'The Atoms Family' **(A Great Electrical Resource Site)**
'Just for Kids' **(Fun and Games - About Electricity)**
'Theatre of Electricity'

Science in Action Textbook **(pgs. 296-315)**

Unit 4 Electrical Principles and Technologies

1.0 Electrical energy can be transferred and stored

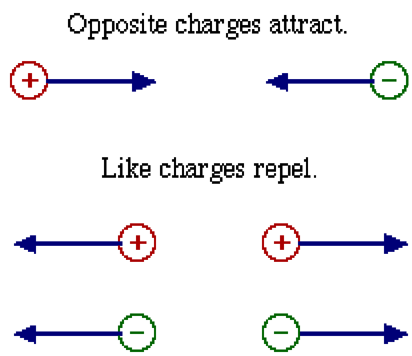
1.1 Static Electricity

When you get a 'shock', feel a 'jolt' or a 'spark', you are experiencing the same type of electrical effect that makes lightning. Static electricity happens when there is an imbalance of electrons (which have negative charges).

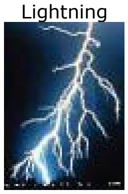
Electrical Charge

Most objects have the same number of positive (**proton**) and negative (**electron**) charges. This makes them **neutral** (no charge).

When there is a difference in the electrical charge, certain actions are predictable, because of
The Laws of Electrical Charges.



Lightning



Spark

VandeGraaff Generator

Charge separation occurs, when a charged object is brought close to a neutral object. The charged electrons repel the electrons in the neutral object and the charged object is then attracted to the protons of the neutral object (balloon on a wall)

Electrical Discharge is the movement of charges whenever an imbalance of charges occurs. The action results in neutralizing the objects. The over-charged electrons repel the electrons in the object and the positive protons attract the charged electrons causing a discharge or 'miniature lightning bolt'.

Van de Graaff (VDG) Generators

These generators build up an excess of static charge using friction. A rubber belt rubs a piece of metal and transfers the charge to a sphere. When you touch the sphere the charge builds up on you.
(Remember! - ***like charges repel*** - that is why your hair strands separate as you touch the sphere as the charge builds up on your body.)

1.2 Current Electricity

Certain animals, namely, the , can produce electric shock, to kill or stun prey. They have a special organ that contains specialized muscle cells called *electroplaques*. Each cell produces a small amount of electricity. When all the cells work together, a large amount of electricity is produce and used to help the eel survive. This type of electricity is like static electricity, which builds up and then discharges. It does not flow continuously.

Electrical devices need a steady flow of electricity. The steady flow of charged particles is called **electrical current**. The flow continues until the energy source is used up, or disconnected.

Amperes

The rate at which an electrical current flows is measured in **amperes** (A). This flow varies from a fraction of an ampere to many thousands of amperes, depending on the device. **Conductors** are used to allow the flow of electrical charges from where they are produced to where they are needed. These conductors are materials (often wires), which allow the flow of electrical charges easily.

Circuits

A **circuit** is a pathway that allows the flow of electricity. Most electrical circuits use wires (as conductors), although others may use gases, other fluids or materials. A circuit consists of a ***conductor***, an ***energy source***, a ***load*** and often a ***switch*** (to control the flow).

Electrical Energy and Voltage

Electrical energy is the energy carried by charged particles. **Voltage** is a measure of how much electrical energy each charged particle carries. The higher the energy of each charged particle, the greater the potential energy. Also called '*potential difference*', the energy delivered by a flow of charged particles is equal to the voltage times the number of particles. Voltage units are **volts** (V), and for safety purposes, the voltage of most everyday devices we commonly use is relatively low, while industries and transmission lines is relatively high.


Voltmeter

Measuring Voltage

The simplest way to measure voltage is with a voltmeter.

[**red** to positive (+) and **black** to negative (-)]


Multimeter

Some voltmeters can measure a wide range of voltages. These multi-meters should be used with caution, so that the sensitive needle is not damaged (by testing a low range with high voltage).

