



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

BACHELOR OF SCIENCE (TELECOMMUNICATION)

SCU 102:CHEMISTRY FOR ENGINEERS II

DATE: 2/8/2019

TIME: 8:30 – 10:30 AM

INSTRUCTIONS:

1. Question number one is **compulsory**
2. Choose any other two questions.
3. Use of sketches and brief illustrations where necessary

Useful constants

$R=8.314\text{J/mol K}$ or $R=0.08206\text{L.atm/mol K}$

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Why is the vapor pressure of a solution less than that of pure solvents (3 marks)
- b) Calculate the volume of a sample of gas originally occupying 908 mL at 717 torr and 20°C after its temperature and pressure are changed to 72°C and 1.07 atm (3 marks)
- c) State the law of mass action (2 marks)
- d) By giving suitable examples differentiate between a weak and strong electrolyte (3 marks)
- e) Calculate the pH of a solution that is $6.9 \times 10^{-2}\text{M}$ in NaOH (3 marks)
- f) State the Le Chatelier's principle (2 marks)

- g) Predict what will happen when molecular bromine is added to a solution containing sodium iodine at room temperature (3 marks)
- h) State the function of a salt bridge (2 marks)
- i) Explain how a weak base and its conjugate acid form a buffer solution (3 marks)
- j) State three assumptions of kinetic theory of matter (3 marks)
- k) State three characteristics of chemical equilibrium (3 marks)

QUESTION TWO (20 MARKS)

- a) 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 mol of glucose is dissolved in 0.909 mol of the alcohol (5 marks)
- b) A galvanic cell consists of a Mg electrode in a 1.0M Mg (NO₃)₂ solution and an Ag electrode in a 1.0M AgNO₃ solution. Calculate the E of this electrochemical cell at 25°C (5 marks)
- c) Calculate the osmotic pressure of a 0.015M solution of glucose C₆H₁₂O₆ in water at 25°C use R=0.0821L.atm/mol.k⁻¹ (5 marks)
- d) Sulfur hexafluoride (SF₆) 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)

QUESTION THREE (20 MARKS)

- a) At 25°C vapour pressure of pure water is 23.76mmHg and that of aqueous urea solution is 22.98mmHg. Estimate the molality of the solution. (7 marks)
- b) 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)
- c) Write expressions of K_c and K_p where applicable for the following reversible reactions at equilibrium (4 marks)
 - i) $\text{HF}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \rightleftharpoons \text{H}_3\text{O}^+_{\text{aq}} + \text{F}^-_{\text{aq}}$
 - ii) $\text{CH}_3\text{COOH}_{(\text{aq})} + \text{C}_2\text{H}_5\text{OH}_{(\text{aq})} \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5_{(\text{aq})} + \text{H}_2\text{O}_{\text{l}}$
- d) A mixture of gases contains 4.46 moles of neon (Ne), 0.74 mole of argon (Ar), and 2.15 moles of xenon (Xe). Calculate the partial pressures of the gases if the total pressure is 2.00 atmosphere at a certain temperature (5 marks)

QUESTION FOUR (20 MARKS)

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

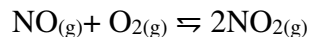


Experimentally the rate law is found to be, $\text{rate} = k[\text{N}_2\text{O}]$

- Write the equation for the overall reaction (2 marks)
 - Identify the intermediates (2 marks)
 - What can you say about 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 atmosphere, 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. (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)

QUESTION FIVE (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 and (3 marks)
 - the van der Waals equation given $a = 4.17 \text{ atm} \cdot \text{L}^2/\text{mol}^2$ and $b = 0.0371 \text{ L/mol}$ (7 marks)
- b) The following equilibrium process has been studied at 230°C



In one experiment the concentration of the reacting species at equilibrium are found to be $[\text{NO}] = 0.0542 \text{ M}$, $[\text{O}_2] = 0.127 \text{ M}$ and $[\text{NO}_2] = 15.5 \text{ M}$. Calculate the equilibrium constant K_c of the reaction at this temperature and predict whether at equilibrium there will be more products or reactants. (7 marks)

- c) State Raoult's law (3 marks)