Total Printed Pages : **16**

Booklet No. 11910

M.Phil./Ph.D. ADMISSION TEST, 2018

Paper II

Subject : 136 - PHYSICS

Roll No. (In figures) .....(In words) .....

OMR Sheet Sr. No. .....

Signatures of Invigilators 1. ..... 2. .....

Names of Invigilators 1. ..... 2. .....

Time : 2 Hours Max. Marks : 200

SEAL

GENERAL INSTRUCTIONS

1. Read the instructions given on the Question Booklet and OMR Sheet before starting the answers. All the entries should be filled by **blue or black ball point pen**.

2. The Question Booklet contains **100** questions and all questions are compulsory.

3. Each question is of **2** marks. There is **no negative marking**.

4. Candidates must ensure that the Question Booklet issued to them has all the questions. Defective Question Booklet can be got changed within **10** minutes.

1. प्रश्नों के उत्तर लिखने से पूर्व प्रश्न-पुस्तिका और ओ.एम.आर. शीट पर दिये हुए निर्देश पढ़ें। सभी प्रविष्टियाँ **नीले अथवा काले बॉल पॉइन्ट पेन** से भरें।

2. प्रश्न-पुस्तिका में **100** प्रश्न हैं और सभी प्रश्न अनिवार्य हैं।

3. प्रत्येक प्रश्न **2** अंक का है। कोई **नकारात्मक अंकन (negative marking) नहीं होगा।**

4. परीक्षार्थी सुनिश्चित कर लें कि उन्हें जो प्रश्न-पुस्तिका दी गई है उसमें सभी प्रश्न अंकित हैं। त्रुटिपूर्ण प्रश्न-पुस्तिका **10** मिनट की अवधि में बदलवाई जा सकती है।

5. In case of any discrepancy between English and Hindi versions of a question, English version will be taken as correct, wherever there are both versions.

6. Select and darken the circle corresponding to the answer [(A) or (B) or (C) or (D)] in OMR sheet.

7. In case more than one circles are darkened in a question, it will not be evaluated.

8. Do not make any stray marks on OMR sheet and do not fold it.

9. Any candidate found removing pages from the Question Booklet may be disqualified and prosecuted.

10. Use of unfair means will disqualify the candidate from the examination.

11. Cell phone, calculator or any such devices are not allowed in the Examination Hall.

12. No candidate is allowed to leave the seat before handing over the original OMR sheet to the invigilator. Candidate can take Question Booklet and Carbon copy of OMR sheet.

5. किसी प्रश्न के अंग्रेजी और हिन्दी रूपान्तरणों में भिन्नता होने की स्थिति में अंग्रेजी रूपान्तरण सही माना जायेगा जहाँ प्रश्न-पत्र दोनों भाषाओं में है।

6. सही उत्तर का चयन करें तथा सम्बन्धित [(A) अथवा (B) अथवा (C) अथवा (D)] गोले को ओ.एम.आर. शीट में काला करें।

7. किसी प्रश्न में एक से अधिक गोले को काला करने पर उसे जाँचा नहीं जायेगा।

8. ओ.एम.आर. शीट पर किसी तरह का चिह्न न बनायें और न ही उसे मोड़ें।

9. प्रश्न-पुस्तिका से पृष्ठ निकालते हुए पाये जाने पर परीक्षार्थी को अयोग्य घोषित किया जा सकता है और उसके विरुद्ध विधिक कार्यवाही भी की जा सकती है।

10. अनुचित साधनों का उपयोग करने पर परीक्षार्थी को परीक्षा के लिए अयोग्य घोषित कर दिया जायेगा।

11. सेलफोन, संगणक और ऐसी किसी भी अन्य प्रविधियों को परीक्षा भवन में लाने की अनुमति नहीं है।

12. ओ.एम.आर. शीट की मूल प्रति वीक्षक को सुपुर्द किये बिना किसी भी परीक्षार्थी को अपना स्थान छोड़ने की अनुमति नहीं है। परीक्षार्थी प्रश्न-पुस्तिका एवं ओ.एम.आर. शीट की कार्बन प्रति को अपने साथ ले जा सकेगा।

1. A meson has a mean life of 4×10^{-8} sec. when measured at rest. How far does this meson go before decaying if its speed is 0.8 c relative to the earth ?

