STATESTICAL MECHANICS

SEMESTER - VI

C C - XIV

DEPARTMENT OF PHYSICS

SHORT ANSWER QUESTIONS

1. What is the meaning and importance of the principle of equal a Priori probability in statistical physics ?
2. Distinguish between microstates and macrostates of a system.
3. State any two laws of probability.
4. Show that probability of macrostate is proportional to its thermodynamic probability?
5. Explain the concepts of constraints of a system.
6. Define the terms (i) probability (i) accessible and inaccessible states.
7. What are n-dependent events ? Derive an expression for the probability of occurrence of two independent events.
8. What is the meaning and importance of the principle of equal a Priori probability in statistical physics ?
9. What is the probability of an impossible event ?
10. What is the probability of a random event ?
11. What is the probability of a certain event ?
12. What is the value of nPn, and 1! ?
13. What is the value of nCn and 0!?
14. What is the probability of drawing a queen of hearts out of a well shuffled pack of cards?
15. What is meant by most probable state of a system ?
16. Give statistical definition of entropy. What are its C.G.S. units.
17. What do you mean by "Additive nature of entropy" ?
18. Why must a reversible process be quasi static ?
19. Show that entropy is an extensive parameter.
20. Define Second Law of Thermodynamics and show that it follows from the law of increase of entropy.
21. What is the significance of 2 0 in relation to entropy ?
22. Discuss law of increase of entropy.
23. What is disorder ? "A natural system always tends to change in the direction of increasing disorder. Explain why ?
24. Why does entropy increase during expansion of gas ?
25. Show that diffusion of gases is an irreversible process.
26. Show that expansion of a gas is an irreversible process.
27. State Third Law of Thermodynamics.
28. How will you say that entropy is a state variable.
29. Can entropy of an assembly ever decrease ?
30. Why is entropy defined in terms of logarithms ?

31. Define microcanonical, canonical and grand canonical ensembles.
32. Define phase space and momentum space.
33. What is the purpose of dividing phase space into cells ?
34. What is the minimum size of a phase space cell in classical and quantum statistics?
35. Explain the phase space and its division into cells.
36. What is meant by available volume ?
37. How we can treat the identical gas molecules as distinguishable in classical statistics?
38. Discuss the dependence of average speed of molecules of a gas on temperature.
39. Will the nature of speed distribution be different if we have a mixture of gases rather than a single gas ? Explain.
40. Hydrogen escapes faster from the earth atmosphere than oxygen. Why?
41. In order to describe a dynamic system which physical quantities we must know ?

CONCEPTUAL QUESTIONS

1. What is the difference between a microstate and a macrostate ?
2. What is thermodynamic probability or frequency of a given macrostate?
3. Define probability of an event.
4. Two six faced dices are thrown simultaneously. List the various ways in which event can happen.
5. What is the range of probability of an event ?
6. When statistical methods give greater accuracy ?
7. What are equally likely events ?
8. What is an equilibrium state ?
9. What are intensive parameters ?
10. What are extensive parameters ?
11. Show that enropy is an extensive parameter.
12. Two systems with entropies S1 and S2 are combined together. What is the entropy of the combination ?
13. What is the value of change of entropy in a reversible process ?
14. What is the physical significance of entropy ?
15. A reversible process must be quasi static. Why ?
16. What is he value of thermodynamic probability for a system in perfect order ?
17. What is the value of entropy of one mole of a perfect gas at 0K.
18. What are the units of entropy in S.I. system ?
19. Can the entropy of a system increases when the system looses heat ?
20. How entropy varies with disorder ?

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. Why are ensembles useful ?
25. Mention fluctuations in Microcanonical, canonical and Grand canonical ensembles.

