

THERMODYNAMICS & STATISTICAL MECHANICS NPTEL MCQ

1. Which of the following is not a state function?

- a) Internal energy
- b) Entropy
- c) Work
- d) Enthalpy

2. For a spontaneous process, which of the following is true?

- a) $\Delta G > 0$
- b) $\Delta G < 0$
- c) $\Delta G = 0$
- d) None of these

3. The partition function of a system having n energy levels (where the energy levels are $0, \epsilon_1, \epsilon_2, \epsilon_3, \dots, \epsilon_n$) at temperature tending to infinity is given by :

- a) 1
- b) n
- c) 0
- d) None of the above

4. This entropy of the system increases in the order

- a) Gas < liquid < solid
- b) Gas < solid < liquid
- c) Solid < liquid < gas
- d) Liquid < gas < solid

5. The number of macrostates for 4 particles having total energy of 6ϵ (where energy levels are equally spaced having spacing ϵ and the minimum possible energy is 0) is:

- a) 9
- b) 7
- c) 3
- d) 6

6. When 2 kJ of energy is added to a 10 L of an ideal gas, the gas expands to 15 L at a constant pressure of 1 atm. The change in internal energy is (assume 1.0 L-atm=0.1 kJ)

- a) 1.5 kJ
- b) 0.5 kJ
- c) 1.0 kJ

d) 1.25 kJ

7. 1 mole of an ideal gas expands from 10 atm against a constant pressure of 1 atm at 27°C. The magnitude of work done by the gas is (assume $R = 2 \text{ calK}^{-1}\text{mol}^{-1}$)

a) 1981 cal

b) 1382 cal

c) 991 cal

d) 7282 cal

8. Which of the following statements is not true for an ideal gas?

a) $(\partial U/\partial V)_T = 0$

b) $(\partial U/\partial P)_T = 0$

c) $(\partial U/\partial T)_V = 0$

d) $(\partial H/\partial P)_T = 0$

9. The condition which holds true for an ideal gas undergoing free expansion under adiabatic condition,

a) $\Delta U < 0, \Delta T < 0$

b) $\Delta U < 0, \Delta T > 0$

c) $\Delta U > 0, \Delta T > 0$

d) $\Delta U = 0, \Delta T = 0$

10. 1 mole of an ideal gas ($C_v = 2.5R$) is allowed to expand at 300 K from 10 atm to 5 atm against an opposing pressure of 1 atm. After the expansion, the gas is heated at constant volume until the pressure becomes 10 atm. The change in internal energy (J) will be

a) -249.42

b) 6484.92

c) 0

d) 6235.5

11. The exact differential is

a) δq_{rev}

b) $\delta q_{\text{rev}}/T$

c) δq_{irrev}

d) $\delta q_{\text{irrev}}/T$

12. State whether the following statement is true or false:

a) The change in internal energy is the heat change that takes place at constant volume.

