CC-14
STATISTICAL MECHANICS

Q.1 (1 Mark)

1. The relation between entropy and probability is_____.
2. Five particles are distributed in two phase cells. Then number of macrostates is_____.
3. Four phase points are distributed in two cells (i and j) in phase space. Then the thermodynamical probability for the macrostate $n_i=3, n_j=1$ is_____.
4. In a random distributin of 10 particles between two boxes with equal probability, the number of maicrostates in macrostate(3,7) is_____.
5. The statistical condition of equilibrium of two system in thermal contact is____.
6. The probability that from two dice the sum of either 7 or 11 is obtain is _____.
7. The relative probability between two different energy states having difference 1.1×10^{-20} joules at 40K temperature is_____.
8. Which of the following speeds is most closely related to kinetic energy of molecules.(Mean speed/root mean square speed)
9. The entropy of assembly of N molecules of an ideal gas is_____.
10. The general expression for pressure P of real gas may be expressed as(n= number density of particles)
11. The partition function is defined as Z=
12. Keeping energy constant, the volume of a perfect gas of μ- atoms is mode 10 times, the change in entropy will be_____.
13. Sackur Tetrode formula for entropy of a perfect gas is_____.
14. The relation between statistical entropy σ and volume of phase space δT accessible to system is _____.
15. The translational partition functions for a gas molecule is_____.
16. Bose Einstein statistics applies to_____.(photons/electrons)
17. Bose-Einstein distribution function is (n_i=
18. Fermi-Dirac statistics applies to_____.(Electrons/Molecules)
19. The ratio of statistical weights of orthostates to statistical weight of parastates of hydrogen having nuclear spins s is_____.
20. In Bose Einstein statistics, the number of particles condensing into ground state are_____.

Q.2 (1.5 Marks)

1. Define probability of an event.
2. N distinguishable particles can be arranged in m compartments in $m \times n$ ways. it is correct or wrong?
3. Two cards are taken out one after the other from a deck of well shuffled cards. The probability of two aces is $\frac{1}{2652}$. Is it correct?
4. What is the principle of equal a prior probability?
5. Can the entropy of a system increases when the system looses heat?
6. What is phase space?
7. When the temperature of the gas sample rise, how does the area under v and n (v) curve vary?
8. In classical statistics, how can we treat the identical gas molecules as distinguishable from each other?
9. A gas has two specific heats whereas a liquid and solid have only one. Why?
10. Do you agree that black body radiation is white?
11. What is the average energy per mode per unit frequency per unit volume in the case of (i) Planck's radiation and (ii) Rayleigh-Jeans radiation?
12. Mentions at least three criteria to define a blackbody.
13. A red and green glass plates are placed a uniformly heated enclosure. What colour will appear when seen through a hole in the enclosure?
14. What is a phase space?
15. Define entropy and thermodynamical probability.
16. Show that the probability of a system is proportional to the logarithm of probability of that system.
17. Show that S = k log 2, where symbols have their usual meanings.
18. Write notes on
    i) Postulate of equal a prior probability
    ii) Entropy and Probability.
19. State Maxwell-Boltzmann distribution law.
20. Define partition function.
21. Define
    i) Phase space
    ii) Probability
    iii) Thermodynamical probability
    iv)Microstate
    v) Macrostate.

22. Define partition function and calculate its value for an ideal monoatomic gas.
23. Give the physical picture of entroppy.
24. Describe how an expression for entropy is set in statistical mechanics.
25. Give an account of Gibb's canonical ensemble.
26. What is Gibb's paradox? What do you mean by thermal radiation? Give the properties of the radiation.
27. What is a black body? Mention its properties. 2
28. Describe the Ferry's and Wien's black body radiation.
29. What is a black body? How is the energy distributed in black body?
30. What do you mean by identical particles?
31. Explain symmetrical and anti symmetrical wave functions.
32. What are microstates and microstates?
33. What are the basic changes made by Bose in Classical Maxwell-Boltzmann statistics?
34. Give an account of Bose-Einstein statistics.
35. Derive an expression for the number of Eigen states in an energy rang
36. What is gas degeneracy?
37. What do you mean by Bose-Einstein condensation?
38. Explain Fermi-Dirac distribution function.
39. Explain the effect of temperature on Fermi-Dirac distribution

Q.2 (2.5 Marks)

