Test Paper : **II** Test Subject : **PHYSICAL SCIENCES** Test Subject Code : **K-2517**	Test Booklet Serial No. : ____________ OMR Sheet No. : ____________ Roll No. ☐☐☐☐☐☐☐☐ (Figures as per admission card)

Name & Signature of Invigilator/s

Signature : ____________________

Name : ____________________

Paper : II

Subject : PHYSICAL SCIENCES

Time : 1 Hour 15 Minutes | Maximum Marks : 100

Number of Pages in this Booklet : **8** | Number of Questions in this Booklet : **50**

ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ಸೂಚನೆಗಳು

1. ಈ ಪುಟದ ಮೇಲ್ತುದಿಯಲ್ಲಿ ಒದಗಿಸಿದ ಸ್ಥಳದಲ್ಲಿ ನಿಮ್ಮ ರೋಲ್ ನಂಬರನ್ನು ಬರೆಯಿರಿ.
2. ಈ ಪತ್ರಿಕೆಯು ಬಹು ಆಯ್ಕೆ ವಿಧದ ಐವತ್ತು ಪ್ರಶ್ನೆಗಳನ್ನು ಒಳಗೊಂಡಿದೆ.
3. ಪರೀಕ್ಷೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ, ಪ್ರಶ್ನೆಪುಸ್ತಿಕೆಯನ್ನು ನಿಮಗೆ ನೀಡಲಾಗುವುದು. ಮೊದಲ 5 ನಿಮಿಷಗಳಲ್ಲಿ ನೀವು ಪುಸ್ತಿಕೆಯನ್ನು ತೆರೆಯಲು ಮತ್ತು ಕೆಳಗಿನಂತೆ ಕಡ್ಡಾಯವಾಗಿ ಪರೀಕ್ಷಿಸಲು ಕೋರಲಾಗಿದೆ.
   (i) ಪ್ರಶ್ನೆ ಪುಸ್ತಿಕೆಗೆ ಪ್ರವೇಶಾವಕಾಶ ಪಡೆಯಲು, ಈ ಹೊದಿಕೆ ಪುಟದ ಅಂಚಿನ ಮೇಲಿರುವ ಪೇಪರ್ ಸೀಲನ್ನು ಹರಿಯಿರಿ. ಸ್ಟಿಕ್ಕರ್ ಸೀಲ್ ಇಲ್ಲದ ಅಥವಾ ತೆರೆದ ಪುಸ್ತಿಕೆಯನ್ನು ಸ್ವೀಕರಿಸಬೇಡಿ.
   (ii) **ಪುಸ್ತಿಕೆಯಲ್ಲಿನ ಪ್ರಶ್ನೆಗಳ ಸಂಖ್ಯೆ ಮತ್ತು ಪುಟಗಳ ಸಂಖ್ಯೆಯನ್ನು ಮುಖಪುಟದ ಮೇಲೆ ಮುದ್ರಿಸಿದ ಮಾಹಿತಿಯೊಂದಿಗೆ ತಾಳೆ ನೋಡಿರಿ. ಪುಟಗಳು/ಪ್ರಶ್ನೆಗಳು ಕಾಣೆಯಾದ, ಅಥವಾ ದ್ವಿಪ್ರತಿ ಅಥವಾ ಅನುಕ್ರಮವಾಗಿಲ್ಲದ ಅಥವಾ ಇತರ ಯಾವುದೇ ವ್ಯತ್ಯಾಸದ ದೋಷಪೂರಿತ ಪುಸ್ತಿಕೆಯನ್ನು ಕೂಡಲೆ 5 ನಿಮಿಷದ ಅವಧಿ ಒಳಗೆ, ಸಂವೀಕ್ಷಕರಿಂದ ಸರಿ ಇರುವ ಪುಸ್ತಿಕೆಗೆ ಬದಲಾಯಿಸಿಕೊಳ್ಳಬೇಕು. ಆ ಬಳಿಕ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯನ್ನು ಬದಲಾಯಿಸಲಾಗುವುದಿಲ್ಲ, ಯಾವುದೇ ಹೆಚ್ಚು ಸಮಯವನ್ನೂ ಕೊಡಲಾಗುವುದಿಲ್ಲ.**
