Test Paper : **III**

Test Subject : **PHYSICAL SCIENCE**

Test Subject Code : **K-2515**

Test Booklet Serial No. : ____________________

OMR Sheet No. : ____________________

Roll No. | | | | | | | | |

(Figures as per admission card)

Name & Signature of Invigilator/s

Signature : ____________________

Name : ____________________

Paper : III

Subject : PHYSICAL SCIENCE

Time : 2 Hours 30 Minutes — Maximum Marks : 150

Number of Pages in this Booklet : **16** — Number of Questions in this Booklet : **75**

ಅಭ್ಯರ್ಥಿಗಳಿಗೆ ಸೂಚನೆಗಳು

1. ಈ ಪುಟದ ಮೇಲ್ತುದಿಯಲ್ಲಿ ಒದಗಿಸಿದ ಸ್ಥಳದಲ್ಲಿ ನಿಮ್ಮ ರೋಲ್ ನಂಬರನ್ನು ಬರೆಯಿರಿ.
2. ಈ ಪತ್ರಿಕೆಯು ಬಹು ಆಯ್ಕೆ ವಿಧದ ಎಪ್ಪತ್ತೈದು ಪ್ರಶ್ನೆಗಳನ್ನು ಒಳಗೊಂಡಿದೆ.
3. ಪರೀಕ್ಷೆಯ ಪ್ರಾರಂಭದಲ್ಲಿ, ಪ್ರಶ್ನೆಪುಸ್ತಿಕೆಯನ್ನು ನಿಮಗೆ ನೀಡಲಾಗುವುದು. ಮೊದಲ5 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 ಕೂಡಲೆ5 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: (A) (B) ● (D)
   (C) ಸರಿಯಾದ ಉತ್ತರವಾಗಿದ್ದಾಗ.
5. ಪ್ರಶ್ನೆಗಳಿಗೆ ಉತ್ತರಗಳನ್ನು, **ಪತ್ರಿಕೆIII ಪುಸ್ತಿಕೆಯೊಳಗೆ ಕೊಟ್ಟಿರುವOMR ಉತ್ತರ ಹಾಳೆಯಲ್ಲಿ ಮಾತ್ರವೇ ಸೂಚಿಸತಕ್ಕದ್ದು.** OMR ಉತ್ತರ ಹಾಳೆಯಲ್ಲಿನ ಅಂಡಾಕೃತಿ ಹೊರತುಪಡಿಸಿ ಬೇರೆ ಯಾವುದೇ ಸ್ಥಳದಲ್ಲಿ 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 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 seventy five 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 oval as indicated below on the correct response against each item.
   Example : (A) (B) ● (D)
   where (C) is the correct response.
5. Your responses to the question of Paper III are to be indicated in the **OMR Sheet kept inside the Booklet**. If you mark at any place other than in the ovals in OMR Answer 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 soon after the examination.
11. **Use only Blue/Black Ball point pen.**
12. **Use of any calculator 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 SCIENCE

PAPER – III

Note : This paper contains **seventy-five (75)** objective type questions. **Each** question carries **two (2)** marks. **All** questions are **compulsory**.

1. S_{ij} and A_{ij} represent a symmetric and an antisymmetric real valued tensor respectively, in six dimensions. The number of independent components of S_{ij} and A_{ij} are

(A) 20 and 16 respectively

(B) 21 and 15 respectively

(C) 18 and 18 respectively

(D) 30 and 6 respectively

2. The Kronecker delta $\delta^i{}_j = \begin{cases} 1 & \text{if} \quad i = j \\ 0 & \text{if} \quad i \neq j \end{cases}$ in 3-dimensional Cartesian co-ordinate system transforms like

(A) a tensor of rank one

(B) a tensor of rank two

(C) an axial vector

(D) a pseudo scalar

3. The Jacobian corresponding to the transformation

$$x_1' = x_1 \cosh\chi + ix_4 \sinh\chi$$

$$x_4' = -ix_1 \sinh\chi + x_4 \cosh\chi$$

is given by

(A) $\sinh\chi \ \cosh\chi$

(B) $\sinh\chi - \cosh\chi$

(C) 1

(D) $x_1\cosh\chi + ix_4 \sinh\chi$

4. Given the components of 3-dimensional Cartesian rank-1 tensors A_i and B_j, which of the following is irreducible under rotations ?