True

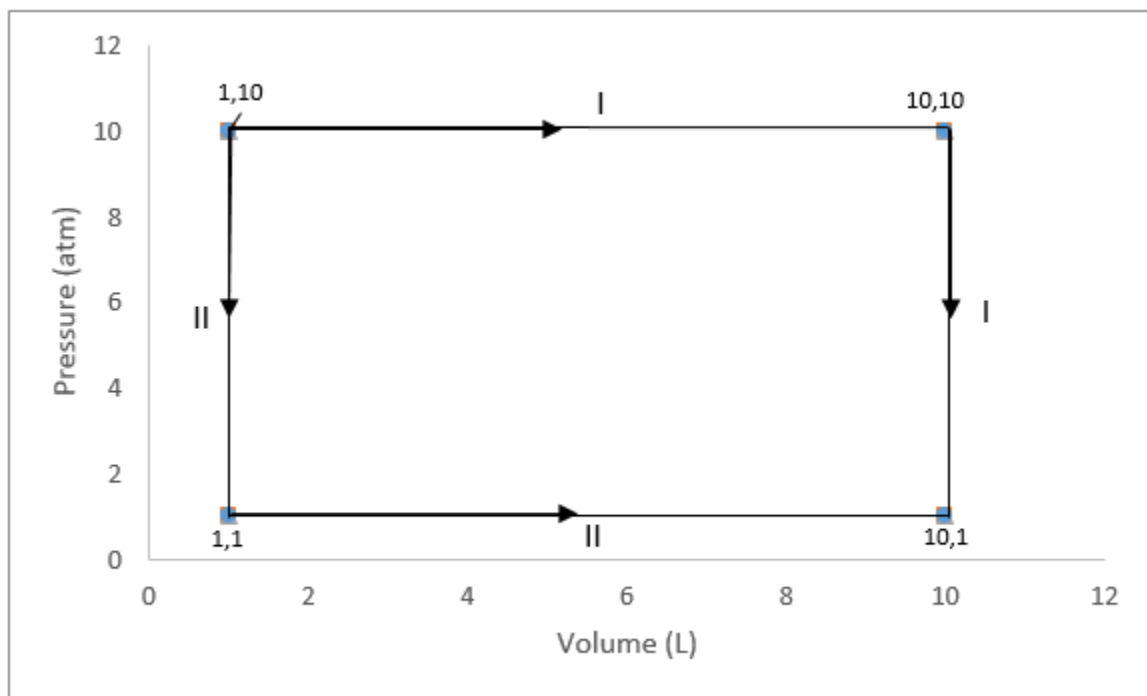
False

b) If a perfect gas expands against zero external pressure under adiabatic conditions, its temperature falls.

True

False

13. The state of 1 mole of an ideal monatomic gas is changed reversibly from (1L, 10 bar) to (10 L, 1 bar) by 2 paths in the figure.



The correct statement is:

a) Work done by the gas and change of its internal energy are more for the path I than for path II.

b) Work done for both the paths are same but internal energy changes are different.

c) Work done by the gas for path II is less but the energy change for both the paths are same.

d) Work done by path I is more but internal energy of the gas in both the states is the same.

14. For an adiabatic reversible expansion of an ideal gas, the plot of $\log P$ versus $\log V$ is linear with a slope equal to

a) $1/\gamma$

b) $-1/\gamma$

c) γ

d) $-\gamma$

15. n ideal gas in a cylinder is compressed adiabatically to one-third of its initial volume. During this process, 20 J work is done on the gas by compressing agent. Which is true?

- a) Change in the internal energy in the process is zero
- b) The internal energy increases by 20 J
- c) The internal energy decreases by 20 J
- d) The temperature of the gas decreases

16. In a cyclic process,

- a) Work done is zero
- b) Work done by the system is equal to the quantity of heat given to the system
- c) Work done does not depend on the quantity of heat given to the system
- d) The internal energy of the system increases

17. 1 mole of an ideal gas with $C_V = 3.0 \text{ cal K}^{-1}\text{mol}^{-1}$ initially at S.T.P. is put through the following reversible cycle:

- I. state 1 to state 2: heated at constant volume to twice the initial temperature.
- II. state 2 to state 3: expanded adiabatically back to its initial temperature.
- III. state 3 to state 1: compressed isothermally back to state 1.

The ΔU (cal) for the cycle:

- a) -254.97
- b) 364.03
- c) 254.97
- d) 0

18. 1 mole of an ideal mono atomic gas is allowed to expand isothermally at 300 K from 1 atm to 0.1 atm (i) reversibly and (ii) irreversibly. ΔG (kJ) for process (i) and (ii) are

- 5.74, -5.74
- 5.74, 7.78
- 8.74, -6.75
- 5.74, -5.74

19. Identify X and Y in $(\partial H/\partial P)_s = (\partial G/\partial X)_y$

- X = T, Y = V
- X = V, Y = P
- X = V, Y = T
- X = P, Y = T

20. 1 mole of oxygen expands adiabatically against a constant external pressure of 1 atm until the pressure balances. The initial temperature and volume are 200°C and 20 lit respectively. The change in entropy (JK^{-1}) is

- 1.906
- 1.172
- 1.906
- 1.172

21. Maximum entropy of mixing is achieved when two ideal gases, X and Y, are mixed in the amounts of

- 1 mole of X and 3 moles of Y
- 3 mole of X and 1 moles of Y
- 2 mole of X and 3 moles of Y
- 2 mole of X and 2 moles of Y

22. In an irreversible process, enthalpy of the universe decreases.

- True
- False

23. The entropy of the universe, for a reversible process, remains constant.

- True
- False

24. ΔH and ΔU for the reaction, at constant temperature are related as:



- $\Delta H = \Delta U$
- $\Delta H = \Delta U + RT$
- $\Delta H = \Delta U + 3RT$
- $\Delta H = \Delta U - 3RT$

