



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS (Electronics and Instrumentation) & BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY AND ENVIRONMENTAL PHYSICS.

BACHELOR OF TECHNOLOGY IN MEDICAL LABORATORY SCIENCES

ACH 4109: PHYSICAL CHEMISTRY

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: APRIL 2016

TIME: 2 HOURS

DATE: Pick Date Select Month Pick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt question ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

PAPER TWO

Question ONE

- A. with the help of equation State Gay-Lussac's (Charles) law. (2 mark)
- B. The volume of 2.00 grams of methane gas is 400 cm^3 at 27°C and a pressure of 152 cmHg. Determine the temperature at which the volume will be 500 cm^3 at the same pressure. (5 marks)
- C. Define the term "buffer solution" (1 mark)
- D. Explain the buffer action of a general weak acid HA and its salt (conjugate base). (4 marks)
- E. The dissociation of hydrogen iodide gas is a "**bimolecular**" reaction which follows "**second order**" kinetics.
 - i. Define the terms "**bimolecular**" and "**second order**" reactions. (3 marks)
 - ii. Write a balanced chemical equation for the reaction. (1 mark)
 - iii. Write the rate equation for the reaction. (2 mark)

F. 48.6 grams of Ammonia occupy a volume of 5.4 L at 45 °C. Calculate pressure it will exert using van der Waals equation. (given $a = 138.9 \text{ Kpa L}^2/\text{mol}$, $b = 0.0371 \text{ L/mol}$, $R = 0.8314 \text{ pa m}^3/\text{k.mol}$).

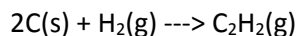
$$(P + a(n^2/v^2))(V - nb) = nRT$$

5 marks

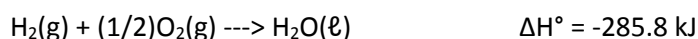
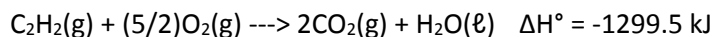
G. State Hess's law.

(2 mark)

H. Calculate the enthalpy for this reaction:



Given the following thermochemical equations:



(5marks)

Question TWO

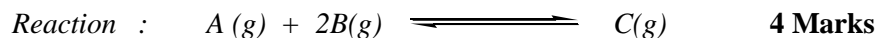
- (a) (i) Define the term "isotherm" (1 mark)
- (ii) Sketch the general Boyle's law isotherm (P-V) curve for an ideal gas, and explain the salient features of the curve. (5 marks)
- (b) (i) Write an equation for the ionization equilibrium of an acid HA dissolved in water. (1 mark)
- (ii) Give an expression for the ionization constant, K_a , of the acid in terms of concentrations (2 marks)
- (iii) Define the term "**diprotic**" acid and the formulae and names of any TWO diprotic acids. (4 marks)
- (c) (i) Define the term "reversible reaction" (1 mark)
- (ii) For the reaction $\text{N}_2 + 3\text{H}_2 = 2\text{NH}_3$ at 500°C, the value of K_p with partial pressures in atmospheres, is 1.44×10^{-5} , assuming ideal gas behaviour. Determine the corresponding value of K_c with concentrations in moles per litre.

$$\{K_p = K_c(RT)^{\Delta n}; R = 0.082 \text{ lit-atm.deg}^{-1}\text{mole}^{-1}\} \quad (6 \text{ marks})$$

Question THREE

- (a) (i) State the kinetic theory of gases. (1 mark)
- (ii) Using the kinetic theory, explain how an increase in temperature and decrease in volume, respectively affect the pressure of a given mass of gas. (4 marks)
- (iii) State TWO main assumptions of the kinetic theory on which the derivation of ideal gas laws were based. (2 marks)

- (iv) Give TWO reasons why real gases do not obey ideal gas laws, based on the assumptions in (iii) above. (2 marks)
- (b) (i) State the “solubility product principle” (1 mark)
- (ii) Using the solubility product principle, explain how the presence of a common ion influences the solubility of a sparingly soluble salt, e.g., Cl⁻ ion on solubility of AgCl (the common ion effect) (6 marks)
- (c) 0.25 moles of A was mixed with 0.45 moles of B and allowed to react to form C. At equilibrium there were 0.16 moles of C in 1 liter vessel. Calculate Equilibrium constant K_x



Question FOUR

- (a) (i) State “Boyle’s law” and “Dalton’s law of partial pressures”. (2 marks)
- (ii) A volume of 125 cm³ of gas X measured at a pressure of 48 cmHg, and 150 cm³ of gas Y at a pressure of 60 cmHg, are passed into a 500 cm³ vessel. Calculate the total pressure of the mixture in the vessel at the same temperature. (8 marks)
- (b) Define the following:
- (i) Exothermic reaction (1 mark)
- (ii) pH (1 marks)
- (iii) pOH (1 mark)
- (iv) Buffer capacity (1 mark)
- (v) Heat of solution (1 mark)
- (c) (i) State Le Chatelier’s principle. (1 mark)
- (ii) The Haber process for the industrial synthesis of ammonia gas, N₂ + 3H₂ ⇌ 2NH₃, is an exothermic reversible reaction. Explain how a decrease in temperature, and an increase in pressure, respectively, will affect the position of equilibrium. (4 marks)

Question FIVE

- (a) (i) Define the terms “heat of combustion” and “heat of formation”. (2 marks)

- (ii) The standard heat of combustion of ethanol is -1365 kJ at 25°C . Calculate its heat of formation from the elements in their standard states at the same temperature.

{The standard heats of formation of CO_2 and H_2O are $-394 \text{ kJ}\cdot\text{mol}^{-1}$ and $-285 \text{ kJ}\cdot\text{mol}^{-1}$, respectively} (9 marks)

- (b) A given mass of gas occupies a volume of 240 cm^3 at a pressure of 1.25 atm .

- (i) Determine the change in volume if the pressure were altered to 0.75 atm . at the same temperature. (6 marks)

- (ii) Determine the volume of double the given mass of gas at a pressure of 0.75 atm . (3 marks)