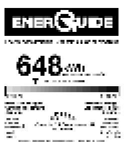
Measuring Voltage with Computers
A voltmeter can be hooked up to a computer. Hook-up the red and black lead in the same way as you would for a voltmeter.

1.3 Electrical Safety

Coming in contact with a power transmission line can prove to be deadly. By touching it, a short circuit can occur, because the electricity is trying to find a path to the ground - you can complete the circuit, but it may be fatal.

The Dangers of Electrical Shock

High voltage power lines carry 50,000V of electricity. However, amperage is more important to consider. 0.001A will likely not be felt at all, 0.015A to 0.020A will cause a painful shock and loss of muscle control (which means you will not be able to let go of the line). Current as low as 0.1A can be fatal. Electrical Dangers vary, depending on the situation. When the current can flow easily, it is more dangerous. **Insulators** (such as wood, rubber and air) hamper the flow of electricity. Moisture is a good conductor of electricity, so avoid water when working with electricity.



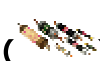
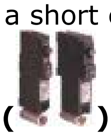
Protecting Yourself From Electrical Shock

The **Canadian Standards Council** issues labels to identify the amount of voltage required to operate electrical devices and the maximum current they use.
Electrical Safety Pointers ...

- **Never handle electrical devices if you are wet or near water**
- **Don't use devices that have a frayed or exposed power cord**
- **Always unplug an electrical device before disassembling it**
- **Don't put anything into an elecrical outlet - except a proper plug for an electrical device**
- **Don't overload an electrical circuit, by trying to operate too many devices at once**
- **Avoid power lines**
- **Don't bypass safety precautions when you are in a hurry**
- **Pull on the plug, not the wire**
- **Never remove the third prong from a 3 prong plug**

Plugs, Fuses and Breakers

The third prong of a **3 prong plug ( )** is a ground wire, connected to the ground wire of the building, in case of a short circuit.

Fuses ( **)** and **circuit breakers (**  **)** interrupt a circuit when there is too much current flowing through it.
Fuses contain a thin piece of metal, that is designed to melt if the current is too high. **Circuit breakers**, on the other hand, trips a spring mechanism, which shuts off the flow of electricity through the circuit, when there is too much current. It can be resused over and over (provided the cause of the increased flow is corrected).

The Danger of Lightning

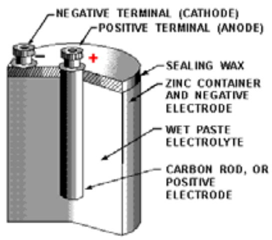
A lightning strike can have 30,000A - more than enough to kill you. Avoid being the target of a lightning strike, by staying low to the ground (horizon) and away from trees. Lightning can also do a lot of damage to a building. Metal **lightning rods**, that are connected to the ground with a grounding wire are fixed on the roof of many buildings to prevent damage to the building during an electrical storm.

1.4 Cells and Batteries

An electrochemical cell supplies a steady current. It is a collection of chemicals designed to produce small amounts of electricity. The electricity comes from chemical reactions within the cell. The tiny cells in a pacemaker can last from 5-12 years

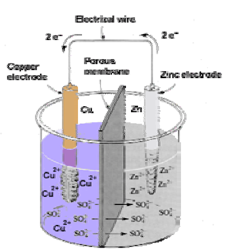
Dry Cells

The electricity-producing cells, that are referred to as 'batteries', are called **dry cells**. They are 'dry' because the chemicals used are in a paste.



The chemical reaction in a cell releases free electrons, which travel from the negative terminal of the cell, through the device, which uses the electricity, and back to the positive terminal of the cell. The dry cell is made up of two different metals, called **electrodes** in an electrolyte. An **electrolyte** is a paste or liquid that conducts electricity because it contains chemicals that form ions. An **ion** is an atom or group of atoms that has become electrically charged through the loss or gain of electrons from one atom to another. The electrolyte reacts with the electrodes, making one electrode positive and the other negative. These electrodes are connected to the terminals.

