



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL, PHYSICAL, MATHEMATICS AND ACTUARIAL
SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION SCIENCE/BSc BIOLOGICAL SCIENCE

1ST YEAR 1ST SEMESTER 2022/2023

REGULAR, MAIN CAMPUS

COURSE CODE: SPB 9101

COURSE TITLE: PHYSICAL CHEMISTRY/BASIC CHEMISTRY 1

EXAM VENUE:

STREAM: BED SCI/BSC BIO

DATE:

EXAM SESSION:

TIME: 2:00 HRS

Instructions:

- 1. Answer question 1 (Compulsory) 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**

Useful data

R= 0.0821 L atm. K⁻¹mol⁻¹

Molar mass N = 14 g.mol⁻¹

Molar mass O = 16 g.mol⁻¹

Molar mass C = 12 g.mol⁻¹

Molar mass H = 1.01 g.mol⁻¹

Molar mass of He = 4 g.mol⁻¹

INSTRUCTIONS: Answer Question 1 and any other TWO questions

QUESTION ONE (30 marks)

- Write the equilibrium constant expression for a simple gas phase isomerization reaction involving the conversion of cis-2-butene to trans-2-butene (2 marks)
- Derive the Van der Waal's equation and explain its significance (4 marks)
- If the volume of a sample of helium is 0.0227 M³ at 273 K and 1.00 x 10⁵ Pa, what is its volume at 293K and 1.04 x 10⁵ Pa (4 marks)
- 50g (0.146 mole) of solute sugar is placed in 117 g (6.5 mole) of the solvent water. The vapor pressure for pure water at 25°C is 23.8 torr.
 - What is the mole fraction of sugar in water 2 marks
 - What is the molality of sugar in water 3 marks
 - What is the molarity of sugar in water 3 marks
 - Calculate the vapor pressure depression 3 marks
 - Calculate the boiling point elevation (the boiling point elevation constant for water is 0.512 °C/molal) 3 marks
 - Calculate the freezing point depression (the freezing point depression constant for water is 1.86 °C/molal 3 marks
 - Calculate the osmotic pressure change 3 marks

QUESTION TWO (20 marks)

- Balance the following chemical equations.
 - $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
 - $\text{Pb}(\text{NO}_3)_2 + \text{KI} \rightarrow \text{PbI}_2 + \text{KNO}_3$ [3 marks]
- Define the term 'Colligative Properties' and describe four types of colligative properties (5 marks)
- The pressure of a 0.0239 M³ sample of N₂ is 1.02 x 10⁵ Pa. The gas is compressed to a volume of 0.0210 m³ while the temperature remains constant at 293 K. What is the new pressure of the gas (3 marks)
- Zinc reacts with hydrochloric acid according to the equation;



What mass of zinc is required to react completely with 30.0 cm³ 1.00 M hydrochloric acid?

(3 marks)

- Write the oxidation and reduction half reactions for the following reaction $\text{Zn (s)} + \text{Cu}^{2+}(\text{aq}) \rightleftharpoons \text{Zn}^{2+} + \text{Cu (s)}$ [2 marks]
- Calculate the volume occupied by one mole of CO₂ at 300 K and 1 bar pressure. [4 marks]

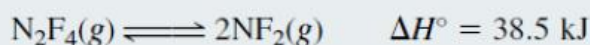
QUESTION THREE (20 marks)

- A quantity of cis-2-butene is added to a 2 liter flask and heated to 400 Oc for 2 years. The concentration of trans-2-butene was then determined to be 0.5 M. What is the concentration of cis-2-butene in the flask (3 marks)

- b. h) A bottle of metal hydrate $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ is mixed with an unknown amount of KCl . In order to find the purity of the $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$, we heat 9.51g of the metal hydrate mixture to remove water from the sample. After heating, the sample has a reduced mass of 9.14g.
- calculate change in sample mass (1 mark)
 - Calculate the moles of evaporated water (1 mark)
 - calculate moles of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ (1 mark)
 - calculate mass of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ in grams (1 mark)
 - calculate the mass percent of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ in the original sample (1 mark)
- c. State Dalton's Law of Partial Pressures 2 marks
- d. Discuss any **five** factors that affect the position of a chemical equilibrium. [5 marks]
- e. Derive the Nernst equation and explain the terms in it. [5 marks]

QUESTION FOUR (20 marks)

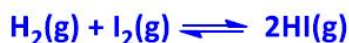
- a. Define the following terms;
- Physical chemistry [2 marks]
 - Graham's law of effusion [2 marks]
- b. Differentiate between an ideal gas and real gas. [4 marks]
- c. The equilibrium concentrations for the reaction between carbon monoxide and molecular chlorine to form COCl_2 at 74°C are $\text{CO} = 0.012 \text{ M}$, $\text{Cl}_2 = 0.054 \text{ M}$ and $\text{COCl}_2 = 0.14 \text{ M}$. Calculate the equilibrium constants K_c and K_p (4 marks)
- d. Consider the following equilibrium process between dinitrogen tetrafluoride and nitrogen difluoride;



- Predict the changes in the equilibrium if;
- The reacting mixture is heated at constant volume [2 marks]
 - NF_2 gas is removed from the reacting mixture at constant temperature and volume [2 marks]
 - The pressure on the reacting mixture is decreased at constant temperature [2 marks]
 - An inert gas, such as helium is added to the reacting mixture at constant volume and temperature [2 marks]

QUESTION FIVE (20 marks)

- a. Using relevant examples, distinguish between a physical and chemical equilibria (4 marks)
- b. Briefly describe any **three** types chemical reactions. [3 marks]
- c. A mixture of 0.500 mol H_2 and 0.500 mol I_2 was placed in a 1.00-L stainless steel flask at 430°C . The equilibrium constant K_c for the reaction is 54.3 at this temperature. Calculate the concentrations of H_2 , I_2 and HI at equilibrium. [6 marks]



- d. Explain the terms;
- i) Redox reactions (1 mark)
 - ii) oxidation (1 mark)
 - iii) reduction (1 mark)
- e. Determine the oxidation number of each element in these compounds
- i) CaO (1 mark)
 - ii) KNO₃ (1 mark)
 - iii) NaHSO₄ (1 mark)
 - iv) CaCO₃ (1 mark)