M.Sc. Physics Code No (481)

16P/218/22

Set No. – (i) Question Booklet No. 4271

(To be filled up by the candidate by ***blue/black ball-point pen***)

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

Roll No.

(Write the digits in words) ....

Serial No. of OMR Answer Sheet .... (2016)

Day and Date .... (Signature of Invigilator)

INSTRUCTIONS TO CANDIDATES

(Use only ***blue/black ball-point pen*** in the space above and on both sides of the OMR Answer Sheet)

1. Within 30 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that no page/question is missing. In case of faulty Question Booklet bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.
2. Do not bring any loose paper, written or blank, inside the Examination Hall *except the Admit Card without its envelope.*
3. A separate Answer Sheet is given. ***It should not be folded or mutilated. A second Answer Sheet shall not be provided. Only the Answer Sheet will be evaluated.***
4. Write your ***Roll Number and Serial Number of the Answer Sheet by pen*** in the space provided above.
5. ***On the front page of the Answer Sheet, write by pen your Roll Number in the space provided at the top, and by darkening the circles at the bottom. Also, wherever applicable, write the Question Booklet Number and the Set Number in appropriate places.***
6. No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) on OMR sheet and also Roll No. and OMR sheet No. on the Question Booklet.
7. Any changes in the aforesaid entries is to be verified by the invigilator, otherwise it will be taken as unfairmeans.
8. Each question in this Booklet is followed by four alternative answers. ***For each question, you are to record the correct option on the Answer Sheet by darkening the appropriate circle in the corresponding row of the Answer Sheet, by ball-point pen as mentioned in the guidelines given on the first page of the Answer Sheet.***
9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circle or darken a circle partially, the answer will be treated as incorrect.
10. ***Note that the answer once filled in ink cannot be changed.*** If you ***do not wish to attempt*** a question, leave all the circles in the corresponding row blank (such question will be awarded zero marks).
11. For rough work, use the inner back page of the title cover and the blank page at the end of this Booklet.
12. Deposit ***only the OMR Answer Sheet*** at the end of the Test.
13. You are not permitted to leave the Examination Hall until the end of the Test.
14. If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.

[उपर्युक्त निर्देश हिन्दी में अन्तिम आवरण-पृष्ठ पर दिये गये हैं।]

Total No. of Printed Pages : 32

17

16P/218/22(i)

No. of Questions : 150

$\frac{1}{2}$ *Hours]* | *[Full Marks : 450*

Ti (1) Attempt as many questions as you can. Each question carries **3 (Three)** marks. ***One mark will be deducted for each incorrect answer. Zero*** mark will be awarded for each unattempted question.

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

1. If a one dimensional potential of a physical system is $V(x)=\frac{x^2}{2}-\frac{x^4}{4}$, the unstable equilibrium of the system would be at :

(1) $x=0$ (2) $x=+1$ (3) $x=-1$ (4) $x=\pm 1$

2. An example of a non-inertial reference frame is when :

(1) a frame of reference is stationary w. r. t. the other frame

(2) a frame of reference moves with a uniform velocity towards the other reference frame

(3) a reference frame moves away from the other reference frame with a uniform velocity

(4) a reference frame rotates with a uniform angular velocity w. r. t. the other frame

3. The change in the wavelength of the scattered light in the Compton scattering is equal to the Comptom wavelength of the electron when :

(1) the deflection angle of photon is $\pi/2$

(2) the deflection angle of photon is 0

(3) the deflection angle of photon is $\pi/3$

(4) the deflection angle of photon is π

P.T.O.

4. The maximum value of the change in the wavelength of the scattered light in the case of Compton scattering is :

(1) 0.024 Å (2) 0.048 Å (3) 0.0 Å (4) 72 Å

5. Raman scattering experiment is important because it leads to give information about :

(1) the quantum nature of light

(2) the quantum nature of the molecule

(3) the quantum nature of atom

(4) the quantum nature of molecule as well as light

6. In an electron-positron annihilation experiment, two photons are produced travel back-to-back. The speed of one photon w. r. t. the other photon would be equal to :

(1) 2C (2) C (3) $\frac{2}{3}C$ (4) $\frac{3}{2}C$

7. In a Compton scattering experiment, the recoil electron has to be :

(1) relativistic

(2) non-relativistic

(3) Sometimes relativistic

(4) Sometimes non-relativistic

8. In the phenomenon of the photo electric effect, the ejected electrons are :

(1) most of the times relativistic

(2) most of the times non-relativistic

(3) always relativistic

(4) most of the times stationary

9. The de Broglie wavelength, associated with a light of wavelength (λ) is :

(1) 2λ (2) $\frac{3}{2}\lambda$ (3) $\frac{2}{3}\lambda$ (4) λ

10. In the case of Rutherford scattering, if the impact parameter is zero, the deflection of the α-particle would be by the :

(1) Angle $\pi/2$ (2) Angle $\pi/4$ (3) Angle π (4) Angle 2π

11. The de Broglie wavelength, associated with a neutron at temperature 27°C, is nearly equal to :

(1) 2.77 Meter (2) 1.77 Angstrom

(3) 2.77 Micrometer (4) 1.77 Nanometer

12. The de Broglie wavelengths associated with 2eV photon and electron are :

(1) $\approx$ 6200 Å and $\approx$ 20 Å, respectively

(2) $\approx$ 7200 Å and $\approx$ 9 Å, respectively

(3) $\approx$ 6200 Å and $\approx$ 9 Å, respectively

(4) $\approx$ 7200 Å and $\approx$ 20 Å, respectively

13. The energy required to dislodge a bound electron from Sodium is 2.3 eV. The threshold wavelength of the light for the photo electric effect to occur is :