UNIT-2

SHORT ANSWER QUESTIONS

1. How many thermodynamic variables are needed to specify the state of system ?
2. What are thermodynamical potentials ? Why are they so called ?
3. Show that dS, dP, dV and d are perfect differentials.
4. What are thermodynamic variables ?
5. Prove that $\frac{E_S}{E_T} = \frac{C_P}{C_V}, where\ E_S = -V\left(\frac{\partial P}{\partial V}\right)_S$
6. Define Gibb's function G. When is the value of this function constant?
7. Are the thermodynamic variables pressure, volume, temperature, entropy and internal energy perfect differentials ?
8. Derive a relation between specific heat at constant pressure Cp, specific heat at constant volume and gas constant R for one mole of an ideal gas.
9. Using Maxwell's thermodynamic relation prove that for any system (i)$TdS = C_V dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$ (ii)$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_S - P$
10. Using Maxwell's thermodynamic relation, prove that
    (a) for a Vanderwaal's gas $C_P - C_V = R\left(1 + \frac{2a}{RTV}\right)$ And
    (b) for perfect gas $C_P - C_V = R.$
11. Obtain the values of partial derivatives of Helmholtz free energy F with respect to volume and temperature.
12. Obtain two partial derivatives of Gibbs function G (P, T) with respect to pressure and temperature.
13. Explain the process of adiabatic compression ? Why is it important ?
14. What do you mean by degrees of freedom. Discuss the degrees of freedom of a monoatomic, diatomic and triatomic gas molecule.
15. Show that the number of degrees of freedom consisting of N-particles and having k independent relations between the particles of the system is $(3N - k)$.
16. State and explain the law of equipartition of energy. Using this law, show that for a perfect gas having n degrees of freedom, is$\gamma = 1 + \frac{2}{n}$.

17. State the law of equipartition of energy and prove that for a diatomic gas, the ratio of the two specific heats at room temperature is $\frac{7}{5}$.
18. Define the term ensemble with examples.
19. What do you understand by the term partition function ?
20. What is the significance of a partition function in statistical physics ?
21. What is meant by an ensemble ? Discuss micro-cononical, conical and grand canonical ensembles. Compare these three types of ensembles.

CONCEPTUAL QUESTIONS

1. Why is it necessary to know the general values of partial differential calculas ?
2. What are the conditions for the differential to be a perfect differential ?
3. Explain why dP, dV, dT and dS are perfect differentials ?
4. Why dW and dQ are not perfect differentials ?
5. What is the general relation for the increase in temperature due to an adiabatic compression of any substance ?
6. When is thermodynamic system said to be in equilibrium ?
7. Briefly discuss the condition of equilibrium under Adiabatic -iscochoric conditions.
8. Does C_v vary with volume for a vanderWaal gas and a perfect gas ?
9. Discuss the conditions for natural change and equilibrium under adiabatic-isobaric process.
10. Briefly discuss the condition of equilibrium of system under isothermal-isobaric condition.
11. Thermodynamic functions are also called thermodynamic potentials. Why ?
12. Prove that $C_P = -T\left(\frac{\partial^2 G}{\partial T^2}\right)_P$. Where symbols have their usual meanings.
13. Define compressibility.
14. Define co-efficient of volume expansion α.
15. Under what conditions or during which processes the thermodynamic function H, F and G remain constant ?
16. Why only four thermodynamic variables are defined ?

UNIT-3

SHORT ANSWER QUESTIONS

1. Distinguish between classical and quantum statistics.
2. What was the need of developing a quantum statistics ?

3. Compare the similarities and dissimilarities in B-E and F-D statistics.
4. Rest mass of photon is zero. Explain its physical significance ?
5. What are different types of photons in terms of possible states of polarisation ?
6. What are bosons and Fermions ? Give examples.
7. What is Fermi energy ? Using Fermi Dirac law of distribution of electron energies, obtain the expression for the Fermi energy.
8. Plot the graph $n(u)$ versus u, where $n(u)$ is the total number of electrons for energy u. Explain the significance of the graph.
9. Does free electrons make any significant contribution to the specific heat of a metal. Explain?
10. What is a black body ?
11. What is the difference between a photon gas and an electron gas ?
12. State Wein's law of energy distribution and explain its significance.
13. Define Solar constant and derive an expression for the temperature of Sun ?
14. Explain how Wein's law helps to identify the change in colour of a body ?
15. Obtain an expression for average kinetic energy at 0K.
16. Explain the conditions under which B-E and F-D statistics give the results of M-B statistics.
17. What is Bose-Einstein condensation and superfluidity ?
18. Derive a relation to express the ratio of the number of atoms existing in two energy levels E1 and E2 having degeneracies d1 and d2 respectively.
19. Distinguish in terms of wavelength the expressions for Wein's radiation formula and Rayleigh Jean's formula using Planck's law of radiation?
20. What is Fermi energy level?
21. What is Bose-Einstein condensation.

CONCEPTUAL QUESTIONS

1. Mention few phenomena which could not be explained using Maxwell-1 Boltzmann statistics ?
2. A blackened platinum wire, when gradually heated, appears first dull red, then blue and finally white. Why ?
3. On a winter night, one feels warmer when clouds cover the sky than when the sky is Clear. Why?
4. Name few phenomena in which Maxwell Boltzmann's statistics met with faiture.
5. "Black body radiation is white". Comment.
6. What is the basic difference between classical and quantum statistics?
7. Mention the basic assumptions to explain Bose-Einstein quantum statistics.

