Chap. 15

Heat Transfer

Conduction

Rate of transfer of heat (Joules/second or Watts)

$Q/t = kA\Delta T/L$, A is the cross-sectional area ΔT is the change on temperature form one end to the other, and L is the length in m

k is the thermal conductivity of the material (units are J/m.K)

Convection

Surface of area A separates two regions that differ in temperature by ΔT

Rate of heat transfer (in Watts) $Q/t = hA\Delta T$ h is the convective surface coefficient

Radiation

Surface radiates heat by radiation (only process for vacuum or outer space)

$Q/t = e\sigma AT^4$ σ is the Stefan-Boltzmann constant = $5.67 * 10^{-8}$ ($W/m^2.K^4$)

A is the area in m^2

e is the emissivity of the surface e=1 for perfect heat emitter

Chap 14.

Thermodynamics

Conservation of energy

Heat into a system

$\Delta Q = \Delta U + W$ where ΔU is change in internal energy (only a function of temperature) and W is work on the OUTSIDE

Expansion at constant pressure, Work $W = P\Delta V$

Isochoric process V=constant $\Delta Q = \Delta U$

Isothermal process T = constant $\Delta U = 0$, $\Delta Q = W$

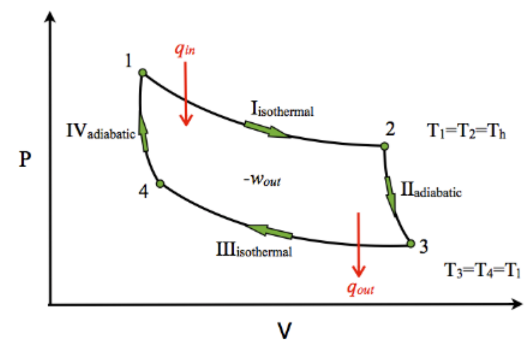
Adiabatic process (no heat change) $\Delta Q=0$, $\Delta U = - W$, e.g adiabatic expansion leads to cooling (ΔU is negative)

Heat engine

Efficiency = $W/\Delta Q_{IN}$ where ΔQ_{IN} is the heat input and W is the work done by the machine on the outside

For an ideal system $W = \Delta Q_{IN} - \Delta Q_{out}$ and the efficiency = $1- \Delta Q_{out} /\Delta Q_{IN}$

For a Carnot cycle, the efficiency = $1- T_{cold}/T_{hot}$



Chap 13.

Heat Energy

Specific heat C = heat to raise mass m by temperature change ΔT.

$C= (\Delta Q)/(m\Delta T)$ or $\Delta Q= mC\Delta T$ Units of C are J/kg K

Latent heats

Heat to melt a solid of mass m

$\Delta Q= mL_M$ L_M is latent heat of melting (J/kg)

Heat to evaporate a liquid of mass m

$\Delta Q=mL_F$ L_F is latent heat of evaporation

Chap. 12

Temperature and Matter

Absolute temperature scale, Kelvin = Celsius + 273

Ideal Gas Law

PV = nRT

P in Pascals, V in m^3, T in Kelvin

n= number of kilomoles R= gas constant =8314 J/kmole/K

ALSO PV = (m/M) RT m= mass of gas, M=molecular weight (kmole)

Kinetic theory of gases

$(1/2)\ mV^2 = (3/2)\ kT$ v = mean sped of a molecule of mass m

k= Boltzmann's constant = $1.38 * 10^{-27}$ J/ K

Thermal expansion

Change in length for change in temperature ΔT

$\Delta L = \alpha L\ \Delta T$ α is coefficient of linear expansion