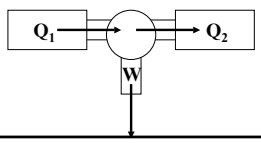
Heat Transfer

How is Heat Transferred?

- Conduction
  - the transfer of energy through collisions of the particles in the material
- Convection
  - the transfer of energy through the transfer of mass
- Radiation
  - the transfer of energy through the electromagnetic waves

Heat Engines

- Any device that converts thermal energy into mechanical energy
- Heat, Q_1, is delivered to the engine, the engine does an amount of mechanical work, and exhausts an amount of heat, Q_2



$$W = Q_1 - Q_2$$

Efficiency of Heat Engines

- Compares the amount of work done by the engine to the amount of heat added
- In an ideal engine:

$$e = \frac{W}{Q_1} \qquad or \qquad e = 1 - \frac{T_2}{T_1}$$

2nd Law of Thermodynamics

- Heat cannot be totally transformed into mechanical work, there must be an exhaust of heat to a cooler "heat sink"
- Proof that it is impossible to obtain absolute zero

Entropy

- The amount of internal energy that cannot be converted into kinetic energy.
- The change in a system's energy is of most importance

$$\Delta S = \frac{\Delta Q}{T}$$

Entropy

- The Law of Entropy
  - the entropy of a system always tends to increase
  - natural processes lead to increasing entropy

Types of Engines

- External Combustion
  - Fuel is burned outside the engine
  - Steam Engines and Turbines
- Internal Combustion
  - Fuel burned inside engine, requiring use of fuel with no solid residue.
  - Gas Engine

Types of Engines

- Jet Engines
  - Hot combustion gases rush out of the engine, the reaction force is the “jet” moving forward.
- Rockets
  - Same principle as jet engines, but rockets also supply the oxidizer.

Heat Pump

- Transfers heat from a low temperature source to a high temperature heat sink.
- Used to cool in the summer and heat in the winter.
- Uses a vapor that easily condenses under compression. The heat absorbed and given off is the heat of vaporization of the substance.

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