Wet Cells



Wet cells are 'wet' because the electrolyte is a liquid (usually an acid). Each electrode (zinc and copper) reacts differently in the electrolyte. The acidic electrolyte eats away the zinc electrode, leaving behind electrons that give it a negative charge. The copper electrode is positive, but it is not eaten away. Electrons travel from the negative terminal (attached to the zinc electrode) through the device and on to the positive terminal (attached to the copper electrode).

A car battery is made up of wet cells.
Each battery has 6 lead-acid wet cells.
Each cell contains alternating positive and negative metal plated (electrodes) in a sulfuric acid electrolyte.

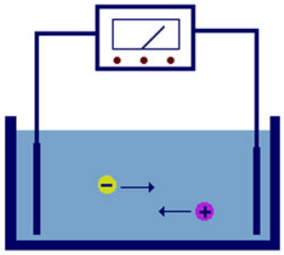
Rechargable Cells

The 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.

Batteries

Connecting cells together creates a **battery**, which is a sealed case with only two terminals.

Electrochemistry

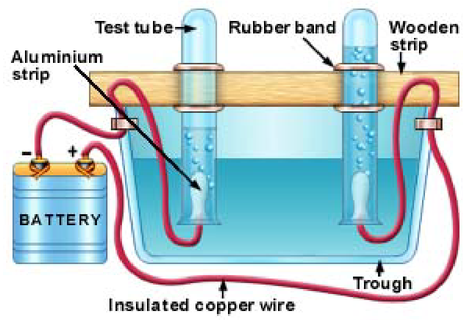


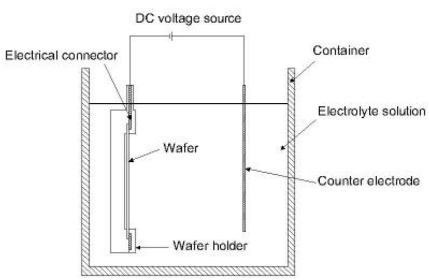
Allesandro Volta made the first practical battery around 1800, by piling zinc and copper plates on top of each other, separating them with electrolyte-soaked paper discs. Humphrey Davy filled an entire room with 2000 cells to make one massive battery. His work led to a whole new field of science called **electrochemistry**, the study of chemical reactions involving electricity.

Electrolysis

Smaller batteries were used to split molecules into their elements, a process called **electrolysis.** Many industries use electrolysis to separate useful elements from solutions.

- Chlorine to make drinking water safe.
- Fuel for the Space Shuttle (to get pure oxygen and hydrogen





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.

Other Electrochemical Applications

Anodizing and **Electrorefining** are other examples of electrochemical process used in Canada. **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 jewellery. **Electrorefining** is used to remove impurities from metal. Another process used by automobile companies bonds special paints onto car parts.

Science in Action Textbook **(pgs. 296-315)**

Unit 4 Electrical Principles and Technologies

2.0 Devices and Systems Convert Energy with Varying Efficiencies

Energy is found in many forms. The four most common forms are chemical, electrical, mechanical and thermal. Measuring energy inputs and energy outputs allows you to calculate the efficiency of devices and systems.

2.1 Energy Forms and Transformations

Neon signs have applications of electrical technology.

- First, electricity must travel all the way through the tube in order for the gas to glow.
- Second, The sign has to have a control to turn it off and on.
- Third, the sign must be safe

A Unique Circuit

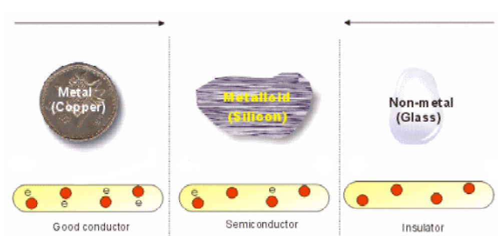
Neon gas acts in the same way as a wire. It conducts the flow of charged electrons from the negative terminal to the positive terminal. There are other gases which act as conductors, including:

- Neon - gives a orange-pink light
- Neon and argon - give a purple light
- Helium - gives a yellowish-white light

Neon is usually an insulator, but electricity 'excites the neon atoms, electrons themselves from the atoms, giving a mixture of charged particles inside the tube (which are good conductors).

