



# KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2008/2009

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF  
SCIENCE

## SCH 403: PHASE EQUILIBRIA

DATE: MONDAY, 1<sup>ST</sup> DECEMBER 2008

TIME: 8.00 A.M. – 10.00 A.M.

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### INSTRUCTIONS:

ANSWER ALL QUESTIONS.

DATA T = 273K, R = 8.314

1. (a) Define the terms:
  - (i) Phase
  - (ii) Component
  - (iii) Degree of freedom
  - (iv) Molality
  - (v) Azeotropic mixture

(7 ½ marks)
  
- (b) Distinguish between
  - (i) Static and dynamic equilibrium
  - (ii) Congruent and incongruent melting compounds.
  - (iii) Boiling point elevation and freezing point depression of a solution.
  - (iv) Triple point and Eutectic point

(6 marks)
  
- (c) What is the mole fraction of glycine in aqueous solution of molality 0.14 mol kg<sup>-1</sup>.

(4 marks)
  
- (d) Give phase rule and define the terms employed.

(2 ½ marks)

2. (a) Show that clausius clapeyron equation is

$$\log \frac{P_2}{P_1} = \frac{\Delta H_v}{2.303R} \left( \frac{T_2 - T_1}{T_2 T_1} \right)$$

(5 marks)

- (b) Calculate the heat of vapourisation of acetone if the vapour pressure of acetone at 0°C is 53.46 mm Hg and at 30°C it is 23.7 mm Hg

$$(R = 1.987 \text{ cal})$$

(3 marks)

- (c) It is impossible to heat a solid above its melting point, but it is possible to supercool some liquids.

Comment on this observation

(2 marks)

3. The phase diagram of water may be given as under.

- (a) Curve OC is inclined towards the pressure axis.  
Using clausius-clapeyron equation, explain how this affects melting point of ice.

(4 marks)

- (b) Explain clearly how curve  $OA^1$  comes about and what it represents. (3 marks)
- (c) (i) Comment on the vapour pressures of curve  $A^1O$  and  $AO$   
(ii) What is metastable equilibrium? (3 marks)
4. (a) Explain how you would determine the molecular weight of a substance in solution, from its osmotic pressure. (5 marks)
- (b) What is meant by relative lowering of vapour pressure? (2 marks)
- (c) 18.2gms of urea is dissolved in 100 gms of water at  $50^\circ\text{C}$ . The lowering of vapour pressure produced is 5 mm Hg. Calculate the molecular weight of urea. The vapour pressure of water at  $50^\circ\text{C}$  is 92 mm Hg. (3 marks)
5. The data below is for methanol-chloroform system.

Boiling point ( $T^\circ\text{C}$ )	$X_{\text{meoH}}$ (liquid)	$X_{\text{meoH}}$ (vapour)
60	0	-
56	0.05	0.25
54	0.1	0.3
53	0.4	0.4
54	0.6	0.45
56	0.8	0.5
59	0.9	0.6
62	0.95	0.7
65	1	-

- (a) Sketch a boiling point-composition diagram for this system. (4 marks)
- (b) Indicate the azeotropic mixture on the diagram. (1 mark)
- (c) At any time which of the two pure liquids will have a higher vapour pressure and why? (2 marks)
- (d) A mixture containing more methanol which boils at  $55^\circ\text{C}$  is distilled. What is the composition of the distillate and residue. (2 marks)

- (e) What is the boiling point of the mixture whose composition is 70 mole percent methanol? (1 mark)
6. (a) Draw a well-labelled LEAD-SILVER SYSTEM. (4 marks)
- (b) Explain what the curves and Eutect point represent. (3 marks)
- (c) Describe Pattinson's desilverization process. (3 marks)

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