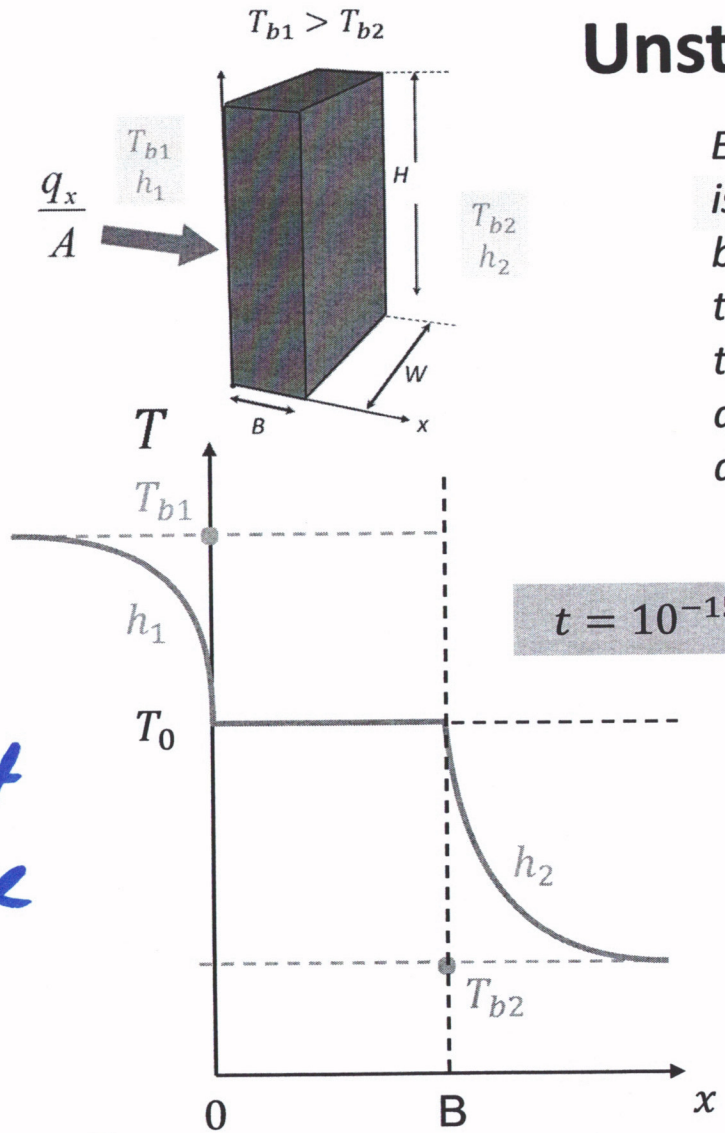
25 Jan 2021
F. Morrison

Unsteady Heat Transfer



Example: A wide, tall slab initially uniformly at T_0 is suddenly subjected to flowing fluid on its two broad faces. The left fluid is at T_{b1} and its heat transfer to the wall is characterized by heat transfer coefficient h_1, while the right side is at T_{b2} and characterized by h_2. What is the temperature distribution across the slab as a function of time?

$t = 10^{-15} s$

What do we think will happen?

- Will there be heat transfer resistance at the boundaries?
- Will there be a linear temperature profile in the slab?
- Femtoseconds after the change what does the profile look like?
- What will the solution trend towards as time goes on ($\rightarrow \infty$)?

What do we think will happen?

