Msc - Physics - II

Set No. 2 **Question Booklet No.** C(481)

14P/218/4(ii)

(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 .....

.....

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 **Answer Sheet**)

1. Within 10 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 prvided 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 Roll No. and OMR sheet no. on the Question Booklet.***
7. ***Any change 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 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 **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.

Total No. of Printed Pages : 32 *[उपर्युक्त निर्देश हिन्दी में आवरण पृष्ठ पर दिये गए हैं]*

ROUGH WORK
रफ़ कार्य

14P/218/4(ii)

No. of Questions : 150

प्रश्नों की संख्या : 150

Time : $2\frac{1}{2}$ Hours ***Full Marks : 450***

समय : $2\frac{1}{2}$ घण्टे ***पूर्णांक : 450***

Note : (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.
अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न **3** (तीन) अंकों का है। *प्रत्येक गलत उत्तर के लिए एक अंक काटा जायेगा।* प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक *शून्य* होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.
यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

01. What is the half life of $^{238}_{92}U$ if $1\,\mu c_i$ of radioactivity requires approximately 7.58×10^{21} no. of ^{238}U nuclei ?

(1) 4.5×10^{6} 1/r (2) 4.5×10^{12} 1/r

(3) 4.5×10^{15} 1/r (4) 4.5×10^{9} 1/r

02. The difference in coulomb energy for nuclei with Z + 1 and Z protons is given by :

(1) $\frac{1}{4\pi\epsilon_o}\cdot\frac{3}{5}\frac{Ze^2}{R}$ (2) $\frac{1}{4\pi\epsilon_o}\frac{6}{5}\frac{Ze^2}{R}$

(3) $\frac{1}{4\pi\epsilon_o}\frac{2}{5}\frac{Ze^2}{R}$ (4) $\frac{1}{4\pi\epsilon_o}\frac{4}{5}\frac{Ze^2}{R}$

03. The H.O. frequency for $^{16}_{8}O$ nucleus is approximately how much times of H.O. frequency for $^{125}_{56}Ba$ nucleus ?

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

04. Interaction cross section of the neutrons with the nucleus, if the mean free path of the neutrons in nuclear matter is about 10^4m, is :

(1) 10^{-48} cm^2 (2) 10^{-48} m^2

(3) 10^{-34} cm^2 (4) 10^{-34} m^2

05. Ground state spin and parity of $^{33}_{16}S$ is :

(1) $\frac{3}{2}$; even (2) $\frac{3}{2}$; odd (3) $\frac{1}{2}$; even (4) $\frac{1}{2}$; odd

06. The primary source of energy released from sun is due to :

(1) nuclear fission (2) nuclear fusion

(3) chemical reactions (4) decay of radioactive atoms

07. Which of the following is **not** true about α–rays ?

(1) great ionizing power but low penetration power

(2) low ionizing power but high penetration power

(3) positively charged He-nuclei

(4) deflected by electric and magnetic fields

08. Nucleus volume is :

(1) proportional to mass number

(2) independent of mass number

(3) inversely proportional to mass number

(4) inversely proportional to square of mass number

09. A nuclear reactor is called sub-critical if :

(1) neutron production exceeds loss

(2) neutron loss exceeds production

(3) neutron production stops

(4) fissile materials is insufficient

10. Complete the fusion reaction : (D = deutrium) $D + {}^{3}_{2}He \rightarrow {}^{4}_{2}He + ...$

(1) `p (2) n (3) 2p (4) 3n

11. Binding energy per nucleon is a measure of :

(1) size of nucleus

(2) shape of nucleus

(3) angular momentum of nucleus

(4) stability of nucleus

12. By capturing an electron, ${}^{54}_{25}M_n$ transforms into :

(1) ${}^{54}_{24}Cr$ (2) ${}^{53}_{24}Cr$ (3) ${}^{53}_{25}Cr$ (4) ${}^{55}_{25}Cr$

13. The surface energy term in liquid drop model is proportional to :

(1) A (2) $A^{2/3}$ (3) $A^{1/3}$ (4) $A^{3/4}$

14. Which of the following is **true** about nuclear forces ?

(1) short range and spin dependent
(2) short range and spin independent
(3) long range and spin dependent
(4) long range and spin independent

15. Which of the following is **not** used as a moderator in a nuclear reactor ?

(1) Zn (2) C (3) D_2O (4) H_2O

16. Binding energy of $^{238}_{92}U$ nucleus is approximately : ($^{1}_{1}H$ = 1.0078 amu, m_n = 1.0087 amu, m_U = 238.0508 amu, amu = 931.64 Meu) :

(1) 100 MeV (2) 300 MeV
(3) 932 MeV (4) 1800 MeV

17. Rate of radioactive decay is proportional to :

(1) decay time (2) no. of atoms
(3) density of atoms (4) length of sample

18. The average life time of a nucleus is related with decay constant, λ as :

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

19. One curie is defined as :

(1) one decay per second (2) 10^6 decays per second
(3) 3.7×10^9 decays per second (4) 3.7×10^{16} decays per second

