



**EMBU UNIVERSITY COLLEGE**  
**(A Constituent College of the University of Nairobi)**

2015/2016 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE  
BACHELOR OF SCIENCE (BIOLOGY), BACHELOR OF SCIENCE (ANALYTICAL  
CHEMISTRY) BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY), BACHELOR  
OF EDUCATION (SCIENCE) AND BACHELOR OF SCIENCE (ENVIRONMENTAL  
CONSERVATION AND NATURAL RESOURCES MANAGEMENT)

SCH 103: GENERAL AND PHYSICAL CHEMISTRY

DATE: APRIL 11, 2016

TIME: 02:00-04:00

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions

Importance information:  $R = 8.314 \text{ Jk}^{-1} = 0.0821 \text{ Latmmol}^{-1}\text{k}^{-1}$

$1 \text{ atm} = 101325 \text{ NM}^{-2} = 101325 \text{ Pa} = 760 \text{ mmHg}$

QUESTION ONE

a) State the following:

i) Boyle's law (2 Marks)

ii) Raoult's law (2 Marks)

b) Explain the terms acid and bases according to Arrhenius and Bronsted-Lowry concepts (4 Marks)

- c) The volume of a gas at 2 atmosphere pressure is  $399 \text{ cm}^3$  at  $5^\circ\text{C}$ . Calculate the volume that the gas will occupy if the pressure is increased to 2.5 atmospheres at the same temperature. (3 Marks)
- d) If it takes 30seconds for  $100\text{cm}^3$  of carbon (IV) oxide to diffuse across a porous plate. How long will it take for  $200 \text{ cm}^3$  of nitrogen (IV) oxide to diffuse across the same plate under similar condition? (C=12.0, N=14.0, O=16.0). (3 Marks)
- e) The solubility of AgCl is  $1.67 \times 10^{-5}$  moles per litre at  $25^\circ\text{C}$ . Calculate the solubility product of AgCl. (3 Marks)
- f) At  $88^\circ\text{C}$  the saturated vapour pressure of benzene and toluene are 953 and 378 mmHg respectively. Calculate the vapour pressure of a benzene-toluene mixture containing 2 mol of benzene per mole of toluene, assuming that Raoult's law is obeyed. (3 Marks)
- g) Write the equilibrium expression for  $K_c$  and  $K_p$  for the following reaction. (4 Marks)
- $$\text{CO}_{2(g)} + \text{H}_{2(g)} \rightleftharpoons \text{H}_2\text{O}_{(l)} + \text{CO}_{(g)}$$
- h) consider the reaction given below;
- $$2\text{SO}_{3(g)} \rightleftharpoons 2\text{SO}_{2(g)} + \text{O}_2$$
- At temperature of 1000 K,  $K_C$  has the value  $4.07 \times 10^{-3}$ . Calculate the value for  $K_p$ . (3 Marks)
- i) State the factors that influence equilibrium concentrations (3 Marks)

## QUESTION TWO

- a) Consider the following electrochemical cell whose  $E^0$  of the cell is 1.10V.
- $$\text{Zn} / \text{ZnSO}_4(1.0 \times 10^{-5} \text{ M}) // \text{CuSO}_4(0.010 \text{ M}) / \text{Cu}$$
- i) Draw the cell diagram (6 Marks)
- ii) Write cathode and anode reactions of the cell (4 Marks)
- iii) Calculate the emf of the cell given that the standard emf of the cell is 1.10V (4 Marks)

b) Explain THREE applications of electrolysis

(6 Marks)

### QUESTION THREE

a) A chemistry student conducted an experiment given below and obtained the data given in the



Experiment	$[\text{N}_2\text{O}]$ (M)	$[\text{O}_2]$ (M)	Initial rate (M/min)
A	0.0100	0.0100	0.00600
B	0.0200	0.0300	0.14400
C	0.0100	0.0200	0.01200

Use the table to;

i) Determine the order of the reaction with respect to  $\text{O}_2$  (3 Marks)

ii) Determine the order of the reaction with respect to  $\text{N}_2\text{O}$  (3 Marks).

iii) Write the rate law (1 Mark)

iv) Calculate the rate constant of the reaction (3 Marks)

b) i) Derive the integrated rate law for the first order reaction.

(6 Marks)

ii) The decomposition of  $\text{N}_2\text{O}_5$  to  $\text{NO}_2$  and  $\text{O}_2$  is a first order reaction.  $K = 4.80 \times 10^{-4}/\text{sec}$  at  $45^\circ\text{C}$ . Initial concentration is  $1.65 \times 10^{-2} \text{ mol/l}$ . Calculate the concentration of  $\text{N}_2\text{O}_5$  after 825 seconds. (4 Marks)

### QUESTION FOUR

a) Derive the ideal gas equation  $PV/T=nR$  (7 Marks)

b) Explain why real gases do not obey the ideal gas equation (3 Marks)

c) Calculate the total pressure of the mixture of gases at the same temperature given that 100 ml of oxygen at 1.75 atmospheres and 200 ml nitrogen at 0.6 atmospheres are passed into a vessel whose capacity is 500 ml. (4 Marks)

d) Calculate the pressure for  $1.0 \text{ dm}^3$  of 5.0 moles  $\text{CO}_2$  at 273 K, using

i) The ideal gas law (3 Marks)

ii) The van der waals equation ( $a=6.58 \text{ latm/mol}^2$ ,  $b= 0.056 \text{ l/mol}$ ) (3 Marks)

**QUESTION FIVE**

- a) i) Derive the Henderson-Hasselbach equation (7 Marks)
- ii) A buffer solution was made by adding 3.2gm of sodium ethanoate to  $1\text{dm}^3$  of 0.01M ethanoic acid. What will be the pH of the buffer? ( $K_a(\text{CH}_3\text{COOH}) = 1.7 \times 10^{-5} \text{ moldm}^{-3}$ ) (3 Marks)
- b) Determine the pH of the solutions below;
- i) 0.0002M solution of  $\text{H}_2\text{SO}_4$  (3 Marks)
- ii) Calculate the pH of 0.1M ammonia solution given  $K_b$  to be  $1.75 \times 10^{-5} \text{ M}$ . (5 Marks)
- c) Write a chemical equation and equilibrium expression for auto ionization of water (2 Marks)

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