

GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

Subject : PHYSICS
Paper Name : Thermodynamics and Mathematical Physics-I
Paper No : II
Semester : 2nd Semester

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

1. According to law of equipartition of energy, the total energy associated with a diatomic gas molecule is
 - (a) $\frac{7}{2}kT$
 - (b) $\frac{6}{2}kT$
 - (c) $\frac{5}{2}kT$
 - (d) $\frac{3}{2}kT$
2. In thermal equilibrium, the average velocity of gas molecules is
 - (a) Proportional to $\sqrt{T}$
 - (b) Proportional to T^2
 - (c) Proportional to T^3
 - (d) Zero
3. For an ideal mono-atomic gas at temperature T, the average kinetic energy of translation varies as
 - (a) $1/T$ ()
 - (b) T^2 ()
 - (c) T ()
 - (d) $\sqrt{T}$ ()
4. The ratio of specific heats C_p/C_V for a monatomic gas molecule is
 - (a) 1.67 ()
 - (b) 1.40 ()
 - (c) 1.33 ()
 - (d) 1.28 ()
5. The ratio of specific heats C_p/C_V for a triatomic gas molecule is
 - (a) 1.67 ()
 - (b) 1.40 ()
 - (c) 1.33 ()
 - (d) 1.28 ()

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6. In a given process for an ideal gas, $dW = 0$ and $dQ < 0$. Then for the gas
- The temperature will decrease
 - The volume will increase
 - The pressure will remain constant
 - The temperature will increase
7. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of
- Second law of thermodynamics
 - Conservation of momentum
 - Conservation of mass
 - First law of thermodynamics
8. In Carnot cycle, the first step is
- Isenthal compression ()
 - Adiabatic compression ()
 - Isenthal expansion ()
 - Adiabatic expansion ()
9. In a reversible adiabatic process, the entropy
- Increases ()
 - Decreases ()
 - First increases then decreases ()
 - Remains unchanged ()
10. The efficiency of carnot's engine is
- $\frac{T_1 - T_2}{T_1}$
 - $\frac{T_2 - T_1}{T_2}$
 - $\frac{T_1 - T_2}{T_2}$
 - $\frac{T_2 - T_1}{T_1}$

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11. If $\vec{B}$ is a magnetic field, then
- $\vec{\nabla} \cdot \vec{B} = 1$
 - $\vec{\nabla} \times \vec{B} = 0$
 - $\vec{\nabla} \cdot \vec{B} = 0$
 - $\vec{\nabla} \times \vec{B} = \infty$
12. In four dimensions, the value of δ_{ii} is
- 1
 - 2
 - 3
 - 4
13. Which of the following statement is NOT true?
- The divergence of a vector $\vec{V}$ is a scalar ()
 - The curl of a vector $\vec{V}$ is a vector ()
 - The gradient of a scalar function ϕ is a vector ()
 - The gradient of a scalar function ϕ is a scalar ()
14. The rank of a tensor T_{jkl}^{ij} is
- 3 ()
 - 4 ()
 - 5 ()
 - 2 ()
15. A vector is a tensor of rank
- 0
 - 1
 - 2
 - 3
16. If H is a Hermitian matrix, then the matrix e^{iH} is
- Hermitian
 - Skew-Hermitian
 - Orthogonal
 - Unitary
17. The adjoint of a symmetric matrix is
- An identity matrix
 - A scalar matrix
 - A diagonal matrix
 - A symmetric matrix

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18. If a square matrix A is such that $|A| = 0$, then the matrix is a

- (a) Zero matrix ()
- (b) Scalar matrix ()
- (c) Singular matrix ()
- (d) Non-singular matrix ()

19. The trace of the matrix

$$A = \begin{pmatrix} 1 & 2 & 3 \\ -2 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \text{ is}$$

- (a) 3 ()
- (b) 2 ()
- (c) 0 ()
- (d) 9 ()

20. Any real square matrix can be expressed as the sum of

- (a) two symmetric matrices
- (b) two skew-symmetric matrices
- (c) a symmetric and a skew-symmetric matrices
- (d) a Hermitian and a skew-Hermitian matrices

21. The value of $\Gamma\left(\frac{-1}{2}\right)$ is

- (a) $-\sqrt{\pi}$ ()
- (b) $\frac{1}{2}\sqrt{\pi}$ ()
- (c) $\frac{-1}{2}\sqrt{\pi}$ ()
- (d) $-2\sqrt{\pi}$ ()

22. The value of $\beta(1,2)$ is

- (a) $\frac{1}{2}$ ()
- (b) $\sqrt{\pi}$ ()
- (c) $\frac{2}{3}$ ()
- (d) $\frac{1}{2}\sqrt{\pi}$ ()

23. The value of $\beta(2, z)$ is

- a. $\frac{1}{z}$
- b. $\frac{1}{(z+1)}$
- c. $\frac{1}{z(z+1)}$
- d. $\frac{(z-1)}{(z+1)}$

24. The value of the integral $\int_0^{\pi/2} (\tan \theta)^{1/2} d\theta$ is

- a. $\Gamma\left(\frac{1}{2}\right)$
- b. $\frac{\pi}{\sqrt{2}}$
- c. $\frac{\sqrt{\pi}}{2}$
- d. $\Gamma\left(\frac{3}{4}\right)\Gamma\left(\frac{1}{4}\right)$

25. The correct expression of $\Gamma(n)$ is

- (a) $\Gamma(n) = \int_0^{\infty} e^x x^{n-1} dx, \quad n > 0$
- (b) $\Gamma(n) = \int_0^{\infty} e^{-x} x^n dx, \quad n > 0$
- (c) $\Gamma(n) = \int_0^{\infty} e^{-x} x^{n-1} dx, \quad n > 0$
- (d) $\Gamma(n) = \int_0^{\infty} e^{-x} x^{n+1} dx, \quad n > 0$

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B. Fill up the blanks [15 (3 from each unit)]

1. The value of universal gas constant (R) (in $\text{J K}^{-1} \text{mol}^{-1}$) is _____.
2. The average _____ of a gas molecule is $\frac{3}{2}kT$.
3. Van der Waals' equation of state is applicable for _____.
4. The root mean square (RMS) velocity of gas molecules is given by _____.
5. According to first law of thermodynamics: Heat supplied = Increase in _____ + work done
6. The process in which pressure remains constant is called _____ process.
7. For any vector field $\vec{A}(x, y, z)$, the value of $\nabla \cdot (\nabla \times \vec{A})$ is _____.
8. If $\nabla \times \vec{A} = 0$, then the vector $\vec{A}(x, y, z)$ is called _____.
9. The cylindrical coordinate system is _____ curvilinear system.
10. The eigenvalues of a _____ matrix are real.
11. The transpose of the product of two matrices is the product of their transposes taken in the _____.
12. The matrix $\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$ is _____.
13. The value of $\Gamma(n) = \infty$ when n is zero or a _____ integer.
14. The value of $\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(x)}$, where $x =$ _____.
15. Given that $\Gamma(n+1) = n\Gamma(n) = n!$, when n is _____.

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Key Answers

A. Multiple choice questions

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

B. Fill up the blanks

1. 8.314
2. Kinetic energy
3. Real gases
4. $\sqrt{\frac{3RT}{M}}$
5. Internal energy
6. Adiabatic
7. Zero
8. Irrotational
9. An orthogonal
10. Hermitian
11. reverse order
12. unitary
13. negative
14. $m+n$
15. an integer.

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