## Special Problem 3-1

Consider the irreversible conversion of species A to B in a stationary liquid film of thickness L and surface area S as shown in the figure below. The reaction proceeds via first order kinetics with  $R_{VA} = -k_V C_A$ . The bottom surface of the film is impermeable and unreactive, and the top surface of the film is maintained at a value of  $C_{A,0}$  (the latter could happen, for example, if one rapidly stirs a liquid and the reaction is limited to a boundary layer thickness of size L). You may assume that the system is at steady state, and that  $C_A = C_A(y)$  only.

- a. Determine the concentration profile  $C_A(y)$  in the film.
- b. Non-dimensionalize your result and plot the dimensionless concentration profile versus dimensionless height for  $Da = \{0.1, 1, 10, 100\}$  where Da is the Damköhler number. Briefly discuss of what is physically happening at low Da versus high Da.

$$C_{A} = C_{A,0}$$

$$y = L \xrightarrow{f} C_{B} = 0$$

$$A \to B$$
Liquid
$$y = 0$$
Inert Solid