



UNIVERSITY EXAMINATIONS FOR THE AWARD OF THE DEGREE OF  
BACHELOR OF EDUCATION  
2021/2022 ACADEMIC YEAR  
MAY SEMESTER 2022

UNIT CODE: LSCH 4105

UNIT TITLE: CHEMICAL KINETICS AND ELECTROCHEMISTRY

DATE: AUGUST 2022

TIME: 2 HOURS

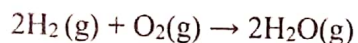
INSTRUCTIONS

1. Answer **question one** and **any other two** questions
2. Do not write anything on this question paper
3. Do not write in the page margins of the answer booklet
4. Begin each question answer on a new page

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**QUESTION 1 (COMPULSORY) (30 MARKS)**

- a) According to collision theory, what criteria is required before a bimolecular reaction can take place. (3 marks)
- b) Explain electrochemistry and state two importance of studying it as a chemist. (4 marks)
- c) Hydrogen gas has a non-polluting combustion product (water vapour).  $H_2$  is used as a fuel aboard the space shuttle and in earthbound cars with prototype engines:

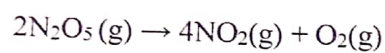


- i. Express the rate in terms of changes in  $[H_2]$ ,  $[O_2]$ , and  $[H_2O]$  with time. (2 marks)
  - ii. When  $[O_2]$  is decreasing at  $0.36 \text{ mol/L}\cdot\text{s}$ , at what rate is  $[H_2O]$  increasing? (2 marks)
- d) Differentiate between chemical kinetics and the reaction rate as used in chemical reactions. (4 marks)
  - e) Draw a potential energy diagram and explain how activation energy and reaction kinetics relate. (4 marks)

- f) Using cyclobutane as an example, show how unimolecular reactions occur and explain the process. (4 marks)
- g) Discuss the limitations of Lindemann mechanism as a theory. (4 marks)
- h) Explain the transition state theory. (3 marks)

### QUESTION TWO (20 MARKS)

- a) Consider the decomposition of  $N_2O_5$  to give  $NO_2$  and  $O_2$ :



Time (s)	Concentration (M)		
	$N_2O_5$	$NO_2$	$O_2$
0	0.0200	0	0
100	0.0169	0.0063	0.0016
200	0.0142	0.0115	0.0029
300	0.0120	0.0160	0.0040
400	0.0101	0.0197	0.0049
500	0.0086	0.0229	0.0057
600	0.0072	0.0256	0.0064
700	0.0061	0.0278	0.0070

reactants decrease with time
products increase with time

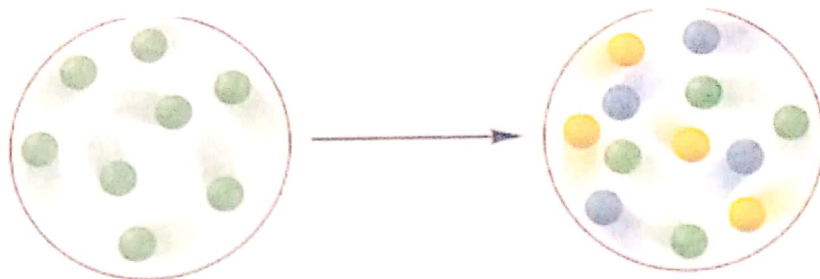
- (i) Draw a graph representing this reaction. (5 marks)
- (ii) Derive formula of the rate of reaction for the reaction. (2 marks)
- b) Briefly discuss the complex reactions in Kinetics. (8 marks)
- c) Calculate the standard Gibb's energy  $\Delta G^0$  for the reaction occurring in Daniell cell;  $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$  at 298 K. The  $E^0$  cell at this temperature is 1.1V. Is the reaction spontaneous? (5 marks)

### QUESTION 3 (20 MARKS)

- a) Discuss the theories of unimolecular reactions as used in explanation of the observed first order kinetics. (10 marks)
- b) Outline two advantages and disadvantages of a glass electrode. (8 marks)
- c) Explain why the products are not involved in a chemical reaction (2marks)

#### QUESTION 4 (20 MARKS)

- a) Clarify the applications of electrochemical series with appropriate examples. (8 marks)
- b) Substance A (green) decomposes to two other substances, B (blue) and C (yellow), in a first-order gaseous reaction. The molecular scenes below show a portion of the reaction mixture at two different times (0 sec and 30 sec):



- (i) Draw a similar molecular scene of the reaction mixture at  $t = 60.0$  s. (3 marks)
- (ii) Find the rate constant of the reaction. (2 marks)
- (iii) If the total pressure ( $P_{\text{total}}$ ) of the mixture is 5.00 atm at 90.0 s, what is the partial pressure of substance B ( $P_B$ )? (3 marks)
- c) Distinguish between reaction intermediates and transition states (activated complex) in chemical kinetics (4 marks)

#### QUESTION 5 (20 MARKS)

- a) The following reaction is a key reaction in the upper atmosphere:  
 $\text{O}_3(\text{g}) + \text{O}(\text{g}) \rightarrow 2\text{O}_2(\text{g})$  The  $E_a(\text{fwd})$  is 19 kJ, and the  $\Delta H_{\text{rxn}}$  for the reaction as written is -392 kJ. Draw a reaction energy diagram, predict a structure for the transition state, and calculate  $E_a(\text{rev})$ . (8 marks)
- b) Discuss the relaxation and electrophoretic effects in electrochemistry. (5 marks)
- c) Differentiate between primary and secondary cells. (7 marks)