



# 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: AUGUST 2017**

**TIME: 2 HOURS**

**DATE: 18 Sep 2017**

## Instructions to Candidates

You should have the following for this examination

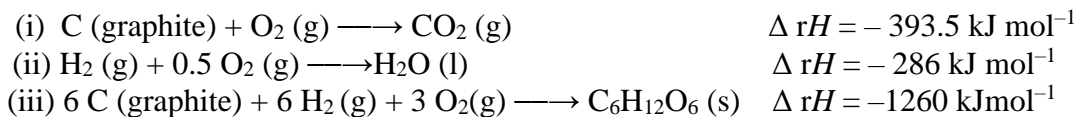
-Answer Booklet, examination pass and student ID

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

**Do not write on the question paper.**

## Question ONE

- The enthalpy of neutralization of  $\text{CH}_3\text{COOH}$  with  $\text{NaOH}$  is  $-51.63 \text{ kJ mol}^{-1}$ . Calculate the enthalpy of ionization of  $\text{CH}_3\text{COOH}$ . Assume that the enthalpy of neutralization of  $\text{HCl}$  with  $\text{NaOH}$  is  $-57.35 \text{ kJ mol}^{-1}$  **(4 marks)**
- Calculate the enthalpy change of  $\text{C}_2\text{H}_2(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_4(\text{g})$  at 298 K in  $\text{kJ mol}^{-1}$  given enthalpy of combustion  $\Delta_c H(\text{H}_2) = -286$ ,  $\Delta_c H(\text{C}_2\text{H}_2) = -1300$ ,  $\Delta_c H(\text{C}_2\text{H}_4) = -1411$  **(4 marks)**
- When one mole of a liquid benzene is completely burnt in oxygen to form liquid water and carbon dioxide gas,  $\Delta H = -3264.58 \text{ kJ}$  at 298 K calculate the enthalpy of reaction at constant volume at the same temperature **(6 marks)**
- Differentiate between molar heat capacity and specific heat of a substance **(4 marks)**
- A gas expands from  $3 \text{ dm}^3$  to  $5 \text{ dm}^3$  against a constant pressure of 1 atm at  $25^\circ \text{C}$  calculate work done in joules by the system against the surroundings? **(4 marks)**
- Give the meaning of the following thermodynamic concepts **(4 marks)**
  - System
  - Surrounding
  - Extensive property
  - Intensive property
- Calculate the enthalpy of combustion of glucose from the following data **(4 marks)**



### 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  $C_v = 12.47 \text{ J}^{-1} \text{ mol}^{-1} \text{ K}^{-1}$  (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  $10.9 \text{ K}^{-1} \text{ mol}^{-1}$  and  $31 \text{ K}^{-1} \text{ mol}^{-1}$  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  $\Delta U$  and  $\Delta H$  in the isothermal and reversible expansion of 4 g of hydrogen gas at  
300 K from an initial volume of 20 dm<sup>3</sup> to a final volume of 60 dm<sup>3</sup>. 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  $C_p = 25 \text{ JK}^{-1} \text{ mol}^{-1}$  (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  $\Delta U$  for each step and the efficiency of the cycle.  
 $C_v = 25 \text{ JK}^{-1} \text{ mol}^{-1}$  (12marks)
- b) Calculate the entropy change when one mole of liquid water is converted into vapour at 100 °C  
The enthalpy of vaporization is  $40.850 \text{ kJ mol}^{-1}$  (3marks)