ENTRANCE EXAMINATION FOR ADMISSION, MAY 2013.

Ph.D. (PHYSICS)

COURSE CODE :122

Register Number :

Signature of the Invigilator
(with date)

COURSE CODE : 122

Time : 2 Hours Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each of the question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you –1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

1. Consider the evaluation of roots of a nonlinear algebraic equation $f(x)=0$ in the region $a \le x \le b$, by bisection method

(A) This method requires the condition $f(a) \cdot f(b) < 0$

(B) This method requires the condition $f(a) \cdot f(b) > 0$

(C) This method requires the condition $f(a) \cdot f(b) \approx 0$

(D) No such condition is required

2. The problem of determining a polynomial of degree $n-1$ that will pass through n number of data points (x_i, y_i) is known as

(A) Interpolation (B) Polynomial curve fitting.

(C) Method of divided differences (D) Lagrange polynomial.

3. Consider the numerical method to evaluate $\int_a^b f(x)dx$ using trapezoidal rule. Let $h=(b-a)$. Then, the error involved is of the order of

(A) h^3 (B) h^2 (C) h (D) h^4

4. If $y=3^{\log(x)}$, then find dy/dx

(A) $\frac{3^{\log x}}{x}\log 3$ (B) $3^{\log x}/x$ (C) $\log\frac{3}{x}$ (D) $(\log x)\,3^{\log x-1}$

5. Evaluate the integral $\int\sqrt{1+\sin^2 x}dx$

(A) $-\sin x-\cos x-C$ (B) $\sin x+\cos x+C$

(C) $\sin x-\cos x+C$ (D) $-\sin x+\cos x+C$

6. The residue of $f(z)=\frac{1}{(z^2+1)^2}$ at the point $z=i$ is

(A) 0 (B) $-\frac{i}{4}$ (C) i (D) $-i$

7. The circle of convergence of the power series $\sum_{n=1}^{\infty} \frac{(z-i)^n}{n}$ is

(A) $\frac{|z-1|^n}{n} < 1$ (B) $|z| < 1$ (C) $|z-i|^n < 1$ (D) $|z-i| < 1$

8. Let $i = \sqrt{-1}$. Then, the value of $\left(\sqrt{3}+i\right)^{14} + \left(\sqrt{3}-i\right)^{14}$ will be

(A) -2^{14} (B) -2^{12} (C) 1 (D) 2^{14}

9. Evaluate the contour integral $\int_{\Gamma}\left(\frac{4}{z-1} - \frac{5}{z+4}\right)dz$ where Γ is the circle $|z| = 2$

(A) 0 (B) $8\pi i$ (C) $-10\pi i$ (D) $-2\pi i$

10. The solution of $x \sin\left(\frac{y}{x}\right)dy - \left(y\sin\left(\frac{y}{x}\right) - x\right)dx = 0$ is

(A) $x = \exp\left(\sin\frac{y}{x}\right)$ (B) $y = \exp\left(\cos\frac{y}{x}\right)$

(C) $x = \exp\left(\cos\frac{x}{y}\right)$ (D) $x = \exp\left(\cos\frac{y}{x}\right)$

11. Let $x = (x_1, x_2, \cdots x_n)$ and $y = (y_1, y_2, \cdots, y_n)$ be any two vectors in n-dimensional vector space. Then, which of the following is correct?

(A) $\|x\| \cdot \|y\| \le |x \cdot y|$ (B) $0 \le \frac{x \cdot y}{\|x\| \cdot \|y\|} \le 1$

(C) $|x \cdot y| \le \|x\| \cdot \|y\|$ (D) $\|x+y\| \le \|x\|^2 + \|y\|^2$

12. Let four vectors in a vector space be given
$x_1 = (4, 0, 2),\ x_2 = (2, 2, 0),\ x_3 = (1, 1, 0), x_4 = (5, 1, 2)$
Then

(A) The set of vectors are linearly independent.

(B) The set of vectors are linearly dependent.

(C) The information is insufficient to evaluate.

