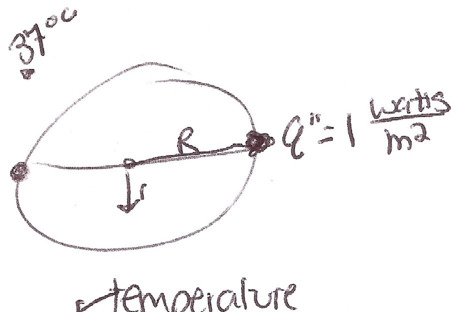
① $\overbrace{\frac{K}{\rho c}\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dT}{dt}\right)}=0$



Integrate ↓ $\boxed{BC1}$ @ $r=R$, $q''=-K\frac{dT}{dr}=1\ \frac{\text{watts}}{m^2}$

$r^2\frac{dT}{dr}=C_1 \rightarrow \frac{dT}{dr}=\frac{C_1}{r^2} \rightarrow \underline{T(r)=-\frac{C_1}{r}+C_2}$ ← temperature profile

$\underline{-K\frac{dT}{dr}\Big|_{r=R}=-K\frac{C_1}{R^2}=q''}$

$\boxed{BC.2}$

@ $r\rightarrow\infty$, $T=37^{\circ C}$

$\underline{37=\cancel{\frac{C_1}{\infty}}^{\,0}+C_2}$

$\frac{1}{r^2}\frac{d}{dr}\left(r^2\frac{dT}{dt}\right)=0$

$\frac{d}{dr}\left(r^2\frac{dT}{dt}\right)=0$

$r^2\frac{dT}{dt}=C_1$

$\underline{C_1=\frac{-q''R^2}{K}}$

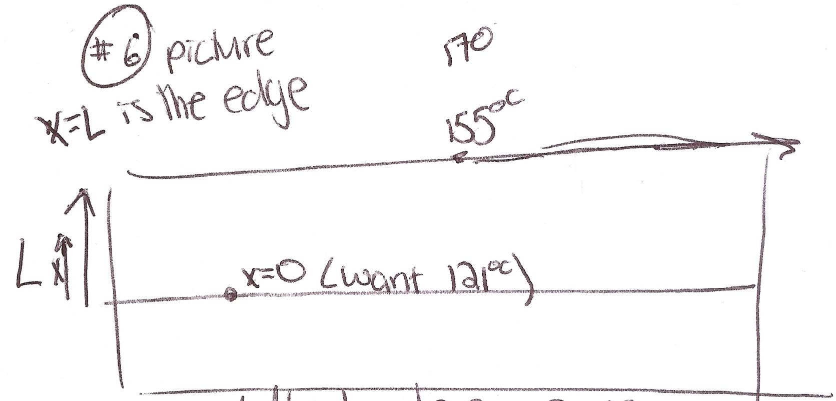
$T(r)=-\frac{C_1}{r}+C_2$

$T(r)=+\frac{q''R^2}{K}\cdot\frac{1}{r}+37^{\circ C}$ ↗ K

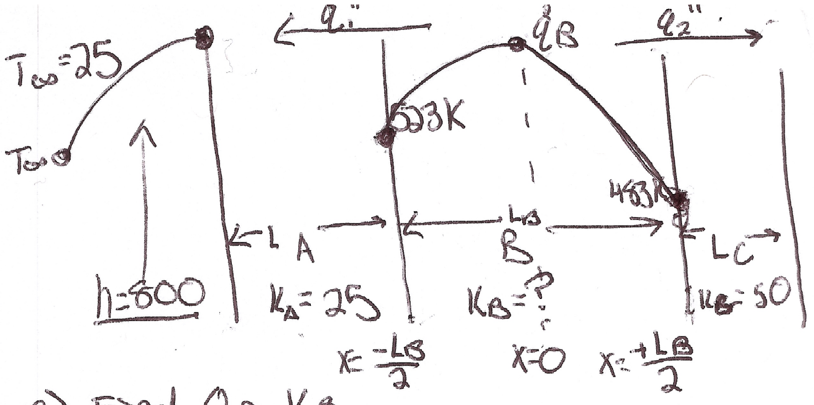
Maximum temp: $r=R$

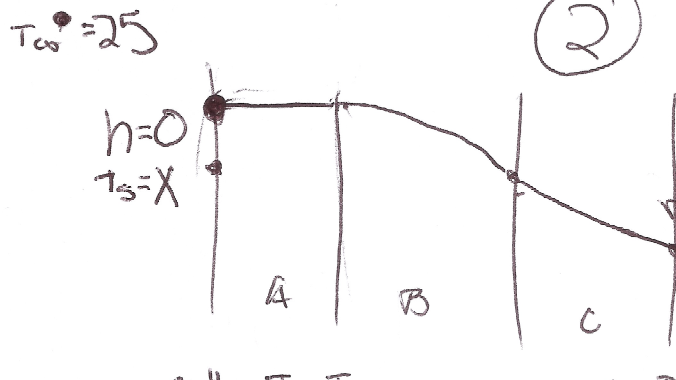
$T_{max}=\frac{q''R^2}{K}\cdot\frac{1}{R}+37$

PROBLEM SIX:



→ Guess oven temp.
→ Solve time to get to 121
→ Use total time to check edge temperature. We want middle to be 121°C





(2)

$q_1'' = \frac{T_1 - T_\infty}{R_{cond}}$ $\quad q_2'' = \frac{T_2 - T_\infty}{R_{cond}}$