20. Complete the following nuclear reactions involving bombardment of α-particles ${}^{14}_{7}N + \alpha = {}^{1}_{1}H + ...$

(1) ${}^{16}_{8}O$ (2) ${}^{17}_{8}O$ (3) ${}^{16}_{7}N$ (4) ${}^{15}_{7}N$

21. ${}^{238}_{92}U$ nucleus decay involves 8 α-decays and 6 β-decays. The end product of the series have :

(1) Z = 82 A = 206 (2) Z = 84 A = 224

(3) Z = 88 A = 206 (4) Z = 84 A = 212

22. Which of the following is **true** about β-decay ?

(1) takes place by strong interactions

(2) is always followed by γ-emissions

(3) a neutron in the nucleus is converted into a proton

(4) a proton in the nucleus is converted into a neutron.

23. According to Hall effect if a conducting materials is placed in a uniform magnetic field and a current is passed, voltage is found to develop at :

(1) parallel to the current

(2) parallel to the magnetic field

(3) perpendicular to the magnetic field and current

(4) 45 degress to the magnetic field and current

24. According to Mosle's law the frequency of the characteristic X-radiation is proportional to the square of :

(1) atomic weight of the element

(2) atomic number of the element

(3) number of neutrons

(4) square of atomic number

25. Because of which property of the crystal X-rays can be diffracted from crystals :

(1) random arrangement of atoms

(2) colour of the crystals

(3) periodic array of atom

(4) transparency of crystals

26. FCC lattice is the reciprocal lattice of the :

(1) BCC lattice

(2) SC lattice

(3) HCP lattice

(4) both of the BCC and SC lattice

27. Mobility of holes as compared to mobility of electrons in intrinsic semiconductors is :

(1) equal (2) greater

(3) less (4) cannot be defined

28. The electronic specific heats in metals are given by : (R is gas constant, k-boltzmann constant) :

(1) $\frac{kT}{Eo}$ (2) $\frac{R}{Eo}kT$ (3) $\frac{Eo}{R}kT$ (4) $\frac{3\,Eo}{R}kT$

29. In one-dimensional periodic chain of atom with lattice parameter 'a' has first brillouin zone at :

(1) a (2) 2a (3) π/a (4) $2\pi/a$

30. What are example of piezo electric materials ?

(1) Rochelle salt (2) lead zirconate

(3) potassium niobate (4) barium titanate

31. Fermi energy level for intrinsic semiconductor lies :

(1) at the middle of the band gap
(2) close to the conduction band
(3) close to valence band
(4) inside valence band

32. Flow of electron is affected by which of the following :

(1) thermal vibration only
(2) impunity atom only
(3) crystal defects only
(4) by all of (1), (2) and (3)

33. Energy band gap size for semiconductors is in the range :

(1) 1-2 eV
(2) 2-3 eV
(3) 3-4 eV
(4) greater than 4 eV

34. Electrical conductivity of insulators is in the range :

(1) 10^{-10} $(\Omega\text{-mm})^{-1}$
(2) 10^{-10} $(\Omega\text{-cm})^{-1}$
(3) 10^{-10} $(\Omega\text{-m})^{-1}$
(4) 10^{-8} $(\Omega\text{-m})^{-1}$

35. Characteristic X-rays are the characteristic of which of the following :

(1) Cathode materials
(2) Anode materials
(3) Accelerating voltage
(4) Tube current

36. X-ray diffraction can be applied to :

(1) liquids only
(2) solid, crystalline materials only
(3) all liquids, solids and crystalline materials
(4) gaseous or vapour materials only

37. The amplitude of scattering of X-rays scattered by a single atom is generally denoted as :

(1) Structure factor
(2) Polarization factor
(3) Form factor
(4) Fractional coordination

38. During X-ray emission if the voltage is increased :
   (1) minimum wavelength decreases
   (2) minimum wavelength increases
   (3) intensity increases
   (4) intensity decreases

39. For a given cubic crystal lattice parameter a is 3.18 A°. The d spacing for a (III) plane is :
   (1) 2.25 Å (2) 1.84 Å (3) 3.18 Å (4) 3.90 Å

40. In the X-ray diffraction of a set of crystal planes having d equal to 0.18 nm, first order reflection is found to be at an angle of 22°. The wavelength of X-ray is : (sin 22° = 0.208) :
   (1) 0.0749 nm (2) 0.0374 nm
   (3) 0.749 nm (4) 0.374 nm

41. A compound formed by elements A and B crystallizes in cubic structure, in which atoms of A are at the corners while that of B are at the face centre. The formula of the compound is :
   (1) AB_3 (2) AB (3) AB_6 (4) A_2B

42. In X-ray diffraction studies, X-rays are scattered by :
   (1) Nucleus (2) Protons only
   (3) Neutrons only (4) Electrons only