1. A reversible process must be quasi statistics. Why?
2. Which two laws in physics were unable to explain the blackbody radiations completely?
3. Give some properties of thermal radiation.
4. Compare black body radiation with a perfect gas.
5. Plot a graph between intensity of radiation and the frequency for investigating the distribution of energy among the radiation emitted by a blackbody at different temperatures.
6. How does Stefan's law of radiation change for small differences of temperature?
7. What is the basic difference between classical and quantum statistics?
8. Mention the basic assumptions to explain Bose-Einstein quantum statistics.
9. A sphere, a cube and a thin circular plate all made of the same material and having the same mass are initially heated to 200°C. Which of these objects will cool fastest and which one slowest when left in air at room temperature?
10. Compare Bose-Einstein statistics with Fermi-Dirac statistics.
11. What is the difference between free electron gas and an ordinary gas obeying kinetic theory?
12. Define Fermi energy?
13. What is Fermi gas?
14. Plot a graph 257 between energy and the mean wavelength at different temperatures?
15. Using Planck's law, derive Rayleigh-Jean's law.

16. What Is the difference between photon gas and an ideal gas?
17. Do the electrons have zero energy at oK ? If not explain why?
18. Give the characteristic of a photon in a photon gas?
19. What is the importance of a black body?
20. Define a black body and explain why it is an ideal absorber of incident radiation?
21. What is the third law of thermodynamics?
22. Explain the unattainability of absolute zero.
23. Explain that the entropy of an isolated system in thermal equilibrium is maximum.
24. What is the general relation for the increase in temperature due to anadiabatic compression of any substance
25. A body which has a surface area 5.0 cm and a temperature of 727 radiates 300 J of energy each minute. What is its emissivity? Stefan Boltzmann constant = 567 x 10 Wm-?
26. 20 Fermi particles are distributed in three compartments having energies - E, 0 and + E respectively. Determine the value of energy of the microstate (7, 8, 5)
27. Calculate the number of different ways of arranging 8 fermions in 12 phase space cell.
28. Show that Gibb's free energy tends to a minimum in system at constant temperature and pressure.
29. Show that Helmholtz's free energy tends to a minimum in system at constant-temperature and pressure.
30. Deduce Sucker-Tetrode relation using partition function.
31. Using canonical distribution, derive equipartition theorem.
32. What is meant by micro canonical, canonical and grand canonical ensembles compare three types of ensembles.
33. How that Helmholtz's free energy.
34. State Kirchhoff s law.
35. State Stefan-Boltzmann law.
36. Derive an expression for radiation pressure.
37. Explain Wien's displacement and Wien's
38. Give distribution law.
39. Give brief introduction of Bose-Einstein and Fermi-Dirac statistics in
40. What is the difference between a boson and fermions?
41. Differentiate between Bose-Einstein and Fermi-Dirac statistics.
42. Give an account of Fermi-Dirac statistics.
43. Write down the distribution functions of Bose-Einstein and Fermi-Dirac Statistics. Explain the terms used.
12. Give the concept of effective mass.
44. Explain the concept of hole.

Q.4 (5 Marks)

1. Derive Maxwell-Boltzmann Law of distribution of molecules in a gas .Derive partition function.
2. What do you mean by the terms: phase space, ensembles, microstate and macrostates?

3. What is meant by microcanonical, canonical and grand canonical ensembles? Compare these three types of ensembles.
4. Define partition function and calculate its value for an ideal monatomic gas. Obtain expression for pressure and entropy in terms of partition function.
5. Discuss and prove the law of equipartition of energy in statistical mechanics.
6. Explain thermodynamics function of a two levels system. Give the idea of negative temperature.
7. Deduce Wien's displacement law for distribution of energy in black body spectrum. Examine it's validity in terms of experimental results.
8. Derive the Rayleigh-Jeans formula

$$E_r d\lambda = \frac{8\pi kT}{\lambda^4} d\lambda$$

Whwre the symbols have their usual meanings.

9. Define Stefan's law. Derive Stefan's-Boltzmann law.
10. Write short notes on:
    (i) Bose-Einstein statistics
    (ii)Fermi-Dirac statistics
11. What is the difference between classical and quantum statistics? Give a brief introduction of Bose-Einstein and Fermi-Dirac statistics in comparison to Maxwell-Boltzmann statistics.
12. Explain Fermi-Dirac distribution function. Discuss the effect of temperature on Fermi-Dirac