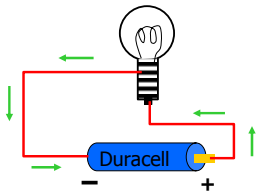
L 27 Electricity and Magnetism [4]

- Alternating current (AC) vs direct current (DC)
- electric power distribution
- household electricity
  - household wiring
    - GFIC's
  - the kilowatt-hour (what you pay for)

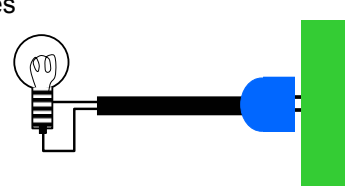
Direct Current DC

- a circuit containing a battery is a DC circuit
- in a DC circuit the current always flows in the **same direction**

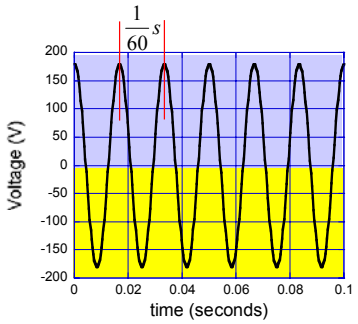


Alternating Current (AC)

- In an AC circuit the current reverses direction periodically
- AC is what you get from the power companies



How does the line voltage change in time?



AC current

- The line voltage reverses polarity 60 times a second (60 Hertz) see
- the current through the bulb reverses direction 60 times a second also
- for heaters, hair dryers, irons, toasters, waffle makers, the fact that the current reverses makes no difference
- battery chargers (e.g., for cell phones) convert the AC to DC

Why do we use AC ?? (DC seems simpler ??)

- AC power is easier to generate
- late 1800's → the war of the currents
- Edison (DC) vs Tesla (Westinghouse) (AC)
- Edison opened the first commercial power plane for producing DC in NY in 1892
- Tesla who was hired by George Westinghouse believed that AC was superior
- Tesla was right, but Edison never gave up!

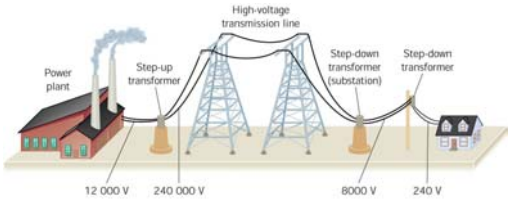
Why AC is better than DC

- DC power is provided at one voltage only
- AC power can be stepped up or down to provide any voltage required
- DC is very expensive to transmit over large distances compared to AC, so many plants are required
- DC power plants must be close to users
- AC plants can be far outside cities
- by 1895 DC was out and AC was in

The electric generator

- When a coil of wire is rotated inside a magnet, electricity is produced
- this electricity is AC
- the voltage depends on how much wire the coil has and how fast it is rotated.
- devices called transformers can make the voltage bigger or smaller
- transformers only work with AC ←

Electric power generation and distribution



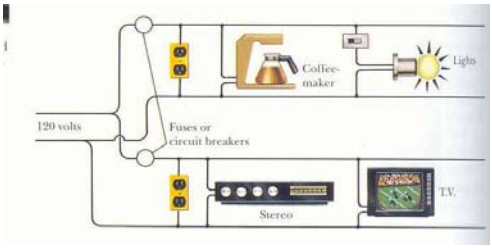
- It is more efficient to transmit electrical power (P = IV) at high voltage and low current.
- The losses along the transmission lines are reduced compared to transmission at low V.

Transformers

This is a typical step-down transformers used to bring the line voltage down to a safe level before it enters your home.

In your home two voltages are available: 220 V &120 V. The 220 is used for the high power appliances like the clothes dryer, oven, etc. The 120 V is for everything else.

House wiring

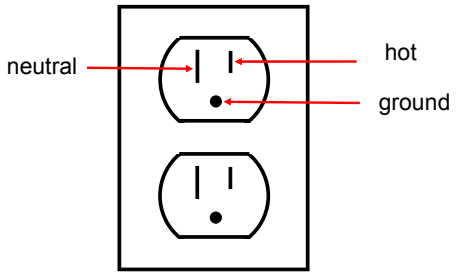


all circuits are connected in parallel

Circuit overload

- if you have too many things plugged into the same circuit, the voltage may drop.
- you may notice that a lamp plugged into the same outlet as a hair dryer dims a bit when you turn on the hair dryer because a hair dryer draws a lot of current
- according to Ohm V = I R, a big I can cause enough drop in the voltage to be noticible!

What everybody needs to know about electricity



Electric outlets

- The current is supposed to flow from the hot side to the neutral, if too much current flows the fuse blows or the circuit breaker trips.
- the ground is there for protection → to provide a safe path for current in the event of a short circuit
- on some circuits (kitchens and bathroons) there is additional protection →**GFCI** → ground fault circuit interrupt. If current accidentally flows through anything other than the hot or neutral it interrupts the circuit very quickly

Paying for electricity

- You pay for the total amount of electrical energy that is used
- the energy is measured in kilowatt-hours
- the kilowatt (kW) = 1000 W is the energy used per unit time
- When kW are multiplied by a time unit (hrs) we get total energy

$$$ example $$$

- At a rate of 10 cents per kWh, how much does it cost to keep a 100 W light bulb on for one day?
- **Solution**: First 100 W = 0.1 kW, one full day has 24 hours, so

  cost = 0.1 kW x 24 hours x $0.10/kWh

  = $0.24 = 24 ¢

→ for one month that amounts to $7.20