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Electric Potential Energy and Voltage

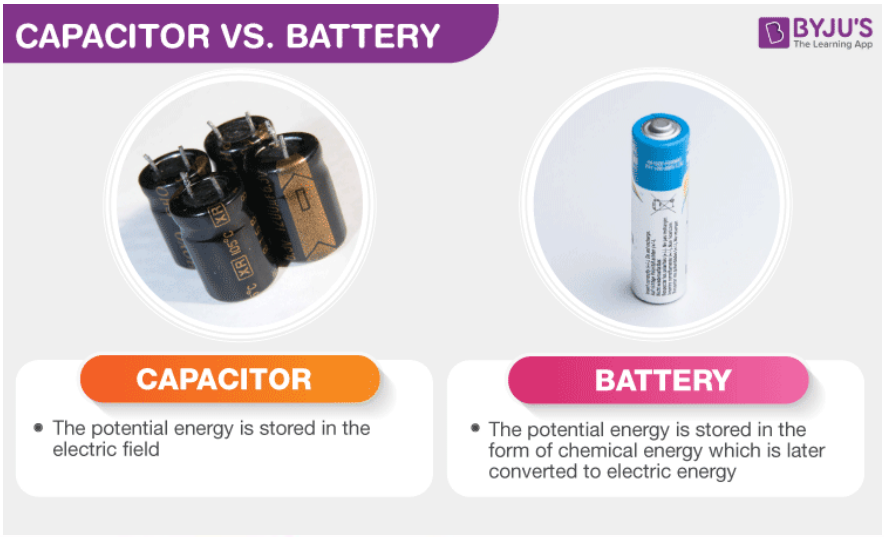
In Physics, **Energy** is defined as the ability to do work (to make things move or change). **Electric Potential Energy** is the ability for stored-up electrical energy to move or cause a change to something in the world.

How do we store electrical energy?

To store electrical energy safely until we wish to use it, we store it in batteries and capacitors. **We will focus on batteries in this course.**

Capacitors are devices that store electrical energy in an electrostatic energy and release all energy into a circuit at once when used.

Batteries are devices that store chemical energy and convert the chemical energy into electrical energy when in use. Batteries cannot discharge all energy at once, it does so over time.



BATTERIES	
Pros	Cons
Power Density	Limited Cycle Life
Storage Capability	Voltage And Current Limitations
Better Leakage Current Than Capacitors	Long Charging Times
Constant Voltage That Can Be Turned Off And On	More Temperature Sensitive Than Capacitors
CAPACITORS	
Pros	Cons
Long Cycle Life	Low Specific Energy
High Load Currents	Linear Discharge Voltage
Short Charging Times	High Self-Discharge
Excellent Temperature Performance	High Cost Per Watt

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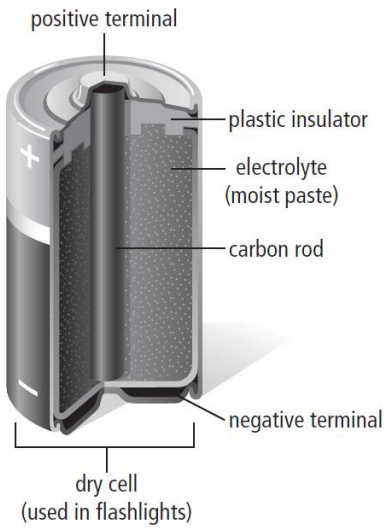
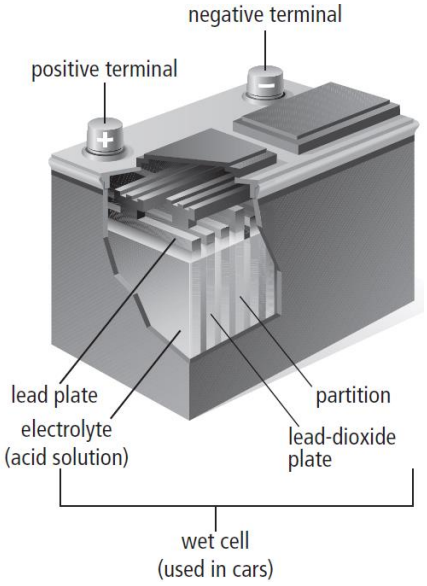
All batteries are types of **electrochemical cells** (they all store energy as chemicals). However, there are two types of batteries: Wet cell and dry cell, which just means that the batteries use non-liquid or liquid chemicals.



