DEPARTMENT OF CHEMISTRY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

FIRST SEMESTER EXAMINATION 2012/2013 SESSION

COURSE CODE: CHM312 **UNITS: 2**

COURSE TITLE: CHEMICAL THERMODYNAMICS

TIME ALLOWED: 2 HOURS

INSTRUCTIONS: ANSWER ANY THREE (3) QUESTIONS **R= 8.314J/K/mol**

Q1. (a) What are the applications of Bond Energy?

(b) The lattice enthalpy of NaCl is +787KJ/mol while the total enthalpy of hydration is - 783KJ/mol., calculate the enthalpy of solution of NaCl at the same temperature. ***(8 Marks)***

(c) Given that the molar heat capacity at constant pressure (C_p) of I_2, H_2 and HI, are given by the following equations; I_2: $Cp = 6.5 + 0.038T$

H_2: $Cp = 6.5 + 0.017T$

HI: $Cp = 6.5 + 0.016T$

Calculate ΔC_p for the reaction:

$$I_2 + H_2 \longrightarrow 2HI$$ ***(20 Marks)***

Q2. (a) (i) How would you predict the spontaneity of a system in terms of ΔS?

(ii) Calculate the entropy change when one mole of an ideal gas expands reversibly from an initial volume of $100cm^3$ to $500cm^3$ at 25°C.

(b) Comment on the change in entropy for each of the following reactions;

(i) $3O_{2(g)} \rightarrow 2O_{3(g)}$

(ii) $SF_{6(g)} \rightarrow SF_{4(g)} + F_{2(g)}$

(iii) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

(c) Differentiate, with examples in each case, between

(i) State function and path functions

(ii) Extensive and intensive properties

(iii) Closed and open system

(iv) Reversible and Irreversible processes

Q3. (a) (i) State the law of mass action

(ii) Express mathematically, the term 'active mass'.

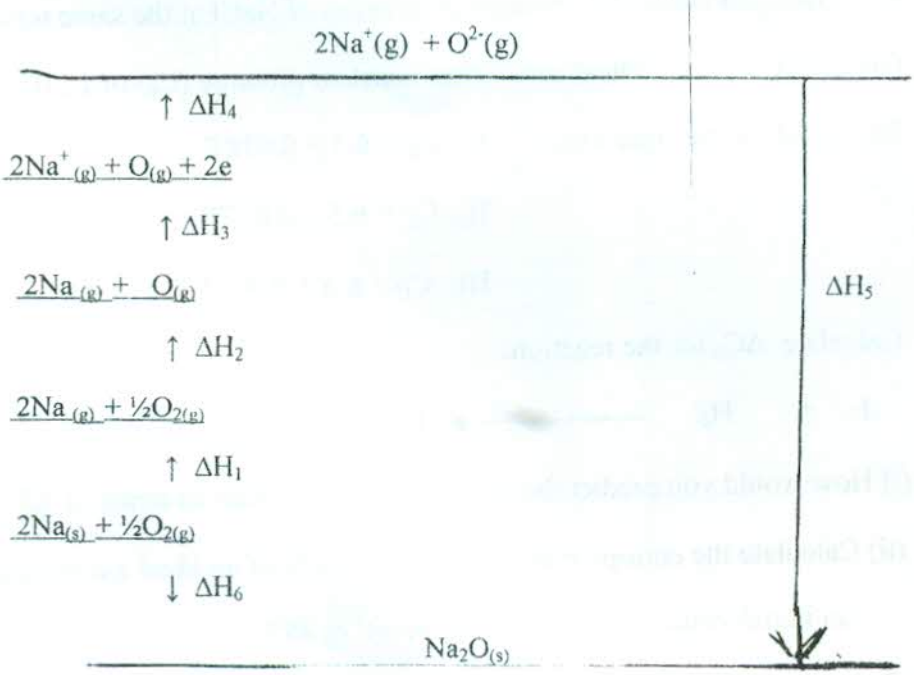
(b) Derive the thermodynamic relationship between the change in free energy (ΔG) associated with a chemical reaction and its equilibrium constant (K).

(c) For the dissociation of water: $H_2O_{(g)} \leftrightarrow H_{2(g)} + \frac{1}{2} O_{2(g)}$

at 1500 °C, the value of Kp is 1.87×10^{-6}. Assuming ideal behavior of gases, calculate the corresponding value of Kc. [R = 0.08205 $atmdm^3K^{-1}mol^{-1}$]. ***(20 Marks)***

Q4. (a) State the Hess's law of constant heat summation

(b) The Born-Haber cycle for calcium oxide Na_2O, is given below:



Where $\Delta H_1 = +108$, $\Delta H_2 = +248$, $\Delta H_3 = +1140$, $\Delta H_4 = +697$, $\Delta H_6 = -530$ (all units in KJ):

(i) Identify the change which represents the enthalpy of formation of Na_2O ***(2 Marks)***

(ii) Use the data above to calculate the lattice enthalpy of Na_2O ***(5 Marks)***

(iii) Use the value of ΔH_4 to calculate the first electron affinity of oxygen, given that the second electron affinity of oxygen is + 857KJ/mol ***(4 Marks)***

(iv) What enthalpy change does the value of ΔH_3 represents? ***(3 Marks)***

(v) Would the value of ΔH_3 be larger or smaller for K than it is for Na? Explain ***(4 Marks)***