



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECU 102: CHEMISTRY FOR ENGINEERS II

DATE: 14/5/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) State three assumptions of kinetic theory of matter. (3 marks)
- b) State the function of a salt bridge in an electrochemical cell. (2 marks)
- c) Calculate the temperature to which a 678-mL sample of gas at 0°C must be heated at constant pressure for the volume to change to 0.896 L. (3 marks)
- d) State the Henry's law. (2 marks)
- e) A mixture of gases contains 4.46 moles of neon (Ne), 0.74 mole of argon (Ar), and 2.1 moles of xenon (Xe). Calculate the partial pressures of the gases if the total pressure is 2.00 atm at a certain temperature. (3 marks)
- f) State and explain three characteristics of chemical equilibrium. (3 marks)

- g) The vapor pressure of ethyl alcohol at a certain temperature is 79.3 torr. Calculate the vapor pressure of the ethyl alcohol in solution at that temperature if 0.175 moles of glucose is dissolved in 0.909 moles of the alcohol. (3 marks)
- h) State Raoult's law (2 marks)
- i) The solubility of pure nitrogen gas in water at 25°C and 1 Atmospheric pressure is 6.8×10^{-4} mol/L. The partial pressure of nitrogen gas in the atmosphere is 0.78 atmospheres. What is the concentration of nitrogen dissolved in water under these atmospheric conditions? (3 marks)
- j) Explain how a weak base and its conjugate acid form a buffer solution. (3 marks)
- k) The decomposition of ethane C_2H_6 to methyl radicals is a first order reaction with a rate constant of $5.36 \times 10^{-4} s^{-1}$ at 700°C. Calculate the half-life of the reaction in minutes (3 marks)

QUESTION TWO (20 MARKS)

- a) State the Le Chatelier's principle (2 marks)
- b) Consider the following equilibrium process

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$
 State and explain the direction of equilibrium shift of when
- More chlorine gas is added to reaction mixture (2 marks)
 - Pressure of the gas is increased (2 marks)
 - Catalyst is added to the reaction mixture (2 marks)
- c) The equilibrium constant K_p for the decomposition of phosphorus pentachloride to phosphorus trichloride and molecular chlorine $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ is 1.05 at 250°C. If the equilibrium partial pressures of PCl_5 and PCl_3 are 0.875 atm and 0.463 atm respectively, what is the equilibrium partial pressure of chlorine at the same temperature? (5 marks)
- d) At 25°C, vapor pressure of pure water is 23.76 mmHg and that of aqueous urea solution is 22.98 mmHg. Estimate the molality of the solution. (R.F.M $H_2O = 18.02$) (7 marks)

QUESTION THREE (20 MARKS)

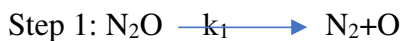
- a) Given that 3.50 moles of NH_3 occupy 5.20 L at 47°C , calculate the pressure of the gas (in atmosphere) using
- The ideal gas equation (3 marks)
 - The van der Waals equation given $a=4.17 \text{ atm} \cdot \text{L}^2/\text{mol}^2$ and $b=0.0371 \text{ L/mol}$ (4 marks)
- b) For the following reaction at a certain high temperature,
- $$\text{CO}_{(g)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{CO}_{2(g)} + \text{H}_{2(g)}$$
- The concentration in a mixture are $\text{CO}_{(g)}=0.0600 \text{ mol/L}$; $\text{H}_2\text{O}_{(g)}=0.120 \text{ mol/L}$; $\text{CO}_{2(g)}=0.150 \text{ mol/L}$; and $\text{H}_2(g)=0.300 \text{ mol/L}$. Calculate the value of the equilibrium constant at this temperature (5 marks)
- c) A 1.45L sample of gas has a pressure of 0.950 atm. Calculate the volume after its pressure is increased to 787 torr at constant temperature (4 marks)
- d) Write expressions of K_c and K_p where applicable for the following reversible reactions at equilibrium (4 marks)
- $\text{HF}_{(aq)} + \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_3\text{O}^+_{aq} + \text{F}^-_{aq}$
 - $\text{CH}_3\text{COOH}_{(aq)} + \text{C}_2\text{H}_5\text{OH}_{(aq)} \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5_{(aq)} + \text{H}_2\text{O}_{(l)}$

QUESTION FOUR (20 MARKS)

- a) A galvanic cell consists of a Mg electrode in a 1.0M $\text{Mg}(\text{NO}_3)_2$ solution and an Ag electrode in a 1.0M AgNO_3 solution. Calculate the standard EMF of this electrochemical cell at 25°C . given
- $$\text{Mg}^{2+} + 2e^- \longrightarrow \text{Mg} \quad E^\circ = -2.37\text{V}$$
- $$\text{Ag}^+ + e^- \longrightarrow \text{Ag} \quad E^\circ = 0.80\text{V}$$
- (5 marks)
- b) Sulfur hexafluoride (SF_6) is a colorless, odorless, very unreactive gas. Calculate the pressure (in atmosphere) exerted by 1.82 moles of the gas in a steel vessel of volume 5.43L at 69.5°C . (5 marks)
- c) A solution containing 1.66g of non-ionic solute in 171g of water freezes at -0.602°C . Calculate the molar mass of the solute. (6 marks)
- d) Calculate the pH of a solution that is $6.9 \times 10^{-2} \text{ M}$ in $\text{NaOH}/\text{l},/\text{l}$. (4 marks)

QUESTION FIVE (20 MARKS)

- a) The gas-phase decomposition of nitrous oxide N_2O is believed to occur via two elementary steps.



Experimentally the rate law is found to be, $\text{rate} = k[\text{N}_2\text{O}]$

- i. Write the equation for the overall reaction. (2 marks)
 - ii. Identify the intermediates. (2 marks)
 - iii. Compare the relative rates of steps 1 and 2? (3 marks)
- b) A small bubble rises from the bottom of a lake, where the temperature and pressure are 8°C and 6.4 atm, to the water's surface, where the temperature is 25°C and pressure is 1.0 atm. Calculate the final volume (in mL) of the bubble if its initial volume is 2.1 mL. (5 marks)
- c) The solubility of CuBr is $2.0 \times 10^{-4} \text{ mol/L}$ at 25°C . Calculate the K_{sp} value of CuBr (5 marks)
- d) By giving suitable examples differentiate between a weak and strong electrolyte (3 marks)