Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF **PURE AND APPLIED SCIENCES**

DIPLOMA IN ANALYTICAL CHEMISTRY
(DAC 12S)

ACH 2210 : CHEMICAL THERMODYNAMICS & PHASE EQUILIBRIA

SEMESTER: EXAMINATIONS

SERIES: DECEMBER 2013

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this paper

- *Answer booklet*

This paper consists of ***FIVE*** questions.
Answer Question **ONE (compulsory)** and any other **TWO** questions
*This paper consists of **5 PRINTED** pages*

Question ONE

(a) Given the reaction $C(s) + 2S(s) \rightarrow CS_2 \quad \Delta H = +87.9KJ$

Illustrate this information in a labelled suitable energy level diagram **(4marks)**

(b) A piece of iron weighing 20g at a temperature of 95˚C was placed in 100g of water at 25˚C. Assuming that no heat was lost to the surroundings calculate the final temperature of the system **(6marks)**

Specific heat capacity of iron = $0.4536Jg^{-1}C^{-1}$

Specific heat capacity of water = $4.2Jg^{-1}C^{-1}$

(c) (i) By use of arrows show how the dissolving in water of solid calcium chloride (CaCl(s)) can be represented by an energy cycle **(3marks)**

(ii) Give the names of the energy changes in the cycle in (ci) **(3marks)**

(iii) Identify the endothermic step in the cycle in (i) **(1mark)**

(iv) Give the equation relating to the energy changes in the cycle **(1mark)**

(d) Two pure liquids A and B have vapour pressures of $1.70 \times 10^4 NM^{-2}$ and $3.50 \times 10^4 NM^{-2}$ respectively at 25˚C. given that a mixture of A and B is an ideal solution calculate the mole fraction of A in a mixture of A and B which has a total vapour pressure of $2.70 \times 10^4\ NM^{-2}$ at 25˚C. **(5marks)**

(e) Give the THREE steps of the overall reaction

$Ca(s) \rightarrow Ca^{2+}(g)$ **(3marks)**

(f) Distinguish enantiotropy from monotropy and give one example for each **(4marks)**

Question TWO

a) In an experiment to determine the heat of neutralization of HCL by NaOH solution $100cm^3$ of 2m HCl was added to $100cm^3$ of 2m NaOH. The experimental data obtained was as follows:-

Temperature of sodium hydroxide 28.2˚C

Temperature of hydrochloric acid 27.2˚C

Final temperature of the mixture 40.7˚C

Specific heat capacity of final solution $4.2Jg^{-1}C^{-1}$

Density of final solution $1g/cm^3$

(i) Determine the heat of neutralization of hydrochloric acid **(9marks)**

(ii) State how the value calculated in (a) (i) differs from the correct value. Explain **(2marks)**

(iii) If 2m HCl was replaced with 2m CH_3COOH suggest the value of heat of neutralization you would expect. Explain **(2marks)**

b) The heat of combustion of compound Cn H_2n + 2, carbon and hydrogen are Q1 Q2 and Q3 $KJmol^{-1}$ respectively. Derive an expression for the heat of formation of the hydrocarbon CnH_2n+2 in terms of Q1 Q2 and Q3 **(7marks)**

