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KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR**

**SECOND YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL EXAMINATIONS
FOR THE DEGREE OF B.Sc. (CHEMISTRY)**

COURSE CODE: SCH 213

COURSE TITLE: BASIC CHEMICAL THERMODYNAMICS

DATE: 18/7/2022

TIME: 8:00AM-10:00AM

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
- Process (2Marks)
 - Work (2Marks)
 - Heat (2Marks)
 - Reversible process (2Marks)
- (b) Deduce the numerical values 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
- $$\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \rightarrow 2\text{HF}(\text{g}) \quad \Delta H = -537 \text{ kJ}$$
- $$\text{C}(\text{s}) + 2 \text{F}_2(\text{g}) \rightarrow \text{CF}_4(\text{g}) \quad \Delta H = -680 \text{ kJ}$$
- $$2 \text{C}(\text{s}) + 2 \text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_4(\text{g}) \quad \Delta H = -52.3 \text{ kJ}$$
- Calculate the ΔH for the reaction of $\text{C}_2\text{H}_4(\text{g})$ with $\text{F}_2(\text{g})$ to make $\text{CF}_4(\text{g})$ and $\text{HF}(\text{g})$ (3marks)
- (d)(i) Starting with $E = q + W$, show that the heat capacity at constant pressure is given by $C_p = \left(\frac{dH}{dT}\right)$ (4Marks)
- (e) (i) Define a system (2Marks)
- (ii) State the three thermodynamic systems (3Marks)
- (f) Using $E = \frac{1}{2}mv^2$ show that kinetic energy of a system is given by $E_k = \frac{3}{2}RT$ (5Marks)

Question Two (20 Marks)

- (a) Using the first law of thermodynamics ($dE = dq + dw$), show the specific heat capacity at constant pressure is given by $C_p = \left(\frac{dH}{dT}\right)$ (10Marks)
- (b) Using the ideal gas equation. Derive and state the physical significance of gas constant R (5 marks)
- (c) Show that $C_p - C_v = 1$ (5 marks)

QUESTION THREE (20 Marks)

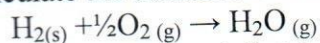
- (a) (i) Using $E = q + W$, show that $\left(\frac{T_2}{T_1}\right) = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$ for reversible adiabatic expansion (10Marks)
- (ii) 2 moles of ideal gas 300K is compressed adiabatically to $\frac{1}{4}$ of the original volume. Find temperature of the gas after compression ($C_v = 12.5 \text{ J K}^{-1} \text{ mol}^{-1}$) (10Marks)

QUESTION FOUR (20 Marks)

- (a) (i) State the Carnot theorem (2Marks)
- (ii) Using the efficiency of the transformation of heat into work in a heat engine, show that $\frac{q_2}{T_2} + \frac{q_1}{T_1} = 0$ (10Marks)
- (iii) From $\Delta S = C_v \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1}$ for one mole of a gas when temperature and volume are variables deduce the equation for entropy changes when pressure and temperature are variables (8Marks)

QUESTION FIVE (20 Marks)

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

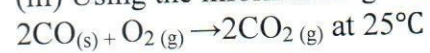


($\Delta H^\circ = -285.64 \text{ kJ mol}^{-1}$, $\Delta S = 1.89 \text{ J K}^{-1}$) (2Marks)

(b) (i) State the second law of thermodynamics (2Marks)

(ii) Define the term entropy

(iii) 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

(c) (i) What is a state variables (2Marks)

(ii) State any three examples of state variables (3Marks)