St. Joseph's College of Arts & Science (Autonomous)
Cuddalore – 607001

QUESTION BANK

CLASS: II - M.Sc., CHEMISTRY, SEMESTER-III

SUBJECT: STATISTICAL THERMODYNAMICS AND ITS APPLICATIONS

SUBJECT CODE: PCH911S

UNIT: I

1-MARKS

1. If a coin is tossed honestly, it will have
   a) a Chance of getting a head only b) chance of getting a tail only
   b) a chance of getting a head or a tail d) none of these.
2. Which statistical should be applied for electrons in metals
   a) Maxwell-Boltzmann b) Fermi-Dirac c) Bose-Einstein d) Any of the above
3. What is the probability of getting even number on throwing a dice
   a) ¼ b) ½ c) 2/3 d) 3/4
4. Hess's Law is an application of a) I-Law of Thermodynamics b) II-Law of thermodynamics c) Entropy change d) $\Delta H=\Delta U+P\Delta V$
5. Calculate the possible number of ways of distribution of 2 particles among 4 energy states, when particles are indistinguishable. a) 8 b) 6 c) 4 d) 2

2-MARKS

1. What is the probability that a dice will turn to 5 or an even number?
2. What is meant by Fermi-Dirac Statistics ?
3. Calculate the thermodynamic probability for 2 particles in 3 degenerate levels for bosons and fermions.
4. Give the equation for number of particles in the i^{th} level if they are maxwellons or bosons or fermions.
5. In a 2-litre space there are 10 molecules. If an imaginary wall divides the space into two equal parts, what is the probability that all 10 molecules will be on the same side of the wall.
6. Calculate the thermodynamics probability for 3 particles in 3 degenerate levels for bosons and fermions.
7. What is Bose-Einstein statistics ?
8. Calculate the thermodynamic probability for 3 bosons in 3 & 4 degenarate levels.

8-MARKS

1. Derive Bose-Einstein statistics.
2. Write a short note on Bose-Einstein statistics.
3. Calculate the nuclear partition function function of ortho & para H_2 and ortho & para D_2
4. Compare Maxwell-Boltzman, Fermic-Dirac and Bose-Einstein statistics.
5. Derive Fermi-Dirac statistics.
6. A bag contain 10 red balls and 5 white balls. All balls are identical except for the colour. a) if a ball is taken at random from the bag. What is the probability that it is red? b) if two balls are drawn independently, what is the probability that both are red?
7. Derive Maxwelll Boltzmann statistics.

UNIT: II

1-MARKS

1. Partition function increases with a) decrease of temperature b) increase of temperature c) same temperature d) zero temperature
2. If we toss the coins twice, the total number of distribution a) 6 b) 2 c) 4 d) 8
3. For rotational partition function, the order of magnitude will be a) 10-100 b) 1-10 c) 100-10^{24} d) always < 1
4. The degenerate of ground nuclear state for ortho hydrogen will be a) 1 b) 3 c) 6 d) 9
5. The degenerate of ground nuclear state for para hydrogen will be a) 1 b) 3 c) 6 d) 9

2-MARKS

1. What is meant by partition functions? Give an example.
2. Calculate the translational partition function for an ideal gas contained a volume 30 lit at 500k. The molecular weight of a gas is 100.
3. Write the equation for Translational and vibrational partition functions in terms of T.
4. The Debye's characteristic temperature for Zn metal is 210K, out the atomic heat capacity at 10K.
5. Write a short on Debye theory?
6. Calculate the rotational partition function of H_2 gas at 300 K, the moment of interia is 0.459×10^{-40} gm cm^2.
7. Calculate translational partition function for H atom at 3000 K in a box of volume 2.494×10^5 $Cm^{3.}$
8. The Debye's characteristic temperature for Zn metal is 230 K. Find out the atomic heat capacity at 12 K.
9. Derive Gibbs free energy in terms of partition function.
10. Derive Helmholtz free energy in terms of partition function.

