

ChE 310: Introduction to Transport Processes

Fall 2011, Homework Set #1 (Due: 8/31/11)

1. Describe in your own words how molecular and convective transports are different.
2. Use your knowledge of the difference between molecular and convective transport to explain why a hot piece of metal will cool slower in stagnant air than it would if air were blown across the metal.
3. (a) Write the term for the molecular flux of species "A" in the z-direction when the total molar concentration of the fluid, C , is constant. What is its driving force? (b) Write the term for the convective molar flux of species "A" in the z-direction. What is its driving force? (c) State two ways to increase the molecular flux. (d) State two ways to increase the convective molar flux.
4. Write the appropriate phenomenological law for the molecular flux of z-momentum in (a) the x-direction, (b) the y-direction, and (c) the z-direction.
5. Describe in your own words how the molecular flux of the z-momentum in the x-direction and the molecular flux of the x-momentum in the z-direction are different.
6. A block of metal is shown in Figure 1. One end of the block ($x = 0$ m) has the temperature of 100 K and another end of the block ($x = 10$ m) has the temperature of 0 K. (a) By your intuition, in which direction ($+x$, $-x$, $+y$, or $-y$) does the heat flow (I am asking the direction of the heat flux (q))? (b) Calculate the temperature gradient ($\Delta T/\Delta x$). (c) what is the direction of the temperature gradient? (d) Compare the directions of the heat flux (q) and the temperature gradient. Base on this comparison, explain why does Fourier's Heat Conduction Equation ($q_x = -k (\Delta T/\Delta x)$) have a negative sign?

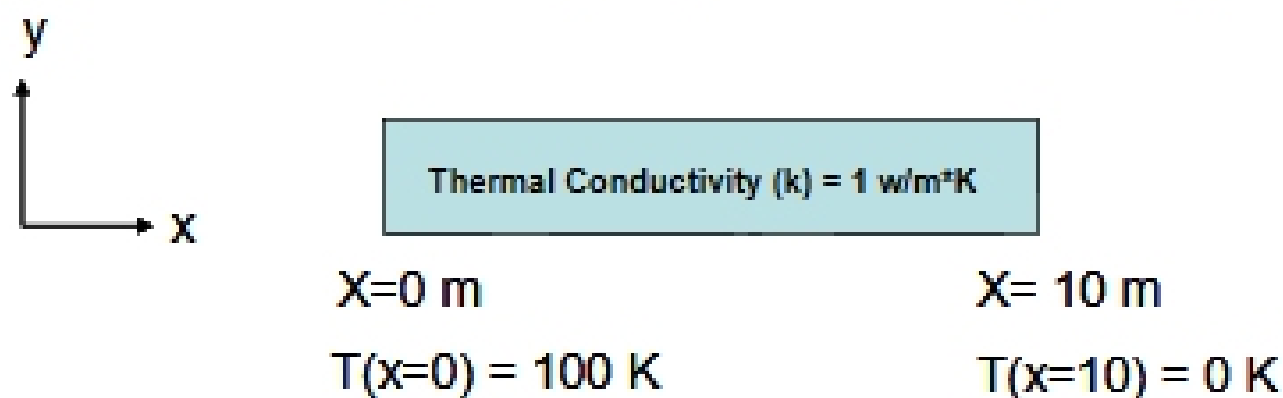


Figure 1

7. Calculate the heat loss per surface area for an insulating wall composed of 25.4 mm thick fiber insulating board, where the inside temperature is 353 K and the outside temperature is 297.1 K. The thermal conductivity (k) of fiber insulating board is 0.048 W/m*K.

8. Give one real life example where the heat, mass and energy transports are very important. Be specific how various transport phenomena affect the performance and/or efficiency of your real life example.

9. One can define the flux of Λ as a product between the volumetric density of Λ and the velocity of Λ . Please derive this expression starting from the general flux equation.