of light are those sources which emit a light wave having the same frequency, wavelength and in the same phase or they have a constant phase difference. A coherent source forms sustained interference pattern when superposition of waves occur and the position of maximum and minimum are fixed.

### 6.2 Youngs Double Slit Experiment

Huygens wave theory of light was experimentally confirmed by a British scientist Thomas Young in 1801. This experiment gave very strong support to the wave theory of light. Youngs double slit experiment is shown in Fig.(6.1). When monochromatic light passing through two narrow slits  $S_1$  and  $S_2$  illuminates a distant screen. A screen is used to

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