25. The Clausius-Clapeyron equation helps to calculate

- latent heat of vapourisation
- boiling point or freezing point
- vapour pressure at one temperature, if the vapour pressure at another temperature is given
- all of the above

26. 1 mole of an ideal gas at 2 atm pressure expands irreversibly and adiabatically into vacuum to decrease its pressure to 1 atm. The change in entropy (JK^{-1}) is

- 5.763
- 7.683
- 0.0
- 0.057

27. $(\partial C_v / \partial V)_T =$

- $-T (\partial P / \partial T)_V (\partial V / \partial P)_S$
- $T (\partial^2 P / \partial T^2)_V$
- $(\partial S / \partial V)_T (\partial V / \partial T)_S$
- $P (\partial^2 V / \partial P^2)_T$

28. A system undergoes a change at constant pressure and temperature absorbing 10 kcal of heat at 400 K. If ΔG of the process is -20 kcal, the ΔS_{sys} (cal K⁻¹) is

- 25
- 100
- 25
- 75

The value of the integral $\oint \frac{dQ}{T}$ in a reversible cycle is

29.

a) $\oint \frac{dQ}{T} > 0$

$\oint \frac{dQ}{T} < 0$

$\oint \frac{dQ}{T} = 0$

$\oint \frac{dQ}{T} = \text{constant}$

30. Which of the following is not Maxwell's equation?

- $(\partial S / \partial V)_T = (\partial P / \partial T)_V$
- $(\partial T / \partial V)_S = -(\partial P / \partial S)_V$
- $(\partial V / \partial P)_S = (\partial T / \partial S)_P$
- $(\partial T / \partial P)_S = (\partial V / \partial S)_P$

31. Total entropy change for an isothermal irreversible expansion is?

- zero
- greater than zero
- less than zero
- any value can be possible

32. The vapour pressure of a solid selenium is given by $\log P \text{ (mm)} = -7440/T + 12.78$ and of liquid selenium by $\log P \text{ (mm)} = -5390/T + 8.63$. The triple point temperature (in $^{\circ}\text{C}$) of selenium is

- 267.83
- 347.67
- 493.98
- 220.98

33. The fugacity (atm) of NH_3 gas ($b = 3.707 \times 10^{-2} \text{ L mol}^{-1}$) at 25°C , having a true pressure of 10 atm, is **(OMIT AS THIS IS OF CHEMISTRY)**

- 10.153
- 11.00
- 15.67
- 9.87

34. The latent heat of fusion of deuterium at 18.56 K is 47 cal mol^{-1} . The slope dP/dT is $40.5 \text{ kg cm}^{-2}\text{mol}^{-1}$. The difference between molar volume of solid and liquid deuterium ($\text{cm}^3\text{mol}^{-1}$) at this temperature is (Given $1 \text{ cal} = 4.184 \text{ J}$, $g = 9.8 \text{ ms}^{-2}$) **(OMIT AS THIS IS OF CHEMISTRY)**

- 0.0625
- 0.026
- 2.669
- 0.261

35. Which of the following term is not zero when ideal two gases are mixed together?

- ΔH_{mix}
- ΔV_{mix}
- ΔG_{mix}
- ΔU_{mix}

36. Standard chemical potential of oxygen at 300 K is 10 kcal mol^{-1} . The volume is decreased to 2.46 L isothermally and the increase in free energy is found to be 1.342 kcal. The fugacity of oxygen (atm) is **(OMIT AS THIS IS OF CHEMISTRY)**

- 9.5
- 1.0

5.46

7.87

37. In the absence of any phase change, the change in entropy when a system is heated from T_1 (K) to T_2 (K) at constant pressure is given as

$(\Delta G_1 - \Delta H_1)/T_1 - (\Delta G_2 - \Delta H_2)/T_2$

$C_p \ln(T_2/T_1)$

$C_p(T_2 - T_1)/(T_2 T_1)$

$\mu_1/T_1 - \mu_2/T_2$

38. The ionic strength of a solution obtained by mixing aqueous solution of 20 mL of 0.05(M) $MgCl_2$, 30mL of 0.05(M) Na_2SO_4 , 25mL of 0.04(M) $AlCl_3$ and 25mL of 0.01(M) glucose at a given temperature is: **(OMIT AS THIS IS OF CHEMISTRY)**