(D) The set of vectors form a basis for the 4-dimensional vector space

13. Let Q be an orthogonal matrix
Then,

(A) $QQ^T = Q^TQ = I$ (B) $Q = Q^T$

(C) $QQ^{-1} = Q^TQ$ (D) $Q^T = -Q$

14. Let x be a coordinate system and x' be rotated coordinate system through an angle θ such that $x = Rx'$. Then, the corresponding rotation matrix R is given by

(A) $\begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$ (B) $\begin{pmatrix} \cos\theta & -\sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$

(C) $\begin{pmatrix} -\cos\theta & \sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$ (D) $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$

15. Choose the correct statement

(A) Let A be any matrix. Then, rank $(A) \neq$ rank (A^T)

(B) If A is a nonsingular matrix, then $(A^{-1})^m = (A^m)^{-1}$ for $m = 1, 2, \cdots$

(C) A matrix A is said to be in echelon form if the nonzero elements in each row is one

(D) The determinant of a square matrix of size $n \times n$ has n cofactors

16. Find the spectral radius of the matrix A, where $A = \begin{pmatrix} 2 & 1 & -1 \\ 3 & 2 & -3 \\ 3 & 1 & -2 \end{pmatrix}$

(A) 4 (B) –2 (C) 1 (D) 2

17. Let A be a square matrix of size $n \times n$ and let $tr(A)$ represent the trace of the matrix. Then, the relation between the eigenvalues λ_i and the trace is

(A) $\sum_{i=1}^{n} \lambda_i = (-1)^n tr(A)$ (B) $\sum_{i=1}^{n} \lambda_i = tr(A)$

(C) $\sum_{i=1}^{n} \lambda_i = (-1)^{n-1} tr(A)$ (D) $\sum_{i=1}^{n} \lambda_i = -tr(A)$

18. What is the nature of the matrix given below?

$$\begin{bmatrix} \frac{1+i}{2} & \frac{-1+i}{2} & 0 \\ \frac{1+i}{2} & \frac{1-i}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

(A) Unitary matrix
(B) Hermitian matrix.
(C) Skew-symmetric matrix
(D) Transformation matrix.

19. Choose the correct statement

(A) The eigenvalues λ of a unitary matrix are all such that $|\lambda| = 1$
(B) The eigenvalues of a skew-Hermitian matrix cannot be zero.
(C) If all elements of a matrix are positive, then it is a positive definite matrix.
(D) Every square matrix A can be diagonalized by the transformation $D = P^{-1}AP$

20. Let $A(t)$ be a non-singular square matrix of size $n \times n$. Then, $\frac{dA^{-1}}{dt}$ is equal to

(A) $\left(\frac{dA}{dt}\right)^{-1}$
(B) $-A^{-1}\left\{\frac{dA}{dt}\right\}A^{-1}$
(C) $-\left\{\frac{dA}{dt}\right\}^{-1}$
(D) $A^{-1}\left\{\frac{dA}{dt}\right\}A^{-1}$

21. If we substitute $u = \sqrt{y}$ in the differential equation $\frac{dy}{dx} - 2y = x\sqrt{y}$ we get

(A) $\frac{du}{dx} - u = \frac{x}{2}$
(B) $\frac{du}{dx} = 2u\frac{dy}{dx}$
(C) $\frac{du}{dx} - u = -\frac{x}{2}$
(D) $\frac{du}{dx} - y = \frac{x}{2}$

22. Simplify the determinant $\begin{vmatrix} \cosh x & \sinh x & 1 \\ \sinh x & \cosh x & 0 \\ \cosh x & \sinh x & 0 \end{vmatrix}$

(A) –1
(B) 0
(C) 1
(D) $\sinh^2 x + \cosh^2 x$

23. If a and b constants, the differential equation $x^2\frac{d^2y}{dx^2}+ax\frac{dy}{dx}+by=0$ will be classified as

(A) Nonlinear homogeneous differential equation with constant coefficients.

(B) Linear second order variable coefficient inhomogeneous differential equation.

(C) Linear second order variable coefficient homogeneous differential equation.

