T. B. C. : PGT – 2/21

Test Booklet Series

A

TEST BOOKLET
PAPER – II
PHYSICS

20445

SI. No.

Time Allowed : 2 Hours

Maximum Marks : 100

: INSTRUCTIONS TO CANDIDATES :

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET **DOES NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET OF THE SAME SERIES ISSUED TO YOU.

2. ENCODE CLEARLY THE TEST BOOKLET SERIES **A, B, C** OR **D**, AS THE CASE MAY BE, IN THE APPROPRIATE PLACE IN THE ANSWER SHEET USING BALL POINT PEN (BLUE OR BLACK).

3. You have to enter your **Roll No.** on the Test Booklet in the Box provided alongside. **DO NOT** write anything else on the Test Booklet.

4. **YOU ARE REQUIRED TO FILL UP & DARKEN ROLL NO., TEST BOOKLET / QUESTION BOOKLET SERIES IN THE ANSWER SHEET AS WELL AS FILL UP TEST BOOKLET / QUESTION BOOKLET SERIES AND SERIAL NO. AND ANSWER SHEET SERIAL NO. IN THE ATTENDANCE SHEET CAREFULLY. WRONGLY FILLED UP ANSWER SHEETS ARE LIABLE FOR REJECTION AT THE RISK OF THE CANDIDATE.**

5. This Test Booklet contains **100** items (questions). Each item (question) comprises four responses (answers). You have to select the correct response (answer) which you want to mark (darken) on the Answer Sheet. In case, you feel that there is more than one correct response (answer), you should mark (darken) the response (answer) which you consider the best. In any case, choose **ONLY ONE** response (answer) for each item (question).

6. You have to mark (darken) all your responses (answers) **ONLY** on the **separate Answer Sheet** provided, by **using BALL POINT PEN (BLUE OR BLACK)**. See instructions in the Answer Sheet.

7. All items (questions) carry equal marks. All items (questions) are compulsory. Your total marks will depend only on the number of correct responses (answers) marked by you in the Answer Sheet. **There will be no negative markings for wrong answers.**

8. Before you proceed to mark (darken) in the Answer Sheet the responses (answers) to various items (questions) in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per the instructions sent to you with your **Admission Certificate**.

9. After you have completed filling in all your responses (answers) on the Answer Sheet and after conclusion of the examination, you should hand over to the Invigilator the *Answer Sheet* issued to you. You are allowed to take with you the candidate's copy / second page of the Answer Sheet along with the **Test Booklet**, after completion of the examination, for your reference.

10. Sheets for rough work are appended in the Test Booklet at the end.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

