

# Generátory

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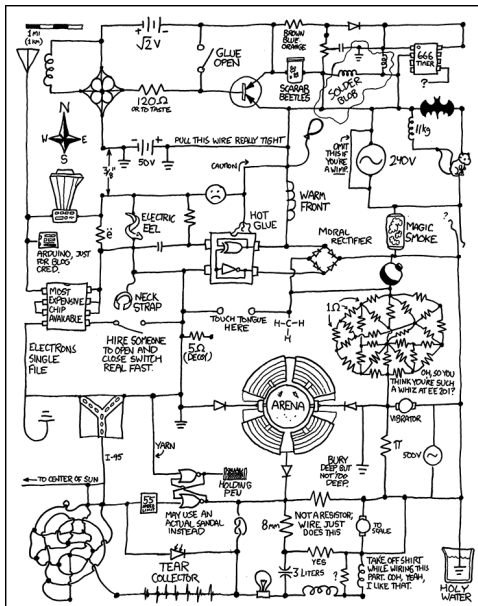
From Latin, from past participle of genero (“beget, father”)

- **One who, or that which, generates, begets, causes, or produces.**
  - ▶ (chemistry) An apparatus in which vapour or gas is formed from a liquid or solid by means of heat or chemical process, as a steam boiler, gas retort etc.
  - ▶ (music) The principal sound or sounds by which others are produced; the fundamental note or root of the common chord.
  - ▶ (mathematics) An element of a group that is used in the presentation of the group: one of the elements from which the others can be inferred with the given relators.
  - ▶ (programming) A subordinate piece of code which, given some initial parameters will generate multiple output values on request.
- **A piece of apparatus, equipment, etc, to convert or change energy from one form to another.**
  - ▶ Especially, a machine that converts mechanical energy into electrical energy.



- **Electrical battery**
- **Alternator, dynamo**
- **Rectifier**
- **Flip-flop**
- **Voltage multiplier**
- **RLC circuit**
- **Crystal oscillator**
- **Klystron**
- **Magnetron**
- **Solar cell**
- **Thermoelectric generator**
- **MHD generator**

# Circuit diagram



# Electromagnetic spectrum

## THE ELECTROMAGNETIC SPECTRUM

THESE WAVES TRAVEL THROUGH THE ELECTROMAGNETIC FIELD. THEY WERE FORMERLY CARRIED BY THE AETHER, WHICH WAS DECOMMISSIONED IN 1897 DUE TO BUDGET CUTS.

### ABSORPTION SPECTRA:

HYDROGEN:

HELIUM:

DEPENDS@:

TAMPAX@:

RED ORANGE YELLOW GREEN BLUE VIOLET

700nm 400nm

### VISIBLE LIGHT

#### OTHER WAVES:

SLINKY WAVES

SOUND WAVES

AUDIBLE SOUND 20 Hz

THAT HIGH-PITCHED NOISE IN EMPTY ROOMS

THE WAVE

SHOUTING CAR DEALERSHIP COMMERCIALS

CIA (SECRET)

HAM RADIO

KOSHER RADIO

CELL PHONE

CANCER RAYS

SPACE RAYS CONTROLLING STEVE BALLMER

99.3 "THE ROCK"

101.5 "THE BOOGEY"

104.3 "THE TROUBLEMAKER"

24/7 NPR PLEDGE DRIVES

ALIENS SETI

GRAVITY

WIFI BRAIN WAVES

SOLARWALK

SUPERMAN'S HEAT VISION

200K BLACK HEAT VISION

SUNLIGHT

MAIN DEATH STAR LASER

POTATO

BLOGORAYS

MAIL-ORDER X-RAY GLASSES

SINISTER GOOGLE PROJECTS

CENSORED UNDER PRIORIT ACT

POWER & TELEPHONE

RADIO & TV

MICROWAVES

TOASTERS

IR

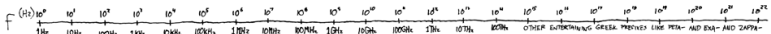
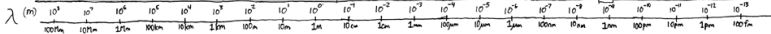
VISIBLE LIGHT

UV

FLUORESCENT LIGHT

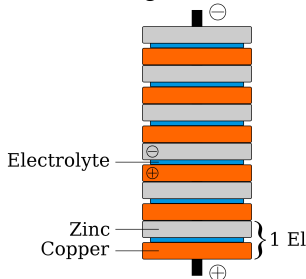
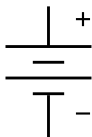
X-RAYS

