National Open University of Nigeria
Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi - Abuja
Faculty of Science
SEPTEMBER 2020_1 EXAMINATION

COURSE CODE: CHM407
COURSE TITLE: REACTION KINETICS
CREDIT: 3 Units
TIME ALLOWED: 3 Hours
INSTRUCTION: Answer Question ONE (1) and any other FOUR (4) Questions
In all calculations R = 8.314 J/mol/K

Question 1 (22 MARKS)

(a) Highlight the special techniques used for measuring the constants of fast reactions. **(3 marks)**

(b) In the reaction: $BrO_3^-(aq) + Br^-(aq) + H^+(aq) \rightarrow Br_2(l) + H_2O(l)$ (equation unbalanced), If the rate with respect to bromate ions is $\frac{d[BrO_3^-]}{dt} = -10^{-3}$ mol $dm^{-3}s^{-1}$. What will be:

i. The rate with respect to Br^- ions, $\frac{d[Br^-]}{dt}$ **(2 marks)**

ii. The rate with respect to Br_2 molecules, $\frac{d[Br_2]}{dt}$ **(2 marks)**

(c) Explain briefly the collision theory of reaction rates. **(5 marks)**

(d) What do you understand by the following terms: (i) inhibition (ii) poisoning? **(5 marks)**

(e) The activation energy of the reaction A + B → Products is 103.3 kJ mol^{-1}. At 40 ^oC the products are formed with the rate constant of 0.133 M min^{-1}. What will be the rate constant of product formation at 80 ^oC? **(5 marks)**

Question 2 (12 MARKS)

(a) The decomposition of hydrogen peroxide is a first-order reaction. The half-life of the reaction is 17.0 minutes.

(i) What is the rate constant of the reaction? **(3 marks)**

(ii) For a bottle of H_2O_2, how long would it take for 86% to decompose? **(3 marks)**

(iii) The reaction is started with $[H_2O_2]$ = 0.1 M, what would be the hydrogen peroxide concentration after 15.0 minutes? **(3 marks)**

(b) State the units of the rate constants for zeroth order, first order and second order reactions. The rate of reaction is measured in M s^{-1} **(5 marks)**

Question 3 **(12 MARKS)**

(a) The saponification of methyl acetate using sodium hydroxide was studied at 298 K. The initial concentrations of the alkali and ester in the reaction mixture were both 1.00×10^{-2} M. The reaction rate was followed by titration of a definite volume of the reaction mixture with standard HC1. The concentrations of unreacted alkali, $[\ A\ ]_t$, at various time intervals are given below:

Time / s	240	550	720	1000	1550
$10^3\,[A]_t$/M	6.85	4.81	4.17	3.38	2.49

Calculate the second order rate constant **(7 marks)**

(b) Many reactions double their rates with every 10^o rise in temperature. Assume such a reaction to take place at about 300 K. What must its activation energy be for this statement to hold? **(5 marks)**

Question 4

(a) What are the basic assumptions of the Langmuir adsorption isotherm? **(4 marks)**

(b) Discuss briefly the modern methods of surface studies **(4 marks)**

(c) Describe briefly the mechanism of an enzyme-catalyzed reaction **(4 marks)**

Question 5

(a) The decomposition of hydrogen iodide on gold at 323K is zeroth order reaction and the rate constant is $1.20 \times l0^{-4}\ Ms^{-1}$

(i) If the initial concentration of hydrogen iodide is 0.500M, calculate its concentration after 3.00×10^3 s. **(3 marks)**

(ii) How long will it take for all of the hydrogen iodide to decompose? **(3 marks)**

(b) (i) What is a Clock reaction? **(1 mark)**

(ii) How would you use the Clock reaction to monitor the kinetics of the reaction: $2KI + K_2S_2O_8 \rightarrow 2K_2SO_4 + I_2$. **(5 marks)**

Question 6

(a) The light absorbed by a molecule is not always used up in producing a chemical reaction; the absorbed energy can be lost through various physical processes. With the aid of a Jablonski diagram, discuss briefly the fate of an electronically excited molecule. **(8 marks)**

(b) State any FOUR commercial applications of fluorescence. **(4 marks)**