



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION (SCIENCE)
1ST YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR
MAIN

COURSE CODE: SCH 101/3111

COURSE TITLE: BASIC PHYSICAL CHEMISTRY

EXAM VENUE: LAB 3

STREAM: (BEd Science)

DATE: 23/04/14

EXAM SESSION: 2.00 – 4.00 PM

TIME: 2.00 HOURS

Instructions:

- 1. Answer ALL Questions in section A and ANY other 2 questions in section B**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Constants:

**Gas Constant, R = 8.314 J/mol.K,
=0.082057 L.atm/mol.K**

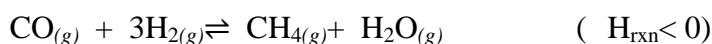
$N_A = 6.022 \times 10^{23}$ molecules/ mol

At room temperature and pressure (RTP), T = 25°C, P = 1atm

SECTION A (30 Marks)

Question 1

- a) Distinguish between each of the following terms;
- Solubility and Colligative property (3mks)
 - Osmotic pressure equilibrium state (3mks)
 - Buffer solution and salts with acidic solutions (3mks)
 - Dalton's law partial pressures and Raoult's law (3mks)
 - Rate law and Reaction order (2mks)
- b) Give two assumptions made when considering a gas to be Ideal. (2mks)
- c) For the reaction;



What is the effect of?

- Increasing the volume of the reaction vessel (1mark)
 - Carrying out the reaction at lower temperature (1mark)
 - Introducing an inert gas into the reaction mixture (1mark)
 - Introducing a catalyst into the reaction vessel (1mark)
 - Separating the water by removing the condensed vapour (1mark)
- d) Consider the reaction; $4\text{NO}_{2(g)} + \text{O}_{2(g)} \rightarrow 2\text{N}_2\text{O}_{5(g)}$, suppose that, at a particular moment during the reaction, molecular oxygen is reacting at the rate of 0.024 M/s. Calculate the rate of formation of N_2O_5 and the rate of depletion of NO_2 . (3mks)
- e) Using Kinetic Theory, explain the deviation of real gas behaviour from the Ideal gas behaviour at high pressures. (3mks)
- f) The solubility of nitrogen gas at 25°C and 1 atm is 6.8×10^{-4} mol/L. What is the concentration (in molarity) of nitrogen dissolved in water under atmospheric conditions? (The partial pressure of nitrogen gas in the atmosphere is 0.78 atm.) (3mks)

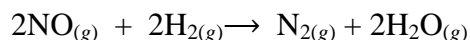
SCTION B (20 Marks Each)

Question 2

- a) Give the meaning of an acid and a base according to Bronsted-Lowry theory. (2mks)
- b) Benzene and toluene form a nearly ideal solution. If at 300K the partial pressure of pure toluene is 32mmHg and that of pure benzene is 103mmHg.
- Compute the vapour pressure of the solution containing 0.6mol fraction of toluene. (2 mks)
 - Calculate the mole fraction of toluene in the vapour for this composition of liquid. (3 mks)
 -
 - Represent this information in a well labelled pressure composition diagram of the binary mixture of benzene and toluene. (3 mks)
- c) Using Kinetic Theory of gases derive the ideal gas equation. (8mks)
- d) The pH of blood must be held very close to 7.40, find the OH⁻ concentrations corresponding to this pH. (2mks)

Question 3

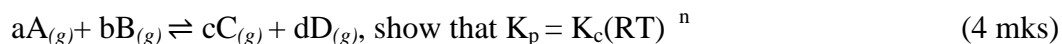
- a) The reaction of nitric oxide with hydrogen at 1280°C is given by the equation,



Experiment	[NO] (M)	[H ₂] (M)	Initial Rate (M/s)
1	5.0×10^{-3}	2.0×10^{-3}	1.3×10^{-5}
2	10.0×10^{-3}	2.0×10^{-3}	5.0×10^{-5}
3	10.0×10^{-3}	4.0×10^{-3}	10.0×10^{-5}

From the above data collected at this temperature, determine;

- the rate law, (3mks)
 - the rate constant, and (2mks)
 - the rate of the reaction when [NO] = 12.0×10^{-3} M and [H₂] = 6.0×10^{-3} M. (2mks)
- b) Oxygen gas generated by the decomposition of potassium chlorate is collected over water. The volume of oxygen collected at 24°C and atmospheric pressure of 762 mmHg is 128 mL. Calculate the mass (in grams) of oxygen gas obtained. The pressure of the water vapor at 24°C is 22.4 mmHg. (3mks)
- c) Given the following equilibrium reaction:



Under what conditions is $K_p = K_c$, give an example of a reaction where $K_p = K_c$.

(2 mks)

- d) A solution is prepared by dissolving 35.0g of haemoglobin, Hb, in enough water to make up 1L volume. If the osmotic pressure of the solution is found to be 10.00mmHg at 25°C, calculate the molar mass of haemoglobin. (4 mks)

Question 4

- a) Which reactant is limiting when 50.0 g of water is added to 50.0 g of calcium carbide, $CaC_2(s)$? What mass of acetylene, $C_2H_2(g)$, is produced, and what mass of excess reactant will be left? Reaction equation:

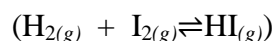


If 18.5g of C_2H_2 was actually obtained, what was the percentage yield? (4 mks)

- b) Calculate the pH of a buffer solution comprising of 0.10M HNO_2 and 0.15M $NaNO_2$. Given K_a of $HNO_2 = 4.5 \times 10^{-4}$

(6mks)

- c) For a mixture of 0.00623M of H_2 , 0.00414M of I_2 and 0.0224M HI in 1.0L flask at 430°C;



- What will be the direction of the reaction at the start of the reaction? (3 mks)
- Calculate the equilibrium concentration of H_2 , I_2 and HI given that K_c for this reaction is 54.3 at 430°C. (7 mks)

Question 5

- a) Given that 3.50 moles of NH_3 occupy 5.20 L at 47°C, calculate the pressure of the gas (in atm) using the van der Waals equation. ($a = 4.17 \text{ atm}\cdot\text{L}^2/\text{mol}^2$, $b = 0.0371 \text{ L/mol}$)

(3 mks)

- b) Briefly explain two factors affecting solubility of gases.

(4 mks)

- c) Ethylene glycol (EG), $CH_2(OH)CH_2(OH)$, is a common automobile antifreeze. It is water-soluble and fairly non-volatile ($T_b = 197^\circ\text{C}$). Calculate the freezing point of a solution containing 651 g of this substance in 2505 g of water. $K_f = 1.86^\circ\text{C/m}$. (3 mks)

- d) Calculate the pH of 0.20M NH_4Br salt solution? K_a for $NH_4^+ = 5.6 \times 10^{-10}$ (6 mks)

- e) A flammable gas made up only of carbon and hydrogen is found to effuse through a porous barrier in 1.50 min. Under the same conditions of temperature and pressure, it takes an equal volume of bromine vapor 4.73 min to effuse through the same barrier. Calculate the molar mass of the unknown gas, and suggest what this gas might be.

(4mks)

******End******

Period	MAIN-GROUP ELEMENTS		TRANSITION ELEMENTS										INNER TRANSITION ELEMENTS									
	1A (1)	2A (2)	3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8)	8B (9)	8B (10)	1B (11)	2B (12)	3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	8A (18)				
1	1 H 1.008												5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18				
2	3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95				
3	11 Na 22.99	12 Mg 24.31											31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80				
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3				
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)				
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	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	71 Lu 175.0					
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)					

- Metals (main-group)
- Metals (transition)
- Metals (inner transition)
- Metalloids
- Nonmetals