GAMMA/COSMIC RAYS



# Electrical battery

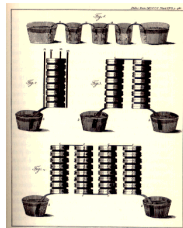
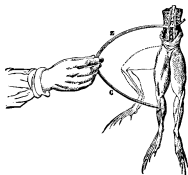
An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy. Since the invention of the first battery (or "voltaic pile") in 1800 by Alessandro Volta, batteries have become a common power source for many household and industrial applications. According to a 2005 estimate, the worldwide battery industry generates US\$48 billion in sales each year, with 6% annual growth.



# Luigi Galvani, Alesandro Volta

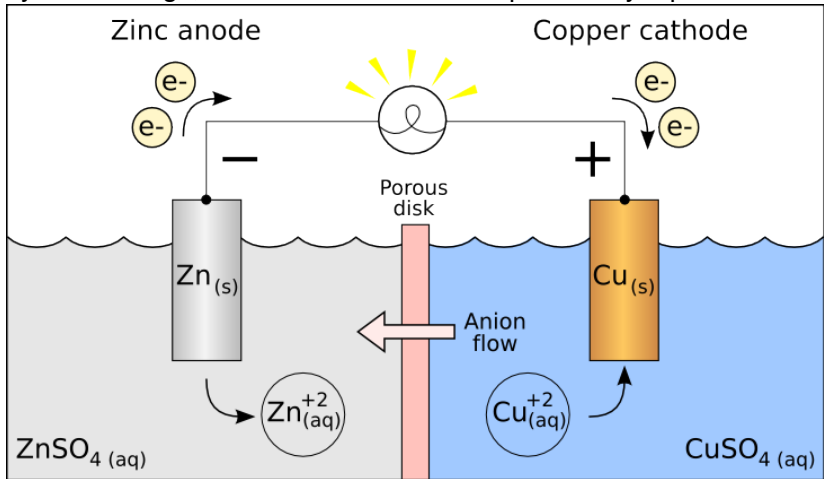
Galvani (AD 1737-1798), Italian physician and anatomy professor in Bologna.

Volta (1745-1827), professor of Physics at Padua.



# Daniell cell

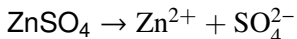
Electrochemical cell that derives electrical E from chem. reactions taking place within the cell. It generally consists of 2 different metals connected by a salt bridge, or individual half-cells separated by a porous membrane.



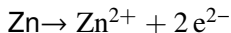


# Daniell cell

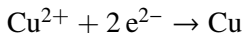
## Dissociation



## Oxidation



## Reduction



The zinc electrode is dissolved and copper is deposited on the copper electrode (as copper ions become reduced to copper metal). By definition, the cathode is the electrode where reduction (gain of electrons) takes place, so the copper electrode is the cathode. The cathode attracts cations, so has a negative charge when current is discharging. In this case, copper is the cathode and zinc the anode.

V elektrochemii se pojmem katoda označuje elektroda, na které probíhá redukce. V případě vložení vnějšího napětí na elektrody (při elektrolýze) má katoda záporný náboj, u elektrického článku kladný náboj.



# Interesting Facts

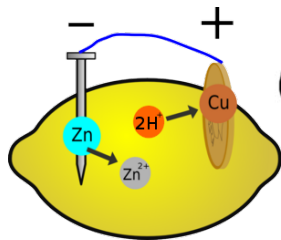
- The word battery originally referred to a collection of Leyden jars hooked together.
- An additional invention pioneered by Volta, was the remotely operated pistol. He made use of a Leyden jar to send an electric current from Como to Milan ( 50 km), which in turn, set off the pistol. The current was sent along a wire that was insulated from the ground by wooden boards. This invention was a significant forerunner of the idea of the telegraph which also makes use of a current to communicate.

