

The source of potential difference and electrical energy is the circuit's emf

Will a bulb in a circuit light up if you remove the battery? Without a potential difference, there is no charge flow and no current. The battery is necessary because the battery is the source of potential difference and electrical energy for the circuit. So, the bulb must be connected to the battery to be lit.

Any device that increases the potential energy of charges circulating in a circuit is a source of *emf*. The emf is the energy per unit charge supplied by a source of electric current. Think of such a source as a “charge pump” that forces electrons to move in a certain direction. Batteries and generators are examples of emf sources.

For conventional current, the terminal voltage is less than the emf

Look at the battery attached to the light bulb in the circuit shown in **Figure 3**. As shown in the inset, instead of behaving only like a source of emf, the battery behaves as if it contains both an emf source and a resistor. The battery's internal resistance to current is the result of moving charges colliding with atoms inside the battery while the charges are traveling from one terminal to the other.

Thus, when charges move conventionally in a battery, the potential difference across the battery's terminals, the *terminal voltage*, is actually slightly less than the emf.

Unless otherwise stated, any reference in this book to the potential difference across a battery should be thought of as the potential difference measured across the battery's terminals rather than as the emf of the battery. In other words, all examples and end-of-chapter problems will disregard the internal resistance of the battery.

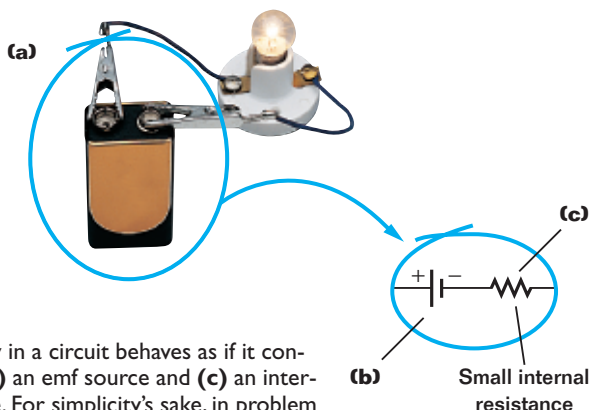


Figure 3

(a) A battery in a circuit behaves as if it contains both (b) an emf source and (c) an internal resistance. For simplicity's sake, in problem solving it will be assumed that this internal resistance is insignificant.

Quick Lab

Simple Circuits

MATERIALS LIST

- 1 miniature light bulb
- 1 D-cell battery
- wires
- rubber band or tape

SAFETY



Do not perform this lab with any batteries or electrical devices other than those listed here.

Never work with electricity near water. Be sure the floor and all work surfaces are dry.

Connect the bulb to the battery using two wires, using a rubber band or tape to

hold the wire to the battery. Once you have gotten the bulb to light, try different arrangements to see whether there is more than one way to get the bulb to light. Can you make the bulb light using just one wire? Diagram each arrangement that you try, and note whether it produces light.

Explain exactly which parts of the bulb, battery, and wire must be connected for the light bulb to produce light.