Types of Batteries

Connecting 2 or more cells together creates a battery, which is a sealed case with only two terminals. Rechargeable Cells Dry cells and wet cells are called **primary cells**. The chemical reactions, which produced the electricity, cannot be reversed. Using an external electrical source to rejuvenate the cell however can reverse the chemical reactions in a rechargeable battery. The reversed flow of electrons restores the reactants in the cell. Rechargeable cells are **secondary cells**, because they store electricity that is supplied by an external source. The most common reactions that are efficient enough to be used for these types of cells are Nickel Oxide and Cadmium (Ni-Cad). The reactants are restored, but the electrodes wear out over time. Pacemaker cells can last from 5-12 years. **Fuel Cells** combine hydrogen and oxygen without combustion. Electricity, heat and pure water are the only by-products of the fuel cell's reaction. They are 50-85% efficient.

Processes & Applications

Electrochemistry - Allesandro Volta made the first practical battery around 1800, by piling zinc and copper plates on top of each other, separating them with electrolyte-soaked paper discs. Humphrey Davy filled an entire room with 2000 cells to make one massive battery.

His work led to a whole new field of science called **electrochemistry**, the study of chemical reactions involving electricity.

Electrolysis – using electricity to split molecules into their elements is called electrolysis. Industries use electrolysis to separate useful elements from solutions; like chlorine to make drinking water safe, and fuel for the Space Shuttle.

Electroplating - Silver and Gold plating can make jewelry and other attractive items look very expensive. The thin coating (which is usually stronger than the original element) is produced through a process called electroplating. This process is often used to protect the metal from corrosion.

Anodizing is a process that coats aluminum parts with a layer of aluminum oxide, which is much harder than aluminum. It is used in products such as screen doors, airplanes, car parts, kitchenware and jewelry.

Electro-refining is used to remove impurities from metal. Another process used by automobile companies bonds special paints onto car parts.

Energy Forms

The scientific definition of energy is 'the ability to do work'. Energy is found in many forms. The four most common forms of energy are:

Chemical - potential or stored energy stored in chemicals, released when the chemicals react.

Electrical - energy of charged particles, transferred when they travel from place to place.

Mechanical - energy possessed by an object because of its motion or its potential to move.

Thermal - kinetic energy of a substance

Measuring energy inputs and energy outputs allows you to calculate the efficiency of devices and systems.

Energy Conversions

Light to Electricity - photovoltaic (PV) cells, are made of semiconductor materials, such as silicon. When light is present, the material, breaks electrons loose – allowing them to flow freely. This current is drawn off by metal contacts on the top and bottom of the cell and then used in devices such as calculators, heater, or emergency telephones. Individual solar cells combined in modules form **arrays** producing more electric current.
Electricity to Motion - The ***piezoelectric effect*** produces sound by converting electricity into motion (vibrations). When a piezoelectric crystal, such as quartz, or Rochelle salt is connected to a potential difference, the crystal expands or contracts slightly.
Electricity to Light - An incandescent resistance filament (load) glows white-hot when electricity is passed through it. In fluorescent tubes a gas glows brightly. **LED**'s (light-emitting diodes) are solid–state components that use a fraction of the power.

Motion to Electricity - A barbeque spark lighter uses the **piezoelectric effect** in reverse. When a crystal or Rochelle salt is compressed or pulled, a potential difference is built up on the opposite sides of the crystal. Conductors then take this through a circuit to produce electric energy (a spark).
Electricity to Heat - Ovens convert electrical energy into thermal energy. A thermo-electric generator is a device based on a thermocouple that converts heat directly into electricity without moving parts. Several thermocouples connected in a series is called a **thermopile**. Thermopiles are extremely reliable, low-maintenance devices and are often used in remote locations for emergency power.
Heat to Electricity - A **thermocouple** is a device that can convert thermal energy into electrical energy - the '***Seebeck Effect***.' It consists of two different metals (bimetal) joined together that conduct heat at slightly different rates. When heated, the difference in conduction results in electricity flowing from one metal to the other.

Conductors and Insulators

In **insulators** - electrons are bonded closely to the nuclei (allowing little movement), while in **conductors**, the electrons are free. When electricity is added, the electrons move toward the positive terminal.

Semiconductors are almost perfect conductors - they have almost no resistance to electron flow. The largest obstacle is to get the semiconductor to work at reasonable temperatures for practical applications.

A gas can also act in the same way as a wire. It conducts the flow of charged electrons from the negative terminal to the positive terminal. Gases usually insulate, but 'some' gas atoms can be excited by electricity.

Resistance

Resistance is a measure of how difficult it is for electrons to flow through a conductor. It is measured in **ohms**. A special type of conductor, called a **resistor**, allows electrons to flow, but provides some resistance. The more resistance a substance has, the greater the energy gain it receives from the electrons that pass through it. The energy gain is evident in heat and light energy (light bulb filament, wire in a toaster). Solutions can also be resistors.

A **switch** is a device that allows the flow of electrons or stops the flow. When the switch is open, the is no flow, because there is a gap in the conductor. When the switch is closed, the switch becomes the 'gap replacement' and allows the flow of electrons to continue. To change the electron flow gradually, a **variable resistor**, or **rheostat** is used (a dimmer switch, volume control knob).

Ohm's Law

Georg Simon Ohm, a mathematician, proved a link between voltage (V), current (I) and resistance (R). The unit of resistance was named after him, the **ohm** Ω

Ohm's Law states that:

as long as temperature stays the same the resistance of a conductor stays constant, and the current is directly proportional to the voltage applied

$$R=V/I$$

Applying Ohm's Law
If the temperature of a resistor changes, the resistance changes as well (resistance is usually low when the resistor is cool, and as the temperature increases, so does resistance).