Thermal Aspects

Junction : 150°C

< 120°C

Ambient : 50°C

Thermal Resistance

$$\Delta T = P \cdot R_\theta$$

$V = I R$.

heat flow rate

J/s = Watts

power

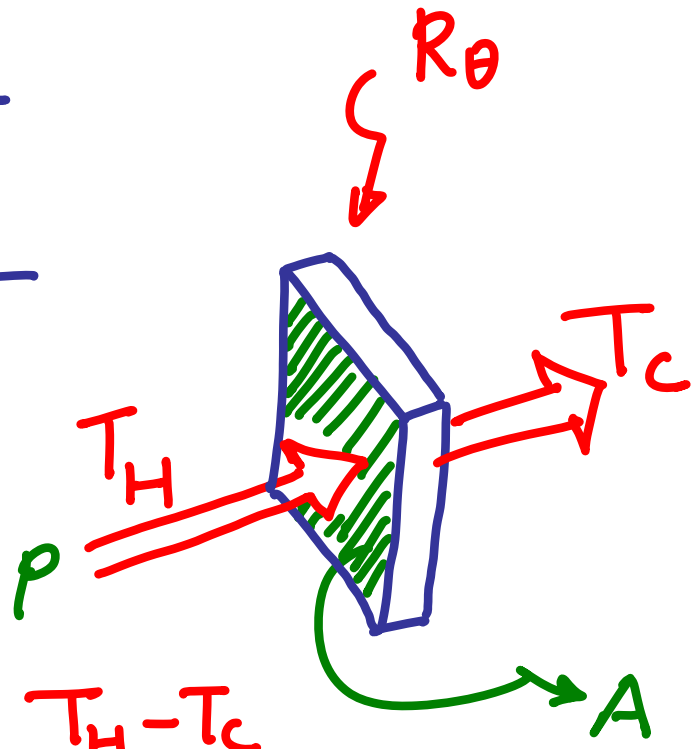
$$P = \frac{\Delta T}{R_\theta}$$

Heat flow rate

Specific

$$q = \frac{P}{A} = \frac{\Delta T}{A R_\theta} = \frac{T_H - T_C}{A R_\theta}$$

W/m^2



