



# Technical University of Mombasa

Faculty of Applied and Health Sciences

## DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF  
TECHNOLOGY IN APPLIED CHEMISTRY (ANALYTICAL OPTION)  
BTAC 12S /BTAC 13S<sub>2</sub>

## ACH 4208: PHYSICAL CHEMISTRY II

SEMESTER EXAMINATION

DECEMBER 2013 SERIES

2 HOURS

Instructions to candidates:

This paper consist of **FIVE** questions

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

### QUESTION ONE

- a) Calculate the standard heat of formation of propane ( $C_3H_8$ ) if its heat of combustion is - 2220.2KJ/mol. The heats of formation of  $CO_2(g)$  and  $H_2O(l)$  are -393.5 and - 285.8KJ/Mol respectively. **(6marks)**
- b) Differentiate between:
- (i) Fugacity and activity
  - (ii) Phase and phase rule equation
  - (iii) Component and degree of freedom. **(2 marks each, 6 total)**
- c) Draw and explain the phase diagram of one component three phase system. **(6marks)**
- d) Calculate the entropy change when one mole of ethanol ( $C_2H_5OH$ ) is evaporated at 351K. The molar heat of vapourisation of ethanol is 39.84KJ/mol. **(4marks)**
- e) The heat of combustion of carbon monoxide at constant volume and at 17°C is - 283.3KJ/mol. Calculate its heat of combustion at constant pressure. ( $R = 8.314 JK^{-1}mol^{-1}$ ) **(6marks)**

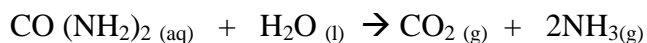
- f) State and give the mathematical description of the second law of thermodynamics. **(2marks)**

## QUESTION TWO

- a) Describe open, closed and isolated systems. **(3marks)**  
b) Using suitable examples, describe what you understand by the terms:
- (i) Extensive properties
  - (ii) Intensive properties
  - (iii) State function
  - (iv) Path functions

**(8marks)**

- c) Calculate the reversible work of expansion of one mole of an ideal gas at 25°C under isothermal conditions, the pressure being changed from 1 to 5 atmosphere. ( $R = 8.314\text{JK}^{-1}\text{mol}^{-1}$ ) **(4marks)**  
d) Urea hydrolyses in the presence of water to produce ammonia and carbon dioxide.



What is the standard entropy change for this reaction when 1 mole of urea reacts with water? The standard entropy data for the reactants and products is shown below:

<i>Substance</i>	<i>S° (cal/mol K)</i>
CO(NH <sub>2</sub> ) <sub>2</sub>	41.55
H <sub>2</sub> O(l)	16.72
CO <sub>2</sub> (g)	51.06
NH <sub>3</sub> (g)	46.01

**(5marks)**

## QUESTION THREE

- a) The thermodynamic quantity enthalpy H, is given as:

$$H = U + PV$$

(i) Describe U, P and V **(3marks)**

(ii) By considering infinitesimal increments to H,U, and V, show that at constant p:

$$\Delta H = dq_p \quad \textbf{(7marks)}$$

- b) Calculate the change in free energy for the isothermal reversible of one mole of an ideal gas from 2.0 atm to 0.2 atm at 25°C. ( $R = 8.314\text{JK}^{-1}\text{mol}^{-1}$ ) **(4marks)**
- c) Calculate the heat of formation of benzene at 25°C, if the heats of combustion of benzene, carbon and hydrogen are -780.98, 94.05 and -68.32Kcal/mol respectively at 25°C. **(6marks)**

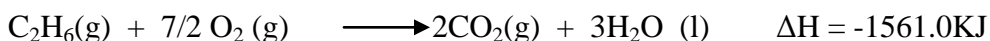
#### QUESTION FOUR

a) Define or explain the following terms:

- (i) Thermo chemistry
- (ii) Thermo chemical equation
- (iii) Entropy
- (iv) Free energy

**(4marks)**

b) Calculate enthalpy of formation of ethane from the following data:



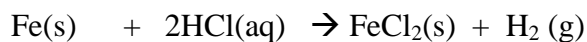
**(6marks)**

c) By the use of a suitable model, show that isothermal reversible expansion work is given as:

$$w = -nRT \ln \frac{V_f}{V_i} \quad \textbf{(10marks)}$$

## QUESTION FIVE

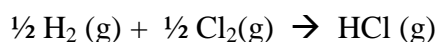
- a) The reaction of iron with dilute HCl can be describe as: ( $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ )



Calculate the work done when 50g of iron reacts with HCl in :

- (i) A closed vessel of fixed volume **(2marks)**  
(ii) An open beaker at  $25^\circ\text{C}$  ( $\text{Fe} = 56\text{g/mol}$ ) **(3marks)**

- b) The heat of the reaction below is  $-22.1\text{KCal}$



Calculate the heat of reaction at  $77^\circ\text{C}$  given the following data

<i>Substance</i>	<i>C.p.m (Calmol<sup>-1</sup>K<sup>-1</sup>)</i>
H <sub>2</sub>	6.82
Cl <sub>2</sub>	7.70
HCl	6.80

**(5marks)**

- c) Four moles of an ideal gas expand isothermally and reversibly from 1 litre to 10 litres at 300K. Calculate the change in free energy of the gas. ( $R = 8.314 \text{ SK}^{-1}\text{mol}^{-1}$ )

**(4marks)**

- d) Using suitable examples, define or explain each of the following terms:

- (i) Spontaneity  
(ii) Gibbs- Helmholtz equation  
(iii) Equation of state

**(6marks)**