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ELECTRICITY

THE DISCOVERY OF ELECTRICITY AND MAGNETISM

Electricity got its name from the Greek word ELEKTRON, which means "amber," a fossilized resin from extinct plants. The early Greeks found that when they rubbed a cloth over amber, it attracted bits of dried material. The materials were said to be charged with an electrical force.

The ancient Greeks also observed that a certain type of rock attracted bits of iron. The rock was an iron ore called "magnetite." Its power of attraction was given the name magnetism. Electricity and magnetism were so much alike that the Greeks considered them to be the same phenomenon.

STATIC ELECTRICITY

It's a common experience in cold, dry weather to walk across a carpet, touch something metal like a doorknob, and get a little shock. A crackling noise can be heard, and, in the dark, a spark flashes. The friction produced by shoes rubbing against the carpet, or by a cloth rubbing against amber, creates an electrical charge, or exchange, between atoms of both materials. These are examples of static electricity.

ELECTRICITY BEGINS IN THE ATOM

Scientific experiments with electricity began several hundred years ago. A theory would be proposed, and then scientists would test it in the laboratory to see if it was true. Through this research by many people, it was learned that materials are made of atoms, smaller than the eye can see. At the core of each atom is a dense mass of protons and neutrons. Their weight accounts for 99 percent of the atom's weight. Surrounding the core are one or more particles called electrons. Most atoms have the same number of protons and electrons. The protons have a positive electrical charge, and the electrons have a negative charge.

Normally, the opposing electrical charges of the protons and electrons balance each other. But the balance is disturbed when an outside energy force is introduced. When two surfaces rub against each other, one material picks up negatively charged electrons from the other. The exchange is signaled by a tiny electrical shock.

In the 18th century, the American scientist and diplomat Benjamin Franklin conducted a number of experiments in electricity. He believed that there were two kinds of electricity, one negative and one positive. As he saw it, friction did not create the electricity. Rather, it was transferred from one substance to another.

ELECTRICITY AND MAGNETISM

The two forces, electricity and magnetism, are closely related. The action of one can affect the other. An invisible field of force extends outward from a magnet. The movement of electric charges in the magnet generates the force. The force is concentrated at each end, or pole, of the magnet. One end is called the north pole and the other the south pole. Magnets can be shaped like a horseshoe or a long bar. Whatever the shape, each has a south and a north pole.

When the north pole of one magnet is brought close to the north pole of another magnet, they repel each other. But if the north pole of one magnet is brought near the south pole of another magnet, they attract and cling to each other. In every case, poles of a magnet that are alike repel each other, and unlike poles attract each other. As magnets are moved farther apart, their forces decline.

Michael Faraday, an English physicist, contributed to the world's knowledge of magnetism, electricity and their relationship. In the 19th century, he conducted experiments with electrical currents. His work is the basis for today's technology by which electricity is generated on a large scale.

Faraday knew that electricity is the flow of electrons through materials called conductors. Metals, such as silver or copper, make excellent conductors. Other materials, such as glass, plastic or rubber, block the flow of electricity. These are called insulators.

In an experiment, Faraday discovered that electricity is produced when metal wires move past a magnet's field of force. The electrogenerator, which is the source of most electricity today, is built upon Faraday's principle. In the electrogenerator, wire travels in a coil past a magnet. Electrons from the magnet's force field enter the wire conductor and travel along it in a flow, or current.

It was not until later in the 19th century that Thomas Edison and other inventors made practical use of Faraday's discovery. They developed ways to produce large amounts of electricity and to send it long distances through wires. Formation of a large-scale electrical industry was based on these developments. For the first time, city streets could be brightly lit at night by electricity. Electric power companies were formed in various parts of the country and the world. All kinds of machines and industrial equipment were designed or adapted to be run by electricity.

ELECTRICITY TRANSMITS ENERGY

Static electricity exists in nature, as the Greeks had learned, but it can't be used or controlled without modern technology. Faraday's experiments led to the development of current electricity, which conveniently transports and distributes energy. Current is the flow of electrons through a wire. Some current moves through the wire in much the way that water flows through a pipe. It can be turned on or off by a control switch. Many different types of energy can be used to produce current electricity.

PRODUCING ELECTRICITY

Inside an electric power plant, mechanical energy from hydropower or steam is transformed into electrical energy through a generator. A large force is produced inside the generator by the rapid spinning of a coil of wire around a giant magnet. This force, or pressure, is used to push electrons through the conductor. The volt is the unit used to measure this force. The force itself is called voltage. Energy is needed to drive the generator. The electricity produced by the generator is strictly due to interaction between the wire coil and the magnet.

Electricity is transmitted from the power plant to homes, offices and other buildings through heavy wire cables. To prevent electricity from leaking out, the cables are insulated. Insulation also protects people and animals from electric shock.

Because current electricity is "electricity in motion," it is said to contain kinetic energy. Electrons flowing through the conductor either move in one direction (direct current, or dc), or they constantly switch directions (alternating current, or ac). The watt is the unit used to measure electrical power. To measure large amounts of power, the kilowatt (1,000 watts) and the megawatt (one million watts) are used.

HIGH-TEMPERATURE SUPERCONDUCTIVITY

Amazing discoveries may enable electricity to travel more efficiently and farther than ever imagined possible. Researchers are testing a new superconductor to replace traditional copper wire conductors. The new material, made of ceramic, can transmit electricity without resistance.

Due to resistance, copper conductors lose up to 70 percent of the energy used to generate electricity. This loss is in the form of wasted heat. The resistance-free superconductor would eliminate that waste, and the cost of sending electricity to factories and homes would be sharply reduced. The superconductor could transmit electricity hundreds of miles without heat loss. This would make it possible to locate nuclear power plants and other potentially dangerous utilities far away from population centers.

Scientists believe that the superconductor could be as important as the discovery of the light bulb, the laser or the transistor. Its development will have a broad impact on several industries. If microchips could be made of the new superconductor, computers could be built smaller than they now are, and signals would travel more rapidly. The magnetic force in the superconductor is so strong that engineers believe it could form the "track" for high-speed trains that could travel up to 300 miles per hour.