(1) 5380 meter (2) 5380 micrometer

(3) 5380 nanometer (4) 5380 angstrom

14. If the incident photon has a wavelength equal to 2Å and its angle of deflection is 90°, the kinetic energy of the recoil electron in the Compton scattering would be :

(1) 1.17×10^{-17} ergs (2) 1.17×10^{-17} joules

(3) 1.17×10^{-17} KeV (4) 1.17×10^{-17} eV

15. The energy equivalent of the root mass of a position is :

(1) 0.511 GeV (2) 0.511 KeV

(3) 0.511 MeV (4) 0.511 eV

16. Threshold wavelength of a photon that is capable of generating photoelectric effect in a metal, is :

(1) the minimal value

(2) the maximum value

(3) the average value

(4) the root square mean value

17. One of the following is ***not*** consistent with the basic concepts of special theory of relativity :

(1) Maxwell's electromagnetic theory

(2) Lorentz transformations

(3) Galilean transformations

(4) Michelson-Morley experiment

18. The electric and magnetic fields of Maxwell's theory remain invariant under :

(1) Gauge transformations

(2) Lorentz transformations

(3) Parity transformations

(4) Galilean transformations

19. Two electrons move in the opposite directions *each* with speed 0.9 C. The relative velocity of one with respect to the other is :

(1) 1.80 C (2) 0.99 C (3) 0.88 C (4) 0.77 C

20. Rutherford scattering is important because it sheds light on :

(1) the structure of the molecule

(2) the size of the molecule

(3) the quantum nature of the molecule

(4) the structure of the atom

21. A rigid body is constrained to move freely on a plane. The number of degrees of freedom for this system is :

(1) One (2) Two (3) Four (4) Five

22. The condition under which the following transformations (with constants $\alpha, \beta, \gamma, \delta$) $q \to Q = \gamma q + \delta p, p \to P = \alpha q + \beta p$ would be canonical is :

(1) $\alpha\delta - \beta\gamma = 1$ (2) $\alpha\gamma - \beta\delta = 0$ (3) $\alpha\gamma - \beta\delta = 1$ (4) $\alpha\delta - \beta^2 = 0$

23. The quark content of a proton is :

(1) udd (2) uud (3) uuu (4) ddd

24. The ground state of a deuteron is :

(1) A pure $^3S_1$ state

(2) A pure $^3P_1$ state

(3) A mixture of $^3S_1$ and $^3P_1$ states

(4) A mixture of $^3S_1$ and $^3D_1$ states

25. According to the nuclear shell-model, the spin and parity of the ground state of the nucleus $_{19}K^{39}$ would be :

(1) $\left(\frac{3}{2}\right)^+$ (2) $\left(\frac{1}{2}\right)^+$ (3) $\left(\frac{3}{2}\right)^-$ (4) $\left(\frac{1}{2}\right)^-$

26. Under the Lorentz transformations, one of the following does *not* remain invariant ?

(1) Rest mass (2) Charge

(3) Proper time (4) Total energy

27. The phase space trajectory of a linear oscillator, with fixed energy, is :

(1) An ellipse (2) A circle (3) A hyperbola (4) A parabola

28. A current of amount 1.6 Ampere flows through a bulb. The number of electrons that flow per second is :

(1) 10^{19} (2) 10^{16} (3) 10^{22} (4) 0

29. Number of generalized coordinates, required to describe the motion of a rolling cylinder (without slipping) on an inclined plane, is :

(1) One (2) Two (3) Three (4) Four

30. The constraints of a rigid body is :

(1) Conservative and rheonomic

(2) Conservative and scleronomic

(3) Holonomic and rheonomic

(4) Non-holonomic and scleronomic

31. A massive particle with total energy E is constrained to move on a finite plane under the influence of a potential $V(x,y)=x^2\left(x^2+y^2\right)$. The average kinetic energy of the particle is :

(1) 2/3 E (2) 1/3 E (3) 1/2 E (4) 3/4 E

32. A massive particle with unit mass moves under the influence of a potential $V(x)=x^3-3x+2$. The angular frequency of the small oscillation, about the minimum of the potential, is :

(1) $\sqrt{6}\,\text{sec}^{-1}$ (2) $\sqrt{3}\,\text{sec}^{-1}$ (3) $1/\sqrt{3}\,\text{sec}^{-1}$ (4) $1/\sqrt{6}\,\text{sec}^{-1}$

33. If A is 3×3 matrix with Tr(A) = 3, det A = 0 and one of the eigenvalue 1, the other two eigenvalues are :

(1) 2 and 0 (2) 1 and 1 (3) 0 and 1 (4) 3 and –1

34. The following vector is orthogonal to the vector $a\hat{i}+b\hat{j}$ (with $a\neq b$)

(1) $a\hat{i}-b\hat{j}$ (2) $-a\hat{i}-b\hat{j}$ (3) $-b\hat{i}+a\hat{j}$ (4) $-b\hat{i}-a\hat{j}$

35. If $\vec{r}$ is a position vector, the value of $\vec{\nabla}^2\left(\vec{r}\,.\,\vec{r}\right)=\vec{\nabla}^2\,r^2$ is equal to :

(1) 6 (2) 0 (3) 3 (4) −3

36. An a. c. voltage source (with 120 V and 60 Hz) is connected across a 2μF capacitor. The power loss in the capacitor is :

(1) 0.000 Watt (2) 10.800 Watt (3) 1.080 Watt (4) 0.972 Watt

37. A particle is described by the Lagrangian $L(x,y,\dot{x},\dot{y},t)=\frac{m}{2}e^{-\alpha t}\left(\dot{x}^2+\dot{y}^2\right)-\frac{1}{2}kx^2$ where α and k are constants. One of the following statements is correct :

(1) p_x is conserved

(2) total energy is conserved

(3) p_y is conserved

(4) L_z is conserved

38. If q_1 and q_2 are generalized coordinates and p_1 and p_2 are corresponding generalized momenta, the Poisson-bracket $\left\{q_1^2+q_2^2, 2p_1+p_2\right\}$ is equal to :

