



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

APPLIED CHEMICAL TECHNOLOGY / METALLURGICAL ASSAYING

SUBJECT: Physical Chemistry PAPER NO: 501/15/S03

DURATION: 3 Hours

NOVEMBER/ DECEMBER 2025 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

1. Answer any Four (4) questions. Each question carries twenty- five (25) marks).
2. Do not write anything on the question paper.

QUESTION 1

- a) Define the following terms:
- i) Phase (2 marks)
 - ii) Adsorptions (2 marks)
 - iii) Absorptions (2 marks)
 - iv) Acid in terms of Bronsted (2 marks)
 - v) K_{SP} (2 marks)
- b) Explain the following
- i) Non – Ideal mixtures of miscible liquids. (5 marks)
 - ii) Distillation of liquid mixtures. (5 marks)
 - iii) Bubble cup distillation column. (5 marks)

QUESTION 2

- a) At 298K, the formation of ammonia has a negative ΔS_{sys}°
- $$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g) \quad \Delta S_{sys}^\circ = -197J/K$$
- Calculate ΔS_{univ}° units and state whether the reaction occurs spontaneously at this temperature. (6 marks)
- b) State and explain the application of the following laws:
- i) Raoult (6 marks)
 - ii) Henry (5 marks)
- c) Discuss Le Chatelier's Principle with reference to the contact and Haber Process. (8 marks)

QUESTION 3

- a) Define conjugate acid and conjugate base. Give one example for each. (4 marks)
- b) Calculate pH of:
- i) A solution where concentration of hydrogen ions = $3.5 \times 10^3 \text{ mol dm}^3$ (2 marks)
 - ii) $0.01 \text{ mol dm}^{-3} \text{ HCl}$
- c) Calculate the pH of a buffer solution containing 0.25 moles/ litre of formic acid and 0.10 moles/ litre of sodium formate K_a for formic acid is 1.8×10^{-4}
- d) Define:
- i) Solubility product (2 marks)
 - ii) Enthalpy of fusion (2 marks)
 - iii) Latent heat of vaporisation (2 marks)
- e) The solubility of Mg(OH)_2 at 25°C was given at $2 \times 10^{-11} \text{ mol dm}^{-3}$. This is its solubility in water. If it were to be dissolved in a solution containing 0.1 mol dm^{-3} sodium hydroxide, what is its solubility. (6 marks)

QUESTION 4

- a) Define azeotropic mixture. (2 marks)
- b) Name two (2) types of Azeotropic mixture and briefly describe each. (10 marks)
- c) Explain miscible liquids. (2 marks)
- d) Explain buffer solution Sodium Benzoate and Benzoic acid. (11 marks)

QUESTION 5

- a) Draw and label phase diagram of pure substance. (5 marks)
- b) Explain phase diagram of pure substance. (5 marks)
- c) Describe variation of vapour pressure of heat liquid system at constant temperature. (10 marks)
- d) Draw and label phase diagram of water. (5 marks)

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