(A) $A_iB_j + A_jB_i$

(B) $A_iB_j - A_jB_i$

(C) A_iB_j

(D) $A_iA_j + B_iB_j$

5. The Simpson's $1/3$ rule gives exact analytic result for the numerical integration of the function

(A) $5x^4 + 2x^2$

(B) log (x)

(C) $10x^2 - 3x$

(D) e^{-x}

6. Which of the following numerical methods is used to find root of a function ?

(A) Runge-Kutta method

(B) Simpson's 3/8 rule

(C) Newton-Raphson method

(D) Trapezoidal rule

7. The 3 × 3 matrix corresponding to the transformation of spatial co-ordinates $x \to -x, y \to -y$ and $z \to -z$.

(A) does not belong to the group O(3)

(B) belongs to the group O(3)

(C) is a continuous transformation of spatial coordinates and hence, belongs to a matrix group

(D) does not have inverse and hence cannot be an element of any matrix group

8. The number of independent real parameters characterizing the group SU(2) are

(A) One (B) Two

(C) Three (D) Four

9. A classical particle is moving in an external potential field V(x, y, z). Identify the conserved quantities under the symmetry operation

$$\begin{pmatrix} x \\ y \end{pmatrix} \to \begin{pmatrix} x' \\ y' \end{pmatrix} = R_z \begin{pmatrix} x \\ y \end{pmatrix}$$

Where R_z denotes the 2 × 2 matrix corresponding to rotation about the z-axis.

(A) x and y components of linear momentum; z component of angular momentum

(B) z component of angular momentum and energy

(C) x and y components of linear momentum; energy

(D) z component of linear momentum and z component of angular momentum

10. In autonomous Hamiltonian systems one finds that the fixed points are

(A) Stable and unstable spirals

(B) Elliptic and saddle

(C) Stable nodes

(D) Unstable nodes

11. If the co-ordinate q and the corresponding canonical conjugate momentum p undergo a linear transformation :
$Q = \alpha q + \beta p$ and $P = \gamma q + \delta p$
The transformation is Canonical if

(A) $\alpha\delta - \beta\gamma = 0$

(B) $\alpha = \beta$ and $\gamma = \delta$

(C) $\alpha\delta - \beta\gamma = 1$

(D) $\alpha = \beta = \gamma = \delta = 1$

12. In the Hamilton-Jacobi theory, canonical transformation $(q, p) \to (Q, P)$ is sought such that the new canonical pair (Q, P) satisfy the dynamical equations

(A) $\dot{P} = -\dfrac{\partial H(Q,P)}{\partial Q}, \dot{Q} = 0$

(B) $\dot{P} = 0, \dot{Q} = \dfrac{\partial H(Q,P)}{\partial P}$

(C) $\dot{P} = 0, \dot{Q} = 0$

(D) $\dot{P} = \dfrac{\partial H(Q,P)}{\partial Q}, \dot{Q} = \dfrac{\partial H(Q,P)}{\partial P}$

13. Lagrangean of a simple pendulum is given by $L = \frac{1}{2} ml^2\dot{\theta}^2 - mgl(1 - \cos\theta)$. The Poisson bracket between θ and $\dot{\theta}$ is given by

(A) $\frac{1}{ml^2}$

(B) $\frac{1}{m}$

(C) 1

(D) $\frac{g}{l}$

14. The function $F(q_i, P_i) = q_iP_i$ where q_i are the old generalized coordinates and P_i are new generalized momenta, generates the transformation

