Physical Science

Chapter 15 Study Guide—Electricity

1. Electric Current
   1. Definition electric current: the flow of electrons or other charged particles from one place to another
   2. Two types of current
      1. DC (direct current)—electricity that flows in only one direction
      2. AC (alternating current)—electricity that continually alternates direction
   3. Cause for electron flow: electrons move because of a difference of charges exist between two places; electrons are repelled by the negative charge and attracted to the positive charge
   4. Voltage—the force or speed with which electrons move; the greater difference between two electric charges, the greater the voltage; the SI unit for voltage is the **volt**
   5. Current—a different measure of electric flow is current, the “volume” of charge that is being transferred; the SI unit for current is the **ampere** (amp)
   6. Power—energy used per unit of time; this is a combination of the previous two factor; power equals voltage times current (P=VI); it tells us how much total electricity is being used in a certain application and is measured in **watts**
   7. Electric companies measure electricity and charge by the **kilowatt-hour**—the amount of energy used 1 kW\*hr is used continuously for 1 hour
   8. Resistance—a measure of how much a material hinders the flow of its electrons
      1. Insulators—substances which do not allow electricity to flow through them
      2. Conductors—substances with a lot of “free” electrons which allow electricity to readily flow through the substance
      3. Ohm—the unit for resistance
      4. Joule heat—resistance is a kind of friction that produces heat; this is called Joule heat (used in applications such as light bulbs, toasters, heaters, hair dryers, electric water heaters).
      5. Factors affecting resistance
         1. Type of material
         2. Diameter of conductor—smaller=more resistance
         3. Length of conductor—longer=more resistance
         4. Temperature—heat=more resistance
      6. Superconductors—a material that allows current to flow through it with no resistance at all; temperatures have to be very cold for this to occur.
      7. Ohm’s Law—V=IR (Voltage=current x resistance)
         1. Resistor—device designed to add resistance to a circuit
         2. Resistors can be used as volume controls or light dimmers
2. Electric Circuits—the path that an electric current follows
   1. Parts of a circuit
      1. Source of current
      2. Set of conductors
      3. A load—device that transforms electrical energy into another useful form of energy
   2. Closed vs. open circuit—a closed circuit is one that includes a complete path back to the source which allows it to perform work; an open circuit is one which do not allow electrons return to their source, which stops the electrons from flowing
   3. Short circuit—a situation where the electricity takes a shortcut back to the source and avoids the load on the circuit; “shorts” can become very hot and cause fires
   4. Circuit protection
      1. Fuse—narrow strip of metal designed to burn out more quickly than the rest of the circuit
      2. Circuit breaker—an automatic switch which “flips” when too much current flows through the circuit
   5. Circuit arrangements
      1. Series circuit—current has to flow through each load on the circuit to reach the next load
      2. Parallel circuit—current has a separate path to each load; current is equally divided between the loads
3. Using Electricity
   1. Lighting
      1. Incandescent lamps—this is what we generally call a regular light bulb; current passes through a filament which glows red hot
         1. Produce a lot of heat so they are not very efficient
         2. Halogen light are a form of incandescent bulb
      2. Fluorescent lamps—current passes through a tube filled with gases which causes them to release radiation; the radiation in turn strikes the coating on the inside of the tube causing it to glow; these are more efficient than incandescent lights
      3. CFLs—same as fluorescent lights only made to screw into a light socket
      4. Neon lights—tubes filled with neon and other gases glow various colors when a current runs through them
      5. LEDs—(light-emitting diodes)—these are made of semiconductors that emit light when a direct current is applied; use very little electricity, produce very little heat, and can last a very long time.
   2. Solenoid—simple device that uses electricity to produce a simple back-and-forth motion
   3. Telegraph—uses electromagnetism to communicate messages over a long distance
   4. Relay—a device that uses an electromagnet to open or close a switch in a circuit
   5. Loudspeaker—converts electric pulses into sound waves
   6. Electric motors
      1. Parts of a motor
         1. Field magnet (permanent magnet) around the outside
         2. Armature—a coil of wire that becomes an electromagnet when electricity is turned on
         3. Commutator for DC motors; slip rings for AC motors
      2. Function of motor
         1. Magnetism is the force that makes motors work—the electricity produces north and south poles in the armature which repel against the like poles of the field magnet and attract to the opposite poles of the field magnet
         2. In order to keep it turning, the armature has to have a constantly oscillating magnetic field making its sides switch rapidly between north and south poles. AC current does this naturally; DC requires a commutator (split ring) to do the job
4. Producing Electricity
   1. Light
      1. Photoelectric effect
      2. Photovoltaic effect—solar panels
   2. Chemical reactions—Electrochemical cell is any device that produces electricity by means of a chemical reaction
      1. Voltaic cell—a battery that cannot be recharged
      2. Storage cell—a battery that can be recharged
      3. Cells in a series—the voltage gets added together
      4. Cells in parallel—the voltage stays constant but the current (amps) increases
   3. Electromagnetic induction—the ability of electricity to convert mechanical motion into electric current; any time a conductors “cuts” magnetic lines of flux, a current is produced in the conductor
      1. Generator is a device that uses electromagnetic induction to produce electricity
      2. A generator is exactly like a motor being run in reverse—a motor turns electricity into motion, whereas a generator turns motion into electricity
      3. A special generator that uses a liquid conductor is called a magnetohydrodynamic generator
5. Changing voltage
   1. Transformer—a device that increases or decreases the voltage of alternating current using electromagnetic induction
   2. Process: electricity moving around bar creates a magnetic field which induces a current in the other coil of wires
   3. Step-up vs. step-down—in a step-up transformer the second coil has more loops than the first, but in a step-down transformer, the second coil has fewer loops than the first
   4. The total current in the two coils is always the same; it is only the ratio of volts to amps that changes