1. Tensor of the zeroth rank is called :

   (A) Vector

   (B) Scalar

   (C) Kronecker tensor

   (D) Gradient

2. Which among the following has the same dimensions as Planck's constant is :

   (A) Angular momentum

   (B) Velocity

   (C) Force

   (D) Speed

3. Regarding the width of the depletion region in a **p-n** junction diode, the width :

   (A) Increases on reverse bias

   (B) Decreases on reverse bias

   (C) Increases on forward bias

   (D) Remains constant

4. The effect on the potential energy due to the space inversion of + x to − x is :

   (A) Increases

   (B) Decreases

   (C) Remains the same

   (D) Becomes zero

5. The total value of the magnetic quantum number are :

   (A) n

   (B) 2ℓ

(C) $2n + 2$

(D) $2\ell + 1$

6. If A and B are two matrices, such that AB = 0 and A is non-singular then :

   (A) B is singular

   (B) B = 0

   (C) B is non-singular

   (D) B = A

7. To be a function harmonic, it must satisfy :

   (A) Poisson equation

   (B) Bessel's equation

   (C) Laplace equation

   (D) Hermite polynomial

8. The phase change of the reflected ray, when the angle of incidence is greater than that of the Brewster's angle is :

   (A) $\pi/2$

   (B) π

   (C) 2π

   (D) $\pi/4$

9. The Poynting theorem is a mathematical statement for the conservation of :

   (A) Charge

   (B) Electromagnetic energy

   (C) Statistics

   (D) Momentum

10. For an isothermal change, the internal energy of the molecules :

    (A) Does not change

    (B) Decreases

    (C) Increases

    (D) Becomes zero

11. In the process of phase transition :

    (A) Only the entropy remains constant

    (B) Only the volume remains constant

    (C) Only the temperature remains constant

    (D) Gibb's potential remains constant

12. For a real gas, in the Joule-Thomson experiment :

    (A) The internal energy remains constant

    (B) The entropy remains constant

    (C) The enthalpy remains constant

    (D) The enthalpy decreases

13. Number of point groups in two dimension are :

    (A) 12

    (B) 10

    (C) 8

    (D) 32

14. Diode that has a negative resistance characteristic is the :

    (A) Schottky diode

    (B) Tunnel diode

    (C) Laser diode

    (D) None of these

15. The feedback element for the integrator circuit is :

    (A) Resistor

    (B) Capacitor

    (C) Zener diode

    (D) Inductor

16. In digital circuits, the active devices generally operate as :

    (A) Rectifiers

    (B) Amplifiers

    (C) Switches

    (D) Waveform generators

17. The low pass filter is the one having :

    (A) A differentiator circuit with larger time constant

    (B) A differentiator circuit with low time constant

    (C) An integrator circuit with larger time constant

    (D) An integrator circuit with low time constant

18. The hyperfine splitting of the spectral lines of an atom is due to :

   (A) Coupling between the spins of two or more electrons

   (B) Coupling between the electron spins and the nuclear spins

   (C) Coupling between the spins and the angular momenta of the electrons

   (D) Influence of the external electromagnetic fields

19. The splitting of the spectral line in the presence of the electric field is :

   (A) Stark effect

   (B) Zeeman effect

   (C) Paschen-Back effect

   (D) Raman effect

20. The existence of space quantization is directly established by :

   (A) Franck-Hertz experiment

   (B) Double slit experiment

   (C) Michelson and Morley experiment

   (D) Stern-Gerlach experiment

21. The reciprocal lattice of a simple cubic lattice is :

   (A) Monoclinic

   (B) Triclinic

   (C) Cubic

   (D) Orthorhombic

22. The quantity which remains invariant under Lorentz transformation :

   (A) $E^2 - C^2 B^2$