(A) $q_i \rightarrow Q_i$ and $p_i \rightarrow P_i$

(B) $q_i \rightarrow P_i$ and $p_i \rightarrow Q_i$

(C) $q_i \rightarrow -Q_i$ and $p_i \rightarrow -P_i$

(D) $q_i \rightarrow -P_i$ and $p_i \rightarrow -Q_i$

15. Conservation of energy is a manifestation of

(A) Isotropy of space

(B) Homogeneity of time

(C) Inhomogeneity of time

(D) Homogeneity of space

16. If an observer measures an uniform electric field of 4 units (CGS) corresponding to a static charge distribution and a second observer, moving relativistically with respect to the first observer, measures an electric field of 5 units. The second observer should find a magnetic field of strength

(A) 2 units

(B) 1 unit

(C) $\sqrt{41}$ units

(D) 3 units

17. Under the transformation C : q $\rightarrow$–q (charge conjugation), $P : \vec{r} \rightarrow -\vec{r}$ (parity) and T : t $\rightarrow$–t (time reversal), the force on a particle of charge q, subjected to an external electric and magnetic fields gets transformed to

(A) $q\left(\vec{E} - \frac{\vec{v} \times \vec{B}}{C}\right)$

(B) $-q\left(\vec{E} - \frac{\vec{v} \times \vec{B}}{C}\right)$

(C) $q\left(\vec{E} + \frac{\vec{v} \times \vec{B}}{C}\right)$

(D) $-q^2\left(\vec{E} + \frac{\vec{v} \times \vec{B}}{C}\right)$

18. A current carrying loop lying in the plane of the paper is in the shape of an equilateral triangle of side a. It carries a current I in the clockwise sense as viewed from above. If $\hat{k}$ denotes the outward normal to the plane of the paper, the magnetic moment $\vec{m}$ due to the current loop is

(A) $\vec{m} = a^2 I\hat{k}$

(B) $\vec{m} = -\frac{1}{2}a^2 I\hat{k}$

(C) $\vec{m} = \frac{\sqrt{3}}{2}a^2 I\hat{k}$

(D) $\vec{m} = -\frac{\sqrt{3}}{4}a^2 I\hat{k}$

19. In an inertial frame of reference, it is found that the electric field $\vec{E}(\vec{r}, t)$ and the magnetic field $\vec{B}(\vec{r}, t)$ are perpendicular to each other at all points i.e., $\vec{E}(\vec{r}, t)\cdot\vec{B}(\vec{r}, t) = 0$. If the fields observed in some other Lorentz frame of reference are denoted by $\vec{E}'(\vec{r}\,', t)$ and $\vec{B}'(\vec{r}\,', t')$

(A) $\vec{E}' \| \vec{B}'$ at all points

(B) $\vec{E}'\cdot\vec{B}' = 0$ at all points

(C) $\vec{E}'\cdot\vec{B}' > 0$ at all points

(D) $\vec{E}'\cdot\vec{B}' < 0$ at all points

20. A charged particle with charge q and mass m is given an initial velocity v_0 in the X-direction in a region, with an electric field $\vec{E}$ also in the X-direction and a magnetic field $\vec{B}$ in the Z-direction. The Y-component of the velocity after $t = \left(\pi m / 2qB\right)$ will be

(A) $-v_0 + E/B$

(B) zero

(C) 2E/B

(D) $-v_0 - E/B$

21. Total power radiated by an electric dipole is proportional to w^n (w denotes the frequency). The value of n is

(A) 1

(B) 2

(C) 3

(D) 4

22. The cutoff frequency of a transverse electric mode TE_{21} in a rectangular wave guide (specified by the sides a, b of its rectangular cross-section) is given by

(A) $\frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\frac{1}{a^2}+\frac{3}{b^2}}$

(B) $\frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\frac{2}{a^2}+\frac{3}{b^2}}$

(C) $\frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\frac{4}{a^2}+\frac{1}{b^2}}$

(D) $\frac{1}{2\sqrt{\mu\varepsilon}}\sqrt{\frac{9}{a^2}+\frac{4}{b^2}}$

23. The first excited state of the hydrogen atom, in the presence of spin-orbit coupling term $H_{spin\text{-}orbit} \propto \vec{S}.\vec{L}$ is denoted by $n^{2s+1}l_j$, where n = 2, s = $\frac{1}{2}$, l = 0, 1 and j = $\frac{1}{2}, \frac{3}{2}$. As a consequence of spin-orbit coupling it is found that

