HEAT TRANSFER.

Defined as the form of energy that is transfered across the boundry of a system, at a given temperature to another system, at a lower temperature by means of a temp gradient. between the two systems.

From a mathimatical standpoint, heat, like work, is a path function and is considered as an inexact differential, δQ. Thus.

$$\int_1^2 \delta Q = {}_1Q_2 \quad (J \text{ or } kJ)$$

where ${}_1Q_2$ is the heat transferred during a given process between states 1, & 2

The rate at which heat is transferred to (or from) a system is given by, $\dot{Q}$, where

$$\dot{Q} = \frac{\delta Q}{\delta t} \quad (W \text{ or } kW)$$

The heat transfer per unit mass is, q.

$$q = \frac{Q}{m} \quad (kJ/kg)$$

note: $q = \frac{\dot{Q}}{\dot{m}}$ (time is cancelled out).

SIGN CONVENTION FOR HEAT TRANSFER.

$$Q \begin{cases} + & \text{when heat goes into the system} \\ - & \text{when heat leaves the system} \end{cases}$$

REMARKS: A process with no heat exchange is called an adiabatic process.

$Q = 0$, for an adiabatic process

REMARK: the integration of the heat transfer rate gives heat transfer

$$ {}_1Q_2 = \int_{t_1}^{t_2} \dot{Q}\, dt $$

HEAT Transfer is a vector quantity (directional)

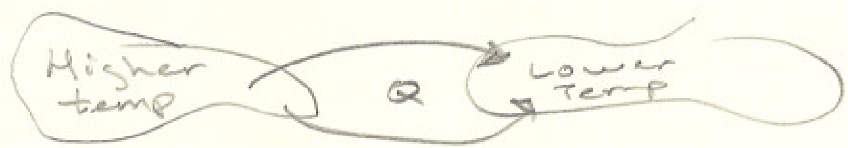
Heat and work are only defined when they cross a boundry

MODES OF HEAT TRANSFER

Heat can be transferred in 3 different ways

- Conduction
- Convection
- Radiation

All of these modes require a temperature difference.



CONDUCTION HEAT TRANSFER.

defined as the transfer of heat from the more energetic particles of a substance, to the adjecent, less energetic particles, as a result of direct interaction between particles.

FOURIER'S LAW OF CONDUCTION:

Conduction is goverend by Fourier's law of conduction, given by

$$ \dot{Q} = -KA \frac{dT}{dx} \quad (W \text{ or } kW) $$

where A is the cross sectional area normal to the x direction of heat flux (m^2)
where k is the thermal conductivity of the substance.

REMARK: the higher the k, the better the material can transfer heat.

note: these notes corrispond with chapter 13.

EX.

GIVEN: consider the plane wall, made of Aluminum. The wall has a thickness of 10cm. The wall has dimensions height = 80cm width = 100 cm

REQUIRED: Calculate the amount of heat transfer rate $\dot{Q}$ (due to conduction) if the surfaces at the wall are maintained at tempertures 100°C, 40°C as shown.

ANALYSIS: For aluminum, using table (13.1)

$$k = 164 \frac{w}{m \cdot k}$$

$$\dot{Q} = -kA \frac{\Delta T}{\Delta x} = -(164)(.8\,m)\frac{(60)}{(0.1)} =$$

$$= 78,720 \text{ w}$$

CONVECTION HEAT TRANSFER.

Convection is the mode of heat transfer between a solid surface and an adjacent fuild (liquid or gas) which is motion.

note: in the absence of motion, fluid transfer becomes conduction.

TYPES OF CONVECTION:

FORCE CONVECTION: when the fluid is forced to flow in a tube, or against a surface. means by some pump, fan, etc.

NATURAL/FREE CONVECTION: considered if the motion is caused by bouyancy forces, induced by density differences due to variation in temp