Test Paper : **III**

Test Subject : **PHYSICAL SCIENCE**

Test Subject Code : K-2516

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**

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 circle as indicated below on the correct response against each item.

   Example : Ⓐ Ⓑ ● Ⓓ

   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 circles in 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 SCIENCE
Paper – III

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

1. Two tensors are said to be reciprocal to each other if their inner product is equal to

   (A) Null tensor

   (B) Unit tensor

   (C) Scalar product

   (D) All of these

2. Two tensors are called conjugate tensors if they are

   (A) Symmetric and reciprocal

   (B) Symmetric but not reciprocal

   (C) Reciprocal but not symmetric

   (D) Neither symmetric nor reciprocal

3. The root of the equation $2X = \cos X + 3$ is

   (A) 1.365

   (B) 1.524

   (C) 1.692

   (D) 1.913

4. The real root of the equations $x^2 - y^2 = 4$ and $x^2 + y^2 = 16$, by using the Newton-Raphson Method [$x_0 = y_0 = 2.828$] is

   (A) 2.612, 1.95

   (B) 3.162, 2.45

   (C) 3.863, 3.17

   (D) 4.768, 4.01

5. The Christoffel symbol of the first kind which vanishes for the line element
   $$ds^2 = a^2 \left(dx^1\right)^2 + a^2 \sin^2 x^1 \left(dx^2\right)^2,$$
   where a is a constant is

   (A) $\gamma_{22,1}$

   (B) $\gamma_{21,2}$

   (C) $\gamma_{12,2}$

   (D) $\gamma_{12,1}$

6. The number of independent elements in a unitary group of order (2×2) and determinant $+1$ is

   (A) Four   (B) Three

   (C) Two   (D) One

7. A one to one mapping of a finite group onto itself is

(A) Isomorphism

(B) Homomorphism

(C) Automorphism

(D) Monomorphism

8. The Cubic polynomial (based on Newton's forward interpolation formula) for the following values is

x	0	1	2	3
f(x)	1	0	1	10

(A) $f(x) = x^3 - 2x^2 + 1$

(B) $f(x) = x^3 + 2x^2 + 1$

(C) $f(x) = x^3 + 2x^2 - 1$

(D) $f(x) = x^3 - 2x^2 - 1$

9. Jacobi identity for Poisson bracket is

(A) $[A, [B, H]] + [B, [H, A]] + [H, [A, B]] = 0$

(B) $[A, [B, H]] - [B, [H, A]] + [H, [A, B]] = 0$

(C) $[A, [B, H]] + [B, [H, A]] - [H, [A, B]] = 0$

(D) $[A, [B, H]] - [B, [H, A]] - [H, [A, B]] = 0$

10. The generating function suitable to the canonical transformation

$q = \sqrt{2p}$ sin Q, $p = \sqrt{2p}$ cos Q is

(A) $\frac{1}{2} q^2 \cot Q$

(B) $\frac{1}{2} pq$

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

(D) p sin q + pq

11. In Noether's theorem

(A) Linear momentum is conserved for a system when Lagrangian is independent of the location of the origin

(B) Energy of a system is conserved when the Lagrangian is independent of basetime

(C) Angular momentum is conserved for a system when Lagrangian is independent of the angle of measurement

(D) All the above are correct

12. P = ap + bq ; Q = cp + dq are canonical under the conditions

(A) ad + bc = 0

(B) ad + bc = 1

(C) ad – bc = 1

(D) ad – bc = 0

13. Which of the following Poisson bracket is non-vanishing ?

(A) (q_i, q_j)

(B) (p_i, p_j)