Conductors and Insulators

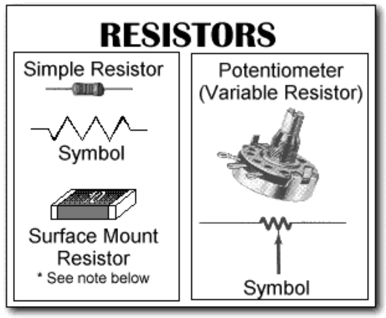
In **insulators** electrons are bonded closely to the nuclei (allowing little movement), while in **conductors**, the electrons are free. When electricity is added, the electrons move toward the positive terminal.



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.

Using Conductors, Resistors and Insulators

A special type of conductor, called a **resistor** allows electrons to flow, but provides some resistance.



Resistance is a measure of how difficult it is for the electrons to flow through a conductor. It is measured in **ohms**. 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. 'Lie detectors' are also special applications of resistance within the body (skin resistance, blood pressure and respiration). An increase in stress (usually associated with a lie) will improve conductivity and show a 'peak' in the recording device.

Switches and Variable 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).

2.2 Modeling and Measuring Electricity

Modeling Voltage

A waterfall is used, as a model, to demonstrate voltage. Water flows when there is a change in the **gravitational potential energy** (elevation). Electricity will not flow unless there is a change in **electrical potential** (voltage).


Voltmeter

Modeling Resistance and Current

Flow of water in pipes is used, as a model, to demonstrate resistance. The size of pipe determines the volume of water allowed through it. The amount of resistance, in a circuit, determines the size of the current.


Multimeter


Resistors

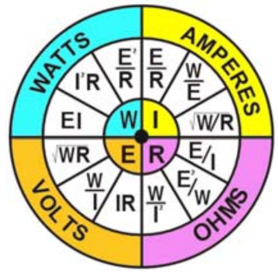
Ohm's Law

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**.

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*

Applying Ohm's Law



Sample textbook problems p. 306 and 307 (use R=V/I)

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).

Using Test Meters

Voltmeters measure voltage difference (**voltage drop**). **Ammeters** measure current (rate of flow) in amperes.
Small currents are measured using **galvanometers**.
Multimeters can measure voltage, current and resistance in a circuit.

Types of Resistors

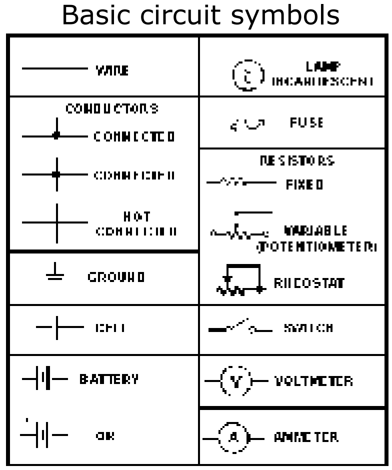
Different resistors are used for different applications, especially in electronics. There are many styles, sizes and shapes. The two most common are the wire-wound and carbon-composition types.

2.3 Analyzing and Building Electrical Circuits

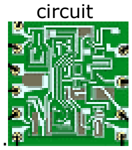
Engineers and designers of electrical circuits use symbols to identify components and connections. A drawing made with these symbols is called a **schematic** or **schematic diagram**.

Circuit Drawings

Basic circuit symbols



Integrated circuits put all of the components in one chip, reducing the size of the circuit

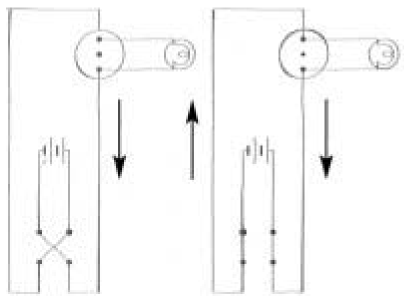


All circuit diagrams have four basic parts:

- **sources** - provides energy and a supply of electrons for the circuit
- **conductors** - provides a path for the current
- **switching mechanisms** - controls the current flow, turning it off and on, or directing it to different parts of the circuit
- **loads** - converts electrical energy into another form of energy

Circuit Analysis Example - Bulldozer

The toy bulldozer has 2 loads, a motor and a bulb. 2 1.5V cells act as the energy source. A switching mechanism connects to 4 wires. The circuit diagram follows.

