# MACHAKOS UNIVERSITY

**University Examinations for 2021/2022 Academic Year**

**SCHOOL OF PURE AND APPLIED SCIENCES**

**DEPARTMENT OF PHYSICAL SCIENCES**

**SECOND YEAR FIRST SEMESTER EXAMINATION FOR**

**BACHELOR OF EDUCATION (SCIENCE)**

**BACHELOR OF EDUCATION (SPECIAL NEEDS EDUCATION)**

**BACHELOR OF SCIENCE (MATHEMATICS)**

**SCH 201: CHEMICAL THERMODYNAMICS**

**DATE: 14/12/2021** **TIME: 2.00-4.00 PM**

**INSTRUCTIONS:**

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

**SECTION A: COMPULSORY**

**QUESTION ONE (30 MARKS)**

a) Define the following terms;

i. Hess law

ii. Isolated system

iii. Specific heat capacity

iv. Surrounding

v. enthalpy

vi. Heat of vaporization

vii. Entropy (7 marks)

b) Calculate q, w, $\Delta H$, $\Delta S_{system}$, $\Delta S_{surr}$ and $\Delta S_{universe}$ for one mole of an ideal gas which expands from $V_1$ to $10V_1$ at 300 K isothermally under reversible conditions (Use R = 8.314 J/Kmol) (6 marks)

c) Calculate $\Delta H^{o}$ for the reaction give that the standard heats of formation of $C_2H_5OH(l)$, $CO_2(g)$ and $H_2O(l)$ are – 277.0, –393.5 and –285.5 $kJmol^{-1}$ respectively. Calculate the standard heat change for the reaction shown $C_2H_5OH(l) + 3O_2(l) \rightarrow 2CO_2(g) + 3H_2O(l)$ (5 marks)

d) Define heat of combustion and state its common applications. (5 marks)

e) Calculate the 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 (atm). (4 marks)

f) Distinguish between Gibbs free energy and internal energy. (3 marks)

**SECTION B (ANSWER ANY TWO QUESTIONS)**

**QUESTION TWO (20 MARKS)**

a) At 73 K, the entropy change for the transition of liquid water to steam is 915 $JK^{-1}$ $mol^{-1}$. Calculate the enthalpy change $\Delta H_{vap}$ for the process. (3 marks)

b) In a given process $\Delta H$ = 100 kJ and $\Delta S$ = 100 $JK^{-1}$ at 400 K were as determined. What would be the value of $\Delta G$ at 400 K? (3 marks)

c) Two moles of an ideal gas expanded isothermally and reversibly at 300 K to twice the original volume. Calculate q, w, $\Delta E$ and $\Delta H$ (R = 8.314 J/Kmol) (5 marks)

d) With the help of suitable examples, differentiate between adiabatic system and a closed system. (3 marks)

e) Explain heat capacity at constant pressure thermodynamically. (3 marks)

f) Distinguish between work done by the system and work done on the system. (3 marks)

**QUESTION THREE (20 MARKS)**

a) $\Delta G$ and $\Delta H$ values for a reaction at 300 K are: –66.944 kJ and –41.84 kJ respectively. Calculate the free energy change at 330 K, assuming that $\Delta H$ and $\Delta S$ remain constant over this temperature range. (3 marks)

b) Under what conditions is $\Delta E = \Delta H$ for a chemical reaction? (2 marks)

c) Providing relevant examples, state and explain heat of sublimation and heat of reaction. (3 marks)

d) Calculate the value of $\Delta E$ and $\Delta H$ on heating 64 grams of oxygen from 0 °C to 1000 °C. $C_V$ and $C_P$ on an average are 5.0 and 7.0 J/mol.K, respectively. (5 marks)

e) State and explain First law of Thermodynamics. (3 marks)

f) Determine the maximum work which can be obtained by the isothermal reversible expansion of two moles to three moles of an ideal gas at 273 K from 1.12 litres to 11.2 litres. (4 marks)

**QUESTION FOUR (20 MARKS)**

a) Distinguish between homogenous and heterogeneous systems. Give an examples for each category. (4 marks)

b) Briefly describe any TWO methods of liquefaction of gases. (4 marks)

c) Explain the following:

i. Increase in volume of a gas for a given decrease in pressure is less in an adiabatic expansion than in isothermal expansion. (2 marks)

ii. All spontaneous processes lead to increase the entropy of the universe (2 marks)

d) When one mole of liquid $Br_2$ is converted to $Br_2$ vapour at 25 ºC and 1 atm pressure, 7.3 kJ of heat is absorbed and 0.59 kJ of expansion work is done by the system. Calculate $\Delta E$ for this process. (4 marks)

e) Define $C_P$ and $C_V$ and state their relationship. (4 marks)

**QUESTION FIVE (20 MARKS)**

a) Calculate the amount of heat necessary to raise 63.5 g of water from -20 º to 105 ºC. Molar heat capacity of water is 18 J/mol.K. (5 marks)

b) Calculate $\Delta E$ for the combustion of one mole of Magnesium in an open container at 208 K and 1 atm pressure, if $\Delta H$ *combustion* = – 145.9 kJ. (5 marks)

c) State the **FOUR** factors that affect the quantity of heat evolved or absorbed in a chemical transformation. (4 marks)

d) Differentiate between reversible and irreversible processes. (3 marks)

e) Calculate the work done on the system if one mole of an ideal gas at 300 K is compressed isothermally and reversibly to one-fifth of its original volume. (3 marks)