Storage type	Specific energy (MJ/kg)
NiMH battery	0.250
Li-ion battery	0.46-0.72
TNT	4.610

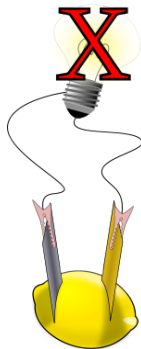


# Lemon battery

- Power of 1 lemon =  $0.9 \text{ V} \times 0.0003 \text{ A} = 0.00027 \text{ W}$
- P of Flashlight bulb =  $2.4 \text{ V} \times 0.5 \text{ A} = 1.2 \text{ W}$ , or about 5,000 lemons
- P of Halogen bulb =  $12 \text{ V} \times 0.83 \text{ A} = 10 \text{ W}$ , or about 37,000 lemons
- P of Red LED bulb =  $1.7 \text{ V} \times 0.0005 \text{ A} = 0.00085 \text{ W}$ , or three lemons in series



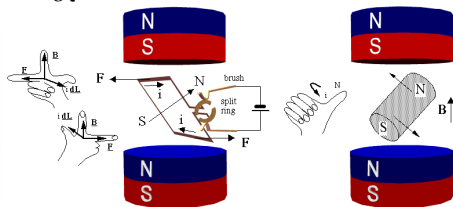
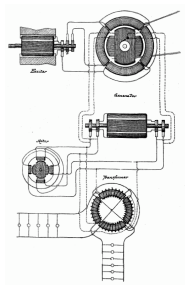
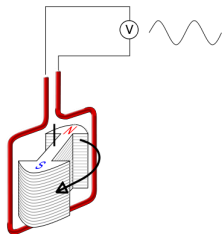
LEMONS  
are pretty good.



# Alternator, dynamo

The induced electromotive force (EMF) in any closed circuit is equal to the time rate of change of the magnetic flux through the circuit.

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\oint_{\partial S} \mathbf{E} \cdot d\mathbf{l} = -\frac{\partial \Phi_{B,S}}{\partial t}$$



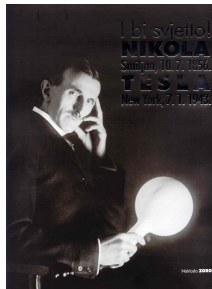
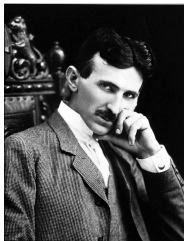
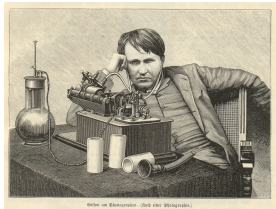
# War of Currents, AC versus DC

- Edison was a brute-force experimenter, but was no mathematician.
- AC cannot be properly understood or exploited without a substantial understanding of mathematics and mathematical physics, which Tesla possessed.

Knowing that just a little theory and calculation would have saved him 90% of the labour. But he (Edison) had a veritable contempt for book learning and mathematical knowledge, trusting himself entirely to his inventor's instinct and practical American sense. (Nikola Tesla)

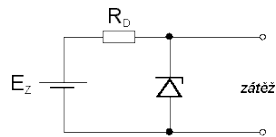
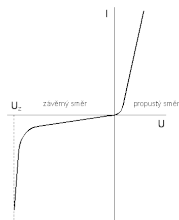
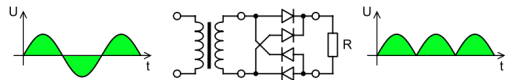
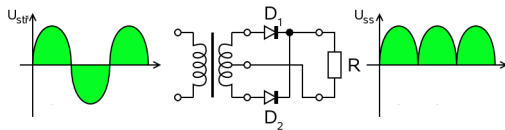
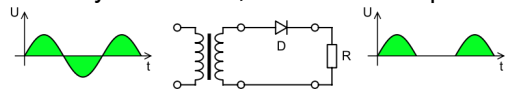
If I find 10,000 ways something won't work, I haven't failed. I am not discouraged, because every wrong attempt discarded is another step forward. (Thomas Edison)

When Edison was a very old man and close to death, he said, in looking back, that the biggest mistake he had made was that he never respected Tesla or his work.



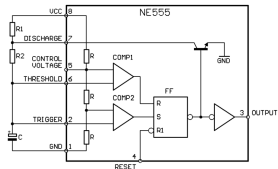
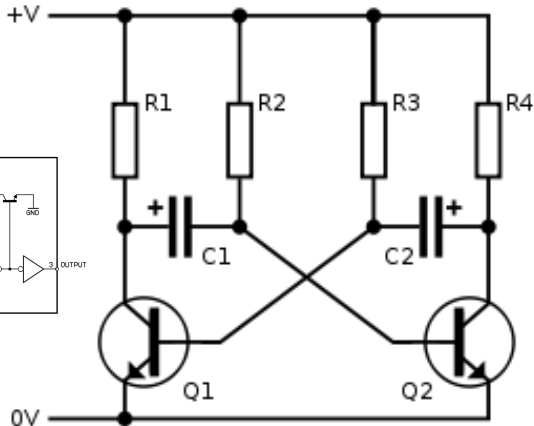
# Rectifier (Usměrňovač)

An electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC). Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components.



