Electricity 101

Electricity is a natural phenomenon.

- We see it in lightning
- Electric eels
- In static electric sparks when we get out of a car or take a synthetic shirt off
- Corrosion of metals

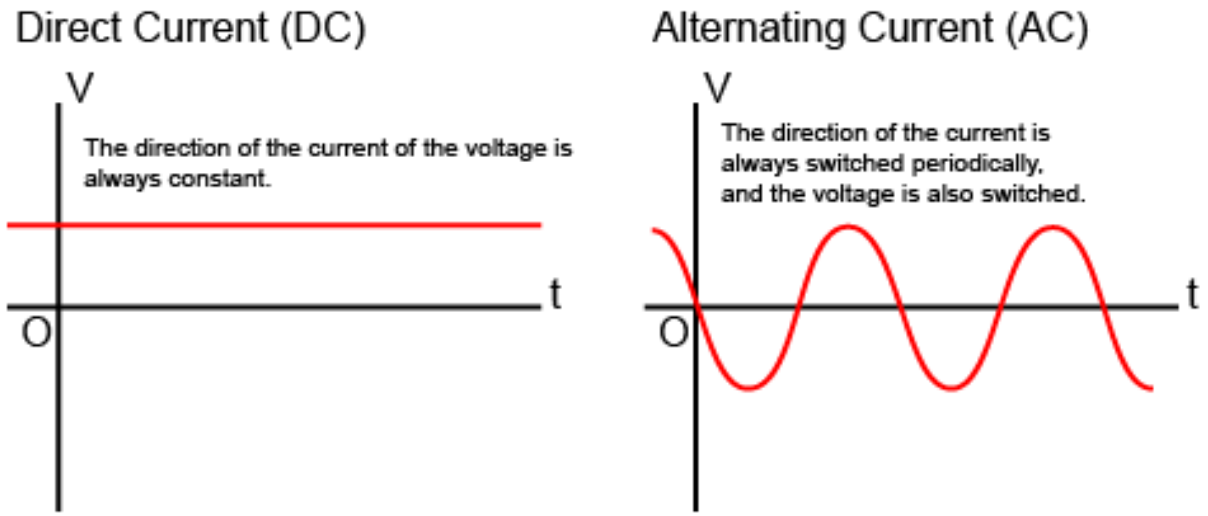
It is also what makes living things work, by the flow of electric current or charges through the neural system.