4. ಪ್ರತಿಯೊಂದು ಪ್ರಶ್ನೆಗೂ (A), (B), (C) ಮತ್ತು (D) ಎಂದು ಗುರುತಿಸಿದ ನಾಲ್ಕು ಪರ್ಯಾಯ ಉತ್ತರಗಳಿವೆ. ನೀವು ಪ್ರಶ್ನೆಯ ಎದುರು ಸರಿಯಾದ ಉತ್ತರದ ಮೇಲೆ, ಕೆಳಗೆ ಕಾಣಿಸಿದಂತೆ ಅಂಡಾಕೃತಿಯನ್ನು ಕಪ್ಪಾಗಿಸಬೇಕು.
   ಉದಾಹರಣೆ : Ⓐ Ⓑ ● Ⓓ
   (C) ಸರಿಯಾದ ಉತ್ತರವಾಗಿದ್ದಾಗ.
5. ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ I ರಲ್ಲಿ **ಕೊಟ್ಟಿರುವ OMR ಉತ್ತರ ಹಾಳೆಯಲ್ಲಿ, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ I ಮತ್ತು ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ II ರಲ್ಲಿ ಇರುವ ಪ್ರಶ್ನೆಗಳಿಗೆ ನಿಮ್ಮ ಉತ್ತರಗಳನ್ನು ಸೂಚಿಸತಕ್ಕದ್ದು.** OMR ಹಾಳೆಯಲ್ಲಿ ಅಂಡಾಕೃತಿಯಲ್ಲದೆ ಬೇರೆ ಯಾವುದೇ ಸ್ಥಳದಲ್ಲಿ ಉತ್ತರವನ್ನು ಗುರುತಿಸಿದರೆ, ಅದರ ಮೌಲ್ಯಮಾಪನ ಮಾಡಲಾಗುವುದಿಲ್ಲ.
6. OMR ಉತ್ತರ ಹಾಳೆಯಲ್ಲಿ ಕೊಟ್ಟ ಸೂಚನೆಗಳನ್ನು ಜಾಗರೂಕತೆಯಿಂದ ಓದಿರಿ.
7. ಎಲ್ಲಾ ಕರಡು ಕೆಲಸವನ್ನು ಪುಸ್ತಿಕೆಯ ಕೊನೆಯಲ್ಲಿ ಮಾಡತಕ್ಕದ್ದು.
8. ನಿಮ್ಮ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸಬಹುದಾದ ನಿಮ್ಮ ಹೆಸರು ಅಥವಾ ಯಾವುದೇ ಚಿಹ್ನೆಯನ್ನು, ಸಂಗತವಾದ ಸ್ಥಳ ಹೊರತು ಪಡಿಸಿ, OMR ಉತ್ತರ ಹಾಳೆಯ ಯಾವುದೇ ಭಾಗದಲ್ಲಿ ಬರೆದರೆ, ನೀವು ಅನರ್ಹತೆಗೆ ಬಾಧ್ಯರಾಗಿರುತ್ತೀರಿ.
9. ಪರೀಕ್ಷೆಯು ಮುಗಿದನಂತರ, ಕಡ್ಡಾಯವಾಗಿ OMR ಉತ್ತರ ಹಾಳೆಯನ್ನು ಸಂವೀಕ್ಷಕರಿಗೆ ನೀವು ಹಿಂತಿರುಗಿಸಬೇಕು ಮತ್ತು ಪರೀಕ್ಷಾ ಕೊಠಡಿಯ ಹೊರಗೆ OMR ನ್ನು ನಿಮ್ಮೊಂದಿಗೆ ಕೊಂಡೊಯ್ಯಕೂಡದು.
10. ಪರೀಕ್ಷೆಯ ನಂತರ, ಪರೀಕ್ಷಾ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಯನ್ನು ಮತ್ತು ನಕಲು OMR ಉತ್ತರ ಹಾಳೆಯನ್ನು ನಿಮ್ಮೊಂದಿಗೆ ತೆಗೆದುಕೊಂಡು ಹೋಗಬಹುದು.
11. **ನೀಲಿ/ಕಪ್ಪು ಬಾಲ್‌ಪಾಯಿಂಟ್ ಪೆನ್ ಮಾತ್ರವೇ ಉಪಯೋಗಿಸಿರಿ.**
12. **ಕ್ಯಾಲ್ಕುಲೇಟರ್, ವಿದ್ಯುನ್ಮಾನ ಉಪಕರಣ ಅಥವಾ ಲಾಗ್ ಟೇಬಲ್ ಇತ್ಯಾದಿಯ ಉಪಯೋಗವನ್ನು ನಿಷೇಧಿಸಲಾಗಿದೆ.**
13. **ಸರಿ ಅಲ್ಲದ ಉತ್ತರಗಳಿಗೆ ಋಣ ಅಂಕ ಇರುವುದಿಲ್ಲ.**
14. **ಕನ್ನಡ ಮತ್ತು ಇಂಗ್ಲೀಷ್ ಆವೃತ್ತಿಗಳ ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆಗಳಲ್ಲಿ ಯಾವುದೇ ರೀತಿಯ ವ್ಯತ್ಯಾಸಗಳು ಕಂಡುಬಂದಲ್ಲಿ, ಇಂಗ್ಲೀಷ್ ಆವೃತ್ತಿಗಳಲ್ಲಿರುವುದೇ ಅಂತಿಮವೆಂದು ಪರಿಗಣಿಸಬೇಕು.**