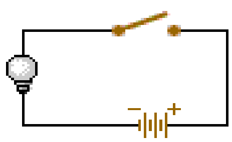


Forward Backward

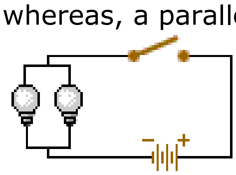
Parallel and Series Circuits

http://www.autoshop101.com/trainmodules/elec_circuits/circ101.html

A series circuit provides only one path for the current to flow,



whereas, a parallel circuit provides multiple pathways.



Applications of Series and Parallel Circuits

House Wiring - uses parallel circuits

Microcircuits (Integrated Circuits) - **transistors** are used with three layers of specially treated silicon, with the middle layer (receiving a small voltage, allowing it to control the voltage in the outer layers, allowing them to act as switches. Microcircuits are made up of transistors and resistors and are built on an extremely small scale.

Science in Action Textbook **(pgs. 318-342)**

Unit 4 Electrical Principles and Technologies

3.0 Devices and systems convert energy with varying efficiencies

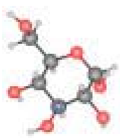
Energy is found in many forms. Measuring energy inputs and energy outputs allows you to calculate the efficiency of devices and systems.

3.1 Energy Forms and Transformations

The scientific definition of energy is the ability to do work. The four most common forms of energy are:

- **chemical** - this is energy stored in chemicals. It is potential or stored energy. It is released when the chemicals react.
- **electrical** - this is energy of charged particles. Electrons are negatively charged and electrical energy is transferred when these charged particles travel from place to place.
- **mechanical** - this is the energy possessed by an object because of its motion or its potential to move.
- **thermal** - this is the total kinetic energy of a substance. The faster the particles move the higher the kinetic energy.

Chemical Energy



Glucose

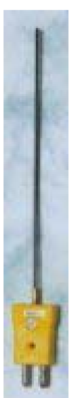
Chemical energy is the energy found in chemicals, including food. **Glucose** molecules are used in your body cells to produce thermal energy and mechanical energy. Chemical energy can also be converted into mechanical and sound energy (a CD player). Chemical energy can also be transformed into mechanical energy, with heat and light (dynamite).

Transformations Involving Chemical and Electrical Energy

Examples of Devices that convert Energy from one form to another include:

Input Energy	Device	Output Energy
electrical	toaster	thermal
chemical	flashlight	electrical, then light and thermal
electrical	blender	mechanical
chemical	battery-operated clock	electrical, mechanical and sound

Transformations Between Thermal and Electrical Energy

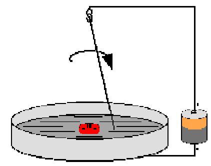


Thermocouple

A **thermocouple** is a device that can convert thermal energy into electrical energy. 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. Thermocouples are useful for measuring temperatures in areas that are difficult to access or too hot for a regular liquid-filled thermometer. Ovens and heaters do the opposite. They convert electrical energy into thermal energy.

3.2 Energy Transformations Involving Electrical and Mechanical Energy

Deflection of a compass needle using electrical current showed that there is a relationship between electricity and magnetism. **Oersted** found that the current created a magnetic field around the wire.
Faraday constructed the first motor.