43. In diamond the coordination number of carbon is :
   (1) 4 and its unit cell has 8 carbon atoms
   (2) 4 and its unit cell has 6 carbon atoms
   (3) 6 and its unit cell has 4 carbon atoms
   (4) 4 and its unit cell has 4 carbon atoms

44. ABABA ..... represents an arrangement of layers called :

(1) hexagonal closed packing (2) cubic closed packing

(3) body centered cubic packing (4) flourite close packing

45. For boron (B) and fluorine (F) atoms, which of the following statements is **true** ?

(1) B and F have normal doublet terms

(2) B and F have inverted doublet terms

(3) B has normal and F has inverted doublet terms

(4) B has inverted and F has normal doublet terms

46. In a weak magnetic field the number of lines for the transition $^1D_2 \rightarrow {}^1P_1$ is :

(1) 9 (2) 6 (3) 3 (4) 1

47. For the three Normal Zeeman triplet lines choose correct answer :

(1) Central line is linearly polarized and other two are circularly polarized.

(2) Central line is circularly polarized and other two are plane polarized.

(3) All are linearly polarized

(4) All are circularly polarized

48. Coupling of orbital and spin motions of electron gives rise to :

(1) Zeeman effect (2) Stark effect

(3) Hyperfine splitting (4) Fine splitting

49. Paschen Back effect is splitting of energy levels when atom are placed in ?

(1) weak magnetic field (2) weak electric field

(3) strong magnetic field (4) strong electric field

50. For the two transitions (i) $^2P_{3/2} \rightarrow {}^2S_{1/2}$ and (ii) $^2P_{1/2} \rightarrow {}^2S_{1/2}$, which statement is **true** ?

(1) (i) stronger than (ii) (2) (ii) is stronger than (i)

(3) both are equally strong (4) nothing can be said

51. In alkali spectrum which of the following corresponds to sharp series ?

(1) 1S – nP n = 2, 3, 4.....

(2) 2P – nD n = 3, 4, 5.....

(3) 2P – nS n = 3, 4, 5 .....

(4) 3D – nF n = 4, 5, 6.....

52. Two equivalent p electrons give rise to spectroscopic terms :

(1) ^1S, ^1D, ^3P (2) ^2P

(3) ^2P, ^2D, ^4S (4) ^1S

53. An atomic orbital with principle quantum number n can accommodate N number of electrons, which of the following statements is **false** ?

(1) $n^2 = N$ (2) $2n^2 = N$

(3) $N = \sum_{l=0}^{n-1} 2(2l+1)$ (4) $N = 2[1 + 3 + 5 + ...2n - 1]$

54. Electronic configuration of an atom with atomic number 25 is :

(1) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$

(2) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$

(3) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^2\ 4p^2$

(4) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^2\ 4p^3$

55. For the Rydberg constant R, which of the statements is **true** ?

(1) It is a universal constant

(2) It depends on atomic weight

(3) It is independent of mass and charge of electron

(4) It is independent of Planck constant

56. Work function of a metal corresponds to green light. One will observe photoelectrons by irradiating the metal surface by :

(1) red light (2) microwave radiation

(3) IR radiation (4) blue light

57. The Compton shift in X-ray wavelength depends on :

(1) Scattering angle only

(2) Scattering angle and wavelength of X-ray both

(3) Wavelength of X-ray only

(4) None of the (1), (2) and (3)

58. Ground state of C_s atom is :

(1) $^1P_1$ (2) ^3P_o (3) ^1S_o (4) $^1S_{\frac{1}{2}}$

59. The radius of the first Bohr orbit in H-atom is :

(1) 1.06 Å (2) 2.12 Å (3) 0.53 Å (4) 4.24 Å

60. Which of the following series of H-atom spectrum lies in the visible region ?

(1) Lyman (2) Balmer

(3) Paschen (4) Bracket

61. A plate of thickness t behaves as a half-wave plate for a light of wavelength λ. Ignoring variation in refractive indices with λ, if a light of 2λ is used the plate will behave as a :

(1) half-wave plate (2) quarter-wave plate

(3) filter (4) normal glass plate

62. A natural light of wavelength λ is allowed to pass through a doubly refracting transparent sheet of calcite which splis it up into E and O rays. After emergence these two rays are combined to interfere. Which statement is **true** ?

(1) There will not be interference effect

(2) There will be interference effect depending on sheet thickness

(3) There will be always destructive interference

(4) There will be always constructive interference

63. A grating of width 2 cm is capable of resolving D_1 and D_2 lines of sodium in the 3rd order. If the wavelength separation of D_1 and D_2 lines is 6 $\mathring{A}$ and average wavelength of D_1 and D_2 lines is 5893 $\mathring{A}$ the number of lines in the grating is :

(1) 164 lines/cm (2) 328 lines/cm

(3) 327 lines/cm (4) 163 lines/cm

64. A parallel beam of light of wavelength 5460 $\mathring{A}$ is incident at an angle of 30° on a plane transmission grating with 6000 lines per centimeter. The highest order of observables spectrum is :

(1) 3 (4) 4 (3) 1 (4) 2

65. In a diffraction experiment (of Fraunhoffer type) with a single slit if the wavelength of the light used is equal to the slit-width. Which of the following is **true** ?

