A.R COACHING CENTRE

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Polytechnic TRB Physics - 2019

Subject Name: **Unit-V: Thermodynamics and Stat Mechanics** - Slip Test-2 **Time**: 60 minutes
Date: 30.11.2019 (FN) **Maximum Marks**: 50

1. Find out the wrong one according to Maxwell thermodynamic relation,

   a. $\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$ b. $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

   c. $\left(\frac{\partial V}{\partial S}\right)_P = -\left(\frac{\partial T}{\partial P}\right)_S$ d. $\left(\frac{\partial V}{\partial T}\right)_P = -\left(\frac{\partial S}{\partial P}\right)_T$

2. Find the wrong statement

   a. The rate of change free energy per mole at constant volume and temperature is called chemical potential.

   b. Gibb's free energy per particle is called chemical potential.

   c. Molal free energy is called chemical potential.

   d. Chemical potential indicates the direction of molecule disorder.

3. Which of the following relations between pressure P and microcanonical partition function Z, is true?

   a. $P = -N\left(\frac{\partial}{\partial V}\ log\ Z\right)_T$ b. $P = -NKT\ log\ Z$

   c. $P = NKT\left[\frac{\partial}{\partial V}\ (log\ Z)\right]_T$ d. $P = NKT^2\left[\frac{\partial}{\partial V}\ (log\ Z)\right]_T$

4. The number of ways in which three indistinguishable particles can be distributed among four cells according to B-E statistics.

   a. 6 b. 20

   c. 16 d. 80

5. Total energy of perfect Bose-Einstein gas is,

   a. $E = \frac{1}{2}\ nKT\left[1 + \frac{A}{2^{5/2}} + \frac{A^2}{3^{5/2}} + \cdots\right]$ b. $E = \frac{3}{2}\ nKT\left[1 + \frac{A}{2^{5/2}} + \frac{A^2}{3^{5/2}} + \cdots\right]$

   c. $E = \frac{1}{2}\ nKT\left[1 - \frac{A}{2^{5/2}} - \frac{A^2}{3^{5/2}} - \cdots\right]$ d. $E = \frac{3}{2}\ nKT\left[1 - \frac{A}{2^{5/2}} - \frac{A^2}{3^{5/2}} - \cdots\right]$

6. Stirling approximation gives $log\ n! =$

   a. $n\ log\ n$ b. $n\ log\ n - n$

   c. $n\ log\ n + n$ d. $n! - n\ log\ n$

7. The maximum number of particles occupying above ground state of B-E condensation represented by the following equation

a. $n' = n\left(\frac{T}{T_o}\right)^{3/2}$ *when* $T < T_o$.

b. $n' = n\left(\frac{T}{T_o}\right)^{3/2}$ *when* $T > T_o$.

c. $n' = n\left(\frac{T}{T_o}\right)^{1/2}$ *when* $T < T_o$.

d. $n' = n\left(\frac{T}{T_o}\right)^{1/2}$ *when* $T > T_o$.

8. In first phase transition, match the properties in both phases.

(A) Gibb's function – (1) changes

(B) Entropy – (2) discontinuous

(C) $\left(\frac{\partial G}{\partial P}\right)_{T,N}$ – (3) constant

(D) Volume – (4) changes

a) (A) - 2, (B) - 1, (C) - 4, (D) - 3
b) (A) - 3, (B) - 4, (C) - 1, (D) - 2
c) (A) - 2, (B) - 1, (C) - 4, (D) - 3
d) (A) - 3, (B) - 1, (C) - 2, (D) - 4

9. Which of the following statement is wrong for Helium-II?

a. The viscosity is zero.

b. Thermal conductivity is very low.

c. Density is same as Helium-I .

d. Flow through capillaries is independent of pressure difference.

10. According to the theorem of equipartition of energy, the energy corresponding to temperature T is,

a. $\frac{1}{2}$

b. $\frac{3}{2}\,KT$

c. KT

d. $\frac{1}{2}\,KT$

11. According to which statistics, the energy at absolute zero, cannot be zero?

a. M-B

b. B-E

c. F-D

d. Both M-B and B-E

12. The slope of the P-T curves for second order phase transition are given by the,

a. Ehrenfest's equation

b. Maxwell equation

c. Gibb's equation

d. Claussius-Clapeyron's equation

13. **Correct** form of Bose temperature

a. $T_B = \frac{2\pi\hbar^2}{mK}\left(\frac{N}{2.612\,V}\right)^{2/3}$

b. $T_B = \frac{0.84}{V^{2/3}}\frac{h^2}{mK}\left(\frac{N}{V}\right)^{2/3}$

c. $T_B = \frac{h^2}{2\pi mKT}\left(\frac{N}{2.612\,Vg_s}\right)^{2/3}$

d. $T_B = \frac{\hbar^2}{2mK}\left(\frac{N}{2.612\,V}\right)^{2/3}$

14. Correct one about photon gas
    a) Photon gas is an ordinary boson gas.
    b) Each photon have energy $E = \frac{1}{2}\, h\nu$.
    c) Applying grand canonical distribution to photons, chemical potential of the reservoir has to be take as zero.
    d) Chemical potential of photon gas is negative.

