Chapter 2

Physical and Electrical Background

Chapter 2: Physical and Electrical Background

- **Force** is capable of modifying the condition of constant speed of a body, or of deforming it.

Chapter 2: Physical and Electrical Background

- A force does **work** if movement of a body is produced.
- The ability of a system to do work on another system is known as **energy**.

Chapter 2: Physical and Electrical Background

- **Power** is the rate of transfer of energy or the rate at which work is done.

$$P \frac{\Delta W}{\Delta t}$$

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- **Heat** is a form of energy that is transferred from one system to another system by thermal interaction.
- **Temperature** provides a way to measure the quantity of heat.

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- The **electric charge** is a physical basic property of a unit of matter that causes it to experience a force when near other electrically charged matter.

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- Coulomb's law states that any two point charges exert a force on each other that is
  - proportional to the product of their charges and
  - inversely proportional to the square of the distance between them.

Chapter 2: Physical and Electrical Background

- The **electric field** strength at a point is the force per unit charge exerted on a positive charge placed at that point.

Chapter 2: Physical and Electrical Background

- **Observation**: The electrostatic force is $4.17*10^{42}$ times stronger than the gravitational force, regardless of the distance between two charges.

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- An **electric dipole** is made of two charged objects, with equal but opposite electric charges, that are separated by a distance.

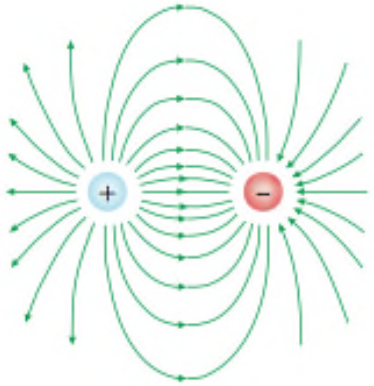

FIGURE 2.12 Electric field in an electric dipole.

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- The drift velocity of electrons in a wire is proportional to the current that flows in the wire.

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- The electrical current is defined as the time rate at which electrical charges flow through a surface.
- To move electric charges, an electric force is necessary.

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- **Curiosity**: Imagine two straight, parallel, and indefinitely long wires having negligible circular cross sections, placed in a vacuum, with 1 *meter* of distance between them.

Chapter 2: Physical and Electrical Background

- The electric force acting on a charge causing its movement produces an electric work.
- The electric voltage is the amount of electric work necessary to move a charge between two points against a static electric field.

Chapter 2: Physical and Electrical Background

- **Carriers** are the charges forming an electric current.

Chapter 2: Physical and Electrical Background

- A DC current is non-varying electric current.
- The direction of the flow of positive and negative charges is one way, and does not change with time.

Chapter 2: Physical and Electrical Background

- An AC current reverses its own direction periodically a specified number of times per second.
- The average value in a period is equal to zero.
- Even if the term AC is used to describe a current, it has become common to use the term to identify a source of alternating voltage.

Chapter 2: Physical and Electrical Background

- A DC voltage is a voltage that does not change polarity across two points with time.
- An AC voltage is a voltage continually changing between positive and negative values.

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- The generation or use of electric power [*W*] over a period of time [*h*] is often expressed in kilowatt-hours [*kWh*].

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- A **magnet** is a body having the property of producing a magnetic field external to itself.

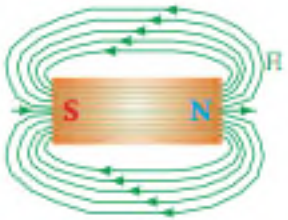

FIGURE 2.24 Magnet section and force lines of the magnetic field it produces.

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- The **magnetic field** is the region around a magnet where magnetic forces act.

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- **Example**: It is known that if a metal screwdriver (non-magnetic material) is rubbed with a magnet, then it will be able to attract screws.
- Therefore, clearly, it can be *magnetized*.

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- **Magnetic induction** represents how the magnetic field changes within a material.

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- The **permeability** of a matter is the measure of degree to which the magnetic lines of force can penetrate into the matter itself.
- Numerically, it is defined as the ratio of magnetic induction $\vec{B}$ to the magnetic field $\vec{H}$.

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- According to **magnetism**, matter can be divided into three types:
  - **diamagnetic**
  - **paramagnetic**
  - **ferromagnetic**

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- The absolute magnetic permeability μ_0 is a universal constant.

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- We get information through **waves.**
- **Electromagnetic** and **mechanical** waves are fundamental.

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- In the following table are the described quantities and their SI units:

Quantity [symbol]	Unit [symbol]
Force $[\vec{F}]$	Newton $[N]$
Energy $[E]$	Joule $[J]$
Work $[W]$	Joule $[J]$
Power $[P]$	Watt $[W]$
Temperature $[T]$	degree Celsius or Centigrade $[°C]$ degree Fahrenheit $[°F]$ Kelvin $[K]$
Charge $[q]$	Coulomb $[C]$
Electric field $[\vec{E}]$	Newtons per Coulomb $\left[\frac{N}{C}\right]$
Current $[I]$	Ampere $[A]$
Voltage $[V]$	Volt $[V]$