

Chapter 32 Electrostatics

Summary

THE BIG IDEA : Electrostatics involves electric charges, the forces between them, and their behavior in materials.

32.1 Electrical Forces and Charges

- ✓ The fundamental rule at the base of all electrical phenomena is that like charges repel and opposite charges attract.
- Electrostatics is electricity at rest.
- Electrical forces arise from particles in atoms.
- In the simple model of the atom, protons in the nucleus attract the electrons and hold them in orbit. Electrons are attracted to protons, but electrons repel other electrons.
- The fundamental electrical property to which the mutual attractions or repulsions between electrons or protons is attributed is called **charge**.
- By convention, electrons are *negatively* charged and protons *positively* charged. Neutrons have no charge and are neither attracted nor repelled by charged particles.

32.2 Conservation of Charge

- ✓ An object that has unequal numbers of electrons and protons is electrically charged.
- An atom with a net positive charge is a *positive ion*; it has lost one or more electrons. An atom with a net negative charge is a *negative ion*; it has gained one or more electrons.
- The principle that electrons are neither created nor destroyed but are simply transferred from one material to another is known as **conservation of charge**.

32.3 Coulomb's Law

- ✓ Coulomb's law states that for charged particles or objects that are small compared with the distance between them, the force between the charges varies directly as the product of the charges and inversely as the square of the distance between them.
- The relationship among electrical force, charges, and distance is **Coulomb's law**. Coulomb's law can be expressed as $F = kq_1q_2/d^2$, where d is the distance between the charged particles; q_1 represents the quantity of charge of one particle and q_2 the quantity of charge of the other particle; and k is the proportionality constant.
- The SI unit of charge is the **coulomb**, abbreviated C.
- The proportionality constant k in Coulomb's law is $9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$.
- Because most objects have almost exactly equal numbers of electrons and protons, electrical forces usually balance out.

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32.4 Conductors and Insulators

✓ **Electrons move easily in good conductors and poorly in good insulators.**

- Materials through which electric charge can flow are called **conductors**.
- Metals are good conductors because their outer electrons are “loose.”
- Electrons in other materials—rubber and glass, for example—are tightly bound and remain with particular atoms. These materials, known as **insulators**, are poor conductors of electricity.
- **Semiconductors** are materials that can be made to behave sometimes as insulators and sometimes as conductors. Atoms in a semiconductor hold their electrons until given small energy boosts.

32.5 Charging by Friction and Contact

✓ **Two ways electric charge can be transferred are by friction and by contact.**

- Electrons are transferred by friction when one material rubs against another.
- *Charging by contact* occurs when electrons are transferred from one material to another by simply touching. If the object is a good conductor, the charge will spread to all parts of its surface. If it is a poor conductor, the extra charge will stay close to where the object was touched.

32.6 Charging by Induction

✓ **If a charged object is brought *near* a conducting surface, even without physical contact, electrons will move in the conducting surface.**

- Electric charge on a conducting object can be redistributed, or **induced**, by the presence of a charged object nearby.
- **Induction** is the charging of an object without direct contact.
- When we allow charges to move off (or onto) a conductor by touching it, it is common to say that we are **grounding** it.
- Charging by induction occurs during thunderstorms. The negatively charged bottoms of clouds induce a positive charge on the surface of Earth below.

32.7 Charge Polarization

✓ **Charge polarization can occur in insulators that are *near* a charged object.**

- When one side of an atom or molecule is induced to be slightly more positive (or negative) than the other side, the atom or molecule is said to be **electrically polarized**.
- A molecule with a little more negative charge on one side than the other is an *electric dipole*.