

Energy

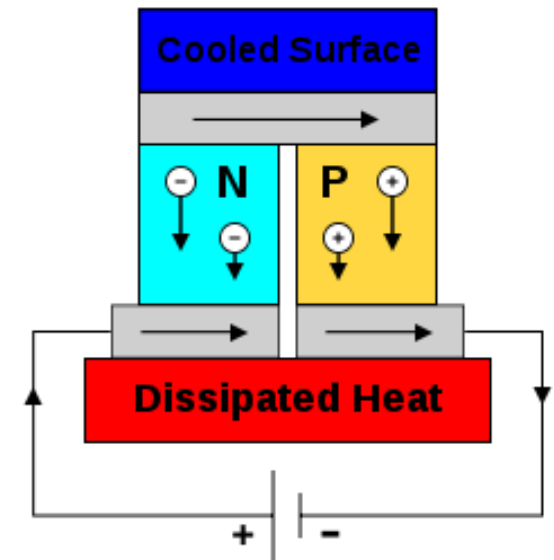
- Can not be created or destroyed
- You can transfer energy
- Decrease in energy requires release of energy
- An increase in energy requires energy absorption
- One form of energy is heat

Power generation

- Burn fuel
 - Heat energy
 - Spins turbine
 - Mechanical to electrical energy produced
 - Electrical energy out
- $2/3$ of energy normally lost in production.

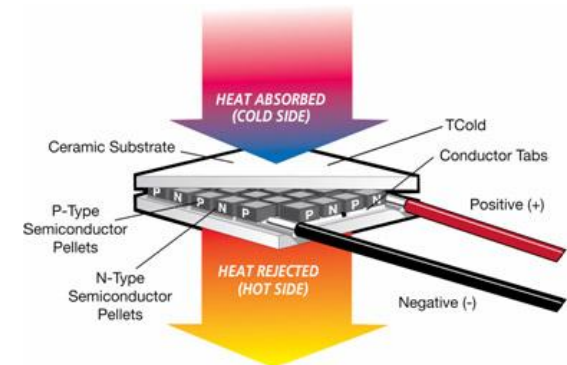
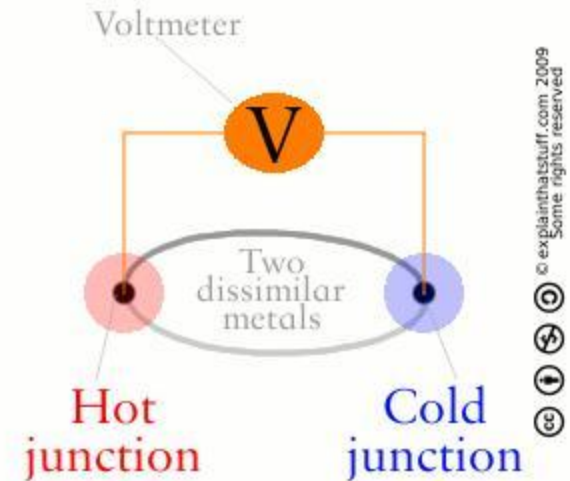
The effect

- **The Seebeck effect:** the production of potential differences through heating of the junctions between two dissimilar conductors. (Thermocouple)
- **The Peltier effect:** passing a current through a junction of dissimilar materials where either absorption or generation of heat occurs depending on the direction of the current. (Cooling/Heating with power input). **High thermal conductivity low electrical conductivity.**
- **The Thomson effect:** the effect of heating or cooling in a homogeneous conductor when an electric current passes in the direction of a temperature gradient. (Make Power From Heat) . **High electrical conductivity low thermal conductivity**