a) Find $\dot{Q}_B, k_B$

(1) $\frac{d^2T_B}{dx^2} = \frac{-\dot{q}_B}{k_B}$

(2) @ $x = \frac{-L_B}{2}$, $T_B = 523 = T_1$

(3) @ $x = \frac{+L_B}{2}$, $T_B = 483 = T_2$

$\frac{dT_B}{dx} = \frac{-\dot{q}_B}{k_B}x + C_1$

$T_B = \frac{-\dot{q}_B x^2}{2k_B} + C_1 x + C_2$

*Note

@ $\frac{L_B}{2}$ $\quad -k_B \frac{dT_B}{dx} = -k_C \frac{dT_C}{dx}$

Steady state, fluxes equal at interface

we know $\frac{dT_B}{dx}$ and $\frac{dT_C}{dx}$

use (2): $523 = \frac{-\dot{q}_B}{2k_B}\left(\frac{-L_B}{2}\right)^2 + C_1\left(\frac{-L_B}{2}\right) + C_2$

use (3): $483 = \frac{-\dot{q}_B}{2k_B}\left(\frac{L_B}{2}\right)^2 + C_1\left(\frac{L_B}{2}\right) + C_2$

$T_B = \frac{\dot{q}_B}{2k_B}\left(\frac{L_B^2}{4} - x^2\right) - \left(\frac{T_1 - T_2}{L_B}\right)x + \left(\frac{T_1 + T_2}{2}\right)$

watts/m³

$L_B \dot{q}_B = q_1'' + q_2''$ $\qquad \underbrace{q_1'' = \frac{T_1 - T_\infty}{R_{cond} + R_{conv}}}$ $\qquad \underbrace{q_2'' = \frac{T_2 - T_\infty}{R_{cond} + R_{conv}}}$

Let's find temp profiles A, C

(1) $\int \frac{d^2T_C}{dx^2} = 0 \longrightarrow \underbrace{\int \frac{dT_C}{dx} = \int B_1} \longrightarrow T_C = B_1 x + B_2$