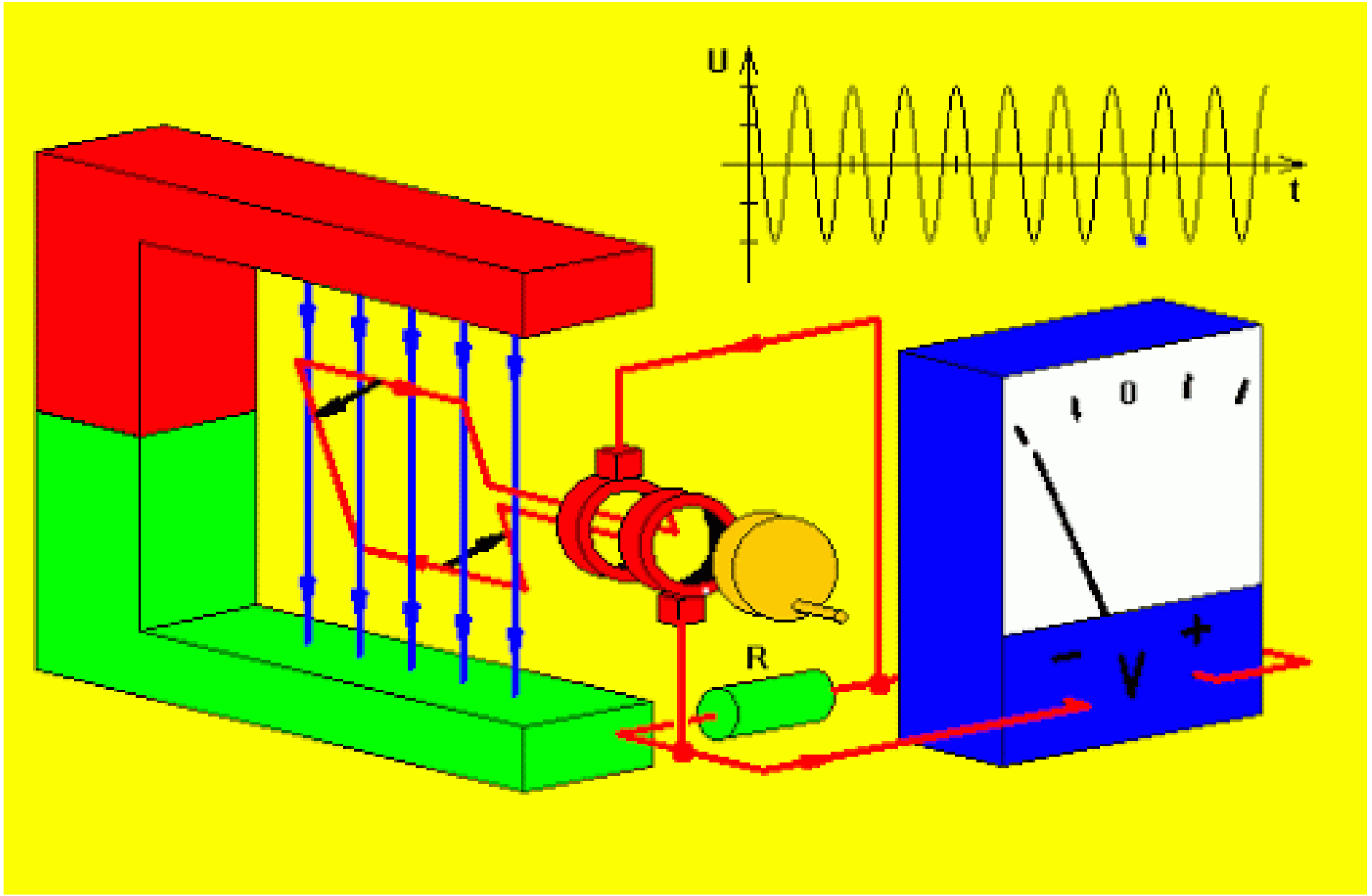
- Electricity is a form of energy, which can be generated by several methods, including mechanical and chemical. In the form we are most familiar with, it is the flow of electrons through conducting circuits, where it powers pumps, motors, mixers, and much more.
- You can think of electricity as something like water moving through a pipe. In the pipe, water always flows from a point of high pressure at the pump or reservoir, to a point of lower pressure at the end of the pipe.
- Metal wires are electrical “conductors” because they contain electrons that can easily separate from their original atoms and freely move throughout the material. Examples of good conductors are gold, silver, copper, lead, aluminium, and mercury.
- Like the water in a pipe, these electrons flow from an area of high electrical pressure to lower electrical pressure. The difference between these two pressures is called the “potential difference,” or voltage, and is measured in volts.

- As the electrons flow, they always seek any available path to an area of lower pressure, completing a “circuit.” In the simplest type of electrical circuit, electrons flow from an electrical source, through an appliance, such as a lamp or motor, then back to the electrical source to make a complete path. As the electrons move, they provide the energy to operate the device.
- The rate of electrons flowing in a wire is called the “electric current,” and is measured in amperes, or amps. The size of the current can be compared to the volume of water flowing through a water pipe.
- Power is the product of volts x amps and is given in watts.
- Energy is the product of power x time. One watt-second is one joule, but the unit we are most familiar with is kilowatt-hours which is how we buy our electrical energy.

- As the current flows through the circuit, it encounters resistance, some from the wire itself, as well as from a light bulb, motor, or other load wired into the circuit.
- Resistance can be compared to friction of water flowing through a narrow section of pipe, which slows down the flow. Resistance is controlled by the inherent material properties of the conductors and is measured in ohms.
- When a resistor is placed into an electric circuit, many of the electrons travelling through the circuit collide with the resistor's atoms. Each collision converts the kinetic or electrical energy into heat and, if hot enough, glowing light.
- Some materials, such as glass, ceramic, and many plastics are so resistant to electron flow that they don't allow any electric current through. These materials are called insulators, and they can be used to enclose and protect an electrical wire to prevent electrical leakage.
- Pure water is a very poor conductor, but conductivity improves rapidly with contamination.

