

3 Modes of Heat Transfer

Conduction  
Convection  
Radiation

} There must be a difference in temperature between one object and another for any of these modes to occur.

Conduction - Exchange of KE between colliding molecules in a material.

- Depends on atomic collisions

- Good conductors - metals

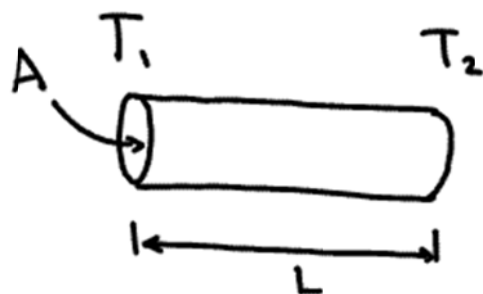
Bad conductors - nonmetals (glass, wood, air)

Heat Transfer Rate

$$H = \frac{Q}{\Delta t} = \frac{\text{Joules}}{\text{sec}} = \text{Watt}$$

Conduction only occurs when one side is different in temp than another.

$$H = \frac{Q}{\Delta t} = \frac{kA(T_2 - T_1)}{L}$$



$k$  = Thermal conductivity of material  $[\frac{J}{s \cdot m \cdot ^\circ C}]$

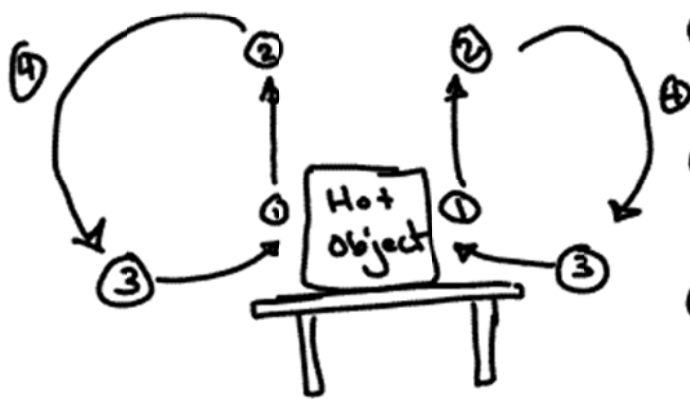
$A$  = Cross-sectional Area  
 $T_1$  = Temp of material at warmer end

$T_2$  = Temp of material at cooler end

$L$  = Length / Thickness of material

Convection - Heat transferred by the movement of heated substances

### Natural Convection



- ① Cool air next to hot object heats up
- ② As air warms  $\rightarrow \rho \downarrow \rightarrow F_{\text{buoyancy}} > F_{\text{gravity}} \rightarrow F_{\text{net}} \text{ upward} \rightarrow \text{hot air rises}$
- ③ Cool air from below rushes in to fill void
- ④ Warm air drops as it cools, creating a circulating current as it cools

Forced Convection - Using a fan to convect heat away

Radiation - Energy is radiated in the form of electromagnetic waves.

- Happens even in a vacuum
- Materials are coated in silver to reflect radiated heat