8. 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.
9. Compare Bose-Einstein statistics with Fermi-Dirac statistics.
10. Which of the three statistics can have occupation index more than one and why ?
11. Define Fermi energy
12. What is the importance of a black body ?
13. Define a black body and explain why it is an ideal absorber of incident radiation ?
14. Why atoms in a Bose-Einsten condensate behave like a superatom ?
15. When was Bose-Einstein condensate experiment carried out in space ?
16. What is Bose-Einstein condensate ?
17. Has someone made a Bose-Einstein condensate ?
18. List some properties of a Bose-Einstein's condensate.
19. What is Fermi gas ?
20. Does Fermi energy depend upon the size or volume of a conductor ?
21. What is the difference between photon gas and an ideal gas ?
22. Do the electrons have zero energy at 0K ? If not explain why ?
23. What is a photon gas?
24. Give the characteristics of a photon in a photon gas ?
25. What happens when a gas becomes degenerate ?
26. Give examples of degenerate matter.
27. What is Fermi Pressure ? What is its cause ?
28. Do electrons have zero energy at 0 K ? If not why ?

UNIT-4

SHORT ANSWER QUESTIONS

1. Name three modes of transmission of radiation

2. Define radiation.
3. What is the wavelength range of thermal radiation ?
4. In which region of the electromagnetic spectrum the thermal radiation lies ?
5. Define reflectance, absorptance and transmittance.
6. What is a black body ? Do we find blackbody in real world ?
7. Give examples of blackbody.
8. An enclosure has perfectly reflecting walls. How can we ensure thermal equilibrium inside it ?
9. State Kirchhoff's law of radiation.
10. Which part of Ferys' black body acts as a perfectly black body ?
11. What is the importance of Kirchhoff's law of radiation ?
12. Explain why Greenhouse effect is responsible for global warming.
13. At what temperature will a body stop radiating ?
14. What is the German word for hole in the Fery's blackbody.
15. State Stefan-Boltzaman's law of radiation.
16. What is the pressure of radiation for normal incidence on a surface ?
17. When does radiation become a diffused one ?
18. Give at least one use of Wien's displacement law.
19. What is Saha's ionisation formula ?
20. Which assumption was used by Rayleigh and Jeans while deriving Rayleigh Jeans's law?
21. Give the difference in the result obtained in Wien's law and Rayleigh-Jeans law.
22. What is ultraviolet catastrophe ?
23. State Planck's law of blackbody radiation.
24. Name the scientist who used Planck's hypothesis to explain photoelectric emission.
25. Which device is used to measure the intensity of blackbody radiations ?
26. Deduce Wien's displacement law from Planck's radiation formula.
27. Are Wien's law and Rayleigh-Jeans law special cases of Planck's law ? Explain.
28. What are merits and demerits of Saha's Ionixation formula ?
29. Would you expect the radiation at Am corresponding to room temperature 300 visible ?
30. What is quantised oscillator.
31. What is the significance of Saha's ionisation formula ?

CONCEPTUAL QUESTIONS

1. What are radiations according to Maxwell ?
2. What happens when radiation is incident on a surface?
3. What is a blackbody ?
4. Explain why a body changes its colour on heating.
5. Define energy density.