(C) (q_i, p_j) if i ≠ j

(D) (q_i, p_j) if i = j

14. Born approximation neglects rescattering of the scattered waves provided the amplitude of the scattered wave is

(A) Large compared to incident wave

(B) Small compared to incident wave

(C) Equal to the incident wave

(D) Zero

15. Magnetic moment of a Dirac particle is obtained in Dirac's theory in the

(A) Relativistic limit

(B) Non-relativistic limit

(C) Saturation limit

(D) Non-central approximation

16. During collision, there is no

(A) Scattering without reaction

(B) Reaction without scattering

(C) Scattering with phase shift

(D) Reaction with phase shift

17. During relativistic motion

(A) $\vec{L}$ is a constant of motion

(B) $\vec{S}$ is a constant of motion

(C) $\vec{J} = \vec{L} + \vec{S}$ is a constant of motion

(D) There is no constant of motion

18. Dirac gamma matrices are

(A) Unit square, zero trace

(B) Zero square, unit trace

(C) Zero square, zero trace

(D) Unit square, unit trace

19. The free particle solutions of the Dirac equation represent

(A) Only particle

(B) Both particle and antiparticle

(C) Only Bosons

(D) Only Fermions

20. Scattering of a free particle in a central potential is

(A) Not accompanied by phase shift

(B) Always accompanied by phase shift

(C) Accompanied by absorption

(D) Accompanied by particle production

21. A second order phase transition is one in which

(A) The plot of entropy as a function of temperature shows a discontinuity

(B) The plot of specific heat as a function of temperature shows a discontinuity

(C) The plot of volume as a function of pressure shows a discontinuity

(D) The plot of compressibility as a function of temperature is continuous

22. The diffusion coefficient of ribo nuclease is 1.1×10^{-6} cm^2/s at 20°C. Its frictional coefficient is

(A) 3.67×10^{-11} Kgs^{-1}

(B) 1.67×10^{-11} Kgs^{-1}

(C) 0.67×10^{-11} Kgs^{-1}

(D) 2.67×10^{-11} Kgs^{-1}

23. If the number of magnetic dipoles in a ferromagnetic material is 3×10^{28} m^{-3} and the Spin magnetic moment is 3×10^{-23} Am^2, the saturation magnetization is

(A) 3×10^5 A/m

(B) 9×10^5 A/m

(C) 10^5 A/m

(D) 27×10^5 A/m

24. If the diffusion distance is much smaller than dimensions of diffusion medium, then the solution of Fick's law is in the form

(A) Gaussian

(B) Error function

(C) Complementary error function

(D) Oscillatory

25. A plasma column has an ion concentration of 10^{12} m^{-3}. Electromagnetic radiation of frequency 9 MHz is incident on it. The refractive index of the plasma column is approximately

(A) Unity

(B) Zero

(C) $2\sqrt{-1}$

(D) $\sqrt{-1}$

26. Pinch effect basically is

(A) Magnetic confinement of plasma

(B) Electrostatic confinement of plasma

(C) Electromagnetic confinement of plasma

(D) Hydrodynamic confinement of plasma

27. The Maxwell's equation of II kind under Lorentz condition is

$\nabla^2 \vec{A} - \dfrac{1}{c^2} \dfrac{d^2 \vec{A}}{dt^2} = -\mu_0 \vec{J}$. If the temporal

coordinate is taken as $x_4 = ict$, the equation in Lorentz covariant form is

(A) $\square^2 \vec{A} = 0$

(B) $\square^2 \vec{A} = -\mu_0 \vec{J}$

(C) $\square^2 \vec{A} = \mu_0 \vec{J}$

(D) $\nabla^2 \vec{A} = -\mu_0 \vec{J}$

28. Assume that Maxwell stress tensor is to be written in terms of a (4 × 4) matrix. Then its elements are expected to be components of

(A) $\vec{E}$ and $\vec{B}$ (B) ϕ and $\vec{A}$

(C) $\vec{E}$ and ϕ (D) $\vec{B}$ and $\vec{A}$

29. Lienard-Wiechert potentials are the

(A) Electromagnetic potentials of a moving charge

(B) Retarded potentials of a moving charge

(C) Electrostatic potentials of a charge

(D) Magnetic potentials of a moving charge

30. The displacement current assumes significance over conduction current

(A) Beyond optical frequencies

(B) Below optical frequencies

(C) At all frequencies

(D) At no frequency

31. A lossless transmission line having $50\,\Omega$ characteristic impedance and length $\dfrac{\lambda}{4}$ is short circuited at one end and connected to an ideal voltage source of IV at the other end. The current drawn from the voltage source is

