



**DEPARTMENT OF CHEMISTRY**  
**FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**  
**SECOND SEMESTER EXAMINATION 2020/2021 ACADEMIC**  
**SESSION**

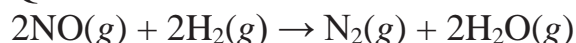
**COURSE CODE: CHM 322**

**COURSE UNIT: 2**

**COURSE TITLE: CHEMICAL KINETICS**

**INSTRUCTION: ANSWER ANY THREE QUESTIONS TIME: 2 hours**

Q1. The reaction of nitric oxide with hydrogen at 1280°C is



From the following data collected at this temperature, determine

- i. the rate law [4 marks]
- ii. the rate constant [2 marks]
- iii. the rate of the reaction when  $[\text{NO}] = 12.0 \times 10^{-3} \text{ M}$  and  $[\text{H}_2] = 6.0 \times 10^{-3} \text{ M}$ . [2 marks]

Experiment	[NO] (M)	[H <sub>2</sub> ]	Initial Rate (M/s)
1	$5.0 \times 10^{-3}$	$2.0 \times 10^{-3}$	$1.3 \times 10^{-5}$
2	$10.0 \times 10^{-3}$	$2.0 \times 10^{-3}$	$5.0 \times 10^{-5}$
3	$10.0 \times 10^{-3}$	$4.0 \times 10^{-3}$	$10.0 \times 10^{-5}$

1b. State four (4) limitations of Collision Theory [1 mark each]

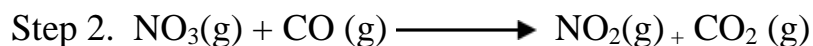
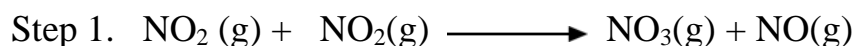
bii. List two (2) advantages of Transition theory over Collision Theory [1 mark each]

biii. Transition state theory attempts to relate the kinetic rates with thermodynamic properties of the transition state and reactants. Show that  $k = \frac{k_B T}{h} e^{-\frac{\Delta H^\ddagger}{RT}} e^{\frac{\Delta S^\ddagger}{R}}$

Q2. differentiate between Homogeneous and Heterogeneous chemical Reaction [3 marks]

2b. The following mechanisms have been proposed for the synthesis of NO<sub>2</sub> (g)

If the experimental rate =  $k_1[\text{NO}_2]^2$ :



- i. Write the equation for the overall reaction [1 mark]
  - ii. Identify the fastest reaction [1 mark]
  - iii. Which of the species in step 1 and 2 is/are intermediate molecule? [1 mark]
  - iv. What is the molecularity of step 1 and 2? [1 mark]
  - v. Identify the slowest reaction [1 mark]
  - vi. Identify the rate determining step [1 marks]
  - vii. Predict the rate law from the reaction mechanisms [2 marks]
  - viii. Comment on the order of the reaction in  $\text{NO}_2(\text{g})$  and  $\text{CO}(\text{g})$  [2 marks]
- c. with the aid of diagram differentiate between continuous flow and stopped flow method for the determination of fast reaction [7 marks]

**Q3.** State the assumption that necessitate the application of steady state approximation for the determination of rate law of a reaction [3 marks]

Given the following reaction



Equation 1

where  $k_1 = 0.2 \text{ M}^{-1}\text{s}^{-1}$ ,  $k_2 = 2000 \text{ s}^{-1}$

- i. State whether steady-state approximation can be applied to the reaction and why. [3 marks]
- ii. Write the rate equations for A, and B. [4 marks]
- iii. Give the expression for  $\frac{d[\text{C}]}{dt}$  using the Steady State Approximation [4 marks]

iv. Calculate  $\frac{d[C]}{dt}$  if  $[A] = 1M$  [3 marks]

v. Calculate  $[C]$  at  $t = 3 \text{ s}$  and  $[A]_0 = 2M$  [3 marks]

**Q4.** Study the following enzyme kinetics equation;



- i. What is the role of enzyme in the reaction? [3 marks]
- ii. Draw a labelled diagram showing the changes in concentration of all the species in the equation with time [7 marks]
- iii. Derive the rate law express given that  $k_2 \gg k_{-1}$  [10 marks]