# 1.1: What is Electricity and Magnetism?

**Learning Objectives**

By the end of this section, you will be able to:

- Define electricity and magnetism.
- Recognize that electricity and magnetism are different aspects of electromagnetism.

**Electricity** is a branch of physics concerned with the effects "associated with the presence and motion of matter possessing an electric charge" [1]. As we will see, an **electric charge** is associated with an **electric field** that can affect other electric charges around it. Common natural phenomena that involve electricity, including lightning and static electricity (Fig. 1.1.1). Electricity also plays a central role in many modern technologies that are pervasive through everyday life, including electric heating, electric lighting, and electric circuits in cellular phones, computers, appliances, automobiles, and other devices that use electrical power. Indeed, it is hard to wake up in the morning, get through your day, and get back to bed at night without encountering multiple electric devices or phenomena!

Figure 1.1.1: Lightning [2] and static electricity [3] are examples of a natural electrical phenomenon.

**Magnetism** is a branch of physics concerned with the effects associated with a **magnetic field**. In contrast to electric charges, magnetic fields do not arise from separate "magnetic charges." Instead, we will see that they are caused by the motion of electric charges or their intrinsic magnetic properties. While magnetic fields are perhaps most commonly associated with permanent iron magnets (Fig. 1.1.2), a temporary magnetic field can be created by electric charges moving through a coil of wire. Like electricity, magnetism also plays a critical role in modern technologies, including motors, generators, relays, solenoids, loudspeakers, hard drives, and many other examples [4].

Figure 1.1.2: Iron filings are attracted to an permanent bar magnet. [5]

While we will start our study of electricity and magnetism by examining them separately for simplicity, it turns out that it will eventually be better to think about the two phenomena as different aspects of one phenomenon called **electromagnetism** [6]. Oscillating charges will generate **electromagnetic waves**, which are oscillations in the **electromagnetic field** that travel from one location to another. The **frequency** of the wave is its number of oscillations per second. Radio waves, infrared light, visible light,

ultraviolet light, x-rays, gamma rays are all examples of electromagnetic waves with different frequency ranges in the **electromagnetic spectrum** [7].

Given the wide range of electromagnetic technologies, it is not possible to include them all in an introductory textbook. In this book, we will be focusing on wireless technology and Amateur Radio as a means to show how the principles of electricity and magnetism can be used in practice.

## References


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