   (B) E^3

   (C) B^2

   (D) ExB

23. The energy ratio of both electric and magnetic fields in an electromagnetic wave is :

   (A) $1 : 1$

   (B) $1 : 2$

   (C) $2 : 1$

   (D) $4 : 1$

24. The selection rule for the electric-dipole transitions for the spin-orbit interactions is :

   (A) $\Delta l = \pm 0, \Delta J = \pm 1, \Delta M_J = 0$

   (B) $\Delta l = \pm 1, \Delta J = \pm 1, \Delta M_J = 0$

   (C) $\Delta l = \pm 1, \Delta J = 0, \pm 1, \Delta M_J = 0, \pm 1$

   (D) $\Delta l = \pm 1, \Delta J = \pm 1, \Delta M_J = 0, \pm 2$

25. The eigenvalues of the Dirac matrices are :

   (A) ± 2

   (B) ± 1

   (C) 0

   (D) i

26. The moment of inertia of a thin uniform rod, through the centre and perpendicular to its length is :

   (A) $M\ell^2/12$

   (B) $M\ell^2/13$

   (C) $M\ell/12$

   (D) $M\ell^2/12$

27. If the Lagrangian of a system does not contain a particular coordinate qk, then for such system :

   (A) $\partial L/\partial qk \neq 0$

   (B) $\partial L/\partial qk = 0$

   (C) $\partial L/\partial pk \neq 0$

   (D) $\partial L/\partial pk = 0$

28. The moment of inertia of a circular laminar disc, about a diameter is :

   (A) $MR^2/2$

   (B) $MR^2/4$

   (C) $MR/4$

   (D) $MR^3/2$

29. In a central force :

   (A) Both energy and angular momentum are conserved

   (B) Only energy is conserved

   (C) Only angular momentum is conserved

   (D) Both energy and angular momentum are not conserved

30. The power radiated by an electric dipole is proportional to :

   (A) Square of frequency

   (B) Speed of light

   (C) Fourth power of frequency

   (D) Dielectric constant of a medium

31. The Ehrenfest's theorem is :

   (A) $d<x>/dt = <P_x>/m$ and $d<P_x>/dt = -<\partial V/\partial x>$

   (B) $d<P>/dt = <P_x>/m$ and $d<x>/dt = -<\partial V/\partial x>$

   (C) $d<V>/dt = -<P_x>/m$ and $\partial<P_x>/\partial t = -<\partial V/\partial x>$

   (D) $\partial<P_x>/dt = -<P>/m$ and $\partial<P_y>/\partial t = -<\partial V/\partial y>$

32. The application of the uncertainty principle is :

   (A) Non-existance of electrons in the nucleus

   (B) Minimum energy of a harmonic oscillator

   (C) Finite width of a spectral linearity

   (D) All of these

33. The total number of tetrahedral voids in the face centred unit cell is :
    (A) 6
    (B) 8
    (C) 10
    (D) 14

34. The zero point energy of the linear harmonic oscillator is :
    (A) $\hbar\omega/2$
    (B) $\hbar\omega$
    (C) $\hbar\omega/3$
    (D) $\hbar\omega/4$

35. A superconductor is a perfect :
    (A) Diamagnet
    (B) Ferromagnetic
    (C) Antiferromagnentic
    (D) Paramagnet

36. The specific heat of electron in normal state is given by the equation $C_n(T) = \gamma T + \beta T_3$. The term βT^3 is due to :
    (A) Exchange coupling
    (B) Repulsion of the electrons
    (C) Electrons in the metals
    (D) Lattice vibrations

37. The unit of spin wave energy is called :
    (A) Phonon
    (B) Magnon

(C) Photon
(D) Meson

38. The cooper pair acts as :
    (A) Bosons
    (B) Fermions
    (C) Photons
    (D) Phonons

39. Parity is conserved in :
    (A) Strong and electromagnetic interaction
    (B) Weak interaction
    (C) Coulombic interaction
    (D) All of these

40. In every closed system, the total relativistic energy and momentum is :
    (A) Not conserved
    (B) Conserved
    (C) Depends on the volume of the system
    (D) None of these

41. In solid state, the Hall effect is used to measure :
    (A) Ratio of charge to mass
    (B) Sign of the charge carriers
    (C) Magnetic susceptibility
    (D) Resistivity of the material

42. The differential equation

$$y = x^2 \left(\frac{dy}{dx}\right) + \sqrt{\left(\frac{dy}{dx}\right)^2} + 1 \text{ has :}$$

