

Summary of Chapter 15 – Electric Forces and Electric Fields

Please read Chapter 15 carefully, and make sure that you understand the summary points below.

► **Electric charges** have the following important properties:

1. Unlike charges attract one another and like charges repel one another.
2. Electric charge is always conserved.
3. Charge is quantized—that is, it exists in discrete packets that are integral multiples of the electron charge.
4. The force between charged particles varies as the inverse square of their separation.

► **Conductors** are materials in which charges move freely. **Insulators** are materials that do not readily transport charge.

► **Coulomb's law** states that the electric force between two stationary charged particles separated by a distance of r has the magnitude

$$F = k_e \frac{q_1 q_2}{r^2}$$

where q_1 and q_2 are the charges on the particles [measured in coulombs] and k_e is the **Coulomb constant**, which has the approximate value

$$k_e = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$$

► The **electric field**, \mathbf{E} , at some point in space \mathbf{x} is defined as the electric force that would act on a small positive charge placed at that point, divided by the magnitude of its charge,

$$\mathbf{E}(\mathbf{x}) = \frac{\mathbf{F}}{q_0}$$

The direction of the electric field at a point in space is defined to be the direction of the electric force that would be exerted on a small positive charge placed at that point.

► The electric field due to a point charge, q , at distance r from the point charge is

$$\mathbf{E} = k_e \frac{q}{r^2} \hat{\mathbf{r}}$$

► **Electric field lines** are useful for describing the electric field in any region of space. The electric field vector, \mathbf{E} , is tangent to the electric field lines at every point. Furthermore, the number of electric field lines per unit area through a surface perpendicular to the lines is proportional to the strength of the electric field in that region.

► A **conductor in electrostatic equilibrium** has the following properties:

1. The electric field is zero everywhere inside the conductor.
2. Any excess charge on an isolated conductor must reside entirely on its surface.
3. The electric field just outside a charged conductor is perpendicular to the conductor's surface.
4. On an irregularly shaped conductor, charge tends to accumulate where the radius of curvature of the surface is smallest—that is, at sharp points.