Code No: RR212305 **Set No. 1**

II B.Tech I Semester Regular Examinations, November 2005
CHEMICAL AND BIO-THERMODYNAMICS
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the PVT relationships with a neat diagrams. Indicate the triple point.
   (b) Write the Virial equation of state, and define the compressibility factor.[8+8]

2. Write short notes:
   (a) Explain with a schematic diagram the adsorption refrigeration machine.
   (b) Write about liquefaction processes. [8+8]

3. A gas obeys the relation P(V-b)=RT and has a constant Cv. Show that,
   (a) U is a function of temperature alone
   (b) γ is constant
   (c) P(V-b)$^{\gamma}$ is constant for a reversible adiabatic process. [5+5+6]

4. The excess Gibbs energy of a particular ternary liquid mixture is represented by the empirical expression, with parameters, $A_{12}, A_{13}, and A_{23}$ functions of T and P only $G^E/RT = A_{12}x_1x_2 + A_{13}x_1x_3 + A_{23}x_2x_3$ Determine the implied expressions for in γ_1 *and* γ_2 *and* $In\ \gamma_3$. [16]

5. Explain in detail about Raoults law. [6+10]

6. Consider a vessel which initially contains only n_0 mol of water vapour .If decomposition occurs according to the reaction.

   $H_2O \rightarrow H_2 + 1/2O_2$

   Find expression which relate the number of moles and the mole fraction of each chemical species to the reaction co-ordinate ε [4+12]

7. (a) Explain the Gaden classification from stoichiometric point of view the product formation in fermentation processes.
   (b) The following stoichiometric equation describes penicillin systhesis
   $1.5Glucose + H_2SO_4 + 2NH_3$ + phenyl acetate → Pencillium G + $CO_2 + 8H_2O$
   the theoretical yield of pencillium is 1.2g/(gram of glucose). Find out the molecular weight of pencillium G. [8+8]

8. Write Short notes
   (a) Yield Coefficients
   (b) Energy source dissimilation [8+8]

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Code No: RR212305 **Set No. 2**

II B.Tech I Semester Regular Examinations, November 2005
CHEMICAL AND BIO-THERMODYNAMICS
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Explain the PVT relationships with a neat diagrams. Indicate the triple point.
   (b) Write the Virial equation of state, and define the compressibility factor.[8+8]

2. A refrigeration machine requires 1 kw of power per ton of refrigeration.
   (a) What is the co-efficient of performance?
   (b) How much heat is rejected to the condenser?
   (c) If the condenser operates at 60^0F, what is the lowest temperature the refrigerator could possibly maintain, assuming that the heat load is always 200 Btu/min? [5+5+6]

3. Develop the property relations appropriate to incompressible fluid, characterized by the behavior that both β and κ are zero. [4+12]

4. (a) Discuss chemical potential as a criterion for phase equilibrium.
   (b) Define partial molar properties: internal energy, enthalpy, entropy, Gibbs energy. [8+8]

5. (a) Describe the criteria for phase equilibrium.
   (b) What is an azeotrope? How azeotropes can be separated. [8+8]

6. Consider a vessel which initially contains only n_0 mol of water vapour .If decomposition occurs according to the reaction.

   $H_2O \rightarrow H_2 + 1/2O_2$

   Find expression which relate the number of moles and the mole fraction of each chemical species to the reaction co-ordinate ε [4+12]

7. (a) Explain the Gaden classification from stoichiometric point of view the product formation in fermentation processes.
   (b) The following stoichiometric equation describes penicillin systhesis
   $1.5Glucose + H_2SO_4 + 2NH_3$ + phenyl acetate → Pencillium G + $CO_2 + 8H_2O$
   the theoretical yield of pencillium is 1.2g/(gram of glucose). Find out the molecular weight of pencillium G. [8+8]

8. Discuss in detail the Degree of reduction for various organic compounds. [8+8]

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Code No: RR212305 **Set No. 3**

II B.Tech I Semester Regular Examinations, November 2005
CHEMICAL AND BIO-THERMODYNAMICS
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Steam at 200 psia and 600 ^0F (state 1) enter a turbine through a standard 3-in. pipeline with a velocity of 10 ft/sec. The exhaust from the turbine is carried through a standard 10-in. pipeline and is at 4 psia and 160 ^0F (state 2).

   Data: $H_1 = 1321.4Btu/lbM$ $\nu_1 = 3.059ft^3/lbM$

   $H_2 = 1129.3Btu/lbM$ $\nu_2 = 92.15ft^3/lbM$

   What is the power output of the turbine in horsepower, assuming no heat losses? [6 +10]

2. Write short notes:

   (a) Explain with a schematic diagram the adsorption refrigeration machine.

   (b) Write about liquefaction processes. [8+8]

3. A gas obeys the equation of state $P(V - B = RT + (AP^2)/T$, where A and B are constants. The mean specific heat (C_p) at atmospheric pressure is 33.6J/mol K. If $A = 1.0^*10^{-3}m^3K/(bar)$ mol; $B = 8.0^*10^{-5}m^3/mol$; calculate

   (a) The entropy change when the state of the gas is changed from state 1(4 bar, 300K) to state 2 (12bar, 400K).

