Electric Potential

PHY 114-01

Fall 2026

Agenda

- Last time:
  - Electrostatic potential energy
- This time:
  - Energy of assembly
  - Electric potential

Review: electric field

Take a minute to recall with your neighbor:

How did we first define the electric field?

Force of point charge Q on point charge q

$$\vec{F} = \frac{kQq}{r^2}\,\hat{r}$$

Divide by q

$$\vec{E} = \frac{kQ}{r^2}\,\hat{r}$$

Field produced by a charge Q

$$\vec{F} = q\vec{E}$$

General definition of field

Definition: electric potential

We will define electric potential as the scalar field quantity that generates a specific potential energy.

Energy of point charges Q and q

$$U = \frac{kQq}{r}$$

Divide by q

$$V = \frac{kQ}{r}$$

Potential produced by a charge Q

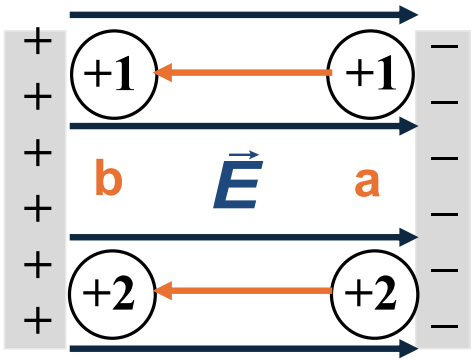
$$U = qV$$

General definition of the electric potential

$$W = -qV$$

* All values represent *relative changes*

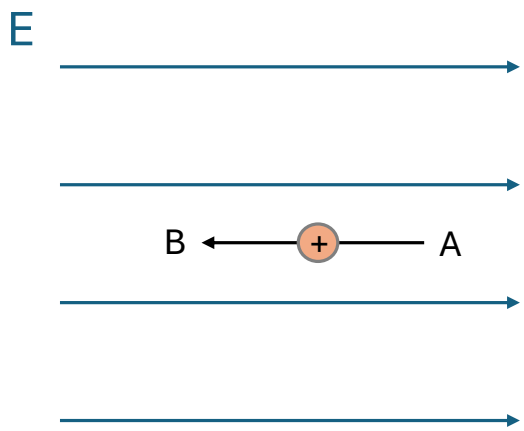
Electric potential



- Electric potential is a property of the electric field
- It's the same for any charge present in the field
- Potential decreases in the direction of the electric field
- Scalar field quantity that depends on *position*
- SI unit for potential is J/C = V (Volts)

- Only **potential differences** are physically meaningful

Checkpoint: electric potential

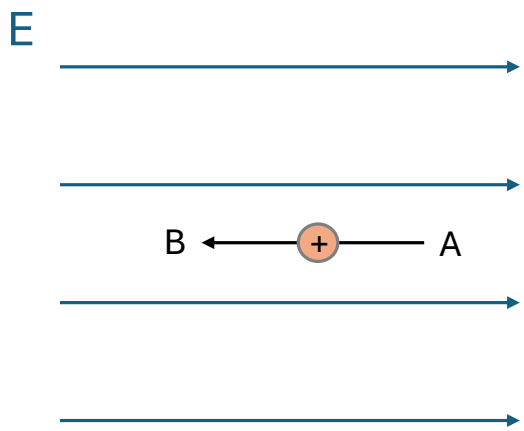


In the figure, we move a proton from point *A* to point *B* in a uniform electric field.

Is the work done by the electric field

A. Positive
B. Negative

Checkpoint: electric potential

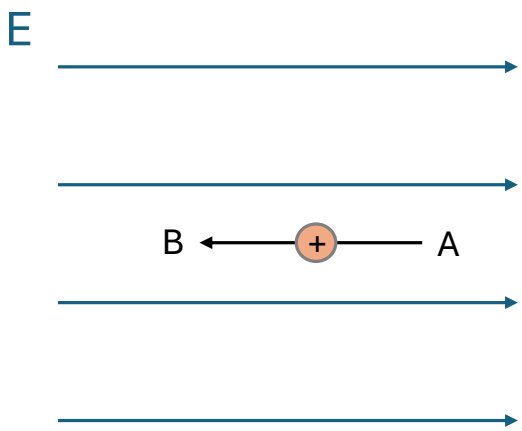


In the figure, we move a proton from point *A* to point *B* in a uniform electric field.

Does the electric potential energy

A. Increase
B. Decrease

Checkpoint: electric potential



In the figure, we move a proton from point *A* to point *B* in a uniform electric field.

Does the proton move to a point of higher or lower potential?

A. Higher
B. Lower

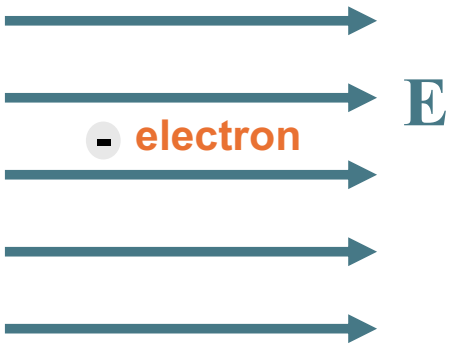
Electron-volts: a unit of energy

- Move a charge -e through a potential of 1V
- The work done by the electric field is $W = qV = e \cdot 1V = 1eV$
  - The potential energy lost is $U = -W = -1eV$
  - The kinetic energy gained by the particle is $\mathrm{K} = -U = 1eV$
- We define this quantity, eV, as an electron volt!
  - The potential energy lost by moving a charge -e through 1V potential.
  - **1eV = 1.6x10^{-19} Joules**

- Commonly used in atomic, particle, and solid state physics

Activity Electric Potential Energy

An electron at rest is in a region of constant electric field *E*. It is then released. Ignore gravity.



(a) Describe the motion of the electron.
(b) If the electron moves a distance of *d*, does the electric field do positive or negative work?
(c) Has it gained or lost electric potential energy (EPE)? Has the electric potential increased or decreased?
(d) Has the electron gained or lost kinetic energy?
(e) Let *E*=100 N/C, and *d*=10 cm, find the work done by the field, change of EPE and KE, in units of eV, and , change of electric potential.

Work in groups!

Lecture 14: Electric Potential

Name: _____

An electron at rest is in a region of constant electric field $\vec{E} = E\hat{x}$. It is then released. Ignore gravity.

1. Describe the motion of the electron.

   negative charge moves against the field ($-\hat{x}$-direction)

2. If the electron moves a distance of d, does the electric field do positive or negative work?

   $\vec{F} = -qE\hat{x}$ so direction is in line w/ force → positive work.

3. Has it gained or lost electric potential energy U? Has the electric potential V increased or decreased?

   $W = -U$ → lost potential energy

   $U = qV$, q is negative so potential increases

   V is property of the field, not the charge.

4. Has the electron gained or lost kinetic energy K?

   lost potential energy → gained kinetic energy

5. Let $E = 100$ N/C, and $d = 10$ cm. Find the work done by the field, change of U and K, in units of eV, and , the change in electric potential.

$$W = F \cdot d$$

$$= (-qE)\cdot(-d) = |q|Ed$$

$$= eEd$$

$$= e\,(100\ \text{N/C})\,(0.1\ \text{m})$$

$$W = e \cdot 10\ \text{V} = 10\ \text{eV}$$

Then $\Delta U = -W = -10\ \text{eV}$

$$\Delta K = -\Delta U = W = 10\ \text{eV}$$

$$\Delta V = +10\ \text{V}$$