(A) 8 m

(B) 16 m

(C) 4 m

(D) 32 m

2. Position vector of two particles are $\vec{r}_1 = \left(2\hat{i} + 5\hat{j}\right)$ and $\vec{r}_2 = \left(-8\hat{i} - 5\hat{j}\right)$ meter respectively and their velocities are $\vec{v}_1 = \left(5\hat{i} + 3\hat{j}\right)$ and $\vec{v}_2 = \left(p\hat{i} + 8\hat{j}\right)$ m/sec. respectively. What will be the value of p if they collide with each other ?

(A) 0 m/sec.

(B) 5 m/sec.

(C) 10 m/sec.

(D) -10 m/sec.

3. If the Lagrangian does not depend on time explicitly :

(A) The Kinetic Energy is constant.

(B) The Potential Energy is constant.

(C) Kinetic and Potential Energy are equal.

(D) The Hamiltonian is constant.

4. The Lagrangian of charged particle in an electromagnetic field is expressed as :

(A) $L = T - q\phi - q(v \cdot A)$

(B) $L = T + q\phi + q(v \cdot A)$

(C) $L = T - q\phi + q(v \cdot A)$

(D) $L = T + q\phi - q(v \cdot A)$

5. The homogeneity of time leads to the law of Conservation of :

(A) Linear momentum

(B) Angular momentum

(C) Parity

(D) Energy

6. According to principle of least action :

(A) $\Delta \int \left(\sum_k p_k q'_k - H\right) dt = 0$

(B) $\Delta \int \sum_k p_k q'_k \, dt = 0$

(C) $\Delta \int (H - L) dt = 0$

(D) $\int \sum_k p_k q'_k \, dt = 0$

7. Poisson brackets for angular momentum components (J_x, J_y, J_z) satisfy the relation.

(A) $[J_x, p_x] = p_z$

(B) $[J_x, p_z] = -p_y$

(C) $[J_x, J_z] = p_x$

(D) $[J_y, J_z] = -J_x$

8. The Phase Space refers to :

(A) Position co-ordinates

(B) Momentum co-ordinates

(C) Both Position and Momentum co-ordinates

(D) Position and Time

9. In the northern hemisphere the displacement of the object thrown vertically upwards takes place towards :

(A) North

(B) South

(C) East

(D) West

10. A clock keeps correct time. With what speed should it move relative to an observer so that it seems to loose 2 minutes per day ?

(A) 3×10^8 m/sec.

(B) 1.58×10^7 m/sec.

(C) 1000 m/sec.

(D) 100 m/sec.

11. The expression for Hamiltonian of a particle in relativistic mechanics is :

(A) $H = \sqrt{p^2c^2 + m_0{}^2 c^4} + V$

(B) $H = \sqrt{p^2c^2 + m_0{}^2 c^4} - V$

(C) $H = p^2 c^2 + m_0{}^2 c^4$

(D) $H = m_0 c^2 + V$

12. Laplace transformation is linear. Choose the **correct** option.

(A) $L\{a f(x) + g(x)\} = \alpha f(x) + g(x)$

(B) $L\{a f(x) + b g(x)\} = a f(x) + b g(x)$

(C) $L\{a f(x) + b g(x)\} = a L\{f(x)\} + b L\{g(x)\}$

(D) $L\{f(x) + b g(x)\} = f(x) + b g(x)$

13. The Fourier transform of Gaussian function is :

(A) Lorentzian

(B) Gaussian

(C) Delta function

(D) None of the above

14. A function $f = u + iv$ is said to be analytic if :

(a) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and (b) $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

(A) Satisfy condition (a)

(B) Satisfy condition (b)

(C) Both (a) and (b)

(D) None of the two

15. If $\phi(x, t)$ is the generating function of $J_n(x)$ so that $\phi(x, t) = \sum_{n=-\infty}^{\infty} J_n(x) t^n$, then $\phi(x, t)$ will be :