$$q = \frac{P}{A} = \frac{\Delta T}{A R_\theta} = \frac{\Delta T}{r_\theta}$$

$A R_\theta \rightarrow r_\theta$

$\Downarrow$

Thermal Resistivity

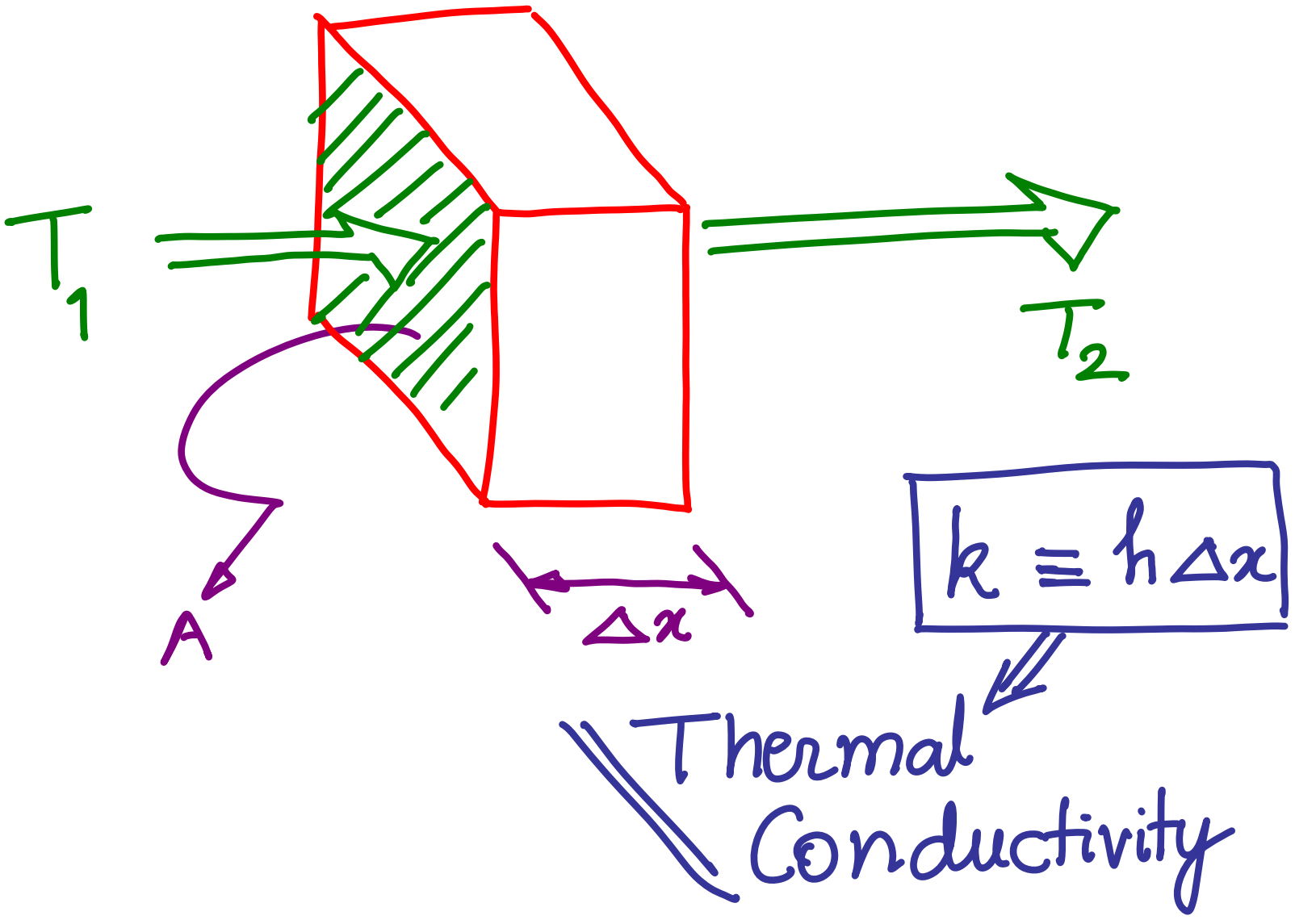
$$r_\theta = A R_\theta \Rightarrow {}^\circ K\, m^2/W$$

$m^2 \cdot {}^\circ K/W$

$$q = \frac{P}{A} = \frac{\Delta T}{A R_\theta} = \frac{\Delta T}{r_\theta} = h \Delta T$$

