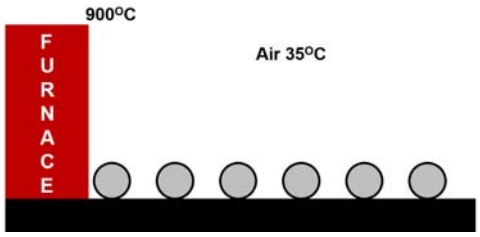
## Heat Transfer - 2

Carbon steel balls ($\rho$ = 7833 kg/m$^3$, $k$ = 54 W/m.C, $c$ = 0.465 kJ/kg.C) 8 mm in diameter are annealed by heating them first to 900 $^O$C ($T_i$) in a furnace and then allowed to cool slowly to 100$^O$C ($T_f$) in ambient air at 35$^O$C ($T_\infty$) as shown in figure. If the heat transfer coefficient is 75 W/m$^{2\cdot}$C. Ignore all radiation effects.




(a) Show how it can be determined if the conduction resistance in the balls is important to include in the solution model. (**15 points**)

(b) Use the lumped capacitance transient model to derive the equation for calculating the time taken to reach final temperature $T_f$ (**50 points**)

(c) Calculate the time taken to reach $T_f$ (**20 points**)

(d) If there are 2500 carbon balls, calculate the total heat transfer to the air (**15 points**)