0.03

0.135

0.075

0.102

39. The mean ionic activity coefficient of a 0.05 m aqueous solution of Na_2SO_4 at 25°C is: **(OMIT AS THIS IS OF CHEMISTRY)**

0.483

0.679

0.536

0.403

40. Calcium carbonate is heated in a closed container and the $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ equilibrium is established. This system has: **(OMIT AS THIS IS OF CHEMISTRY)**

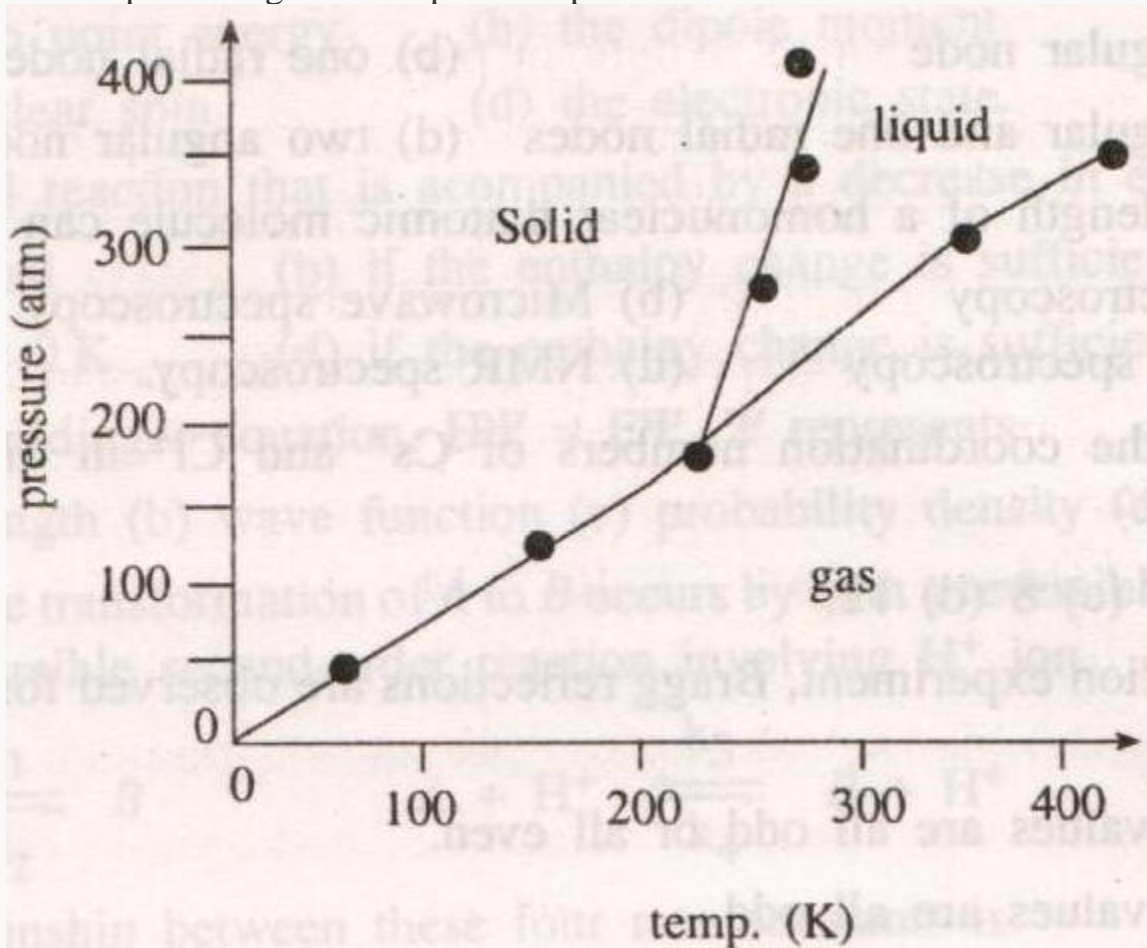
3 phases and 2 independent components

2 phases and 2 independent components

2 phases and 3 independent components

3 phases and 3 independent components

41. The phase diagram for a pure compound is shown below:



At a temperature greater than 210 k and pressure of 60 atm, the compound exists as:

- Both solid and gas at equilibrium
- vapour
- solid
- vapour and liquid in equilibrium

42. The two component system which has both a lower critical solution temperature and an upper critical solution temperature is: **(OMIT AS THIS IS OF CHEMISTRY)**

- Water - phenol
- Water - triethylamine
- Water - nicotine
- Water - acetic acid

43. Consider an equimolar immiscible mixture of water (B.P. = 100°C) and toluene (B.P. = 110°C). Which is not true? **(OMIT AS THIS IS OF CHEMISTRY)**

- The system will boil at a constant temperature till one of the components is exhausted in the liquid phase.