Thermal Coefficient

$$h = \frac{1}{r_\theta} \Rightarrow W/^\circ K/m^2$$


T_1
T_2
A
Δx
$k \equiv h \Delta x$
Thermal
Conductivity

$$k = h\,\Delta x \Rightarrow W/^{\circ}K/m$$

$$W/^{\circ}K/m^{2}$$

$$q = \frac{P}{A} = h\,\Delta T \quad (T_1 - T_2)$$

$$= \frac{k}{\Delta x} \cdot \Delta T = k\,\frac{\Delta T}{\Delta x}$$

$$q = \frac{P}{A} = k\frac{\Delta T}{\Delta x}$$

$$= k\frac{\partial T}{\partial x}$$

$$P = \frac{\Delta T}{R_\theta}$$

R_θ = Thermal Resistance

$$q = \frac{\Delta T}{r_\theta}$$

r_θ = Thermal Resistivity = AR_θ

$$q = h\Delta T$$

h = Thermal coefficient = $\frac{1}{r_\theta}$

$$q = k\frac{\Delta T}{\Delta x}$$

k = Thermal conductivity = $h\Delta x$

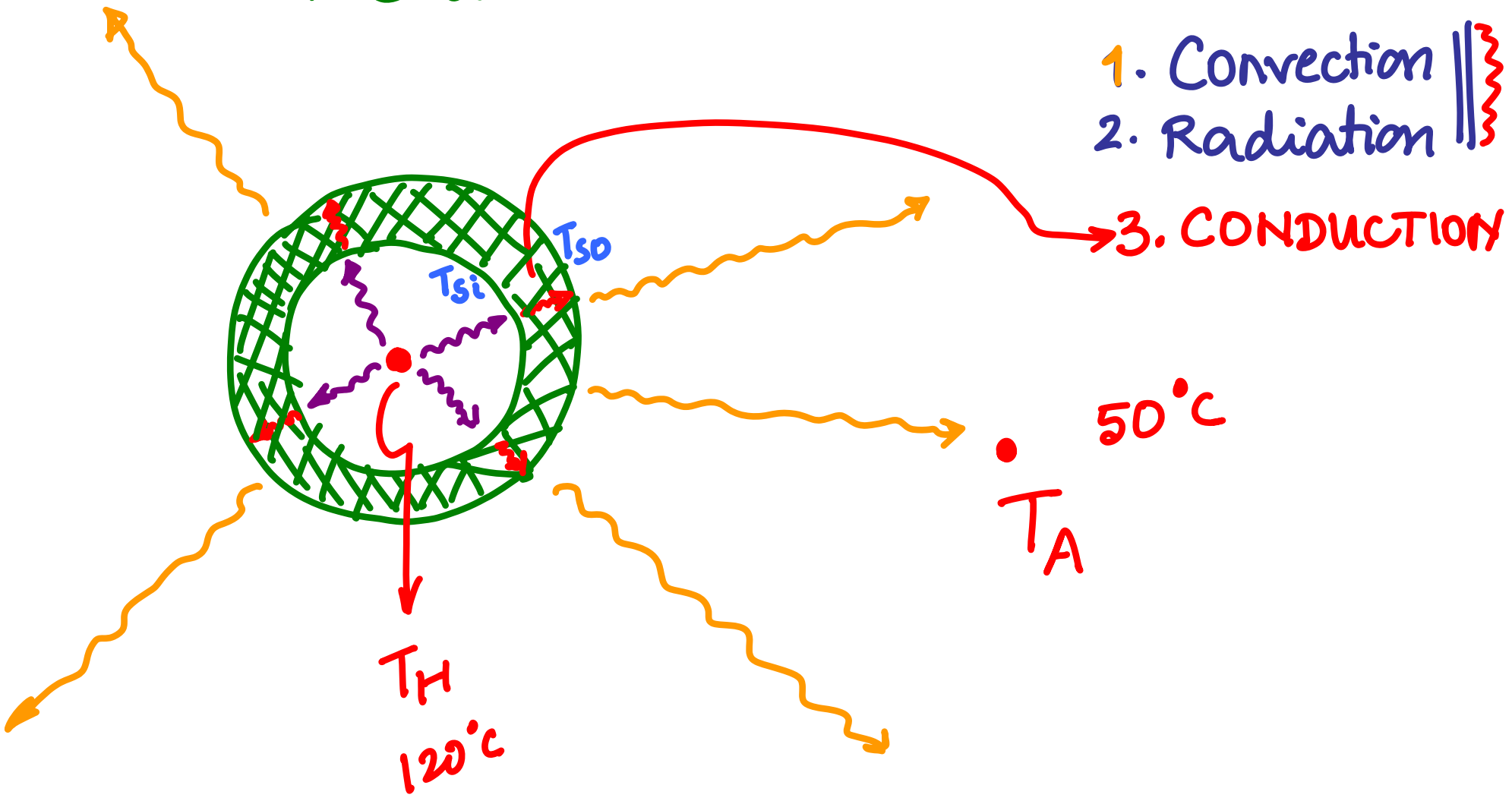
heat flow rate $\Rightarrow P$

Temperature difference $(T_H - T_C)$

Material Property

$(R_\theta, r_\theta, h, k)$

Heat Removal Method



1. Heat within SOLIDs

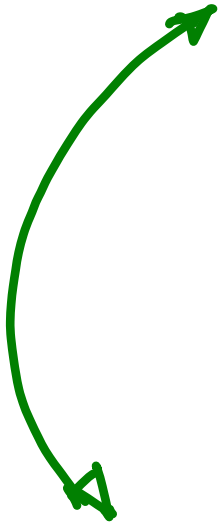
CONDUCTION

2. Heat flow SOLID-FLUID