(A) Order = 1 and degree = 1

(B) Order = 1 and degree = 3

(C) Order = 2 and degree = 1

(D) Order = 1 and degree = 2

43. If u and v are analytic functions, then :

(A) $u \pm v$, $u.v$ is analytic functions and u/v is not a analytic functional

(B) $u \pm v$, $u.v$ and u/v is analytic functions

(C) Only u/v is analytic a function

(D) Only $u \pm v$ is analytic function

44. The value of $\int_0^\infty e^{-x^2} dx$ is :

(A) $\sqrt{\pi}$

(B) $\sqrt{\pi/2}$

(C) $\sqrt{\pi}/2$

(D) π

45. The value of Legendre's polynomial $P_1(x)$ is :

(A) x

(B) x^2

(C) $3x^2 - 1$

(D) $(3x^2 - 1)/2$

46. The connection between the beta and gamma function is given by :

(A) $\beta(x, y) = \dfrac{\Gamma(x)\,\Gamma(y)}{\Gamma(x+y)}$

(B) $\beta(x, y) = \Gamma(x)\,\Gamma(y)$

(C) $\beta(x, y) = \dfrac{1}{\Gamma(x+y)}$

(D) $\beta(x, y) = \dfrac{\Gamma(x)\,\Gamma(y)}{\Gamma(x)}$

47. The Rodrigues formula $(-1)^n e^{x^2} \dfrac{d^n}{dx^n} e^{-x^2}$ is associated with the following polynomial :

(A) Legendre

(B) Associated Legendre

(C) Lagure

(D) Hermite

48. The value of Legendre's polynomial $P_1(-1)$ is :

(A) -1^n

(B) -2

(C) 1

(D) 2

49. The generating function for $P_1(-1)$ is :

(A) $P_n(x)$

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

(C) $(1 - 2xz + z^2)$

(D) $(1 + 2xz + z^2)^{-\frac{1}{2}}$

50. The generating function for $J_n(x)$ is :

(A) $e^{\frac{1}{2}\left(z - \frac{1}{z}\right)}$

(B) $e^{\frac{1}{2}\left(z + \frac{1}{z}\right)}$

(C) $e^{\frac{x}{2}\left(z - \frac{1}{z}\right)}$

(D) $e^{\frac{x}{2}\left(z + \frac{1}{z}\right)}$

51. The differential equation $x^2 \frac{d^2 y}{dx^2} + x \frac{dy}{dx} + (x^2 - n^2)y = 0$ where n is a real number, is :

(A) Legendre's differential equation

(B) Besel's differential equation

(C) Chebyshev's differential equation

(D) Associated Legendre differential equation

52. The Stirling's formula is :

(A) $\ln N ! = N \log (N) - N$

(B) $\ln N ! = \log (N) - N$

(C) $\ln N ! = N \log (N) + N$

(D) $\ln N = N \log (N) - N$

53. In statistical mechanics, the large number of similar, non-interacting and independent system which are grouped together is termed as :

(A) A set

(B) A group

(C) An ensemble

(D) A state

54. The Maxwell velocity distribution is valid for a classical gas :

(A) Under steady flow of particles

(B) In equilibrium irrespective of the nature of the particle interaction

(C) Only in the absence of the inter particle interactions

(D) Having interactions between the molecules

55. The conserved quantities in the scattering of a particle from a spherically symmetric potential are :

(A) E, L^2, L_z

(B) Only E

(C) Only L^2

(D) Only L

56. A discontinuous change in the specific heat is a characteristic feature of :

(A) First order phase transition

(B) Zeroth order phase transition

(C) Third order phase transition

(D) Second order phase transition

57. The volume of a cell in six dimensional phase space is :

   (A) h^2

   (B) h^4

   (C) h^3

   (D) h^{-2}

58. The Fermi energy of free electron gas depends on the electron density (ρ) as :

   (A) $\rho^{-2/3}$

   (B) $\rho^{2/3}$

   (C) $\rho^{-1/3}$

   (D) $\rho^{1/3}$

59. The Clausius-Clapeyron latent heat equation is :

   (A) $\dfrac{dP}{dT} = \dfrac{L}{k(V_2 - V_1)}$

   (B) $\dfrac{dP}{dT} = \dfrac{T}{L(V_2 - V_1)}$

   (C) $\dfrac{dP}{dT} = \dfrac{L}{T(L_2 - L_1)}$

   (D) $\dfrac{dP}{dT} = \dfrac{L}{T(V_2 - V_1)}$

60. The value of $\left[x, \dfrac{d}{dx}\right]$ is :

   (A) 1

   (B) x

   (C) 0

   (D) −1

61. The energy eigenvalues of a simple harmonic oscillator is :

   (A) Continuous

   (B) Both discrete and equispaced

   (C) Discrete and unequally spaced

   (D) Cannot be predicted

62. An antiproton is the one, that has :

   (A) The mass of an electron and charge of a proton

   (B) The mass of a proton and charge of an electron

   (C) The mass and charge of a neutron

   (D) The mass and charge of a proton

63. A moderator is used to :

   (A) Accelerate the neutrons

   (B) Slow down the neutrons

   (C) Provide necessary energy for the neutrons to undergo fission

   (D) Slow down the alpha particles

64. The strongly interacting bosons with zero spin are called :

   (A) Mesons

   (B) Hadrons

   (C) Baryons

   (D) Leptons

65. One of the main result of the famous Rutherford's gold foil experiment is :

   (A) All the alpha particles passed through the foil without any deviation

   (B) The alpha particles were linearly polarized

   (C) All the alpha particles were reflected back from the gold foil

   (D) Most of the alpha particles passes through the foil with negligible deflection but some were deflected through large angles

