Problem 1.

You are developing a process to extract exciting new flavors from MCO's novel cola nuts for a new soft drink.

The nuts are basically spherical, with a radius of 2 cm. The density of flavoring agents in the nuts is 0.02 gm/cm^3. Using pure water as the extraction solvent, the effective diffusivity through nut is $D_{eff} = 8.7 \times 10^{-3}$ cm^2/min. The aqueous solubility of the flavoring agents is 50 gm/L of water. Assume that the extraction is controlled by diffusion of the flavoring agents through the nut matrix and that the flavor solution leaving the nut is saturated.

A. Calculate the time (min) needed to extract 100% of the flavoring agents.

B. Calculate the time (min) needed to extract 90% of the flavoring agents.

Problem 2.
For a 1st order reaction in a catalyst particle, calculate the effectiveness factors for a flat plate (thickness 2 cm), a cylinder (R=2 cm) and a sphere (R=2 cm). For the cylinder, use the chart. For the flat plate and the sphere, use both the analytical equation and the chart.

$De = 5.31 \times 10^{-3}$ cm2/s
$ke = 0.18\ s^{-1}$

Problem 3.

A catalyzed chemical reaction (A->B) has an effective 1^{st} order reaction constant ke = 0.2/sec. The effective diffusivity of A in the catalyst particle is 7.2×10^{-4} cm^2/sec. It has been proposed to use either spherical or cylindrical catalyst particles with a radius of 0.3 cm. Calculate the difference in effectiveness between these alternative catalyst particle shapes.