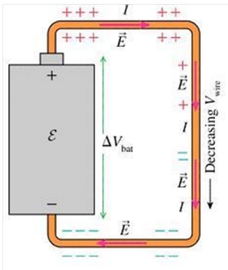
10.4 - Electric Potential Energy

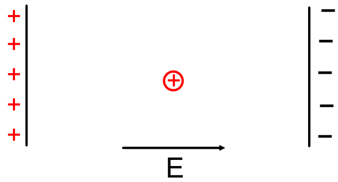


Electric Potential Energy

Imagine a positive charge between two oppositely charged parallel plates.

The charge is forced towards the negative plate by the electric field, gaining speed as it goes.

Finally, the charge collides with the negative plate, unable to move further.



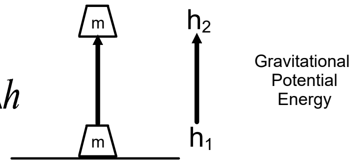
Gravity Analogy

The charge in the field is analogous to a mass held above the earth.

Both charge and mass have potential energy: when released, they move to an area of lower potential energy, gaining kinetic energy as they go.

Remember:

$$\Delta U_g = mg\Delta h$$



Analogy: FAIL

The analogy fails in one fundamentally huge way: electric fields act on both positive and negative charges, moving them one way or another depending on charge.

However, ALL massive objects attract each other, so positive and negative designations are meaningless.

A reference frame for electric fields must be built to accommodate positive and negative charges, so calculations always work out.

Reference Frame Conventions

A positive charge (of any sort) has higher electric potential than a negative one (due to using a positive test charge for comparisons).

Positive charges accelerate toward negative ones.

Negative charges accelerate toward positive ones.

Electric potential increases when moving nearer to positive charges (OR farther from negative charges).

Electric potential decreases when moving farther from positive charges (OR closer to negative charges).

Electric Potential Difference

For a point source of charge, the potential from it vs. distance is:

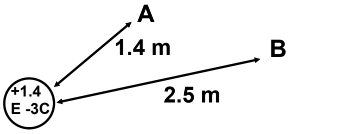
$V = \frac{kq}{r}$	V = potential (J/C) k = 9.0 E 9 Nm^2/C^2 q = charge (C) r = distance (m)

From a point charge, potentials compared between two distances is thus:

$$\Delta V = \frac{kq}{r_{Closer}} - \frac{kq}{r_{Farther}}$$

1. Two Point Example

What is the potential difference (voltage) between points A and B, located 1.4 m and 2.5 m from a +1.4 E -3 C point charge?



$$\Delta V = \frac{kq}{r_A} - \frac{kq}{r_B}$$

$$= \frac{9.0E9\,Nm^2/C^2 \bullet 1.4E-3C}{1.4\,m} - \frac{9.0E9\,Nm^2/C^2 \bullet 1.4E-3C}{2.5\,m}$$

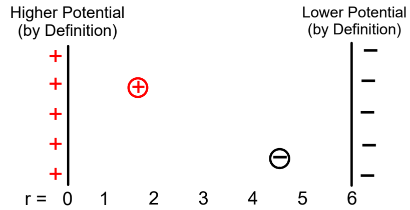
$$= 3.96E6V = 3.96MV$$

Work Done on Charges

Work moves a positive charge from lower potential to higher potential (towards a positive charge).

Likewise, it takes work to move a negative charge towards a negative charge (towards lower potential).

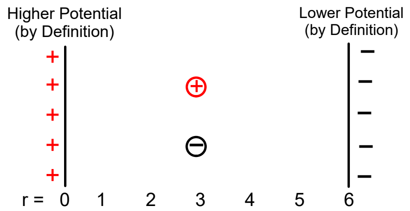
As charges are moved, work done on them equals their increase in potential energy.



Work Done on Charges

If charges are allowed to move in a natural direction, they gain kinetic energy as they accelerate.

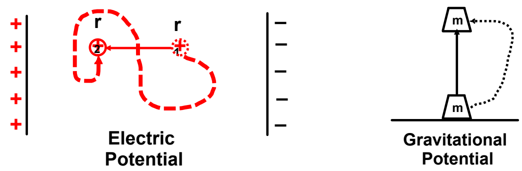
The increase in kinetic energy equals the loss of potential energy.



A Note on Path

Any charge moved in an electric field results in **conservative** work done: path doesn't matter.

Like moving an object in a gravitational field: a raised object gains potential energy regardless of whether it moved straight up, or along an incline.



Homework

10.4 Problems.
Due: Next Class.

Finish Unit 10 Review:
Scanned: Soon!

Do Application Problems

Attachments

AP Phys Unit 11.1 Notes - Voltage, Batteries, DC.pdf