Grade 12 physics V2

SPH4U

Qinghao Hu

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Contents

Chapter 1

Electricity and Magnetism

1.1 The Magnetic Force on a Straight Conductor

1.1.1 Definitions

Theorem 1.1.1
The magnetic force on a straight conductor can be described by this formula:

$$F_M = BIL\sin\theta$$

F_M is the magnitude of the magnetic force on the straight conductor (in N)
B is the strength of the magnetic field that the conductor is in(in T)
I is the current flowing through the conductor in A
L is the length of the conductor that is the magnetic field (in m)
θ is the angle in between the current and the magnetic field

Derive a formula for the magnetic force on the conductor

Lemma 1.1.2
The magnitude of the magnetic force of one charged particle in the conductor can be evaluated by this formula:

$$F_{M(single\ charge)} = |q|\,vB\sin\theta \tag{1.1}$$

Lemma 1.1.3
If one of the charged particles travels from one end of the conductor to the other end, we can rewrite v into

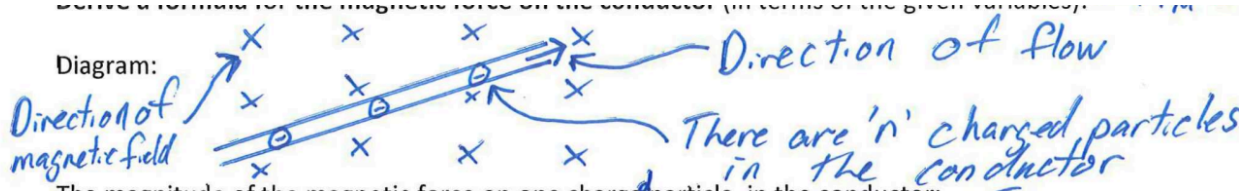
$$v = \frac{L}{\Delta t} \tag{1.2}$$

Lemma 1.1.4
Current is defined as the amount of charge that passes through a location, per unit time. In the time of Δt, n charges pass through the end of the conductor

$$I = \frac{nq}{\Delta t} \tag{1.3}$$

Proof. Assume we have a straight conductor with these parameters in magnetic field:

A length of L
A magnetic Field strength of B
A current of I
Angle between the current and the magnetic field: θ



The F_M on all of the charged particles in the conductor will be the sum of all the F_M on the individual charged particles. Each particle will experience an idential F_M because each particle has the same velocity and charge. Also the magnetic field that the conductor is in is uniform.

So we can multiple 1.1 by n:

$$F_{M(\text{on all charge})} = n \times |q|\,vB\sin\theta \tag{1.4}$$

Sub 1.2 into 1.4:

$$F_{M(\text{all charge})} = n \times \frac{|q|}{\Delta t}LB\sin\theta \tag{1.5}$$

Sub 1.3 into 1.5

$$F_{M(\text{all charge})} = ILB\sin\theta$$

□

The direction of the force

If you want to use the Right hand Rule # 3, you should point your thumb to the direction of the current flow

In the contrary, if you want to use Left hand Rule # 3, you should point your thumb to the direction of the electron flow

1.1.2 What is Tesla

1 Tesla is the strength of the magnetic field that will cause a force of 1 Newton to be exerted one a 1m long straight conductor that has a current of 1 A

Proof.

$$F_M = BIL\sin\theta(\theta = 90^\circ)$$
$$B = \frac{F_M}{IL}$$
$$1T = \frac{1N}{1A \times 1m}$$

□

If we have 2 Tesla of magnetic Field Strength:

$$2T = \frac{2N}{1A \times 1m}$$