(1) diffraction pattern disappears

(2) the central maximum fills the entire screen

(3) theory used becomes invalid

(4) the pattern is unaffected

66. In an experiment a thin wire is illuminated by a narrow slit placed parallel to the wire. The slit is illuminated by a light source of wavelength λ. On the screen fringes are seen in geometrical shadow of the wire and on either side of the shadow. Which of the following is **true** ?

(1) In geometrical shadow one observes interference fringes only

(2) In geometrical shadow one observes diffraction fringes only

(3) In geometrical shadow one observes interference and diffraction fringes both

(2) On either side of the geometrical shadow one observes interference fringes only

67. The He-Ne laser line 6328 Å has band-width 0.1 Å. The coherence length of the light beam is :

(1) 4 mm (2) 4 cm (3) 4 m (4) 40 m

68. In an experiment for determining refractive index of gas using Michelson interferometer a shift of 400 fringes is seen when all the gas is removed from the tube. If the light wavelength is 6000 Å and the tube length is 20 cm, then refractive index of the gas is :

(1) 1.0006 (2) 1.0012 (3) 0.9994 (4) 0.9988

69. In a Fabry-Perot etalon the reflectivity of the two mirrors is 90%. The coefficient of fineses is :

(1) 360 (2) 36 (3) $\frac{360}{19}$ (4) 6

70. In a Newton's ring experiment the light is reflected from the upper (ray 1) and lower (ray 2) surfaces of the planoconvex lens and the upper (ray 3) surface of the glass plate supporting the lens. The circular rings are observed due to interference between :

(1) ray 1 and ray 2 (2) ray 1 and ray 3

(3) ray 1, ray 2 and ray 3 (4) ray 2 and ray 3

71. In an experiment of interference of polychromatic light by extremely thin film the fringes in the reflected light are observed. The colour of the fringes :

(1) depends on the colour of source

(2) depends on the angle of incidence of light

(3) depends on the direction of reflected light

(4) is always dark (black)

72. In a two beam interference experiment the intensities of the beams are 2^2 and 5^2 units. The visibility of the fringe pattern is :

(1) $\frac{21}{29}$ (2) $\frac{9}{49}$ (3) $\frac{3}{7}$ (4) $\frac{20}{29}$

73. Which of the following statements is **incorrect** ?

(1) No signal can travel with velocity greater than C

(2) Simultaneity is frame in dependent

(3) Proper time is same in all inertial frame

(4) Total energy of a particle does not depend on the choice of the inertial frame

74. If a clock moves with a very high velocity, the time interval in that clock will appear to a stationary observer as :

(1) shorter

(2) longer

(3) unchanged

(4) shorter or longer depends on the direction of the velocity

75. Which of the following does **not** remain invariant in special theory of relativity ?

(1) $\frac{E^2}{c^2} - \vec{p}^2$ (2) $d^3\,\vec{p}$

(3) $\frac{d^3\,\vec{p}}{E}$ (4) $c^2\,t^2 - x^2 - y^2 - z^2$

76. Which of the following is **incorrect** ?

(1) Laws of mechanics are covariant under Galilean transformation

(2) Maxwell's equations are covariant under Galilean transformation

(3) Laws of mechanics are covariant under Lorentz transformation

(4) Maxwell's equations are covariant under Lorentz transformation

77. Kinetic energy of a free relativistic particle is given as (m_0 is rest mass; p is the momentum of the particle) :

(1) $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} m_0 c^2$ (2) pc (3) $\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right) m_0 c^2$ (4) mc^2

78. A meter scale which is moving with a speed v along its length appears to be a centimeter scale to a stationary observer. Which of the following is **correct** ?

(1) $v^2 = 0.99\ c^2$ (2) $v^2 = 0.9999\ c^2$

(3) $v = 0.99\ c$ (4) $v^2 = 0.9\ c^2$

79. The speed at which the kinetic energy of an electron is equal to twice its rest energy is :

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

80. Which of the following remains invariant under Lorentz transformation ?

(1) charge density (2) current

(3) charge (4) current density

81. State of a one dimensional simple harmonic oscillators is $\psi(x, t) = \frac{1}{5}\left[3\phi_0 - 2\sqrt{2}\,\phi_1 + 2\sqrt{2}\,\phi_2\right]$, where ϕ_n are the eigen functions of the Hamiltonian with eigen values $E_n = (n + \frac{1}{2})\hbar\omega$. The expectation value of the energy in the state $\psi(x, t)$ is :

