



**TECHNICAL UNIVERSITY OF MOMBASA**  
**Faculty of Applied & Health**  
**Sciences**

DEPARTMENT OF PURE & APPLIED SCIENCES

**DIPLOMA IN SCIENCE LABORATORY & TECHNOLOGY (DSLT 12J)**

ACH 2209: CHEMICAL THERMODYNAMIC & PHASE DIMENSION

**SPECIAL/SUPPLEMENTARY EXAMINATION**

**SERIES: JUNE 2013**

**TIME: 2 HOURS**

**Instructions to Candidates:**

You should have the following for this examination

- *Answer Booklet*

This paper consist of **FIVE** questions

Answer question **ONE (COMPULSORY)** and any other **TWO** questions

Maximum marks for each part of a question are as shown

This paper consists of **THREE** printed pages

### Question One (Compulsory)

- a) Define Helmholtz and Gibbs free energy **(4 marks)**
- b) When one mole of water at 100°C and latim pressure is converted to steam at 100°C the amount of heat observed is 40, 670. Calculate DE **(6 marks)**
- c) 0.1 mole of an ideal gas is expanded isothermally at 273K from 3dm<sup>3</sup> to 5dm<sup>3</sup>, determine the energy. **(4 marks)**
- d) 3dm<sup>3</sup> of hydrogen initially at STP are expanded isothermally and reversibly to a volume of 4dm<sup>3</sup>. Calculate work done. **(4 marks)**
- e) Two moles of an ideal gas at STP are heated at constant volume to temperature of 350K determine the increase in entropy for the system  $C_v = 12.475 \text{ mol}^{-1}\text{k}^{-1}$  **(4 marks)**
- f) Calculate the change in free energy when 11.21dm<sup>3</sup> of the perfect gas at 0°C and 760mmHz pressure expanded isothermally until its pressure is 190 mmHz **(4 marks)**
- g) Differentiate between open and isolated system **(4 marks)**

### Question Two

- a) The molar heat of fusion and vaporization of senzene are 10.9w/mol and 31.0w/mol respectively. Calculate the entropy change for the solid – liquid and liquid – vapour transition for senzene at latim pressure, senzene meat at 5.5°C and boils at 80.1°C **(6 marks)**
- b) Calculate the standard enthropy or reactin at 125°C for the reaction.



$$\Delta H^\circ_{298} = -92.2\text{k} \text{ at } 25^\circ \text{C}$$

Value of molar heat capacities at constant pressure are given below.

Substance	$C_p \text{ (jk}^{-1} \text{ mol}^{-1}\text{)}$
CH <sub>2</sub>	$(29.038 - 0.836 \times 10^{-3} T + 20.097 \times 10^{-7} T^2)\text{jk}^{-1}$
CN <sub>2</sub>	$(26.957 + 5.906 \times 10^{-3} T - 3.373 \times 10^{-7} T^2) \text{jk}^{-1}$
CNH <sub>3</sub>	$(25.870 + 32.968 \times 10^{-3} T - 30.430 \times 10^{-7} t^2)\text{jk}^{-1}$

- c) State the first law of thermodynamic **(2 marks)**

### Question Three

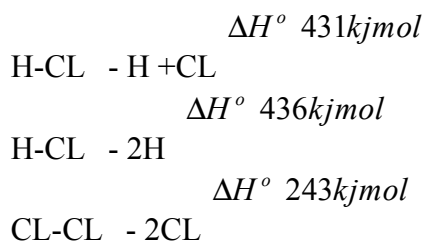
- a) The equilibrium constant K<sub>p</sub> for the reaction

$\text{Na(s)} + 3\text{H}_2\text{(s)} \rightarrow 2\text{NH}_3\text{(s)}$  is  $1.64 \times 10^{-4}$  at 673K and  $1.44 \times 10^{-5}$  at 773K determine the mean entropy of formation  $\Delta H_f$  for one mole of ammonia from its elements in this temperature range. **(8 marks)**

- b)** The boiling point of water at pressure of 50 atm is  $265^\circ\text{C}$  and at 1 atm is  $100^\circ\text{C}$ , assuming the temperature of the sink is  $40^\circ\text{C}$ . Compare the theoretical efficiencies of a steam engine operating between the boiling point of water and that of the sink at  
**(i)** 1 atm  
**(ii)** 50 atm **(7 marks)**

#### Question Four

- a)** State the thermo chemical laws associated with Hess and Kirchoff and show their thermodynamic basis. **(6 marks)**  
**b)** Differentiate between isothermal and adiabatic system. **(4 marks)**  
**c)** Estimate the heat of formation of HCL given that:



#### Question Five

Illustrate water phase diagram and explain how it differs from those of other substances. **(15 marks)**