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

BTAC

ACH 4208 : PHYSICAL CHEMISTRY II

SPECIAL/SUPPLEMENTARY EXAMINATION

MARCH 2014 SERIES

2 HOURS

Instructions to candidates:

This paper consist of **FIVE** questions
Answer question **ONE** (compulsory) and any other **TWO** questions

Question ONE

a) Define

(i) Standard Enthalpy of formation **(2marks)**

(ii) Liquefaction of gases **(2marks)**

(iii) Activity of ideal gases **(2marks)**

(iv) Heat capacity **(2marks)**

b) At 20˚C the EmF of $Hg|Hg_2Cl_2(s)|HCl(aq)|H_2g|PE$ is 0.2692V and of 30˚C is 0.2660V find the valves of change in free energy and entropy change at 25˚C

$0.5Hg_2Cl_2(s)\ Cl(s) + ½\ H_2(g) \rightleftharpoons Hg(l) + HCl(aq)$ **(5marks)**

c) Calculate

(i) Equilibrium constant at 25˚C given ΔH_f° of $CH_3OH(g)$, $CO(g)$ and $H_2(g)$ as 161.9, -110.5 and 130.6 Kj per mole respectively $Co(g) + H_2(g) \rightleftharpoons CH_3OH(g)$ **(5marks)**

(ii) Standard free energy change for the reaction below (ΔH_f° of $Fe_2O_3(g)$ $O_3(g)$, $Co(g)$, $Fe(s)$ and $CO_2(g)$ as -824.3, -110.5, 0 and 393.5 Kj per mole respectively while standard entropies of $Fe_2O_3(g)$, $CO(g)$, $Fe(s)$ and $CO_2(g)$ as 87.4, 197.6, 27.3 and 213.6 joules per kilo mole respectively)

$Fe_2O_3(g) + CO(g) \rightarrow Fe(s) + CO_2(g)$ **(7marks)**

c) Sketch phase diagram for substance X dissolve in ice and show the following eutectic and congruent mP with their respective composition **(5marks)**

Composition in mole per cent	Congruent, melting point	Eutectic point	Compound
20	-	-20	
30	-	-10	
25	5	-	$X.4H_2O$
35	10	-	$X2H_2O$

Question TWO

a) Differentiate between incongruent melting and congruent melting point **(3marks)**

b) The vapour pressure of water at 25˚C is 2.47×10^3 Pascal while its partial pressure is 2.35×10^3 pascal. Calculate activity of water **(3marks)**

c) During combustion of 1.5grams of Mapthalene C_8H_{10} in constant volume colorimeter 1500grams of water rose from 15.17˚C to 22.84˚C. Given heat capacity of Naphalene as 1.8×10^3δ/˚C and specific heat of water as 4.184δ/˚C calculate molar molar enthalpy of combustion of Napthalene **(5marks)**

d) Differentiate between path function and state function **(2marks)**

e) Given standard enthalpies of formation of $NH_4NO_3(s)$, $NH_4^+(aq)$, $NO_3^-(aq)$ as -365.56, -132.51 and -205.0 kilojoules per mole respectively and standard entropies of $NH_4NO(s)$ $NH_4^+(aq)$, $NO_3(aq)$ as 151.08, 113.4 and 146.4 Kjoules per mole respectively. Calculate standard free energy change at 25˚C

f) Reaction $NH_4NO(s) + H_2O(l) \rightarrow NH_4^+$ a1) $+ NO_3^-(aq)$ **(5marks)**

Question THREE

a) The partial pressure at 300Kelvin for $CH_4(g)$ 0.320, $CS_2(g)$ 0.252, $H_2S(g)$ 0.125

and $H_2(g)$ as 0.1 atmospheres respectively calculate change in free energy.

Reaction $CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$ **(6marks)**

b) A bomb calorimeter contains 2ml of benzene (density 0.856g/ml) with excess oxygen. One combustion of benzene the temperatures changes by 6.329˚C. Calculate enthalpy of combustion of benzene (heat capacity of benzene is 11250.8joules/˚C)

$C_6H_6(l) + 7.5O_2(g) \rightarrow CO_2(g) + 3H_2O(l)$ **(5marks)**

c) The change is free energy and entropy change during adiabatic isothermal compression of one mole of an ideal gas at 300Kelvin is from 101.3KPa to 10.13 mPa. Calculate work done **(4marks)**

d) Calculate enthalpy of formation of KOH(s)

$K(s) + O_2(g) + H_2(g) \rightarrow KPH(s)$

Using the following data

I. $2Ks + 2HsO(l) \rightarrow 2KOH(aq) + H_2(g)$ $\Delta H, = -376.6Kj$

II. $2H_2(g) + O_2 \rightarrow 2H_2O(l)$ $\Delta H_2 = -577.4KJ$

III. $2KOH(s) + aq \rightarrow KOH(aq)$ $\Delta H_3 = -58.58Kj$

(5marks)

Question FOUR

a) Given Pc = 45.0atm, VC = 275.8L.Per mole calculated van der Waals constant Q and B

(3marks)

b) Two liquids A and B form ideal solution at 300K, The partial pressure of solution containing 1 mole of A and 3 moles of B is 550mm of Hq. If one mole of B is added to this solution the vapour pressure increases by 10mm of Hg. Determine vapour pressure of A and B **(6marks)**

c) At 30C combustion of Hydrocarbon at constant pressure release 515.3Kj determine work done

$C_xH_N(l) + 12O_2(g) \rightarrow 6CO_2(g) + 5H_2O(l)$ **(6marks)**

d) Explain

(i) Classical thermodynamics

(ii) Joule Thomson effect **(5marks)**

Question FIVE

a) An aqueous solution containing 28% by mass of liquid A (Rmm = 140) has A vapour

pressure of 160mmHg at 37˚C is 150mmHg). **(5marks)**

b) Explain

(i) Equilibrium thermodynamics

(ii) Non-Equilibrium thermodynamics **(4marks)**

c) Sketch a well labelled diagram of water system showing all phases at equilibrium.

(5marks)

d) Calculated the valve of gas constant R for one mole of ages at S.T.P (273 Kelvin and 760 tons) **(3marks)**

e) Explain Zenith law of thermodynamics **(3marks)**