15. For cyclic process
    a. $dQ = 0$ b. $dW = 0$
    c. $dU = 0$ d. $dS = 0$

16. Gibb's Helmholtz equation is given as
    a. $F = U + T\left(\frac{\partial F}{\partial T}\right)_V$ b. $F = U - T\left(\frac{\partial F}{\partial T}\right)_V$
    c. $F = T - U\left(\frac{\partial F}{\partial T}\right)_V$ d. None of these

17. The equation $n_i = \frac{g_i}{e^{\alpha+\beta E_i} - 1}$ is known as
    a. Fermi-Dirac distribution law b. Bose-Einstein distribution law
    c. Maxwell-Boltzmann distribution law d. None of the above

18. In equilibrium which of the following statement correct?
    a) The probability of the system is minimum.
    b) The entropy of the system is minimum.
    c) Both (a) and (b) are minimum.
    d) The probability and entropy both are maximum.

19. The average kinetic energy 3.306 eV of silver at 0 K, the temperature is,
    a. 2.55×10^2 K b. 2.55×10^4 K
    c. 5.51×10^2 K d. 5.51×10^4 K

20. According to Pauli's the limiting value of the paramagnetic susceptibility related to the temperature (T) as,
    a. T^o b. T^1
    c. T^2 d. T^4

21. Three identical spin 1/2 fermions to be distributed in two non-degenerate distinct energy levels. The number of ways this can be done is
    a. 2 b. 4
    c. 6 d. 10

22. The change in internal energy of the gas is directly proportional to
    a. change in volume. b. change in pressure.
    c. change in temperature. d. change of pressure and volume.

23. Which one of the following thermodynamic relations is not correctly related to the law of energy?
    a. $dU = dQ - dW$
    b. $dU = T\ dS - P\ dV$
    c. $dH = T\ dS + V\ dP$
    d. $dF = S\ dT - P\ dV$

24. If the average energy of an oscillator of frequency $0.68 \times 10^{14}\ s^{-1}$ at $T = 1800\ K$ then energy of the classical oscillator is,
    a. $4.554 \times 10^{-21}\ J$
    b. $2.943 \times 10^{-21}\ J$
    c. $2.484 \times 10^{-20}\ J$
    d. $4.111 \times 10^{-20}\ J$

25. The solar radiation emits the wavelength 4753 A^o, then the surface temperature of the sun is
    a. 6017 K
    b. 6097 K
    c. 5907 K
    d. 6117 K

26. Luminosity of Rigel star in orion constellation is 17000 times that of our sun. If the surface temperature of the sun is 6000 K, then the temperature of the star is,
    a. $68520 \times 10^2\ K$
    b. 68520 K
    c. $57640 \times 10^2\ K$
    d. 57640 K

27. Find out the nature of statements, according to thermionic emission
    (i) The emission co-efficient is dependent of temperature.
    (ii) The height of the well above fermi level is called the work function.
    (iii) It's obey the Maxwell-Boltzmann statistics.
    (iv) The positive charge effectively higher the work function it aids electron to escape.
    (v) The work function of the iron value is 4.48 eV

    Code:

    a) All the statement are correct
    b) Statement (i), (ii), (iv) are correct ; (iii), (v) are wrong
    c) Statement (i), (iii), (v) are correct ; (ii), (iv) are wrong
    d) Statement (ii), (iii), (v) are correct ; (i), (iv) are wrong

28. Fermi velocity is
    a. $V_F = \sqrt{\frac{2E_F}{m}}$
    b. $V_F = \sqrt{\frac{2m}{E_F}}$
    c. $V_F = \sqrt{\frac{m}{2E_F}}$
    d. $V_F = \sqrt{\frac{E_F}{2m}}$

29. The liquid helium λ-transition graph is drawn between the x and y axis (where T- temperature ; c-specific heat ; S– entropy ; E-energy.)
    a. $T\ v_s\ S$
    b. $T\ v_s\ c$
    c. $T\ v_s\ V$
    d. $T\ v_s\ E$

30. Planck's radiation law is,
    a. $E_\nu = \frac{8\pi h\nu^2}{c^3}\ \frac{1}{e^{h\nu/KT} - 1}$
    b. $E_\nu = \frac{8\pi h\nu^3}{c^2}\ \frac{1}{e^{h\nu/KT} - 1}$
    c. $E_\lambda = \frac{8\pi hc}{\lambda^5}\ \frac{1}{e^{hc/\lambda KT} - 1}$
    d. $E_\lambda = \frac{8\pi hc}{\lambda^4}\ \frac{1}{e^{hc/\lambda KT} - 1}$

31. In canonical ensemble, the probability density for the subsystem is
    a. $\rho(E) = Ae^{-\tau/E}$
    b. $\rho(E) = Ae^{\tau/E}$
    c. $\rho(E) = Ae^{-E/\tau}$
    d. $\rho(E) = Ae^{E/\tau}$

32. Find the **wrong** statement in canonical ensemble,
    a) The two systems in thermal contact with heat reservoir, $\log \rho$ is additive.
    b) In thermal equilibrium with reservoir, the fluctuations appear in energy and in temperature.
    c) The probability density of a canonical ensemble depends upon both energy and temperature.
    d) Canonical ensembles apply equally to macroscopic system.