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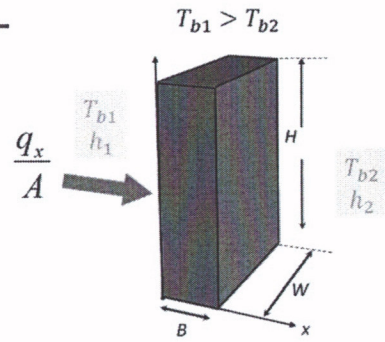
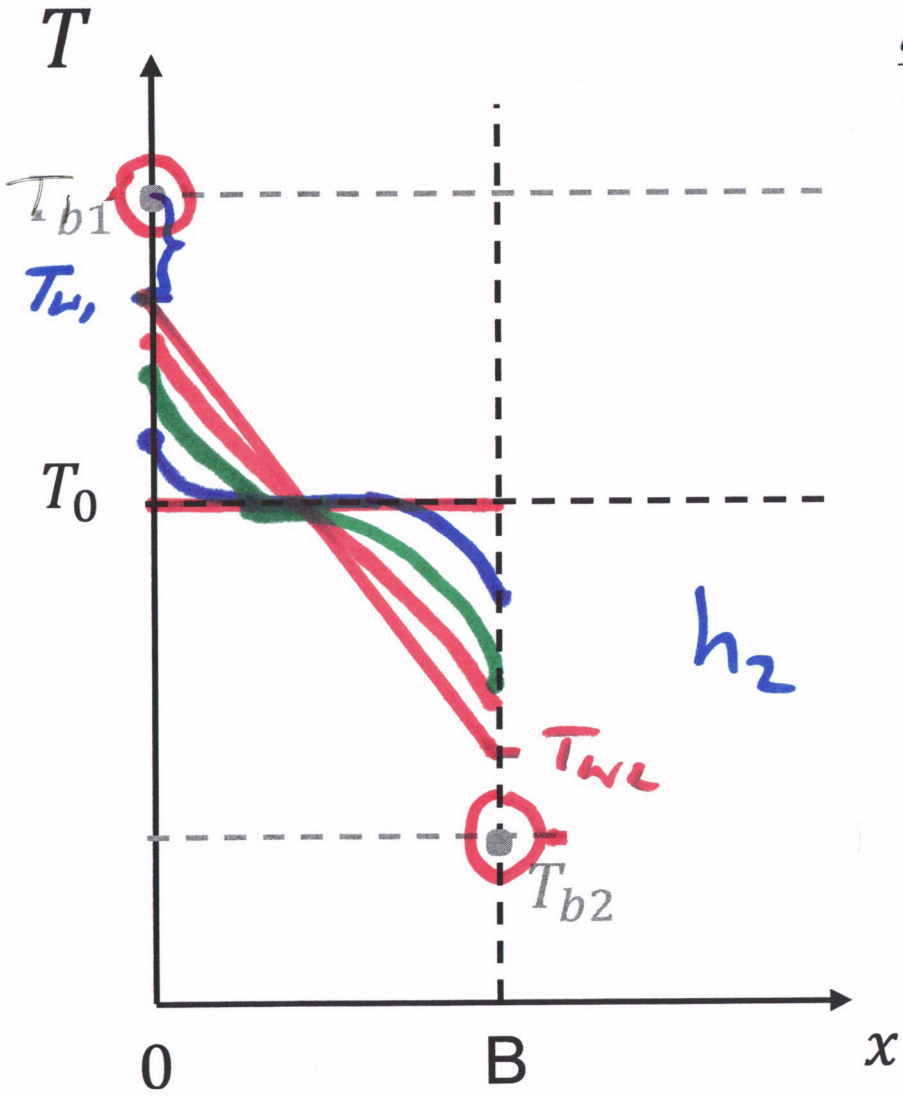
Heat Transfer: Steady vs. Unsteady