(A) Zero

(B) 0.02 A

(C) Infinite

(D) 0.2 A

32. Assuming perfect conduction for a transmission line, pure TEM propagation is not possible in

(A) Coaxial cable

(B) Air filled cylindrical wave guide

(C) Parallel thin wire in air

(D) Semi infinite parallel plate wave guide

33. In a rectangular wave guide there is one half-wave variation of electric field across the narrow dimension and two half wave variations of electric field across the wider dimension. The dominant mode is expected to be

(A) TE12   (B) TM12

(C) TE21   (D) TM21

34. Which of the following expression is correct for the propagation of electromagnetic wave in a medium with conductivity $'\sigma'$?

(A) $\nabla^2\vec{E} = \dfrac{\partial^2\vec{E}}{\partial t^2} + \mu\sigma\dfrac{\partial\vec{E}}{\partial t}$

(B) $\nabla^2\vec{E} = \mu_0\,\epsilon_0\,\dfrac{\partial^2\vec{E}}{\partial t^2}$

(C) $\nabla^2\vec{E} = \mu\sigma\dfrac{\partial^2\vec{E}}{\partial t^2}$

(D) $\nabla^2\vec{E} = \mu\sigma\dfrac{\partial^2\vec{E}}{\partial t^2} + \mu_0\,\epsilon_0\,\dfrac{\partial\vec{E}}{\partial t}$

35. According to liquid drop model, the asymmetry energy is negative and proportional to

(A) $\dfrac{(A-2z)^2}{z}$

(B) $\dfrac{(A-2z)^2}{A}$

(C) $\dfrac{(A-2z)^2}{\sqrt{A}}$

(D) $\dfrac{(A-z)^2}{A}$

36. The mass numbers of two nuclei are 27 and 125 respectively. If the radius of the first nucleus is 3.9 fermi. The radius of the other nucleus is

(A) 0.65 fermi   (B) 0.065 fermi

(C) 6.5 fermi   (D) 65 fermi

37. ^{16}O is an even-even nucleus. In the ground state it is expected to have

(A) Neither magnetic dipole moment nor electric quadrupole moment

(B) Both magnetic dipole moment and electric quadrupole moment

(C) Only dipole moment

(D) Only quadrupole moment

38. The ground state spin of ^{7}Li nucleus is

(A) 0

(B) 1/2

(C) 3/2

(D) 5/2

39. The magic numbers are

(A) 2, 8, 20, 50, 82 and 126

(B) 2, 8, 18, 20, 40, 50, 82 and 126

(C) 2, 8, 18, 20, 40, 82, 126 and 208

(D) 4, 16, 40, 100, 208

40. The electrons can not reside inside the nucleus because

(A) The Debroglie wavelength of the electron is smaller than that of the nucleus

(B) Electron is negatively charged

(C) The magnetic moment of the electron is several times more than that of the nucleus

(D) Electron is a very light particle

41. The binding energy of the deuteron is around

(A) 2.75 keV

(B) 2.75 eV

(C) 2.75 MeV

(D) 27.5 MeV

42. In the rotational spectrum of an odd – A nucleus, the band head has a spin – parity assignment of $\frac{3}{2}^+$ and Zero energy. The ratio of the energies of the next two states is around

(A) 0.24

(B) 2.4

(C) 24

(D) 0.024

43. Isospin doublet is formed by

(A) Electron and proton

(B) Electron and neutron

(C) Proton and pion

(D) Proton and neutron

44. Beta decay involves

(A) V plus A interaction

(B) V minus A interaction

(C) A minus V interaction

(D) Tensor minus Pseudoscalar interaction

45. Gamma decay involves

(A) Strong interaction

(B) Electromagnetic transition of nuclei

(C) Weak interaction inside the nucleus

(D) Gravitational interaction

46. Strange particles are characterized by

(A) Fast production, slow decay

(B) Fast production, fast decay

(C) Slow production, fast decay

(D) Slow production, slow decay

47. A certain beta decay obeys the selection rule $\Delta J = 0$, No change in parity. and $0 \rightarrow 0$ allowed. It is a