Thermoelectric cooling

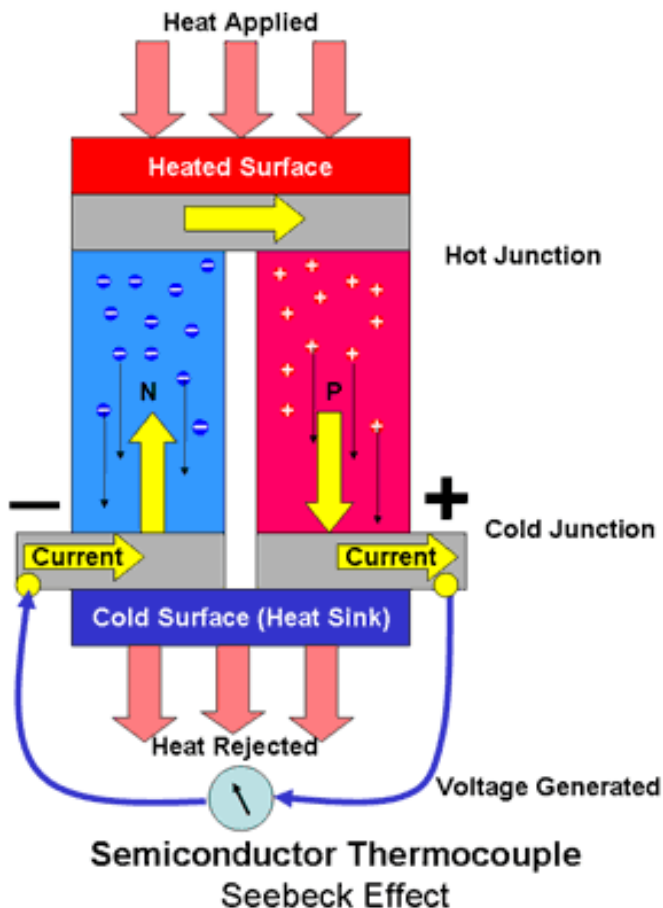
- Electronic cooling
 - I. No refrigerant
 - II. No compressors
 - III. No line sets
 - IV. No oil
 - V. No expansion device
 - VI. Heat transfer occurs in the direction of charge carrier movement.
- Semiconductors
- The Peltier effect



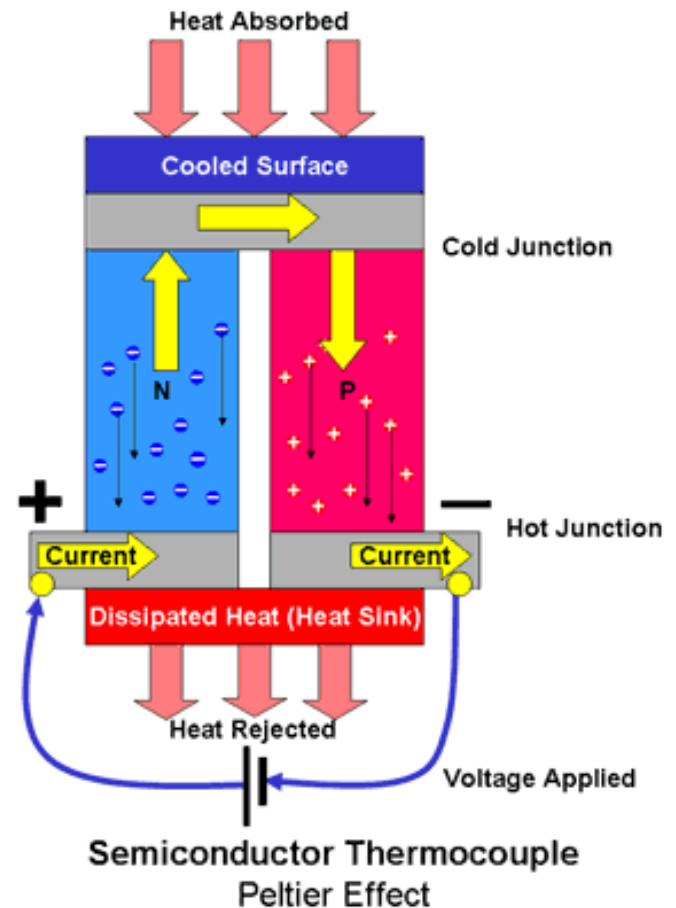
Semiconductors

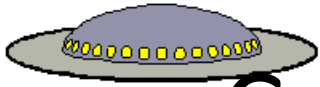
Heat transfer occurs in the direction of charge carrier movement.

