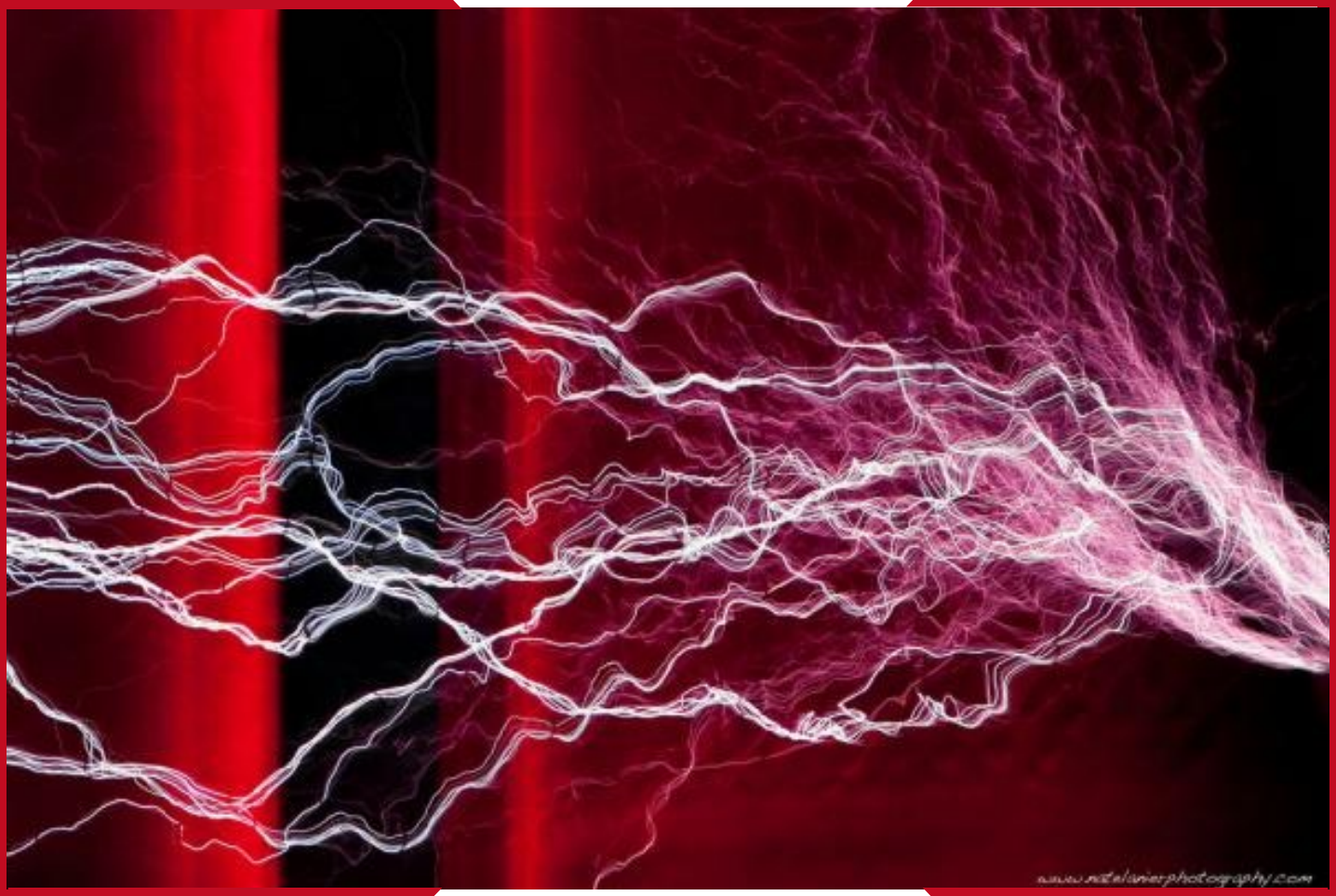
ENERGY

Physical Science



CHAPTER 10

electrical energy is all around us, and is essential to the proper functioning of our bodies.