Instructions for the Candidates

1. Write your roll number in the space provided on the top of this page.
2. This paper consists of fifty multiple-choice type of questions.
3. At the commencement of examination, the question booklet will be given to you. In the first 5 minutes, you are requested to open the booklet and compulsorily examine it as below :
   (i) To have access to the Question Booklet, tear off the paper seal on the edge of the cover page. Do not accept a booklet without sticker seal or open booklet.
   (ii) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to pages/questions missing or duplicate or not in serial order or any other discrepancy should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given.**
4. Each item has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example : Ⓐ Ⓑ ● Ⓓ
   where (C) is the correct response.
5. Your responses to the questions are to be indicated in the **OMR Sheet kept inside the Paper I Booklet only**. If you mark at any place other than in the circles in the OMR Sheet, it will not be evaluated.
6. Read the instructions given in OMR carefully.
7. Rough Work is to be done in the end of this booklet.
8. If you write your name or put any mark on any part of the OMR Answer Sheet, except for the space allotted for the relevant entries, which may disclose your identity, you will render yourself liable to disqualification.
9. You have to return the test OMR Answer Sheet to the invigilators at the end of the examination compulsorily and must NOT carry it with you outside the Examination Hall.
10. You can take away question booklet and carbon copy of OMR Answer Sheet after the examination.
11. **Use only Blue/Black Ball point pen.**
12. **Use of any calculator, Electronic gadgets or log table etc., is prohibited.**
13. **There is no negative marks for incorrect answers.**
14. **In case of any discrepancy found in the Kannada translation of a question booklet the question in English version shall be taken as final.**

PHYSICAL SCIENCES
Paper – II

Note : This paper contains **fifty (50)** objective type questions. **Each** question carries **two (2)** marks. **All** questions are **compulsory**.

1. The absolute value of the integral $\oint \vec{r} \times d\vec{r}$ around an equilateral triangle of side 'a' with the origin at its center is

(A) a^2 (B) $2a^2$

(C) $\frac{\sqrt{3}}{2}a^2$ (D) πa^2

2. If F [f(x)] = $\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x)\, e^{-ikx} dx$, then F^2 [f(x)] is equal to

(A) f(x) (B) –f(x)

(C) f(–x) (D) $\frac{f(x) + f(-x)}{2}$

3. The Fourier transform of $\frac{df}{dx}$ is related to the Fourier transform $h(k) = \int_{-\infty}^{\infty} e^{ikx} f(x)\, dx$ of the function f(x) by

