MOVING CHARGES AND MAGNETISM

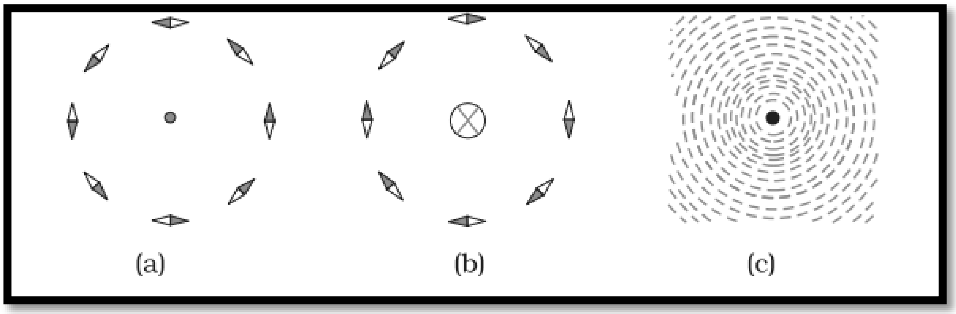
INTRODUCTION OF MOVING CHARGE

INTRODUCTION

Both Electricity and Magnetism have been known for more than 2000 years. However, it was only about 200 years ago, in 1820, that it was realized that they were intimately related*. During a lecture demonstration in the summer of 1820, Danish physicist Hans Christian Oersted noticed that a current in a straight wire caused a noticeable deflection in a nearby magnetic compass needle. He investigated this phenomenon. He found that the alignment of the needle is tangential to an imaginary circle which has the straight wire as its center and has its plane perpendicular to the wire. This situation is depicted. It is noticeable when the current is large and the needle sufficiently close to the wire so that the earth's magnetic field may be ignored. Reversing the direction of the current reverses the orientation of the needle. The deflection increases on increasing the current or bringing the needle closer to the wire. Iron filings sprinkled around the wire arrange themselves in concentric circles with the wire as the center. Oersted concluded that moving charges or currents produced a magnetic field in the surrounding space

Following this, there was intense experimentation. In 1864, the laws obeyed by electricity and magnetism were unified and formulated by

who then realized that light was electromagnetic waves. Radio waves were discovered by Hertz, and produced by J.C.Bose and G. Marconi by the end of the 19th century. A remarkable scientific and technological progress took place in the 20th century. This was due to our increased understanding of electromagnetism and the invention of devices for production, amplification, transmission and detection of electromagnetic waves.



The magnetic field due to a straight long current-carrying wire. The wire is perpendicular to the plane of the paper. A ring of compass needles surrounds the wire. The orientation of the needles is shown when (a) the current emerges out of the plane of the paper, (b) the current moves into the plane of the paper. (c) The arrangement of iron filings around the wire. The darkened ends of the needle represent north poles. The effect of the earth's magnetic field is neglected.

In this chapter, we will see how magnetic field exerts forces on moving charged particles, like electrons, protons, and current-carrying wires. We shall also learn how currents produce magnetic fields. We shall see how particles can be accelerated to very high energies in a cyclotron. We shall study how currents and voltages are detected by a galvanometer.

In this and subsequent Chapter on magnetism, we adopt the following convention: A current or a field (electric or magnetic) emerging out of the plane of the paper is depicted by a dot (¤). A current or a field going into the plane of the paper is depicted by a cross

(b) correspond to these two situations, respectively

MAGNETIC FORCE ON MOVING CHARGE

When a charge q moves with velocity $\vec{V}$ in a magnetic field $\vec{B}$ then the magnetic force experienced by moving charge is given by following formula:

$\vec{F} = q\left(\vec{V} \times \vec{B}\right)$ Put q with sign.

$\vec{V}$: Instantaneous velocity

$\vec{B}$: Magnetic field at that