

Electric Potential Difference

Read from **Lesson 1** of the **Current Electricity** chapter at **The Physics Classroom**:

- <http://www.physicsclassroom.com/Class/circuits/u911a.html>
- <http://www.physicsclassroom.com/Class/circuits/u911b.html>
- <http://www.physicsclassroom.com/Class/circuits/u911c.html>

MOP Connection: Electric Circuits: sublevels 2 and parts of 3

Review:

- Electric field** is defined as the aura about the space surrounding a charged object that exerts an electrical influence upon other charged objects in that space. The **direction of the electric field vector** is defined as the direction that a positive test charge would be accelerated. **Potential energy** is the energy stored in an object due to the position of that object.

A Gravitational Analogy:

- Two diagrams are shown at the right.

In diagram A, a mass is held at an elevated position. When let go of, the mass falls from point A to point B.

In diagram B, the mass is originally at point A and a person moves it back up to point B.

For each diagram, indicate if work is done by a non-conservative force in moving the object from its initial position (point A) to its position at point B. Finally, indicate the position of greatest gravitational potential energy.

Circle the answers in the space below the diagrams.

Diagram A



Diagram B



W_{nc} done on mass: Yes or No
Highest PE: A or B

W_{nc} done on mass: Yes or No
Highest PE: A or B

- The following diagrams show an electric field and two points - labeled A and B - located within the electric field. A positive test charge is shown at point A. For each diagram, indicate whether work must be done upon the charge to move it from point A to point B. Finally, indicate the point (A or B) with the greatest electric potential energy and the greatest electric potential (PE/charge).

Work done on test charge? Yes or No	Work done on test charge? Yes or No
Potential energy is greatest at: A B	Potential energy is greatest at: A B
Electric potential is greatest at: A B	Electric potential is greatest at: A B
Work done on test charge? Yes or No	Work done on test charge? Yes or No
Potential energy is greatest at: A B	Potential energy is greatest at: A B
Electric potential is greatest at: A B	Electric potential is greatest at: A B

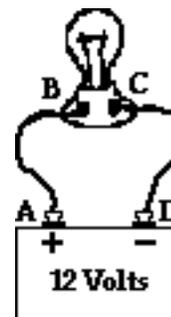
Electric Circuits

4. When work is done on a positive test charge to move it from one location to another, potential energy _____ (increases, decreases) and electric potential _____ (increases, decreases).

When a positive test charge naturally moves from one location to another (without the exertion of a non-conservative force), potential energy _____ (increases, decreases) and electric potential _____ (increases, decreases).



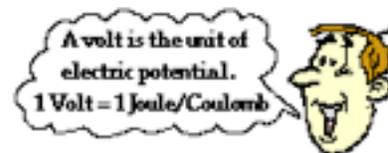
5. The diagram at the right shows a light bulb connected to a 12-V car battery. The + and - terminals are shown.
- As a + charge moves through the battery from D to A, it _____ (gains, loses) potential energy and _____ (gains, loses) electric potential. The point of highest energy within a battery is the _____ (+, -) terminal.
 - As a + charge moves through the external circuit from A to D, it _____ (gains, loses) potential energy and _____ (gains, loses) electric potential. The point of highest energy within the external circuit is closest to the _____ (+, -) terminal.
 - Use >, <, and = signs to compare the electric potential (V) at the four points of the circuit.



$$V_A \quad _____ \quad V_B \quad _____ \quad V_C \quad _____ \quad V_D$$

6. The **role of a battery** in an electrical circuit can be described in three different ways. First, it is the energy supply. Second, the energy supplied by the battery is required to do work upon the charge to move it against the electric field from the negative terminal to the positive terminal. And third, by moving the charge against the field from negative to positive terminal, the battery establishes an electric potential difference across the two ends of the external circuit.

Without a potential difference between two locations, charge will not move. When there is an electric potential between two locations, charge will move from the location of high potential to the location of low potential. The amount of potential difference (ΔV) between two locations is related to the work done in moving an amount of charge (Q) from the low potential to the high potential location.



$$\Delta V = V_{\text{high}} - V_{\text{low}} = \frac{\text{Work}}{Q}$$

- It takes _____ J of work to move 1.0 C of charge from the - to the + terminal of a 1.5-volt battery.
- It takes _____ J of work to move 2.0 C of charge from the - to the + terminal of a 12-volt battery.
- It takes 18 J of work to move _____ C of charge from the - to the + terminal of a 12-volt battery.
- It takes 12 J of work to move 2.0 C of charge from the - to the + terminal of a _____-volt battery.
- It takes _____ J of work to move _____ C of charge from the - to the + terminal of a 12-volt battery.

7. In the battery, energy is supplied to the charge to move it from low potential (- terminal) to high potential (+ terminal). Once at the + terminal, the charge spontaneously moves through the external circuit, losing energy as it passes through each electrical device. The electric potential that is gained by the charge when it passes through the battery is lost by the charge as it moves through the external circuit. These gains and losses in electric potential are often represented using an electric potential diagram. For the circuit at the right, complete the electric potential diagram, showing the relative potential of locations A, B, C, D, E, and F.