(1) 0 (2) $2(q_1+2q_2)p_1$

(3) $3\left(q_1^2+q_2^2\right)$ (4) $2(2q_1+q_2)$

39. One of the following operator is hermitian :

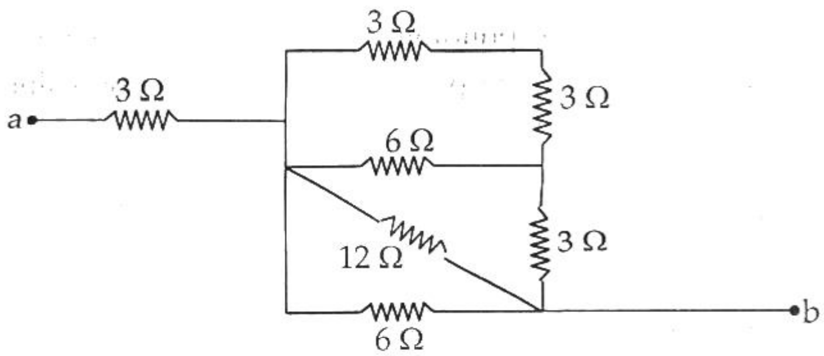
(1) $\hat{x}\,\hat{p}_x$ (2) $\left[\hat{x},\hat{p}_x^2\right]$ (3) $-i\frac{d^2}{dx^2}$ (4) $\frac{d^2}{dx^2}$

40. One of the following is ***not*** an eigen state of the parity operator ?

(1) $\cos x + x\sin x$ (2) $x(\cos x + \sin x)$

(3) $x\cos x + \sin x$ (4) $x\cos x\sin x$

41. The equivalent resistance in the following circuit between 'a' and 'b' :



is as follows :

(1) 3.53 Ω (2) 5.40 Ω (3) 0.36 Ω (4) 4.72 Ω

42. Degeneracy of the first excited state of an isolated hydrogen atom is :

(1) Two (2) Four (3) Six (4) Eight

43. The normalized ground state of a particle of mass m which is constrained to move inside a potential $V(a) = \begin{cases} 0 & -L \le x \le +L \\ \infty & \text{elsewhere} \end{cases}$

is given by :

(1) $\sqrt{\frac{2}{L}} \sin \frac{\pi x}{L}$

(2) $\sqrt{\frac{2}{L}} \cos \frac{\pi x}{L}$

(3) $\sqrt{\frac{1}{L}} \sin \frac{\pi x}{2L}$

(4) $\sqrt{\frac{1}{L}} \cos \frac{\pi x}{2L}$

44. The weak interaction violates the :

(1) Time reversal symmetry

(2) Charge conjugation symmetry

(3) Space translational symmetry

(4) Parity symmetry

45. The wave function of a particle $\psi = \frac{1}{\sqrt{2}}(\varphi_0 + i\varphi_1)$ is given in terms of the eigen states φ_0 and φ_1 corresponding to the ground state energy and the first excited state energy E_0 and E_1 respectively. The expectation value of the Hamiltonian in the state ψ is given by :

(1) $\frac{1}{2}E_0 + E_1$ (2) $\frac{E_0}{2} - E_1$ (3) $\frac{E_0 - 2E_1}{3}$ (4) $\frac{E_0 + 2E_1}{3}$

46. The energy eigenvalue corresponding to the bound state ψ_{543} (r, θ, φ) for a hydrogen like atom is :

(1) 0.544 eV (2) 5.440 eV (3) – 0.544 eV (4) –5.440 eV

47. The gauge transformation between the scalar-vector potentials $\left(\varphi, \vec{A}\right)$ and $\left(\varphi', \vec{A}'\right)$ is :

(1) $\varphi' = \varphi + \alpha x,\ \vec{A}^1 = \vec{A} + \alpha t\hat{k}$

(2) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} - \alpha t\hat{k}$

(3) $\varphi' = \varphi + \alpha x, \vec{A}^1 = \vec{A} + \alpha t\hat{i}$

(4) $\varphi' = \varphi + \alpha x,\ \vec{A}^1 = \vec{A} - \alpha t\hat{i}$

48. The electric field $\vec{E}$, corresponding to the potential, $\varphi(\vec{r}, t) = 0$, $\vec{A}(\vec{r}, t) = -\frac{1}{4\pi \epsilon_0} \frac{qt}{r^2}\hat{r}$, is given by :

(1) $\vec{E} = 0$

(2) $\vec{E} = -\frac{1}{4\pi \epsilon_0} \frac{q\hat{r}}{r^2}$

(3) $\vec{E} = \frac{1}{4\pi \epsilon_0} \frac{q\hat{r}}{r^2}$

(4) $\vec{E} = -\frac{1}{4\pi \epsilon_0} \frac{qt}{r^2}\hat{r}$

49. The quark content of a neutron is :

(1) uud (2) udd (3) uds (4) $ud\bar{s}$

50. The weakest of the four fundamental interactions of nature is :

(1) Electromagnetic (2) Strong

(3) Gravitation (4) Weak

51. The degrees of freedom, when the FCC and BCC irons co-exist together in equilibrium, is :

(1) Two (2) (2) One (1) (3) Zero (0) (4) Minus one (–1)

52. For the same diffusion time, the depth of penetration at 500°C and 850°C is in the ratio 1 : 6. The activation energy for the above diffusion process is :

(1) 57 KJ $mole^{-1}$ (2) 37 KJ $mole^{-1}$ (3) 144 KJ $mole^{-1}$ (4) 74 KJ $mole^{-1}$

53. The maximum possible decrease in energy during the grain-growth of copper, where the grain boundary energy is 0.5 $J m^{-2}$ and the initial grain-diameter is 0.3 mm, is as follows :