Make Electricity



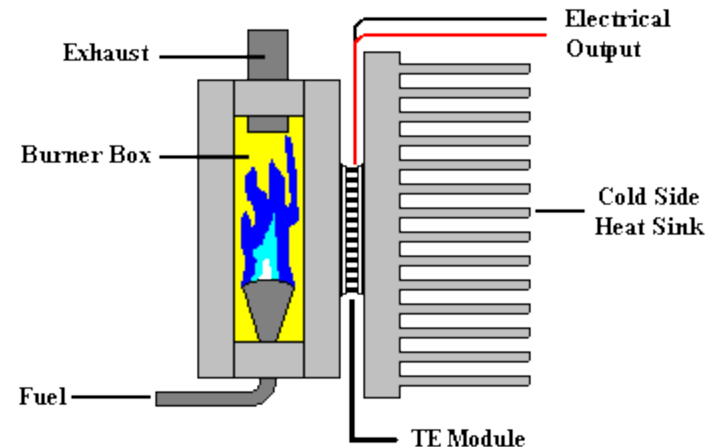
Make hot/Cold



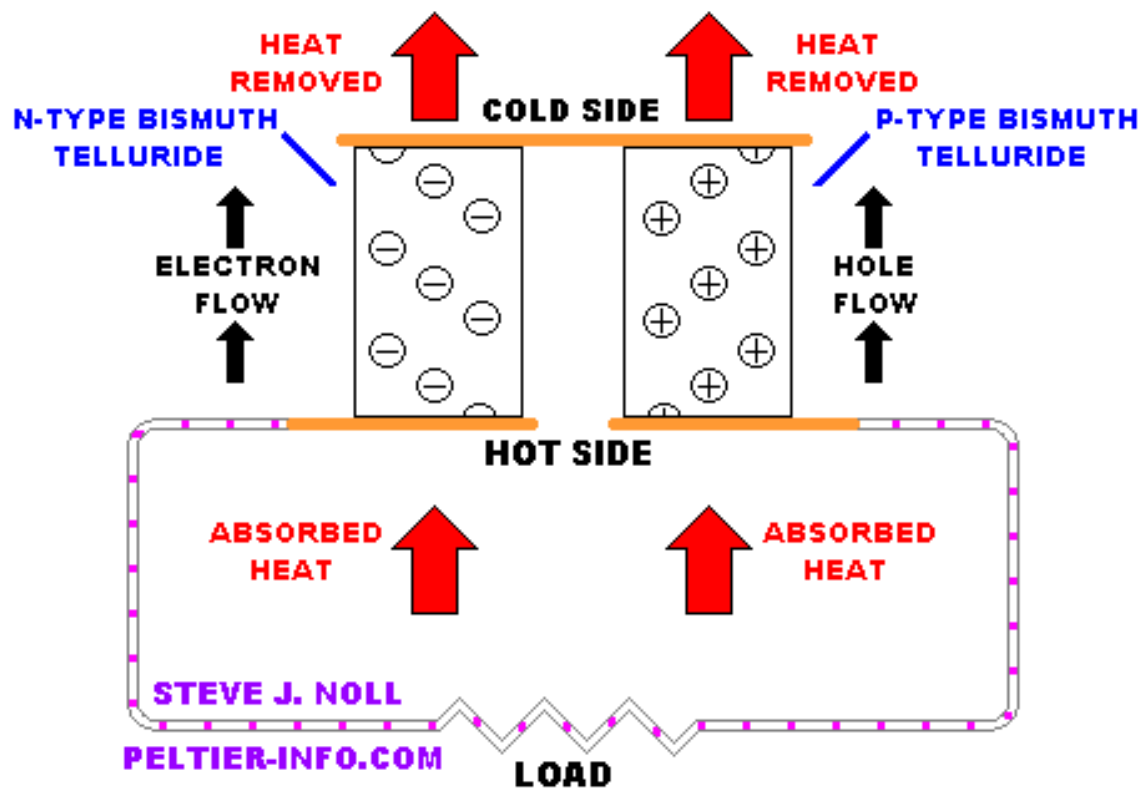


Converting heat to electricity

- Used in space craft to make electricity
 - Cold junction is space which is just 3 degrees above absolute 0 and
 - the **Hot side of the junction is heated by radioactive material.**



