KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.E.
Year : III

Course : CHEG 312
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 24 DEC 2024

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle in the most appropriate option from each set of choices

1. How will the Lineweaver-Burk plot change as competitive inhibition concentration [I] is increased?
   a. Slope and intercept will go up
   b. Slope and intercept will go down
   c. Slope will go up, intercept will stay the same
   d. Intercept will go down, slope will stay same

2. According to the Monod equation, the overall reaction order goes to ___ as the substrate concentration becomes very high
   a. -1 b. 0 c. 0.5 d. 1

3. In a particular fermentation reaction, the $Y_{C/S} = 0.2$. If the inlet concentration of substrate is 4 g/dm^3 and the conversion is 75%, what concentration of cells (g/dm^3) has been produced?
   a. 0.08 b. 0.2 c. 0.6 d. 0.8

4. One step is rate determining in a reaction sequence of three elementary steps. Approximately what would be the ratio of the net rate of the rate determining step relative to the other two steps?
   a. 10 b. 1 c. 0.5 d. 0.05

5. For the reversible exothermic reaction, A←→B, a new catalyst is found that lowers the activation energy for the forward reaction by 60 kJ/mol. What is the best estimate of how much it lowers the activation energy for the reverse (endothermic) reaction?
   a. 0 kJ/mol b. 30 kJ/mol c. 60 kJ/mol d. 90 kJ/mol

6. For an endothermic reaction, which of the following type of operation will experience the smallest conversion?
   a. Adiabatic b. Isothermal
   c. Use of co-current heat exchanger d. Use of concurrent heat exchanger

7. Assuming equilibrium is always reached in the reactor, how can we increase the maximum achievable conversion for the reversible exothermic adiabatic reaction A←→B,
   a. Decrease concentration of an inert b. Increase the inlet temperature
   c. Use stoichiometric feed ratio d. Decrease inlet temperature

8. A catalytic reaction in a PBR is affected by mass transfer to the external surface of the catalyst particle. If the feed concentration is doubled, the rate of reaction will
   a. Remain the same
   b. Double
   c. Increase by less than a factor of two
   d. Increase by more than a factor of two

9. An adiabatic PFR reaches 70% conversion for the un-catalyzed reaction A→B. The same reaction reaches 70% conversion in an adiabatic catalytic reactor that is one tenth of the size. The catalyst significantly lowered the activation energy of the reaction and increased the reaction rate. The outlet temperature from the catalytic reactor is _____ from the non-catalytic reactor.
   a. Greater than
   b. Less than
   c. The same as
   d. Significantly greater than

10. For turbulent flow in a PBR, if the particle size of the catalyst doubles, the pressure drop will
   a. Not change
   b. Be smaller
   c. Be twice as large
   d. Be four times as large

11. 20 ideal CSTRs are in series. Each has an average residence time of 5 min. If a molecule enters the first CSTR at t=0, what is the most likely time it will exit the 20^{th} reactor?
   a. 5 min b. 30 min c. 100 min d. 200 min

12. For the reaction $N_2 + 3H_2 \rightarrow 2NH_3$ if the heat of formation of ammonia is -11 kcal/mol. What is the standard heat of reaction?
   a. -11 kcal/mol b. 11 kcal/mol c. -22 kcal/mol d. 22 kcal/mol

13. Determine the equilibrium conversion of a first order equilibrium reaction A←→R. The initial concentration of A is 0.182 mol/L and the equilibrium constant is 2.68.
   a. 0.52 b. 0.73 c. 0.82 d. 0.86

14. For the problem in question 13, what is the equilibrium concentration of A in mol/L?
   a. 0.049 b. 0.068 c. 0.133 d. 0.167

15. Pick the correct statement about Thiele modulus
   a. Measures the ratio of internal diffusion rate to external diffusion rate
   b. Measures the ratio of internal diffusion to surface reaction rate
   c. Measures the ratio of surface reaction rate to internal diffusion rate
   d. Measures the effect of catalyst particle diameter on the reaction rate

16. Pore tortuosity is defined as
   a. The ratio of actual distance a molecule travels between two points to the shortest distance between those two points
   b. The ratio of volume of void space to the volume of the particle
   c. Time it takes for the molecules to travel from point A to B inside a catalyst particle
   d. The ratio of surface reaction to external diffusion rate

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17. The Weisz-Prater and Mear's criterion help determine if
    a. Internal diffusion and mass transfer from bulk to catalyst surface is the rate limiting step
    b. Internal diffusion or catalytic surface reaction is the rate limiting step
    c. The catalytic reaction rate
    d. Helps measure the activation energy for a catalytic reaction mechanism.

18. The gas-phase reaction $A(g) \rightarrow 3B(g)$ obeys zeroth-order kinetics with r = 0.25 moles/liter·hr at 200 C. Gas constant R = 0.082 L·atm/mol·K. Starting with pure A at 1 atm, calculate the initial concentration of A.
    a. 0.0212 mol/L b. 0.0258 mol/L c. 0.000233 mol/cm^3 d. 0.000267 mol/cm^3

19. For a bioreaction following Michaelis- Menten kinetics, how would the rate of product formation change if the catalyst amount is halved?
    a. No change in rate
    b. The rate is halved
    c. The rate is doubled
    d. Insufficient information to calculate the rate

20. The conversion for an isothermal irreversible reaction in an ideal PFR will _____ with decrease in space time
    a. Decrease b. Increase
    c. Remain unchanged d. Decrease logarithmically