(A) $\frac{dh(k)}{dk}$ (B) $\int h(k)\, dk$

(C) –ik h(k) (D) ik h(k)

4. The value of the integral $\oint_C z^2\, dz$, where C is a unit circle, is

(A) $1/3$ (B) zero

(C) $2\pi i$ (D) $z^3/3$

5. The value of the integral $\frac{1}{\pi i} \oint_C \frac{dz}{z^2 - 1}$ where the contour C is a circle of radius $a \neq 1$, with origin as centre is given by

(A) 1, independent of a

(B) 1, if a > 1

(C) 1, if a < 1 and 0, if a > 1

(D) 0, independent of a

6. Consider the matrix

$$A = \begin{pmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{pmatrix}$$. The product of the eigen values of the matrix is

(A) 1 (B) zero

(C) –1 (D) –6

7. The average value of a function f(x) = sin x in the interval $0 \le x \le \pi$ is

(A) $1/2$ (B) $2/\pi$

(C) $1/\pi$ (D) $4/\pi$

8. Eigen values of real 3×3 matrix

(A) must have at least one of the eigen values real

(B) must be all real

(C) must have at least two real eigen values

(D) must have all three eigen values imaginary

9. A 3×3 matrix has eigen values 0, $2 + i$ and $2 - i$. Which of the following statements is correct ?
(A) The matrix is Hermitian
(B) The matrix is unitary
(C) The matrix is singular
(D) The matrix is non-singular

10. There are 40 persons in a room all born in the month of April. The probability that at least two of them share the same birthday is closest to
(A) 0.4 (B) 0.7
(C) 0.8 (D) 0.9

11. A particle of mass m is thrown upwards from the surface of the earth with initial velocity components u_x, u_y, along the horizontal and vertical directions, respectively. The trajectory therefore is given by $x(t) = u_x t$, $y(t) = u_y t - \frac{1}{2}gt^2$. The instant of time at which the acceleration and velocity vectors are perpendicular to each other is given by
(A) u_y/g (B) u_x/g
(C) $|u_x - u_y|/g$ (D) $(u_x + u_y)/g$

12. The phase curve of a freely falling body under gravity is
(A) ellipse (B) hyperbola
(C) stable node (D) stable star

13. The fixed point of a one-dimensional harmonic oscillator obeying the dynamical equation $\ddot{x} + w^2 x = 0$, is
(A) unstable spiral (B) saddle
(C) stable spiral (D) elliptic

14. A planet is revolving around a star in an elliptic orbit. The ratio of the farthest distance to the closest distance of the planet from the star is 1.5. The eccentricity of the orbit is given by
(A) 1.5 (B) 0.2
(C) 0 (D) 0.4

15. If a particle experiences a force $\vec{F} = \dot{r}\,\vec{r}$ (where $\vec{r}$ denotes the instantaneous position vector of the particle) the force is identified to be
(A) central and conservative
(B) non-central and non-conservative
(C) non-central and conservative
(D) central and non-conservative

16. The Lagrangian is $L = \sqrt{1 + \left(\frac{dy}{dx}\right)^2}$, where y(x) is a function of x. The stationary condition on the action, $S = \int_{x_1}^{x_2} L\,dx$ with fixed end points x_1, x_2 leads to one of the following expressions with a, b constants. The correct option is
(A) $y = ax + b$ (B) $y = ax^2 + b$
(C) $y = a/x + b$ (D) $y = a/x^2 + b$

17. A particle of mass m is subjected to one-dimensional potential $V(x) = -\frac{1}{2}kx^2 + \frac{\lambda}{4}x^4$. If the particle executes small amplitude oscillations about the minimum of the potential the frequency of oscillation is, [λ and k are positive constants.]
(A) $\sqrt{k/m}$ (B) $\sqrt{\sqrt{\lambda}/m}$
(C) $\sqrt{\lambda/k}$ (D) $\sqrt{2k/m}$

18. The elements of a moment of inertia tensor of a rigid body expressed as a 3×3 matrix in the body fixed co-ordinate system as, $I = \begin{pmatrix} I_0 & 0 & 0 \\ 0 & 2I_0 & I_0 \\ 0 & I_0 & 2I_0 \end{pmatrix}$, where $I_0 > 0$ the rigid body is
(A) spherical (B) symmetric
(C) asymmetric (D) hyperboloid

19. Which of the following gives valid upper and lower bounds on the angle θ between the angular momentum $\vec{L}$ and the angular velocity $\vec{\omega}$ of a rigid body ?

