TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

DIPLOMA IN ANALYTICAL CHEMISTRY

DAC 15S

ACH 2210 : CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRIA

SPECIAL SUPPLEMENTARY EXAMINATION

SERIES: AUGUST2017

TIME: 2HOURS

DATE: 18Sep2017

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attemptquestion ONE (Compulsory) and any other TWO questions.

Do not write on the question paper.

Question ONE

a) The enthalpy of neutralization of CH_3COOH with NaOH is -51.63 kJ mol^{-1} Calculate the enthalpy of ionization of CH_3COOH. Assume that the enthalpy of neutralization of HCl with NaOH is -57.35 kJ mol^{-1} **(4marks)**

b) Calculate the enthalpy change of $C_2H_2\ (g) + H_2\ (g) \longrightarrow C_2H_4\ (g)$ at 298 K in kJ mol^{-1} given enthalpy of combustion $\Delta cH\ (H_2) = -286$, $\Delta cH\ (C_2H_2) = -1300$, $\Delta cH\ (C_2H_4) = -1411$ **4marks)**

c) When one mole of a liquid benzene is completely burnt in oxygen to form liquid water and carbon dioxide gas, $\Delta H = -3264.58$Kj at 298K calculate the enthalpy of reaction at constant volume at the same temperature **(6marks)**

d) Differentiate between molar heat capacity and specific heat of a substance **(4 marks)**

e) A gas expands from $3dm^3$ to $5dm^3$ against a constant pressure of 1 atm at 25 °C calculate work done in joules by the system against the surroundings? **(4marks)**

f) Give the meaning of the following thermodynamic concepts **(4 marks)**
   i) System
   ii) Surrounding
   iii) Extensive property
   iv) Intensive property

g) Calculate the enthalpy of combustion of glucose from the following data **(4marks)**

(i) C (graphite) + O_2 (g) ⟶ CO_2 (g) $\Delta r H = -393.5$ kJ mol^{-1}

(ii) H_2 (g) + 0.5 O_2 (g) ⟶ H_2O (l) $\Delta r H = -286$ kJ mol^{-1}

(iii) 6 C (graphite) + 6 H_2 (g) + 3 O_2(g) ⟶ $C_6H_{12}O_6$ (s) $\Delta r H = -1260$ kJ mol^{-1}

Question TWO

Explain how water's phase diagram differs from that of carbon dioxide gas **(15marks)**

Question THREE

a) Two moles of an ideal gas at STP are heated at constant volume to a temperature of 350K determine the increase in entropy for the system Cv = $12.47 J^{-1} mol^{-1} K^{-1}$ **(4marks)**

b) sketch the density-temperature diagram ear 0oc showing clearly the anomalous behavior of water and explain the behavior **(6marks)**

c i) state the second law of thermodynamic **(2marks)**

ii) explain why heat engine with 100% efficiency would violate the second law of thermodynamic **(3marks)**

Question FOUR

a) The molar heat of fusion and vaporization of benzene are $10.9 K^{-1} mol^{-1}$ and $31 K^{-1} mol^{-1}$ respectively calculate the enthalpy change for the solid to liquid and liquid to vapour transition of benzene at 1 atm benzene melt at 5.5°C and boils at 80.1°C **(5marks)**

b) Calculate the value of ΔU and ΔH in the isothermal and reversible expansion of 4 g of hydrogen gas at 300 K from an initial volume of 20 dm^3 to a final volume of 60 dm^3. Assume that hydrogen gas obeys ideal gas law **(6marks)**

c) Calculate the change in entropy when 2 moles of an ideal gas are heated from 300 K to 600 K at a constant pressure under reversible condition. It is given that $C_P = 25$ JK^{-1} mol^{-1} **(4marks)**

Question FIVE

a) One mole of an ideal gas undergoes reversible changes in a Carnot cycle. First it expands isothermally from a most compressed state of 10 bar and 600 K to a pressure of 1bar then adiabatically to most expanded state at 300 K. Finally it is brought back to its initial state via isothermal compression and adiabatic compression respectively. Calculate q, w and ΔU for each step and the efficiency of the cycle. CV= 25 JK^{-1} mol^{-1} **(12marks)**

b) Calculate the entropy change when one mole of liquid water is converted into vapour at 100 °C The enthalpy of vaporization is 40.850 kJ mol^{-1} **(3marks)**