one way to observe static electricity is by combing your hair with a comb, and then placing the comb by little pieces of paper. the little pieces of paper will jump right on to the comb.

the electrostatic force, is much greater than gravity.

when electrostatic charges were first investigated in the 1600s, it was soon discovered that electrically charged objects could exert forces of both attraction and repulsion.

the law of charges states: like charges repel; unlike charges attract.

generally it is the valance electrons, or the combining electrons that can contribute to the movement of storage of an electrical charge.

neutrally charge particles have the same amount of positive charges (protons) and negative charges (electrons).

in materials that have a weak affinity for their electrons, or a weak "grip" on their electrons, their electrons can easily be taken, so when you touch a door nob and you get a shock. you are receiving those loosely held electrons and the in-balance created between the materials charges is what generates the charge to shock you with.

when in a circumstance like this, the net positive, or negative charge, is called the coulomb (C).

one coulomb is the charge carried in 6.24×10^{18} protons or electrons.

the electrostatic force is a field force.

a charged object can exert a force on distant charges not in direct contact with it.

physicists use lines of force to model electric fields.

they align with the direction of the electrostatic forces vector would move a tiny positive charge.

line of force in the field model are useful because they help us visualize both the direction and strength of an electric field.

the field strength is represented by the distance between the lines of force.

electrostatic field will have an effect on each other if brought close enough.

the same fields together repel each other and the opposite attract.

the electric field vector can point in only one direction.

Electrical induction is the creation of a charged region of a neutral object when exposed to a nearby electrical charge.

in the comb and paper illustration, the paper is attracted to the comb because the molecules in the paper rearrange to become an electric dipole (a molecule who's electrons and protons have shifted to create positive and negative poles).

the positive poles point toward the negatively charged comb, while the negatively charged poles point away from the comb.

water molecules are naturally dipoles.

in most charges there will be leakage of energy, or discharge.

how can one tell if an object has a positive charge or a negative charge?
using the electroscope. which uses the law of charges.

some materials offer little resistance to electrical conductors. these substances are called electrical conductors. (usually: copper, aluminum, silver, and gold)

electrical insulators do not allow electrons to move as easily. (usually: glass, wood, and rubber)

some conductors are called semi conductors and allow limited electron flow or conduct only under certain conditions. (Silicon, Germanium)

static charges move when conditions allow them.

when objects with different charges touch, some of the electrons transfer from one object to the other.

the loss of static charge as electrons move to another object is called electrical discharge.

electrical charges can discharge slowly. lightning is an instantaneous discharge of electrical energy.

in the mid 1700s Benjamin Franklin started experimenting with lightning.

a little later the lightning rod was invented to protect buildings, but resulted in 3000 deaths in 1767. as lightning struck a gun powder buildings lightning rod, setting off the powder.

the first scientists study of electricity could not product enough electrical charge for more than a mere demonstration.

in 1745 Ewald von Kleist invented a device for storing a charge. Pieter van Musschenbroek invented a similar device a few months later.

the device was called the Leyden jar after Musschenbroek's hometown in Leiden, Netherlands.

the Leyden jar is a jar coated inside and out with layer of lead. leaving the upper end of the jar uncoated, and insulated stopper plugged the jar.

a metal rod was inserted through the stopper, which was attached to a metal chain resting on the inner lead coating. a metal ball rests atop the metal rod.

glass separated the two lead layers as an insulator.

an electrical charge can be called a ground charge if it is connected to the ground by a wire.

modern charge storage devices are called capacitors. it stores charge in electronic circuits.

electrostatic principals help control pollution in some factories.

the smoke in factories can be charged as it goes up the smoke stack, and collected on metal plates as it nears the top.

electrical discharges are short-lived because an object has only a limited number of excess electrons to lose. to use energy to do work, we need a continuously flowing supply of energy.

electricity that involves constantly changing charges is called electrical current.

nearly all current running through solids involves the flow of electrons. electrical current flows most easily through conductors, such as metal wires.

electrons may also flow through ionized gases such as plasma.