ONE SEEBECK DEVICE "COUPLE" CONSISTS OF ONE N-TYPE AND ONE P-TYPE SEMICONDUCTOR PELLET



THERE MUST BE A TEMPERATURE DIFFERENCE BETWEEN THE HOT AND COLD SIDES FOR POWER TO BE GENERATED

Electron flow

Semiconductors

- Types of materials that allow electrons to flow easily with low conductivity are good conductors of heat! (Semiconductors)
 - Negative end is Cold
 - Positive end is Hot
- Types of materials that have a high electrical conductivity with a low thermal conductivity are used to make electricity. (Conductors) Slow down heat while allowing electrons to flow easily.
 - Metal Alloys

The Effect

- Current treats the P-type material as a hot junction needing to be cooled
 - p-type: bismuth-telluride-antimony (BiTeSb) compound
- Current treats the N-type as a cold junction needing to be heated.
 - n-type: bismuth-telluride-selenium (BiTeSe) compound
- Reversing the polarity will switch the hot and cold sides.

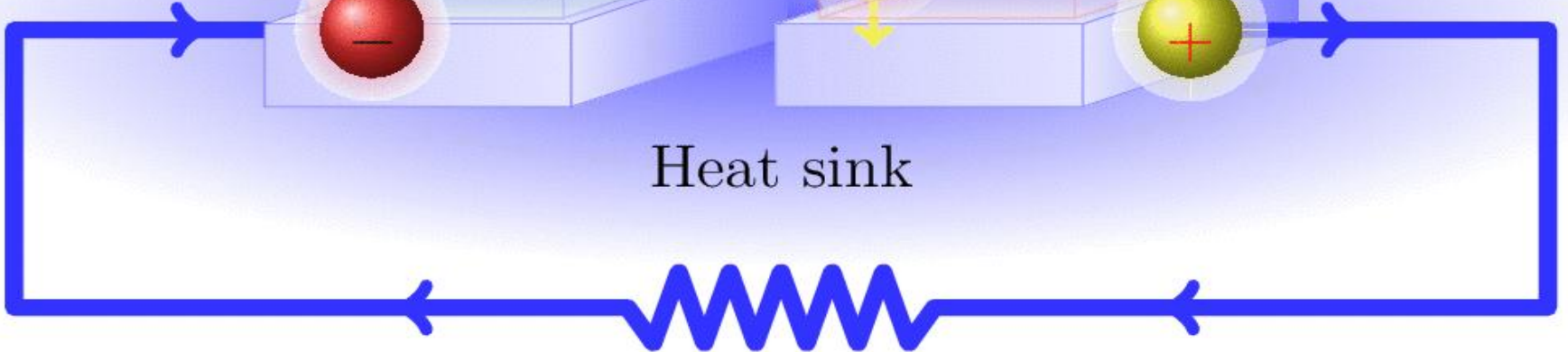
Heat source



n

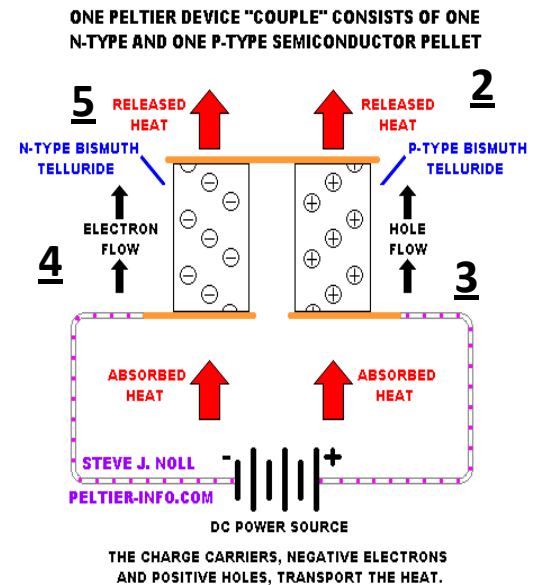
p

Heat sink

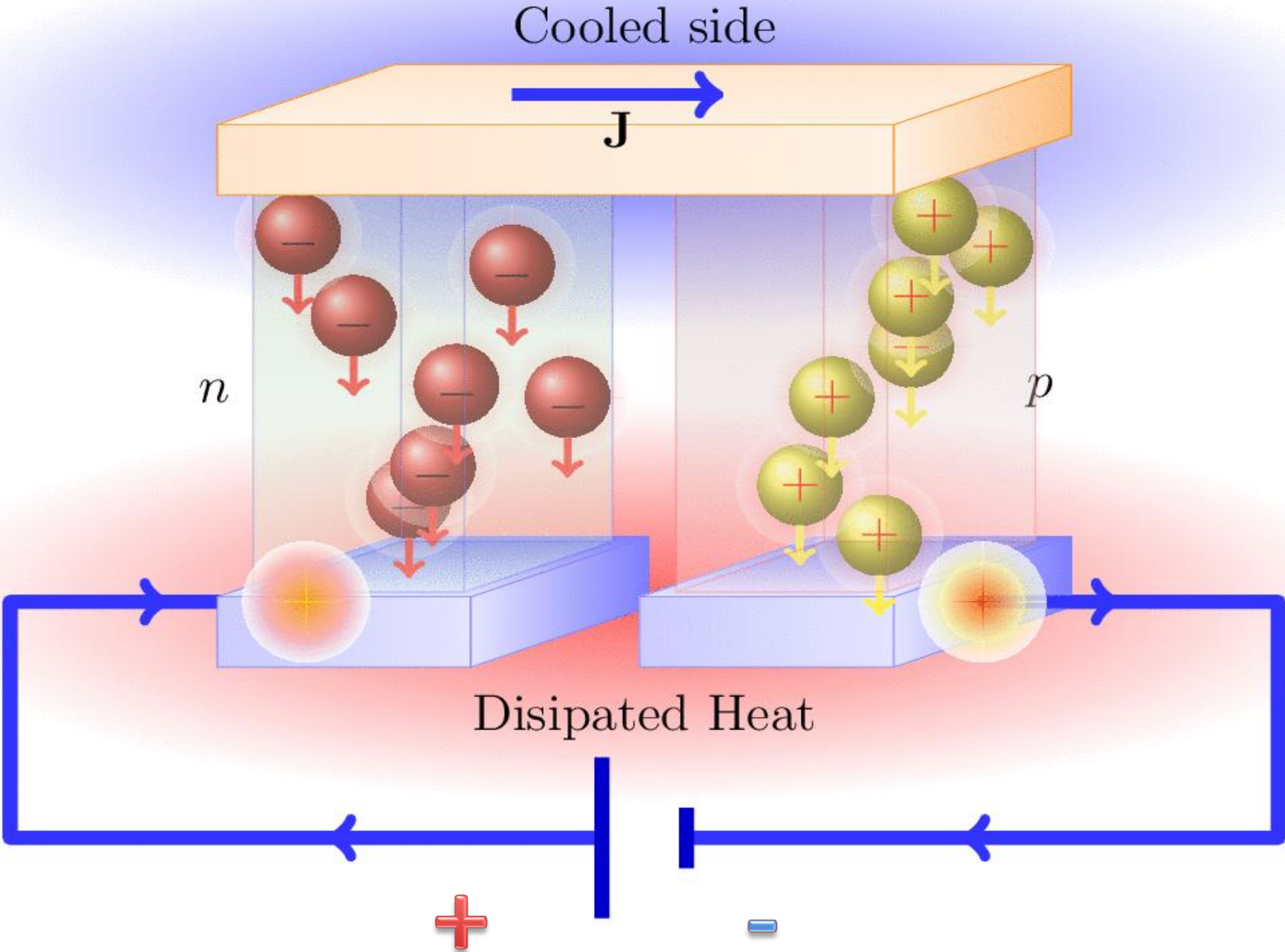


Method of Heat Transport

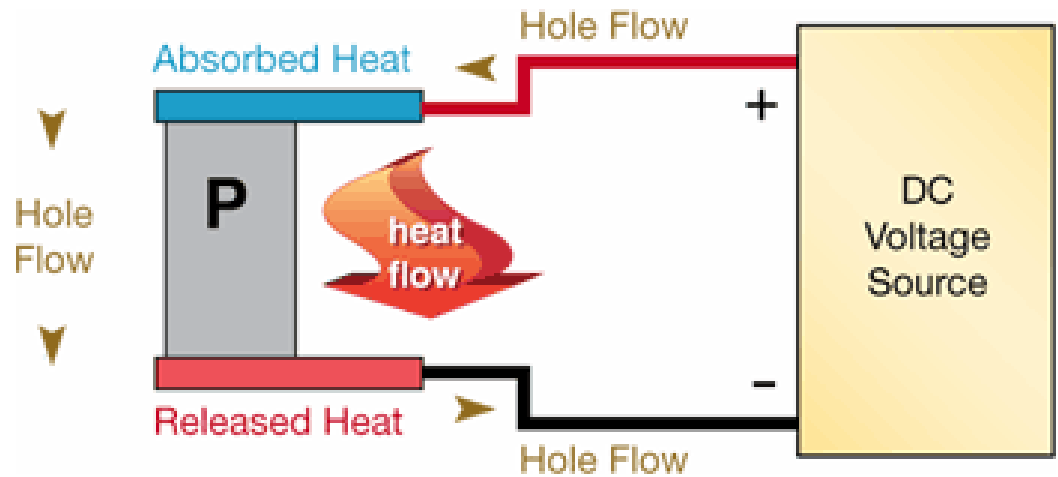
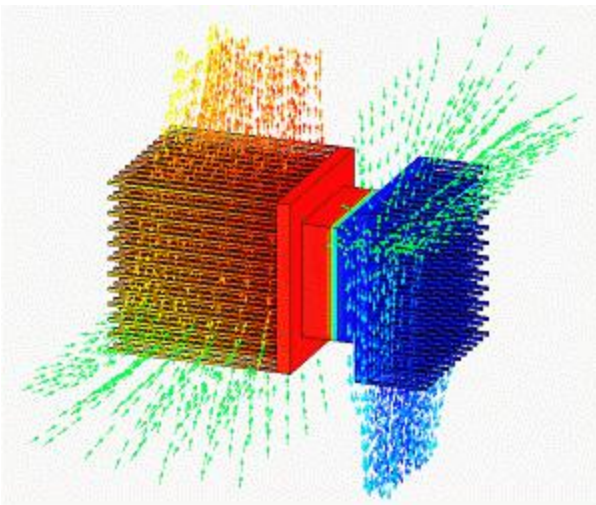
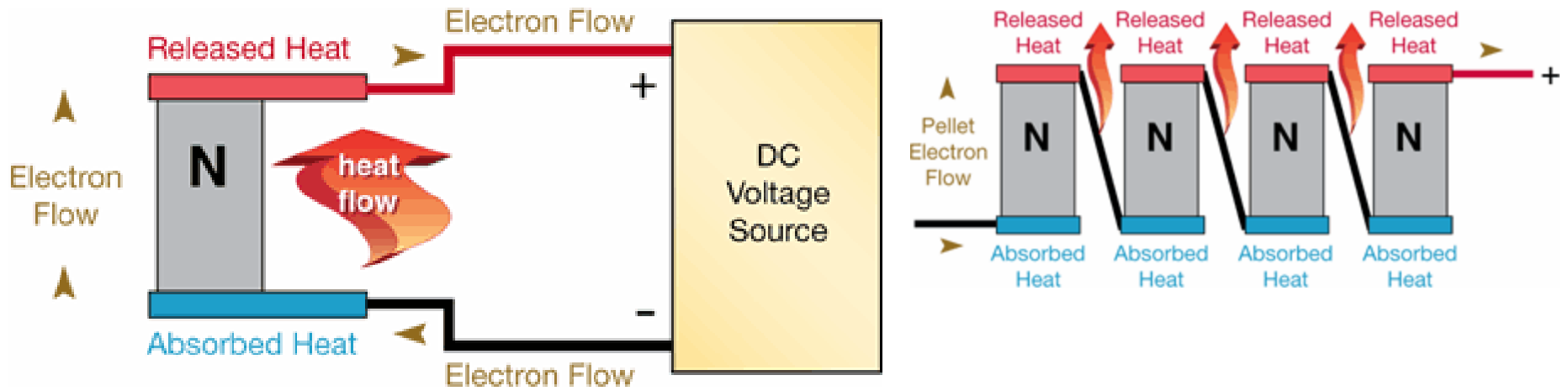
1. Electrons can travel freely in the copper conductors but not so freely in the semiconductor.
2. As the electrons leave the copper and enter the hot-side of the p-type, they must fill a "hole" in order to move through the p-type. When the electrons fill a hole, they drop down to a lower energy level and release heat in the process.
3. Then, as the electrons move from the p-type into the copper conductor on the cold side, the electrons are bumped back to a higher energy level and absorb heat in the process.
4. Next, the electrons move freely through the copper until they reach the cold side of the n-type semiconductor. When the electrons move into the n-type, they must bump up an energy level in order to move through the semiconductor. Heat is absorbed when this occurs.
5. Finally, when the electrons leave the hot-side of the n-type, they can move freely in the copper. They drop down to a lower energy level and release heat in the process.