6. Define spectral energy density.
7. Do you agree that black body radiation is white ?
8. A solid copper sphere of density p and specific heat c and radius r at initial temperature T1 is suspended inside an enclosure whose walls are at zero kelvin. What is the expression for the time required for the temperature of the sphere to drop to temperature T2 ?
9. An Earthen jug is made red hot in a furnace .When it is removed from the furnace, the hole in the mouth of jug glow brightest. Explain why ?
10. How does Stefan's law of radiation change for small differences of temperature?
11. What causes ultraviolet catastrophe ?
12. How does the quantisation of energy developed by Max Planck solve the ultraviolet catastrophe ?
13. What does Saha's ionisation formula describe.
14. What is the range of values for the emissivity of a surface ?
15. What is a diffuse surface ?
16. Consider the following items in our daily life iron rod (or of any metal) glowing from red to yellow, light bulbs, heaters, night vision equipment, cooling of earth at night, candle flame etc. What is common in all these ?
17. Do you agree that the ultraviolet catastrophe is a discrepancy ? Explain.
18. What is the average energy per mode per unit frequency per unit volume in the case of (i) Planck's radiation and (i) Rayleigh-Jeans radiation?
19. What should be the limits considered for the energy of harmonic oscillator to be in classical limit ?
20. What are the main shortcomings of Planck's quantum theory ?
21. How radiations can explain Greenhouse effect ? Explain.
22. Why do animals curl into a ball when they feel cold ?
23. Cooking iutensils are otten blackened at the bottom and polished at top. Explain.
24. Why is there the word displacement in Wien's displacement law ?
25. The pockets formed by coals in a coal fire appear brighter than coal themselves. Why?
26. Define solar constant.
27. Who solved the ultraviolet catastrophe ?
28. A cube, a sphere and a thin circular plate all made of the same material and having the same mass are initially heated to some temperature. Which of these objects will cool fastest and which one will cool slowest when left in air at room temperature ? give reason.
29. Why days are hot and nights cold in deserts?
30. Obtain an expression for the rate of cooling using Stefan's law. What are the factors on which rate of cooling depends when a body is allowed to cool ?

31. Which two laws in physics were unable to explain the blackbody radiations completely?
32. Give some properties of thermal radiation.
33. Compare black body radiation with a perfect gas.
34. A red and green glass plates are placed a uniformly heated enclosure. What colour will appear when seen through a hole in the enclosure ?
35. What is the wavelength at which human body radiates maximum energy ?

UNIT-1

LONG ANSWER QUESTIONS

1. What is the meaning and importance of the principle of equal a probability in statistical physics ?
2. Discuss in detail the distribution of 4 different particles in two identical compartments and tabulate the result.
3. Taking the case of n particles distributed in 2 compartments with equal a priori probability discuss the variation of probability of macrostate on account of small deviations from the state of maximum probability.
4. Discuss the distribution of n distinguishable particles in k compartments which are further sub divided into g-cells of equal a priori probability.
5. Prove that for a dynamic system the fraction of the total time that the system spends in any particular macrostate is proportional to the thermodynamical probability for that macrostate.
6. A large number (n) of particles is distributed in two compartments of equal a priori probability. Discuss the variation of probability of macrostate on account of small deviation from the state of maximum probability.
7. For n distinguishable particles to be distributed in two compartments, prove that the thermodynamic probability of macrostate $(n_1, n_2)$is $W(n_1, n_2) = \frac{n!}{n_1! n_2!}$ where $n = n_1 + n_2$.
8. Calculate the percentage error made in using the Stirling formula $\ln n! = n \ln n - n$, $where\ n = 5$
9. Explain the concepts of (i) microstates and macrostates (if) thermodynamic probability (W) (iii) Constraints on a system.
10. Write down the various microstates and macrostates for a system of 2 distinguishable particles distributed in 2 compartments.
11. Prove that the probability of a microstate corresponding to distribution of N particles in two identical compartments is $\frac{1}{2}N$.
12. What do you mean by most probable macrostate ? Derive an expression for the probability of this state corresponding to distribution of N particles in two identical compartments.
13. Discuss reversible and irreversible processes. Why must a reversible process be quasi-static in nature ?
14. Give statistical definition of entropy. State the units of entropy.
15. What is entropy of state ? Derive the relation between entropy, (a thermodynamical quantity) and thermodynamical probability, (a statistical quantity)

16. Discuss the law of increase of entropy on the basis of statistical physics.
17. Using statistical definition of entropy, show that the change in entropy dS of the system due to infinitesimal addition of heat ∂Q is $dS = \frac{\partial Q}{T}$ Assume the volume and number of particles of the system remains constant.
18. Give two cases of natural process in which entropy change.
19. State Third Law of Thermodynamics. How can it be derived on statistical considerations?
20. What are reversible and irreversible Processes ? Show that the process of expansion of gas is irreversible in nature.
21. Prove that the entropy of a thermodynamic system remains constant in any reversible process.
22. Why does entropy increases during free expansion of a gas ?
23. Give the statistical definition of entropy. Show that the process of diffusion of one gas into another is always accompanied by an increase in entropy.
24. Discuss the law of increase of entropy on the basis of statistical physics and apply it to explain expansion of ideal gases and diffusion of one gas into another. Comment on the statement "entropy is a measure of disorder."
25. Give the concept of ensemble. Differentiate between microcanonical, canonical and grand canonical ensembles. Where are they used ?
26. Apply M-B statistics to an ideal gas in equilibrium. Experimentally how do you verify the distribution of molecular speeds ?
27. Calculate the average and root mean square speed of the molecules obeying M-B statistics.
28. Assuming M-B distribution of molecular speeds calculate average and rms speeds of molecules.
29. Derive an expression for the number of phase space cells lying in the kinetic energy interval u and $u + du$.
30. Treating ideal gas as a system governed by classical statistics, derive Maxwell Boltzmann law of distribution of speeds.
31. Explain the terms : position space, momentum space and phase space. What is the purpose of dividing phase space into cells ?
32. For any classical, system occupying volume V, derive an expression for the number of phase space cells in the momentum interval p to $(p + dp)$.
33. (a) Using expression for M-B law of distribution of molecular speeds derive the value of average speed.(b) Briefly discuss the Zartmann and K, experiment for verification of M-B distribution Law of molecular speeds.