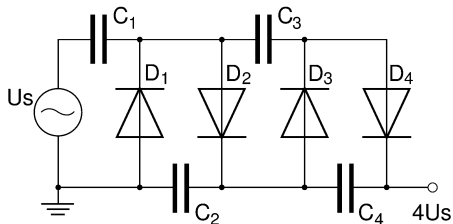
# Flip-flop (Klopný obvod, AKO)

Po zapojení obvodu se začnou oba kondenzátory C1 a C2 nabíjet a tranzistory Q1 a Q2 se začnou otevírat. Jelikož jsou použity reálné tranzistory, které mají (vlivem nedokonalé výroby) mírně odlišné parametry, jeden z tranzistorů se otevře dříve. Za předpokladu, že se dříve otevře tranzistor Q1, kondenzátor C1 se začne vybíjet, čímž uzavře tranzistor Q2. Kondenzátor C2 se nabíjí a ještě více otevírá Q1 (kladná zpětná vazba). V okamžiku, kdy se C1 přebije na opačnou polaritu, vzroste na bázi Q2 napětí a ten se začne otevírat. Toto způsobí nabíjení kondenzátoru C1 a vybíjení C2. V tomto okamžiku se obvod skokově překlápá a na výstupu (kolektor jednoho z tranzistorů) se objeví opačná úroveň napětí.



# Voltage multiplier

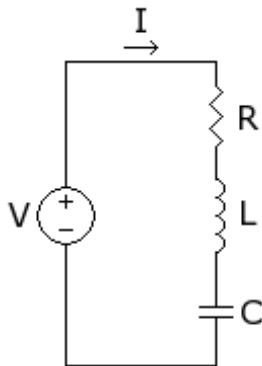
A voltage multiplier is an electrical circuit that converts AC electrical power from a lower voltage to a higher DC voltage by means of capacitors and diodes combined into a network.



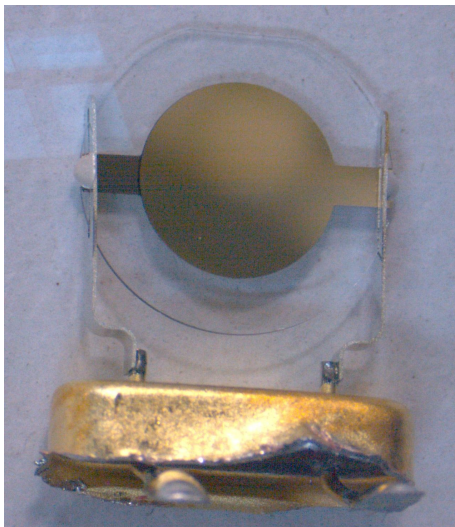


# RLC circuit

$$\omega_0 = \frac{1}{LC}$$

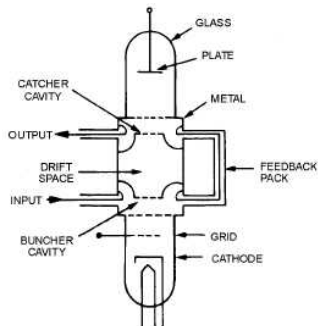
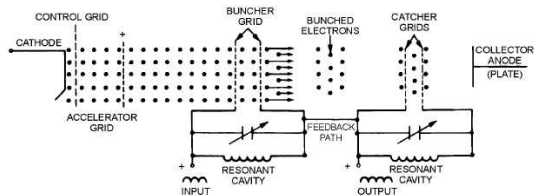


# Crystal oscillator

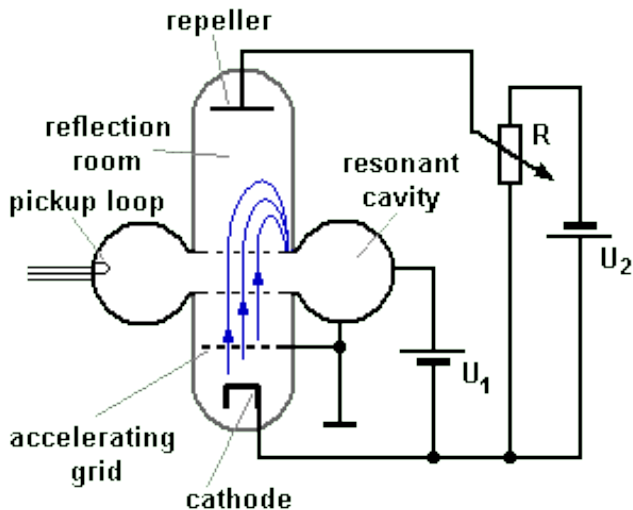


# Two-cavity klystron

Linear-beam vacuum tube, Amplifiers at microwave and radio  $\nu$ . Klystron amplifiers have the advantage (over the magnetron) of coherently amplifying a reference signal so its output may be precisely controlled in amplitude, frequency and phase.