(1) 0.5 $KJ m^{-3}$ (2) 2.5 $KJ m^{-3}$ (3) 5.0 $KJ m^{-3}$ (4) 10.0 $KJ m^{-3}$

54. If the enthalpy of motion of a vacancy, at temperature 25°C, is 100 KJ $mole^{-1}$, the time taken by a vacancy to jump to an adjacent site, is :

(1) 3×10^{17} sec (2) 2×10^{26} sec (3) 3×10^{3} sec (4) 3×10^{4} sec

55. For a spherical FCC crystal of radius r, the volume-to-surface ratio is given by :

(1) $\frac{3}{r}$ (2) $r/3$ (3) $3r$ (4) $\frac{\pi r}{3}$

56. If the interfacial energy increases by 10%, the homogeneous nucleation barrier for a spherical particle increases by :

(1) 10% (2) 21% (3) 33% (4) 100%

57. The method to increase the yield strength of a crystalline material is :

(1) Grain refinement

(2) Annealing in the air

(3) Cold working

(4) By increasing inter-precipitate spacing

58. If the activation energy for oxidation is 100 KJ mole^{-1}, the ratio of oxidation rates at 800°C and 500°C is given by :

(1) 8270 (2) 78 (3) 10 (4) 312

59. The switching time for a Josephson junction is of the order of magnitude :

(1) 10^{-2} m sec (2) 10^{-2} n sec (3) 10 μ sec (4) 5 μ sec

60. The degeneracy of the quantum state, with , $n_x^2 + n_y^2 + n_z^2 = 6$,is :

(1) 8 (eight) (2) 12 (twelve)

(3) 48 (forty eight) (4) 24 (twenty four)

61. In the expression for bonding force $F(r) = \frac{A}{r^m} - \frac{B}{r^n}$ [$n > m$, (A, B) = constant] if n takes the value between 7 and 10, the bonding is called as :

(1) Ionic (2) Covalent (3) Metallic (4) Dipole

62. If copper has bond energy of 56 KJ (mole)$^{-1}$, the enthalpy of the atomization of copper in the same unit is approximately :

(1) 56 (2) 112 (3) 336 (4) 672

63. A unit cell has a = 5Å, b = 8Å, c = 3Å, $\alpha = 90°$, $\beta = 65°$, $\gamma = 54°$. The space lattice for this unit cell is :

(1) Orthorhombic (2) Monoclinic

(3) Rhombohedral (4) Triclinic

64. The Miller indices of the line of intersection of a $(1\bar{1}1)$ and a $(1\bar{1}0)$ planes are :

(1) $[1\bar{1}0]$ (2) [2 1 0] (3) $[\bar{1}\,\bar{1}0]$ (4) $[1\bar{1}1]$

65. The t-vector is parallel to the b-vector in the dislocation of the type :

(1) Screw (2) Edge (3) Mixed (4) Frenkel defect

66. Assuming the ideal C/a ratio for the $HCP\ Ti$ (with a = 2.95Å), the radius of the largest sphere that will fit interstitially in Ti; is :

(1) 0.53 Å (2) 0.66 Å (3) 0.61 Å (4) 0.96 Å

67. The Fermi level (E_F) depends on the length L of the linear solid as :

(1) $\frac{1}{L^2}$

(2) $\frac{1}{L^3}$

(3) $\frac{1}{L}$

(4) Independent of L

68. The first measured T_C in a ceramic superconductor by Bednorz and Mueller was :

(1) 04 K (2) 23 K (3) 34 K (4) 90 K

69. If the Fermi energy of silver is 5.5 eV, the wave number of the fastest electron at 0°K has the magnitude in $(\text{meter})^{-1}$ as :

(1) 0.85×10^{10} (2) 7.54×10^{10} (3) 1.20×10^{10} (4) 0.19×10^{10}

70. A cobalt k_α radiation of wavelength 1.79Å is used in a camera of radius 57.3 mm. The first S-value on the powder pattern of an FCC crystal (a = 4.05 Å), taken with this camera, is :

(1) 45 mm (2) 51 mm (3) 75 mm (4) 90 mm

71. The physical phenomenon, generated due to the transfer of momentum, is :

(1) Thermal conductivity

(2) Viscosity

(3) Diffusion

(4) Elasticity

72. The liquification of helium is possible :

(1) At ordinary temperature
(2) Below – 268°C
(3) At – 196°C
(4) Below – 83°C

73. Internal energy of a system changes in :

(1) Isothermal change
(2) Adiabatic change
(3) Free expansion
(4) Cyclic process

74. According to celebrated Clausius theorem :

(1) $\oint \frac{dQ}{T} > 0$
(2) $\oint \frac{dQ}{T} < 0$
(3) $\oint \frac{dQ}{T} =$ non-zero constant
(4) $\oint \frac{dQ}{T} = 0$

75. For a perfectly black-body, the absorption power is :

(1) One
(2) More than one
(3) Less than one
(4) Zero

76. Wien's displacement law is :

(1) $\lambda T =$ constant
(2) $\frac{1}{3}\frac{\lambda}{T} =$ constant
(3) $\frac{\lambda}{TV} =$ constant
(4) $\frac{\lambda T}{V} =$ constant

77. A Carnot engine works between ico temperature (0°C) and the steam temperature (100°C). Its efficiency is :

(1) 36.6%
(2) 37.8%
(3) 26.8%
(4) 73.2%

78. Clausius-Clapeyron equation is :

(1) $\frac{dP}{T} = L(V_2 - V_1)$

(2) $\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$

(3) $dT = \frac{L}{T}(V_2 - V_1)\,dp$

(4) $\frac{dP}{dT} = \frac{T}{L(V_2 - V_1)}$

79. The number of allowed modes per unit volume in the wavelength range λ and $\lambda + d\lambda$ is :

(1) $\frac{8\pi}{\lambda^4} d\lambda$

(2) $\frac{8\pi\lambda^2}{C^3} d\lambda$ (C = speed of light)