(D) Nonlinear homogeneous differential equation with variable coefficients

24. Given that $y_1(x)=x^2$ is one solution of $x^2y''-3xy'+4y=0,\ x>0$, then, the second linearly independent solution is

(A) $y_2(x)=x^2(A+Bx)$ (B) $y_2(x)=\log x$

(C) $y_2(x)=x^2(A+B\log x)$ (D) $y_2(x)=x^2\log x$

25. The eigenvector x corresponding to eigenvalue $\lambda=-i$ of the matrix $\begin{pmatrix}1 & 2 & 1\\ 0 & 1 & 1\\ 2 & 0 & 1\end{pmatrix}$ is

(A) $[i\ \ 1\ \ -(1+i)]^T$ (B) $[2\ \ 1\ \ 2]^T$

(C) $[-i\ \ 1\ \ -1+i]^T$ (D) $[i\ \ 1\ \ (1+i)]^T$

26. Let $L[f(t)]=F(s)$ represent the Laplace transform. If $k>0$ then

(A) $L[f(kt)]=\frac{1}{s}F\left(\frac{k}{s}\right)$ (B) $L[f(kt)]=\frac{1}{k}F\left(\frac{s}{k}\right)$

(C) $L[f(kt)]=\frac{1}{s}F\left(\frac{s}{k}\right)$ (D) $L[f(kt)]=\frac{1}{k}F\left(\frac{k}{s}\right)$

27. Let $f(t)$ be defined and integrable over intervals within $0\le t\le\infty$ and let δ represent delta function. Then, the value of $\int_0^\infty f(t)\,\delta(t-a)dt$ is equal to

(A) $f(a)$ (B) 1 (C) 0 (D) a

28. Which of the following is correct?

(A) $x=\pm 1$ are regular singular points of Hermite differential equation.

(B) $x=\pm 1$ are regular singular points of Legendre differential equation.

(C) $x=\pm 1$ are regular singular points of Bessel differential equation.

(D) There are no singular points for Legendre differential equation

29. In terms of gamma function, ${}^nC_m$ is equal to

(A) $\dfrac{\Gamma(m+1)}{\Gamma(m+1)\Gamma(n-m+1)}$

(B) $\dfrac{\Gamma(n)}{\Gamma(m)\,\Gamma(n-m)}$

(C) $\dfrac{\Gamma(n+1)}{\Gamma(m+1)\,\Gamma(m-n+1)}$

(D) $\dfrac{\Gamma(n+1)}{\Gamma(m+1)\,\Gamma(n-m+1)}$

30. Which of the following will best represent the half range Fourier series of the function $f(x)=x$ in the range $0 \le x \le \pi$

(A) Fourier cosine series is not possible because the given function is an odd function

(B) $f(x)=2\sum_{n=1}^{\infty}\dfrac{\sin nx}{n}$

(C) $f(x)=\dfrac{\pi}{2}-\dfrac{4}{\pi}\sum_{n=1}^{\infty}\dfrac{\cos(2n-1)x}{(2n-1)^2}$

(D) Fourier series for this function is undefined because the series will not converge

31. In the case of two-body central force problem, if l is the angular momentum and r the radial distance, then the equivalent one-dimensional potential is expressed as

(A) $V'(r)=V(r)+\dfrac{1}{2}\dfrac{l^2}{mr^3}$

(B) $V'(r)=V(r)+\dfrac{1}{2}\dfrac{mr^2}{l^2}$

(C) $V'(r)=V(r)+\dfrac{1}{2}\dfrac{l^2}{mr^2}$

(D) $V'(r)=V(r)+\dfrac{1}{2}\dfrac{ml^2}{r^2}$

32. The physical dimension of the line integral $I=\int_{t_1}^{t_2} L\,dt$ of Hamilton's principle is the same as the dimension of

(A) Angular Momentum

(B) Energy

(C) Momentum

(D) Force

33. The Lagrangian of a physical system is given by

$$L=\frac{m}{2}\dot{q}^2+m\dot{q}q\omega\sin\omega t-\frac{m}{2}q^2\omega^2(1-\cos\omega t)$$

Its equation of motion describes

(A) an anharmonic oscillator

(B) forced oscillations

(C) a simple harmonic oscillator

(D) two coupled oscillators

34. The Lagrangian of a particle moving in a central potential $V(r)$, is given by

$$L = \frac{1}{2}m\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(r)$$

In addition to this potential V, if a velocity dependent potential of the form $\lambda r\dot{r}$, where λ is some constant, is introduced, then

(A) equations of motion remain the same

(B) only the equation of motion in r is changed

(C) both equations of motion are changed

(D) only the equation of motion in θ is changed

35. A rod moves at a relativistic speed. The direction of its velocity makes an angle of 45° with its length in its rest frame. If l_0 is the proper length of the rod and l is its contracted length, then the condition that maximum speed cannot exceed c corresponds to :