(A) $(1-t)^{-1} \exp\left\{\frac{-xt}{1-t}\right\}$

(B) $\exp \frac{x}{2}\left(t - \frac{1}{t}\right)$

(C) $(1 - 2xt + t^2)^{-1/2}$

(D) $\exp\{-x^2 - (t-x)^2\}$

16. If $\vec{A} = -y\hat{i} + x\hat{j}$ then the value of $\oint (\vec{\nabla} \times \vec{A}) \cdot \vec{ds}$ through circular area $x^2 + y^2 = r^2$, $z = 0$ is given as :

(A) πr^2

(B) $2\pi r^2$

(C) $\frac{\pi r^2}{2}$

(D) zero

17. To Convert a Contra variant tensor A^μ into a covariant tensor A_μ we make use of :

(A) an asymmetric tensor $B_{\mu\nu}$

(B) Kronecker delta δ^μ_ν

(C) a metric tensor $g_{\mu\nu}$

(D) a mixed tensor B^μ_ν

18. Eigen values for matrix $\begin{pmatrix} 0 & 1 & 2 \\ 1 & 0 & 0 \\ 0 & 0 & 2 \end{pmatrix}$ are :

(A) $2, 1, -1$

(B) $1, 1, 2$

(C) $2, 1, 2$

(D) $1, 0, -1$

19. For an orthogonal matrix S :

(A) $SS^J = 1$

(B) $\det(S) = \pm 1$

(C) Both (A) and (B) are correct

(D) None of these is correct

20. Singular point and residue of function $f(t) = \frac{1}{\sin t}$ are :

(A) $0, 1$

(B) $1, 0$

(C) $\pi, 0$

(D) $0, \pi$

21. Metric tensor in spherical coordinate is :

(A) $\begin{pmatrix} 0 & 1 & 0 \\ 0 & r^2 & 0 \\ r^2\sin\theta & 0 & 0 \end{pmatrix}$

(B) $\begin{pmatrix} 0 & 0 & 1 \\ r^2 & 0 & 0 \\ 0 & 0 & r^2\sin\theta \end{pmatrix}$

(C) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & r^2 & 0 \\ 0 & 0 & r^2\sin^2\theta \end{pmatrix}$

(D) $\begin{pmatrix} 1 & 0 & 0 \\ 0 & r & 0 \\ 0 & 0 & r\sin\theta \end{pmatrix}$

22. The orthogonality relation for Laguerre polynomials may be written as :

(A) $\int_{-\infty}^{+\infty} e^{-x} L_n(x) L_m(x) dx = n!m!\delta_{nm}$

(B) $\int_{-\infty}^{\infty} L_n(x) L_m(x) dx = n!\, n!\, \delta_{nm}$

(C) $\int_{-\infty}^{\infty} L_n(x) L_m(x) dx = \frac{2}{(2n+1)}\delta_{nm}$

(D) $\int_{-\infty}^{+\infty} e^{-x^2} L_n(x) L_m(x) dx = 2^n n!\sqrt{\pi}\,\delta_{nm}$

23. The maximum power absorbed by a variable impedance from a source of E.M.F. E and internal resistance r is :

(A) $E^2/(r + R_L)$

(B) $E^2/2r$

(C) $E^2/4r$

(D) E^2/r

24. The maximum wavelength of incident photons which can generate electron-hole pairs in Germanium is : ($E_G = 0.75$ eV)

(A) 5600 Å

(B) 16560 Å

(C) 130 Å

(D) 64840 Å

25. The change in collector current of a transistor in common emitter configuration, when the base current is changed by 4 mA is : ($\alpha = 0.9$).

(A) 36 mA

(B) 12 mA

(C) 16 mA

(D) 32 mA

26. In a transistor both, emitter-base junction and base-collector junctions are forward biased, the transistor operates in :

(A) Cut-off region

(B) Saturation region

(C) Active region

(D) Inverted region

27. If S_1, S_2 and S_3 respectively are the terminal stability factor of fixed bias, collector to base feedback bias and universal bias then which of the following statements is true ?