a cathode-ray tube (CRT) is used in some TVs to display "painted" images

physicists use several models to describe electron flow through wires. one is called the electron diffusion theory.

in this model, electrons move from areas of high concentration to low concentrations just as gaseous perfume particles do in a room.

current is maintained in the conductor by a continuous supply of electrons at the source, which maintains this imbalance in electron concentrations.

another model says that electrons flow from one point of higher electrical potential energy to a point of lower electrical potential energy.

electrical current running through wires is caused by electrons.

conventional current is the flow of electrons through a conductor.

electrical current can also involve the flow of ions (charged atoms) in chemical current-carrying solutions and in some plasmas.

oppositely charged particles flow in opposite directions at the same time.

current that flow in one direction through a conductor is called a direct current (DC).

this chapter includes on direct current, but there is another form of electrical energy called alternating current (AC). discussed in chapter 11

for current to flow, there must be a complete path from the source through a conductor and back to the electron sink again. (source)

this path is called the electrical circuit.

to make a circuit useful it contains and electrical load, such as a light bulb, which converts electricity to some other form of energy.

a switch allows you to open or close the electrical circuit.

electrons cannot be created or destroyed.

a battery consists of one or more electrochemical cells that supply electrons released by a chemical reaction.

batteries that use solid or paste like chemicals are called dry cells, they are portable

wet cells use acidic combinations or metallic combinations to store charge.

a generator consists of one or more coils of wire rotated in a magnetic field by some form of prime mover, such as a motor or a turbine powered by steam, water, or wind.

you might think of a generator as lifting charges to a higher electrical potential, like a pump that refills a water tower.

electrons are strongly affected by electromagnetic energy.

engineers have developed devices called photovoltaic (PV) or solar cells that use light rays absorbed in some kinds of semiconductors.

it is a lot easier in science to measure the potential difference between two points than to measure the potential energy from one, in electricity that is.

the potential difference between two points is the amount of work required to move a charge between them.

we measure potential difference in a unit called the Volt (V). A 1 V potential difference requires 1 J to move 1 C of charge between the points. the volt is defined as this:

$$1V = \frac{1J}{1C}$$

batteries are rated by the potential differences between their positive and negative connections or poles.

Voltages are measured on a voltammeter.

Electrical current is measured in the unit called the ampere (A).

electrical currents are measured by ammeters.

$$1A = \frac{1C}{1s}$$

every component of a circuit hinders the flow of charges to some extent.

this property is called electrical resistance.

a device called a resistor can change the voltage within portions of the circuit.

in general high electrical resistance is undesirable.

in circuit as the energy passes through, some energy will always be lost because of the electrical resistance.

George Ohm came up a relationship between voltage, current and resistance in electrical circuits.

Direct current is directly proportional to voltage.
Direct current is inversely proportional to resistance.

Ohms law: $V = IR$

resistance is measured in ohms Ω

Energy = power x time interval ($E = P \times \Delta t$)

Electrical energy is thus dispensed and billed in units of kilowatt-hours (kWh).

DC power formula $P = V \times I$

in parallel circuits the loads are connected in separate branches of the circuit. the current flows through more than one path, splitting up to flow through each load.

if the wires on an appliance are damaged to where the actual wire is showing, and both of the showing wires are touching, the energy will bypass the appliance and just hop on the returning wire thus making a short circuit.

doubling the current running through a wire quadruples the amount of electrical energy converted to thermal energy in the resistance.

to prevent currents in faulty circuits from starting fires, over current protection was invented. each circuit must have a circuit breaker!

it is a switch that can manually or automatically switch open if the current flowing through it exceeds a certain value.

electrical arcing happens when amounts of current jump tiny gaps between segments of the conductor, this can cause flame.

arc-fault circuit interrupters (AFCI) are "intelligent" microprocessors that can detect the arcing short circuit. and break the circuit.

older homes use devices called fuses to protect their circuits.

ground fault circuit interpreters (GFCI) protect against shock in exposed locations.

they monitor the voltage between the wires supplying an appliance or the outlet.

a GFCI device can be a special out let of a portable extension cord.