University of Al-Mustaqbal
College of Science
Department of Medical
Physics

Electrical Material

First Stage

Lecture name : Electric Potential

Lecture number : 4

Name of lecturer

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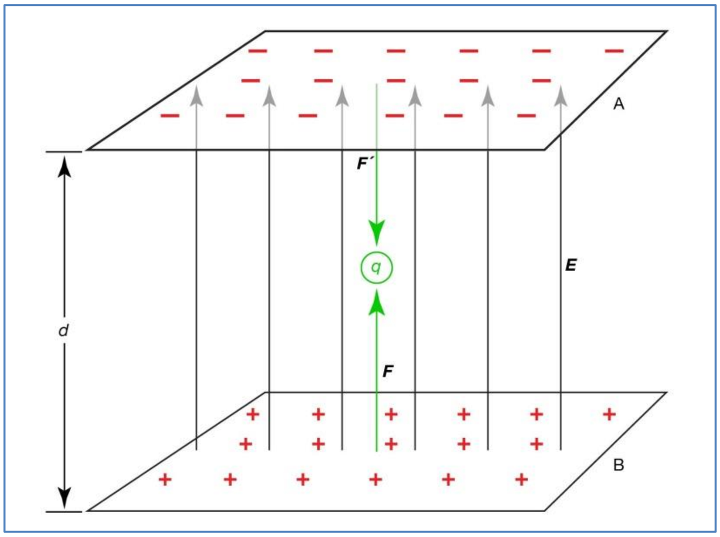
Introduction to Electric Potential



The diagram shows how electric potential decreases in the direction of the electric field.

Electric potential is a fundamental concept in electricity and electromagnetism. It helps us understand how electric fields store and transfer energy. Electric potential is closely related to electric force and electric field, but instead of focusing on force, it focuses on energy.

Electric potential (V) at a point in space is defined as the electric potential energy (U) per unit charge (q):

$$V = U / q$$

The SI unit of electric potential is the volt (V), where:

1 volt = 1 joule / coulomb

Electric potential allows us to analyze electric systems more easily, especially when dealing with complex charge distributions.

Electric Potential Energy

q1 (+) ←—— Repulsion ——→ q2 (+)

q1 (+) ——— Attraction ——→ q2 (-)

Like charges have higher potential energy when close, while unlike charges have lower potential energy.

Electric potential energy is the energy a charge has due to its position in an electric field. When a positive test charge is placed near another charge, work is done to move it against or along the electric force.

For two point charges:

$U = k (q1\ q2) / r$

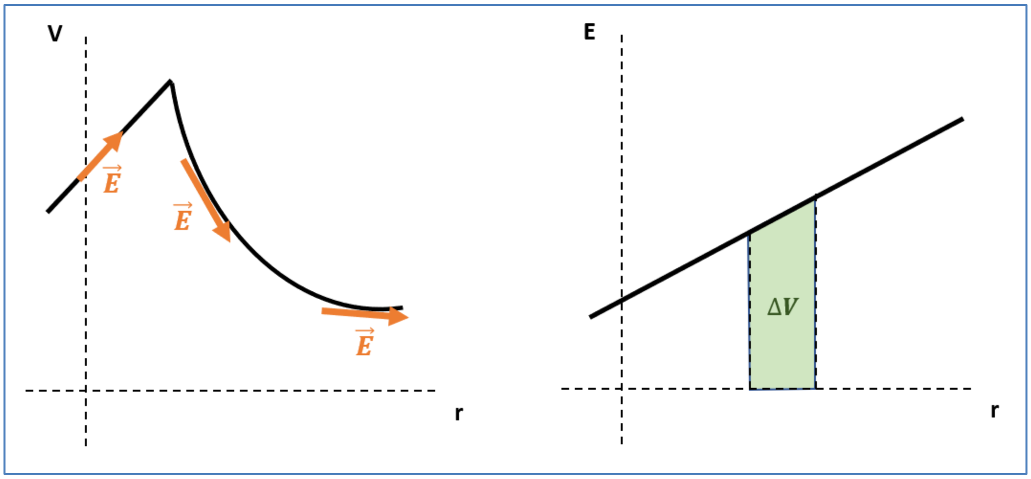
Where:

- $k = 9 \times 10^9\ N \cdot m^2/C^2$
- r = distance between charges

Key points:

- Like charges → positive potential energy (repulsion)
- Unlike charges → negative potential energy (attraction)
- Electric potential energy depends on position, not path

Page 3: Electric Potential and Electric Field



Electric field lines are always perpendicular to equipotential lines.

Electric potential and electric field are closely related. The electric field is the negative gradient of electric potential:

$E = -\, dV / dr$

This means:

- Electric field points in the direction of decreasing potential
- Strong electric fields correspond to rapid changes in potential

In a uniform electric field:

$\Delta V = -\, E\, d$

Where d is the displacement in the direction of the field.

This relationship is very important in capacitors and medical physics applications.

Electric Potential Due to a Point Charge

Illustration 4: Point Charge and Equipotential Surfaces

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    ○    ○    ○      (Equipotential circles)
       ○    Q    ○
    ○    ○    ○
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The potential decreases as the distance from the point charge increases.

The electric potential due to a point charge Q at a distance r is given by:

$V = k Q / r$

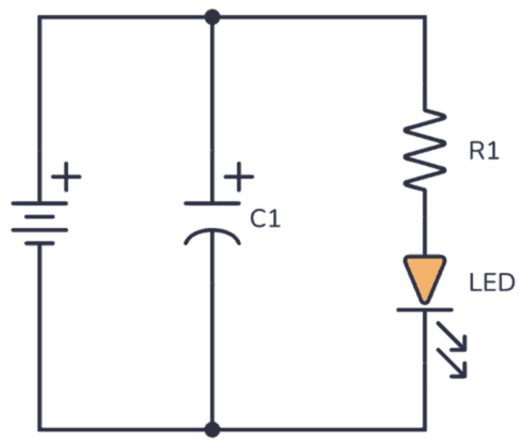
Important characteristics:

- Potential is a scalar quantity (no direction)
- Potential can be positive or negative
- Reference point is usually taken at infinity ($V = 0$)

For multiple charges, the total electric potential is the algebraic sum of individual potentials:

$V_{total} = V1 + V2 + V3 + ...$

Applications of Electric Potential



Capacitors store energy using electric potential difference.

Electric potential has many practical applications, especially in medical and engineering fields:

- Capacitors in medical devices
- Defibrillators
- Electrocardiography (ECG)
- Imaging systems
- Particle accelerators

Understanding electric potential helps explain how energy is transferred and controlled in electric systems.