(A) $^2S_{1/2}$, $^2P_{3/2}$, $^2P_{1/2}$ states are degenerate

(B) S and P states split, but $^2P_{3/2}$ and $^2P_{1/2}$ states are still degenerate

(C) The energy of $^2S_{1/2}$ remains unaltered, but $^2P_{3/2}$ and $^2P_{1/2}$ states split into two

(D) $^2S_{1/2}$ and $^2P_{1/2}$ have same energy and are above the $^2P_{3/2}$ level

24. The relativistic Klein-Gordan equation

(A) is not covariant under relativistic Lorentz transformation

(B) could result in non-positive probability density

(C) always results in non-positive current density

(D) successfully explains hydrogen energy spectrum with relativistic corrections

25. The Heisenberg equation of motion $\frac{dx}{dt} = \frac{1}{i\hbar}[x, H]$ with the Dirac Hamiltonian $H = C\vec{\alpha}.\vec{p} + \beta mc^2$ results in the identification of the following velocity operator of a free relativistic electron

(A) $\vec{p}/m$

(B) $C\vec{\alpha}$

(C) $C\beta$

(D) $C\vec{\alpha}.\vec{p}$

26. The Dirac Hamiltonian $H = C\vec{\alpha}.\vec{p} + \beta mc^2$ commutes with

(A) $\vec{\alpha}$

(B) $\vec{p}$

(C) $\vec{\gamma} \times \vec{p}$

(D) β

27. In the Dirac's relativistic theory of hydrogen atom, the first excited states with total angular momentum and orbital angular momentum quantum numbers $j = \frac{1}{2}$ (i) l = 0 and (ii) l = 1

(A) have different energies

(B) are degenerate

(C) agree with the non-relativistic Schrodinger treatment of hydrogen atom (with spin-orbit term added)

(D) agree with the non-relativistic Schrodinger treatment of hydrogen atom, without spin-orbit coupling term

28. The expression $\left(\vec{p}-q\vec{A}\right)\times\left(\vec{p}-q\vec{A}\right)$, where $\vec{p}$ is the linear momentum operator, $\vec{A}$ denotes the vector potential, simplifies to

(A) $i\hbar q\vec{B}$

(B) $-i\hbar q\vec{B}$

(C) $i\hbar\,\vec{p}\times\vec{B}$

(D) $-i\hbar\,\vec{p}\times\vec{B}$

(Given that $\vec{B}=\vec{\nabla}\times\vec{A}$)

29. The Dirac matrices $\alpha_x, \alpha_y, \alpha_z$ and β are transformed into new matrices $\alpha'_x = T\alpha_x T^+$, $\alpha'_y = T\alpha_y T^+$, $\alpha'_z = T\alpha_z T^+$ and $\beta' = T\beta T^+$, where T is a unitary matrix. The new set of matrices

(A) Do not have the same eigenvalues as those of old matrices

(B) Are not Hermitian, like the old set of matrices

(C) The new matrices are antihermitian

(D) The new matrices obey $\alpha'^2_x = \alpha'^2_y = \alpha'^2_z = \beta^2 = I$

30. Tr $\left[\alpha_x\alpha_y\alpha_z\beta\alpha_x\alpha_y\alpha_z\beta\right]$ for Dirac matrices simplifies to

(A) 1

(B) 2

(C) 0

(D) 4

31. Which of the following is a first order phase transition ?

(A) Vaporization of liquid at its boiling point

(B) Ferromagnetic to paramagnetic

(C) Normal liquid Helium to superfluid Helium

(D) Superconducting state to normal state

32. The susceptibility of a diamagnetic substance

(A) increases linearly with temperature

(B) decreases linearly with temperature

(C) remains constant with temperature

(D) varies non-linearly with temperature

33. Iron possesses the following magnetism

(A) Pure ferromagnetism

(B) Ferromagnetism and diamagnetism

(C) Paramagnetism and diamagnetism

(D) Ferrimagnetism and diamagnetism

34. In the random motion of Brownian particles, the Einstein coefficient of diffusion is proportional to

(A) T^2

(B) T^3

(C) T

(D) Independent of temperature

35. A drunkard performs a one dimensional random walk. If he starts at the origin, the probability that after taking six equal steps, he will be back at the origin is