(1) $0.46\ \hbar\omega$ (2) $1.46\ \hbar\omega$

(3) $0.5\ \hbar\omega$ (4) 0

82. In a quantum system an observable is represented by an operator A. If $|\psi>$ is a state of the system which is not a eigen state of A, then $r = <\psi/A/\psi>^2 - <\psi/A^2\ \psi>$ must be :

(1) equal to zero (2) greater than zero

(3) less than zero (4) greater than or equal to zero

83. The wave function of a particle at t = 0 is given by $|\psi|(0)> = \frac{1}{\sqrt{2}}[|u_1> + |u_2]$, where $|u_1>$ and $|u_2>$ where $14_1>$ and $14_2>$ are the normalized eigen states with eigen values E_1 and E_2, respectively, ($E_2 > E_1$). The shortest time after which $|\psi(t)>$ will become orthogonal to $|\psi(0)>$ is :

(1) $\frac{-\hbar\pi}{2(E_2 - B_1)}$ (2) $\frac{\hbar\pi}{E_2 - E_1}$ (3) $\frac{\sqrt{2}\hbar\pi}{E_2 - E_1}$ (4) $\frac{2\hbar\pi}{E_2 - E_1}$

84. The value of $<\frac{1}{r}>$ in the ground state of H-atom is :

(1) a_0 (2) $\frac{1}{a_0}$ (3) 0 (4) $\frac{1}{2a_0}$

85. A system is known to be in a state described by the wave function $\psi(\theta,\phi) = \frac{1}{\sqrt{30}}(5\,y_4^0 + y_6^0 - 2y_6^3)$, where $y_\ell^m(\theta,\phi)$ are spherical harmonics. The probability of finding the system in state with m = 0 is :

(1) 0 (2) $\frac{1}{5}$ (3) $\frac{13}{15}$ (4) $\frac{1}{6}$

86. The de Broglie wave length of an electron with energy 100 eV is equal to :

(1) 12.3 A° (2) 1.23 A° (3) 123 A° (4) 0.123 A°

87. If a system is invariant under parity, which of the following statements is incorrect ?

(1) The wave functions must have definite parity

(2) <x> is always zero

(3) $\langle px^2 \rangle$ is always zero

(4) Half of wave functions are positive under parity

88. Consider a system in a state $|\psi>$ given by $|\psi> = \frac{1}{\sqrt{3}}\left[|\psi_1> + \sqrt{2}|\psi_2>\right]$. $|\psi>$ and $|\psi_2>$ are orthogonal and normalized eigen vectors of the system with energy eigen values E_1 and E_2, respectively. If a measurement of energy is performed on the system, what is the probability of getting a value E_2 ?

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

89. Probabilities current density is represented by the operator :

(1) $\frac{i\hbar}{2m}(\psi \bar{\nabla} \psi^* - \psi^* \bar{\nabla} \psi)$ (2) $\frac{\hbar}{2i\,m}(\psi \bar{\nabla} \psi^* - \psi^* \bar{\nabla} \psi)$

(3) $\frac{i\hbar}{2\,m}(\psi^* \bar{\nabla} \psi - \psi \bar{\nabla} \psi^*)$ (4) $\frac{\hbar}{2i\,m}(\psi \bar{\nabla} \psi^* - \psi \bar{\nabla} \psi^*)$

90. Degeneracy of the 10^{th} exciated state of a 2-d isotropic simple harmonic oscillator is :

(1) 10 (2) 11 (3) 45 (4) 100

91. The wave function for a 1-d simple harmonic oscillator has odd number of real zeros, Which of the following statements is **incorrect** :

(1) The wave function is odd under parity

(2) The wave function passes through origin

(3) The wave function does not have definite parity

(4) The state for this wave function is non-degenerate

92. Consider one sided simple harmonic oscillator described by the potential $V(x) = \frac{1}{2} m w^2 x^2, 0 \le x \le \infty$. The value of $< x >$ in any state will be :

(1) 0 (2) a positive number

(3) always be negative (4) can be positive or negative

93. The ground state energy of the system described by the Hamiltonian :

$H = \frac{bx^2}{2m} + ax^2 + bx + c$ is :

(1) $\hbar\sqrt{\frac{2a}{m}} + c - \frac{b^2}{4a}$ (2) $\hbar\sqrt{\frac{2a}{m}} - c + \frac{b^2}{4a}$

(3) $\hbar\sqrt{\frac{a}{2m}} - c + \frac{b^2}{4a}$ (4) $\hbar\sqrt{\frac{a}{2m}} + c - \frac{b^2}{4a}$

94. How many based states are there for the potential $V(x) = V_o \delta(x)$, $V_o < 0$?

(1) 0

(2) infinite

(3) 1

(4) depends on the magnitude of V_o

95. An electron is confined to a box of length L. If the length of the box charges to 2L, how would the uncertainty of momentum charge ?

