

II B.Tech I Semester Supplementary Examinations, November 2006
CHEMICAL AND BIO-THERMODYNAMICS
(Bio-Technology)

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

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Explain the PVT relationships with 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) Write about condensable-fluid cycle.
 - (b) Write about simple power-plant cycle.
 - (c) Write about analysis of the steam-power plant cycle. [4+6+6]
3. The PVT behavior of a certain gas is described by : $P(V-b) = RT$, where b is a constant. If C_V is also a constant, show that -
 - (a) U is a function of T only
 - (b) γ is a constant
 - (c) for a mechanically reversible process, $P(V-b)^\gamma$ is a constant [5+5+6]
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. The Stability criteria apply to a particular phase. However, there is nothing to preclude their application to problems in phase equilibria, where the phase of interest (e.g; a liquid mixture) is in equilibrium with another phase (e.g; a vapour mixture). Consider binary isothermal vapour/liquid equilibria at pressures low enough that the vapour phase may be considered an ideal-gas mixture. what are the implications of liquid-phase stability to the features of isothermal P-X-Y diagrams. [4+12]
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 synthesis

$1.5\text{Glucose} + \text{H}_2\text{SO}_4 + 2\text{NH}_3 + \text{phenyl acetate} \rightarrow \text{Pencillium G} + \text{CO}_2 + 8\text{H}_2\text{O}$
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 about Elemental balance. [6+10]

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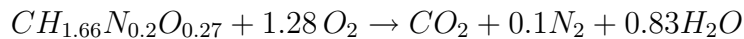
1. A gas is confined in a cylinder by a piston, 2 in. in diameter, on which rests a "weight". The mass of the piston and weight together is 8 lbm. The local acceleration of gravity is 32.00 ft/sec². Assume standard atmospheric pressure.
 - (a) What is the force exerted on the gas by the atmosphere, the piston, and the weight in pounds force, assuming no friction between the piston and cylinder?
 - (b) What is the pressure of the gas in pounds force per square inch?
 - (c) If the gas in the cylinder is heated, it will expand, pushing the piston and weight upward. Assuming that enough heat is supplied to raise the piston and weight 8 in., calculate the work done by the gas in raising the piston and weight. What is the change in potential energy of the piston and weight? Give your answers in foot-pounds force. [4+4+8]
2. (a) Describe Rankine's power cycle with a T-S diagram and its distinguishing features over Carnot's cycle.
 (b) How is refrigeration accomplished, and what is meant by a "ton of refrigeration"? [8+8]
3. A gas obeys the relation $P(V-b)=RT$ and has a constant C_v . 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. Estimate ϕ_1 and ϕ_2 for an equimolar mixture of methyl ethyl ketone (1)/toluene(2) at 50^o C and 25 kPa. Set all $k_{ij} = 0$. The required data are as follows. [16]

ij	T_{cij}	$P_{cij}(\text{bar})$	$V_{cij}(\text{cm}^3/\text{mol})$	Z_{cij}	ω_{ij}
11	535.05	41.5	267	0.249	0.323
22	591.8	41.1	316	0.264	0.262
12	563.0	41.3	291	0.256	0.293
5. Discuss in detail about Solid/liquid Equilibrium. [8+8]
6. Discuss in detail about liquid-phase reactions. [8+8]
7. (a) Explain the Gaden classification from stoichiometric point of view the product formation in fermentation processes.

- (b) The following stoichiometric equation describes penicillin synthesis

$1.5\text{Glucose} + H_2SO_4 + 2NH_3 + \text{phenyl acetate} \rightarrow \text{Pencillium G} + CO_2 + 8H_2O$
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.



Assuming the heat of combustion of 104 kcal per mole O_2 , calculate the heat released by combustion of bacteria in k cal/gram. [8+8]

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1. Steam at 200 psia and 600 °F (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 °F (state 2).

$$\text{Data: } H_1 = 1321.4 \text{ Btu/lbM} \quad \nu_1 = 3.059 \text{ ft}^3/\text{lbM}$$

$$H_2 = 1129.3 \text{ Btu/lbM} \quad \nu_2 = 92.15 \text{ ft}^3/\text{lbM}$$

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

2. Write short notes:

- (a) Write the efficiency of the gas-turbine power plant.
 (b) Explain about the working of turbojet power plant with a neat sketch. [8+8]

3. (a) Write fundamental property relationships for U, H, A (Helmholtz energy) and G

- (b) Write the Maxwell's equations. [8+8]

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 γ_3 . [16]

5. Discuss in detail the quantitative Expression to Raoult's Law. [6+10]

6. Discuss the Effect of temperature on the Equilibrium Constant. [6+10]

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

- (b) The following stoichiometric equation describes penicillin synthesis
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 the theoretical yield of pencillium is 1.2g/(gram of glucose). Find out the molecular weight of pencillium G. [8+8]

8. Estimate the heat of combustion of Pseudomonas fluorescens growing in glucose medium. [4+12]

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1. (a) What do you mean by chemical equilibrium process? [8+8]
 (b) Write the "Phase Rule" and its significance in finding the degrees of freedom.
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. Consider the steady-state, adiabatic, irreversible flow of an incompressible liquid in a horizontal pipe of constant cross sectional area. Show that:
 - (a) The velocity is constant.
 - (b) The temperature increases in the direction of flow
 - (c) The pressure decreases in the direction of flow. [5+5+6]
4. What is the ideal work for separation of an equimolar mixture of methane and ethane at 1750C and 3 bar in a steady-flow process in to product streams of the pure gases at 350C and bar if $T\sigma=300K$? [16]
5. Explain the relation between equilibrium and stability in a closed system. [6+10]
6. For a system in which the following reaction occurs

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

Assume there are present initially 2 mol CH_4 , 1Mol H_2O , 1mol CO , and 4Mol H_2 . Determine expression for the mole fraction y_i as functions of ε . [10+6]
7. Relation between TCA and lipid synthesis. [6+10]
8. Discuss the average yield coefficient for activated sludge. [8+8]
