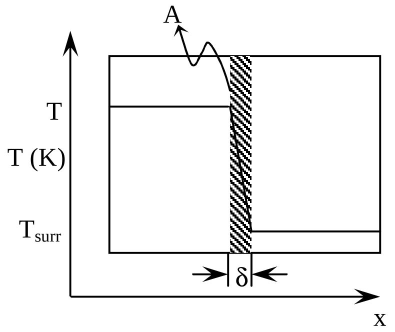
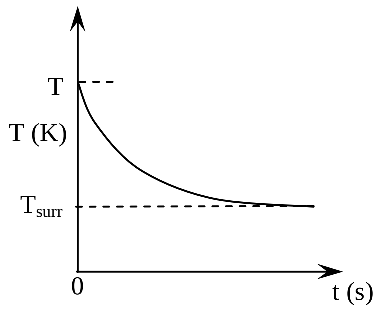
Kinetics of Thermal Transfer

Conduction:

$$J_q = -\,\mathcal{K}\,\frac{dT}{dx}$$





$\sim J\,m^{-2}\,s^{-1} = W\,m^{-2}$

$1\,W = 1\,J\,s^{-1}$

$\mathcal{K} \sim J\,m^{-1}\,K^{-1}\,s^{-1}$

$$dT/dx = (T - T_{surr})/\delta$$

$$\frac{\text{đ}q}{dt} = J_q\,A$$

$$\frac{\text{đ}q}{dt} = -\frac{\mathcal{K}A}{\delta}\,(T - T_{surr})$$

$$\text{đ}q = C_p dT$$

$$C_P\,\frac{dT}{dt} = -\frac{\mathcal{K}A}{\delta}\,(T - T_{surr})$$

$$d(T - T_{surr})/dt = dT/dt$$

Newton's Law of cooling:

$$\frac{d(T - T_{surr})}{dt} = -\left(\frac{\mathcal{K}A}{\delta\,C_P}\right)(T - T_{surr})$$

$$\int_{T_o}^{T} \frac{d(T - T_{surr})}{(T - T_{surr})} = -\int_0^t \left(\frac{\mathcal{K}A}{\delta\,C_P}\right) dt$$

$$(T - T_{surr}) = (T_o - T_{surr})\,e^{-\frac{\mathcal{K}A}{\delta\,C_P}\,t}$$

Stefan-Boltzmann law:

$$J_{q,radiative} = \sigma\,T^4$$

$$\sigma = 5.6704\times10^{-8}\ W\cdot m^{-2}\cdot K^{-4}$$