(2) $483 = B_1\left(\frac{L_B}{2}\right) + B_2$

(2) $\frac{L_B}{2} = x$, $T_C = T_2 = 483$

(3) @ $\frac{L_B}{2} = x$, $-k_C \frac{dT_C}{dx} = q_2''$

(3) $\frac{dT_C}{dx} = \frac{q_2''}{-k_C}$ @ $\frac{L_B}{2} = x$

$\boxed{B = \frac{q_2''}{-k_C}}$

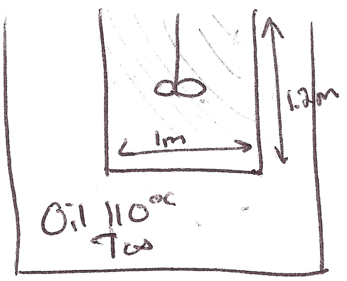
(3) $Bi = \frac{h_{air} R}{K_{bean}} \leq 0.2$ (close enough)

$R_{cond} = \frac{1}{K}$

$$\frac{T - T_\infty}{T_i - T_\infty} = \exp\left(-\frac{UA}{mc} t\right)$$

$$U = \sum R = \frac{1}{h}$$

(4)



$T_i = 15°C$

$T = 50$

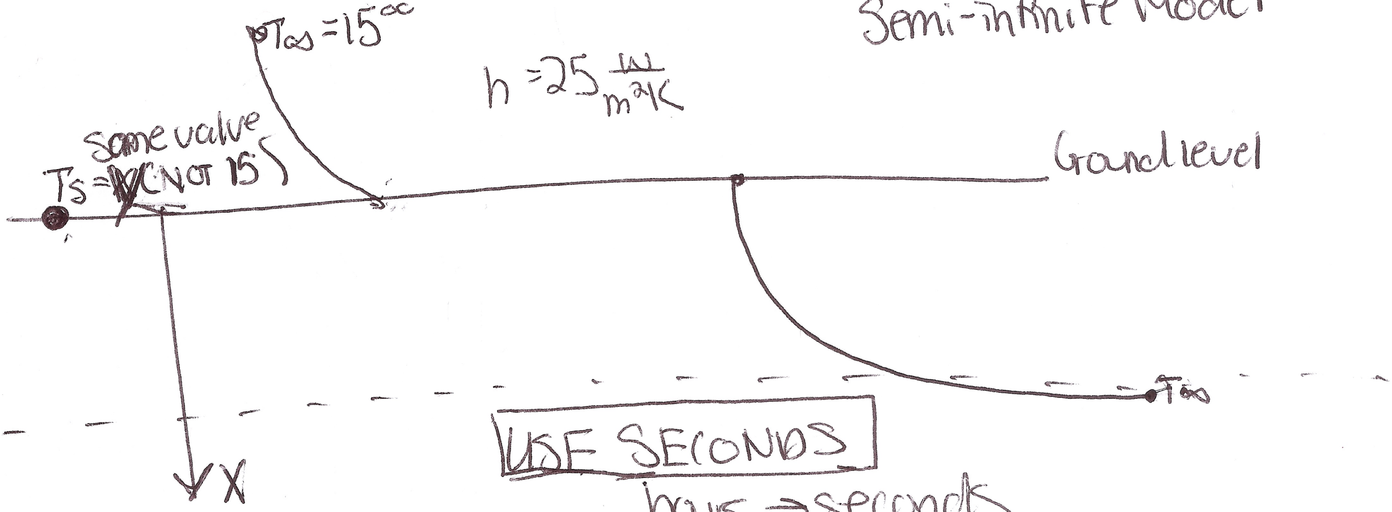
$h = 250 \frac{W}{m^2K}$

$A = 4.2 m^2$

(5)

Semi-infinite Model

$h = 25 \frac{W}{m^2K}$



$\boxed{\text{USE SECONDS}}$

hours → seconds

$$\eta = \frac{x}{2\sqrt{\alpha t}}$$

erf(η)	η

(1) Depth $T(x,4) = -2$

(2) Temp Surface $T(0,4) = X$

$Flux = h_{air}(T_s - T_{air})$

I used MATHCAD ROOT function to get X.

→ MATHCAD has erfc)