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

$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

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 [NO] = 12.0 3 10^{-23} *M* and [H_2] = 6.0 3 10-^{23} *M*. **[2 marks]**

Experiment	[NO] (M)	[H_2]	Initial Rate (M/s)
1	5.0 x 10^{-3}	2.0 x 10^{-3}	1.3 x 10^{-5}
2	10.0 x 10^{-3}	2.0 x 10^{-3}	5.0 x 10^{-5}
3	10.0 x 10^{-3}	4.0 x 10^{-3}	10.0 x 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 $k = \frac{k_b T}{h} e - \frac{\Delta H^*}{RT} e\frac{\Delta S^*}{R}$

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

2b. The following mechanisms have been proposed for the synthesis of NO_2 (g)

If the experimental rate = $k_1[NO_2]^2$:

Step 1. NO_2 (g) + NO_2(g) ⟶ NO_3(g) + NO(g)

Step 2. NO_3(g) + CO (g) ⟶ NO_2(g) + CO_2 (g)

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 NO_2 (g) and CO (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

A à ^{k_1} B à ^{k_2} C

Equation 1

where k_1= 0.2 $M^{-1}s^{-1}$, k_2 = 2000 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 $\frac{d[C]}{dt}$ using the Steady State Approximation [**4 marks**]

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

v. Calculate [C] at t = 3 s and $[A]_0$ = 2M [**3 marks**]

Q4. Study the following enzyme kinetics equation;

$$E + S \underset{k-1}{\overset{k1}{\rightleftharpoons}} ES \xrightarrow{k2} E + P$$ Equation 2

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 $k_2 >>> k_1$ [10 **marks**]