33. The density matrix can be applied to
    a) the statics of a classical mechanical system.
    b) the dynamics of a classical mechanical system.
    c) the statics of a quantum mechanical system.
    d) the dynamics of a quantum mechanical system.

34. Two stars A and B emit maximum radiation at 3500 and 4900 respectively. The temperature for the two stars A and B are in the ratio
    a. 5 : 7
    b. 7 : 5
    c. 3 : 5
    d. 5 : 3

35. A perfect black body is radiating at T_1 k. Its radiation rate is to be increased to 16 times. What will be temperature T_2 k for this?
    a. $T_1 = 2T_2$
    b. $T_2 = 2T_1$
    c. $T_1 = 4T_2$
    d. $T_2 = 4T_1$

36. Fermi energy of a solid is practically
    a. dependent of temperature
    b. independent of temperature
    c. both (a) and (b)
    d. none of these

37. The average kinetic energy in silver is 3 eV. What is the fermi energy of the free electrons in silver at 0 k?
    a. 3.306 eV
    b. 3 eV
    c. 5 eV
    d. 5.51 eV

38. Fermi-Dirac statistics applies to
    a. common gas at normal temperature
    b. photon gas
    c. phonon gas
    d. electron gas in metals

39. The combined form of first and second law of thermodynamics is
    a. $T\ dS = dU - P\ dV$
    b. $dU = T\ dS + dQ$
    c. $dQ = T\ dS + P\ dV$
    d. $T\ dS = dU + P\ dV$

40. The momentum of a photon gas of energy 3 *joule* is about:
    a. $1 \times 10^{8}\ kg\ m\ s^{-1}$
    b. $1 \times 10^{-8}\ kg\ m\ s^{-1}$
    c. $9 \times 10^{8}\ kg\ m\ s^{-1}$
    d. $9 \times 10^{-8}\ kg\ m\ s^{-1}$

41. For a Vander Waal's gas, the equation of state is
    a. $\left(P - \frac{a}{v^2}\right)(v - b) = RT$
    b. $\left(P - \frac{a}{v^2}\right)(v + b) = RT$
    c. $\left(P + \frac{a}{v^2}\right)(v + b) = RT$
    d. $\left(P + \frac{a}{v^2}\right)(v - b) = RT$

42. In the process of phase transition Gibb's potential function is
    a. zero
    b. remains constant
    c. discontinuous
    d. infinite

43. If two particle interchange their position for energy state, a new state are generated is called
    a. Maxwell-Boltzmann statistics
    b. Bose-Einstein's statistics
    c. Fermi-Dirac statistics
    d. Both (a) and (b)

44. In B-E statistics the chemical potential is always
    a. zero
    b. positive
    c. negative
    d. both (b) and (c)

45. According to the $T - P$ distribution which one is variable parameter
    a. T
    b. P
    c. N
    d. V

46. The superfluidity ${}_2He^3$ obeys
    a. M-B statistics
    b. B-E statistics
    c. F-D statistics
    d. both (a) and (b)

47. Most probable speed is
    a. $V_{mp} = 1.73\sqrt{\frac{kT}{m}}$
    b. $V_{mp} = 1.59\sqrt{\frac{kT}{m}}$
    c. $V_{mp} = \sqrt{\frac{3}{2}} \times V_{rms}$
    d. $V_{mp} = \sqrt{\frac{2}{3}} \times V_{rms}$

48. Helmholtz free energy of thermodynamic functions for canonical ensemble is
    a. $F = -\frac{1}{\beta}\ \log Z$
    b. $F = \tau\ \log Z$
    c. $F = \frac{1}{\beta}\ \log Z$
    d. $F = -Z\ \log \tau$

49. According to Lioville's theorem, the rate of change of density in phase-space is
    a. zero
    b. one
    c. infinite
    d. constant

50. Partition function co-relation with thermodynamic quantity of Gibb's potential is
    a. $G = RT - NKT\ \log Z$
    b. $G = -NKT\ \log Z$
    c. $G = NKT^2\ \left[\frac{\partial}{\partial T}(\log Z)\right]_V$
    d. $G = NK\ \log Z$

Answer Key:

Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans	Q.No	Ans
1	c	11	c	21	b	31	c	41	d
2	d	12	a	22	c	32	b	42	b
3	c	13	a	23	d	33	d	43	a
4	b	14	c	24	c	34	b	44	c
5	d	15	c	25	b	35	b	45	d
6	b	16	a	26	b	36	b	46	c
7	a	17	b	27	d	37	c	47	d
8	d	18	d	28	a	38	d	48	a
9	b	19	b	29	b	39	d	49	a
10	d	20	a	30	c	40	b	50	a