(A) l cannot be less than $\sqrt{2}\, l_0$ (B) l cannot be greater than $l_0/\sqrt{2}$

(C) l cannot be less than $l_0/\sqrt{2}$ (D) l cannot be less than l_0

36. A heavy symmetrical top spinning with one point fixed on a frictionless horizontal plane, stays upright because of

(A) the conservation of linear momentum

(B) the conservation of angular momentum

(C) the conservation of energy

(D) the conservation of kinetic energy

37. A pendulum with a bob at the bottom has a constant length. Another bob is hung via a spring from the bob of the first pendulum. The entire system is constrained to move in a vertical plane. How many degrees of freedom does the system have?

(A) 6 (B) 4 (C) 2 (D) 3

38. The potential energy of a system is given by $V(x) = \frac{a}{x^2} + bx^2$, where a and b are some constants with appropriate physical dimensions. The minimum value of the potential energy is equal to

(A) $\sqrt{a/b}$ (B) $2\sqrt{ab}$ (C) $2a/b$ (D) $\sqrt{b/a}$

39. In Rayleigh scattering, the amplitude of scattered light (wave length λ) is inversely proportional to

(A) λ (B) λ^3 (C) λ^2 (D) λ^4

40. In anomalous dispersion of light, refractive index of the medium decreases with

(A) Decrease of wavelength of the light

(B) Increase of wavelength of the light

(C) Constant wavelength of the light

(D) Oscillatory wavelength of the light

41. The instantaneous values of E and H in an electromagnetic wave at any point of a medium (ε, μ) are connected through the relation

(A) $E/H = (\mu/\varepsilon)$ (B) $E/H = (\varepsilon/\mu)^{1/2}$

(C) $E/H = (\mu\varepsilon)^{1/2}$ (D) $E/H = (\mu/\varepsilon)^{1/2}$

42. Ohm's law gives the relation between current density (J), electrical conductivity (σ) and electric field (E)

(A) $E = \sigma J$ (B) $E = J/\sigma$ (C) $E = \sigma/J$ (D) $E = J/\sigma^2$

43. SI unit of electric flux density $\vec{E}$ is

(A) Ampere/m^2 (B) C/m^2

(C) N/C (D) Ampere/m

44. An un-polarized light upon incidence on an interface of two media has

(A) Polarized reflected component and partially polarized transmitted component

(B) Un-polarized reflected component and polarized transmitted component

(C) Un-polarized transmitted component and polarized reflected component

(D) Polarized reflected component and polarized transmitted component

45. For a uniformly moving charged particle

(A) The electric field is spherically symmetric about the center of the charged path

(B) The electric field is stronger in the direction perpendicular to the direction of velocity

(C) The electric field is stronger in the direction of velocity

(D) The electric field is stronger in the opposite direction of velocity

46. A one dimensional random walker takes a step to the right or left with equal probability. After N steps, the root mean square distance moved by the random walker varies as

(A) N (B) N^2 (C) $\sqrt{N}$ (D) $1/\sqrt{N}$

47. In a low temperature ordered phase of AuCu binary alloy, Cu atoms are at the face centers and Au atoms are at the corners of a cubic unit cell. In the high temperature disordered phase Au and Cu atoms can by anywhere. If the total number of atoms is N, what the change in entropy per mole when the alloy undergoes a phase change from disordered to ordered phase? (You may use In $M! \approx M \ln M - M$)

(A) $R\left[\ln(2) - \frac{3}{4}\ln(3)\right]$ (B) $R\left[\ln(3) - \frac{3}{4}\ln(4)\right]$

(C) $R\left[\ln(3) - \frac{3}{4}\ln(2)\right]$ (D) $R\left[\ln(4) - \frac{3}{4}\ln(3)\right]$

48. Consider N two level atoms with ground and excited state energies for each atom being ε_1 and ε_2 respectively. Let T be the temperature corresponding to a situation when the average number of particles in the excited state is $N/3$. What will be the temperature of a system if the excited state is doubly degenerate?