(3) $\frac{4\pi\lambda^2}{C^3} d\lambda$ (C = speed of light)

(4) $\frac{4\pi}{\lambda^4} d\lambda$

80. The critical temperature of a Vander Waals gas is :

(1) $3b$

(2) $\frac{8a}{27Rb}$ (a & b = Vander Walls parameters, R = Gas constant)

(3) $\frac{8a}{27b}$

(4) $\frac{a}{27b^2}$

81. A body is moving uniformly on a circular path with speed v. The magnitude of the change in its velocity when it has swept an angle θ, is :

(1) $2v \sin \theta/2$

(2) $2v \sin \theta$

(3) $2v \cos \theta$

(4) $2v \cos \theta/2$

82. A particle is moving with 90% of the speed of light. The ratio of its relativistic mass with its rest mass is approximately :

(1) 2.3 (2) 3.0 (3) 5.0 (4) 2.0

83. The ratio $\left(\frac{\partial V}{\partial T}\right)_P$ is negative for :

(1) Water at 10°C
(2) Ice at 0°C
(3) Water between 0°C and 4°C
(4) Water at 100°C

84. The hydrogen gas ejecting away from a porus plug at 300 K shows :

(1) Cooling effect
(2) Heating effect
(3) Sometimes cooling sometimes heating
(4) Coating effect

85. A Gaussian surface encloses no charge only one of the following is true for a point inside it :

(1) Electric field must be zero
(2) Electric potential must be zero
(3) Electric field and potential are zero
(4) Electric flux is zero

86. Extremely low temperature can be produced by one of the following :

(1) Adiabatic demagnetization of paramagnetic salt
(2) Adiabatic magnetization of paramagnetic salt
(3) Isothermal magnetization of diamagnetic salt
(4) Isothermal demagnetization of diamagnetic salt

87. An electromagnetic wave, going through vacuum, is described by $E = E_0 \sin(kx - wt)$, $B = B_0 \sin(kx - wt)$.

One of the following is true ?

(1) $E_0 k = B_0 w$ (2) $E_0 B_0 = w\ k$

(3) $E_0 w = B_0 k$ (4) $E_0 B_0 = fk$ $(w = 2\ \pi f)$

88. The dielectric constant of a material at optical frequencies is mainly due to :

(1) Ionic polarizability

(2) Electric polarizability

(3) Dipolar polarizability

(4) Ionic and dipolar polarizabilities

89. A clock moves away from an observer with a uniform velocity. This clock would seem to lose 1 minute per day if it moves with the velocity :

(1) 1.12×10^7 m/sec

(2) 2.24×10^7 m/sec

(3) 12.24×10^7 m/sec

(4) 1.12×10^6 m/sec

90. A beam of metal, supported at the two ends, is loaded at the centre. The depression, in terms of the Young modulus (Y), at the centre is proportional to :

(1) Y^2 (2) Y (3) $\frac{1}{Y}$ (4) $\frac{1}{Y^2}$

91. Mean free path of the molecules of a gas at pressure P and temperature T is 2 μm. if the pressure and temperature are doubled, the mean free path of the molecules would be :

(1) 2×10^{-6} m (2) 2×10^{-6} cm (3) 12×10^{-5} m (4) 20×10^{-6} m

92. If the radius of a spherically symmetric black-body radiation enclosure becomes 1/4th of the original, the temperature will become (assuming adiabetic process)

(1) Four times (2) Eight times (3) Doubled (4) Sixteen times

93. The Maxwell equation that remains unchanged when the medium is changed, is as follows :

(1) $\vec{\nabla} . \vec{E} = \rho / \epsilon_0$

(2) $\vec{\nabla} . \vec{B} = 0$

(3) $\vec{\nabla} \times \vec{E} = -\frac{1}{C^2} \frac{\partial \vec{E}}{\partial t}$

(4) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$

94. If a plane EM wave propagating in space has an electric field of amplitude 9×10^3 V/m, the amplitude of magnetic field is :

(1) 2.7×10^{12} Tesla

(2) 9.0×10^{-3} Tesla

(3) 13.0×10^{-4} Tesla

(4) 3.0×10^{-5} Tesla

95. For a transmission line with homogeneous dielectric, the capacitance per unit length is C, relative permitivity of dielectric is ϵ_r, and velocity of light in free space is v. The characteristic impedance Z_0 is equal to :

(1) $\frac{\epsilon_r}{vC}$ (2) $\frac{\epsilon_r}{\sqrt{vC}}$ (3) $\frac{\sqrt{\epsilon_r}}{V_C}$ (4) $\sqrt{\frac{\epsilon_r}{vC}}$

96. One of the following is a doubly magic nucleus ?

(1) ${}^{14}_{7}N_7$ (2) ${}^{17}_{8}O_9$ (3) ${}^{208}_{82}Pb_{126}$ (4) ${}^{209}_{82}Pb_{127}$

97. The life time of a free neutron to decay into a proton, an electron and an antineutrino is approximately :

(1) 10^{-23} sec (2) 10^{-20} sec (3) 10^{-8} sec (4) 10^{3} sec

P.T.O.