66. In a differential region dx, the probability of finding a particle is :

   (A) $\psi(x, t)\, dx$

   (B) $\psi^*(x, t)\, dx$

   (C) $\psi(x, t).\psi^*(x, t)\, dx = |\psi(x, t)|^2\, dx$

   (D) $\dfrac{\psi(x, t)dx}{\psi^*(x, t)dx}$

67. The expectation value of a dynamical variable governed by a Hermitian operator is :

   (A) The mean value of the quantity given by the probability density

   (B) The time average of the quantity

   (C) The median value of the quantity given by the probability density

   (D) The mode of the measured values

68. An observable, that has no explicit time dependence and it commutes with the Hamiltonian, then it is a quantum mechanical :

   (A) Dynamical variable

   (B) Universal constant

   (C) Constant of motion

   (D) Potential energy of the system

69. According to the compound nuclear theory, the nuclear reaction is :

   (A) One step process

   (B) Two step process

   (C) Three step process

   (D) Four step process

70. Parity is not conserved in :

   (A) Alpha decay

   (B) Gamma decay

   (C) Beta decay

   (D) None of these

71. The spherical harmonics are the part of :

   (A) Hilbert space

   (B) Null basis set

   (C) Orthogonal basis set

   (D) Both Orthogonal and Hilbert space

72. The validity of the Wentzel, Kramers, and Brillouin (WKB) approximation is when :

    (A) System have large mass

    (B) System have high energy

    (C) System potential varying slowly

    (D) System have large mass, high energy and potential slowly varying

73. The value of commutator $[p, x]\psi$ is :

    (A) $(i\hbar)\psi$

    (B) $-(i\hbar)\psi$

    (C) $(ih)\psi$

    (D) $-(ih)\psi$

74. What is the base of the duodecimal number system ?

    (A) 12

    (B) 10

    (C) 16

    (D) 2

75. The gate which has high output, when all the inputs are also high :

    (A) OR

    (B) NAND

    (C) AND

    (D) NOT

76. The circuit in which the present output depends only on the present input is :

    (A) Sequential circuit

    (B) Combinatinoal circuit

    (C) Both sequential and combinational circuits

    (D) None of these

77. The number of MOS transistors required to form SRAM is :

    (A) 6

    (B) 8

    (C) 4

    (D) 2

78. The transistors (used in IC) which are not driven into saturation belongs to :

    (A) Bipolar unsaturated logic family

    (B) Bipolar saturated logic family

    (C) Unipolar logic family

    (D) None of these

79. The storage capacity of a shift register depends on :

    (A) Number of inductors used

    (B) Number of capacitors used

    (C) Number of stages (flip flop)

    (D) Number of resistors used

80. The oscillator which uses both positive and negative feedback :

    (A) Wein-bridge oscillator

    (B) Hartley oscillator

    (C) Colpitts oscillator

    (D) Armstrong oscillator

81. The main difference between the oscillator and an amplifiers is, it :

 (A) Has more gain

 (B) Requires no input signal

 (C) Requires no d.c. supply

 (D) Always has the same input

82. For bit comparison purpose, the gate that can be used is :

 (A) Two input exclusive OR gate

 (B) Two input NAND gate

 (C) Two input NOR gate

 (D) Two input exclusive NOR gate

83. Which among the following can be used to develop an inverter gate ?

 (A) A transistor

 (B) An inductor and capacitor

 (C) Only capacitor

 (D) Diodes

84. Which of the following can be a wave function ?

 (A) $\sin x$

 (B) $\cos x$

 (C) $\cot x$

 (D) $\tan x$

85. For a free particle which among the following is true ?

 (A) The solutions are not energy eigenfunctions

 (B) The solutions are not momentum eigenfunctions

 (C) The solution of the Schrodinger equation are both energy and momentum eigenfunctions

