THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

P.O. Box 62157

00200 Nairobi - KENYA

Telephone: 891601-6

MAIN EXAMINATION

JANUARY – APRIL 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCE (CHEMISTRY)

REGULAR PROGRAMME

CHEM 201:PHYSICAL CHEMISTRY I

Date: APRIL 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and ANY OTHER TWO Questions	

Q1. a) Substances A and B are known to form a eutectic mixture. The melting point of the A-B alloy is lowest when X_A = 0.6. Both substances are less soluble at very high ratios. Sketch the Eutectic diagram for the A-B alloy mixture explaining its different sections. **(5 marks)**

b) Calculate the thermal energy needed to raise the temperature of 25.0 g of iron from 201 K to 1067 K. (Specific heat capacity of iron is 0.45 J K^{-1} g^{-1}) **(5 marks)**

c) If:

$$CH_2O_{(g)} + H_2O_{(g)} \rightarrow CH_{4(g)} + O_{2(g)} \quad \Delta H = +275.6\,kJ \quad \ldots 1$$

$$CH_2O_{(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)} \quad \Delta H = -526.7\,kJ \quad \ldots 2$$

$$H_2O_{(l)} \rightarrow H_2O_{(g)} \quad \Delta H = 44.0\,kJ \quad \ldots 3$$

Calculate the ΔH for:

$$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$$ **(5 marks)**

d) Using the ideal gas law, calculate the mass of a 10.89 L sample of ammonia gas measured at standard conditions.
Hint: Use K units for temperature and atm. units for Pressure.
(R = 0.0821 L. atm./ mol. K, mass number for N = 14; H = 1). **(5 marks)**

e) Substances A and B react in the following way:
A + B ⟶ C + D

The table below depicts the concentrations of the reactants and products at different temperatures:

Temp. (K)	207	273	387	498	567
Conc. of A (mg/l)	1.56	3.66	4.23	5.87	7.02
Conc. of B (mg/l)	2.12	4.01	5.93	6.67	7.45
Conc. of C (mg/l)	9.81	8.16	8.02	7.13	5.29
Conc. of D (mg/l)	10.11	9.04	8.65	7.63	5.33

Using the Van't Hoff equation graphically determine if the reaction is exothermic or endothermic in nature (R = 8.314 J/ K.mol.) (Use graph paper provided) **(5 marks)**

f) Gas A (T_A = 125K) and gas B (T_B = 501K) contained in two compartments separated from their surroundings. Calculate the entropy change (ΔS) if the partition between the two compartments is removed and the two gases are allowed to mix (ΔU_A=7.8KJ) **(5 marks)**

Q2. a) Pt. and Ag form a peritectic alloy. The melting point of Ag is 920°C while that of Pt. is 1,750°C. The peritectic temperature is 1,200°C. Sketch the peritectic phase diagram of these two metals **(6marks)**

b) A piston is used to reversibly compress 0.6 moles of an ideal gas from 121 ml to 56 ml at 300K.

i) Calculate the PV work done on the gas **(5 marks)**

ii) If the gas then undergoes further adiabatic compression, the temperature increases by 17K. Assuming that its heat capacity at constant volume (C_V) is 15 J K^{-1} $mol.^{-1}$, calculate its change in internal energy (ΔU) (R = 8.314 J/K. mol.) **(5 marks)**

iii) Calculate the enthalpy change (ΔH) in the gas after the above two steps **(4 marks)**

Q3. a) Use relevant examples to define the following terms:

i) Enthalpy of Reaction ($\Delta_r H$)

ii) Standard Enthalpy of Formation ($\Delta_f H^o$ ¿

iii) Enthalpy of Combustion ($\Delta_c H$ ¿ **(6 marks)**

b) Calculate the enthalpy change OF 0.15moles of a substance experiencing a temperature change of 450K if $C_{v.m}$ = 18 J/K. mol. (R = 8.314 J/K. mol.).

(4 marks)

c) Using a diagram, explain the differences between the following thermodynamic processes:
   i) Adiabatic Process
   ii) Isochoric Process
   iii) Isothermal Process
   iv) Isobaric Process **(6 marks)**

d) Describe Dalton's Law of Partial Pressures **(4 marks)**

Q4. a) 0.75 moles of a material experiences a change in enthalpy (ΔH) of 12.35 J/mol. at 238K.
   i) Calculate the heat capacity at constant volume (C_V) for the material (R = 8.314 J/K. mol.) **(3 marks)**

   ii) Calculate the change in internal energy (ΔU) of the reaction **(3 marks)**

b) Two similar metals of the same size and cross-sectional area are contacted to each other. Temperature of the hotter metal is 607 K and that of the colder metal is 78 K. Calculate the entropy change due to heat transfer after contact. (C_V = 0.871 J/g. K) **(5 marks)**

c) Using a relevant diagram, illustrate how real gases deviate from ideality **(5 marks)**

d) Using relevant diagrams, describe the inverse lever rule **(4 marks)**

Q5. a) Using a diagram, explain the Maxwell's distribution of gases at different temperatures **(4 marks)**

b) Explain the applications of thermodynamics in:
   i) Protein Folding
   ii) Mineral Exploration **(6 marks)**

c) Describe the different types of thermodynamic systems **(6 marks)**

d) Explain why at constant heat flow, a change of entropy is higher at low temperature than at high temperature **(4 marks)**

END