KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.Sc. (CHEMISTRY)

COURSE CODE: SCH 213

COURSE TITLE: BASIC CHEMICAL THERMODYNAMICS

DATE: 14/12/2022 **TIME:** 9:00-11:00AM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 Hours

Answer **Question ONE** and **any TWO** of the remaining

KIBU observes ZERO tolerance to examination cheating

QUESTION ONE (30 Marks)

(a) Define the following terms

i. Energy

ii. Heat **(2Marks)**

iii. Thermodynamics **(2Marks)**

iv. Adiabatic process **(2Marks)**

(2Marks)

(b) Deduce the significance of gas constant R using ideal gas equation $pv = nRT$

(3Marks)

(c) (i) State the Hess's law **(2marks)**

(ii) . From the following enthalpies of reaction

$H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{(g)}$ ΔH = –285 kJ

$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$ ΔH = –394 kJ

$2\,C_{(s)} + 2\,H_{2\,(g)} \rightarrow C_2H_{4\,(g)}$ ΔH = –52.3 kJ

Calculate Heat of the reaction of $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$ **(3marks)**

(d)(i) Starting with $\Delta E = q - W$, show that the heat capacity at constant volume is given by $C_v = (\frac{dE}{dT})$ **(5Marks)**

(e) (i) Define a system **(2Marks)**

(ii)State three thermodynamic systems **(3Marks)**

(f)) Calculate the standard Gibbs free energy for the reaction at 25°C **(4Marks)**

$C_{(s)} + O_{2\,(g)} \rightarrow CO_{2\,(g)}$

$(\Delta H^o = -393.4kJmol^{-1}, \Delta S = 2.9jK^{-1})$

Question Two (20 Marks)

(a) Calculate the standard Gibbs free energy for the reaction at 25°C **(5Marks)**

$H_{2(s)} + \frac{1}{2}O_{2\,(g)} \rightarrow H_2O_{(g)}$

$(\Delta H^o = -285.64kJmol^{-1}, \Delta S = 1.89jK^{-1})$

(b) Using $E = \frac{1}{2}mv^2$ show that kinetic energy of a system is given by $E_k = \frac{3}{2}RT$ **(5Marks)**

(c) Using the information given below, calculate the entropy of the reaction $2CO_{(s)} + O_{2\,(g)} \rightarrow 2CO_{2\,(g)}$ at 25°C **(6Marks)**

	$S^{\theta} jK^{-1}mol$
CO_2	148
CO	47
O_2	205

(d) (i) What is a state variables **(2Marks)**

(ii) State any two examples of state variables **(2Marks)**

QUESTION THREE (20 Marks)

(a) (i) Using $\Delta E = q - W$, show that $\left(\frac{T_2}{T_1}\right) = \left(\frac{V_1}{V_2}\right)^{\propto -1}$ for reversible adiabatic expansion **(10Marks)**

(ii) 2 moles of ideal gas 300K is compressed adiabatically to ¼ of the original volume. Find temperature of the gas after compression $(C_v = 12.5jk^{-1}mol^{-1})$ **(10Marks)**

QUESTION FOUR (20 Marks)

(a) (i) State the second law of thermodynamics **(2Marks)**

(ii) Starting with $\Delta E = q - W$, Show that entropy change of a system when temperature and volume are variables is given by $\Delta S = \left[nC_v ln\left(\frac{T_2}{T_1}\right) + nRln\left(\frac{V_2}{V_1}\right)\right]$ **(10Marks)**

(iii) For one mole of a gas when temperature and volume are variables the entropy is given by;

$\Delta S = \left[C_v ln\left(\frac{T_2}{T_1}\right) + Rln\left(\frac{V_2}{V_1}\right)\right]$. Using this expression show that entropy of an isothermal process is $\Delta S = \left[Rln\left(\frac{P_1}{P_2}\right) = Rln\left(\frac{V_2}{V_1}\right)\right]$ **(5Marks)**

(b) Distinguish between isobaric and isochoric processes **(3Marks)**

QUESTION FIVE (20 Marks)

(a)Starting with the first law of thermodynamics $(dE = dq - dw)$, derive $C_p = \left(\frac{dH}{dT}\right)$ **(10Marks)**

(b) Using the ideal gas equation. Derive the numerical values of gas constant R **(5 marks)**

(c) Using $\Delta E = q - W$, show that heat of an isothermal reversible process is

$q = nRTln\left\{\frac{V_2}{V_1}\right\}$ **(5 marks)**