Intro to Conduction and Radiation

Define heat transfer - energy transport due to a temperature difference

1. Potential energy transfer

2. \[ KE = \frac{1}{2} m v^2 = \frac{3}{2} k_B T \]

3. Measure of the tendency of an object to spontaneously give up energy to its surroundings

4. Inverse of the rate of change of entropy with internal energy with volume and N held constant

3 modes of heat transfer

1. Conduction - transfer mechanisms
   - Electrons, phonons, molecules
     - (lattice vibration)

   Mean free path of a molecule in a gas \( \lambda_m \sim 10^{-9} m \)

   Mean free path of phonons \( \lambda_p \sim \lambda_m \)

   Mean free path of electron \( \lambda_e \ll \lambda_p \)

Solve the problem using an infinitesimal volume
Forster's Law (phenomenological) (1822)

\[ \frac{q_b}{A} \sim \frac{dT}{dn} \]

Constant of proportionality

\[ \frac{q_b}{A} = q'' = -k \frac{dT}{dn} \]

\( k \) is a material property (includes effects from electrons, phonons, and molecular motion)

2 convection \( q'' = h \Delta T \)

3 radiation heat transfer due to emission and absorption of photons caused by changing energy levels of electrons and phonons

\( \chi_{\text{photon}} = 10^{-10} \text{ m} \rightarrow 10^{-9} \text{ m} \)

\[ q'' \propto T^4 \] phenomenological
\[ q_{\text{in}} = \sigma(T_\text{ref} - T_\text{sur}) \]

\[ \varepsilon(\theta, \phi, T, \lambda) \]

- G: irradiance
- J: radiosity
- E: emission