JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATION 2012/2013

1ST YEAR 1ST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE AND BIOLOGICAL SCIENCE

(SCHOOL BASED)

COURSE CODE: SCH 301

TITLE: CHEMICAL DYNAMICS & EQUILIBRIA

DATE: 5/5/2013 **TIME: 9.00-11.00AM**

DURATION: 2 HOURS

INSTRUCTIONS

1. **Answer ALL questions in Section A**
2. **Answer ANY two Questions from Section B**

Section A This section contains ONE COMPULSORY question

QUESTION 1 (Compulsory -30 marks)

a. Briefly explain each of the following terms: (10 marks)

i. First law of thermodynamics
ii. The entropy
iii. Adiabatic system
iv. Chemical phase
v. Triple point
vi. Gibbs free energy
vii. Chemical potential
viii. Molality
ix. Colligative properties
x. Osmotic pressure

b. State the second law of thermodynamics (1 mark)

c. Show that entropy is a state function (3 marks)

d. In each of the following equations predict whether the reaction is accompanied by increase or decrease in disorder of the particles. In each case, explain your answer.

i. $2NH_3(g) \rightleftharpoons 3H_2(g) + N_2(g)$ (2 marks)

ii. $NaCl(s) \xrightarrow{\text{excess } H_2O(l)} Na^+(aq) + Cl^-(aq)$ (3 marks)

e. State the phases rule and explain the terms (4 marks)

f. Fig.1 shows a phase diagram for water. Study it and use it to answer the questions that follow.

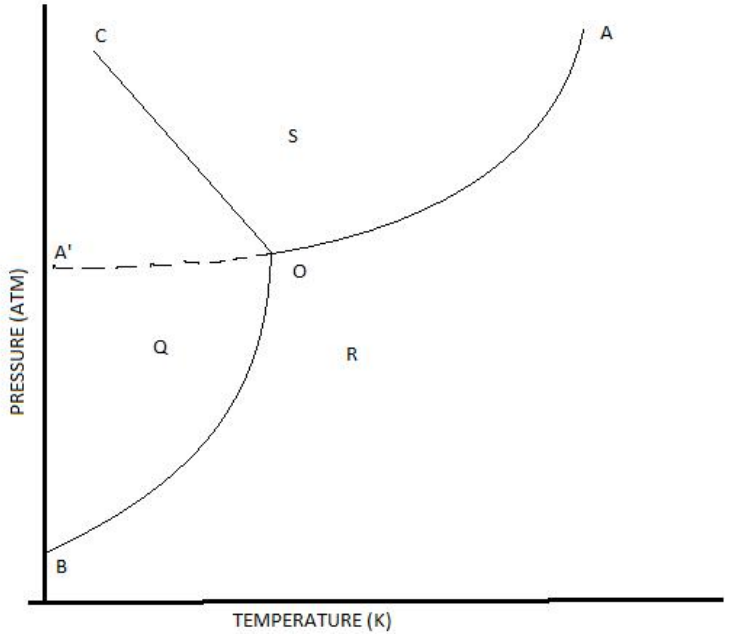

Fig. 1: Phase diagram of water

g. Identify the

i. Phases labelled Q, R and S respectively. (3 marks)

ii. boundary lines OA, OA', OB and OC (4 marks)

Section B: This section contains FOUR questions. Answer ONLY TWO questions.

QUESTION 2 (Optional, 20 marks)

a. The latent heat of vaporization of water at 100 ^{o}C and 1 atmosphere of pressure is 22.6 x 105 Kkg^{-1}. Calculate the change in entropy for the conversion of
   i. 1 kg of water to steam at 100 ^{o}C (3 marks)
   ii. 1 mol of water to steam at 100 ^{o}C (3 marks)

b. Using a heating curve to illustrate, calculate the entropy change when 1 mol of ice is heated from 250 K to 300 K assuming the heat capacity of water and ice to be 75.3 and 37.7 JK^{-1} respectively and that the enthalpy of fusion of ice is 6.02 kJmol-1. (12 marks)

c. Briefly comment on the values of entropy changes in the system while water is heated from 250 K to 300 K as in question 1 (b) above. (2marks)

[Total 20 marks]

QUESTION 3 (Optional, 20 marks)

a. State the conditions of entropy and Gibbs free energy necessary for a state of equilibrium (2 marks)

b. Briefly discuss the role of entropy and enthalpy in determining Gibbs free energy and, hence, the reaction spontaneity of a system (4 marks)

c. For the reaction :

$$C(s) + 2H_2(g) \longrightarrow CH_4(g)$$

at 298 K, calculate ΔG, given:

Substance	$\Delta_{\overline{Hf}}$ (kJmol^{-1})	$\Delta_{\overline{Sf}}$ (Jmol-1K-1)
C(s)	0	5.7
H_2 (s)	0	130.6
CH_4 (g)	-78.4	186.2

(4 marks)

d. Given , $\left(\frac{\partial G}{\partial P}\right)_T = V$,
   i. show that $\Delta G = nRTln\left(\frac{P_2}{P_1}\right)$ (6 marks)
   ii. Calculate the molar free energy of hydrogen gas at 10^{-5} atmospheres of pressure at 289 K and comment on the significance of the sign of the value of molar free energy. (4 marks)

[Total 20 marks]

QUESTION 4 (Optional, 20 marks)

a. For a one-component system such as water, derive the Claussius-Clapeyron equation (10 mark)

b. Sketch a phase diagram for sulphur and explain the various processes involved in transition from low temperature (298 K) to high temperatures (400 K). (10 marks)

[Total 20 marks]

QUESTION 5 (Optional, 20 marks)

a. The vapour pressure of carbon tetrachloride, CCl_4, and that of silicon tetrachloride, $SiCl_4$, at 25 ^oC are 114.9 mmHg and 238.3, mmHg respectively. Assuming ideal behaviour, calculate:
   i. The total vapour pressure of a mixture of equal weights of the two liquids. (8 marks)
   ii. The composition of the vapours of the mixture of CCl_4 and $SiCl_4$ at equilibrium at 25 ^oC. (4 marks)

b. For each of the following solutions calculate the boiling point elevations:
   i. 1.0 molal aqueous solution of glucose ($C_6H_{12}O_6$) (2 marks)
   ii. 1.0 molal aqueous solution of sodium chloride (NaCl) (2 marks)
   iii. 1.0 molal aqueous solution of lithium carbonate (Li_2CO_3) (2 marks).

c. Explain the differences, if any, in the values of the boiling point elevations among the three solutions in **QUESTION 5** Part (b) above (2 marks)

[Total 20 marks]

-END-