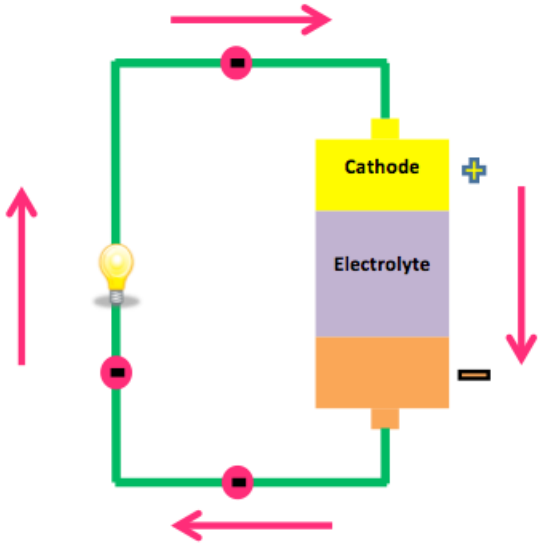


How does a battery provide electric energy?

A battery provides energy to push negative charges through conductors that are connected together. Energy to push electrons is available if positive and negative charges are separated. In a flashlight battery, for example, energy from chemical reactions does the work of separating the charges.

Batteries contain **electrolytes**, a material that allows electrons to flow from one end of the battery to the other. This is often referred to as **battery acid** (because they are usually a paste made from acid).

Each end of the battery has a **terminal** (called **electrodes**) that are either positively or negatively charged (caused by separating the charged ions). The **positive end** is called the **cathode**, while the **negative end** is called the **anode**.



To draw energy from a battery, a wire made of conductive material is used to connect the positive and negative ends together, allowing electrons to flow.

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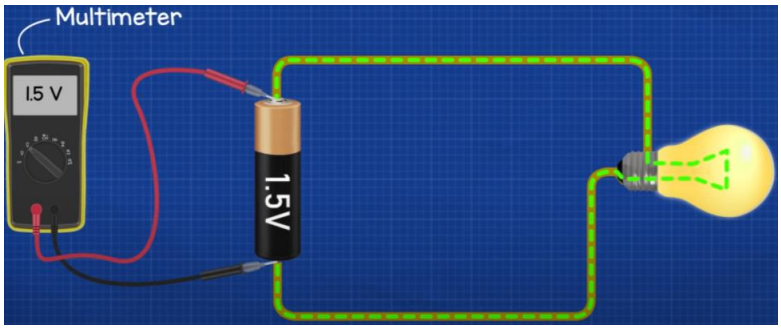
Electrons/energy will not leave the battery very fast without <u>both ends</u> of the battery connected in a circuit. However, over time, some energy can leak out.

Voltage

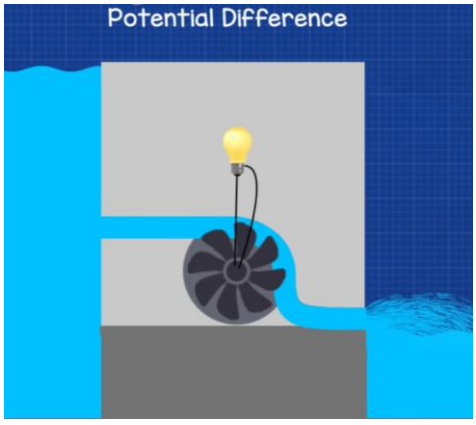
Voltage is the <u>potential difference</u> of a battery, measured in **Volts (V)**. The **potential difference** is the difference of electrical energy between two points. As the energy moves from the place of higher energy to lower energy, the energy can be used along the way by various devices. <u>Think of voltage as the pushing force in the circuit.</u>

To measure Voltage/Potential difference, a **voltmeter** (or **multimeter,** if it can measure other things) can be used. A **voltmeter** is a device that has two conductive wires attached to a device that displays how much energy is leaving one end of the battery (or circuit) compared to the other.



Voltage is similar to a dam on a river. One side has higher water (more electrons, anode), the other has lower water (less electrons, cathode). The potential energy/voltage would be like the height from one water source to the other.

Another way to understand voltage is the pressure on the electrons caused by the battery.



Due to the fact that batteries are stored chemical energy, **the voltage of a battery depletes over time**. This means that if a lightbulb is attached to the circuit, it will go dimmer over a longer period (like a flashlight).