- There are two types of electric current.
- These are direct current (DC) and alternating current (AC).
- With direct current the electricity always flows in one direction, as compared to the flow of a river.
- It is the type of electricity obtained from batteries, solar cells, etc.
- On the other hand, alternating current (AC) is a method in which the positive and negative sides are switched periodically and the direction of the flow of electricity changes accordingly.
- This is the flow of electricity obtained from a mechanical generator (alternator).
- The electricity produced at power stations and sent to homes is transmitted as alternating current.
- The diagram below shows the flow of DC and AC electricity.

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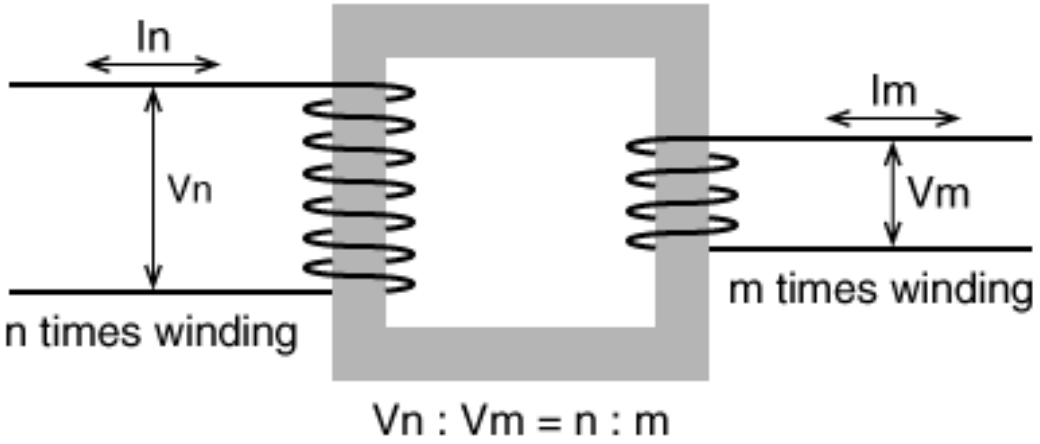
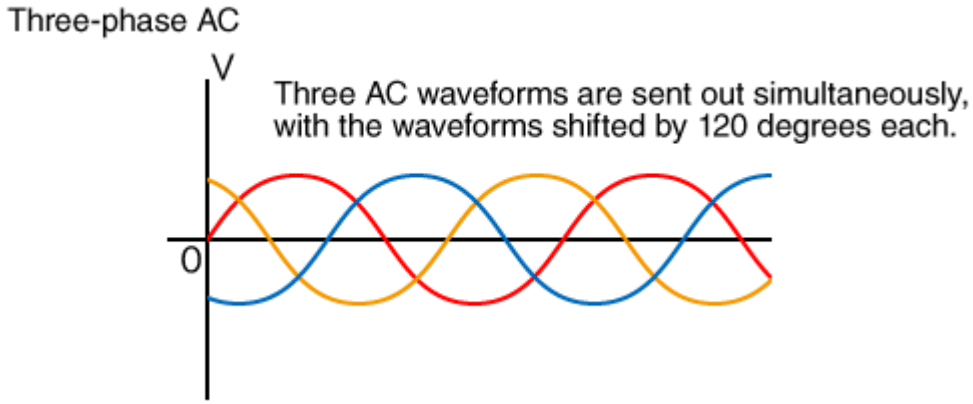
- AC, with its cyclic positive and negative voltage, has the following advantages over DC:
  - Easy to transform (step up or down in voltage using a transformer)
  - Easier to shut down while power is flowing
  - No need to worry about positive and negative voltage (polarity)
- AC is traditionally produced by rotating machinery and the waveshape they produce is sinusoidal. In Australia, the mains frequency is 50 Hertz (cycles per second). Other countries, particularly in North America have 60 Hertz. The higher frequency means that slightly smaller transformers can be used.
- There was a battle in the USA in the 1880s over whether DC or AC should be the dominant system. The main reason AC came out on top is the transformer.
- The use of AC permitted large power stations to be built close to the energy source, water or coal. The generated voltage is then stepped up to hundreds of thousands of volts for transmission to the end users where it is stepped down to suitable working voltages.
- Higher transmission voltage means lower current, for the same power, so much lower losses since the losses are proportional to the square of the current.
- Until fairly recently, there were areas in some cities, including Melbourne, where DC power was still required.
- Melbourne's tram network runs on DC power. This can be the source of corrosion in nearby gas and water pipes.

