



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)

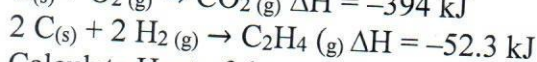
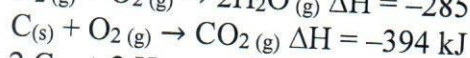
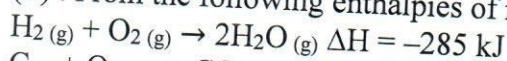
(a) Define the following terms

- i. Energy (2Marks)
- ii. Heat (2Marks)
- iii. Thermodynamics (2Marks)
- iv. Adiabatic process (2Marks)

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

(c) (i) State the Hess's law (3Marks)

(ii) From the following enthalpies of reaction (2marks)



Calculate Heat of the reaction of $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$

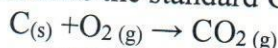
(d)(i) Starting with $\Delta E = q - W$, show that the heat capacity at constant volume is given (3marks)

$$\text{by } C_v = \left(\frac{dE}{dT}\right)$$

(e) (i) Define a system (5Marks)

(ii) State three thermodynamic systems (2Marks)

(f) Calculate the standard Gibbs free energy for the reaction at 25°C (3Marks)

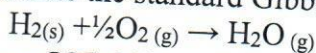


$$(\Delta H^\circ = -393.4 \text{ kJ mol}^{-1}, \Delta S = 2.9 \text{ J K}^{-1})$$

(4Marks)

Question Two (20 Marks)

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



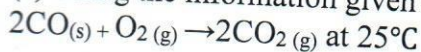
$$(\Delta H^\circ = -285.64 \text{ kJ mol}^{-1}, \Delta S = 1.89 \text{ J K}^{-1})$$

(5Marks)

(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



(6Marks)

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

(d) (i) What is a state variables

(ii) State any two examples of state variables

(2Marks)

(2Marks)

QUESTION THREE (20 Marks)

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

(10Marks)

(ii) 2 moles of ideal gas 300K is compressed adiabatically to $\frac{1}{4}$ of the original volume. Find temperature of the gas after compression ($C_v = 12.5 \text{ J K}^{-1} \text{ mol}^{-1}$)

(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 $\Delta S = \left[nC_v \ln \left(\frac{T_2}{T_1} \right) + nR \ln \left(\frac{V_2}{V_1} \right) \right]$ **(10Marks)**
(iii) For one mole of a gas when temperature and volume are variables the entropy is given by;
 $\Delta S = \left[C_v \ln \left(\frac{T_2}{T_1} \right) + R \ln \left(\frac{V_2}{V_1} \right) \right]$. Using this expression show that entropy of an isothermal process is $\Delta S = \left[R \ln \left(\frac{P_1}{P_2} \right) = R \ln \left(\frac{V_2}{V_1} \right) \right]$ **(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
 $q = nRT \ln \left\{ \frac{V_2}{V_1} \right\}$ **(5 marks)**