CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE IN

CHEM 821: ADVANCED CHEMICAL THERMODYNAMICS

STREAMS: MSC **TIME: 3 HOURS**

DAY/DATE: TUESDAY 09/04/2019 **2.30 P.M. – 5.30 P.M.**

INSTRUCTIONS:

- **Answer ALL questions**

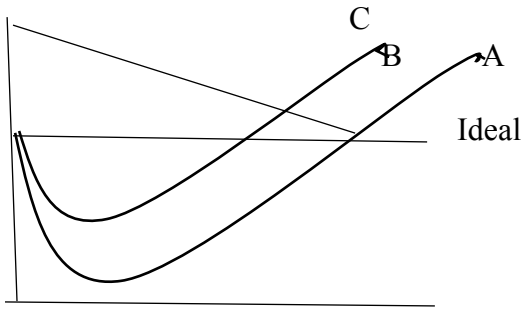
QUESTION ONE (20 MARKS)

(a) Briefly explain intermolecular forces at low moderate and high pressures. (3 marks)

(b) (i) Using an equation define the compressibility factor (Z) (2 marks)

(ii) Explain the following: When Z=1, Z ¿ 1 and Z ¿ 1. (3 marks)

(c) A, B, C can either be $N_2, SO_2 \wedge O_2.$ Predict with reasons the identity of the gases. (4 marks)



(d) (i) State the two faulty assumptions in the kinetic theory of gases. (1 mark)

(ii) Briefly discuss the corrections made to the kinetic theory of gases. (4 marks)

(iii) From this corrections derive the van der Waals equation. (3 marks)

QUESTION TWO (20 MARKS)

(a) (i) Define the Boyle temperature Tb (1 mark)

(ii) Using the expression $\left(p+\frac{a}{v^2}\right)(v-b)=RT$ derive (6 marks)

(b) Explain why biological systems may constitute exceptions to the second law of thermodynamics because they carry out irreversible processes that result in a decrease in the entropy of the biological system. (3 marks)

(c) The system Pb (m.pt 327 ^0C) and Sb (m.pt 631 ^0C) exhibits a simple eutectic at 86% Pb (by mass) and 246 ^0C . Breaks in the cooling curves in thermal analysis were found for the following compositions.

T (^0C ¿		550	500	400	300	296
Mass % Pb	30	44	66	80	96	

Draw a tentative phase diagram for the system and label it. Calculate the amount of antimony that crystallizes out from 20kg of melt containing 35% Pb by mass after cooling it to a temperature of 400 ^0C . How much is the maximum amount of Sb that can be recovered form this melt? (6 marks)

(d) Define the term

(i) Activity of a component or a solution (2 marks)
(ii) Activity coefficient (2 marks)

QUESTION THREE (20 MARKS)

(a) Derive an expression relating temperature and volume from a Van der Waals gas in a reversible and analytical transformation. (5 marks)

(b) Draw the cooling curves for a pure component and a mixture of components and explain. (5 marks)

(c) Draw a graphical illustration to distinguish between the Henry's law and Raoul's law. (5 marks)

(d) Write the expression of the virial equation. (2 marks)

(e) Using equations express the form of Vander Waals equation at

(i) Low pressure
(ii) Fairly high pressure
(iii) Very low pressure and temperature. (3 marks)