- Boiling point of the mixture will be less than that of water.
- The vapour will have a constant composition till one of the component gets exhausted.
- The boiling point will be between 100°C and 110°C.

44. Suppose in one dimensional random walk problem, for a walk in 4 steps ($N=4$), if one take 3 steps forward and 1 step backward. Then the probability of taking 3 steps forward will be equal to (suppose, with every step you will flipping a coin)-

- $f_2(4)$
- $f_4(2)$
- $f_4(-2)$
- $f_{-2}(4)$

45. Suppose, you have 3 distinguishable particles and have three similar baskets and have to place these balls in these baskets. How many macrostate and microstate are possible, respectively?

- 2 and 10
- 2 and 8
- 3 and 12
- 3 and 10

46. Using Boltzmann distribution, the probability of an oscillator occupying the first two levels ($n=0$ and 1) is found to be 0.637 and 0.223 and the probability of oscillator energy in energy level $n \geq 3$ is 0.042. Then what is the probability in $n=2$ levels?

- 0.902
- 0.420
- 0.098
- 0.000

47. When $T \rightarrow 0$, value of the single particle partition function will be (given: degeneracy of level $j=g_j$):

- 1
- ∞
- 0
- $\sum g_j$

48. In a sample of atomic oxygen at 27° c, what proportion of atoms are in the first excited electronic state if it lies 1000 kJ mol⁻¹ above the ground state?

- 0

- $10^{-400.93}$
- $10^{-174.09}$
- $e^{-174.09}$

49. The translational partition function of a H-atom is 8×10^{33} at 3700 K in a volume of 0.064 m^3 . What is the thermal wavelength value in meter?

- 10^{-12}
- 4×10^{-12}
- 2×10^{-11}
- 2×10^{-12}

50. Gibbs paradox in statistical mechanics is related to

- additive property of the temperature
- additive property of the energy
- additive property of the momentum
- additive property of the entropy

51. The molecular partition function for a system in which the energy levels are equispaced by E is

- $1/(1-e^{\beta E})$
- $1/(1+e^{-\beta E})$
- $1/(1-e^{-\beta E})$
- $1/(1+e^{\beta E})$

52. The value of molecular partition function of NO(g) for rotation at 3600 K is 19.06. What is the value of the characteristic rotational temperature Θ_r ?

- 188.88 K
- 94.44 K
- 196.92 K
- 96.96 K

53. Partition function of a system is represented by $Q = \exp(a^3 T^{3/2} V^3)$, where 'a' is a constant. Calculate average pressure of the system (given: k_B is the Boltzmann constant)?

- $4k_B a^3 T^{5/2} V$
- $2k_B a^3 T^{5/2} V^2$

$2k_B a^3 T^{3/2} V^2$

$4k_B a^2 T^{5/2} V^2$

54. In a classical micro canonical ensemble for a system of 'N' interacting particles, the fundamental volume in phase which is regarded as equivalent to one microstate is-

h

h^N

h^{3N}

h^{6N}

55. In a grand canonical ensemble, a system A of fixed volume is in contact with a large reservoir B, then-

A can exchange neither energy nor particles with B.

A can exchange both energy and particles with B.

A can exchange only energy with B.

A can exchange only particles with B.

56. What is the fraction of $O_2(g)$ molecules in $v=0$ and $v=1$ vibrational states at 383 K. ' Θ_{vib} ' of $O_2(g)$ is 3683 K.