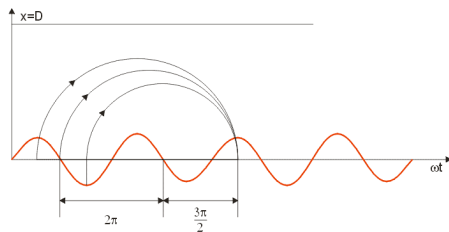
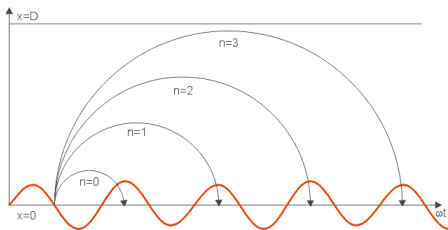


# Reflex klystron

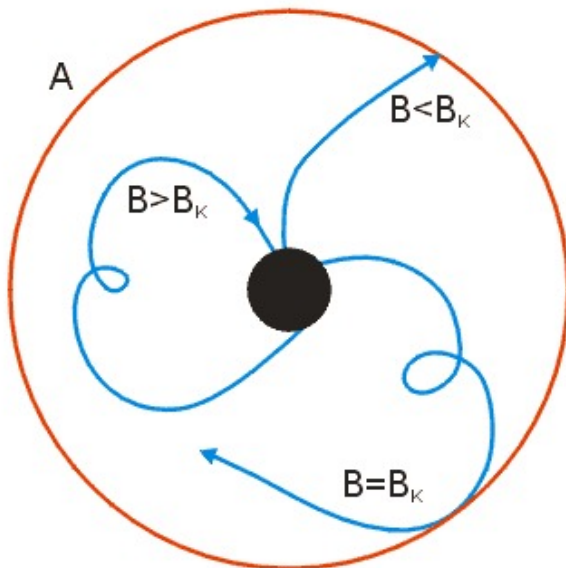


# Reflex klystron

There are often several regions of reflector voltage where the reflex klystron will oscillate; these are referred to as modes.

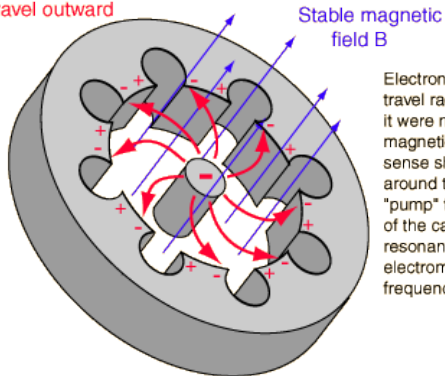


# Magnetron



# Magnetron

Hot cathode emits electrons which travel outward



Stable magnetic field  $B$

Electrons from a hot filament would travel radially to the outside ring if it were not for the magnetic field. The magnetic force deflects them in the sense shown and they tend to sweep around the circle. In so doing, they "pump" the natural resonant frequency of the cavities. The currents around the resonant cavities cause them to radiate electromagnetic energy at that resonant frequency.





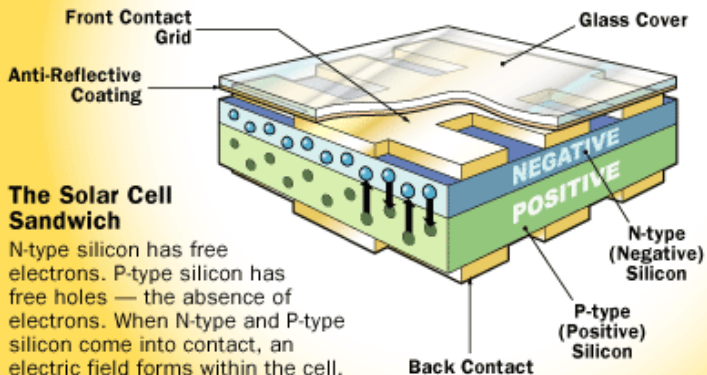
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## How Solar Cells Work