(A) $0 \le \theta \le \pi$ (B) $0 \le \theta \le 3\pi/4$

(C) $0 \le \theta \le 7\pi/6$ (D) $0 \le \theta \le \pi/2$

20. Volume of a sphere is V_0 in its rest frame. Its volume V in an inertial frame moving with a speed c/2 along x-axis relative to the rest frame is

(A) $V < V_0$ (B) $V = V_0$

(C) $V = 2V_0$ (D) $V \to \infty$

21. The electric flux through any closed surface is a measure of

(A) the total charge inside the surface

(B) the total charge outside the surface

(C) the total charge at the surface

(D) the total charge, both, inside and outside the surface

22. Which of the following Maxwell's equations need modification on assumption of the existence of the magnetic monopoles ?

(A) $\vec{\nabla}.\vec{D} = \rho$ (B) $\vec{\nabla}.\vec{B} = 0$

(C) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ (D) $\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

23. Match the following :

P) Biot-Savart law	1. $\oint \vec{E}.\vec{dl} = 0$
Q) Gauss' law	2. $d\vec{B} = I\frac{\vec{dl} \times \vec{r}}{cr^2}$
R) Ampere's law	3. $\vec{\nabla}.\vec{E} = \rho/\epsilon_0$
S) $\vec{\nabla} \times \vec{E} = 0$	4. $\vec{\nabla} \times \vec{B} = \mu_0\vec{J}$

(A) P – 2, Q – 1, R – 3, S – 4

(B) P – 1, Q – 3, R – 4, S – 2

(C) P – 2, Q – 3, R – 4, S – 1

(D) P – 4, Q – 2, R – 3, S – 1

24. A plane polarized light is refracted by a dielectric medium of refractive index, μ. If the angle of incidence is $i=\tan^{-1}\mu$, the angle of refraction is

(A) $r = \pi/2$ (B) $r = \tan^{-1}\mu$

(C) $r = \frac{\pi}{2} - \tan^{-1}\mu$ (D) $r = \pi - \tan^{-1}\mu$

25. A parallel plate capacitor is filled with insulating material of dielectric constant, ϵ_r. As a result, the following effects are observed

(A) the dielectric will reduce electric field and potential difference

(B) the dielectric will reduce electric field and increase potential difference

(C) the dielectric will increase electric field and the potential difference

(D) the dielectric will not alter the electric field and the potential difference

26. The electric field in a source free region is given by $\vec{E} = x\hat{i} + by\hat{j}$. The value of b is

(A) –1 (B) 0

(C) 1 (D) ∞

27. Consider three charges $2q, -q, -q$ kept at (0, 0, a), (0, 0, 0) and (0, 0, –a). The electric dipole moment is

(A) zero

(B) 3qa along the z-axis

(C) qa along the z-axis

(D) dependent on the origin

28. An electrostatic field is said to be conservative, when

(A) divergence of the electric field is zero

(B) curl of the electric field is zero

(C) curl of the electric field is equal to $-\frac{\partial \vec{B}}{\partial t}$

(D) the Laplacian of the electric field is zero

29. Magnetic field of an infinitely long ideal solenoid of radius R, carrying a current I

(A) is constant inside and decays as $\frac{1}{r}$ outside the solenoid

(B) is constant inside and decays as exp(–r) outside solenoid

(C) increases radially (i.e. proportional to r) inside and zero outside the solenoid

(D) is constant inside and zero outside the solenoid

30. The electric field of an electromagnetic wave (in SI units) is given by

$$\vec{E} = 2\hat{x}\,E_o \sin\left[(ct+z)\frac{w}{c}\right] + 3\hat{y}\,E_o \sin\left[(ct+z)\frac{w}{c}\right].$$