34. (a)Discuss the common approach in dealing with M-B, B-E and F-D statistics. (b) Give a brief account of Zartmann and K, experiment for the verification of Maxwell Boltzmann law of distribution of molecular speeds.

35. (a)Derive Maxwell Boltzmann law of distribution of speeds show that the number of molecules in speed range from $V to\ V + \ dV$ is given by

$n(v)dV = 4\pi n(\frac{m}{2\pi KT})^{3/2}V^2\left(\frac{mV^2}{e^{2KT}dV}\right)$ (b) Calculate the root mean square velocity from the above relation.

36. Derive Maxwell Boltzmann law of distribution of molecular speeds. Use this law to obtain an expression for the most probable speed of the molecules.

37. Define root mean square velocity using ME distribution of molecular speeds, show that the Its velocity of the molecules is given by $V_{rms} = \sqrt{\frac{3KT}{m}}$.

38. Derive Maxwell law of distribution of molecular speeds. Show that average molecular speed is given by $V_{av} = \sqrt{\frac{8KT}{\pi m}}$.

39. Distinguish between the Frost probable speeds up and its speed. Show that the ratio $V_{rms}\ and\ V_{mp}$ is $\sqrt{\frac{3}{2}}$.

UNIT -2

LONG ANSWER QUESTIONS

1. Starting from four thermodynamic potentials, derive Maxwell's thermodynamic Relations.
2. Define various thermodynamical potentials. How are they related to the thermodynamical variables $T, P\ V\ and\ S$.
3. Define Helmholtz function and Gibb's function. Derive thermodynamical relation between them.
4. What are thermodynamic potentials ? What is their significance ? Establish any two thermodynamic relations.
5. Explain the effect of pressure on substances that expand or contract on heating using thermodynamical relations ?
6. Prove that for any substance the ratio of the adiabatic and isothermal elasticities is equal to the ratio of the two specific heats.
7. Define thermodynamic variables and thermodynamic potentials, derive from them Maxwell's thermodynamical relations.

8. Prove the following thermodynamic relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ and hence using it, derive Clausius-Clapeyron latent heat equation. Discuss the effect of pressure on the melting point of solids.
9. Establish from thermodynamical principles the relation $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P$ the symbols having their usual meaning. Hence prove that for an ideal gas $C_P - C_V = R$ and for an vanderWaal's gas.$C_P - C_V = R\left[1 + \frac{2a}{RTV}\right]$
10. What do you mean by canonical ensemble ? For what type of system is it suitable ?
11. Define ensemble. Differentiate between microcanonical and canonical ensemble. where will you use grand canonical ensemble.
12. Write short notes on (i)Micro-canonical, and canonical ensemble. (ii)Grand canonical ensemble,(iii)Gibb's paradox
13. What do you mean by partition function ? Express helmholtz free energy and entropy interms of partition function.
14. State and prove law of equipartition of energy ?
15. Explain what do you mean by degrees of freedom of a particle. A particle in translatory motion has three degrees of freedom but if it is rotating also, then it has six degrees of freedom. Explain.
16. State the law of equipartition of energy. Prove that the energy associated with each degree of freedom is $\frac{1}{2}$ KT.
17. What is meant by degrees of freedom ? State the law of equipartition of energy. Prove that for a perfect gas whose molecules have f degrees of freedom $\frac{C_P}{C_V} = 1 + \frac{2}{f}$. Hence calculate molar specific heats and values of y for a monoatomic, diatomic and triatomic gas. How far these values agree with experiment.
18. Derive Sackur Tetrode equation.

