

# GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

Subject: PHYSICS

Paper name: Thermal & Statistical Physics

Paper No: PHY/VI/CC/19 (T)

Semester: 6<sup>TH</sup>

Rename this file as [Subject]-[Semester]-[Paper No] and submit directly to [zoology@pucollege.edu.in](mailto:zoology@pucollege.edu.in)

## A. Multiple choice questions [25 (5 from each unit)]

1. According to kinetic theory of gases, energy associated with one gram molecule of a diatomic gas is

- (a)  $\frac{3}{2}K_B T$  [ ]
- (b)  $\frac{3}{2}RT$  [ ]
- (c)  $\frac{5}{2}K_B T$  [ ]
- (d)  $\frac{5}{2}RT$  [ ]

2. If  $C_p = 29.08 J mole^{-1}K^{-1}$  and  $C_v = 20.77 J mole^{-1}K^{-1}$ , then the gas molecule is

- (a) monoatomic [ ]
- (b) diatomic [ ]
- (c) triatomic [ ]
- (d) atomicity cannot be determined from the given data [ ]

3. Which one of the following is the same for molecules of all gases at a given temperature ?

- (a) mass
- (b) speed
- (c) momentum
- (d) kinetic energy

4. Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of gas molecules inside will

- (a) increase
- (b) decrease
- (c) remain same
- (d) decrease for some, while increase for others

5. At what temperature is the r.m.s. velocity of hydrogen molecule equal to that of an oxygen molecule at 47 °C ?

- (a) - 73 K
- (b) 3 K
- (c) 20 K
- (d) 80 K

## GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

6. Viscosity of a gas is due to transport of  
(a) momentum [ ]  
(b) energy [ ]  
(c) mass [ ]  
(d) temperature [ ]
7. The change in specific volume when 1 kg of water freezes is  $91 \times 10^{-6} m^3$  and Latent heat of ice  $L = 3.36 \times 10^5 J kg^{-1}$ . Then the pressure required to freeze ice at 272 K is  
(a) 134.2 Atm. [ ]  
(b) 135.2 Atm. [ ]  
(c) 136.2 Atm. [ ]  
(d) 137.2 Atm. [ ]
8. The pressure exerted by the molecules on the container of a gas is due to  
(a) molecules losing their K.E.  
(b) molecules gaining their K.E.  
(c) sticking to the walls  
(d) change of momentum
9. On the basis of kinetic theory of gases, the mean K.E. of 1 mole per degree of freedom is  
(a)  $\frac{1}{2} RT$   
(b)  $\frac{1}{2} KT$   
(c)  $\frac{3}{2} RT$   
(d)  $\frac{3}{2} KT$
10. If the degrees of freedom of a gas are  $f$ , then the ratio of its specific heats  $C_p/C_v$  is given by  
(a)  $1 - 1/f$   
(b)  $1 + 1/f$   
(c)  $1 + 2/f$   
(d)  $1 - 2/f$
11. The thermodynamic probability of a system at equilibrium is  
(a) maximum [ ]  
(b) minimum [ ]  
(c) 1 [ ]  
(d) 0 [ ]
12. The probability of occurrence of two independent events is equal to the \_\_\_\_\_ of their probability.  
(a) sum [ ]  
(b) difference [ ]  
(c) product [ ]  
(d) ratio [ ]

## GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

13. Which of the following is NOT a fundamental postulate of statistical mechanics?
- (a) The total number of molecules in a system is constant
  - (b) The total energy of the system remains constant
  - (c) All cells in phase space are of equal size
  - (d) All macrostates are equally probable.
14. The principle of equal a priori probability says that
- (a) all macrostates of a system are equally probable
  - (b) all microstates of a system are equally probable
  - (c) the system spends equal time in all microstates
  - (d) both (b) & (c) are correct.
15. The equilibrium state of a system corresponds to
- (a) any macrostate
  - (b) any microstate
  - (c) the most probable macrostate
  - (d) the most probable microstate
16. The internal energy  $U$  of a system is given by
- (a)  $NK_B T \frac{\partial}{\partial T} (\log Z)$  [ ]
  - (b)  $NK_B T^2 \frac{\partial}{\partial T} (\log Z)$  [ ]
  - (c)  $NK_B T^3 \frac{\partial}{\partial T} (\log Z)$  [ ]
  - (d)  $NK_B T^4 \frac{\partial}{\partial T} (\log Z)$  [ ]
17. In canonical ensemble, the partition function is expressed as
- (a)  $\sum_r e^{-E_r/K_B T}$  [ ]
  - (b)  $\sum_r e^{-K_B T E_r}$  [ ]
  - (c)  $\sum_r e^{-E_r/K_B T^2}$  [ ]
  - (d)  $\sum_r e^{-K_B T^2 E_r}$  [ ]
18. An ensemble is a collection of all possible
- (a) macrostates of a given system
  - (b) microstates of a given macrostate
  - (c) macroscopically identical but independent thermodynamic systems
  - (d) None of the above
19. For a system of very large number of particles  $N$ , we can write
- (a)  $\ln N! = N \ln N - N$
  - (b)  $\ln N! = N - N \ln N$
  - (c)  $\ln N! = N - \ln N$
  - (d)  $\ln N! = 2 \ln N - N$

## GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

20. If  $S_1$  and  $S_2$  be entropies of two independent systems, the entropy of the combined system is
- (a)  $S_1 S_2$
  - (b)  $S_1 + S_2$
  - (c)  $S_1 - S_2$
  - (d)  $S_1 / S_2$
21. Pauli's exclusion principle applies to
- (a) M-B statistics
  - (b) F-D statistics
  - (c) B-E statistics
  - (d) all of these
22. The number of different arrangements of six indistinguishable particles among four cells of equal a priori probability if there is no restrictions on the number of particles entering into a cell is
- (a) 24
  - (b) 30
  - (c) 17280
  - (d) 84
23. At absolute zero of temperature, the highest occupied energy state is called
- (a) microstate
  - (b) macrostate
  - (c) Fermi level
  - (d) Dirac level
24. B-E statistics is applicable to
- (a) identical and distinguishable particles
  - (b) indistinguishable particles having integral spin
  - (c) indistinguishable particles having half-integral spin
  - (d) all types of particles
25. Which of the following particles obey M-B statistics?
- (a) electrons
  - (b) protons
  - (c) neutrons
  - (d) gas molecules

## GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

### B. Fill up the blanks

1. The most probable velocity of gas molecules is given by \_\_\_\_\_
2. The average kinetic energy of a gas molecule depends only on the \_\_\_\_\_ of the gas.
3. The theory of translational Brownian motion was successfully explained by \_\_\_\_\_.
4. At \_\_\_\_\_, the three phases of water can co-exist in equilibrium at fixed temperature and pressure.
5. The enthalpy (H), internal energy (U), pressure (P) and volume (V) of a gas are related by the relation \_\_\_\_\_
6. Gibb's free energy function (G), entropy (S) and enthalpy (H) are related by the relation \_\_\_\_\_
7. Statistical mechanics deals with \_\_\_\_\_ parameters of a system in equilibrium from a knowledge of the \_\_\_\_\_ properties of the constituent particles.
8. A \_\_\_\_\_ is a hypothetical space consisting of position and momentum.
9. The dimension of phase space is \_\_\_\_\_ .
10. The relevant macroscopic parameters of a given \_\_\_\_\_ ensemble are E, V, N.
11. Entropy (S) and thermodynamic probability (W) are related by the relation: \_\_\_\_\_
12. A microcanonical ensemble is a collection of all possible \_\_\_\_\_ of a given system
13. The Fermi level is that energy level for which the probability of occupation at  $T > 0$  is \_\_\_\_\_
14. Maxwell-Boltzmann statistics is applicable to \_\_\_\_\_ & \_\_\_\_\_ particles.
15. The \_\_\_\_\_ statistics can be applied to Planck's black body radiation

# GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

## Key Answers

### A. Multiple choice questions

- |         |         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|---------|
| 1. (d)  | 2. (b)  | 3. (d)  | 4. (c)  | 5. (c)  | 6. (a)  | 7. (c)  |
| 8. (d)  | 9. (a)  | 10. (c) | 11. (a) | 12.(c)  | 13. (d) | 14. (d) |
| 15. (c) | 16.(b)  | 17. (a) | 18. (c) | 19. (a) | 20. (b) | 21.(b)  |
| 22. (d) | 23. (c) | 24.(b)  | 25. (d) |         |         |         |

### B. Fill up the blanks

1.  $\sqrt{\frac{2K_B T}{m}}$
2. temperature
3. Einstein
4. triple point
5.  $H = U + PV$
6.  $G = H - TS$
7. Macroscopic, microscopic
8. phase space
9. 6
10. microcanonical
11.  $S = k \ln W$
12. microstates
13.  $\frac{1}{2}$
14. Identical & distinguishable
15. Bose-Einstein

---

**Compiled by:**  
**Dr. Arup Kumar**  
**Associate Professor,**  
**Head of the Dept. of Physics,**  
**Govt. Zirtiri Res. Science College, Aizawl, Mizoram**