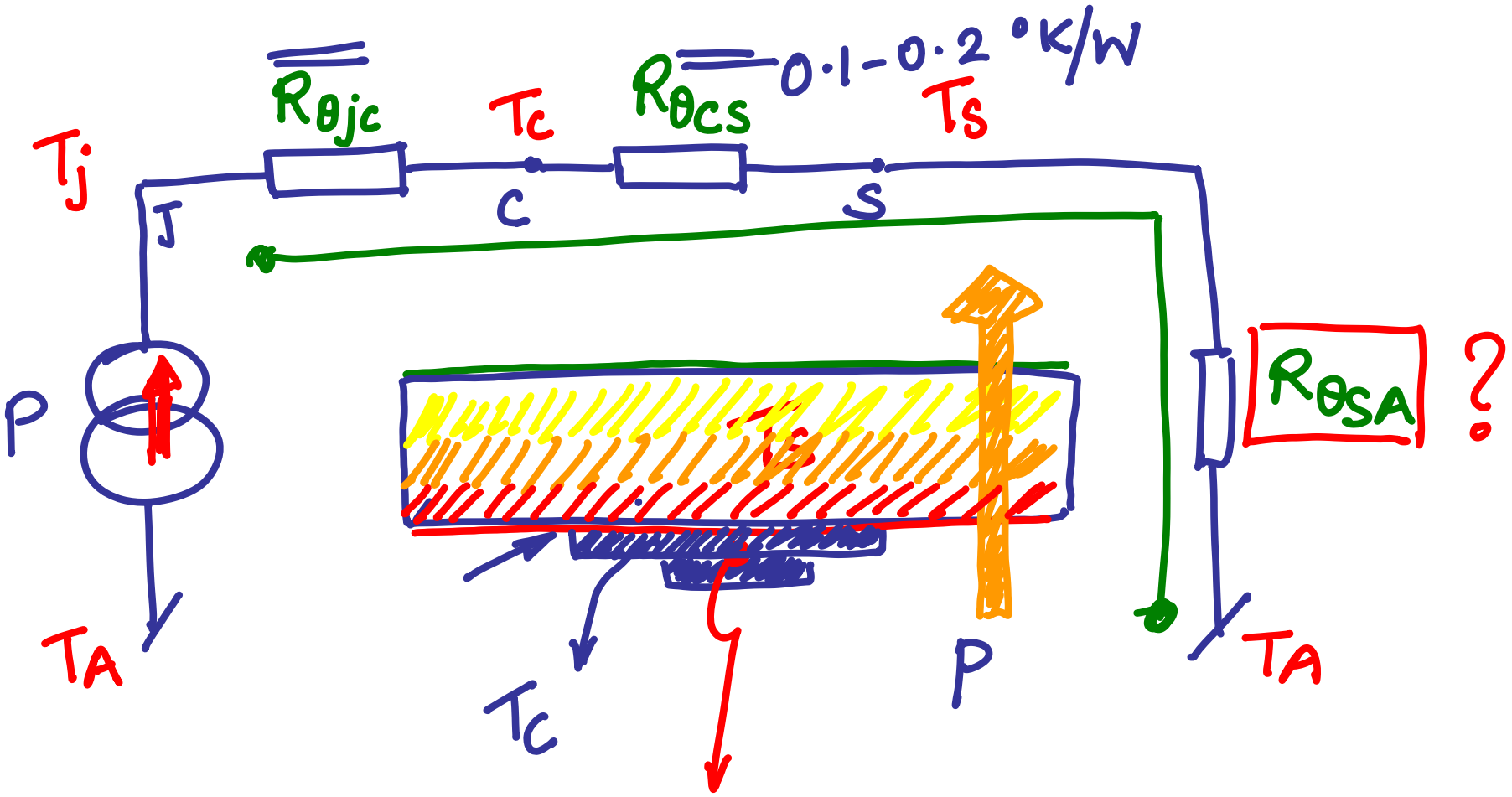
CONVECTION

3. Heat flow without medium

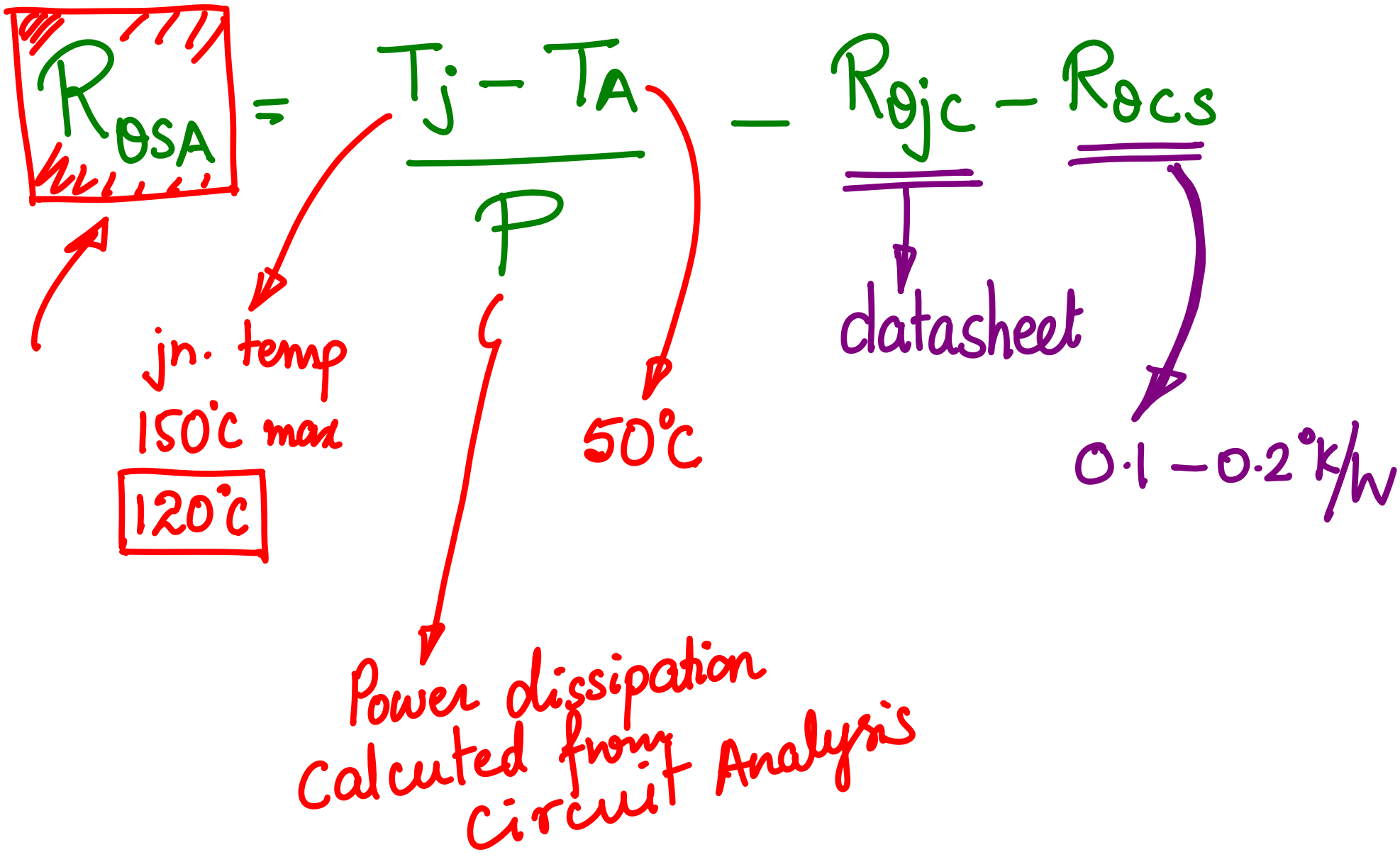
RADIATION

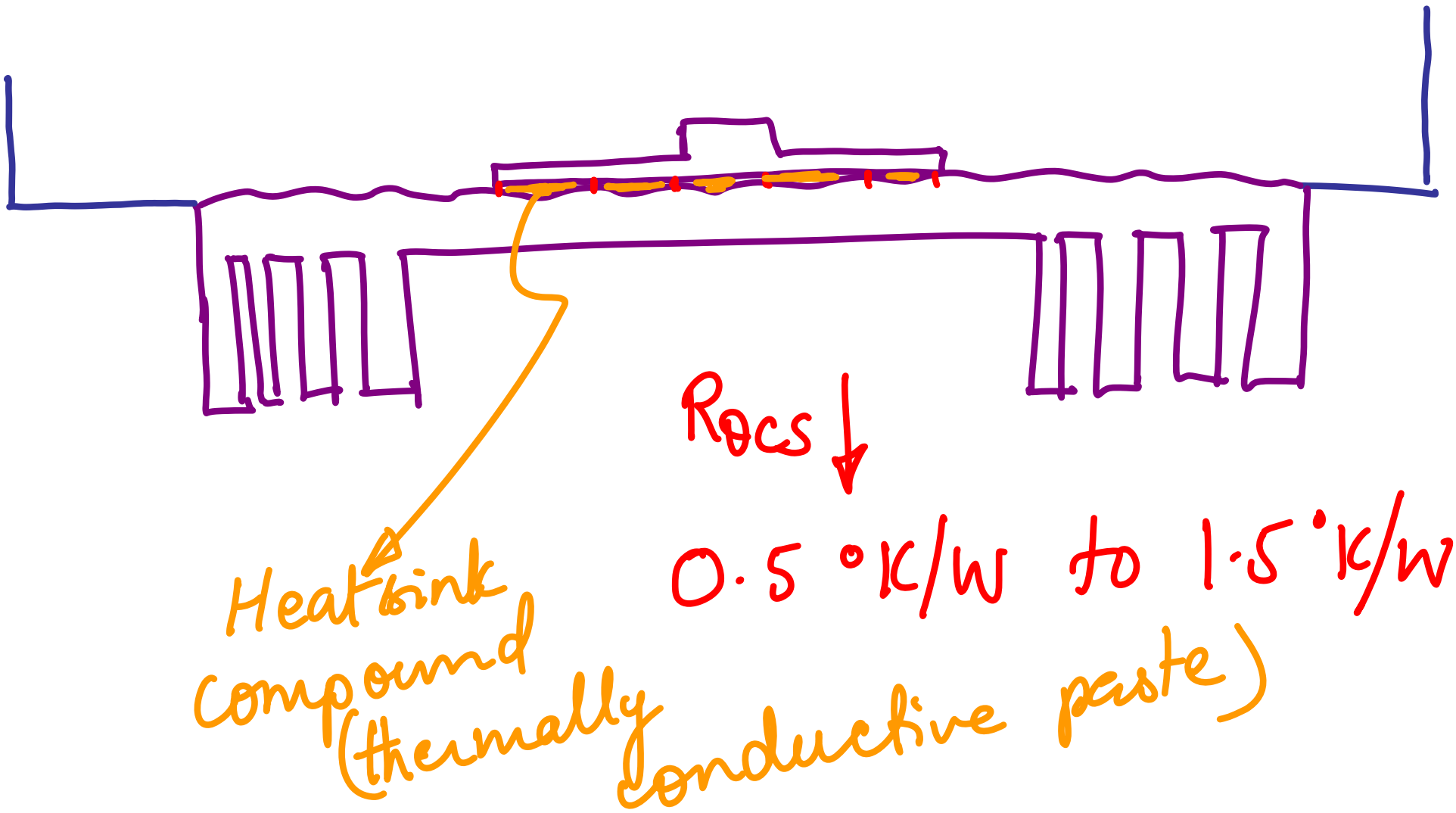


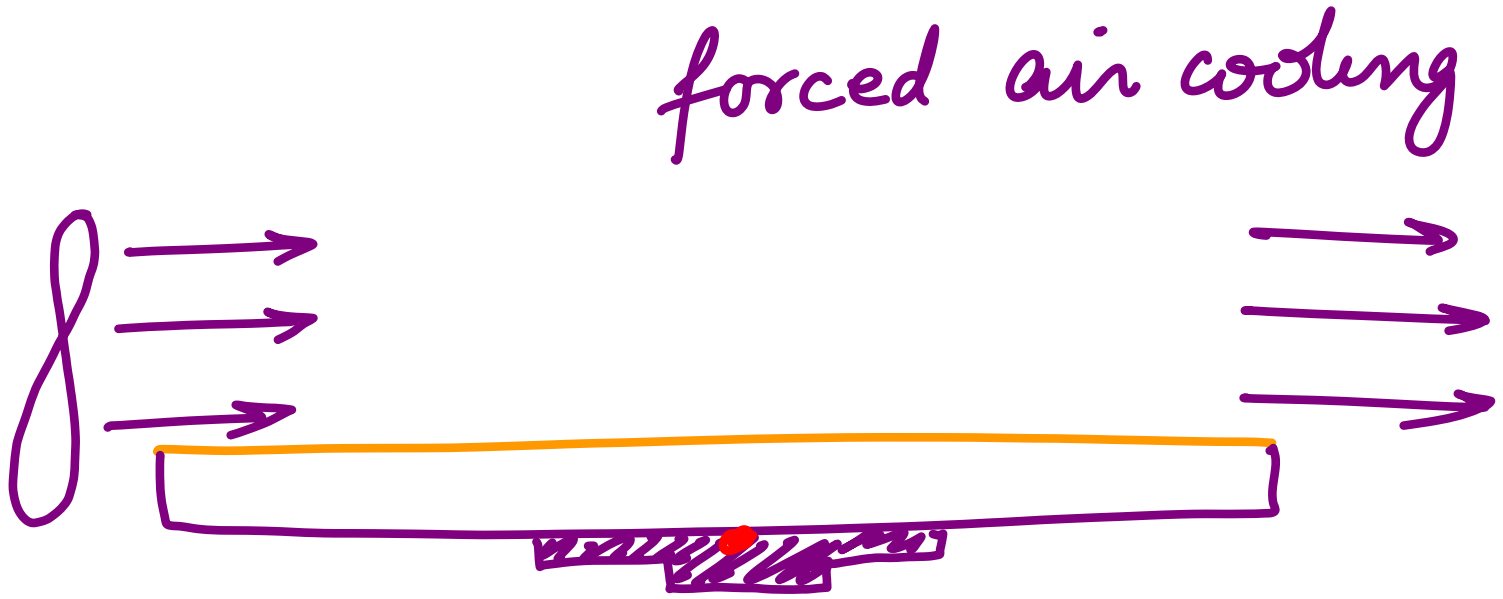
4. Mass flow rate mechanism

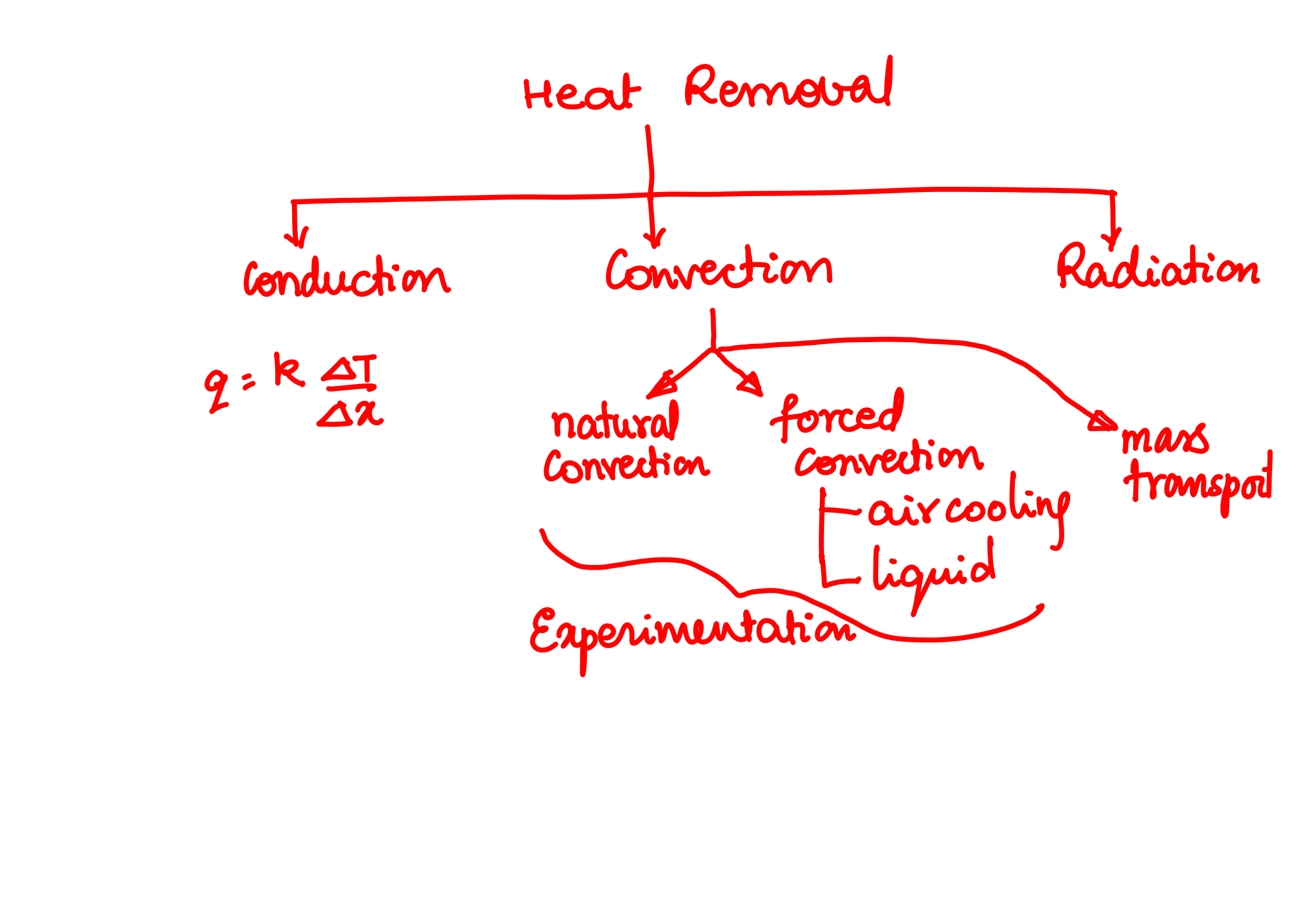