(A) $S_3 > S_2 > S_1$

(B) $S_3 > S_1 > S_2$

(C) $S_1 > S_2 > S_3$

(D) $S_2 > S_3 > S_1$

28. Which of the following is the relation between the constants of JEFT ?

(A) $\mu = 1/ r_d g_m$

(B) $\mu = r_d g_m$

(C) $r_d = \mu g_m$

(D) $g_m = r_d/\mu$

29. The use of emitter feedback resistor R_E causes :

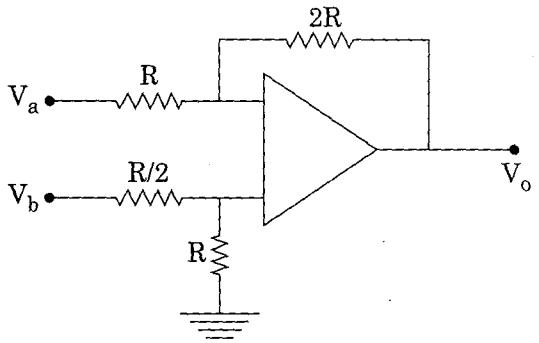
(A) increase in the voltage gain of transistor amplifier.

(B) increase in the thermal bias stability factor of amplifier.

(C) decrease in the bandwidth of transistor amplifier.

(D) decrease in the voltage gain of transistor amplifier.

30. The output V_0 of the OP. amplifier circuit shown in figure is :



(A) $V_o = 2(V_b - V_a)$

(B) $V_o = V_b - V_a$

(C) $V_o = \frac{3}{2}(V_b - 2V_o)$

(D) $V_o = V_b - 2V_a$

31. The input offset current of a differential amplifier is :

(A) the difference of two base currents

(B) the difference of two collector currents

(C) average of two collector currents

(D) average of two base currents

32. The main difference between a register and a counter is :

(A) A register has no specific sequence of states

(B) A counter has no specific sequence of states

(C) A register is capable of storing one bit of information but counter has no bit

(D) None of the above

33. A 12-bit DAC has a step size of 8 mV, then the percentage resolution is :

(A) 0.24%

(B) 0.024%

(C) 2.4%

(D) 0.36%

34. A closed cylinder of radius R and length L is placed in uniform electric field E, parallel to the axis of the cylinder. Then the electric flux through the cylinder must be :

(A) $2\pi R^2 E$

(B) $(2\pi R^2 + 2\pi RL)E$

(C) $2\pi RLE$

(D) Zero

35. Using Poisson's equation, find the volume charge density if the potential is $\phi = 5x^2 + y^2 - 3z^2$.

(A) $6\epsilon_0$

(B) $2\epsilon_0$

(C) $-2\epsilon_0$

(D) $-6\epsilon_0$

36. A semicircular ring of radius R is given a uniform charge Q, then the electric field at its centre will be :

(A) $\frac{kQ}{\pi R^2}$

(B) $\frac{2kQ}{\pi R^2}$

(C) $\frac{kQ}{2\pi R^2}$

(D) Zero

37. Which of the component of the electric field intensity is always continuous at the boundary ?

(A) Tangential

(B) Normal

(C) Horizontal

(D) Vertical

38. The normal component of electric field intensity of a surface with permittvity is 3.5 is given by 18 units then the normal field intensity of the surface in air will be :

(A) 5.14 units

(B) 0.19 units

(C) 63.00 units

(D) 29.00 units

39. Which of the following identity is always zero for static fields ?

(A) grad (curl ϕ)

(B) curl (div ϕ)

(C) div (grad ϕ)

(D) curl (grad ϕ)

40. A charged particle moves into a uniform field at right angle to the direction of the field. Which of the following quantity changes ?

(A) Speed of the particle

(B) Kinetic energy of the particle

(C) Velocity of the particle

(D) Magnitude of charge of the particle

41. A long straight vertical wire carries a current of 5 amperes directed upwards. The position of neutral point will be : (Horizontal component of earth's magnetic field $B_H = 2 \times 10^{-5}$ Wb/m^2)

(A) 2.5 cm

(B) 5 cm

(C) 10 cm

(D) 1.25 cm

42. Relation between electric and magnetic radiation fields of a point charge moving with constant velocity $\left(\vec{v}\right)$ is given by :