The magnetic field of the electromagnetic wave is

(A) $\vec{B} = \hat{x}\,(E_o w)\sin\left[(ct+z)\frac{w}{c}\right] + \hat{y}\,(2E_o w)\sin\left[(ct+z)\frac{w}{c}\right]$

(B) $\vec{B} = \hat{x}\left(\frac{2E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right] - \hat{y}\left(\frac{2E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right]$

(C) $\vec{B} = -\hat{x}\left(\frac{3E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right] + \hat{y}\left(\frac{2E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right]$

(D) $\vec{B} = \hat{x}\left(\frac{3E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right] - \hat{y}\left(\frac{2E_o}{c}\right)\sin\left[(ct+z)\frac{w}{c}\right]$

31. The expectation value of the z co-ordinate $\langle z \rangle$ in the ground state of the hydrogen atom (wave function of which is given by $\psi(\vec{r}) = Ae^{-r/a_0}$, where A denotes the normalisation constant and a_0 is the Bohr radius), is

(A) a_0 (B) zero

(C) $a_0/2$ (D) $a_0/4$

32. A particle is placed inside a one dimensional box with rigid walls. The first excited state energy of the particle is 4 eV. The ground state energy is

(A) 2 eV (B) 3 eV

(C) 1 eV (D) 0 eV

33. If the wave function in momentum space is given by $\phi(P) = \frac{N}{P^2 + \alpha^2}$, ($\alpha$ is a constant) then the corresponding wave function in the configuration space (aside from a multiplicative constant) is

(A) $e^{-\alpha^2 x^2/\hbar^2}$ (B) $\cos(Px/\hbar)$

(C) $\sin(Px/\hbar)$ (D) $e^{-\alpha|x|/\hbar}$

34. The eigen state of momentum $\vec{P}$ with eigen value $\vec{P}_0$ for a particle of mass m in momentum representation is

(A) $\psi(\vec{x}) = A\sin\left(\frac{\vec{P}\cdot\vec{x}}{\hbar}\right)$

(B) $\delta(\vec{P} - \vec{P}_0)$

(C) $\delta\left(\vec{r} - \frac{\vec{P}_0 \cdot t}{m}\right)$

(D) $e^{i\vec{P}_0 \cdot \vec{r}/\hbar}$

35. If operators A, B commute then, which one of the following is true for their common eigen state.

(A) $\Delta A \, \Delta B > \hbar/2$

(B) $\Delta A - \Delta B \neq 0$

(C) $\Delta A + \Delta B > 0$

(D) $\frac{\Delta A}{\Delta B}$ is indeterminate

36. The first excited state of a two dimensional harmonic oscillator under the potential

$V(x, y) = \frac{1}{2} m w^2 \left(x^2 + 4y^2\right)$ is

(A) $2 \hbar w$ (B) $3 \hbar w$

(C) $3/2 \, \hbar w$ (D) $5/2 \, \hbar w$

37. The wave function of the hydrogen atom is given by

$|\psi\rangle = \frac{1}{\sqrt{3}} \left(\psi_{210} + \psi_{310} + \psi_{420}\right)$ where

$\psi_{n l m_e}$ are the energy eigen functions. This state is an eigen state of

(A) linear momentum P_z

(B) linear momentum P_x

(C) orbital angular momentum L_z

(D) orbital angular momentum L_x

38. At a given instant of time, a rigid rotator is in the state $\psi(\theta, \phi) = \sqrt{3/4\pi} \, \sin\theta \, \sin\phi$. A measurement of L_z, in units of $\hbar$, will find which of the following possible values ?

