NATIONAL OPEN UNIVERSITY OF NIGERIA
University Village, Nnamdi Azikiwe Expressway, Plot 91, Cadastral Zone, Jabi, Abuja
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

JANUARY/FEBRUARY 2017 EXAM

COURSE CODE: CHM 407
COURSE TITLE: Reaction Kinetics
COURSE UNIT: 3 units
TIME: 2 hours
INSTRUCTION: Answer *Question 1* and *any other three (3) questions*

1. (a) Define the term, ‘’molecularity ‘’of a reaction (2 marks)

(b) Given a reaction characterized by four consecutive steps, A, B., C and D and the time taken for the completion of the reaction are 10, 20, 30 and 40 minutes for steps A, B, C abd D respectively. Also, the number of molecules associated with the steps are 1,2 ,3 and 4 respectively. Use this explanation to answer the following questions,

(i) Define the term, rate determining step and state the step that is associated with your definition. Give reason for your answer (2 marks)

(ii) Calculate the molecularity of the reaction. Give reason for your answer (2 marks)

(c) What do you understand by the term rate law? (3 marks)

(d) What is the basic requirement for photochemical reactions? (2 marks)

(e) Kinetic data for the reaction, $Cl_2 + 2NO = 2NOCl$ are presented in the Table below. Answer the questions that follows

$[Cl_2]$ ^{o}/M	[NO] ^{o}/M	Initial rate/Ms^{-1}
0.10	0.10	3.0×10^{-3}
0.20	0.10	6.0×10^{-3}
0.20	0.20	2.4×10^{-2}

(i) Use the above information to calculate the order of the reaction (13 marks)

ii. Calculate the rate constant of the reaction (2 marks)

2. (a) A second order reaction may be a reaction involving only one reactant (for example, A). However, in some cases, two reactants (A and B) may be involved. Answer the following questions

i. Write a rate law for a second order reaction involving one reactant, A (2 marks)

ii. Write a rate law for a second order reaction involving two reactants (A and B) (2 marks)

(b) Given a second order reaction occurring according to the equation, A = Product, derive an integrated rate law for the reaction. Given that the initial concentration of the reactant is $[A]_0$ and the concentration after time, t is $[A]_t$. (6 marks)

(c) How can you prove graphically that a given reaction is a second order? (3 marks)

(d) Define the term, half life of a reaction (2 marks)

3. (a) Derive an integrated rate law for a first order reaction given that the concentration of the reactant changes from initial value of $[A]_0$ to $[A]_t$, after time, t. (6 marks)

(b) Show that the half life of a first order reaction is independent of the concentration of the reactant. (4 marks)

(c) Calculate the half life of a reaction that is first order with respect to the concentration of the reactant, given that the rate constant is 0.02 /s (3 marks)

(d) How can you show graphically that a given reaction is a first order reaction (2 marks)

4. (a) Given that a rate law for a reaction is expressed as, $R = k_n[A]^x[B]^y$,, answer the following questions

i. What is the order of the reaction with respect to the reactant, A (1 mark)

ii. What is the order of the reaction with respect to the reactant, B? (1 mark)

iii. Calculate the overall order of the reaction given that x = 2 and y = 1 (2 mark)

(b) A given reaction is second order with respect to the reactant, A. If the rate constant for the reaction is 0.001 /s and the rate of the reaction is 0.016 mol/s. Calculate the concentration of the reactant that was used in obtaining the rate law. (4 marks)

(c) Derive an expression for the half life of a second order reaction (4 marks)

(d) Calculate the half life of a second order reaction whose rate constant and initial concentration of reactant are 0.20 /s and 0.4 mol/dm^3 (3 marks)

5. (a) Given the reaction, $2N_2O_5 = 4NO_2 + O_2$, write an expression for the theoretical rate equation with respect to the reactant and the products. (3 marks)

(b) In writing theoretical rate equation in 'a' above, was it necessary to use positive and negative signs? If yes give reasons for the choice of the sign (2 marks)

(c) Derive an integrated rate law for a zero order reaction (5 marks)

(d) The decomposition of hydrogen iodide on gold at 323K is zeroth order reaction and the rate constant is $1.20 \times l0^{-4}$ M^{S-1} a). If the initial concentration of hydrogen iodide is 0.500M. Answer the following questions

i. calculate its concentration after 3.00 × 103s. (2 marks)

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