 (D) It does not have a definite solution

86. The maximum current which can flow though a 60k ohms resistor, rated 6W is :

 (A) 10 mA

 (B) 1 mA

 (C) 10 MA

 (D) 100 mA

87. The residue of $\cot z$ at $z = 0$ is :

 (A) 1

 (B) 0

 (C) -1

 (D) 2

88. The rest mass of an electron is m_o when it moves with a velocity $v = 0.8 c$, then its rest mass is :

 (A) $m_o / 0.6$

 (B) $m_o / 0.4$

 (C) m_o

 (D) $m_o / 2$

89. If E_1 is the energy of the lowest state of a one dimensional potential box of length a and E_2 is the energy of the lowest state when the length of the box is doubled, then :

   (A) $E_2 = 4 E_1$

   (B) $E_1 = 4 E_2$

   (C) $E_1 = 6 E_2$

   (D) $E_1 = 2 E_2$

90. An electric current of 4 amp, flows through a resistances of 30 ohm. It is being cooled by running water and is kept at temperature 300 K, change in entropy per second of the resistance is :

   (A) 1.6 joule deg^{-1}

   (B) 0.6 joule deg^{-1}

   (C) 1.2 joule deg^{-1}

   (D) 0.5 joule deg^{-1}

91. If the temperature of the sun increases by a factor of 4, then the total power radiated by the sun increases by a factor of :

   (A) 16

   (B) 156

   (C) 256

   (D) 4

92. At low temperature, the electronic contribution of the specific heat of a metal is :

   (A) An exponential function of T

   (B) Independent of T

   (C) Zero

   (D) A linear function of T

93. The Bragg's law equation can also be written as :

   (A) $2\vec{K}.\vec{G} + \vec{G}^2 = 0$

   (B) $2\vec{K}.\vec{K} + \vec{G}^2 = 0$

   (C) $2\vec{K}.\vec{G} + \vec{K}^2 = 0$

   (D) $\vec{K}.\vec{G} + \vec{G}^2 = 0$

94. The spacing between successive (100) planes in NaCl is 2.75 Å. X-ray incident upon the surface of this crystal, is found to give rise to first order Bragg reflection at a grazing angle of 30°. Then the wavelength of the X-ray is :

   (A) 1.75 Å

   (B) 0.85 Å

   (C) 2.75 Å

   (D) 1.82 Å

95. The reciprocal lattice for a bcc lattice is :

    (A) Cubic

    (B) bcc

    (C) Both bcc and fcc

    (D) fcc

96. Among the following, which nuclear reaction is strong ?

    (A) $\pi^- + p \rightarrow \Lambda^0 + K^0$

    (B) $\Lambda^0 \rightarrow p + \pi^-$

    (C) $K^0 \rightarrow \pi^+ + \pi^-$

    (D) $\Xi^- \rightarrow \Lambda^0 + \pi^-$

97. The missing particle (x) in the reaction $p + q \rightarrow \pi^+ + n + \Lambda^0 + x$ is :

    (A) Ξ^+

    (B) γ^+

    (C) π^+

    (D) K^+

98. The strangeness quantum number is conserved in :

    (A) Strong, weak and electro-magnetic interactions

    (B) Strong and electromagnetic interactions only

    (C) Weak interactions only

    (D) Strong and weak interactions only

99. The relation between the group and phase velocity of the particles is :

    (A) $v_g = v_p - \lambda \dfrac{dv_p}{d\lambda}$

    (B) $v_p = v_g - \lambda \dfrac{dv_p}{d\lambda}$

    (C) $v_g = v_p - \lambda \dfrac{dv_g}{d\lambda}$

    (D) $v_g = v_p - \dfrac{dv_p}{d\lambda}$

100. If the partition function is Z, then the mean energy (E) is given by :

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

    (B) $\dfrac{\partial \log(z)z!}{\partial \beta}$

    (C) $\dfrac{\partial \log(z)}{\partial \alpha}$

    (D) $\dfrac{-\partial \log(z)}{\partial \beta}$

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SPACE FOR ROUGH WORK