66.6×10^{-5}

0.32×10^{-5}

6.66×10^{-6}

6.66×10^{-5}

57. The value of molecular partition function of $CO(g)$ for rotation at 4200 K is 16.04. What is the value of the characteristic rotational temperature Θ_r ? **(OMIT AS THIS IS OF CHEMISTRY)**

130.92 K

261.85 K

276.85 K

136.92 K

58. What is the fraction of $N_2(g)$ molecules in $v=0$ and $v=1$ vibrational states at 453 K. ' Θ_{vib} ' of $N_2(g)$ is 3240 K. **(OMIT AS THIS IS OF CHEMISTRY)**

7.85×10^{-4}

78.5×10^{-4}

6.66×10^{-5}

0.78×10^{-4}

59. The molecular partition function of a system is given by $q(T) = (k_B T/hc)^{3/2} (8\pi^2 m k_B T/h^2)^{3/2}$, where the symbols have their usual meanings. The heat capacity at constant volume for this system is (for one mole)-

- 6R
- 3R
- 3R/2
- 9R/2

60. Consider a two levels quantum system with energies $E_1=0$ and $E_2=E$. The Helmholtz free energy of the system is given by ($\beta=1/k_B T$)-

- $-k_B T \ln(1+e^{-\beta E})$
- $k_B T \ln(1+e^{-\beta E})$
- $1.5k_B T$
- $E - k_B T$

61. Consider a system of 'N' number of non-interacting distinguishable particles where each particle can be in three energy levels only. The lowest one, called the ground state, is non-degenerate, and its energy is considered to be zero of energy. The middle one, at energy E and is doubly degenerate. The highest one, at energy 2E and is triply degenerate. Considering canonical ensemble calculate the internal energy(U):

- $[(2NEe^{-\beta E}(1+3e^{-\beta E})) / (1+2e^{-\beta E}+3e^{-2\beta E})]$
- $[(2Ee^{-\beta E}(1+3e^{-\beta E})) / (1+2e^{-\beta E}+3e^{-2\beta E})]$
- $[(2NEe^{-\beta E}) / (1+2e^{-\beta E}+3e^{-2\beta E})]$
- $[(2NE(1+3e^{-2\beta E})) / (1+2e^{-\beta E}+e^{-2\beta E})]$

62. Consider the question 62, calculate the entropy of the system-

- $k_B \ln(1+2e^{-\beta E}+e^{-2\beta E}) + \{(2NE(1+3e^{-2\beta E})) / (T(1+2e^{-\beta E}+3e^{-2\beta E}))\}$
- $Nk_B \ln(1+2e^{-2\beta E}+3e^{-3\beta E}) + \{(2NEe^{-\beta E}(1+3e^{-\beta E})) / (T(1+e^{-\beta E}+3e^{-2\beta E}))\}$
- $Nk_B \ln(1+2e^{-\beta E}+3e^{-2\beta E}) + \{(2NEe^{-\beta E}(1+e^{-\beta E})) / (T(1+3e^{-\beta E}+e^{-2\beta E}))\}$
- $Nk_B \ln(1+2e^{-\beta E}+3e^{-2\beta E}) + \{(2NEe^{-\beta E}(1+3e^{-\beta E})) / (T(1+2e^{-\beta E}+3e^{-2\beta E}))\}$

63. The molecular partition function of a system is given by, $q(T) = aT^4$, 'a' is a constant. The internal energy of the system is (for one mole)

- 3RT
- 6RT
- 4RT
- 2RT

64. Consider a three levels quantum system with energies $E_1=0$, $E_2=E$, and $E_3=2E$. The Helmholtz free energy of the system is given by ($\beta=1/k_B T$)-

- $-k_B \ln(1+e^{-\beta E}+e^{-2\beta E})$
- $-k_B T \ln(1+e^{-\beta E}+e^{-2\beta E})$
- $-1.5k_B T$
- $E-k_B$

65. Consider a very simple gas made up of two identical particles. Suppose that each particle can be in one of the three possible quantum states. In case of FD-statistics, what will be the probability of having both particles in the same state?

- 1
- 1/2
- 1/4
- 0

66. Fermi function $f(E)=1/(e^{(E-E_f)/k_B T}+1)$ gives the probability of occupation of electron per energy state. Then the probability of number of electrons at absolute temperature ($T=0$ k) when $E=E_f$ is

- 1
- 0
- ∞
- 1/2

67. Using the fermi function of the above question , evaluate the temperature at which there is 1% probability that a state with an energy 0.5 eV above the fermi energy, will be occupied by an electron ($1\text{eV}=1.6\times 10^{-19}$ J)

- 1261.83 K
- 1295.82 K
- 1361.45 K
- 800.36 K

68. In which options all are bosons:

- electron, photon, nucleus of ^2H , nucleus of $^{22}\text{Na}_{11}$, nucleus of $^{18}\text{O}_8$
- photon, nucleus of ^2H , nucleus of $^{22}\text{Na}_{11}$, nucleus of $^{18}\text{O}_8$
- proton, nucleus of ^2H , nucleus of $^{22}\text{Na}_{11}$, nucleus of $^{18}\text{O}_8$
- photon, nucleus of ^2H , nucleus of $^{22}\text{Na}_{11}$, nucleus of $^{17}\text{O}_8$

69. Consider a gas made up of two identical particles. Suppose that each particle can be in one of the four possible quantum states. In case of FD-statistics, what will be the probability of having both particles in the same state?

