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6 SEM TDC PHY M 1

2015

(May)

PHYSICS

(Major)

Course : 601

(Statistical Mechanics)

Full Marks : 60

Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×5=5

(a) Boltzmann entropy relation is

(i) $S = C_v \log W$

(ii) $S = C_p \log W$

(iii) $S = G \log H$

(iv) $S = K \log W$

The symbols represent their usual meanings.

(b) The energy density of a monochromatic radiation inside a cavity of temperature T is proportional to

(i) T^2

(ii) T^3

(iii) T^4

(iv) T^5

(c) The unit of Stefan constant is

(i) $\mathrm{J\,s^{-4}\,m^{-2}}$

(ii) $\mathrm{J\,s^{-1}\,m^{-2}\,K^{-2}}$

(iii) $\mathrm{J\,s^{-1}\,m^{-2}\,K^{-4}}$

(iv) $\mathrm{J\,s^{-1}\,m^{2}\,K^{-2}}$

(d) The partition function of a system consisting of canonical ensemble is given by

(i) $Z = \int e^{-\beta E} d\Gamma$

(ii) $Z = \int e^{\beta / E} d\Gamma$

(iii) $Z = \Delta\Gamma$

(iv) $Z = \dfrac{1}{\int e^{\beta E} d\Gamma}$

(e) If Z represents the partition function then the mean energy E is given by

(i) $\overline{E} = \partial\beta(\log Z)$

(ii) $\overline{E} = -\dfrac{\partial}{\partial\beta}(\log Z)$

(iii) $\overline{E} = \dfrac{1}{\partial\beta(\log Z)}$

(iv) $\overline{E} = \partial\beta\left(\dfrac{1}{\log Z}\right)$

2. What are the important distinctions between canonical and grand canonical ensembles? 4

3. State and explain the Liouville's theorem. 5

4. What are Lagrange's undetermined multipliers? Explain their thermodynamical interpretations. 2+4=6

5. Calculate the partition function of an ideal monatomic gas. 5

6. Express Gibbs' potential (G) in terms of partition function (Z). 4

7. Derive the particular distribution law which is applicable to photons. 6

Or

Derive an expression for Fermi-Dirac law of energy distribution for free electrons in a metal.

8. Define fermion and boson and give at least three examples. 2

9. What is the condition for most probable distribution? Derive the following relation for fermions : 2+4=6

$$W = \Pi \frac{g_i\,!}{n_i\,!(g_i - n_i)!}$$

10. Compare Bose-Einstein and Fermi-Dirac statistics. 4

11. Show that the average energy of Planck's oscillator of frequency ν in thermal equilibrium at temperature T is

$$\overline{E} = \frac{h\nu}{e^{h\nu/kT} - 1}$$ 4

Or

How many photons are present in 1 cm^3 of radiation at 727 °C?

$$\left[\text{Given } \int_0^\infty \frac{x^2 dx}{e^x - 1} = 2 \cdot 405\right]$$

12. Derive Planck's law of blackbody radiation. 5

13. Write short notes on the following : 2+2=4

(a) Stefan's law

(b) Fermi level

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