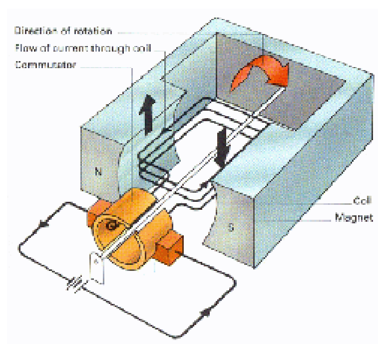


Electric Motors

By coiling (copper) wire around a (iron) metal core a strong **electromagnet** can be made. When attached to an electrical source it will produce a strong magnetic field. To keep this electromagnet spinning in a magnetic field, the direction that the current is traveling through the coil must be switched. This is accomplished by with a gap, which allows the polarity of the electromagnet change just before it aligns with the permanent magnet. Many electric motors use a **commutator** (a split ring that breaks the flow of electricity for a moment and then reverses the flow in the coil, when the contact is broken, so is the magnetic field) and **brushes** (contact points with the commutator) to reverse the flow of electricity through the magnetic field. The **armature** (the rotating shaft with the coil wrapped around it) continues to spin because of momentum, allowing the brushes to come into contact once again with the commutator.

Simple Motor

St. Louis Motor



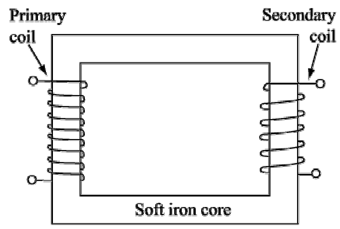
The Steering Analogy

Turning a steering wheel is similar to turning the armature in a motor. At some point you have to release the wheel and start again. This is what the commutator allows the armature to do.

Direct and Alternating Current

Some motors run on **direct current** (***DC***). It is 'direct', because the electricity flows in only one direction. **Alternating current** (***AC***) flows back and forth 60 times per second.

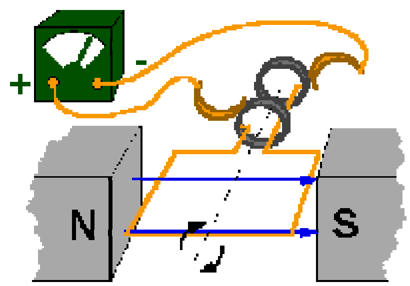
Transformers are used to change the amount of voltage with hardly any energy loss. Voltage change is necessary because the most efficient way to transmit current over long distances is at high voltage and then reduced when it reaches its destination, where it will be used.



A **step-up transformer** increases voltage, while a **step-down transformer** reduces voltage.

Generating Electricity

Michael Faraday discovered **electromagnetic induction** in 1831. He demonstrated that moving a conducting wire through a magnetic field by moving it back and forth through the field, Faraday created the first electricity-producing generator, which could generate electrical current.



Massive coils of wire rotating in huge generators can produce enough electricity to power an entire city.

Generating DC and AC

A **DC generator** is much the same as a DC motor. The spinning armature produces the electricity (if electricity is passed through a DC generator, it will spin like a motor). The central axle of an **AC generator** has a loop of wire attached to two slip rings. The current is switched as the loops move up and down alternatively through the magnetic field. The slip rings conduct the alternating current to the circuit through the brushes (the brush and ring assembly allows the whole loop to spin freely). In large AC generators many loops of wire are wrapped around an iron core.

3.3 Measuring Energy Input and Output

http://www.asme.org/educ...lten.htm#SMT
http://www.enged.com/students.../systems09.html

Power

Power *is the rate at which a device converts energy*. The unit of power is the **watt** (**W**), which is equal to 1 **joule** per second. For an electrical device the power is the current multiplied by the voltage.

(**P**) Power in watts
(**I**) current in amperes
(**V**) voltage in volts

$$P = I \times V$$
$$I = P / V$$
$$V = P / I$$

Shortcut

$$\frac{P}{I\ V}$$

Energy

The power rating of a device can be used to determine the amount of energy the device uses. Multiply the power rating by the time the device is operating.