Question THREE

(a) Sketch a clearly labelled phase diagram for sulphur system **(6marks)**

From the diagram identify the following

(i) All triple points

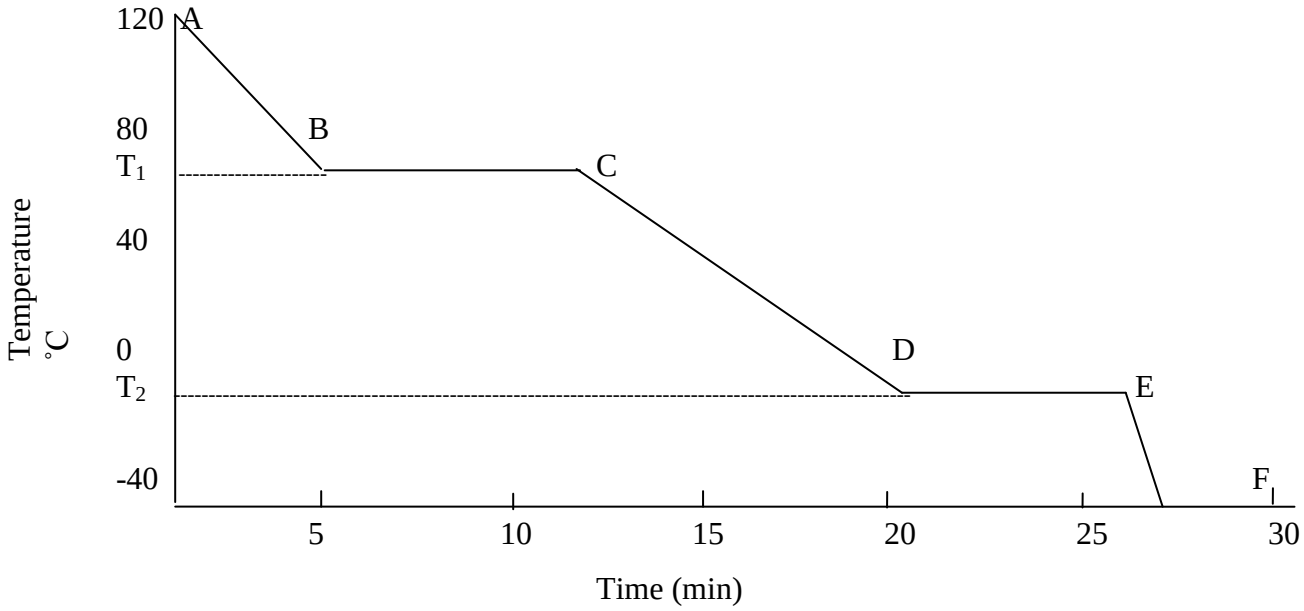
(ii) Melting point of each allotrope

(iii) Transition temperature curve **(5marks)**

(b) Discuss the application of phase rule in the sulphur system **(9marks)**

Question FOUR

(a) The following temperature time graph represents the cooling curve of substance X.



(i) List SIX requirements of an experiment carried out to give this data **(6marks)**

(ii) State what each of the section of the graph represent **(5marks)**

(iii) Identify the temperatures T1 and T2 **(2marks)**

(iv) Identify from the graph the sections that represent latent heat and give the names of the corresponding heat changes **(2marks)**

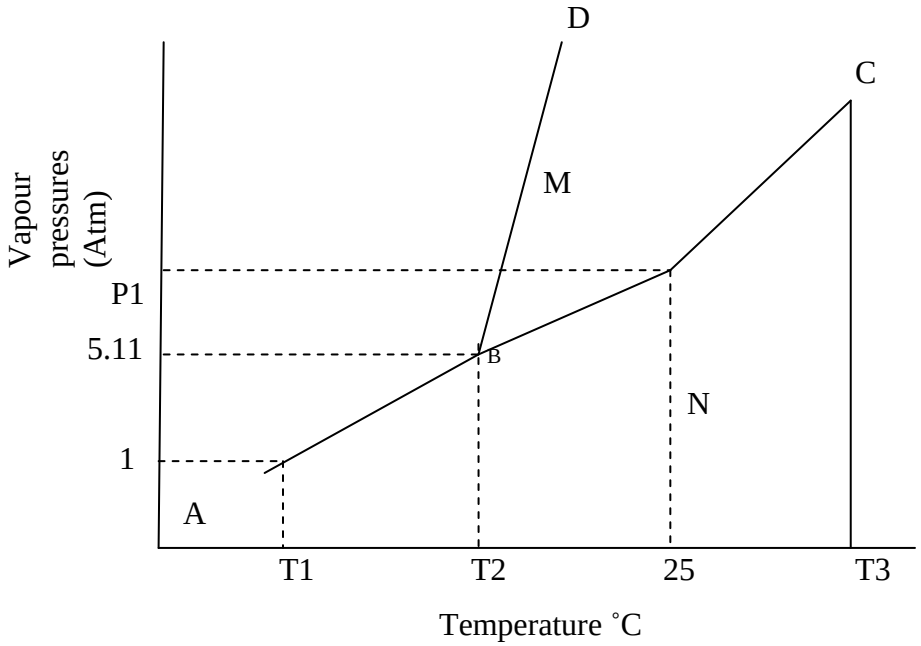
(b) The combustion of one mole of ethanol C_2H_5OH in oxygen at standard conditions (25˚C and 1 atmosphere pressure) produced 1235.8KJ of heat. Calculate

(i) The heat that would have been produced if the reaction were carried out at constant volume **(4 ½ marks)**

(ii) ΔE for the reaction R = $8.314K^{-1}Mol^{-1}$ **(½ mark)**

Question FIVE

(a) The following represents the phase diagram of carbon dioxide



(i) Identify phases M and N **(2marks)**

(ii) Identify temperatures T1 and T2 **(2marks)**

(iii) State the significance of

(a) Pressure P1

(b) Temperature T3

(2marks)

(iv) 5g samples of solid carbon dioxide and ice are placed in separate open beakers and exposed to atmosphere for 50min. State and explain what will be observed in each case

(b) (i) State what is meant by heat of formation of a compound **(1mark)**

(ii) Give the equation for the formation at anhydrous potassium carbonate corresponding to its heat of formation **(2marks)**

(iii) Given the heat of formation of $CO_2(g)$ $H_2O(l)$ are -394 and $-241.8KJMol^{-1}$

Respectively and that the heat of combustion of ethanol $C_2H_5OH(l)$ is -1235.8KJ, Calculate the heat of formation of liquid ethanol at the same temperature **(6marks)**