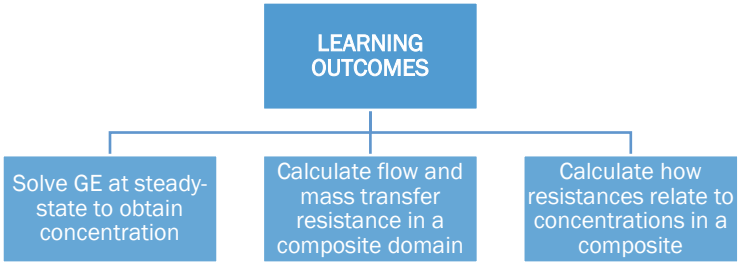
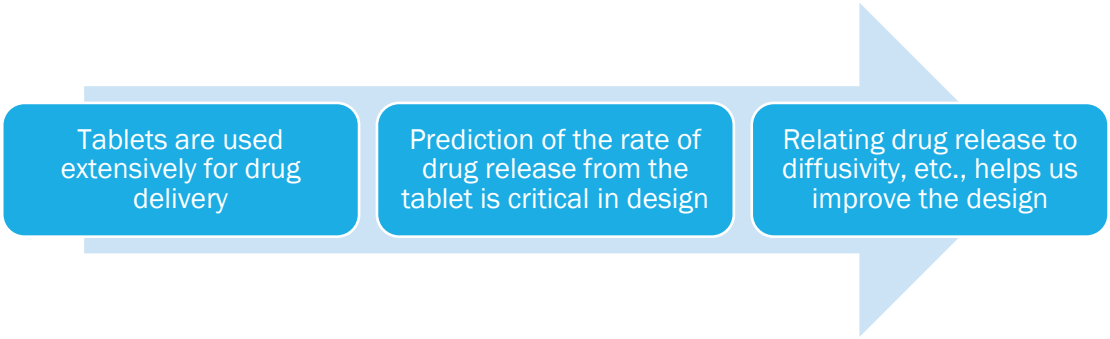
PROBLEM SOLVING: STEADY-STATE MASS TRANSFER

12.15 Drug diffusion through a tablet

Learning Outcomes (1 min)



Why bother with it? (1 min)



Problem 12.15 Drug diffusion through a tablet

A schematic of a spherical tablet is shown in Figure 12.27. Here the main ingredient of the drug naproxen sodium (abbreviated as N from now on) diffuses through the three layers shown, which are designed to provide a more uniform release of the drug out of the tablet (among other things). The thickness of the layers 1, 2, and 3 and their diffusivities are shown in table below (The tabulated data are for reference only and you do NOT need to use them). 1) Write the governing equation for the diffusion of N in any of the layers, assuming steady state. 2) For concentration specified boundary conditions $c(r = r_i) = c_i$ and $c(r = r_o) = c_o$, where r_i and r_o are the inner and the outer radii, respectively, solve the governing equation for c as a function of position. 3) Derive the expression for flow in terms of a concentration difference divided by resistance and obtain the expression for resistance.

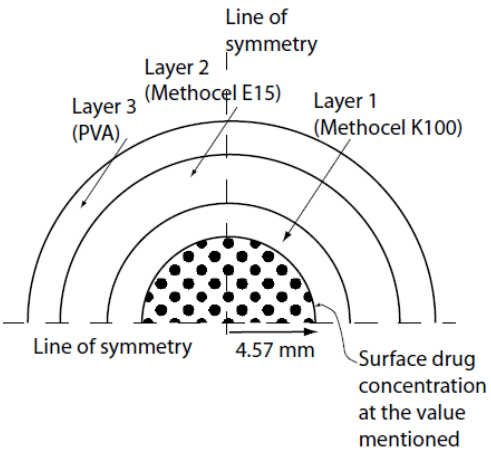
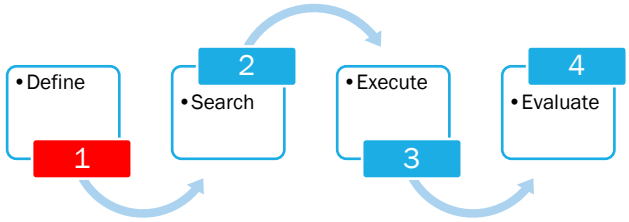


Figure 12.27: Schematic of a tablet.