(1) uncertainly of momentum will be twice

(2) uncertainly of momentum will be half

(3) uncertainly of momentum will be one fourth

(4) uncertainly of momentum will be four times

96. Which of the following sets of quantum numbers is **not** possible ?

(1) $n = 2, l = 3, m_l = 2$ (2) $n = 3, l = 2, m_l = -2$

(3) $n = 6, l = 2, m_l = 0$ (4) $n = 7, l = 3, m_l = -3$

97. An electron in hydrogen atom is described by quantum numbers $n = 8$, $m_e = 4$. What are the possible values of the orbital quantum number l ?

(1) 4, 5, 6, 7 (2) 5, 6, 7, 8

(3) 0, 1, 2, 3, 4, 5, 6, 7 (4) 0, 1, 2, 3, 4

98. Which of the following is a eigenstate of momentum operator ?

(1) $\cos kx + i \sin kx$ (2) $i \sin kx$

(3) $\cos kx$ (4) $A \cos kx + B \sin kx$

99. Which of the following statements is **incorrect** about complex conjugation operator ?

(1) It is an Hermitian operator

(2) It has eigen values ±1

(3) It is not a linear operator

(2) It has eigen values ±1

100. Which of the following operators is **not** linear operator :

(1) Momentum (2) Parity

(3) Time reversal (4) Angular momentum

101. Which of the following is **not** true about the matrix

$$A=\begin{pmatrix}\cos\theta & -\sin\theta & 0\\ \sin\theta & \cos\theta & 0\\ 0 & 0 & 1\end{pmatrix}$$

(1) A is orthogonal

(2) A has no inverse

(3) When acting on a vector it preserves the magnitude of the vector

(4) Using A Cartesian unit vectors can be resolved into circular cylindrical unit vectors

102. The generating function for Hermite polynomial is $g(t, x) = e^{-t^2+2tx}$. The zero of the Hermie polynomial $H_2(x)$ on the positive x axis is :

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

103. For Bessel function $J_n(x)$ given that :

$J_n'(x)=\frac{1}{2}[J_{n-1}(x)-J_{n+1}(x)]$ (n is an integer), $\frac{d}{dx}J_0(x)$ is :

(1) $J_1(x)$ (2) $-J_1(x)$ (3) $-J_{-1}(x)$ (4) $J_0(x)$

104. The Legendre series expansion for the function $f(\theta)=\sin^2\left(\frac{0}{2}\right)$ can be given as :

(1) $\frac{1}{2}[P_0(\cos\theta)-P_1(\cos\theta)]$ (2) $\frac{1}{2}[P_2(\cos\theta)-P_3(\cos\theta)]$

(3) $[P_1(\cos 0)-P_2(\cos\theta)]$ (4) $[P_0(\cos\theta)+P_1(\cos\theta)]$

105. A 2×2 matrix has determinant 1 and trace 2. Its eigen values are :
(1) ± 1 (2) 0, 1 (3) 1, 1 (4) 0, 2

106. The value of $\vec{\nabla} \times \frac{\hat{r}}{r^2}$ is :
(1) $-\frac{r}{r^3}$ (2) $4\pi\delta^3(r)$ (3) 1 (4) 0

107. The Lagrangian for a one dimensional harmonic oscillator is :
(1) $\frac{1}{2}m\dot{x}^2 - \frac{1}{2}kx^2$ (2) $\frac{1}{2}m\dot{x}^2 + \frac{1}{2}kx^2$
(3) $m\dot{x} + kx$ (4) $\frac{1}{2}(mx^2 + kx^2)$

108. The dimensions of action are :
(1) ML^2T^{-2} (2) MLT^{-2} (3) MLT^{-1} (4) M^2LT^{-1}

109. The Hamiltonian is equal to the total energy for :
(1) dissipative systems (2) conservative systems
(3) non-conservative systems (4) any system is general

110. The potential energy of a simple pendulum consisting of a bob of mass 'm' attached to a string of length 'l' displaced from the vertical by an angle 'θ' and allowed to oscillate (assume the potential energy to be zero at the rest position) will be :
(1) $\frac{1}{2}ml^2\dot{\theta}^2 - mgl\cos\theta$ (2) $2mgl\sin^2\frac{\theta}{2}$
(3) $\frac{1}{2}ml\theta^2$ (4) $\frac{1}{2}gl\sin\theta$

111. The unique output for a NAND logic gate is a 0 :

(1) when all inputs are 0 (2) when all inputs are 1

(3) when any one input is 0 (4) when any one input is 1

112. In a amplifier the negative feedback is a process where a portion of output signal is fed to the input of the normal amplifier with the condition that the input signal is :