(A) Pure allowed GT transition

(B) Pure allowed Fermi transition

(C) Mixed transition

(D) Pseudo scalar transition

48. During beta decay, parity is

(A) Not conserved and helicity is not conserved

(B) Conserved

(C) Not conserved but helicity is conserved

(D) Is conserved along with helicity

49. During gamma decay, gamma rays are emitted with energy not exceeding

(A) 2 MeV

(B) 20 MeV

(C) 200 MeV

(D) 20 KeV

50. Density of states in the conduction band for electrons assumed to be essentially free in two dimension is proportional to

(A) $E^{1/2}$

(B) E^0 (independent of energy)

(C) $E^{-1/2}$

(D) E^{-1}

51. Effective magnetron number for $Ce^{3+}(4f^1 5s^2 p^6)$ is

(A) 1

(B) 1.5

(C) 2

(D) 2.5

52. In the longwavelength regime, the dispersion relation for magnons in a ferromagnet in one dimension with the nearest neighbour interaction yields

(A) $\omega \propto K$

(B) $\omega \propto K^2$

(C) $\omega \propto K^3$

(D) ω independent of K

53. The total number of $(Na^+ + Cl^-)$ ions per unit cell of NaCl is

(A) 2   (B) 4

(C) 6   (D) 8

54. In an allowed band of semiconductor, the effective mass 'm' of the electron is infinite

(A) At the bottom of the energy band

(B) At the top of the energy band

(C) In the middle of the energy band

(D) Never

55. The polarization P in a solid dielectric is related to electric field E and electric flux density D by the relation

(A) $E = \epsilon_0 D + P$

(B) $D = E + \epsilon_0 P$

(C) $D = \epsilon_0 E + P$

(D) $D = \epsilon_0 [E + P]$

56. Paramagnetic susceptibility of Fermi gas of conduction electrons is

(A) Proportional to 1/T

(B) Proportional to $1/T^3$

(C) Proportional to $1/T^2$

(D) Independent of temperature

57. Heat capacity of superconducting state is proportional to

(A) $K_B T$

(B) $K_B T^2$

(C) $K_B T^3$

(D) $e^{-\Delta/K_B T}$

58. For Fe (Z = 26) the resultant spin in Bohr magneton is

(A) 1

(B) 2

(C) 3

(D) 4

59. Madelung constant for the one dimensional crystal of infinite line of ions of alternate signs [eg.. $+ - + - ...$] is

(A) 4 ln 4

(B) 4 ln 2

(C) 3 ln 2

(D) 2 ln 2

60. The low temperature heat capacity of insulators will be proportional to

(A) T

(B) 1/T

(C) T^3

(D) $1/T^3$

61. At any temperature the probability of occupation of electron at Fermi energy is

(A) 0

(B) $\dfrac{1}{2}$

(C) $\dfrac{3}{4}$

(D) 1

62. The Weigner-Seitz cell for any two dimensional Bravais lattice is

(A) Square

(B) Triangle

(C) Hexagon or rectangle

(D) Both A) and B)

63. The Lane condition for x-ray diffraction is (G is the reciprocal lattice vector)

(A) $2\,K.G = G^2$

(B) $K . \left(\dfrac{1}{2}G\right) = 2G^2$

(C) $2\,K.G = G$

(D) $\dfrac{1}{2}K . \dfrac{1}{2}G = 2G^2$

64. Assertion A : Van der Waal's type bonding single crystals do not exist at room temperature.

   Reason R : Van der Waal's type single crystals are light weight.

