National Open University of Nigeria
Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi - Abuja
Faculty of Science
Department of Pure and Applied Science
2020_2 Examination

Course Code: CHM407
Course Title: Reaction Kinetics
Credit: 3 Units
Time Allowed: 3 Hours
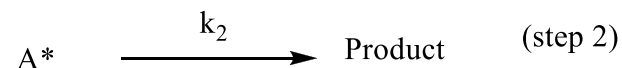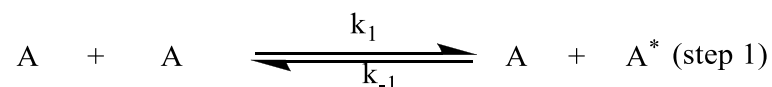**Instruction:** Answer Question ONE (1) and any other FOUR (4) Questions
In all calculations R = 8.314 J/mol/K

Question 1

1(a)   Highlight the basic features of a zero order reaction and justify why the decomposition of ammonia in the presence of tungsten is zero order   (2 marks)
(b)   Given that the initial concentration of the reactant is a_0 and concentration after time, t is a_t, derive from first principle, an integrated rate law for a zero order reaction   (7 marks)
(c) What is half life? Hence derive an expression for the half life of a zero order reaction
(4 marks)
(d) (i) What is rate law ?   (1 mark)
(ii) Given that a single reactant (A) gives a single product (P), write an expression for the rate law if the order of the reaction is second order. Hence identify all the terms in the equation
(5 marks)
(e)(i) What is activation energy ? Hence explain the effect of a catalyst on the activation energy
(3 marks)

Question 2

2(a)   Given that a reaction occurs through the steps shown below

$$A \ + \ A \quad \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} \quad A \ + \ A^* \ (step \ 1)$$

$$A^* \quad \xrightarrow{k_2} \quad Product \qquad (step \ 2)$$

Derive the Linderman mechanism and the law of mass action to derive expression for the integrated rate law   (6 marks)

(b)   Show the Linderman mechanism if $k_{-1}[A] \gg k_2$ and if $k_2 \gg k_{-1}[A]$ (4 marks)

(c)   Differentiate between unimolecular and bimolecular reaction   (2 marks)

Question 3

3. (a)   State the five steps involve in the mechanism of catalysis based on modern theory
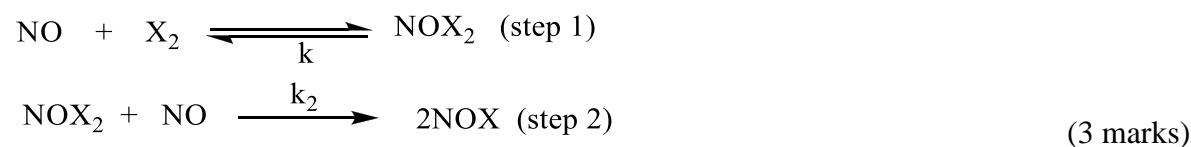
(5 marks)

(b)   Define the term, selectivity of a catalyst. Hence show that the reaction between CO and H$_2$ can yield different products depending on the catalyst   (4 marks)

(c)   Write a short note on the activity of a catalyst. Use the formation of water from hydrogen and oxygen to explain your answer   (3 marks)

Question 4

4a. With the aid of equations, highlight the mechanism for the photosynthesis reaction involving hydrogen and chlorine in the presence of sunlight to produce HCl Identify each steps in the equation and state the features   (7 marks)

(b)   With the aid of suitable equation, explain the process of photosynthesis in plant (2 marks)

(c)   Use suitable equations to show that photolysis of HBr is an example of photdissociation reaction   (3 marks)

Question 5

5 (a)   Show that the reaction 2NO + X$_2$ = 2NOX occurs through termolecular collision if the mechanism of the reaction is

$$NO \ + \ X_2 \ \underset{k}{\rightleftharpoons} \ NOX_2 \ (\text{step 1})$$

$$NOX_2 \ + \ NO \ \xrightarrow{k_2} \ 2NOX \ (\text{step 2})$$ (3 marks)

(b)   Can a molecularity of a reaction be zero or fractional or more than three? Give reason for your answer   (2 marks)

(c)(i)   Show that for the reaction; $A \rightarrow Product$, the integrated rate law is given as $\frac{1}{a_t} - \frac{1}{a_0} = k_2 t$ (4 marks)

(ii)   Derive and expression for the half life of a second order reaction.   (3 marks)

Question 6

6(a)   State the three theories of reaction, write equation for any other theory that relates rate constant and activation energy and explain how activation energy and pre-exponential constant can be obtained graphically to estimate activation energy.   (7 marks)

(b)   State two characteristics of complex reaction   (2 marks)

(c)   Highlight three methods that can be used to characterised chain reaction   (3 marks)