Electric Potential Difference
Lesson Notes

Learning Outcomes

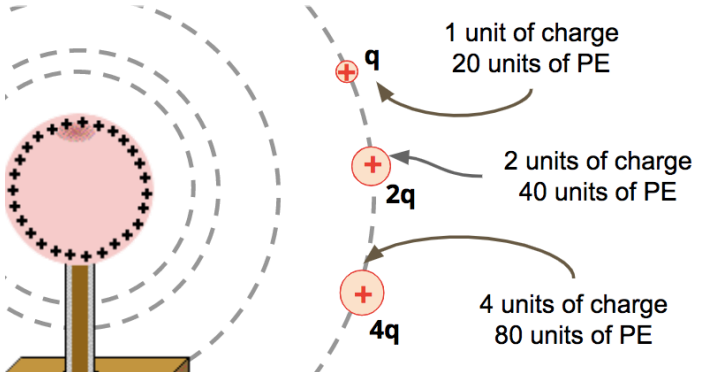
- What is meant by electric potential difference?
- How can one describe the changes occurring in electric potential as a charge passes through a circuit?

Electric Potential ... Revisited

The electric potential (**V**) describes the amount of energy (**PE**) stored in an electric field at a location in a way that is independent of the amount of charge (**q**).

Electric Potential

$V = PE/q$



Objects with different charge will have different PE values …

… but the same electric potential when located at the same *location*.

Electric Potential Difference

The work done (**W**) on the + test charge in moving it against the electric field from location A to location B is equal to the gain in potential energy (**PE**) of the charge.

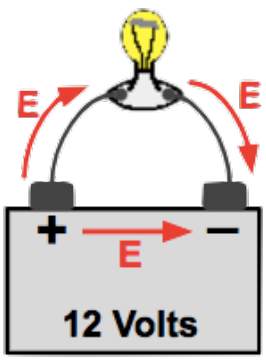
$$\text{Work} = \Delta PE = PE_B - PE_A$$

This change in potential energy corresponds to a change in the electric potential. It could be said that there is an **electric potential difference** (**ΔV**) between locations A and B given by the equations …

$$\Delta V = V_B - V_A = \frac{PE_B}{q} - \frac{PE_A}{q} = \frac{\Delta PE}{q} = \frac{\text{Work}}{q}$$

Changes in Electric Potential in Circuits

- Movement of + charge through the battery is *against the E field*. Work is required, causing charge to gain PE and V. The + terminal is the location of greatest potential.
- Movement of + charge in the wires results in a loss of PE and V. The - terminal is the location of lowest potential in a circuit.
- **Electric potential** (**V**) is sometimes referred to as **voltage** since it is measured in the unit **Volt**.
- A 12-volt battery supplies 12 Joule of energy to every 1 Coulomb of charge that passes through it.



The Role of the Battery

The electrochemical cell or the battery (collection of cells) serves the function of …

- … supplying energy to the circuit,
- … to move the charge from the - to the + terminal,
- … so as to establish an electric potential difference across the *two ends* of the circuit.

Analogy:

- Water in the water slide of a water park flows in a *circuit*. That is, it flows around and around in a continuous loop.
- The top of the slide is the high potential location. The bottom of the slide is the low potential location.
- A pump moves the charge from the bottom to the top of the slide.

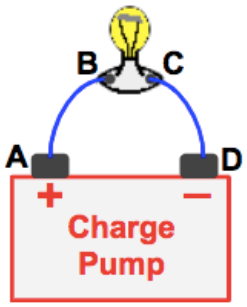
The battery is like a **charge pump**.

It pumps the charge *uphill* through the battery from the - to the + terminal.

Internal vs. External Circuit

Internal Circuit (battery, cell, charge pump, energy source)
Energy is supplied to the charge to move it from the - to the + terminal. Charge gains PE and electric potential in the internal circuit.

External Circuit (includes wires, bulbs, etc.)
Energy is lost by the charge as it moves through the wires (a little) and the circuit elements (mostly).



$V_A > V_B >>>> V_C > V_D$

High V — Low V

Electric Potential Diagrams

Electric potential diagrams depict the changes or differences in electric potential for the various locations of an electric circuit. Demonstrate your understanding by completing the following electric potential diagrams.