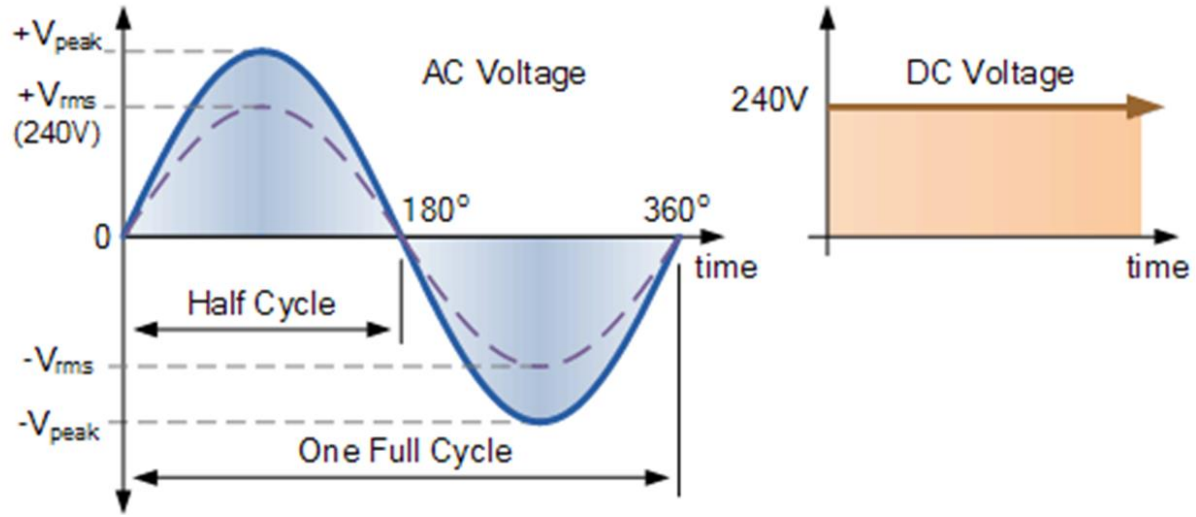


By adding windings to the machines it is possible to generate polyphase voltages, almost universally 3-phase, which is useful for powering large motors.