(1) in phase (2) 90° out of phase

(3) 180° out of phase (4) any arbitrary phase

113. In a RC coupled amplifier, the reduction in voltage gain in the high frequency range results due to :

(1) coupling capacitor

(2) shunt capacitance in the circuit

(3) series capacitance in the circuit

(4) bypass capacitor in the inner circuit

114. The function of emitter resistance R_E in CE transistor amplifier is :

(1) to have desirable values of I_{CR}

(2) to provide positive feedback

(3) to provide negative feedback

(4) to provide larger amplification

115. The input impedance of an amplifier increases by the introduction of feedback. It is due to :

(1) positive feedback

(2) current series negative feedback

(3) current shunt negative feedback

(4) voltage shunt negative feedback

116. The transistor amplifier has highest input impedance in :
- (1) CB configuration
- (2) CE configuration
- (3) CC configuration
- (4) both in CC and CE configuration

117. The relation between current gains β and α of a transistor is :

(1) $\beta = \frac{\alpha}{(1+\alpha)}$ (2) $\beta = \frac{\alpha}{(1-\alpha)}$

(3) $\beta = \frac{(1+\alpha)}{\alpha}$ (4) $\beta = \frac{(1-\alpha)}{\alpha}$

118. When transistor is operating in active region, collector junction is :
- (1) reversed biased for npn transistor only
- (2) reversed biased for pnp transistor only
- (3) forward biased for both npn and pnp transistor
- (4) reversed biased for both npn and pnp transistor

119. Transistor is a :
- (1) voltage controlled device
- (2) current controlled device
- (3) both voltage and current controlled device
- (4) neither voltage nor current controlled device

120. Which power supply is called a better power, if voltage regulation is :

(1) 5% (2) 20% (3) 50% (4) 100%

121. The rms value of full wave rectified waveform is :

(1) 0.636 times the peak value (2) 0.707 times the peak value
(3) 0.5 times the peak value (4) 0.373 times the peak value

122. The breakdown does not destroy a zener diode provided the zener current is less than the :

(1) breakdown voltage
(2) zener test current
(3) maximum zener current rating
(4) barrier potential

123. When operated in cut off and saturation, the transistor acts like a :

(1) a linear amplifier (2) a switch
(3) a variable capacitor (4) a variable resistor

124. The conduction electron have more mobility than holes because they :

(1) are lighter
(2) have negative charge
(3) experience collision less frequently
(4) needs less energy to move them

125. When a reverse voltage increases from 5V to 10 V in a semiconductor diode, the depletion layer :

(1) becomes smaller (2) becomes larger
(3) becomes unaffected (4) breaksdown

126. The dynamic resistance of an ideal p-n junction with forward current of 10 mA at room temperature is :

(1) 2.5 Ohm (2) 0.4 Ohm (3) 0.25 Ohm (4) 4.0 Ohm

127. A n type semiconductor is formed by adding impurity atoms of :

(1) phosphorous, antimony, or arsenic
(2) aluminium, boron or indium
(3) cobalt, aluminium or selenium
(4) aluminium, boron or selenium

128. A coil of inductance 0.2 H and resistance 50 Ohm is connected in parallel with a capacitor of 30 μF. The value of resonant frequency is :

(1) 250 Hz (2) 52 Hz (3) 370 Hz (4) 350 Hz

129. The plane velocity v_p and group velocity vg of a EM wave through a dispersive medium is given by :

(1) $v_g = v_p + \lambda \frac{dv_p}{d\lambda}$ (2) $v_g = v_p - \lambda \frac{dv_p}{d\lambda}$

(3) $v_g = v_p - \frac{dv_p}{d\lambda}$ (4) $v_g = v_p - \frac{d^2v_p}{d\lambda^2}$

130. The relative magnitude of vector H in a plane wave is 1 A/m. The magnitude of electric vector E for a plane wave in free space is :

(1) 377 V/m (2) 37.7 V/m (3) 1 V/m (4) 3.77 V/m

131. In Electromagnetic field $\sqrt{\mu / \epsilon}$ has the dimension of :

(1) an inductance (2) a capacitance
(3) an impedance (4) an electric field

132. The direction of propagation of EM wave is given by the direction of :

(1) Vector E (2) Vector H
(3) Vector (E×H) (4) Vector E and Vector H

133. Which one of the following Maxwell's equations implies the absence of magnetic monopole :

(1) div D = ρ (2) div B = 0

(3) curl $E = -\frac{\partial B}{\partial t}$ (4) curl $H = J + \frac{\partial D}{\partial t}$

134. A 300 MHz plane wave propagating through a non-conducting medium is having $\mu_r = 1$, $\epsilon_r = 78$. The velocity of wave through medium is :

(1) 33.97×10^6 m/s (2) 3.39×10^6 m/s
(3) 3.32×10^8 m/s (4) 7.8×10^7 m/s

135. Curl $E = -\frac{\partial B}{\partial t}$ is representing :

(1) Ampere's law
(2) Gauss's law
(3) Ohm's law
(4) Faraday's law

136. The extended Ampere's law equation can be expressed as :

(1) $\nabla \times H = J$
(2) $\nabla \times H = J + \frac{\partial D}{\partial t}$
(3) $\nabla \times E = -\frac{\partial B}{\partial t}$
(4) $\nabla . E = -\frac{\partial B}{\partial t}$