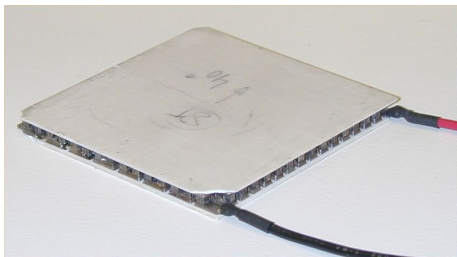
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### The Solar Cell Sandwich

N-type silicon has free electrons. P-type silicon has free holes — the absence of electrons. When N-type and P-type silicon come into contact, an electric field forms within the cell.

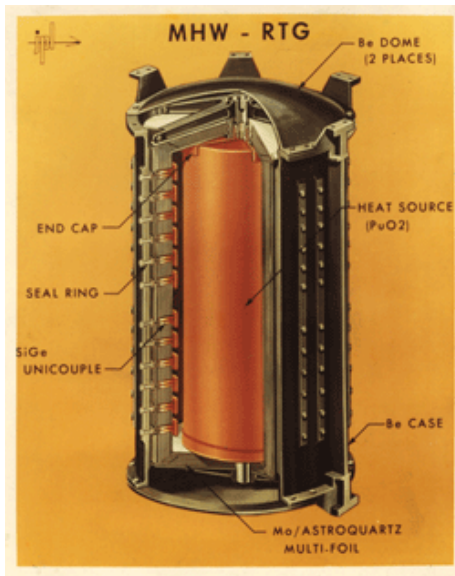
# Thermoelectric generator



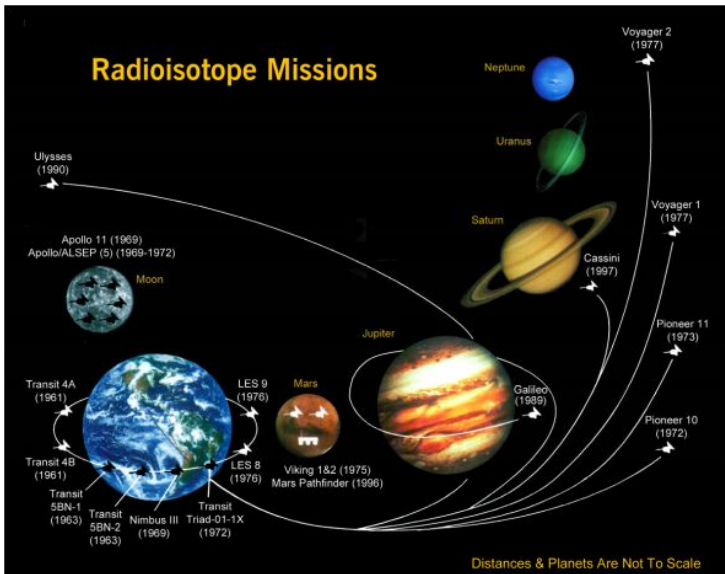
- Seebeck effect
- Older Seebeck-based devices used bimetallic junctions and were bulky while more recent devices use bismuth telluride ( $\text{Bi}_2\text{Te}_3$ ) semiconductor p-n junctions
- Radioisotope thermoelectric generator ( $^{238}\text{Pu}$ ,  $^{90}\text{Sr}$ , Pioneer 10, 11; Voyager 1, 2; Galileo, Ulysses, Cassini...)
- Automotive thermoelectric generator



# RTG Voyager 1 & 2

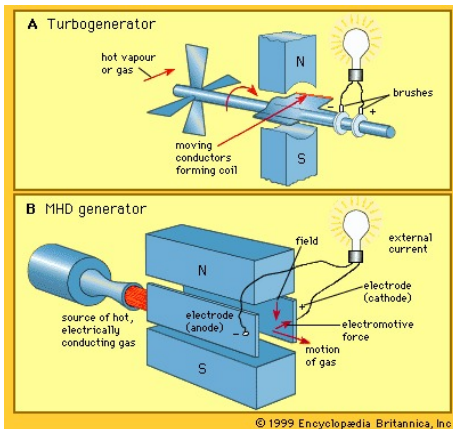


# RTG Missions



## Lorentz Force Law

$$\mathbf{F} = Q \cdot (\mathbf{v} \times \mathbf{B})$$



# Any Questions?



There are  
**NO STUPID QUESTIONS**  
or stupid answers.