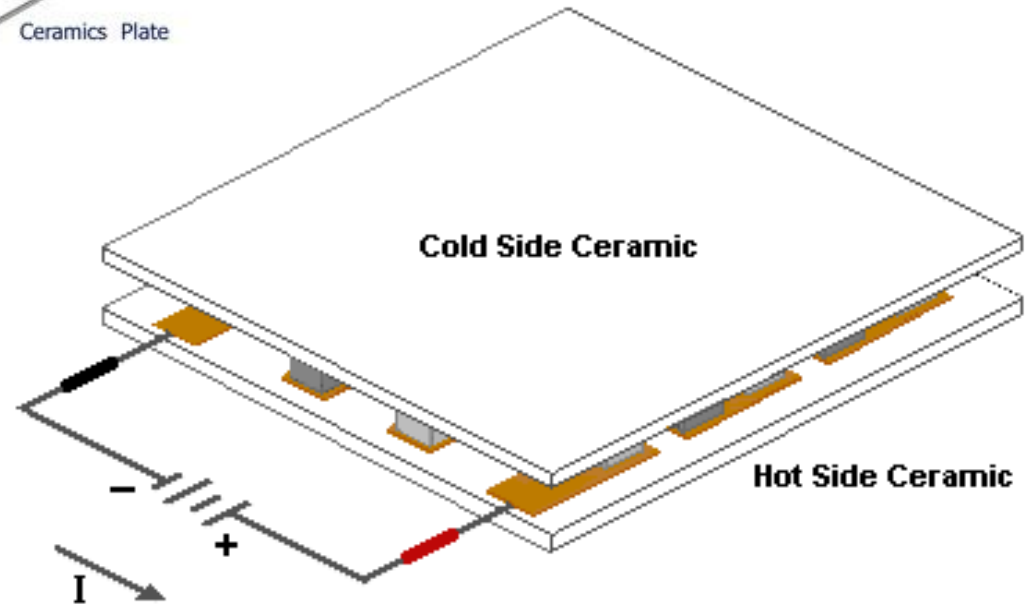
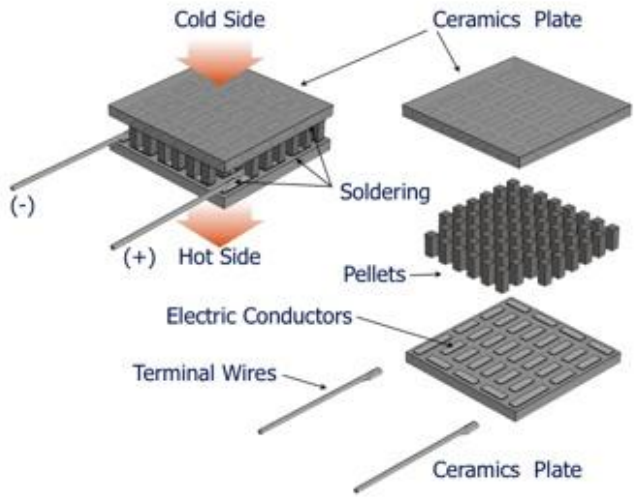
Heat transfer occurs in the direction of charge carrier movement.





Heating or Cooling



The Parts



 P-Type Die

 N-Type Die

 Copper Pad

 DC Power Source