- 1/8
- 1
- 0
- 4

70. Suppose the Fermi function $f(E) = 1/(e^{(E-E_f)/k_B T} + 5)$ gives the probability of occupation of electron per energy state. Then the probability of number of electrons at absolute temperature ($T=0$ K) when $E=E_f$ is

- 1/2
- 1
- 0
- 1/6

71. The volume of a mole of liquid ${}^4\text{He}$ is $27 \times 10^{-6} \text{ m}^3$. The mass of a ${}^4\text{He}$ atom is $6.65 \times 10^{-24} \text{ gm}$. Assume liquid ${}^4\text{He}$ is an ideal boson gas with zero spin. Then the value of Boson temperature (in K) will be: (Given: $h = 6.62 \times 10^{-34} \text{ JK}^{-1} \text{ mol}^{-1}$, $k_B = 1.38 \times 10^{-23} \text{ Jk}^{-1}$, $N_A = 6.023 \times 10^{23}$ and Reimann Zeta function, $\zeta(3/2) = 2.612$)

- 3.2
- 1.68
- 1.55
- 6.08

72. Among the following : i) At 0°C , hydrogen contains mainly para hydrogen.

ii) At 0°C , hydrogen contains mainly ortho hydrogen.

iii) At the liquefaction temperature of air, the ratio of ortho and para hydrogen is 1:1.

iv) At the liquefaction temperature of air, the ratio of ortho to para hydrogen is 3:1.

v) At room temperature, the ratio of ortho to para hydrogen is 3:1.

vi) At room temperature, the ratio of ortho to para hydrogen is 1:3.

vii) Even at high temperature the ratio of ortho to para hydrogen can never be more than 3:1.

- all of the above is true.
- ii, iii, vi, vii are true.
- i, iii, v, vii are true.
- ii, iv, v, vii are true.

73. For $^{16}\text{O}_8$ molecule in ground electronic state, the value of Ψ_{rot} will be-

- only even
- only odd
- even or odd
- zero

74. $^{16}\text{O}_8$ molecule in ground electronic state will be-

- both boson and fermion
- only fermion
- other than boson or fermion
- only boson

75. $^{16}\text{O}_8$ molecule is in ground electronic state. The value of Ψ_{elec} will be-

- symmetric
- both antisymmetric and symmetric
- antisymmetric
- either symmetric or antisymmetric

76. The volume of a mole of liquid Ne is $54 \times 10^{-6} \text{ m}^3$. The mass of a Ne atom is $27 \times 10^{-24} \text{ gm}$. Assuming liquid Ne is an ideal boson gas with zero spin. Then the value of Boson temperature (in K) will be (given: $h=6.62 \times 10^{-34} \text{ JK}^{-1} \text{ mol}^{-1}$, $k_B=1.38 \times 10^{-23} \text{ JK}^{-1}$, $N_A=6.023 \times 10^{23}$ and Reimann Zeta function, $\zeta(3/2)=2.612$)

- 0.49
- 3.2
- 1.0
- 2.0

77. The value of the molar heat capacity at constant volume will be (in $\text{cal mol}^{-1} \text{ degree}^{-1}$ unit)

- 24.9
- 6.00
- 0.246
- 24.9×10^7

78. The molar volume of metallic Mg is 26.1 cc. Each atom of Mg contributes its two 3s electron to the conduction of electron gas. Determine the fermi energy, $E_f = (3N/8\pi V)^{2/3} (h^2/2m)$ (given: $\pi=3.14$, $h=6.626 \times 10^{-34} \text{ JK}^{-1} \text{ mol}^{-1}$, $m_e=9.31 \times 10^{-31} \text{ kg}$, $N_A=6.023 \times 10^{23}$)

- $1.32 \times 10^{-20} \text{ J}$

- $7.53 \times 10^{-18} \text{ J}$
- $2.35 \times 10^{-18} \text{ J}$
- $7.53 \times 10^{-19} \text{ J}$

