

Current batteries

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I am reading a basic electronics book: "There are no Electrons: Electronics for Earthlings" and I came across a clever passage about the fact that you need a closed circuit in order for current to flow. Here is the passage I am curious about:

Does anyone have a straight-forward answer to this question?

The confusion here is from the initial poor description of how a battery works.

A battery consists of three things: a positive electrode, a negative electrode, and an electrolyte in between. The electrodes are made of materials that strongly want to react with each other; they are kept apart by the electrolyte.

The electrolyte acts like a filter that blocks the flow of electrons, but allows ions (positively charged atoms from the electrodes) to pass through. If the battery is not connected to anything, the chemical force is pulling on the ions, trying to draw them across the electrolyte to complete the reaction, but this is balanced by the electrostatic force-- the voltage between the electrodes. Remember-- a voltage between two points means there is an electric field between those points which pushes charged particles in one direction.

When you add a wire between the ends of the batteries, electrons can pass through the wire, driven by the voltage. This reduces the electrostatic force, so ions can pass through the electrolyte. As the battery is discharged, ions move from one electrode to the other, and the chemical reaction proceeds until one of the electrodes is used up.

Thinking about two batteries next to each other, linked by one wire-- there is no voltage between the two batteries, so there is no force to drive electrons. In each battery, the electrostatic force balances the chemical force, and the battery stays at steady state.

(I kind of glossed over what it means for two materials to "want" to react with each other. Google "Gibbs free energy" for more details on that. You might also google "Nernst equation.")

Forget the batteries for a second, that's just one of a thousand analogies you could use to describe voltage/current and the reason that no current flows has nothing to do with the electro-chemical properties of batteries, it's far simpler.

In your battery example, there is no return current path so no current will flow. There is obviously a more deep physics reason for why this works but as the question asked for a simple answer I'll skip the math, google Maxwell's Equations and how they are used in the derivation of Kirchhoff's voltage law.

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Batteries do make a good example for this simply because they are current sources with completely isolated grounds. This example would be equally true of any other power source with a completely isolated "ground".

However, this is not an easy thing to find, for instance doing this with 2 bench supplies would likely make one of the bench supplies very unhappy, but that's not because the effect is different, the difference is that the bench supplies are likely both grounded to the electrical wiring in the building and as such there is a return path for current to flow through.

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