UNIT-3

1. Derive an expression for the most probable distribution of particles for system obeying Bose-Einstein statistics.
2. Starting from basic assumptions, derive the relation for the occupation index $\frac{n_i}{g_i} = \frac{1}{e^{\alpha}e^{u_i/KT}}$ where the symbols have their usual meanings.
3. What are black body radiations. Can classical theory explain these radiations. Explain in detail how Planck could explain these radiations and hence derive Planck's law for black body radiations.
4. Using Planck's law of blackbody radiations, derive Stefan's law of radiation.
5. Establish that Wein's displacement law can be obtained from Planck's law.
6. Starting from basic assumptions, derive Fermi-Dirac distribution law.
7. What is the difference between Bose-Einstein statistics and Fermi-Dirac Statistics. Mention the basic assumptions and starting from the expression of thermodynamic probability in the case of particles following F-D statistics, derive an expression for the occupation index. $\frac{n_i}{g_i} = \frac{1}{e^{\alpha}e^{u_i/KT}}$ Where the symbols have their usual meanings.
8. Derive an expression for the energy distribution of free electrons in a conductor using Fermi-Dirac distribution law.
9. Define Fermi energy ? Derive an expression for it. Also derive an expression for the average energy of electron at 0K in terms of Fermi energy.
10. Compare all the three types of statistics in statistical physics.
11. Show that the Fermi energy depends upon electron concentration and is independent of size or volume of the conductor.
12. Discuss the variation of the energy (u) in BE, FD and MB statistics in terms of Fermi function $f(u)$ (or occupation index).
13. Using BE distribution law derive Planck's law of black body radiation.
14. What are the assumptions of Bose-Einstein statistics ? Derive the Bose-Einstein distribution law of speeds.
15. What is Stefan's law ? How it can be derived from Planck's law ?
16. What is a degenerate gas ? How do the Bose and Fermi distribution tend to classical distribution.
17. Discuss Bose-Einstein condensation and how it differs from ordinary condensation.

UNIT-4

LONG ANSWER QUESTIONS

1. Give an example each from our daily life to explain the phenomena of conduction, convection and rediation. State the properties of thermal radiation.
2. Show that the radiation in an isothermal enclosure depends only on the temperature and not on the nature of walls of the enclosure or on the bodies present inside it.
3. Explain the properties of thermal radiations in detail, What do you mean by thermal radiation and (ii) Explain Prevost theory of heat exchanges ?
4. What is a black body and blackbody radiation ? Describe how an idea of a black body has been achieved in practice.
5. Explain the terms emissive power and the absorptive power. Prove that at any temperature the ratio of the emissive power to the absorptive power of a substance is constant and is equal to the emissive power of a perfectly blackbody.
6. What do you mean by pressure of radiation ? Prove that the pressure of radiation is equal to the energy density. Show that diffuse radiation exerts pressure on the walls of the container equal to $1/3^{rd}$ of its energy density.
7. State Stefan's law of radiation and prove it from thermodynamical considerations.
8. State Stefan's law of radiation and explain how it is used to estimate the temperature of sun's surface ?
9. Write a short account of the distribution of energy in the spectrum of a blackbody.Explain graphically the energy distribution of blackbody radiation with wavelength at different temperatures. Discuss the important results with reference to Wien's and Rayleigh-Jeans law.
10. What is Wien's distribution law ? Deduce it from thermodynamical considerations.
11. Show that the average energy of a Planck's oscillator of frequency fin thermal equilibrium with heat reservoir of temperature T is given by $\overline{E} = \frac{hf}{\left[e^{hf/k_BT}-1\right]}$.
12. Derive an expression for the number of resonators per unit volume lying in the wavelength $\lambda \; to \; \lambda + d\lambda$.
13. What is Saha's ionisation formula ? State the assumptions which Saha had considered to derive it. Derive the relation and mention its importance.
14. State and derive Rayleigh-Jeans law. Compare the results of Rayleigh-Jeans law with that of theoretical results obtained for the distribution of energy density.
15. Name the scientist who first introduced the term ultraviolet catastrophe. Explain the reason for ultraviolet catastrophe and how it can be overcome ?

16. Why classical theory was unable to explain the distribution of energy in the spectrum of blackbody radiation ? Explain how Planck was successful in calculating the average energy of Planck's oscillator and derive Planck's law using it.
17. Show that the Wien's law and Rayleigh-Jeans law are special case of Planck's law of radiation.
18. Explain giving experimental details the results of Lummer – Pringsheim's experiment for the verification of radiation laws.