KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2009/2010

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE AND BACHELOR OF EDUCATION (SCIENCE)

SCH 305: CHEMICAL KINETICS

DATE: Tuesday, 29th December, 2009 TIME: 11.00 a.m. – 1.00 p.m.

INSTRUCTIONS:

Answer **ALL FOUR** questions.

Useful data:

$R = 8.314$ J mole $^{-1}$ K^{-1}

$0^oC = 273.15K$

Q.1. a) Write concisely to distinguish between *molecularity* and *order* of a chemical reaction. (4 marks)

b) Derive the kinetic equation for a second order reaction, in a single substance, and show the half-life as a function of the initial reactant concentration. (6 marks)

c) In the decomposition of gaseous ethanal at 518^oC, the time taken to decompose half the material was found to be 410 sec, when the initial pressure was 363 mmHg and 880 sec for the initial pressure of 169 mmHg. Work out the apparent order of the reaction. (5 marks)

d) Account for the effect of temperature on the rate of a chemical reaction. (4 marks)

Q.2 a) Explain, using a suitable example, the essential features of a chain reaction. (6 marks)

b) The decomposition of nitrogen (IV) oxide, according to the equation:

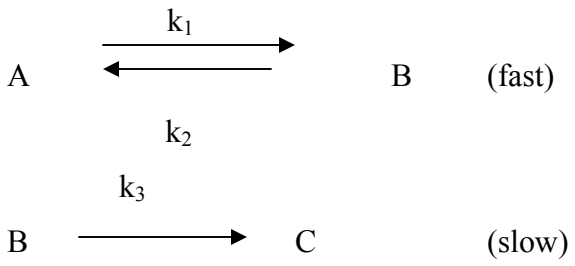
$$2NO_{2(g)} \rightarrow 2NO_{(g)} + O_{2(g)} ,$$

obeys second order kinetics. The following table gives the specific reaction rate constant, *k*, at four temperatures:

T, K	592	603.2	627	651.5
$k(mol^{-1}ls^{-1})$	0.522	0.755	1.70	4.020

Determine, graphically, the value of the activation energy of the reaction. (8 marks)

c) With the aid of the stationary-state concept, derive the rate law for the following mechanism:



(4 marks)

Q.3 a) The hydrolysis of methyl acetate (in the presence of dilute hydrochloric acid as a catalyst) shows first order kinetics and is represented thus:

$$CH_3COOCH_3 + H_2O \xrightarrow{H^+} CH_3COOOld + CH_3OH.$$

The reaction is followed by titrating constant volumes of the reaction mixture with standard sodium hydroxide. The following data were obtained:

t, sec	Titre, cm^3
0	24.36
1200	25.85
4500	29.32
7140	31.72
∞	47.15

Determine the value of the specific rate constant through a graphical method. (10 marks)

b) The rate equation for a reaction of *nth* order in substance A is represented thus:

$$-\frac{d}{dt}[A]=K[A]^n$$

Show that the half-life is given by:

$Ln\ t_{½} = Ln\left(\frac{2^{n-1}-1}{k(n-1)}\right) - (n–1)Ln\ A_o$, where A_o is the initial molar concentration of substances A. (7 marks)

Q.4 a) Write concisely on the kinetics of heterogeneous unimolecular gas reactions at low and high pressures. (8 marks)

b) Give the Arrhenius kinetic equation and explain two ways in which this equation may be used to determine the activation energy of a chemical reaction. (8 marks)