(A) $T/3$ (B) $2T$ (C) $T/2$ (D) $3T$

49. Consider an ideal gas. Which of the following properties are different for distinguishable and indistinguishable particles

(A) Internal energy (B) Pressure

(C) Entropy (D) Temperature

50. A system has energy levels E, $2E$, $3E$,.., where the excited states are triply degenerate. Four non interacting Bosons are placed in this system. If the total energy of these bosons is 5 E, the number of microstates is

(A) 1 (B) 2 (C) 4 (D) 3

51. The total energy per particles of a collection of fermions is 3.0 eV. The Fermi energy of the system is

(A) 1.8 eV (B) 3.0 eV (C) 5.0 eV (D) 4.0 eV

52. The Hamiltonian for a collection of anharmonic oscillators of a solid is $H = \sum_{i=1}^{3N} \frac{p_i^2}{2m} + \frac{\lambda}{4} x_i^4$ Molar specific heat of such a solid is

(A) $\frac{3}{2}R$ (B) $\frac{9}{4}R$ (C) $\frac{5}{2}R$ (D) $\frac{3}{4}R$

53. An ideal gas of particle density n approaches equilibrium because of collisions. Consider each particle to be a hard sphere of radius r. If the mean free path (distance travelled between two successive collisions) is λ what is the mean free path if the radius is reduced to $\frac{r}{2}$?

(A) $\lambda/4$ (B) 4λ (C) $\lambda/2$ (D) 2λ

54. An n-channel FET having a pinch-off voltage $V_p = -5V$ shows a transconductance g_m of 1mA/V, when the applied gate to source voltage $V_{GS} = -3\,V$. Its maximum transconductance (in mA/V) will be

(A) 1.5 (B) 2.0 (C) 3.0 (D) 2.5

55. If A and B are two numbers, then, in C or C++ language, A^B can be programmed as

(A) $A^{**}B$ (B) $pow(A, B)$ (C) $A\hat{}B$ (D) $pwr(A, B)$

56. The maximum current which can flow through a 20 k ohms resistor, rated 2 W is

(A) 1 mA (B) 10 mA (C) 40 mA (D) 100 mA

57. The depletion region in diode is created by

(A) ionization (B) diffusion (C) recombination (D) all of these

58. A diode that has a negative resistance characteristic is the

(A) Tunnel diode (B) Schottky diode

(C) Laser diode (D) Hot-carrier cathode

59. The use of negative feedback in the op-amp is to

(A) Reduce the voltage gain of an op-amp

(B) Make linear operation possible

(C) Both (A) and (B)

(D) Make the op-amp oscillate

60. In a 8085 microprocessor system with memory mapped I/O,

(A) I/O devices have 8 bit addresses

(B) I/O devices are accessed using IN and OUT instructions

(C) There can be a maximum of 256 input devices and 256 output devices

(D) Arithmetic and logic operations can be directly performed with the I/O data

61. The decimal equivalent of the hexadecimal number E5 is

(A) 279 (B) 427 (C) 229 (D) 3000

62. Which of the following has the least packing fraction?

(A) FCC (B) Diamond structure

(C) BCC (D) Simple cubic

63. The ideal $\frac{c}{a}$ ratio for the hexagonal close-packed structure is

(A) $\sqrt{\frac{8}{3}}$ (B) $\sqrt{\frac{8}{\pi}}$ (C) $\frac{\sqrt{8}}{3}$ (D) 1.333

64. A 2-D lattice has the basis vectors $2\vec{i}$ and $\vec{i}+2\vec{j}$. The basis vectors of the reciprocal lattice are

(A) $\left(\pi\vec{i}+\frac{\pi}{2}\vec{j}\right)$ and $\left(\pi\vec{j}\right)$ (B) $\left(\pi\vec{i}-\frac{\pi}{2}\vec{j}\right)$ and $\left(\pi\vec{j}\right)$

(C) $\left(\pi\vec{j}-\frac{\pi}{2}\vec{i}\right)$ and $\left(\pi\vec{j}\right)$ (D) $\left(\pi\vec{i}-\frac{\pi}{2}\vec{j}\right)$ and $\left(-\pi\vec{j}\right)$

