Reg.No.:								

VIVEKANANDHA COLLEGE OF ENGINEERING FOR WOMEN
[AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY, CHENNAI]
Elayampalayam – 637 205, Tiruchengode, Namakkal Dt., Tamil Nadu.

Question Paper Code: 1003

B.E. / B.Tech. DEGREE END-SEMESTER EXAMINATIONS – MAY 2019
Second Semester
Biotechnology
U15GE204 – BIOCHEMICAL THERMODYNAMICS
(Regulation 2015)

Time : Three Hours Maximum : 100 Marks

Answer ALL the questions

PART – A

(10 x 2 = 20 Marks)

1. Differentiate between intensive and extensive properties.
2. What are high energy compounds? Give examples.
3. State the ideal gas law.
4. Draw the Pressure-Temperature diagram for a pure substance and label it.
5. Give the latent heat of vaporization of water at 373.15 K (100◦C) is 2257 kJ kg^{-1}, estimate the latent heat at 573.15 K (300◦C).
6. Define the standard heat of reaction.
7. Write down the equation for Gibbs free energy.
8. Comment on the following equation:
   ΔS (isolated system) ≥ 0
9. What do you mean by Energy coupling?
10. Define thermodynamic efficiency of growth.

PART – B

(5 x 13 = 65 Marks)

11. a) i. Derive the equation for I law for thermodynamics for flow process. (8)

ii. A system consisting of a gas confined in a cylinder is undergoing the following series of processes before it is brought back to the initial conditions.

Step 1: a constant pressure process when it receives 50 J of work and gives up 25 J of heat.

Step 2: A constant volume process when itreceives 75 J of heat

Step 3: Adiabatic process

Determine the change in internal energy during each step and the work done during the adiabatic process. (5)

(OR)

b) With suitable examples, outline the different oxidation and reduction reactions occurring biologically and the connection between these mechanisms with ATP metabolism.

12. a) i. Derive the equation for work done in an adiabatic process involving ideal gas. (10)

ii. Show that $C_P - C_V = R$ for an ideal gas. (3)

(OR)

b) i. Write a short note on Compressibility factor. (5)

ii. State the principle of corresponding states. Explain the generalized compressibility chart based on principle of corresponding states. (8)

13. a) One method for the manufacture of 'synthesis gas' (primarily a mixture of CO and H_2) is the catalytic reforming of CH_4 with steam at high temperature and atmospheric pressure:

$$CH_4(g) + H_2O(g) \longrightarrow CO(g) + 3H_2(g)$$

The only other reaction which occurs to an appreciable extent is the water-gas- shift reaction:

$$CO(g) + H_2O(g) \longrightarrow CO_2(g) + H_2(g)$$

If the reactants are supplied in the ratio, 2 mol steam to 1 mol CH_4, and if heat is supplied to the reactor so that the products reach a temperature of 1300 K, the CH_4 is completely converted and the product stream contains 17.4 mol% CO. Assuming the reactants to be preheated to 600 K, calculate the heat requirement for the reactor.

(OR)

b) i. The standard heat of reaction at 298 K for the following reaction is -42.433 kJ.

$$C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(g)$$

Calculate the heat of reaction at 400K. The constants in the heat capacity equation

$$C_P = \alpha + \beta T + \gamma T^2$$

are as given below: (C_P is in J/mol K and T in K)

	A	B	γ
C_2H_4	11.85	119.75×10^{-3}	-36.53×10^{-6}
H_2O	30.38	9.62×10^{-3}	$+1.19 \times 10^{-6}$
C_2H_5OH	29.27	166.39×10^{-3}	-49.93×10^{-6}

(8)

ii. Define Heat capacity. Derive the equation for heat capacity at constant volume. (5)

14. a) i. Derive the Clausius-Clapeyron equation. (5)

ii. The equation of state of a certain substance is given by the expression $V = RT/P - C/T^3$, and the specific heat is given by the relation $C_P = A+BT$ where A, B and C are constants. Derive the expression for changes in enthalpy and entropy for

a. Isochoric process (4)

b. Isobaric process (4)

(OR)

b) Describe the third law of thermodynamics. Explain with a suitable example.

15. a) Explain the principle how ligands bind to receptor. Describe the bio energetics involved in the process.

(OR)

b) Exemplify the dynamics and energetics involved in the protein folding.

PART – C

(1 x 15 = 15 Marks)

16. a) State the Carnot principle. Justify how Carnot cycle can be used as a model for the ideal refrigeration cycle and mention its limitations.

(OR)

b) Production of single cell protein from hexadecane is described by the following reaction equation, where $CH_{1.66}O_{0.27}N_{0.20}$ represents the biomass. If RQ = 0.43.

$$C_{16}H_{34} + aO_2 + bNH_3 \longrightarrow cCH_{1.66}O_{0.27}N_{0.20} + dCO_2 + eH_2O$$

Determine the stoichiometric coefficients.