Name: Enrolment No:	UPES — UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, June 2021

Course: Physical Chemistry II — **Semester: II**
Program: B. Sc. (Hons.) Chemistry — **Time 03 hrs.**
Course Code: CHEM1006 — **Max. Marks: 100**

SECTION A

1. **Each question will carry 5 marks**
2. **Instruction: Complete the statement/ Select the correct answer**

S. No.	Question	Marks	CO
Q 1	Define extensive and intensive properties. Give two examples of each.	5	CO1
Q 2	One mole of an ideal gas at 25°C is allowed to expand reversibly at constant temperature from a volume of 10 litres to 20 litres. Calculate the work done by the gas. ($R = 8.314\ JK^{-1}Mol^{-1}$)	5	CO2
Q 3	For the reaction $H_2F_2(g) \longrightarrow H_2(g) + F_2(g)$; $\Delta E = -14.2$ kcal/mole at 25° C. Calculate ΔH for the reaction. ($R = 1.98\ CalK^{-1}mol^{-1}$)	5	CO1
Q 4	Suppose that a reaction has ΔH = -24 kJ and ΔS= -60 J/K. At what temperature will it change from spontaneous to non-spontaneous? (a) 500 K (b) 401 K (c) 300 K (d) 40.1 K	5	CO2
Q 5	Choose the correct criterion of spontaneity in terms of properties of the system alone (a) $(dS)_{H,P}<0$ (b) $(dS)_{U,V}>0$ (c) $(dS)_{T,P}<0$ (d) $(dS)_{T,V}>0$	5	CO2
Q 6	For an ideal gas which obeys PV = RT, what is the value of $\left(\frac{\partial S}{\partial V}\right)_T$?	5	CO2

SECTION B

1. **Each question will carry 10 marks**
2. **Instruction: Write short / brief notes**

Q 1	Describe the Joule-Thomson Effect and prove that it is an iso-enthalpic process.	**10**	**CO2**
Q 2	Define heat of formation. 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 kJ mol^{-1} respectively. Calculate the standard heat change for the reaction $C_2H_5OH(l) + 3O_2(l) \rightarrow 2CO_2(g) + 3H_2O(l)$.	**10**	**CO1**
Q 3	Define the second law of thermodynamics. What do you mean by spontaneous process? Calculate the entropy change when 2 moles of an ideal gas are allowed to expand isothermally at 293 K from a pressure of 10 atmosphere to a pressure of 2 atmosphere. ($R = 8.314$ $JK^{-1}mol^{-1}$)	**10**	**CO2**
Q 4	Discuss the free energy and entropy of mixing (i.e. $\Delta_{mix}G$ and $\Delta_{mix}S$) of ideal gases using chemical potential concept.	**10**	**CO3**
Q 5	2.0 mole of He, 4.0 moles of Ne and 5.0 moles of Ar are mixed at the same temperature (298 K) and pressure (1 bar). Assuming ideal gas behaviors, calculate the value of ΔG_{mix}. (Given: R = 8.314 J/K/mol) **OR** Derive the thermodynamic expression of boiling point elevation of a solution.	**10**	**CO3**

SECTION-C

1. **Each question carries 20 marks**
2. **Instruction: Write long answers**

Q 1	**(a)** Derive Gibbs-Helmholtz equation. **OR** Derive the thermodynamic expression of freezing point depression of solution. **(b)** State the Plank's third law of thermodynamics. Calculate the third law entropy of a substance at 300 K using the following data: (i) Heat capacity of solid from 0 K to normal melting point 200 K, $C_p(s)$ = 0.1T J/K/mol (ii) Enthalpy of fusion = 7 kJ/mol (iii) Heat capacity of liquid from 200K to normal boiling point 300 K, $C_p(l)$ = 0.2 T J/K/mol (iv) Enthalpy of vaporization = 20 kJ/mol (v) Heat capacity of gas from 300 K to 350 K, $C_p(g)$ = 0.3 T J/K/mol **OR** Prove that the chemical potential of a pure substance in two phases in equilibrium are equal.	**10** **10**	**CO3**