

B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, OCTOBER 2014**Fifth Semester****Core Course—THERMAL AND STATISTICAL PHYSICS**

(Common For Model I and Model II B.Sc. Physics, B.Sc. Physics-EEM and B.Sc. Physics-Instrumentations)

Time : Three Hours

Maximum Weight : 25

Part A*Answer all questions.**Objective type questions-Weight 1 for each bunch.***BUNCH I**

Choose the most appropriate answer :

1. When a gas in a vessel expands, its internal energy decreases. The process involved is
 - (a) Irreversible.
 - (b) Reversible.
 - (c) Adiabatic.
 - (d) Isothermal.
2. For 100% efficiency of Carnot engine, the temperature of the sink should be
 - (a) 0°C.
 - (b) 0°K.
 - (c) 273°K.
 - (d) 0°F.
3. Heat capacity of a substance is infinite. It means :
 - (a) Heat is given out.
 - (b) Heat is taken in or given out.
 - (c) No change in temperature whether heat is taken in or given out.
 - (d) None of these.
4. Maxwell's law of distribution is ($n_i =$)

(a) $\frac{g_i}{Ae^{-\beta\epsilon_i}}$

(b) $\frac{g_i}{Ae^{\beta\epsilon_i}}$

(c) $\frac{g_i}{Ae^{\beta\epsilon_i} + 1}$

(d) $\frac{g_i}{Ae^{\beta\epsilon_i} - 1}$

Turn over

BUNCH II

Choose the most appropriate answer :

5. Work required to generate 1kcal of heat is :

- (a) 4.2 J. (b) 4.2×10^7 J.
(c) 4.2×10^3 J. (d) 42J.

6. Which of the following has the highest specific heat ?

- (a) Copper. (b) Water
(c) Hydrogen. (d) Silver.

7. Partition function of a perfect gas is $Z =$:

- (a) $\frac{V}{h^3} (2\pi mkT)^{1/2}$. (b) $\frac{V}{h^3} (2\pi mkT)^{3/2}$.
(c) $\frac{V}{h^3} (2\pi mkT)$. (d) $\frac{V}{h^3} (2\pi mkT)^{-1/2}$.

8. Which of the following is not a Maxwell's relation ?

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

BUNCH III

Choose the most appropriate answer :

9. A gas behaves as an ideal gas

- (a) At very low pressure and high temperature.
(b) At high pressure and low temperature.
(c) At high pressure and high temperature.
(d) At low pressure and low temperature.

10. Phase space is divided into

- (a) Groups. (b) Subgroups.
(c) Sets. (d) Cells.

11. During the adiabatic expansion of 10 moles of a gas the internal energy decreases by 50J. Work done during the process is

- (a) + 50 J. (b) -50 J.
(c) 0. (d) + 100J.

12. First law of thermodynamics can be explained on the basis of
- (a) Boyle's law, (b) Maxwell's law.
- (c) Charle's law, (d) Joule's law.

BUNCH IV

Choose the most appropriate answer :

13. Which of the following is suitable for photons ?
- (a) Fermi-Dirac Statistics. (b) Bose-Einstein Statistics.
- (c) Maxwell-Boltzmann Statistics. (d) None of these.

14. The energy density $\frac{U}{V}$ of an ideal monatomic gas is related to its pressure P as :

- (a) $\frac{U}{V} = 3P$. (b) $\frac{U}{V} = \frac{3}{2}P$.
- (c) $\frac{U}{V} = \frac{P}{3}$. (d) $\frac{U}{V} = \frac{5}{2}P$.

15. Quantum statistics approaches to classical statistics if :

- (a) $\frac{g_i}{n_i} = 1$. (b) $\frac{g_i}{n_i} \gg 1$.
- (c) $\frac{g_i}{n_i} \ll 1$. (d) Never.

16. The value of γ for a molecule having n degrees of freedom is :

- (a) $\gamma = 1 + \frac{2}{n}$. (b) $\gamma = 1 + \frac{n}{2}$.
- (c) $\frac{n+1}{2}$. (d) $\frac{n-1}{2}$.

(4 × 1 = 4)

Part B

Answer any five questions.
Short Answer Questions-Weight 1 each.

17. What is a reversible process ?
18. Why white clothes in summer are comfortable ?

Turn over

19. State and explain Planck's law of radiation ?
20. Explain the principle of increase of entropy.
21. Describe the Helmholtz and Gibbs functions associated with a system.
22. What do you mean by statistical equilibrium ?
23. State Fermi-Dirac distribution law.
24. What do you mean by microstates and macro states of a system of particles ?

(5 × 1 = 5)

Part C

*Answer any four questions.
Short Essays/Problems-Weight 2 each.*

25. Calculate the radiant emittance of a black body at 6000K. Stefan's constant = $5.672 \times 10^{-8} \text{ Wm}^{-2}\text{K}^{-4}$.
26. One mole of ideal gas at 28°C expands isothermally to three times the original volume. Calculate the work done.
27. Prove the thermodynamic relations

$$TdS = C_V dT + T \left(\frac{\partial P}{\partial T} \right)_V dV$$

$$TdS = C_P dT - T \left(\frac{\partial V}{\partial T} \right)_P dP$$

28. A Carnot engine has the efficiency 50% when the temperature of the sink is 27°C. Find the change in temperature of the source to get an efficiency of 60%.
29. Derive the expressions for the entropy and specific heat of an ideal monatomic gas in terms of partition function.
30. The Fermi energy for lithium is 4.72eV at absolute zero. Calculate the number of conduction electrons in lithium.

(4 × 2 = 8)

Part D

*Answer any two questions.
Essays-weight 4 each.*

31. Explain the working of a petrol engine. Obtain an expression for its efficiency.
32. Derive Maxwell's thermodynamic relations.
33. What is Gibbs paradox ? How is it resolved ?

(2 × 4 = 8)