98. The process $K^0 \rightarrow \pi^+\pi^-$ is governed by the weak interaction. It is an example of a :

(1) Non-leptonic decay

(2) Leptonic decay

(3) Semi-leptonic decay

(4) Leptonic as well as semi-leptonic decay

99. The typical radius (R) of a nucleus varies with its mass number as :

(1) $R \sim A^{1/5}$ (2) $R \sim A^{1/3}$ (3) $R \sim A^{1/4}$ (4) $R \sim A^{1/6}$

100. Two nuclei an said to be isobars :

(1) If their mass number is same

(2) If their atomic number is same

(3) If their neutron number is same

(4) If their mass number and atomic number are same

101. The de Broglie wavelength of an electron, accelerated through a potential of 150 volts, is approximately :

(1) 1.004 Å (2) 2.004 Å (3) 3.004 Å (4) 4.004 Å

102. Typical *life* time of the strong interaction in the realm of nuclear reactions is :

(1) 10^{-8} sec (2) 10^{-10} sec (3) 10^{-20} sec (4) 10^{-23} sec

103. If H is a Hermitian matrix, then e^{iH} is one of the following :

(1) Hermitian matrix (2) Unitary matrix

(3) Orthogonal matrix (4) Null matrix

104. If A is a skew-symmetric matrix and R is its rank, then :

(1) $R = 1$ (2) $R \leq 1$ (3) $R > 1$ (4) $R \geq 1$

105. If I and O are (2 × 2) identity and null matrices in $I + pA + qA^2 = 0$ then, p and q values for the matrix $A = \begin{pmatrix} 1 & 2 \\ -2 & 1 \end{pmatrix}$ are one of the following :

(1) $p = \frac{2}{5}, q = \frac{1}{5}$ (2) $p = -\frac{2}{5}, q = \frac{1}{5}$

(3) $p = \frac{2}{5}, q = -\frac{1}{5}$ (4) $p = -\frac{2}{5}, q = -\frac{1}{5}$

106. The value of the Legendre polynomial $P_n(x)$ for n = 3, is :

(1) $\left(\frac{5x^3 + 3x}{2}\right)$ (2) $\left(\frac{5x^3 + 3x}{1}\right)$ (3) $\left(\frac{5x^3 - 3x}{2}\right)$ (4) $\left(\frac{5x^3 - 3x}{1}\right)$

107. If A_μ and B^ν are covariant and contravariant tensors of rank 1, then $(A_\mu B^\nu)$ corresponds to :

(1) Contravariant tensor of rank one

(2) Covariant tensor of rank one

(3) Mixed tensor of rank one

(4) Mixed tensor of rank two

108. One of the following recurrence relations is correct for the Hermite polynomial $H_n(x)$:

(1) $H_n'(x) = 2(n+1)H_{n+1}(x)$ (2) $H_n'(x) = 2(n-1)H_{n-1}(x)$

(3) $H_n'(x) = 2nH_{n+1}(x)$ (4) $H_n'(x) = 2nH_{n-1}(x)$

P.T.O.

109. The value of the Bessel functions $[J_{1/2}(x)]^2 + [J_{-1/2}(x)]^2$ is one of the following :

(1) $\frac{2}{\pi x}$ (2) $\frac{\pi x}{2}$ (3) $\sqrt{\frac{2}{\pi x}}$ (4) $\sqrt{\frac{\pi x}{2}}$

110. The generating functional for the Bessel function is :

(1) $e^{x(z+z^{-1})} = \sum_{n=-\infty}^{+\infty} J_n(x)z^n$

(2) $e^{x(z-z^{-1})} = \sum_{n=-\infty}^{+\infty} J_n(x)z^n$

(3) $e^{\frac{x(z+z^{-1})}{2}} = \sum_{n=-\infty}^{+\infty} J_n(x)z^n$

(4) $e^{\frac{x(z-z^{-1})}{2}} = \sum_{n=-\infty}^{+\infty} J_n(x)z^n$

111. One of the following is true :

(1) $\frac{d}{dx}[x^n J_n(x)] = x^{n-1} J_{n-1}(x)$

(2) $\frac{d}{dx}[x^n J_n(x)] = x^{n+1} J_{n-1}(x)$

(3) $\frac{d}{dx}[x^n J_n(x)] = x^n J_{n+1}(x)$

(4) $\frac{d}{dx}[x^n J_n(x)] = x^n J_{n-1}(x)$

112. In the Bessel equation $x^2 \frac{d^2y}{dx^2} + (x^2 - n^2)y + x\frac{dy}{dx} = 0$:

(1) $x = 1$ is a regular singular point

(2) $x = 1$ is an irregular singular point

(3) $x = 0$ is a regular singular point

(4) $x = 0$ is an irregular singular point

113. The eigenvectors of the matrix $A = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$ are as follows :

(1) $\begin{pmatrix} 1 \\ i \end{pmatrix}$ and $\begin{pmatrix} 1 \\ -i \end{pmatrix}$

(2) $\begin{pmatrix} 1 \\ i \end{pmatrix}$ and $\begin{pmatrix} -1 \\ i \end{pmatrix}$

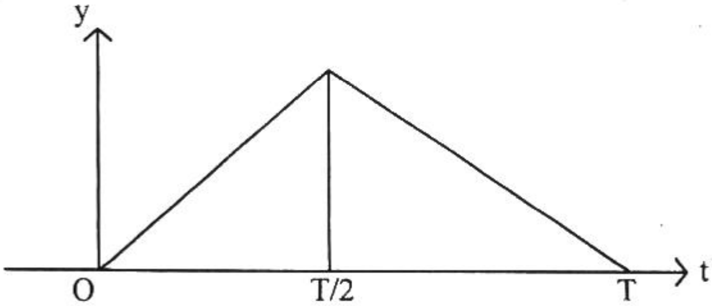
(3) $\begin{pmatrix} i \\ 1 \end{pmatrix}$ and $\begin{pmatrix} -i \\ 1 \end{pmatrix}$

(4) $\begin{pmatrix} i \\ 1 \end{pmatrix}$ and $\begin{pmatrix} i \\ -1 \end{pmatrix}$

114. The first term in the Fourier series of $f(x) = \frac{(\pi - x)^2}{4}$, in the range $(-\pi < x < \pi)$, is :

(1) $\frac{\pi}{12}$ (2) $\frac{\pi^2}{6}$ (3) $\frac{\pi}{6}$ (4) $\frac{\pi^2}{12}$