137. The amplitude of electric field component of sinusoidal plane wave having impedance 377 Ohm in free space is 20 V/m. The power per square meter carried by the wave is :

(1) 0.53 W/m^2
(2) 2.53 W/m^2
(3) 37.7 W/m^2
(4) 3.77 W/m^2

138. The ratio of electric field vectors E and magnetic field vector H (i.e. E/H) has the dimension of :

(1) Resistance
(2) Inductance
(3) Capacitance
(4) Product of Inductance and capacitance

139. When a plane electromagnetic wave is propagates in a linear, isotropic, dielectric medium, the electric field E and magnetic field H vectors are :

(1) parallel to each other
(2) mutually perpendicular to each other
(3) at an angle of 45°
(4) at an angle of 60°

140. The pointing vector S of an electromagnetic wave is :

(1) $S = E \times H$ (2) $S = E \times B$

(3) $S = E / B$ (4) $S = E / H$

141. There are more than two systems A, B, C..... which are almost independent of each other. Suppose that they interact with each other weakly, so that they can be regarded as a compound system A+B+C ..... If Z_A, Z_B, Z_C are the partition function of the individual system, then partition function $Z_{A+B+C....}$ is given as :

(1) $Z_{A+B+C.....} = Z_A + Z_B + Z_C.....$ (2) $Z_{A+B+C.....} = Z_A . Z_B . Z_C.....$

(3) $Z_{A+B+C.....} = Z_A . (Z_B + Z_C)$ (4) $Z_{A+B+C.....} = 1/(Z_A . Z_B . Z_C.....)$

142. One mole of an ideal gas at temperature T undergoes a free expansion which double its volume. The charge in entropy is given as :

(1) $\Delta S = NkT \ln 2$ (2) $\Delta S = N \ln 2$

(3) $\Delta S = k \ln 2$ (4) $\Delta S = Nk \ln 2$

143. In a quantity $\Omega(E)$ defined as $\Omega(E) = \frac{1}{w}\int..... \int_{H<E} d\bar{p}_1 \, d\bar{v}_1 .....d\bar{p}_N \, d\bar{v}_N$,

the term w is given as :

(1) h^{3N} (2) N! (3) $N!h^{3N}$. (4) N!h3

144. Consider a gas of three particles with four available states. Find number of states available if the gas is Bose-Einstein :

(1) 64 (2) 4 (3) 16 (4) 20

145. If a system is in contact with a reservoir at constant imperative and pressure and if its internal parameters are fixed so that it can only do work on the pressure reservoir, then the stable equilibrium situation is characterized by the condition :

(1) G = maximum (2) F = minimum

(3) G = minimum (4) H = minimum

146. The pressure of an ideal Bose gas at the transition point (T_c) is given as :

(1) $P(T_c) = NkT_c/V$
(2) $P(T_c) = 0.5134\ (NkT_c/V)$
(3) $P(T_c) = 1.5\ (NkT_c/V)$
(4) $P(T_c) = 0.5\ (NkT_c/V)$

147. The Fermi-Dirac distribution law is given in the form :

(1) $n_i = \frac{gi}{e^{(\epsilon i + \mu)/kT} - 1}$
(2) $n_i = \frac{gi}{e^{(\epsilon i + \mu)/kT} + 1}$
(3) $n_i = \frac{gi}{e^{(\epsilon i - \mu)/kT} + 1}$
(4) $n_i = \frac{gi}{-(\epsilon i - \mu)/kT} + 1}$

148. Equation of state of a system in grand canonical ensemble is given as :

(1) $PV = kT \ln \Xi$
(2) $PV = k^2T^2 \ln \Xi$
(3) $PV = \ln \Xi$
(4) $PV = (kT)^{-1} \ln \Xi$

149. Mean square fluctuation in the energy E of a system in the canonical ensemble is :

(1) $k^2T^2C_v$
(2) kT^2C_v
(3) kTC_v
(4) $kT^2C_v^2$

150. Entropy probability relation is :

(1) $S = k \log W$
(2) $W = S \log k$
(3) $W = k \log S$
(4) $S = W \log k$

अभ्यर्थियों के लिए निर्देश

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

1. प्रश्न पुस्तिका मिलने के 10 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, प्रश्नपुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्नपुस्तिका पर अनुक्रमांक 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 लिए आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।***
9. प्रत्येक प्रश्न के उत्तर के लिए 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 संबंधित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।***
11. रफ कार्य के लिए प्रश्न-पुस्तिका के मुखपृष्ठ के अंदर वाला पृष्ठ तथा उत्तर-पुस्तिका के अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त *केवल* ***ओ एम आर उत्तर-पत्र*** परीक्षा भवन में जमा कर दें।
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।