



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY (INDUSTRIAL OPTION)

BTAC 16S, SEPT 2016

ACH 4208 PHYSICAL CHEMISTRY II

SPECIAL/ SUPPLEMENTARY EXAMINATIONS

SERIES: SEPTEMBER 2018

TIME: 2 HOURS

## 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 question

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

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## *Paper two*

### QUESTION ONE

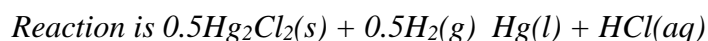
A. Calculate Enthalpy of formation of benzene from heat of combustion of liquid benzene which is - 630.31 per mole. Given enthalpy of formation of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  as -393.5 and -285.85 kilo joules respectively. **5 marks**

B. Define

i. standard enthalpy of formation (iii) Liquefaction of gases

ii. activity of ideal gases (iv) heat capacity **8 marks**

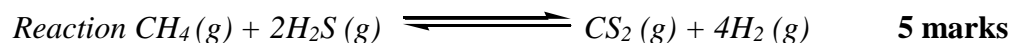
C. At  $20^\circ\text{C}$  the standard EMF of the cell  $\text{Hg}|\text{Hg}_2\text{Cl}_2(\text{s})|\text{HCl}(\text{aq})\text{H}_2$ , Pt is 0.2692V and at  $30^\circ\text{C}$  it is 0.2660V. Find the values of change in free energy, Enthalpy of reaction and entropy change at  $25^\circ\text{C}$ . **6 marks**



- D. Discuss liquefaction of gases **5 marks**
- E. Sketch a well label diagram of water showing all phases at equilibrium **6 marks**

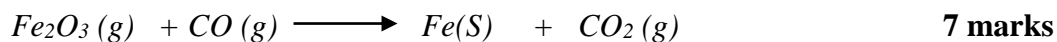
### QUESTION TWO

- A. 1.22 grams of benzene  $C_6H_6$  was burnt in constant volume calorimeter. Consequently the temperature of water rose from  $15.17^\circ C$  to  $22.84^\circ C$ . If the quantity of water was 1500grams and heat capacity of bomb calorimeter was  $1.75 \times 10^3$  Joules  $^\circ C$ . Calculate Heat of reaction on molar basis given specific heat of water as  $4.184 J/^\circ C.g$  **5 marks**
- B. Calculate vapour pressure of water at 298kelvin given enthalpy of vaporization at normal Bp as  $410.26 J/mol$  **5 marks**
- C. Determine Work done At  $25^\circ C$  for combustion of hydrocarbon at constant pressure if it releases 515.3kj of heat **5 marks**
- D. Given partial pressures at 300 kelvin fo the following equilibrium as  $CH_4(g)$  as 0.320,  $CS_2(g)$  as 0.252 ,  $H_2S$  as 0.125 and  $H_2(g)$  as 0.1 Calculate change in free energy and Predict if below equilibrium is spontaneous or non-spontaneous



### QUESTION THREE

- A. Calculate the standard free energy change for the following reaction at  $25^\circ c$  . Given standard enthalpies of formation of  $Fe_2O_3(g)$  ,  $CO(g)$ ,  $Fe(S)$  and  $CO_2(g)$  as -824.3, -110.5,0 and 393.5 Kilojoules per mole respectively wile 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.



- B. Differentiate between path function and state function **3 marks**
- C. Calculate Change in free energy and entropy during adiabatic isothermal compression of one mole of an ideal gas at 300 kelvin from 101.3 KPa to 10.13MPa. **4 marks**
- D. Calculate the value for  $\Delta H$  for the  $CS_2(l) + 3 O_2(g) \rightarrow CO_2(g) + 2 SO_2(g)$  **6 marks**  
 Given:
- $C(s) + O_2(g) \rightarrow CO_2(g)$ ;  $\Delta H_f = -393.5$  kJ/mol
  - $S(s) + O_2(g) \rightarrow SO_2(g)$ ;  $\Delta H_f = -296.8$  kJ/mol
  - $C(s) + 2 S(s) \rightarrow CS_2(l)$ ;  $\Delta H_f = 87.9$  kJ/mol

#### QUESTION FOUR

- A. Given standard enthalpies of formation of  $\text{NH}_4\text{NO}_3(s)$ ,  $\text{NH}_4^+(aq)$ ,  $\text{NO}_3^-(aq)$  as  $-365.56$ ,  $-132.51$  and  $-205.0$  Kilojoules per mole respectively and standard Entropies of  $\text{NH}_4\text{NO}_3(s)$ ,  $\text{NH}_4^+(aq)$ ,  $\text{NO}_3^-(aq)$  as  $151.08$ ,  $113.4$  and  $146.4$  joules per kilo mole respectively  
Calculate standard free energy change at  $25^\circ\text{C}$  for the reaction :
- Reaction*  $\text{NH}_4\text{NO}_3(s) + \text{H}_2\text{O}(l) \rightarrow \text{NH}_4^+(aq) + \text{NO}_3^-(aq)$  **6 marks**
- B. The critical constant of chlorine are  $P_c = 45.0$  atmospheric and  $V_c = 275.8$  L per mol  
calculate Vander Waals constants  $a$  and  $b$  **4 marks**
- C. discuss Joule-Thomson effect **4 marks**
- D. A and B form ideal solution. At  $300$  K, the vapour pressure of a solution containing  $1$  mole of A and  $3$  moles of B was  $550$  mmHg. At the same temperature, if one more mole of B is added to this solution, the vapour pressure of the solution increases by  $10$  mmHg. Determine vapour pressure of A and B in their pure states. **6 marks**

#### QUESTION FIVE

- A. An aqueous solution containing  $28\%$  by mass of a liquid A (molecular Mass =  $140$ ) has a vapour pressure of  $160$  mm at  $37^\circ\text{C}$ . Find the vapour pressure of the pure liquid A. (The vapour pressure of water at  $37^\circ\text{C}$  is  $150$  mm). **6 marks**
- B. Define
- i. Equilibrium thermodynamics
  - ii. Non-equilibrium **5 marks**
- C. state zeroth law of thermodynamics **3 marks**
- D. Sketch phase diagram for a substance X (not specific substance) dissolve in ice using the following data and identify Eutectic and congruent melting points **6 marks**

Composition in mole percent	20	30	25	35
Temperature $^\circ\text{C}$	-20	-10	5	10
Compound			X .4H <sub>2</sub> O	X 2H <sub>2</sub> O