

SUMMARY

The goal of Chapter 25 has been to develop a basic understanding of electric phenomena in terms of charges, forces, and fields.

GENERAL PRINCIPLES

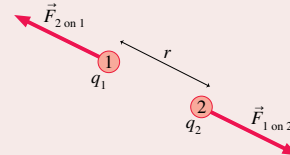
Coulomb's Law

The forces between two charged particles q_1 and q_2 separated by distance r are

$$F_{1 \text{ on } 2} = F_{2 \text{ on } 1} = \frac{K|q_1||q_2|}{r^2}$$

These forces are an action/reaction pair directed along the line joining the particles.

- The forces are repulsive for two like charges, attractive for two opposite charges.
- The net force on a charge is the sum of the forces from all other charges.
- The unit of charge is the coulomb (C).



IMPORTANT CONCEPTS

The Charge Model

There are **two kinds of charge**, called *positive* and *negative*.

- Fundamental charges are protons and electrons, with charge $\pm e$ where $e = 1.60 \times 10^{-19} \text{ C}$.
- Objects are charged by adding or removing electrons.
- The amount of charge is $q = (N_p - N_e)e$.
- An object with an equal number of protons and electrons is **neutral**, meaning no *net* charge.

Charged objects exert **electric forces** on each other.

- Like charges repel, opposite charges attract.
- The force increases as the charge increases.
- The force decreases as the distance increases.

There are **two types of material**, **insulators** and **conductors**.

- Charge remains fixed in or on an insulator.
- Charge moves easily through or along conductors.
- Charge is transferred by contact between objects.

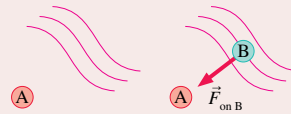
Charged objects attract neutral objects.

- Charge polarizes metal by shifting the electron sea.
- Charge polarizes atoms, creating electric dipoles.
- The **polarization** force is always an attractive force.

The Field Model

Charges interact with each other via the **electric field** \vec{E} .

- Charge A alters the space around it by creating an electric field.

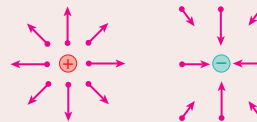


- The field is the agent that exerts a force. The force on charge q_B is $\vec{F}_{\text{on } B} = q_B \vec{E}$.

An electric field is identified and measured in terms of the force on a **probe charge** q .

$$\vec{E} = \vec{F}_{\text{on } q} / q$$

- The electric field exists at all points in space.
- An electric field vector shows the field only at one point, the point at the tail of the vector.



The electric field of a **point charge** is

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}$$