   (b) The mean heat capacity at 12 bar? [8+8]

4. (a) Write Gibbs / Duhem equation.

   (b) A laboratory needs to use 2,000 cm^3 of an antifreeze consisting of 30 mole percent solution of methanol in water. What volumes of pure methanol and pure water at 25 0C must be mixed to form 2,000 cm^3 of antifreeze, also at 25^0C? Partial molar volumes for methanol and water in 30 mole percent methanol solution at 25^0C are: for methanol 38.632 cm^3mol^{-1} and for water 17.765 cm^3mol^{-1}. For pure species the volumes are: $40.727cm^3mol^{-1}$ for methanol and $18.068cm^3mol^{-1}$ for water. [8+8]

5. Explain in detail about Raoults law. [6+10]

6. Consider a vessel which initially contains only n_0 mol of water vapour .If decomposition occurs according to the reaction.

   $H_2O \rightarrow H_2 + 1/2O_2$

   Find expression which relate the number of moles and the mole fraction of each chemical species to the reaction co-ordinate ε [4+12]

7. (a) Explain the Gaden classification from stoichiometric point of view the product formation in fermentation processes.

   (b) The following stoichiometric equation describes penicillin systhesis
   $1.5Glucose + H_2SO_4 + 2NH_3$ + phenyl acetate → Pencillium G + $CO_2 + 8H_2O$
   the theoretical yield of pencillium is 1.2g/(gram of glucose). Find out the molecular weight of pencillium G. [8+8]

8. Assume that experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon (alkane or glucose) to biomass.

   (a) Calculate the stoichiometric coefficient for the following biological reactions
   Hexadecane:$C_{16}H_{34} + aO_2 + bNH_3 \rightarrow c(C_{4.4}H_{7.3}N_{0.86}O_{1.2}) + dH_2O + eCO_2$
   Glucose: $C_6H_{12}O_6 + aO_2 + bNH_3 \rightarrow dH_2O + eCO_2$

   (b) Calculate the yield coefficients Yx/s (g dw cell/g substrate), $Y_{x/O2}$ (g dw cell/g O2) for both reactions. Comment on the differences. [8+8]

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Code No: RR212305 **Set No. 4**

II B.Tech I Semester Regular Examinations, November 2005
CHEMICAL AND BIO-THERMODYNAMICS
(Bio-Technology)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
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1. Explain the formulation of the first law of Thermodynamics and illustrate any two examples. [8+8]

2. Steam is flowing through a horizontal, well-insulated 3-in. - ID iron pipe, 1500 ft long. The velocity at the entrance to the pipe, where the steam is dry and saturated at 150 psia, is 100 ft/sec. The steam discharges from the exit of the pipe into an adiabatic reversible turbine which exhausts at 14.7 psia. The steam leaving the turbine is in the dry-saturated condition.

   (a) Calculate the horsepower produced by the turbine.

   (b) Represent by a sketch on T-S plane the change in the state of the steam as it flows through the pipe and the turbine.

   (c) What is the state of the steam entering the turbine? [6+6+4]

3. Find the values of the residual enthalpy HR and the residual entropy SR for n-butane gas at 500 K and 50 bar as given by Redlich/Kwong equation of state. For the conditions of interest: $\beta = 0.08664\ P_R/T_R$; $q = 0.4278/(0.08664T_R^{1.5})$ $\varepsilon = 0\ and\ \sigma = 1$. [16]

4. (a) Write the interrelationships between partial properties.

   (b) The enthalpy of a binary liquid system of species 1 and 2 at fixed T and P is represented by

   H $= 400x_1 + 600x_2 + x1x_2(40x_1 + 20x_2)$

   Where H is in J mol^{-1}. Determine the expressions for the partial molar enthalpies of the species 1 and 2 as a function of x_1, and numerical values for the pure species enthalpies at infinite dilution. [8+8]

5. Explain Formulation of vapour liquid equilibrium. [4+12]

6. Consider a system in which the following reactions occur.

   $CH_4 + H_2O \rightarrow CO + 3H_2 - - - - - - - - - - (1)$

   $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2 - - - - - - - - - (2)$

   Where the numbers (1) and (2) indicate the value of jute reaction index. If there are present initially 2 mol CH_4 and 3 mol H_2O, determine expressions for the yi as functions of ε_1 and ε_2. [4+12]

7. (a) Explain the Gaden classification from stoichiometric point of view the product formation in fermentation processes.

(b) The following stoichiometric equation describes penicillin systhesis
$1.5Glucose + H_2SO_4 + 2NH_3$ + phenyl acetate $\rightarrow$ Pencillium G + $CO_2 + 8H_2O$
the theoretical yield of pencillium is 1.2g/(gram of glucose). Find out the molecular weight of pencillium G. [8+8]

8. (a) Define the "Yield Coefficient" and explain its significance in the growth of cells by substrate utilization

(b) The following is the stoichiometric equation for combustion of the cell Pseudomonas fluorescens growing in glucose medium.
$CH_{1.66}N_{0.2}O_{0.27} + 1.28\,O_2 \rightarrow CO_2 + 0.1N_2 + 0.83H_2O$
Assuming the heat of combustion of 104 kcal per moleO_2, calculate the heat released by combustion of bacteria in k cal/gram. [8+8]

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