Electricity and the Waterfall Analogy

To discuss electrochemistry meaningfully, the fundamental properties of electricity must be defined.

Introduction

The **voltage** between two points is a short name for the electrical force that would drive an electric current between those points. In the case of static electric fields, the voltage between two points is equal to the **electrical potential difference** between those points. In the more general case with electric and magnetic fields that vary with time, the terms are no longer synonymous. Electric potential is the energy required to move a unit electric charge to a particular place in a static electric field. The first is *voltage*, usually abbreviated "V" and measured in *volts* (also abbreviated "V".) Voltage, also sometimes called *potential difference* or *electromotive force (EMF)*, refers to the amount of potential energy the electrons have in an object or circuit. In some ways, you can think of this as the amount of "push" the electrons are making to try to get towards a positive charge. The more energy the electrons have, the stronger the voltage.

The **current** means the rate of flow of electric charge. This flowing electric charge is typically carried by moving electrons, in a conductor such as wire; in an electrolyte, it is instead carried by ions. The SI unit for measuring the rate of flow of electric charge is the ampere. Electric current is measured using an ammeter. *Current* is usually abbreviated "I" ("C" is reserved for the principle of *charge*, the most fundamental building block of electricity.) Current is measured in *amperes* or *amps*, abbreviation "A". Current refers to how much electricity is flowing--how many electrons are moving through a circuit in a unit of time.

The **resistance** of an object is a measure of its opposition to the passage of a steady electric current. An object of uniform cross section will have a resistance proportional to its length and inversely proportional to its cross-sectional area, and proportional to the resistivity of the material. Discovered by Georg Ohm in 1827, electrical resistance shares some conceptual parallels with the mechanical notion of friction. The SI unit of electrical resistance is the ohm (Ω). Resistance refers to how much the material that is conducting electricity opposes the flow of electrons. The higher the resistance, the harder it is for the electrons to push through.

The waterfall Analogy

If we draw an analogy to a waterfall, the voltage would represent the height of the waterfall: the higher it is, the more potential energy the water has by virtue of its distance from the bottom of the falls, and the more energy it will possess as it hits the bottom. Then current represents how much water was going over the edge of the falls each second . Resistance refers to any obstacles that slows down the flow of water over the edge of the falls (e.g. rocks in the river before the edge).

Water Fall	Angel Falls in Venezuela	Bridalveil Fall in Yosemite Valley (California)	Niagara Falls (New York and Canada)
Height (Voltage)	**Impressively Large** 979 m (3,212 ft) in Venezuela	**Medium** 188 m (617 ft)	**Small** 52 m (167 ft)
Flow (Current)	**Medium ?**	**Medium** 1,800 m³ per minute in high flow	**Impressively Large** 168,000 m³ of water falls over the crest line every minute in high flow
Resistance	**Negligible**	**Negligible**	**Negligible**

Ohms Law

These voltage, current and resistance are related via a principle known as Ohm's Law:

$$V = I * R$$

which states that the voltage of a circuit is equal to the current through the circuit times its resistance. Another way of stating Ohm's Law, that is often easier to understand, is:

$$I=V/R$$

which means that the current through a circuit is equal to the voltage divided by the resistance. This makes sense, if you think about our waterfall example: the higher the waterfall, the more water will want to rush through, but it can only do so to the extent that it is able to as a result of any opposing forces. If you tried to fit Niagara Falls through a garden hose, you'd only get so much water every second, no matter how high the falls, and no matter how much water was waiting to get through! And if you replace that hose with one that is of a larger diameter, you will get more water in the same amount of time.

Outside Links

- http://en.wikipedia.org/wiki/Voltage

Contributors

- Catherine Schmidt-Jones and Douglas L. Jones see http://cnx.org/content/m17281/latest/
- http://en.wikipedia.org/wiki/Voltage
- http://en.wikipedia.org/wiki/Electric_current

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