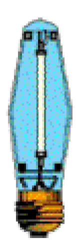
(**E**) Energy in joules
(**P**) Power in watts (J/s)
(**t**) time in seconds

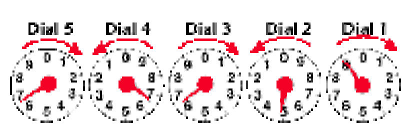
$$E = P \times t$$
$$P = E / t$$
$$t = E / P$$

Shortcut

$$\frac{E}{P\ t}$$

Kilowatt Hours is used as a unit for energy. The energy calculation is the same, except that hours are substituted for seconds and kilowatts (**kW**) are substituted for watts.
Electricity meters measure the energy used in kilowatt hours and then bills you for every kilowatt hour used.


Arc Discharge light



Energy Dissipation
Energy is neither created nor destroyed. It doesn't appear and then disappear, but transformed from one form to another. This is known as the **Law of Conservation of Energy**.

No device is able to be 100% efficient in transforming energy.

Most often, the energy is lost, or dissipated as **heat**. Mechanical systems also dissipate energy to their surroundings, but not as obvious as the heat loss. Much of the dissipated energy is **sound**.

Understanding Efficiency
The **efficiency** of a device is the ratio of the useful energy that comes out of a device to the total energy that went in. The more input energy converted to output energy, the more efficient the device is.

$$\%\ \text{Efficiency} = \frac{\text{Joules of useful output}}{\text{Joules of input energy}} \times 100\%$$

Most of the energy transformed in a lightbulb is wasted as heat. (5% is **light** energy, while 95% is **heat**)

Comparing Efficiencies
Comparing efficiencies of devices the energy cost and their environmental impact can be determined.

- **Florescent lights** are about 4x more efficient than incandescent lights.
- **Arc-discharge** lights (streetlights) are even more efficient.
- **Hybrid gasoline-electric** vehicles are more efficient than gas-powered vehicles.

3.4 Reducing the Energy Wasted by Devices

Devices, which have an **energy-efficient design**, are an important consideration for the consumer, because these devices use less electricity. Energy costs money and it also affects the environment, so reducing energy consumption is a good practice.

Limits to Efficiency
Electric heater come very close to being 100% efficient, but devices, which convert electricity to other forms, can never be 100% efficient. Some energy is lost, or dissipated in a form that is not useful output. Friction causes thermal energy to be lost, or dissipated in many devices.

Increasing Efficiency
Increasing the efficiency of a device depends on its purpose. The easiest way to increase efficiency in many devices is to **reduce friction**, as much as possible. **Insulating** a device from heat loss is also another practical way to increase efficiency. Using **capacitors** in electrical circuits is also another way to increase efficiency.

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Unit 4 Electrical Principles and Technologies

4.0 The use of electrical energy affects society and the environment

4.1 Electrical Energy Sources and Alternatives

The burning of **fossil fuels** (oil, coal, or natural gas) generates 65% of electric power.

Using Heat to Generate Electricity
Coal is mined, crushed into a powder, blown into a combustion chamber and burned to release heat. This heat boils water and superheats the resulting steam to a high temperature and pressure, which then turns a **turbine**. The turbine shaft rotates large electromagnetic coils in the **generator** to produce electricity.
In a nuclear reactor, atoms of a heavy element, usually uranium, are split (**nuclear fission**) in a chain reaction, which releases an enormous amount of energy.
Heat from the Earth's core can also be used to generate electricity. This **geothermal energy** (hot water and steam) is channeled through pipes to drive turbines - connected to generators, which produce the electricity.
Biomass is another type of fuel used to generate electricity. The gases produced from the decomposition of garbage in landfills can be used as fuel for stem-driven generators.

Waste heat from many industrial processes is used to produce steam generated electrical power. This process is called **cogeneration**.

Using Water to Generate electricity
Hydro-electric power plants generate 20% of the world's electricity. **Gravitational energy** is transformed into electrical energy.

Alternative Energy Sources
Tides - moving water can power turbines, which then run generators. When the tide comes in, the water is trapped in large reservoirs and then allowed to flow out past turbines.
Wind - this energy is harnessed by large propeller-type blades, which turn a shaft - connected to a generator.
Sunlight - **Solar cells** (made from silicon) enable the energy from the sun to be transformed (**photoelectric effect**) into electricity.
Batteries - from small portable batteries to rechargeables and most recently to the **fuel cells** all provide an electrical source by using chemical reactions within the cells.

