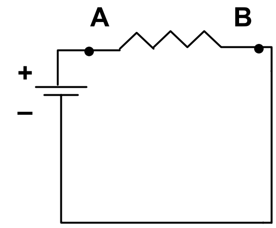
Electric Power: Energy Changes in Circuits



1. Consider the circuit shown in the diagram. Let us suppose that a current *I* is flowing in this circuit. What is the definition of current, in terms of charge and time?

   I =

2. Let's consider the current as it flows between point A and point B. Draw an arrow on the circuit to indicate the direction of flow of a conventional current of positive charges.

3. In the time Δt, we will say that a quantity of charge equal to Δq flows past point A. How much charge will flow past point B in the same amount of time?

4. As it flows between points A and B, what will happen to the potential energy of this quantity of charge? Will it *increase, decrease, or remain the same*?

5. We have already learned that the average *kinetic energy* of this charge will not change. Will the *total energy* of this charge *increase, decrease,* or *remain the same*?

6. If your answer to #5 was "increase," where does the extra energy come from? If your answer was "decrease," where does the lost energy go?

7. In terms of V_A and V_B (the potential at points A and B), what will be the change in potential of the charge as it moves between points A and B? Use absolute value symbols (vertical lines) to express this as a positive quantity.

8. What will be the change in the *potential energy* of this charge as it flows between points A and B?

   ΔPE =

Is this an *increase*, a *decrease*, or *no change* in the charge's PE?

9. Consider the amount of *energy change per unit time* of the charge Δq. What is the name given to the quantity *"energy change per unit time"*?

10. Let's use the symbol "P" for the quantity "energy change per unit time." Use algebraic symbols to express the fact that "P" equals "energy change per unit time." Use the symbol "ΔTE" to represent "energy change."

11. Explain why $\Delta TE = \Delta PE$ for the charge Δq. Rewrite your algebraic expression from #10 in terms of ΔPE.

12. We would like to find a mathematical expression for the "energy change per unit time" in terms of the current I and the given values of the potential, V_A and V_B . In #11, you wrote down an expression for the energy change per unit time in terms of ΔPE. Use your result from #8 to write this in terms of V_A and V_B.

13. Now use your definition of I from #1 to write your expression from #12 in terms of I and V_A and V_B .

14. Write down in words the meaning of the algebraic expression you obtained in #13. Use only words; no mathematical symbols.

15. Now consider the current as it flows through the battery. Suppose the potential difference between the terminals of the battery is ΔV_{bat} (this is called the battery "voltage"). What is the change in potential energy of the charge Δq as it flows from the negative battery terminal, to the positive battery terminal? Is this an increase, a decrease, or no change?

    $\Delta PE =$

16. Using the same argument that we went through for the flow through the resistor, write down an expression for the *amount of energy supplied by the battery per unit time.* Use the symbol "P" to represent this quantity.

17. Write down in words the *meaning* of the algebraic expression you obtained in #16. Do not use any mathematical symbols.

18. In the case of the resistor, you can use Ohm's law to write your result from #13 in terms of I and R, ***or*** in terms of R, V_A and V_B . Do this (i.e., write two new equations), and explain why you can ***not*** use these equations when considering the flow through the battery itself.