(A) $20/64$

(B) $5/64$

(C) $1/2$

(D) $1/64$

36. Below the critical temperature, the number of Bosons occupying a state, above the ground state varies as

(A) T

(B) $T^{3/2}$

(C) T^2

(D) $T^{5/2}$

37. A silicon diode is used as a transducer to measure low temperature, where the following property is measured

(A) Change in energy gap

(B) Change in carrier concentration

(C) Change in forward bias voltage

(D) Change in minority carriers

38. An amplifier whose bandwidth is 100 KHz, has a noise power spectrum density input of 7×10^{-21} J. If the input resistance is 50 KΩ and amplifier gain is 100. What is the noise output voltage ?

(A) 1.183 mV

(B) 11.83 mV

(C) 0.83 mV

(D) 118.3 mV

39. At the input, an amplifier has a signal voltage level of 4 μV and the noise voltage level of 2μV, the signal to noise ratio at the input is

(A) 2 μV

(B) 8 μV

(C) 4 μV

(D) 0.5 μV

40. Grounding problem include

(A) A varying voltage

(B) A varying current and unwanted voltage

(C) Resistance coupled devices can have interference through a common power source, such as power spikes or brownouts caused by other devices in a factory

(D) A varying temperature

41. The Fourier transform of a function x(t) is X(F). The Fourier transform of $\frac{d}{df}X(f)$ will be

(A) $\frac{d}{df}X(f)$

(B) $j\,2\pi f\,X(f)$

(C) $-jf\,X(f)$

(D) $\frac{X(f)}{j\,f}$

42. An FM signal with modulation index m_f is passed through a frequency tripler. The modulation index of the output signal will be

(A) $\frac{1}{3}m_f$

(B) $9\,m_f$

(C) $3\,m_f$

(D) $27\,m_f$

43. Consider the following statements

1) The bandwidth of the A.M. wave depends on the bandwidth of the modulating signal.
2) The bandwidth of the A.M. wave depends on the modulation index.
3) The bandwidth of F.M. wave, for all practical purpose, depends on the modulation frequency.
4) The banwidth of FM wave, for all practical purpose, depends on the amplitude of the carrier.

Of these statements, the correct statements are

(A) (1) and (2)

(B) (1) and (3)

(C) (1) and (4)

(D) (2) and (4)

44. The ratio of frequencies of the first line of the Lymann series and the first line of Balmer series is

(A) 27/5

(B) 27/8

(C) 8/27

(D) 4/27

45. 10^{-23} Am^2 is approximately equal to

(A) 100 Bohr magneton

(B) 1 Bohr magneton

(C) 10^{-3} Bohr magneton

(D) 10^{3} Bohr magneton

46. Electronic spectra of molecules are observed in the

(A) Visible region

(B) UV region

(C) Visible and UV regions

(D) Infrared region

47. The Lande g-factor for the $3S_1$ level is

(A) 2 (B) 4/3

(C) 1/2 (D) 3/2

48. The degeneracies of the J states arising from the $3P_J$ term with spin-orbit interaction are

(A) 1, 3, 5 (B) 1, 2, 3

(C) 3, 5, 7 (D) 1, 2, 5

49. In HCl molecule, the zero point energy is 0.18 eV, then the energy gap between the two vibrational levels is

(A) 0

(B) 0.18 eV

(C) 0.36 eV

(D) 0.54 eV

50. You are shown a spectrum consisting of a series of equally spaced lines. This could be

(A) The rotational spectrum of CO

(B) The vibrational spectrum of N_2

(C) The NMR spectrum of CH_4

(D) The Mossbauer spectrum of Fe_3SO_4

51. Under the LS coupling scheme, the possible spectral terms $^{2s+1}L_J$ for the electronic configuration $2s'3s'$ are

(A) $^2S_{1/2}$, $^2P_{3/2}$, $^2P_{1/2}$

(B) $^1S_0$, $^3S_1$

(C) $^1S_0$, $^1S_1$, $^3S_0$, $^3S_1$

(D) $^3S_0$, $^3S_1$

52. The sodium doublet lines are due to transitions from $2P_{3/2}$ and $2P_{1/2}$ levels to $2S_{1/2}$ level. On application of a weak magnetic field, the total number of allowed transitions becomes

