Quiz 12 (25 points)   Name:

Please put name on back of last sheet for returning assignment

Honesty Policy on Take home Assignments

All work on this assignment that you submit under your name should be solely the results of your efforts. If you copy someone else's work and put your name on it, you are being dishonest. Anything that appears with your name must reflect nerve impulses that originated from your brain. I expect and require honesty from all my students. The penalty for dishonesty in class is automatic failure and a report to the Dean of Students Office.

Please read, sign, and date the statement below, and return with your assignment paper. **Your assignment will not be graded unless this statement/quiz sheets accompanies the assignment.**

I have read and understand the policies regarding academic honesty as related to this course and the University. By signing this statement below, I affirm that I have neither sought nor received help from anyone in the completion of this assignment and that the solutions presented here are solely the result of my efforts.

Signature: Date:

Printed name:

Assignment

TAOCO has come up with a brilliant idea for a continuous mini-reactor to make product B from reactant A (A->B) using an immobilized enzyme. The reactor is basically a concentric cylinder containing immobilized enzyme. A flowing stream in the center constantly removes product/unconverted reactant. The reactant diffuses inwards radially from the outside (1 dimensional) while reacting. When it reaches the flowing stream near the center, it is swept away for recovery (see drawing below).

Assumptions/boundary conditions:

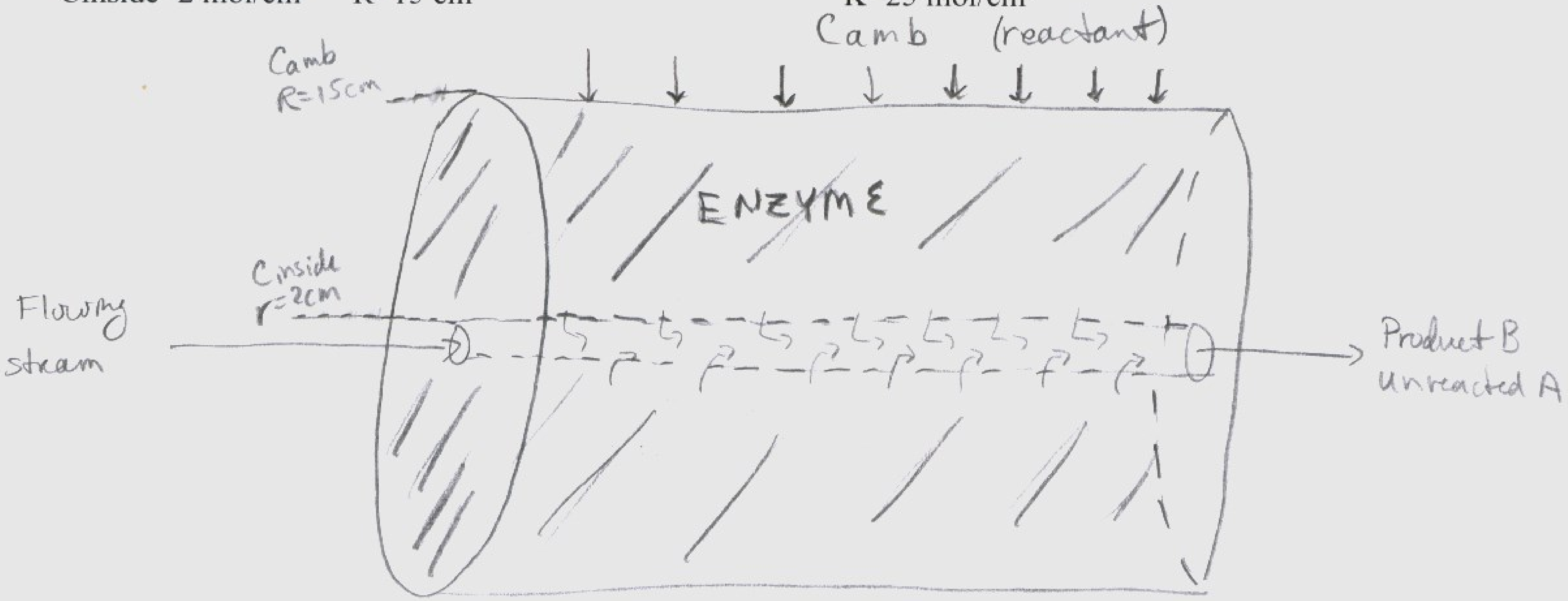
The center stream is operated so as to keep the exiting reactant concentration at a fixed value, Cinside.

The external conditions are such that the surface reactant concentration is constant at Camb.

At time=0, the concentration inside the reactor is uniform at Cinside, with Camb at R.

Data values:

Camb=50 mol/cm^3	r = 2 cm	D=0.01 cm^2/sec	V=0.05 mol/cm^3-sec {rxn rate = -V*C/(K+C)}
Cinside=2 mol/cm^3	R=15 cm		K=25 mol/cm^3



A. (5 points) Derive the partial differential equation governing this reactor system, i.e. the concentration vs. radial position and time, i.e. dC/dt = f(C,r). (suggest using a mass balance)

B. (5 points) Derive the forward finite difference equation for this system and present in the format:

$$C_m^{p+1} = [\ ]C_{m+1}^p + [\ ]C_m^p + [\ ]C_{m-1}^p$$

C. (10 points) Using this equation (part B), calculate the reactant concentration gradient (C vs. r) at different times. Use whatever values you wish for Δr and Δt. (use whatever computational platform you wish) Using your model, provide gradient plots vs. time (select appropriate times to show gradient changes) for the following situations:

1. No reaction occurs (V=0) Evaluate how long it takes for the system to come to steady state/equilibrium (might want to think what this should look like). Analyze your solution, i.e. explain if your solution makes sense.
2. Reaction occurs (V=0.05) Evaluate how long it takes for the system to come to steady state/equilibrium. (might want to think what this looks like) Analyze your solution, i.e. explain if your solution makes sense.

D. (5 points) Look carefully at your model/calculation values for reaction (part C.2), particularly close to the flowing exit stream. Does the model make sense near this region (explain). How does this relate to the problem assumptions?