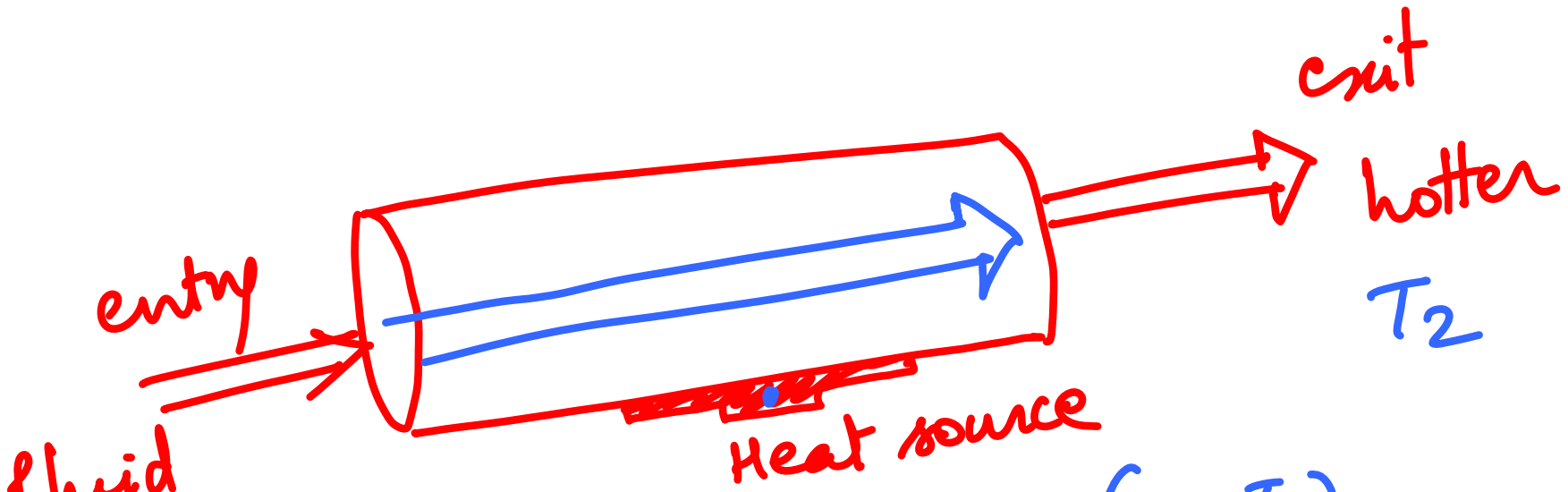
$$R_\theta = \frac{\Delta T}{P} = \frac{T_j - T_A}{P} = R_{\theta jc} + R_{\theta cs} + R_{\theta SA}$$


$R_{\theta SA} = \frac{T_j - T_A}{P} - R_{\theta jc} - R_{\theta cs}$
jn. temp
150°C max
120°C
50°C
datasheet
0.1 – 0.2°K/W
Power dissipation
Calcuted from
circuit Analysis


$R_{\theta CS}$
0.5 °K/W to 1.5 °K/W
Heatsink compound (thermally conductive paste)


forced air cooling


Heat Removal
Conduction
Convection
Radiation
$q = k \frac{\Delta T}{\Delta x}$
natural Convection
forced convection
air cooling
liquid
mass transpot
Experimentation



$$P = \frac{dm}{dt} \cdot C_p \cdot \Delta T \qquad (T_2 - T_1)$$