(A) $\vec{B} = \frac{1}{c}\left(\vec{v} \times \vec{E}\right)$

(B) $\vec{B} = \frac{1}{c^2}\left(\vec{v} \times \vec{E}\right)$

(C) $\vec{E} = \frac{1}{c}\left(\vec{v} \times \vec{B}\right)$

(D) $\vec{E} = \frac{1}{c^2}\left(\vec{v} \times \vec{B}\right)$

43. The circular plate capacitor has radius 12 cm and the plates are separated by 5 mm. This capacitor is charged by an external circuit with a constant charging current of 0.15 A, then the magnetic field between the plates, at a distance 6.5 cm from the axis of circular plates is :

(A) 1.35×10^{-7} Tesla

(B) Zero

(C) 2.70×10^{-7} Tesla

(D) 3.4×10^{-7} Tesla

44. A dielectric medium ($\epsilon_r = 4$) is placed in a time varying electric field $E = 100 \sin (2000\ \pi t)$ Volt/m, then the displacement current density of the medium will be :

(A) 11.1×10^{-6} Amp/m^2

(B) 22.3×10^{-6} Amp/m^2

(C) Zero

(D) 44.6×10^{-6} Amp/m^2

45. Miller indices (hkl) of a plane that makes an intercept of 2 Å, 3 Å and 4 Å on the co-ordinate axis with a : b : c = 4 : 3 : 2 :

(A) (2 3 4)

(B) (4 3 2)

(C) (4 2 1)

(D) (1 2 4)

46. Number of Bravais lattices for orthorhombic, tetragonal, cubic and monoclinic lattices are respectively :

(A) 4, 3, 3, 2

(B) 4, 2, 3, 2

(C) 2, 2, 3, 4

(D) 4, 3, 2, 1

47. For neutron diffraction from a crystal having d = 1 Å, the energy of the neutron should be :

(A) 2.6×10^{-21} J

(B) 1.3×10^{-21} J

(C) 3.9×10^{-21} J

(D) 5.2×10^{-21} J

48. Energy in a crystal lattice is given by $E = 2k^2 + 4$, then the effective mass of electron in the crystal (m^*) is :

(A) $\frac{\hbar^2}{2}$

(B) $\frac{\hbar^2}{2k}$

(C) $\frac{\hbar^2}{4}$

(D) $\frac{\hbar^2}{4k}$

49. The velocity of moving electron in one-dimensional crystal lattice is :

(A) $\frac{1}{\hbar^2}\frac{d^2E}{dk^2}$

(B) $\frac{1}{\hbar}\frac{dE}{dk}$

(C) $\frac{1}{\hbar^2\left(d^2E/dk^2\right)}$

(D) $\frac{1}{\hbar(dE/dk)}$

50. The specific heat for Aluminium at 300 K, if its Debye temperature is 375 will be :

(A) 300 J/mol-K

(B) 600 J/mol-K

(C) 993 J/mol-K

(D) 375 J/mol-K

51. If the velocity of sound in a solid is 3×10^3 m/s and interatomic distance is 5 Å, then the cut-off frequency for linear lattice will be :

(A) 0.6×10^{13} Hz

(B) 1.2×10^{13} Hz

(C) 1.8×10^{13} Hz

(D) 2.4×10^{13} Hz

52. The concentration of charge carriers in a semiconductor are 5×10^{19} electrons/m^3 and 10×10^{22} holes/m^3. If the mobilities of electrons and holes are 0.01 and 0.005 m^2/V-s respectively :

(A) 1×10^{-3} m^3/C

(B) 4×10^{-3} m^3/C

(C) 10×10^{-3} m^3/C

(D) 8×10^{-3} m^3/C

53. Relative permeability of a substance is 0.99, then the nature of substance is :

(A) Paramagnetic

(B) Diamagnetic

(C) Ferromagnetic

(D) Anti-Ferromagnetic

54. The change in angular frequency of orbital electron in an atom after applying magnetic field of intensity 1 Tesla is :

(A) 2.2×10^{10} rad/s

(B) 4.4×10^{10} rad/s

(C) 8.8×10^{10} rad/s

(D) 1.1×10^{10} rad/s

55. If Mossbauer spectrum of $Fe(CO)_5$ is recorded in presence of a magnetic field, then the original spectrum with two lines changes into :