65. In a certain crystal, the volume of primitive cell is V. Then, the volume of the first Brillouin zone is

(A) $\frac{2\pi^3}{V}$ (B) $2\pi^3 V$ (C) $\frac{8\pi^3}{V}$ (D) $\frac{1}{V}$

66. Which of the following type of bonds are directional?

(A) Metallice (B) Ionic

(C) Covalent (D) Van Der Waals

67. Phonon is a quantum of

(A) Electromagnetic wave (B) Magnetization wave

(C) Elastic wave (D) Micro wave

68. In the absence of Umklappa process, the thermal conductivity of an insulating crystal is

(A) zero

(B) non-zero, but finite

(C) infinite

(D) equal to thermal conductivity of a conducting crystal

69. At absolute zero of temperature, all the allowed states of energy up to Fermi level will be

(A) empty (B) occupied

(C) half filled (D) partially filled

70. Consider a quantum system perturbed by a time dependent periodic potential. Let the system be in one of the discrete Eigen states of unperturbed Hamiltonian initially. If the final state of transition is discrete/continuum state, the resident probability of initial state respectively

(A) Decays/Oscillates (B) Decays/Decays

(C) Oscillates/Decays (D) Oscillates/Oscillates

71. The wave function of a scattered partial for large distances from the scattering potential is given by $\psi(\vec{r}) = \exp\left(i\,\vec{k}\cdot\vec{r}\right) + \cos^2\theta \dfrac{\exp\left(i\,\vec{k}\cdot\vec{r}\right)}{r}$

(A) $\frac{4\pi}{5}$ (B) 0 (C) $\frac{\pi}{4}$ (D) $\frac{5\pi}{4}$

72. Momentum wave packet of a particle in one dimension is given by $\varphi(p) = \sqrt{\frac{d}{2\hbar}}\,\Theta\left(\frac{\hbar}{d} - |p - p_o|\right)$, where Θ is a step function. The expectation of the momentum is

(A) 0 (B) p_0 (C) $2p_0$ (D) $\frac{p_0}{2}$

73. Consider a one dimensional potential $V(x) = -\delta(x)$. Let $\varphi_a(x) = \exp(-\alpha|x|)$ be a trial wave function. For what value of α energy is minimum

(A) 1/2 (B) 1 (C) 2 (D) 3/2

74. If three angular momenta are $j_1 = \frac{1}{2}, j_2 = \frac{1}{2}$ and $j_3 = \frac{1}{2}$, what are the allowed values of total angular momentum

(A) 0,1 (B) 1/2, 3/2 (C) 0, 1, 2 (D) 1/2, 3/2, 5/2

75. Let $\psi_n(x)$ are eigen functions of the Hamiltonian $\hat{H}$. Then, the expected value of it in the state given by $f(x)\sum_{n=1}^{\infty} c_n \psi_n(x)$ is

(A) $\Sigma_n |c_n|^2 E_n$ (B) $\Sigma_n |c_n|^2$ (C) $\Sigma_n E_n^2$ (D) $E_n \psi_n$

76. For a free particle, its classical and quantum speeds are related by

(A) $v_{classical} = v_{quantum}$ (B) $v_{classical} >> v_{quantum}$

(C) $v_{classical} << v_{quantum}$ (D) $v_{classical} = 2v_{quantum}$

77. In a finite square-well potential V_0 then number of bound states is

(A) 1 (B) infinite

(C) zero (D) finite

78. What is the nature of the operator? $Q = i\,(d/d\phi).\ (0 \le \phi \le 2\,\pi)$?

(A) Non Hermitian

(B) Hermitian and real eigen values

(C) Hermitian and complex eigenvalues

(D) Non Hermitian and complex eigen values

79. What is the polarization of a moving photon?

(A) its energy density

(B) the orientation of its strong and week fields

(C) the direction in which it is moving

(D) the orientation of its electric and magnetic fields

80. The CCD (image sensor) of a digital camera forms an image with pixels, small regions that form a tiny part of the whole image. What structure performs a similar function in the human eye?

(A) optic nerve
(B) lens
(C) iris
(D) rods and cones

81. Stimulated emission of photons will have polarization and phase

(A) polarization is perpendicular and same phase to incident photons
(B) independent of the state of incident photons
(C) Same as incident state of incident photons
(D) Polarization is perpendicular with phase correlation to that of incident photon

82. The highest efficiency of laser output with respect to pumping power is observed in

(A) Two level atom in a laser system
(B) Three level atom in a laser system
(C) Independent of number of levels in a laser system
(D) Four level atom in a laser system

83. Fill in the blank : ———— requires a quantum mechanics description

(A) Spontaneous emission
(B) Absorption
(C) Stimulated emission
(D) Scattering

84. Lasers rod have to have cut at ———— angle to produce polarized light

(A) Critical angle
(B) Perpendicular to the optic axis
(C) Brewster angle
(D) At an angle of 45° to that of the optic axis