(A) 4

(B) 6

(C) 8

(D) 10

53. For a molecule with principal moments of inertia $I_1 = I_2 = I < I_3$, the eigenvalue of the first excited state of the rotational Hamiltonian is

(A) $\hbar^2/2I$

(B) $\hbar^2/I$

(C) $\frac{\hbar^2}{2}\left(\frac{I}{I_3} - \frac{1}{I}\right)$

(D) $2\hbar^2/I$

54. Packing efficiency in a crystal is maximum for

(A) BCC

(B) FCC

(C) BCT

(D) SCC

55. When the Molten zinc is cooled to a solid state, it crystallizes in HCP structure. The number of nearest neighbours of zinc atom will be

(A) 4

(B) 6

(C) 8

(D) 12

56. A substance A_xB_y crystallises in fcc lattice form in which A atoms occupy each corner of the cube and B atoms occupy the centre of each face of the cube. Identify the correct composition of the substance A_xB_y.

(A) A_4B_3

(B) A_3B

(C) AB_3

(D) A_2B_2

57. The structure factor of a single cell of identical atoms of form factor is given by $S_{hkl} = f\sum_j e^{-2\pi i}(hx_j + ky_j + lz_j)$, where (x_j, y_j, z_j) are the co-ordinates of an atom and h, k, l are the Miller indices. Which of the following statement is correct for diffraction peaks of bcc and fcc lattice

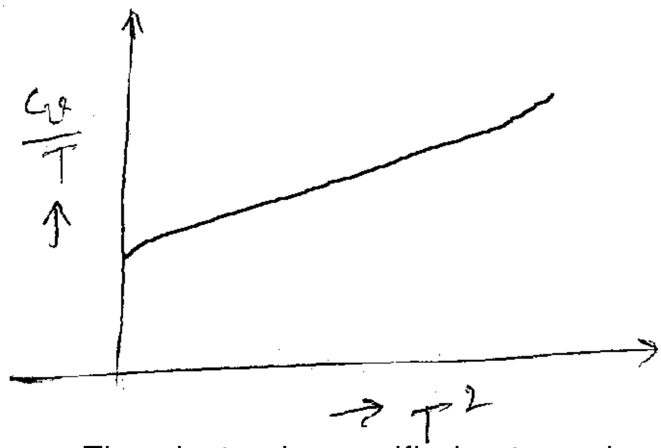
(A) bcc (210) (110) (222)
fcc (111) (311) (400)

(B) bcc (200) (110) (222)
fcc (111) (311) (400)

(C) bcc (200) (110) (222)
fcc (111) (211) (400)

(D) bcc (200) (210) (222)
fcc (111) (211) (400)

58. The total specific heat of a metal at low temperature is plotted as a function of temperature which is shown in figure below .



The electronic specific heat can be obtained from

(A) The slope of the graph

(B) The y intercept

(C) ${}^{c_v}\!/\!_T$ at $T = \theta_D$ (θ_D is Debye temperature)

(D) The x intercept

59. The electrical resistivity of a metal at 300 K is 4.9×10^{-8} (Ω-m). If the Lorentz number is 2.45×10^{-8} W-ohm/K^2. The thermal conductivity of the metal will be

