

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER– III EXAMINATION – SUMMER 2026****Subject Code:3130405****Date:17-06-2026****Subject Name:Concepts of Thermodynamics and Bioenergetics****Time:02:30 PM TO 05:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		MARKS
Q.1	(a) Explain equation of state (EOS) and state its usefulness.	03
	(b) What is fugacity and fugacity coefficient?	04
	(c) Derive the Maxwell's equations from the first principles and state its significance in thermodynamics.	07
Q.2	(a) Explain phase rule. What is degree of freedom at triple point? Why?	03
	(b) Discuss the effect of temperature and pressure on equilibrium constant.	04
	(c) Define energy rich compounds. Explain coupled reaction with example.	07
	OR	
	(c) Explain the working of pH electrodes.	07
Q.3	(a) Write the linear form of equation that relates activation energy and temperature.	03
	(b) 1. The E_0 of the $2H^+ + 2e^- \rightarrow H_2$ half reaction is arbitrarily set at zero. Calculate E'_0 at pH 8. 2. The E_0 of the $NAD^+ + 2H^+ + 2e^- \rightarrow NADH + H^+$ half reaction is -0.32v at pH 7. Calculate E'_0 at pH 5	04
	(c) Explain the concept of thermodynamic analysis of processes with reference to the lost work and irreversibility.	07
	OR	
Q.3	(a) Which assumptions are made to derive ΔG^0 from ΔG ? Write expression of both ΔG^0 , and ΔG .	03
	(b) Explain classical and statistical thermodynamics.	04
	(c) Assuming validity of Raoult's Law, draw P-x ₁ -y ₁ diagram for binary mixture at temp of 75°C. Clearly show vapor region, liquid region, bubble point and dew point curves. Data given: At 75°C, $P_1^{sat} = 83.21$ kPa and $P_2^{sat} = 41.98$ kPa	07
Q.4	(a) Discuss the estimation of thermodynamic properties using equation of state.	03
	(b) Calculate standard state ΔG values at pH 5 for dissociation of acetic acid: $HOAc \leftrightarrow OAc^- + H^+$. $K_a = 1.75 \times 10^{-5}$. Calculate G_{ion} at pH 5 for the same reaction.	04
	(c) Discuss several hypotheses explaining how electron transport in mitochondria or bacterial membranes can be coupled to ATP formation.	07
	OR	
Q.4	(a) Write down Raoult's Law explaining each term associated with it with its applicability.	03
	(b) Explain concept of entropy in brief.	04
	(c) Explain Vander Waals equation of state and derive expressions of constants 'a' and 'b'.	07
Q.5	(a) With reference to thermodynamics, define the following: i) isolated system ii) intensive property iii) adiabatic process	03

- (b) Define and explain dew point and bubble point temperature. **04**
(c) Mention and explain the common forms of the statements of the second law of thermodynamics. **07**

OR

- Q.5** (a) Explain the importance of azeotropes with examples. **03**
(b) Explain heat engine and its related terminologies. **04**
(c) Explain PVT behavior of pure substance with the help of PT and PV diagram in brief. **07**
