Chapter 25

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Electric Potential

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Lecture 01

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Electric Potential Energy And Potential

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Electrical Potential Energy

When a test charge is placed in an electric field, it experiences a force.

$$\vec{F}_e = q_\circ \vec{E}$$

The electric force is conservative.

The work done by a conservative force:

- Is path independent
- Along a closed path is ZERO
- Equals the decrease in potential energy.

$$W = -\Delta U$$

This will define the electric potential energy .

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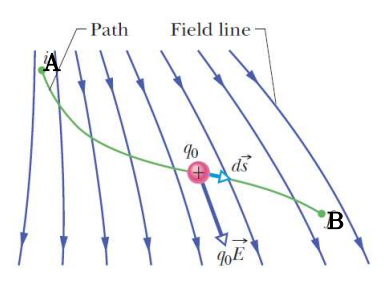
Electric Potential Energy, cont

•The work done by the electric force on the charge is:

$$W = \vec{F}_e \cdot d\vec{s} = q_\circ \vec{E} \cdot d\vec{s}$$

•$d\vec{s}$: is an infinitesimal displacement vector that is oriented tangent to the path.



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Electric Potential Energy, cont

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•The potential energy of the charge-field system is changed by:

$$\Delta U = -W$$

$$\Delta U = -q_\circ \vec{E} \cdot d\vec{s}$$

•For a finite displacement of the charge from (A) to (B), **the change in potential energy** of the system is

$$\Delta U = U_B - U_A = -q_\circ \int_A^B \vec{E} \cdot d\vec{s}$$

•Because the force is conservative, the line integral does not depend on the path taken by the charge.

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Electric Potential

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The electric potential is the potential energy per unit charge:

$$V = \frac{U}{q_\circ}$$

- The potential is a **scalar** quantity.
- SI units:

$$1\,Volt = 1\ J/C$$

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Electric Potential

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- As a charged particle moves from (A) to (B) in an electric field, it will experience a **change in electric potential**.

$$\Delta V = V_B - V_A = \frac{\Delta U}{q_\circ}$$

  - We often take the value of the potential to be **ZERO** at some convenient point in the field. (Usually at infinity)
  - Assume a charge moves in an electric field without any change in its kinetic energy. The work by the field is:

$$W = -\Delta U = -q\,\Delta V$$

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Electron-Volts

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- **Another unit of energy** that is commonly used in atomic and nuclear physics is the electron-volt.
- **One electron-volt** is defined as the energy a charge-field system gains or loses when a charge of magnitude (e) (an electron or a proton) is moved through a potential difference of $(1\ volt)$.

$$1\ e.V = 1.6 \times 10^{-19}\ J$$

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