85. A monochromatic electromagnetic wave means that

(A) The field strength at a point varies with time according to sine and cosine function
(B) The wave always travels in same direction
(C) Electric field vector lies in one direction only
(D) Magnetic field vector must be perpendicular to the direction of propagation

86. Polarization of light proves the

(A) Corpuscular nature of light

(B) Longitudinal nature of light

(C) Transverse nature of light

(D) Quantum nature of light

87. Consider the function $f(x)$ in the interval $a \le x \le b$. Let x_0 be any point within this interval .If $h \to 0$ then , using Taylor series the first derivative $f'(x_0)$ can be approximated to

(A) $\frac{f(x_0 - h)}{2h} + \frac{f(x_0 + h)}{2h}$

(B) $\frac{3f(x_0) - 4f(x_0 + h) + f(x_0 + 2h)}{2h}$

(C) $\frac{-f(x_0 - h)}{h} + \frac{f(x_0 + h)}{h}$

(D) $\frac{-3f(x_0) + 4f(x_0 + h) - f(x_0 + 2h)}{2h}$

88. In the FORTRAN programming language, a fixed number of repeated computations can be done using the ———— statement

(A) DO... ENDDO statement

(B) FOR...NEXT statement

(C) do... od statement

(D) CASE statement

89. Other more complicated models for the nucleus have also been proposed, such as the interacting boson model, in which pairs of neutrons and protons interact as bosons, analogously to ————

(A) Excitons

(B) Cooper pairs of electrons

(C) Plasmons

(D) Gluons

90. The color group SU (3) corresponds to a local gauge symmetry. Its gauging give rise to

(A) QCD

(B) QED

(C) Electro weak

(D) GUT

91. The electric charge labels a representation of a local gauge symmetry group that is gauged to give QED. What is it?

(A) U (1)
(B) SU (1)
(C) SU (2)
(D) SU (3)

92. The octet of light spin–1/2 baryons described in SU (3) are n = neutron, p = proton Θ = *Xi* baryon and other particles such as

(A) pi = pi meson and omega hardron
(B) Quarks and colors
(C) Tau and theta particles
(D) Δ = Lambda baryon and Σ = sigma baryon

93. In the nuclear reaction ${}^{1}_{0}n + {}^{6}_{3}Li \rightarrow {}^{3}_{1}T + {}^{4}_{2}He + 4.784\ MeV$ neutrons are important in order to

(A) Create chain reaction
(B) Initiate spallation in tritium
(C) Have Neutron capture cross section in reactors
(D) Breed tritium in dry fusion bombs

94. Fill in the blanks for the following nuclear reaction ${}^{14}N + {}^{4}_{2}He \rightarrow {}^{17}O +$ ————

(A) Beta particle
(B) Proton
(C) Gamma particle
(D) Alpha particle

95. Because of their charge and large mass, alpha particles are easily

(A) Absorbed by materials , and they can travel only a few cm in air
(B) Not absorbed by materials , and they can travel only a few cm in air
(C) Absorbed by materials, and they cannot travel only a few cm in air
(D) Travel only a few cm in air

96. The liquid drop model is able to reproduce many features of nuclei, including the general trend of binding energy with respect to mass numbers, as well as one of the below

(A) Islands of isomers

(B) Magic number

(C) Occupation of nucleons

(D) The phenomenon of nuclear fission

97. The SI units for Stefan-Boltzmann constant is

(A) $J.s.m^{-2}.K^{-4}$

(B) $Wm^{-2}K^{-4}$

(C) $Wm^{2}K^{-4}$

(D) $Wm^{-2}K^{4}$

98. Bohr magneton μ_B is equal to

(A) $\frac{eh}{2\pi m}$

(B) $\frac{e\hbar}{4\pi m}$

(C) $\frac{e\hbar}{2\pi m}$

(D) $\frac{eh}{4\pi m}$

99. Heat conduction is governed by

(A) Fick's law

(B) Stefan-Boltzmann law

(C) Beer law

(D) Fourier law

100. The pairs of energy levels characterized by the same n, S and J values but different L values in X ray spectra are known as

(A) Satellites

(B) Hyperfine structure

(C) Screening doublets

(D) Regular doublets