79. Two identical particles have to be distributed in three energy levels. The ratio of the probability that the two particles occupy same state to the probability that the two particles occupy different states for B-E statistics is-

- 1
- $1/2$
- $2/3$
- $1/3$

80. 5 identifiable particles are distributed in three non-degenerate levels with energies 0, E and 2E. The most probable distribution for a total energy 3E is-

- $N_1=2, N_2=2, N_3=1$
- $N_1=2, N_2=1, N_3=2$
- $N_1=4, N_2=1, N_3=0$
- $N_1=3, N_2=1, N_3=1$

81. The temperature of 72 g of water is raised from 30°C to 80°C at constant pressure. The change in the enthalpy of the system (given that $C_{p,m}$ of water = $50 \text{ JK}^{-1}\text{mol}^{-1}$) is-

- 0 kJ
- 2.5 kJ
- 7.5 kJ
- 13.5 kJ

82. For the combustion of 1 mole of liquid benzene at 25°C , the heat of reaction at constant pressure is given by- $\text{C}_6\text{H}_6(\text{l}) + 7/2 \text{ O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$; $\Delta H = -780980 \text{ cal}$. What would be the heat of reaction at constant volume? **(OMIT AS THIS IS OF CHEMISTRY)**

- 780 kcal
- 780 kcal
- 580 kcal
- 580 kcal

83. $C_P > C_V$, (where C_P is specific heat of a gas at constant pressure and C_V is specific heat of a gas at constant volume) because at constant pressure,

- the attraction between the molecules is larger
- the coefficient of expansion differs

- work is done by the expanding gas
- None of the above

85. An electric current of 3 Ampere flows through a rod of resistance of 10 ohm. It is being cooled by running water and is kept at a temperature of 300 K. The change in entropy per second of the resistance is

- 0.3 J⁻¹deg⁻¹
- 3 J⁻¹deg⁻¹
- 30 J⁻¹deg⁻¹
- 0

86. 1 mole of an ideal monoatomic gas is taken from the state I (24.6 L, 1 atm, 300 K, S° = 81 J K⁻¹) to the state II (2 atm, 320 K). ΔG (J) for the entire process is

- 98.8
- 210.5
- 335.8
- 3470.7

87. A three level systems of N atoms with energies E = -E₀, 0 and E₀ is in thermal equilibrium at temperature T. Let, β=(k_BT)⁻¹. If βE₀=2, the probability of finding the system in the level E=0 is (given e^x+e^{-x} = 2coshx)

- (1+2cosh2)⁻¹
- cosh2/2
- (cosh2)⁻¹
- (2cosh2)⁻¹

88. According to the theory of equipartition of energy if a system is in thermal equilibrium at temperature T, then each independent quadratic term contributes how much energy to the total energy value-

- RT/2N
- k_BT/2N
- 3k_BT/2N
- 3RT/2N

89. The entropy of an isolated system always. and becomes a at the state of equilibrium.

- decreases, minimum
- increases,maximum

- increases, minimum
- decreases, maximum

90. Which of the following statements is true

- A given macrostate typically corresponds to a huge number of microstates.
- A given macrostate always has exactly one microstate
- Entropy is a function of the microstates of the system
- Different microstates always correspond to different macrostates

91. From a standard deck of cards if you have a hand of 8 cards, 5 of which are black, calculate the entropy of the system

- 15.25
- 27.89
- 76.50
- 18.95

92. Alice has 3 black and 3 red cards in hand picked from a standard deck of 52 cards, while Bob has 4 black and 2 red cards also from a standard deck of cards. Whose hand of cards has a higher entropy?

- Alice
- Bob
- Both have same entropy
- Cannot be determined

93. Consider a case where there are 3 steps in a staircase all with equal height h and there are 3 different people on the staircase with equal weights w . How many ways can the potential energy be $8wh$?

- 6
- 3
- 1
- 7

94. For the same system as the above question what value of the potential energy will have the maximum possible ways of occurrence

- $3wh$
- $9wh$
- $6wh$
- $4wh$

95. Consider a staircase with 3 steps and 3 identical marbles arranged on them. The steps are of height h and marbles are of weight w . How many ways can the potential energy be $6wh$?

1

2

7

96. For a system of marbles on an endless staircase there can be cases of negative temperature

True

False