(A) 150 W/m/k

(B) 600 W/m/k

(C) 12 W/m/k

(D) 25 W/m/k

60. It is difficult to determine the Hall coefficient for a metal as compared to a semiconductor because, the

(A) Hall coefficient will be too small

(B) Hall voltage will be very high

(C) Hall effect will not be exhibited in a metal

(D) Lorentz force will not act on free electrons

61. At low temperature, the Seebeck effect is mainly due to

(A) Phonons

(B) Electrons

(C) Change in fermi level

(D) Phonon drag of the electron

62. Due to the breaking of periodicity at the surface of a semiconductor

(A) Impurity states are created in the band gap

(B) Doping of the semiconductor takes place

(C) Surface states are created in the band gap

(D) Extended states are created in the band gap

63. In an indirect band gap semiconductor, for an electron to get excited to the conduction band only when

(A) a photon of energy higher than the band gap is required

(B) a phonon is required

(C) a photon of energy higher than the band gap and a phonon are required

(D) a photon, phonon and temperature are required

64. Josephson effect provides a standard for

(A) temperature

(B) voltage

(C) resistance

(D) energy

65. According to shell model, the ground state spin-parity of ^{15}O is

(A) $\frac{3}{2}^{+}$

(B) $\frac{1}{2}^{+}$

(C) $\frac{1}{2}^{-}$

(D) $\frac{3}{2}^{-}$

66. The nuclear asymmetry energy term in the liquid drop model is a consequence of

(A) The Pauli exclusion principle

(B) The short-range nature of the nuclear force

(C) Saturation property of the nuclear force

(D) Charge independence of the nuclear force

67. The experimentally observed spin g-factors of proton and neutron indicate that

(A) both proton and neutron are elementary point particles

(B) both proton and neutron are not elementary point particles

(C) while proton is an elementary point particle, neutron is not

(D) while neutron is an elementary point particle, proton is not

68. If pion-nucleon scattering at low energies is described by an effective interaction potential of the form

$$V \propto \frac{e^{-\mu r}}{r}\vec{I}(\pi)\cdot\vec{I}(N)$$

where $\vec{I}(\pi), \vec{I}(N)$ denote the pion, nucleon isospin operators respectively. Here, $\vec{I}$ denotes the total isospin of the pion-nucleon system. What is the ratio of the scattering cross-section $\sigma_I = 3/2$ and $\sigma_I = 1/2$?

(A) $1/2$

(B) 3

(C) $1/4$

(D) $3/4$

69. ^{10}Be nucleus in its first excited state has spin-parity 2^{+}. It gets de-excited to the ground state (which has spin-parity O^{+}) by γ-decay. The multipole value carried by the γ ray is

(A) M2

(B) E1

(C) E2

(D) M1

70. It is experimentally observed that three of the low lying energy levels of an even-even nucleus have spin-parity 0^+, 2^+ and 4^+. The ratio of the energies E_{4^+}/E_{2^+} is found to be ≈ 3.33. This feature can be explained by

(A) Shell model

(B) Vibrational model

(C) Rotational model

(D) Fermi gas model

71. Nuclear magnetic moments are

(A) 10^{-2} times smaller than

(B) 10^{-3} times smaller than

(C) 10^{+3} times larger than

(D) of the same order as the magnetic moment of the electron

72. Which of the following decay is forbidden ?

(A) $\mu^- \rightarrow e^- + \nu_\mu + \bar{\nu}_e$

(B) $\pi^+ \rightarrow \mu^+ + \nu_\mu$

(C) $\pi^+ \rightarrow e^+ + \nu_e$

(D) $\pi^+ \rightarrow e^+ + e^- + e^-$

73. Which of the following has an internal structure ?

(A) Photon

(B) Muon

(C) Electron

(D) Pion

74. The reaction $\gamma \rightarrow e^+ + e^-$ (for $E_\gamma > 2m_eC^2$) cannot take place because it violates the conservation of

(A) Charge

(B) Parity

(C) Charge conjugation

(D) Lepton number

75. Which of the following is true for β-decay of the neutron ? The process

(A) Violates both parity and lepton number conservation

(B) Violates parity, but conserves lepton number

(C) Conserves parity, but violates lepton number conservation

(D) Conserves both parity and lepton number

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Space for Rough Work

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Space for Rough Work