

A First Course on Kinetics and Reaction Engineering

Unit 8. Lesson Plan

Before Class

- Provide the redacted slides to the students and tell them to bring them to class
- Bring a deck of playing cards to class for use in Activity 8.1

During Class

- Introduce today's topic and where it fits in the course (Slides 1 and 2)
- Review of Unit 8 (5 to 10 minutes)
 - Slide 3
- Ask whether the students have any questions from their pre-class preparation and answer them
 - Slide 4
- Learning Activity (~20 minutes)
 - Slide 5: Put the slide up, call volunteers to the front and explain how the activity will work:
 - ▶ the person representing the first step should start moving cards, one at a time at a moderate rate to a new pile, next to the reactant pile
 - ▶ the person representing the reverse of the first step should move cards back to the reactant pile, but only if there are three or more in the intermediate 1 pile (to simulate the equilibrium concentration of intermediate 1)
 - ▶ the person representing the second step should pick up one card from the intermediate 1 pile (it does not matter how many are in the pile) and WALK to the back corner of the room and put it on the intermediate 2 pile then walk back to the intermediate 1 pile and repeat
 - ▶ the person representing the third step should pick up any available card, one at a time, from the intermediate 2 pile and move it to the product pile
 - Assign a volunteer to count the number of times the second step occurs and a second volunteer to count the number of times the product is formed.
 - Say start and let the activity proceed until 20 or more cards are in the product pile
 - Tell the volunteers to stop and compare the two rates (times step 2 occurred and times product formed); they will be equal to within one; make the point that the overall process can't move any faster than the most demanding step.
 - Discuss the analogy to reaction mechanisms
 - (Optionally) Add in a fifth volunteer representing the reverse of the second step (with responsibilities equal to those of the reverse of the first step) and repeat.
- Learning Activity (20 minutes)
 - Slide 6 (in groups or as individuals): Display the problem statement, answer any questions. Tell them that the algebra for the three rate-determining step assumptions is easy and they should be able to get a final rate expression, but the algebra for the Bodenstein steady

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state approximation is complicated, so they should just set it up. Let them work, circulating, observing, correcting and answering questions. When time is almost up or most seem to be finished, continue

- Slides 7 through 10: Walk them through each of the four solutions. Note that the algebra for the Bodenstein steady state solution is complicated by hand, but very easy if symbolic algebra software, such as Maple, is used.
- Slide 11: Show them the comparison of the four rate expressions. Show them how the three rate-determining solutions are simplifications of the Bodenstein steady state approximation solution.
- Slide 12: show them what's next and how it relates to what's already been covered

After Class

- Provide the complete slides to the students.