(A) 3 lines

(B) 4 lines

(C) 5 lines

(D) 6 lines

56. Transition temperature T_c and critical field H_c for a superconductor are related as :

(A) $H_c = H_o \left(1 - \frac{T_c}{T}\right)$

(B) $H_c = H_o (T + T_c)$

(C) $H_c = H_o (T^2 + T_c^2)$

(D) $H_c = H_o \left[1 - \left(\frac{T}{T_c}\right)^2\right]$

57. For a superconductor below critical temperature (T_c) :

(A) $\vec{E} = 0$ but $\vec{B} \neq 0$

(B) $\vec{E} \neq 0$ but $\vec{B} = 0$

(C) $\vec{E} \neq 0$ but $\vec{B} \neq 0$

(D) $\vec{E} = 0$ and $\vec{B} = 0$

58. If Spin of a particle is $\frac{1}{2}$, then the shape of wave function will be :

(A) Symmetrical

(B) Antisymmetrical

(C) Symmetrical and Antisymmetrical both

(D) None of these

59. According to Bose-Einstein distribution law :

(A) $n_i = \frac{g_i}{\left(e^{\alpha+\beta\epsilon_i}+1\right)}$

(B) $n_i = \frac{g_i}{e^{\alpha+\beta\epsilon_i}}$

(C) $n_i = \frac{g_i}{\left(e^{\alpha+\beta\epsilon_i}-1\right)}$

(D) none of these

60. The significance of Bose-Einstein and Fermi-Dirac statistics becomes negligible at :

(A) low temperature

(B) low temperature and low pressure

(C) high temperature and low pressure

(D) low temperature and high pressure

61. The Fermi energy at absolute zero temperature is given by :

(A) $E_F = 0$

(B) $E_F = \frac{h^2}{2m}\left(\frac{3n}{8\pi V}\right)^{2/3}$

(C) $E_F = 2mh^2\left(\frac{3n}{8\pi V}\right)^{3/2}$

(D) $E_F = \frac{h^3}{4m}\left(\frac{3n}{8\pi V}\right)^{3/2}$

62. At high temperature ($kT >> h\nu$) the average energy of Plank oscillator will be :

(A) kT

(B) $h\nu$

(C) $\frac{h\nu}{e^{h\nu/kT}}$

(D) $\frac{3}{2}$ kT

63. The phase space has :

(A) two dimensions

(B) three dimensions

(C) four dimensions

(D) six dimensions

64. Which of the following relation hold true ? All symbols have their usual meaning.

(A) $TDS = C_V DT + T\left(\frac{\partial P}{\partial T}\right)_V dV$

(B) $TDS = C_V DT + T\left(\frac{\partial S}{\partial T}\right)_V dV$

(C) $TDS = C_V DT - T\left(\frac{\partial P}{\partial T}\right)_V dV$

(D) $TDS = C_V DT - T\left(\frac{\partial S}{\partial T}\right)_V dV$

65. In terms of internal energy U, temperature T, pressure P and volume V, the Helmholtz free energy F is :

(A) $F = U - TS$

(B) $F = U + PV$

(C) $F = U - TS + PV$

(D) $F = U + TS - PV$

66. The temperature at which average speed of H_2 is equal to the average speed of N_2 at 40°C is :

(A) 22.3 K

(B) 44.6 K

(C) 273 K

(D) 10.3 K

67. Solution (ϕ) of time dependent Schrödinger's equation for a free particle in momentum space is :

(A) $Ae^{ipx/\hbar}$

(B) $Ae^{-ip^2t/2\hbar m}$

(C) $Ae^{ipt/\hbar}$

(D) Ae^{-iEt}

68. Let H be the Hamiltonian operator for a free particle. Commutator $[x, [x, H]]$ is :

(A) $-\frac{\hbar^2}{m}$

(B) $-\frac{\hbar}{m}$

(C) $m\hbar^2$

(D) $m\hbar$

69. Let $\psi(\tilde{r})$ be $e^{i\,\tilde{k}\cdot\tilde{r}}$. Associated current density is :

(A) $\hbar k$

(B) $-\hbar k$

(C) $\hbar k/m$

(D) $-\hbar k/m$

70. A unitary transformation $\hat{U}$ is operating on an operator $\hat{A}$. Expectation value of $\hat{A}$ and eigen value of $\hat{A}$:

