EMBU UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF NAIROBI)

FIRST SEMESTER EXAMINATIONS 2014/2015

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SCH 203: PHYSICAL CHEMISTRY

DATE: DECEMBER 16, 2014 **TIME: 13:30 – 15:30**

INSTRUCTIONS:

Answer QUESTION ONE and any other TWO Questions

QUESTION ONE

Define the following terms (8 marks)

i) Isolated system

ii) Adiabatic process

iii) Critical pressure

iv) State function

a) Differentiate between extensive and intensive properties of matter (4 marks)

b) State Raoult's Law for an ideal mixture of liquids. (2marks)

Calculate the Van der Waals constants for ethane (C_2H_6) given that the critical temperature, T_c = 32.1° C, the critical pressure P_c = 48.8 atm and the critical density d_c = 0.21g/dm^3. Molecular weight= 30.07g/mol. (4 marks)

c) Calculate q, w, and ΔU for the reversible isothermal expansion of one mole of an ideal gas at $37^{o}C$ from a volume of $20dm^3$ to a volume of $30\ dm^3$.

(3 marks)

d) From the first law of thermodynamics, derive the expression

$$C_p - C_v = R$$ (3 marks)

e) Explain TWO corrections that have been factored in the Van der Waals equation of state.

(4 marks)

f) Explain the Joule- Thompson effect on liquefaction of gases? (2 marks)

QUESTION TWO

a) Imagine a substance with the following points on the phase diagram: a triple point at 0.5 atm and -5°C; a normal melting point at 20°C; a normal boiling point at 150°C; and a critical point at 5 atm and 1000°C. The solid liquid line is "normal" (meaning positive sloping).

i) Sketch the phase diagram, using units of atmosphere and Kelvin.

(5 marks)

ii) Describe what one would see at pressures and temperatures above 5 atm and 1000°C.

(3 marks)

iii) Describe what will happen to the substance when it begins in a vacuum at -15°C and is slowly pressurized. (2 marks)

QUESTION THREE

a) Pure water boils at 100°C and pure ethanol boils at 78.5°C. An azeotropic mixture of ethanol and water contains 95.6% by mass of ethanol, and boils at 78.2°C.

i) What is an azeotropic mixture? What would happen if you boiled a mixture of this composition? (4 marks)

ii) Draw the phase diagram for mixtures of ethanol and water, including both liquid composition and vapour composition curves. (6 marks)

QUESTION FOUR

a) An ideal mixture of two liquids A and B contained 1 mole of A and 4 moles of B. The vapour pressure of pure A at the temperature of the mixture was 10 kPa, and that of pure B was 12.5 kPa.

i) Calculate the partial vapour pressure of A in the mixture. (2 marks)

ii) Calculate the partial vapour pressure of B in the mixture. (2marks)

iii) Calculate the total vapour pressure of the liquid. (2 marks)

b) Suppose you had two liquid mixtures:

C: butan-1-ol and butan-2-ol

D: ethanol and pentane

c) One of these is likely to be almost ideal, and the other is very unlikely to be ideal. Which is which? (2 marks)

d) Explain your answer to part

With reference to the intermolecular forces in the two mixtures, and the way these affect ideality. (2 marks)

QUESTION FIVE

A 50.0 g aluminium disk at 300 K is placed in 200cm^3 of ethyl alcohol at 10.0 K, and then quickly removed. The aluminium temperature is found to have dropped to 120 K.

Heat capacity for aluminium is 900J/KgK

Heat capacity for ethyl alcohol is 2400 J/KgK

Density of ethyl alcohol is 790 Kg/ m^3

i) Calculate the amount of heat lost by the disk? (4 marks)

ii) What is the new temperature of the ethyl alchol (6 marks)

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