

Chapter 1

Electrical Fundamentals



Unit 1 – Matter

Unit 2 – Electron Theory

Unit 3 – Magnetism

Unit 4 – Electricity

Unit 5 – Electromagnetism

Unit 6 – Uses of Electromagnetism

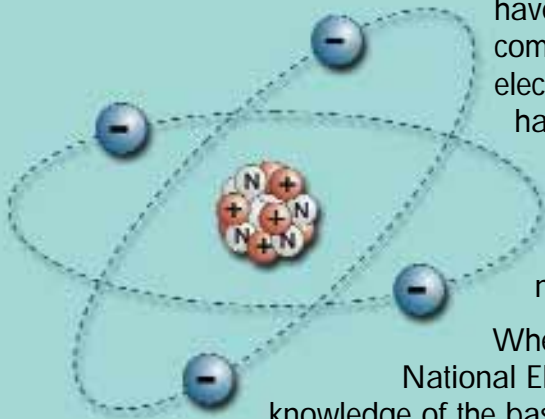




Unit 1 – Matter

Introduction

Do you know where electricity comes from? To be able to say yes to that question, you must understand a bit about the physics of matter. What value does a brief study of the nature of matter have for the student of electrical theory? The understanding that comes from that study lays the foundation for understanding electrical theory. Only when you know the theory can you truly have confidence in the practical aspects of your electrical work.



Don't discount the role of physics in electrical theory and application. Many of the electrical innovations of the 20th Century — things such as radar — originated with physicists, not electrical engineers.

When people have a hard time understanding and applying the National Electrical Code (NEC), the root cause is often a lack of knowledge of the basic physics behind electricity. When you know the physics, then you can understand the rules, codes, and laws that arise from it.

1.1 Matter

Everything on earth that has weight and occupies space is called matter, which is made up of atoms of elements. When the atoms of elements combine, they produce compounds. The smallest particle of a compound is called a molecule. **Figure 1-1**

1.2 Atomic Theory

An atom contains three types of subatomic particles: electrons, protons, and neutrons. The central part of the atom is called the nucleus and it contains protons (positive charge) and neutrons (no charge), while electrons (negative charge) orbit around the nucleus. **Figure 1-2**

Electrons – Electrons are much smaller than protons and they are 1,840 times lighter. Because of their light weight and mobility (ease of separation from the atom), electrons actively participate in the transfer or flow of electrical energy.

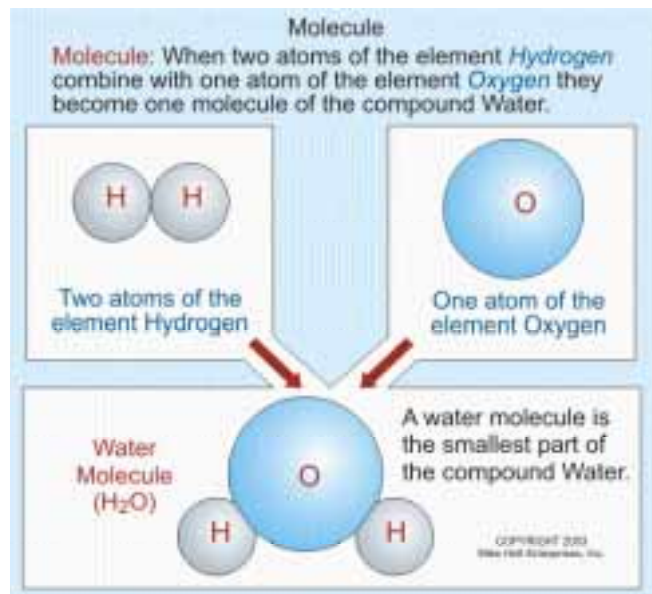


Figure 1-1



Unit 1 – Summary

1.1 Matter

When the atoms of elements combine, they produce compounds. The smallest particle of a compound is called a molecule.

1.2 Atomic Theory

An atom contains three types of subatomic particles: electrons, protons, and neutrons. Electrons are much smaller than protons and they actively participate in the transfer or flow of electrical energy.

1.3 Law of Electrical Charges

The Law of Electrical Charges states that “subatomic particles with like charges repel each other and particles with unlike charges attract each other.” Therefore, electrons repel electrons and electrons and protons are attracted to each other.

1.4 Law of Atomic Charges

Most of the time, the electrical charge of an atom is balanced or neutral. Under this condition, the atom has no electrical charge. If an atom contains more electrons than protons, then the atom has a negative atomic charge.

1.5 Charged Material (Static Charge)

Static charge is due to an excess of, or a deficiency of, electrons between objects that have been separated. An object can become positively or negatively charged depending on whether it loses or gains electrons.

Static Voltage

The voltage developed is related to the amount of charge deposited on a body and to the capacitance of this body with respect to its surroundings. If leakage of charge from the surface of the insulating body is not rapid enough, a sparking voltage can be reached, and a high-voltage static discharge can occur.

Reducing Static Charge

Providing a path to the earth can often reduce the electrostatic charge between objects. In addition, cotton clothing, ion generators, humidifiers, as well as antistatic furniture, walls, and flooring are used to reduce this charge.

1.6 Neutralizing a Charge

Because of the Law of Electric Charges [1.3], the build up of electrons on a negatively charged object can discharge when it comes close enough to a positively charged or uncharged object.

1.7 Lightning

Lightning is the discharging of high-voltage cells within clouds to each other, to the earth, and sometimes to space. When the cell charge reaches a critical level, it develops a “stepped leader” ionized path resulting in a high-current discharge, which temporarily neutralizes the positive and negative charge between the objects.

CAUTION: *Contrary to popular belief, lightning strikes both metallic and nonmetallic objects with the same frequency.*

DANGER: *Over 100 deaths, 250 injuries, and billions of dollars in property damage are caused each year in the United States because of lightning.*

1.8 Lightning Protection

To protect property, air terminals connected together and to the earth by larger conductors should be placed on top of the structure so that lightning can be harmlessly directed from the structure into the earth.

CAUTION: *Lightning protection is intended to protect the building structure itself. If protection of electrical equipment from lightning is important, then surge-protection devices must be installed on the electrical system in accordance with the National Electrical Code.*

Conclusion

Understanding a bit about the physics of matter is essential to understanding the principles behind electrical theory. The movement of the electrons in the atoms that make up the matter of our universe is what gives us electricity. Understanding this movement allows us to harness electricity and even protect ourselves from undesirable electricity such as lightning.

A strong knowledge of electrical theory has important practical implications. For example, every now and then someone comes out with a product that allegedly makes standard lightning protection or grounding systems no longer necessary. With your knowledge of electrical theory, you won't be fooled by these claims. However, developing that knowledge begins with a solid foundation in the physics of matter. Test your foundation with the following questions.