Renewable and Nonrenewable Energy
Coal is a **non-renewable** resource (it cannot be replaced, as it is used up). Other **fossil fuels** are non-renewable as well.
Renewable resources can be replenished over and over again. These types of resources include; **wind energy**, **solar energy**, **tidal energy**, **biomass energy**, **geothermal energy**. **Tree harvesting** can also be renewed, but it takes a much longer period of time to renew this resource.

4.2 Electricity and the Environment

Air pollution

The burning of fossil fuels releases problem substances into the atmosphere.

- **Fly ash**, from the burning of coal, is carried up the smokestack and released into the atmosphere.
- **Sulfur Dioxide (SO_2)** - causes acid rain
- **Nitrogen oxides (NO)** - causes air pollution
- **Carbon dioxide (CO_2)** - is the cause of global warming.

Other Environmental Effects

- **Strip-mining** techniques removes all plants and animals from large areas of land resulting in **habitat and species destruction**.
- **Oil and Gas wells** can often give off poisonous gases.
- **Steam turbines** often release warm water into nearby lakes and rivers. The increase in water temperature can affect the local marine ecology and can kill fish.
- **Mines and refineries** that produce nuclear fuel can also cause damage to the environment, because of the radioactive waste.
- **Dams**, **wind farms** and **solar cell arrays** can destroy large areas of ecological habitat.
- **Tidal power plants** can disrupt the habitat of fish and other marine life.

Conserving Energy and Nonrenewable Resources

Fossil fuel reserves are decreasing, but with less reliance on these fuels we will be able to see a decrease in pollution. Conserving energy can be accomplished a little at a time.

This device helps to calculate the use of electricity in your home and can show you how much money you are using to pay for it. By knowing this, you will likely be motivated to find ways to lower your costs. Finding ways to lower our dependence on fossil fuels and finding alternative fuel sources is a decision that will determine much of what our future environment will be like.

A Sustainable Future

Sustainability means using resources at a rate that can be maintained indefinitely. If sustainability is not achieved, future generations will suffer. A sustainable approach often means a different way of getting what you want. Personal decisions can affect sustainability, even if it seems like it’s only on a small scale.

4.3 Electrical Technology and Society

Benefits of Electrical Technologies

Electrical technologies have improved our standard of living. Most improvements or inventions have come as a result of a desire to improve **speed**, **efficiency** or **convenience**. This has resulted in freeing up people's time to do other things.

Drawbacks of Electrical Technologies

More technology means more resources are needed to manufacture and operate them, making sustainability more difficult to achieve. As technology advances, obsolete devices become waste, adding to our problems of waste disposal. Some technologies are too expensive for some countries to adopt, leading to isolation and exclusion.

Computers and Information

Computers have revolutionized the way we accomplish many tasks, including writing, calculations and communications. Computers use **binary numbers** (**0, 1**) to store and transmit data which has led to the **digital technology** era.

Electricity and Computers

Electrical current is used in one way or another in storing or transmitting information. Lasers, photo-detectors, and electrical pulses all enable electronic devices to complete the tasks they are made to do.
A computer **hard drive** - uses electrical pulses to record and transmit information, by using an aluminum or glass **disk**, with a thin layer of magnetic material that spins at 300km/h. The electrical pulses are sent to an arm with read and write **heads**, which are magnetic coils that magnetize spots on the spinning disk.
Reading - magnetic spots induce current in the electromagnetic coil, reproducing 0's and 1's in the original signal and are sent to the computer's processor.
Writing - electrical signals are responded to from the computer's processor.

Electrical Transmission of Information

Electrical signals are sent from computer to computer throughout the world, making the storage and transmission of information compact, easy and relatively cheap. Concerns about this include; access, privacy and safety. Misleading or false information is also a problem and the 'information explosion' has created other storage, handling and access problems. Search engines help locate some of the information you may be looking for, but they cannot access everything.