(A) 0 (B) $1/2, -\frac{1}{2}$

(C) 1,–1 (D) 1, 0, –1

39. Hamiltonian of a spin $\frac{1}{2}$ system is given by $H = -\alpha \vec{\sigma} \cdot \vec{B}, \alpha > 0$, where $\vec{B}$ denotes the external magnetic field. The energy eigen values are

(A) $-\alpha\left(B_x \mp B_y + B_z\right)$

(B) $\alpha\left(B_x \pm i B_y\right)$

(C) $\pm \alpha \left|\vec{B}\right|$

(D) $\pm \alpha B_z$

40. Suppose we have two non-interacting particles, both of mass m in the one dimensional infinite square well $0 \le x \le a$. If the particles are identical Bosons, then the wave function of the first excited state, $\psi(x_1, x_2)$ is given by

(A) $\frac{2}{a} \sin\left(\pi x_1/a\right) \sin\left(\pi x_2/a\right)$

(B) $\frac{2}{a} \sin\left(2\pi x_1/a\right) \sin\left(2\pi x_2/a\right)$

(C) $\frac{\sqrt{2}}{a}\left[\sin\left(\frac{\pi x_1}{a}\right)\sin\left(\frac{2\pi x_2}{a}\right) + \sin\left(\frac{2\pi x_1}{a}\right)\sin\left(\frac{\pi x_2}{a}\right)\right]$

(D) $\frac{\sqrt{2}}{a}\left[\sin\left(\frac{\pi x_1}{a}\right)\sin\left(\frac{2\pi x_2}{a}\right) - \sin\left(\frac{2\pi x_1}{a}\right)\sin\left(\frac{\pi x_2}{a}\right)\right]$

41. A quantum system with energy levels $n \hbar w$, n = 0, 1, 2, ... ∞ is in equilibrium at a temperature T. The partition function characterising the system is given by

(A) $ln\left(\hbar w/KT\right)$ (B) $e^{-\hbar w/KT}$

(C) $\left(1 - e^{-\hbar w/KT}\right)$ (D) $\frac{1}{\left(1 - e^{-\hbar w/KT}\right)}$

42. Statistics of indistinguishable particles goes over to statistics of distinguishable particles when

(A) the number of states is much larger than the number of particles

(B) the number of particles is much larger than the number of states

(C) number of states and number of particles are equal

(D) number of states are less than half of the number of particles

43. A reversible adiabatic process is

(A) Isobaric (B) Isochronic

(C) Isentropic (D) Isothermal

44. The average energy for a photon gas at temperature $T = \frac{1}{K\beta}$, where the energy levels are given by

$E_j = j\hbar w$, j = 0, 1, 2, ...

(A) KT (B) $\frac{\hbar w}{\left(e^{\beta\hbar w} + 1\right)}$

(C) $\frac{3}{2}$KT (D) $\frac{\hbar w}{\left(e^{\beta\hbar w} - 1\right)}$

45. There are 3 possible energy states for a system of two particles. Assuming Maxwell Boltzmann (distinguishable particles), Bose Einstein and Fermi Dirac statistics, the number of possible states for the system respectively are

(A) 9, 6, 3 (B) 9, 9, 3

(C) 9, 3, 6 (D) 6, 3, 2

46. N particles are distributed among three states having energies E = 0, E = KT, E = 2KT. If the total equilibrium energy of the system is 1000 KT, the value of N is closest to

(A) 4500 (B) 1500

(C) 7500 (D) 2400

47. A small concentration of minority carriers is injected into a homogeneous semiconductor crystal at one point. An electric field of 25 V/cm is applied across the crystal and this moves the minority carriers a distance of 3 cm in 10 μ sec. The mobility $\left(\text{in } \frac{cm^2}{\text{Volt} - \text{Sec}}\right)$ of the minority carriers be

(A) 120 (B) 12000

(C) 33.3×10^{-6} (D) 33.3×10^{6}

48. Avalanche photodiodes are preferred over PIN diodes in optical communication system, because of

(A) higher sensitivity

(B) larger bandwidth

(C) larger power handling capacity

(D) speed of operation

49. In 8085 microprocessor system with memory mapped I/O,

(A) I/O devices have 8-bit addresses

(B) I/O devices are accessed using IN and OUT instructions

(C) There can be a maximum of 256 input devices and 256 output devices

(D) Arithmetic and logic operations can be directly performed with the I/O data

50. A diode that has a negative resistance characteristic is the

(A) Schottky diode

(B) Tunnel diode

(C) Laser diode

(D) Zener diode

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Space for Rough Work