University of Eswatini

Department Of Chemistry

November 2018 Re-Sit Examination

TITLE OF PAPER : **Transport and Chemical Kinetics**

COURSE NUMBER : **CHE 341**

TIME : **3 Hours**

Important Information : Each question is equivalent to **25%** of the entire exam.

: Answer **questions one (1)** and any other three **(3)** questions in this paper.

: Marks for **ALL** procedural calculations will be awarded.

: Start each question on a fresh page of the answer sheet.

: Diagrams must be large and clearly labelled accordingly.

: Additional material: data sheet, graph paper and the periodic table.

You are not supposed to open this paper until permission has been granted by the Chief Invigilator

Question 1 [25 Marks]

a) The conductance of KI at 25° in a solvent mixture of water and ethylene carbonate was measured and the following data was obtained:

c (mmol/dm^3)	17.68	10.88	7.19	2.67	1.28	0.83	0.19
Am (S cm^2 mol^{-1})	42.45	45.91	47.53	51.81	54.09	55.78	57.42

i. Show that this data confirms that KI is a strong electrolyte [9]

ii. Find the limiting molar conductivity. [4]

b) For the perchlorate ion in water at 25°C, λ_m°=67.2 S cm^2 mol^{-1}. Calculate the following;

i. The mobility u of ClO4- in water, [4]

ii. The drift speed of ClO4- in water in a field of 24 V/cm [3]

c) With an aid of a diagram, describe Newtonian flow. [5]

Question 2 [25 marks]

Given that cyclobutane decomposes by first order kinetics at 438°C at constant volume and the decomposition is given by;

$$C_4H_8(g) \rightarrow 2C_2H_4(g)$$

a) Express the rate of reaction in terms of the change in total pressure as a function of time. [3]

b) The rate constant of the reaction is 2.48 x 10^{-4} s^{-1} calculate the half-life of the reaction. [5]

c) After initiation of the reaction, how long will it take for the initial pressure of C_4H_8 to drop to 90% of its initial value? [6]

d) If the rate constant for a reaction is 2.45 x10^{-4} M^{-1} s^{-1} at 302°C and 0.950 M^{-1} s^{-1} at 508 °C and given that the reaction follows Arrhenius type of kinetics, calculate

i. The Arrhenius parameters E_a and A. [7]

ii. The rate constant at 400°C. [4]

Question 3 [25 Marks]

a) With an aid of a diagram, describe Newtonian flow. [5]

b) An enzyme catalysed reaction conversion of a substance at 25°C has Michaelis constant of 0.042 mol L^{-1}. The rate of reaction is 2.45 x 10-4 mol L^{-1} s^{-1} when the substrate concentration is 0.89 mol L^{-1}. What is the maximum velocity of this enzmolysis [5]

c) Discuss the features, advantages and limitations of the Michaelis – Menten mechanism of enzyme action [5]

d) Compute the root mean square speed, the mean speed and the relative mean speed for CO_2 at 300K. [10]

Question 4 [25 Marks]

a) Derive the pressure of the perfect gas according to the kinetic model. [10]

b) Write short notes on the Maxwell-Boltzman's distribution. [10]

c) What is the difference between a strong electrolyte and a weak electrolyte? Give examples of each. [5]

Question 5 [25 Marks]

a) Calculate the mean free path of argon at 0.5 atm [5]

b) List the three assumptions of the Kinetic model [3]

c) Calculate the diffusion constant of Nitrogen at 25°C and

i. 10.0 kPa, [4]

ii. 100 kPa [2]

d) Given the following; $\lambda_m^0\,(KCl)$ = 0.0149 Sm^2mol^{-1}, $\lambda_m^0\,(NaCl)$ = 0.0127 and $\lambda_m^0\,(KNO_3)$ = 0.0145, determine the conductivity of $NaNO_3$ at infinite dilution. [5]

e) Derive the Ostwald dilution law for a weak electrolyte [6]

Question 6 [25 Marks]

a) Write short notes on the following;

(i) Limiting molar conductivity. [3]

(ii) Collision frequency. [4]

(iii)Half-life. [3]

b) Discuss one way of measuring transport numbers. [7]

c) Write short notes on the two major classes of polymerization kinetics. [8]

The End

THE PERIODIC TABLE OF ELEMENTS

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
Period 1	1 H 1.008																	2 He 4.002
2	3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31											13 Al 26.9	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.01	25 Mn 54.9	26 Fe 55.85	27 Co 58.71	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.7	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 91.22	42 Mo 95.94	43 Tc 98.9	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	71 Lu 174.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 196.9	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 208.9	84 Po 210	85 At 210	86 Rn 222
7	87 Fr 223	88 Ra 226.0	103 Lr 257	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une									

NON-METALS

METALLOIDS

METALS

Lanthanides	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 146.9	62 Sm 150.9	63 Eu 151.3	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0
Actinides	89 Ac 227.0	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu 239.1	95 Am 241.1	96 Cm 247.1	97 Bk 249.1	98 Cf 251.1	99 Es 254.1	100 Fm 257.1	101 Md 258.1	102 No 255

*Numbers **below** the symbol indicates the **atomic masses**; and the numbers above the symbol indicates the atomic numbers.*

SOURCE: International Union of Pure and Applied Chemistry, I mills, ed., Quantities, Units, and symbols in Physical Chemistry, Blackwell Scientific publications, Boston, 1988, pp 86-98.