initially slab at T_0

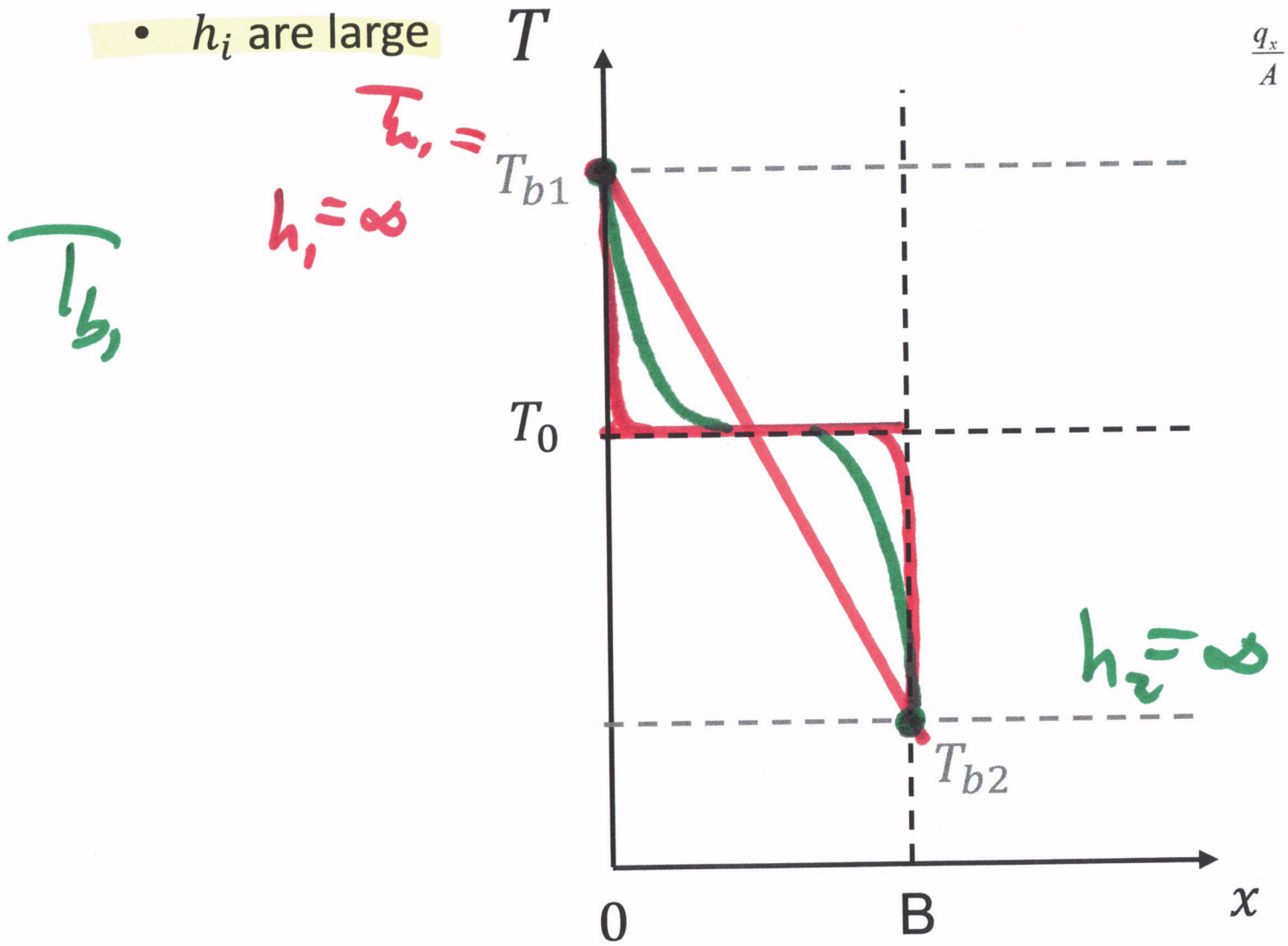


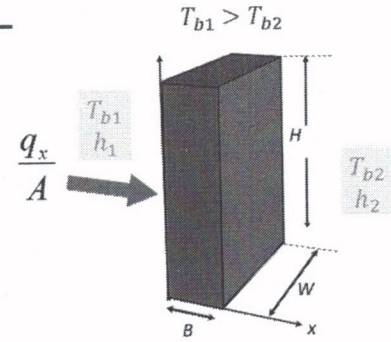


h_1

h_2

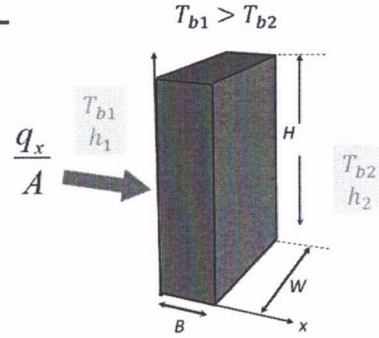
- h_i are large

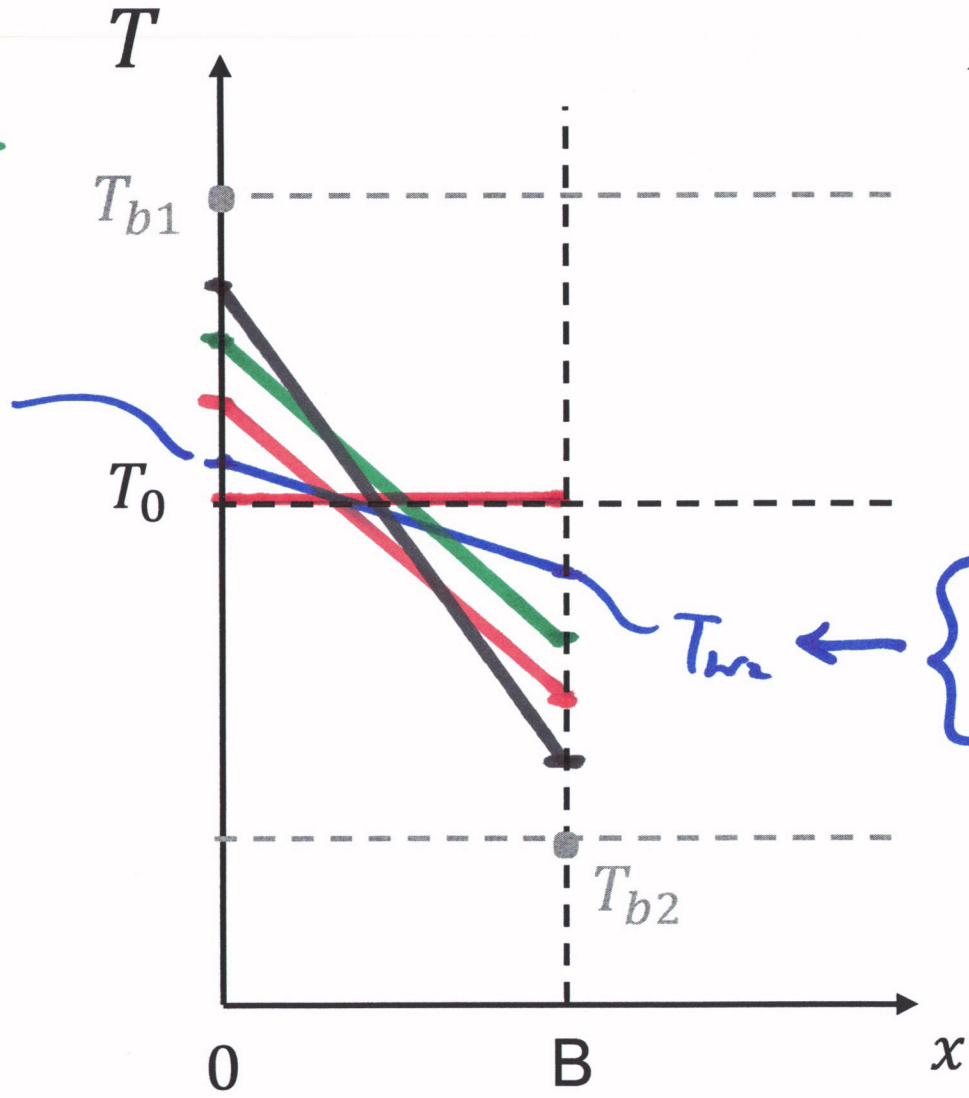




- k is large

h_1, h_2 finite





when system reaches steady state ($t \to \infty$) { T_{w1}

T_{w2} ← { when system reaches steady state

no resistance to heat xfer $\frac{1}{k} \to 0$