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63/1 (SEM–6) CC14/PHYHC6146

2024

PHYSICS

Paper : PHYHC6146

(Statistical Mechanics)

Full Marks : 60

Pass Marks : 24

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer from the following : ***(any five)*** 1×5=5

   (a) A dice of Ludo is thrown. The probability of getting four dots upward is

   (i) 1/3

   (ii) 1/6

   (iii) 4/6

   (iv) 1

Contd.

(b) 5 distinguishable particles are distributed in 2 compartments. Then total number of microstates of the system is

(i) 4

(ii) 10

(iii) 16

(iv) 32

(c) In classical statistics, occupation index is

(i) <1

(ii) >1

(iii) <<1

(iv) >>1

(d) Change in entropy in reversible process is

(i) 0

(ii) 1

(iii) 1/2

(iv) >0

(e) The relation between emissivity for a black body, e and absorptivity a is

(i) $e = a^2$

(ii) $a = e^2$

(iii) $e = a$

(iv) $ea = 1$

(f) A body will radiate heat most rapidly if its surface is

(i) white and polished

(ii) white and rough

(iii) black and polished

(iv) black and rough

(g) "Good absorbers are good emitters." The statement is called

(i) Stefan's law

(ii) Wein's law

(iii) Prevost law

(iv) Kirchhoff's law

(h) Bosons have spin value

(i) 0

(ii) 1

(iii) 1/2

(iv) 0 *or* 1

(i) Which is not true about photon ?

(i) Its rest mass is zero

(ii) It travels with speed of light

(iii) Its energy is entirely kinetic

(iv) It has a momentum equal to $h\lambda$

(j) The M-B, B-E and F-D statistics give identical result for a system, when

(i) temperature is closed to 0°K

(ii) occupation index is very high

(iii) occupation index is very low

(iv) pressure is very high

2. Answer the following questions : ***(any five)*** 2×5=10

(a) What do you mean by negative temperature ?

(b) Explain partition function.

(c) The absolute temperature of a perfectly black body is increased to twice its value. Then find the emission of energy per unit area.

(d) State Wein's displacement law.

(e) What do you mean by Bose-Einstein condensation ?

(f) Find the number of distinct ways of arranging 6 bosons in 4 phase space cells.

(g) What is Chandrasekhar mass limit ?

3. Answer the following questions : ***(any five)*** 5×5=25

(a) MB distribution law is applicable for what type of particles ? Deduce MB energy distribution law. 1+4=5

(b) Find the relation between entropy and probability.

(c) Explain Saha's ionization formula.

(d) State and prove Stefan-Boltzmann law.

(e) Using Planck's formula of black body radiation, find Stefan's constant.

(f) Explain superfluidity of Helium by BE condensation.

(g) Write the postulates of BE statistics. Derive BE energy distribution law. At what condition BE statistics is converted to MB statistics? 1+3+1=5

(h) What is Fermi temperature? Deduce the expression for fermi energy. 1+4=5

(i) Show that the average speed of molecules are

$\bar{V} = [8kT/\pi m]^{1/2}$ using MB statistics.

4. Answer the following questions : ***(any two)*** 10×2=20

(a) What do you mean by degrees of freedom? State the law of equipartition of energy. Prove that for a perfect gas

$$C_p/C_v = 1 + 2/f$$

where the symbols have their usual meanings. 1+2+7=10

(b) Derive Sackur-Tetrode equation.

(c) What is white dwarf star? Show that mass of the white dwarf star is less than the mass of the sun. 2+8=10

(d) Derive the relation between entropy (S) and thermodynamic probability (W). Find the relation of partition function with entropy (S). 5+5=10
