3 TDC (Special) PHY M 3

2016

(July)

PHYSICS

(Major)

Paper : 30300

(Thermal Physics)

Full Marks : 67

Time : Three hours

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

Choose the correct answer : 1×6=6

(a) The thermodynamic potential of a system that remains constant in Joule-Thomson effect is

(i) U *(ii)* H

(iii) F *(iv)* G

where U, H, F and G have their usual significance.

(b) The mean free path of a gas is proportional to

(i) σ (ii) σ^2

(iii) $\frac{1}{\sigma^2}$ (iv) $\frac{1}{\sqrt{\sigma}}$

(c) The ratio of the most probable velocity, the mean velocity and root-mean-square velocity of a perfect gas is

(i) $1:\sqrt{2}:\sqrt{3}$

(ii) $\sqrt{2\pi}:\sqrt{8}:\sqrt{3\pi}$

(iii) $1:\sqrt{\pi}:\sqrt{8}$

(iv) $1:\sqrt{3\pi}:\sqrt{8}$

(d) Pauli's exclusion principle has been used in

(i) MB-statistics

(ii) Fermi-Dirac statistics

(iii) Bose-Einstein statistics

(iv) Both BE and FD statistics

(e) The first law of thermodynamics gives the concept of

(i) internal energy

(ii) temperature

(iii) entropy

(iv) energy

(f) If E be the total emissive power of a black body of temperature T and u is the energy density in a cavity of the same temperature, then the relation between E and u is

(i) $E = \frac{u}{4c}$ (ii) $\frac{cu}{4\pi}$

(iii) $\frac{uc}{4}$ (iv) $\frac{1}{4}uc$

2. Derive Maxwell's law of distribution of velocities of the molecules of a gas. 8

Or

What are transport phenomena ? Show that $\eta = \frac{1}{3}\rho\bar{c}\lambda$, where η is the viscosity of the gas, ρ the density, $\bar{c}$ the mean molecular velocity and λ the mean free path.

2+6=8

3. Derive van der Waals' equation of sta
Deduce expressions for the critical consta
in terms of a and b. 6+3

4. Answer ***any two*** questions : 5×2=

(a) State Carnot's theorem and prove
from the Kelvin statement of seco
law of thermodynamics.

(b) Deduce the Clapeyron's latent h
equation from Maxwell's therm
dynamical relations.

(c) What is entropy of a system? Sh
that entropy of the universe increa
in all irreversible processes and rema
constant in reversible processes.

5. What are thermodynamic potentials? G
physical significance of each of them.
2+6

Or

State Planck's law of black-body radiati
Obtain an expression for mean energy of
oscillator in light of Planck's hypothesis

6. What do you mean by ultravio
catastrophe?

7. State the important distinction between Bose-Einstein and Fermi-Dirac statistics. 4

8. State and prove the Boltzmann's theorem of entropy and probability. 4

Or

Show that the entropy of a thermodynamical system is proportional to the logarithmic probability of that system. 4

9. What is the partition function in statistical physics? Determine the partition function for an ideal monoatomic gas. 2+4=6

10. Derive the expression $n_i = \frac{g_i}{e^{\alpha+\beta E_i} - 1}$ for the most probable distribution of the particles of a system obeying, BE statistics and hence deduce Planck's black-body radiation formula. 7+3=10