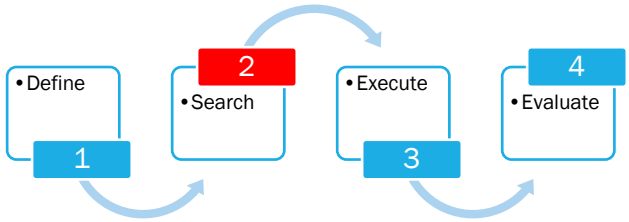
Layer	Thickness (mm)	Drug diffusivity (mm^2/s)
1 (Methocel K100)	0.89	9.7×10^{-2}
2 (Methocel E10)	0.76	0.15×10^{-2}
3 (PVA)	0.13	0.24×10^{-2}

Solution



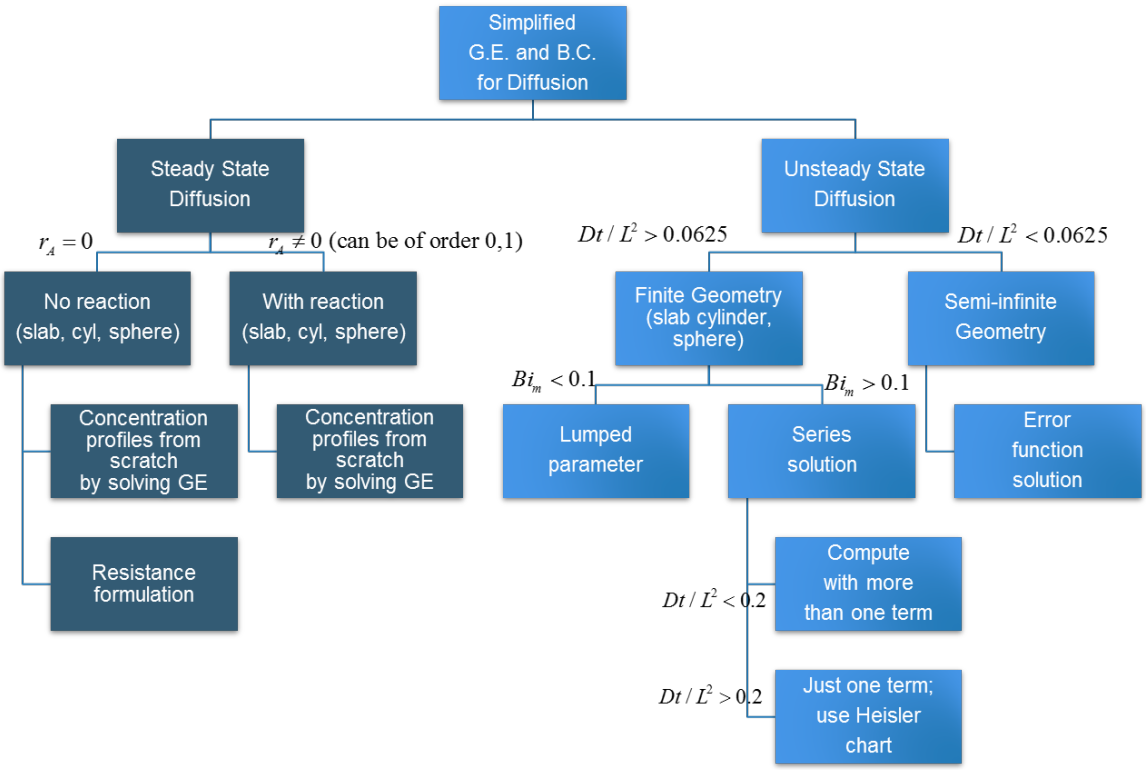
Define and understand the problem (5 min)

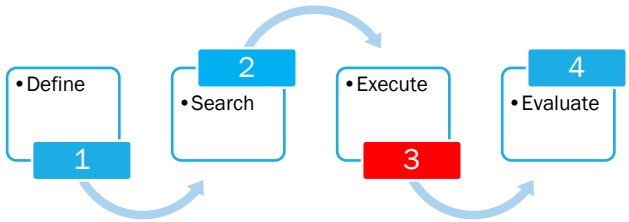
What is the physical process? What are we solving for?



Choosing solution approach (3 min)

Choose your solution approach for the drug concentration. The map below can be helpful.



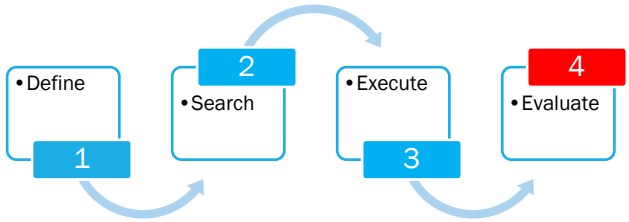


Implementing the solution (15 min)

Part 1.

Part 2.

Part 3.



Evaluating and interpreting the solutions: Class discussion (15 min)

How do we trust our computed resistance formula? Show at least one approach.

For the given data, what are the resistances for each layer and are they similar?

Of the two concentration profiles below over the three layers, which one is correct and why?