(A) change

(B) do not change

(C) eigen value remains unchanged, expectation value changes

(D) eigen value changes, expectation value does not change

71. Let A and B be 2×2 matrices, the **correct** statement for products AB and BA is :

(A) Traces of products and eigen values are different

(B) Traces and eigen values are same

(C) Traces are different, eigen values are same

(D) Traces are same, eigen values are different

72. Given /jm > is an eigen state of J^2 and J_z with eigen value $j(j+1)\hbar^2$ and $m\hbar$. Correct statement in the following is :

(A) J_+/jm> and J_-/jm> are eigen states of J^2 with same eigen value

(B) J_+/jm> and J_-/jm> are eigen states of J_z with same eigen value

(C) J_+/jm> is an eigen ket of J_z with eigen value $(m-1)\hbar$

(D) J_-/jm> is an eigen ket of J_z with eigen value $(m+1)\hbar$

73. Given a plane rotator with electric dipole moment $\tilde{p}$, executes rotational motion in a plane. It is placed in uniform electric field $\tilde{E}$. In the first order correction to energy level of rotator is $\left(\psi(\varphi)=\frac{1}{\sqrt{2\pi}}e^{im\varphi}\right)$:

(A) $E_n^{(1)}=\frac{1}{2\pi}$

(B) $E_n^{(1)}=\frac{pE}{2\pi}$

(C) $E_n^{(1)}=-pE/2\pi$

(D) $E_n^{(1)}=0$

74. Variation method to determine energy of a given system enables one to determine :

(A) lower bound of energy

(B) upper bound of energy

(C) exact energy of the system

(D) only ground state energy of the system

75. At classical turning points in a 1-D harmonic oscillator :

(A) Potential (V) energy is minimum

(B) Kinetic energy (K) is maximum

(C) V = K

(D) E(total energy) = V

76. The **correct** statement for partial wave scattering method is :

(A) It is suitable for low energies and phase shift is positive for repulsive potential.

(B) Suitable for high energy and phase shift is positive for attractive potential.

(C) Suitable for low energy scattering and phase shift is positive for attractive potentials.

(D) Suitable for high energy scattering and phase shift is positive for attractive potentials.

77. Position probability densities in Klein-Gordon and Dirac equation are :

(A) $\frac{i\hbar}{2mc^2}\left(\psi^*\frac{\partial\psi}{\partial t}-\psi\frac{\partial\psi^*}{\partial t}\right),\ \psi^*\psi$

(B) $\frac{i\hbar}{2mc^2}\left\{\psi^*\frac{\partial\psi}{\partial t}-\psi\frac{\partial\psi^*}{\partial t}\right\},\ \psi^+\psi$

(C) $\psi^*\psi,\ \psi^+\psi$

(D) $\psi^*\psi,\ c\psi^+\alpha\psi$

78. Fine structure in H-atom spectrum arises due to :

(A) spin-orbit coupling

(B) relativistic correction

(C) (A) and (B) both

(D) other effects

79. Structure of H_α-line in H-atom consists of :

(A) 5 lines

(B) 7 lines

(C) 2 lines

(D) 4 lines

80. To show the existence of electron spin in atoms in Stern-Gerlach experiment :

(A) silver atoms and uniform magnetic field was used

(B) silver atoms and non-uniform magnetic field

(C) silver atoms and uniform electric field

(D) silver atoms and non-uniform electric field

81. Extra energy term in Hamiltonian which is necessary to account for relativistic motion of electron in H-atom is :

(A) $p^4/8\,m_0^3\,c^2$

(B) $-p^4/8\,m_0^3\,c^2$

(C) $p^3/m_0^2\,c$

(D) $-p^3/m_0^2\,c$

82. In He atom singlet and triplet energy levels are non-combining (no transitions). This follows from following selection rule :

