Al-Mustaqbal University college

Medical Physics Department

Electricity and Magnetism

Lecture First

Electric Charge and the Structure of Matter

Sarah mohammed

2021-2022

Electric charge, Charge is conserved, Electric Charge and the Structure of Matter

1- Introduction

You are surrounded by devices that depend on the physics of electromagnetism, which is the combination of electric and magnetic phenomena. This physics is at the root of computers, television, radio, telecommunications, household lighting, and even the ability of food wrap to cling to a container. This physics is also the basis of the natural world. Not only does it hold together all the atoms and molecules in the world, it also produces lightning, auroras, and rainbows. The physics of electromagnetism was first studied by the early Greek philosophers, who discovered that if a piece of amber is rubbed and then brought near bits of straw, the straw will jump to the amber. We now know that the attraction between amber and straw is due to an electric force. The Greek philosophers also discovered that if a certain type of stone (a naturally occurring magnet) is brought near bits of iron, the iron will jump to the stone. We now know that the attraction between magnet and iron is due to a magnetic force.

From these modest origins with the Greek philosophers, the sciences of electricity and magnetism developed separately for centuries until 1820, in fact, when Hans Christian Oersted found a connection between them: an electric current in a wire can deflect a magnetic compass needle. Interestingly enough, Oersted made this discovery, a big surprise, while preparing a lecture demonstration for his physics students. The new science of electromagnetism was developed further by workers in many countries. One of the best was Michael Faraday, a truly gifted experimenter

with a talent for physical intuition and visualization. That talent is attested to by the fact that his collected laboratory notebooks do not contain a single equation. In the mid-nineteenth century, James Clerk Maxwell put Faraday's ideas into mathematical form, introduced many new ideas of his own, and put electromagnetism on a sound theoretical basis.

2- Electric charge

Electric Charge The strength of a particle's electrical interaction with objects around it depends on its electric charge (usually represented as q), which can be either **positive** or **negative**. Particles with the same sign of charge repel each other, and particles with opposite signs of charge attract each other. An object with equal amounts of the two kinds of charge is electrically neutral, whereas one with an imbalance is electrically charged and has an excess charge.

Two Types. There are two types of electric charge, named by the American scientist and statesman Benjamin Franklin as positive charge and negative charge.

Q/ How to know what type of charge is in the body?

Through an electroscope.

3-Charge is conserved

The law of conservation of charge is very useful. It tells us that the net charge in a system is the same before and after any interaction within the system. Of course, we must ensure that no external charge enters the system during the interaction and that no internal charge leaves the system. Mathematically, conservation of charge can be expressed as

$$q_{\text{initial}} = q_{\text{final}}$$

where q_{initial} is the net charge of the system before the interaction,

and q_{final}, is the net charge after the interaction.

The **law of conservation of charge** states that electric charge can neither be created nor destroyed. In a closed system, the amount of charge remains the same. When something changes its charge it doesn't create charge but transfers it.

First is the principle of conservation of charge: The algebraic sum of all the electric charges in any closed system is constant.

The second important principle is: The magnitude of charge of the electron or proton is a natural unit of charge.

Every observable amount of electric charge is always an integer multiple of this basic unit. We say that charge is quantized.

$$q = Ne$$

Example 1: How many electrons are there in one coulomb of negative charge?

Reasoning The negative charge is due to the presence of excess electrons, since they carry negative charge. Because each electron has a charge whose magnitude is e = 1.60 $*10^{-19}$ C the number of electrons is equal to the charge magnitude of one coulomb (1.00 C) divided by e.

Solution The number N of electrons is

$N=q/e =$

4- Atomic Structure

All matter is composed of **atoms**, each of which has a central **nucleus** and one or more electrons that travel in orbits around the nucleus, like satellites around the earth. The nucleus contains one or more **positively** charged particles called **protons**. The positive charge of a proton is 'opposite' to the negative charge of an electron, in the sense that the total, or net, charge of the combination is zero. Thus, an atom that has the same number of electrons in orbit as it has protons in its nucleus is **electrically neutral**. The nucleus of every atom except that of hydrogen also contains one or more neutrons, which carry no electrical charge. The number of protons and neutrons in the nucleus of an atom uniquely determines the element it represents - iron, copper, oxygen, and so on - and all the atoms of a given element have identical nuclei.

Summary of Subatomic Particles

Proton	Neutron	Electron
In nucleus	In nucleus	Outside nucleus
Tightly Bound	Tightly Bound	Weakly Bound
Positive Charge	No Charge	Negative Charge
Massive	Massive	Not very massive