115. Consider the following triangular periodic wave of period T.



The first term in the Fourier series of this triangular periodic wave is :

(1) a (2) $a/2$ (3) $-a$ (4) $-a/2$

116. The Wronskian $W(y_1, y_2)$ for the two solutions $y_1(x)$ and $y_2(x)$ of the second order differential equation is :

(1) $W = y_1 y_2' - y_2 y_1' \left(y_1' = \frac{dy_1}{dx} \right)$

(2) $W = y_1 y_2' + y_2 y_1' \left(y_2' = \frac{dy_2}{dx} \right)$

(3) $W = y_1 y_2' - y_1' y_2'$

(4) $W = y_1 y_2' + y_1' y_2'$

117. The difference $\left(x\frac{\partial}{\partial y} - y\frac{\partial}{\partial x} \right)$ can be expressed in terms of the polar coordinates (r, θ, φ) as :

(1) $\frac{\partial}{\partial r}$ (2) $\frac{\partial}{\partial \theta}$ (3) $\frac{\partial}{\partial \varphi}$ (4) $\frac{\partial}{\partial \varphi} + \frac{\partial}{\partial \theta}$

118. The square of the orbital angular momentum operator $\vec{L} = -1\left(\vec{r} \times \vec{\nabla}\right)$ can be expressed as :

(1) $|\vec{L}|^2 = -r^2 \vec{\nabla}^2 + \frac{\partial}{\partial r}\left(r^2 \frac{\partial}{\partial r}\right)$

(2) $|\vec{L}|^2 = r^2 \vec{\nabla}^2 - \frac{\partial}{\partial r}\left(r^2 \frac{\partial}{\partial r}\right)$

(3) $|\vec{L}|^2 = -r^2 \vec{\nabla}^2 - \frac{\partial}{\partial r}\left(r^2 \frac{\partial}{\partial r}\right)$

(4) $|\vec{L}|^2 = r^2 \vec{\nabla}^2 + \frac{\partial}{\partial r}\left(r^2 \frac{\partial}{\partial r}\right)$

119. One of the following functions form an orthonormal set for the Languerre polynomial $(L_n(x))$:

(1) $e^{-x} L_n(x) \;\; 0 \le x \le \infty$

(2) $e^{-x/2} L_n(x) \;\; 0 \le x \le \infty$

(3) $e^{-x} L_n(x), \; -\infty \le x \le +\infty$

(4) $e^{-x/2} L_n(x) \;\; -\infty \le x \le +\infty$

120. The orthonormality relation of the Hermite polynomials is :

(1) $\int_{-\infty}^{+\infty} e^{-x^2} H_n(x) H_m(x)\, dx = \frac{n!}{2^n} \sqrt{\pi}\, \delta_{nm}$

(2) $\int_{-\infty}^{+\infty} e^{-x^2} H_n(x) H_m(x)\, dx = \frac{n!}{2^n \sqrt{\pi}}\, \delta_{nm}$

(3) $\int_{-\infty}^{+\infty} e^{-x^2} H_n(x) H_m(x)\, dx = \frac{\sqrt{\pi}}{2^n n!}\, \delta_{nm}$

(4) $\int_{-\infty}^{+\infty} e^{-x^2} H_n(x) H_m(x)\, dx = 2^n n! \sqrt{\pi}\, \delta_{nm}$

121. Two coherent sources, whose intensity ratio is 25 : 16, produce interference fringes. The ratio of the maximum and minimum intensities of the fringe system will be :

(1) 25 : 1 (2) 25 : 16 (3) 5 : 4 (4) 81 : 1

122. Two independent light sources can not produces interference pattern because :

(1) their phase difference can not be constant

(2) their frequencies can not be the same

(3) their amplitudes can not be the same

(4) their phase difference may be constant but amplitudes can not be the same

123. In the Lloyd mirror experiment, the central fringe is :

(1) Dark (2) Bright (3) Coloured (4) Not formed

124. Resolving power of the Febery Perrot interferometer is :

(1) Smaller than the Michelson interferometer

(2) Larger than the Michelson interferometer

(3) Equal to the Michelson interferometer

(4) Double of the Michelson interferometer

125. If the outer orbit of an atom contains two electrons, the possible multiplicity would be :

(1) 1, 3 (2) 1 (3) 3 (4) 0

126. The selection rules for an atomic transition is :

(1) $\Delta J = 0, \pm 1$ (2) $\Delta J = 0$ (3) $\Delta J = \pm 1$ (4) $\Delta J = 0, \pm 1, \pm 2$

127. For the hydrogen like atoms, the ground state configuration is :

(1) $^2S_{1/2}$ (2) $^2P_{1/2}$ (3) $^2S_0$ (4) $^2S_{3/2}$

128. For an electron with the quantum number l = 2, the possible values of j are :

(1) 3/2, 3/2 (2) 5/2, 3/2

(3) 5/2, 3/2, 1/2 (4) 3/2, 1/2

129. Uhlenbeck and Gondsmit introduced the concept of :

(1) Electron spin (2) Electron charge

(3) Proton spin (4) Neutron spin

130. Optical pumping is not suitable for the gas laser because, in this laser, the active atoms have :

(1) Broad energy levels

(2) Sharp energy levels

(3) Large number of Stark components

(4) Large number of Zeeman components

131. In a He-Ne laser, the key factor in the process of population inversion is :

(1) The energy transfer from He to Ne

(2) The energy transfer from Ne to He

(3) The metastable state of Ne

(4) The collision of electron with the wall

132. In a Frank-Herz experiment, one plots a graph between grid potential and plate current. The observed deep in this curve is due to :