(A) Both A and R are correct

(B) Both A and R are wrong

(C) A is correct and R is wrong

(D) A is wrong and R is correct

65. Match the following for the allowed reflections of SC, DCC, BCC and FCC lattices and choose the correct one

Lattices	Structure Factor (s)
1) SC	a) When h, k, l are all odd or all even and $(h + k + l)$ should be divisible by four
2) DCC	b) When h, k, l are all odd or all even
3) BCC	c) All values of $(h^2 + k^2 + l^2)$
4) FCC	d) Even values of $(h+k+l)$

(A) $1 - d, 2 - a, 3 - c, 4 - b$

(B) $1 - b, 2 - a, 3 - d, 4 - c$

(C) $1 - a, 2 - d, 3 - c, 4 - b$

(D) $1 - c, 2 - a, 3 - d, 4 - b$

66. KCl crystal has a density of $1.98 \times 10^3 \, kg/m^3$ and its molecular weight is 74.55 g. The inter atomic distance [Avogadro number $N = 6.023 \times 10^{23}$ g atom] is

(A) $8.3 \times 10^{-10} m$ (B) $8.3 \times 10^{-8} m$

(C) $6.3 \times 10^{-10} m$ (D) $6.3 \times 10^{-8} m$

67. Match the following and identify the correct matching in the choice given below :

Direct lattice	Corresponding reciprocal lattice
a) SC	p) FCC
b) BCC	q) BCC
c) FCC	r) SC

(A) a – p, b – q, c – r

(B) a – r, b – p, c – q

(C) a – q, b – p, c – r

(D) a – r, b – q, c – p

68. An atom is having the outer electronic configuration 4p 4d. The spectral terms for L – S coupling scheme are

(A) $^1P_1, \, ^3P_{0,1,2}$

(B) $^1S_0, \, ^1P_1, \, ^1D_2, \, ^1F_3, \, ^3S_1, \, ^3P_{0,1,2}, \, ^1G_4, \, ^3F_{2,3,4}$

(C) $^1S_0, \, ^1P_1, \, ^1D_2, \, ^3S_1, \, ^3P_{0,1,2}, \, ^3D_{1,2,3}$

(D) $^1P_1, \, ^1D_2, \, ^1F_3, \, ^3P_{0,1,2}, \, ^3D_{1,2,3}, \, ^3F_{2,3,4}$

69. The number of possible terms of a one-electron atom $^2D_{5/2}$ is

(A) Two

(B) Four

(C) Five

(D) Three

70. The wavelength of the first line in Balmer series in the hydrogen spectrum is λ. The wavelength of the second line is

(A) $\dfrac{5\lambda}{36}$

(B) $\dfrac{3\lambda}{16}$

(C) $\dfrac{20\lambda}{27}$

(D) $\dfrac{3\lambda}{4}$

71. Phase shift through an Op-Amp is due to

(A) The external RC circuit

(B) Negative feedback

(C) Internal RC circuit

(D) The gain roll-off

72. Table gives the number of accidents that took place during the days of a week. Assuming that accidents are uniformly distributed over the week,

Week days	Mon.	Tue.	Wed.	Thurs.	Fri.	Sat.
No. of Accidents	14	18	12	11	15	14

The Chi-square value is

(A) 3.1428   (B) 2.1428

(C) 3.781   (D) 4.832

73. When using a D.C signal conditioning system, with a carrier of 3 kHz, the data frequency should be limited to

(A) 1 kHz

(B) 5 Hz

(C) 600 Hz

(D) 2 MHz

74. An Op-Amp has a gain bandwidth product of 1.5 MHz. If the closed loop gain is 10, then the operating band width would be

(A) 1.5 MHz

(B) 150 kHz

(C) 15 MHz

(D) 15 kHz

75. Which of the following is not a transducer ?

(A) Strain gauge

(B) Microphone

(C) Thermo Couple

(D) Potentiometer

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ಚಿತ್ತು ಬರಹಕ್ಕಾಗಿ ಸ್ಥಳ
Space for Rough Work

ಚಿತ್ತು ಬರಹಕ್ಕಾಗಿ ಸ್ಥಳ
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