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$_2$

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 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 = $8.314JK^{-1}mol^{-1}$) **(4marks)**

d) Urea hydrolyses in the presence of water to produce ammonia and carbon dioxide.

$CO(NH_2)_{2\,(aq)} + H_2O_{(l)} \rightarrow CO_{2\,(g)} + 2NH_{3(g)}$

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:

Substance	*S˚ (cal/mol K)*
$CO(NH_2)_2$	41.55
$H_2O(l)$	16.72
$CO_2(g)$	51.06
$NH_3(g)$	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:

$\Delta H = dq_p$ **(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. ($R = 8.314 JK^{-1}mol^{-1}$) **(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:

$C(g) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H = 393.4KJ$

$H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O$ $\Delta H = -284.61KJ$

$C_2H_6(g) + 7/2\ O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(l)$ $\Delta H = -1561.0KJ$

(6marks)

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

$$w = -nRT\ In\frac{Vf}{Vi}$$ **(10marks)**

QUESTION FIVE

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

$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(s) + H_2(g)$

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˚C (Fe = 56g/mol) **(3marks)**

b) The heat of the reaction below is -22.1KCal

$\frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g) \rightarrow HCl(g)$

Calculate the heat of reaction at 77˚C given the following data

Substance	*C.p.m ($Calmol^{-1}K^{-1}$)*
H_2	6.82
Cl_2	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. ($R = 8.314\ SK^{-1}mol^{-1}$)

(4marks)

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

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

(6marks)