8-MARKS

1. Calculate the nuclear partition function function of ortho & para H_2 and ortho & para D_2
2. Write a short notes on Rotational partition function and vibrational function.
3. Derive translational partition function and find out its contribution to heat capacity.
4. Describe partition function.
5. Calculate the translational partition function of a molecule of O_2 gas at 1 atm and 298K moving in a vessel of volume 24.4dm^3.
6. Derive internal energy in terms of partition function.
7. Find out the rotational contribution to heat capacity of solids.
8. Derive vibratioanal partition function and find out its contribution to heat capacity.
9. Explain the application of partition functions to heat capacities of ideal gases.
10. Explain the rotational partition function for mono, diatomic & polyatomic ideal gases.
11. Derive Einstein's model for heat capacity of solids. Give its limitation.

UNIT: III

1-MARKS

1. For micro canonical ensemble of system in which each number has the same values of a) N, V and E b) N,V and T c) V, T and μ d) V,E and T
2. Which type of ensemble has thermal and material contact with surrounding? a) Micro-canonical b) Canonical c) Grand-canonical d) All

2-MARKS

1. Define ensemble.
2. What is grand canonical ensemble?
3. Define Micro-Canonical ensemble.
4. Explain the significance of different ensembles.

8-MARKS

1. Write briefly about canonical , micro-canonical & grand-canonical ensembles.
2. Explain the thermodynamic function of canonical ensembles & grand canonical ensembles.
3. Describe the proprerties of grand canonical, micro-canonical& canonical ensembles.

UNIT: IV

1-MARKS

1. For gases, when temperature is decreased, its chemical potential will a) increases b) decrease c) remains same d) increases or decreases

2. For closed system, dG is a) SdT-VdP b) VdP-SdT c) PdV-SdT d) PdV+SdT
3. Fugacity is always equal to a) Temperature b) pressure c) volume d) zero
4. A system which can exchange both matter and energy with its surruonding is called a) isolated system b) closed system c) open system d) none of these

2-MARKS

1. What is fugacity?
2. What is partial molar properties?
3. Give any two significance of partial molar properties.
4. What is the condition for standard state for gas in terms of fugacity?
5. What is chemical potential?

5-MARKS

1. What is the variation of chemical potential with temperature?
2. Explain the variation of fugacity with pressure.
3. Derive the variation of chemical potential with pressure?
4. Explain the variation of fugacity with temperature.
5. Derive Gibbs Duhem equation.
6. Explain the concept of chemical potential with free energy.
7. Derive the alternative definitions of chemical potential.

UNIT-V

1-MARKS

1. The transformation from water intoice, the Gibbs free energy change is a) 0 b) -79 Cal/g c) -7.9 Cal/g d) -0.29 Cal/g
2. Which true for ideal solution, if a_i & x_i represents activity and mole fraction a) $a_i > x_i$ b) $a_i < x_i$ c) $a_i = x_i$ d) $a_i = 0$
3. For real gases, a) $a \propto P$ b) $a \propto 1/P$ c) $a \propto 1/P^2$ d) $a \propto P^2$
4. it may be stated that each substance in a given state has a tendency to escape from that state and this escaping tendency is called----------(fugacity)
5. The--------- of any substance may therefore, be defined as the ratio of fugacity of the substance in the given state to the fugacity of the same substance in the standard state.(activity)
6. The ratio---------- is called activity coefficient of a gas and is represented by the symbol γ. It gives a direct measure of the extent to which any gas deviates from ideal behaviour at any given pressure and temperature for the farther this ratio is from unity, the greater is the non-ideality of the gas.(f / P)

2-MARKS

1. Define activity.
2. What is meant by activity co-efficient of the gases?
3. What is partial molar properties?
4. What is activity of the components?
5. Calculate the free energy change accompanying the composition of 1 mole of gas at 57°C from 25 to 200 atm pressure.
6. What is Gibbs-Duhem equation?
7. Derive the criteria for thermodynamic equilibrium for three component system.
8. Explain the determination of activity co-efficient of electrolytes by EMF method.
9. What is the influence of an ion in a mixture on activity co-efficient of a given electrolyte?

5-MARKS

1. Calculate the activity of co-efficient of H_2O at 0°C with the following data n-propyl alcohol =0.13146 mol/kg, T=0.239℃, ΔH_{fus}=6.01KJ/mol.
2. Explain Three component system.
3. Explain activity and activity coefficient.
4. How will you determine activity and activity coefficient.
5. Determine standard free energy.
6. Explain the thermodynamics behind ideal and non ideal binary solutions.