(A) $\Delta l = \pm 1$

(B) $\Delta J = 0$

(C) $\Delta J = \pm 1$

(D) $\Delta S = 0$

83. The spectral term for a particular atomic state is $^4D_{5/2}$. The minimum number of electrons which could give rise to this state is :

(A) 2

(B) 3

(C) 4

(D) 5

84. In following relations one corresponding to principal series in alkali atoms is :

(A) $\bar{\nu}_m = \dfrac{R}{(1+s)^2} - \dfrac{R}{(m+p)^2}$ $m = 2, \ldots$

(B) $\bar{\nu}_m = \dfrac{R}{(2+p)^2} - \dfrac{R}{(m+s)^2}$ $m = 2, \ldots$

(C) $\bar{\nu}_m = \dfrac{R}{(2+p)^2} - \dfrac{R}{(m+d)^2}$ $m = 3, 4, 5$

(D) $\bar{\nu}_m = \dfrac{R}{(3+d)^2} - \dfrac{R}{(m+f)^2}$ $m = 4, 5, \ldots$

85. An atom is in $^2P_{3/2}$ state. Associated Lande's g-factor is :

(A) $3/2$

(B) $4/3$

(C) $1/2$

(D) $2/3$

86. In a transition from $^1D_2$ to $^1P_1$ in presence of magnetic field number of component lines which appear are :

(A) 9

(B) 6

(C) 3

(D) 4

87. In a rigid rotator $J = 1 \leftarrow 0$ transition occurs at 20.68 cm^{-1}. The wavelength of transition for $J = 15 \leftarrow 14$ will be :

(A) 32 μm

(B) 3.2 m

(C) 32 cm

(D) 3.2 cm

88. With an exciting line 4358 Å in a sample stokes line is observed at 4458 Å, Wavelength of anti-stokes line is :

(A) 4658 Å

(B) 4262 Å

(C) 4312 Å

(D) 4400 Å

89. At room temperature (T = 300 K) stimulated emission dominates spontaneous emission for :

(A) visible region

(B) microwave region

(C) X-ray region

(D) ultraviolet region

90. If neutron and proton have same kinetic energy the probability of tunneling through a potential barrier for proton is :

(A) greater than neutron

(B) smaller than neutron

(C) equal

(D) it depends on potential barrier

91. A nucleus of mass number 238 splits into two nuclei of equal masses. Initially its radius was 8 Fermi. The radii of new nuclei will be nearly :

(A) 5.0 Fermi

(B) 7.0 Fermi

(C) 4.0 Fermi

(D) 6.35 Fermi

92. Energy of 24 MeV is released when two deuterons are fused to form an α-particle. Energy released from fusion of 4 gm of deuteron atoms will be :

(A) 72 MeV

(B) 7.2×10^{24} MeV

(C) 1.44×10^{25} MeV

(D) 3.6×10^{21} MeV

93. In matter particles and anti-particles differ in following :

(A) isospin (I)

(B) mean life time

(C) parity

(D) third component of isospin (I_3)

94. Non-zero Quadrupole moment of a nuclei is exhibited by following shape of nuclei :

(A) spherical

(B) ellipsoidal

(C) (A) and (B)

(D) shape does not indicate quadrupole moment

95. A freshly prepared radioactive source of half life 2 hours emits radiation of intensity 32 times the permissible safe limit. The minimum time after which it would be possible to work safely with the source is :

(A) 6 hours

(B) 10 hours

(C) 12 hours

(D) 32 hours

96. Nuclear fission was explained by :

(A) liquid drop model

(B) shell model

(C) collective model

(D) radioactive model

97. Binding energy of deuteron is :

(A) 1 MeV

(B) 8 MeV

(C) 2.2 MeV

(D) 4 keV

98. First generation matter particles are (symbols have their usual meaning) :

(A) ν_e, e^-, μ, d

(B) ν_μ, μ^-, c, s

(C) ν_e, e^-, t, b

(D) ν_e, e^-, ν_μ, μ^-

99. The substance used in solid state detector is :

(A) conductor

(B) semiconductor

(C) insulator

(D) any alloy

100. The carrier particle of string interaction is :

(A) photon

(B) quark

(C) graviton

(D) gluon

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