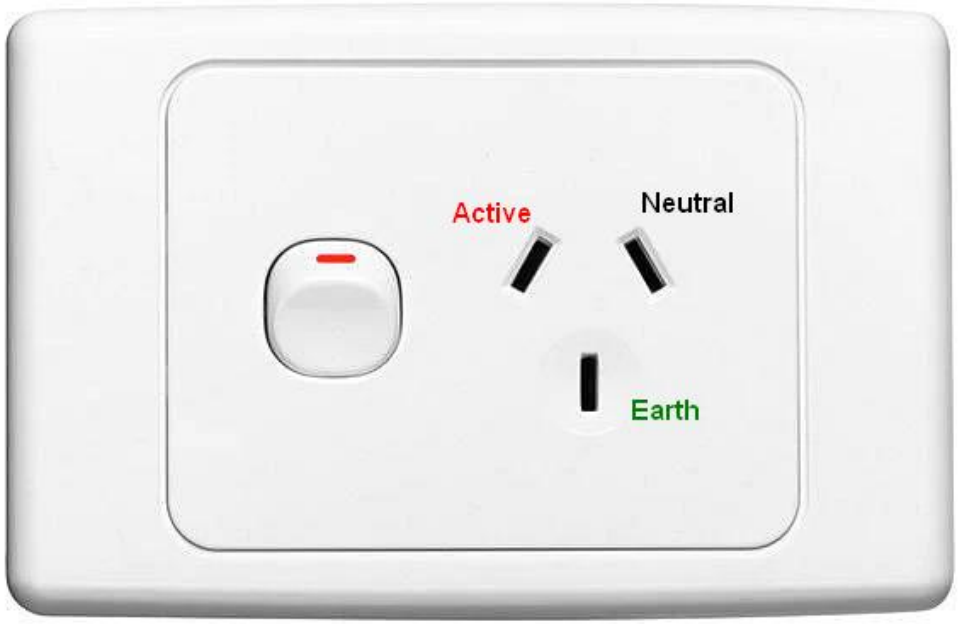


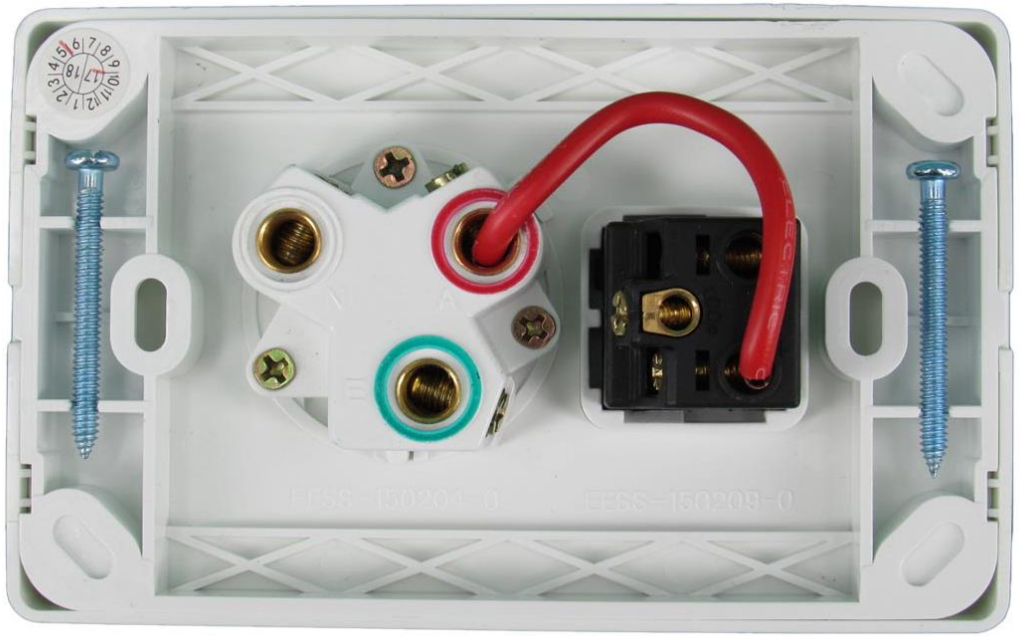
- In Australia power is generally distributed around neighbourhoods as 4-wire 3-phase. One wire for each phase, and a wire for neutral.
- The phase to phase voltage is 415 volts and phase to neutral is 240 volts.
- The neutral line is grounded (earthed) at the local transformer and at the switchboard of each premises.
- Most households have traditionally only had a two-wire supply from the street, but the advent of electric cars is likely to result in more 3-phase connections.
- A 240 volt AC supply actually swings between +340 and -340 volts. It is called 240 volt because it is equivalent to 240 volt DC.

RMS Voltage Equivalent



Facing the power point, active is on the top left – (note: active wires can have any colour except green, yellow, a combination of green and yellow, black or light blue). The neutral is on the top right and the wire can have the colour black or light blue. Earth wire is usually green and yellow.





- If a power point or extension cable is wired the with the active and neutral swapped, everything will still work but the appliance may still be ‘live’ when it is switched off. Always remove the power plug if you are going to poke around inside your toaster!
- The first rule when dealing with electricity is ‘don’t assume it’s off’.
- Strange as it may seem, most fatal electrics shocks happen to people who should know better. Here are some electro-medical facts that should make you think twice before taking that last chance.
- Offhand it would seem that a shock of 10,000 volts would be more deadly than 240 volts. But this is not so! Individuals have been electrocuted by appliances using ordinary house currents of 240 volts and by electrical apparatus in industry using as little as 42 volts direct current. The real measure of the shock's intensity lies in the amount of current forced through the body, and not the voltage
- Any electrical device used on a house wiring circuit can, under certain conditions, transmit a fatal current. While any amount of current over about 10 milliamperes (0.01 amp) is capable of producing painful to severe shock, currents between 100 and 200 milliamperes (0.1 to 0.2 amp) are lethal.
- Currents above 200 milliamperes (0.2 amp), while producing severe burns and unconsciousness, do not usually cause death if the victim is given immediate attention.
- Resuscitation, consisting of artificial respiration, will usually revive the victim. From a practical viewpoint, after a person is knocked out by an electrical shock it is impossible to tell how much current passed through the vital organs. Artificial respiration must be applied immediately if breathing has stopped – AFTER the electrical hazard is made safe.