QUESTION 1.

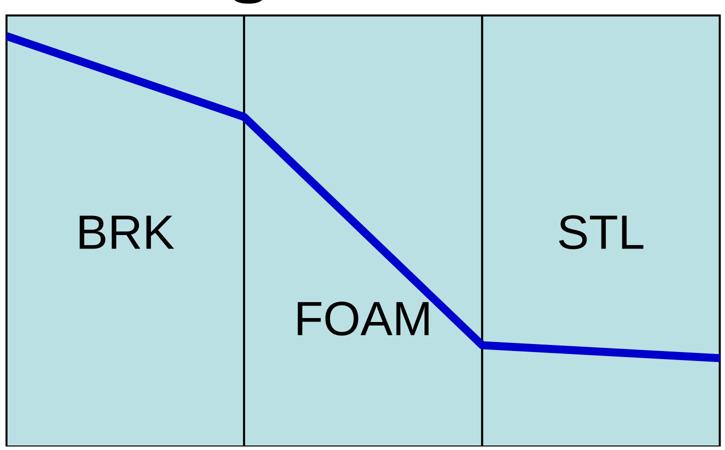
Write the equation for internal energy change for subcooled water entering a heat exchanger at T_1 and leaving as a superheated vapor at T_2.

$$\Delta U = \dot{m} c_{p,liq} (T_{sat} - T_1) + \dot{m}\, h_{fg} + \dot{m} c_{p,vap} (T_2 - T_{sat})$$

QUESTION 2.

For a composite wall made of equal thicknesses of:
BRICK | POLYMER FOAM | STAINLESS STEEL

Draw an estimate of the steady state temperature profile assuming the brick side is hotter.



QUESTION **3**.

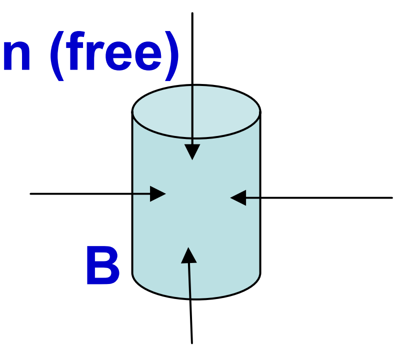
3-part question:

A. For a cold soda can sitting on a table, which mode(s) of heat transfer are most important?

B. Draw the can with arrows showing the direction of heat transfer.

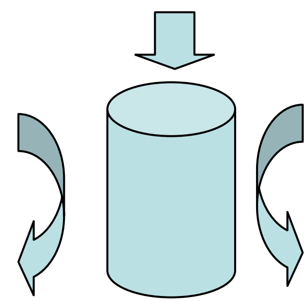
C. Use a different color to show the direction of any fluid flow in the problem.

A. conduction & convection (free)



B

C

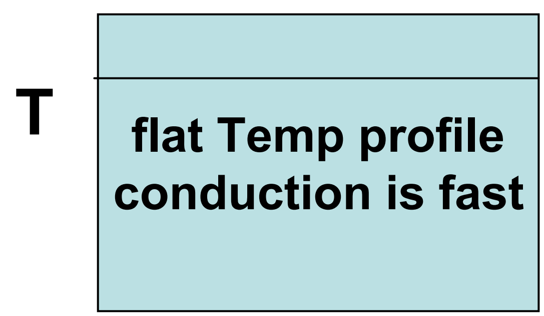


QUESTION 4.

Write the equation for the Biot Number.

What does the temperature profile look like in a solid if Bi = 0.0001?

$Bi = hL_c/k_{solid}$



QUESTION 5.

Write the Stefan-Boltzmann equation. What are the units of the Stefan-Boltzmann constant?

$$q = \varepsilon\sigma\,(T_s^4 - T_{sur}^4)$$

units = $W/m^2\text{-}K^4$

QUESTION 6.

Write Newton's Law of Cooling for flow through a large tube bundle. What temperature do you use to find fluid properties?

$$q = hA(T_s - T_{mean})$$

where $T_{mean} = (T_{in} + T_{out}) / 2$

Fluid properties at T_{mean}

QUESTION 7.

The surface of a pipe is held constant @ 125 ^oC. Glycerin enters the pipe at 25 ^oC and exits at 35 ^oC.

A. What temperature do you use to look up fluid properties? 30 ^oC

B. What is the ΔT associated with internal energy change? 35 - 25 = 10 ^oC

C. What is the temperature driving force for heat transfer?

$$\Delta T_{lm} = (125\text{-}25) - (125\text{-}35) / \ln (100/90)$$
$$= 94.9\ ^oC$$

QUESTION 8.

What are the 5 terms that make up the total resistance in a heat exchanger?

h_i = internal (tubeside) convective heat transfer coefficient
$R_{f,i}$ = internal fouling factor
k_w = conduction term through wall $\ln(D_o/D_i)/2\pi L k_w$
h_o = external (shellside) convective heat transfer coefficient
$R_{f,o}$ = external (shellside) fouling factor

QUESTION 9.

Given a shell & tube heat exchanger with a low shell-side Reynolds number:
List 2 changes you can make to increase Re.

possibilities: decrease baffle pitch, decrease shell diameter, increase # of tubes, decrease tube pitch

List two changes that will increase Re if Re is low on the tubeside.

possibilities: decrease tube diameter, decrease number of tubes, use a rough surface in pipes

QUESTION 10.

Write Fourier's Law for heat conduction in the x-direction.
What are the English units for thermal conductivity?

$$q = -k \, dT/dx$$

k is in Btu/h-ft-°F (W/m-K)

QUESTION 11.

LIST THREE OF THE FOUR HEAT TRANSFER REGIMES FOUND IN POOL BOILING.

Free Convection
Nucleate
Transition
Film

QUESTION **12**.

What Reynolds number marks the transition from laminar to turbulent flow for:
A. Flow over a flat plate
B. Flow through a pipe.

5×10^5
~2100-2300