(1) Inelastic collision of the e^- with atom

(2) Elastic collision of the e^- with atom

(3) Inelastic collision between atoms

(4) Elastic collision between atoms

133. An unpolarized light of intensity I_0 passes through a Nicole prism, the intensity of the emergent light will be :

(1) I_0 (2) $I_0/3$ (3) $I_0/2$ (4) $I_0/4$

134. An unpolarized light passes through a doubly refracting calcite crystal. If μ_0 and μ_e are the refractive indices of the crystal for the ordinary and extra-ordinary rays, then :

(1) $\mu_0 > \mu_e$ (2) $\mu_e > \mu_0$ (3) $\mu_e = \mu_0$ (4) $\mu_e = 2\mu_0$

135. A plane polarized light falls normally on a quarter wave plate whose electric vector is at an angle of 30° from the optic axis. The emergent beam will be :

(1) Unpolarized

(2) Plane polarized

(3) Circularly polarized

(4) Elliptically polarized

136. In the Newton ring experiment, the fringes are circular because they are formed due to :

(1) Equal thickness of the air film

(2) Varying thickness of the air film

(3) Diffraction

(4) Reflection between the upper and lower surface of the plane convex lens

137. A zone plate has focal length 1 m for λ = 6000Å. The radius of the first transparent zone will be :

(1) 0.077 cm (2) 0.062 cm (3) 0.200 cm (4) 0.300 cm

138. If the number of lines in a grating is increased, its resolving power would :

(1) increase

(2) decrease

(3) remains constant

(4) first increase and later on decrease

139. The reason behind the missing orders in a double slit Fraunhoffer diffraction pattern is :

(1) overlapping of the interference minima with the diffraction maxima

(2) overlapping of the interference maxima with the diffraction minima

(3) overlapping of the interference maxima and minima

(4) overlapping of the diffraction maxima and minima

140. In the Compton scattering, there is an :

(1) inelastic collision of a photon with a free e^-

(2) inelastic collision of a photon with a proton

(3) inelastic collision of a photon with a neutron

(4) inelastic collision of a photon with a bound electron of an atom

141. An elementary particle that experiences only the weak interaction of nature is :

(1) Neutron (2) Proton (3) Electron (4) Neutrino

142. An elementary particle that participate only in the strong interaction is a :

(1) Quart (2) Gluon (3) Meson (4) Baryon

143. A pure Fermi-transition in the nuclear β-decay is the one where :

(1) $\Delta J = \pm 1,\ O^+ \to O^+$
(2) $\Delta J = 0,\ O^+ \to O^+$
(3) $\Delta J = \pm 2,\ O^+ \to O^+$
(4) $\Delta J > 3,\ O^+ \to O^+$

144. Hadrons are the particles which are called as baryons, mesons, hypsons, etc. Their characteristic feature is :

(1) they always experience electromagnetic interaction

(2) they always experience weak interaction

(3) they always experience strong interaction

(4) they always experience electromagnetic, weak and strong interaction

145. A photon, which is the quantum of light radiation, coming out from a source :

(1) is always a relativistic particle in the free space

(2) can be made non-relativistic in the free space

(3) can be made relativistic as well as non-relativistic in the free space

(4) can be made stationary in the free space

146. The number of quarks in a typical meson is always :

(1) Three (2) Two (3) Four (4) Five

147. The following nuclear β-decay $\underset{0^+}{\overset{6}{He}} \to \underset{1^+}{\overset{6}{Li}} + e^- + \bar{\nu}, |\Delta J| = 1$ is an explicit example of the :

(1) Forbidden transition

(2) Mixed transition

(3) Pure Fermi transition

(4) Pure Gamow-Teller transition

148. Geiger's law for the "Range Energy" relationship for the α-particle is well known. Infact, the range R and velocity v of the α-particle are related by :

(1) $R \alpha v^5$ (2) $R \alpha v^4$ (3) $R \alpha v^3$ (4) $R \alpha v^2$

149. The typical energy of a γ-ray is :

(1) Approximately in the range KeV

(2) Approximately in the range MeV

(3) Approximately in the range GeV

(4) Approximately in the range eV

150. A radioactive substances has a half life period of 30 days. The time taken, for 3/4 of the original number of atoms to disintegrate, is :

(1) 100 days (2) 80 days (3) 120 days (4) 60 days

अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण-पृष्ठ पर तथा ओ०एम०आर० उत्तर-पत्र के दोनों पृष्ठों पर केवल ***नीली/काली बाल-प्वाइंट पेन*** से ही लिखें)

1. प्रश्न पुस्तिका मिलने के 30 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।
2. परीक्षा भवन में *लिफाफा रहित प्रवेश-पत्र के अतिरिक्त,* लिखा या सादा कोई भी खुला कागज साथ में न लायें।
3. उत्तर-पत्र अलग से दिया गया है। ***इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा। केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।***
4. अपना *अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ* ***पर पेन से*** निर्धारित स्थान पर लिखें।
5. ***उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।***
6. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न-पुस्तिका पर अनुक्रमांक संख्या और ओ० एम० आर० पत्र संख्या की प्रविष्टियों में उपरिलेखन की *अनुमति नहीं है।*
7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।
8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। ***प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार बाल-प्वाइंट पेन से गाढ़ा करना है।***
9. प्रत्येक प्रश्न के उत्तर के लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. ***ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है।*** यदि आप किसी प्रश्न का ***उत्तर नहीं देना चाहते हैं,*** तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर **शून्य** अंक दिये जायेंगे।
11. रफ कार्य के लिये इस पुस्तिका के मुखपृष्ठ के अंदर वाला पृष्ठ तथा अंतिम खाली पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त ***केवल ओ० एम० आर० उत्तर-पत्र*** ही परीक्षा भवन में जमा करें।
13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।
14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित दंड का/की भागी होगा/होगी।