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TEST BOOKLET

Sl. No. 3798

Subject Code : 20

Subject : Physics

LECTURERS FOR NON-GOVT. AIDED COLLEGES OF ODISHA

Time Allowed : 2 Hours

Maximum Marks : 150

: INSTRUCTIONS TO CANDIDATES :

1. **IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET CONTAINS 23 PAGES AND DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.**

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

3. The Test Booklet contains **100** questions. Each question comprises four answers. You have to select the correct answer which you want to mark (darken) on the **Answer Sheet (OMR Sheet)**. In any case choose ONLY ONE answer for each question. If more than one answer is darkened, it will be considered as wrong.

4. You have to mark (darken) all your answers only on the **OMR Answer Sheet using BLACK BALL POINT PEN** provided by the State Selection Board. You have to do rough work only in the space provided at the end of the Test Booklet. See instructions in the Answer Sheet.

5. All questions carry equal marks i.e. of one and half mark for each correct answer and each wrong answer will result in negative marking of **0.50** mark.

6. Before you proceed to mark (darken) the answers in the **OMR Answer Sheet** to the questions in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per the instructions in your Admit Card.

7. On completion of the examination, you should hand over the **original Answer Sheet (OMR Sheet)** issued to you to the Invigilator before leaving the Examination Hall. You are allowed to take with you the candidate's copy (carbon copy) of the **OMR Answer Sheet** along with the Test Booklet for your reference.

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2021

1. A one-dimensional coupled oscillator consists of two identical masses connected to three identical springs. The free ends of the springs are fixed to two parallel walls. It can move on a frictionless horizontal surface. Which of the following statements is true about the motion of a coupled oscillator, if it is in a normal mode ?

(A) All parts of the oscillator is oscillating sinusoidally with the frequency of the mode.

(B) All parts of the oscillator is oscillating with a linear combination of two frequencies of the normal modes.

(C) One mass oscillates with the frequency of one mode, while the other oscillates with the frequency of the other mode.

(D) The period of oscillation is a common period of the two modes.

2. Three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are defined as : $\vec{a} = x\hat{i} - y\hat{j} + z\hat{k}$, $\vec{b} = x\hat{i} + y\hat{j} - 2z\hat{k}$, $\vec{c} = x\hat{i} - y\hat{j} + \hat{k}$. Which of the following statements is true ?

(A) $\vec{a}$ and $\vec{b}$ both may represent a magnetic field.

(B) $\vec{b}$ and $\vec{c}$ both may represent a magnetic field.

(C) $\vec{a}$ and $\vec{c}$ both may represent a magnetic field.

(D) $\vec{a}$, $\vec{b}$ and $\vec{c}$ all may represent a magnetic field.

3. A particle of mass m = 0.1 kg is initially motionless on a frictionless surface. At time t = 0, an impulse is imparted to the block and it starts moving on the surface with a uniform acceleration a = 10 m/s^2. What is the action S(in J-s) of the particle at a time t = 1s ?

(A) 2

(B) 3

(C) 4

(D) 5

4. A particle of mass m and angular momentum L is moving in an attractive potential $U(r) = -\frac{\alpha}{r^2}$, where α is a positive constant of appropriate dimensions. It may reach the centre of force due to the potential U(r), if :

(A) $\alpha < -\frac{L^2}{2m}$

(B) $\alpha = -\frac{L^2}{2m}$

(C) $\alpha > -\frac{L^2}{2m}$

(D) $\alpha < -\frac{L^2}{m}$

5. At time t, two electric charges are at a distance r. The distance between them is r' at time t'. The equations of motion allow a series of similar paths. If $t'/t = (r'/r)^{\beta}$, then $\beta =$

(A) 1 / 2

(B) 1

(C) 3 / 2

(D) 2

6. The components of a second rank tensor σ_{ij} for i = 1, 2, 3 are given as : $\sigma_{ij} = \psi\delta_{ij} + c(\partial_j v_i + \partial_i v_j)$, where c is a constant, ψ is a scalar field and v_i(for i = 1, 2, 3) are the components of a divergence free vector field $\vec{v}$. The value of $\partial_j \sigma_{ij}$ is :

(A) $\partial_i \psi + c\partial_j \partial_j v_i$

(B) $\partial_i \psi$

(C) $\partial_i \psi + 2c\partial_j \partial_j v_i$

(D) $c\partial_j \partial_j v_i$

7. If $P_n(x)$ is the Legendre polynomial of degree n, then $\left[\frac{d}{dx} P_n(x)\right]_{x=1}$ is equal to :

(A) n(n + 1)

(B) n(n + 1) / 2

(C) n(n + 1) / 4

(D) n(n + 1) / n !

8. If $H_n(x)$ is Hermite polynomial of order n, then which of the following relations is correct ?

(A) $|H_n(x)| \geq |H_n(ix)| / 2$

(B) $|H_n(x)| \geq |H_n(ix)|$

(C) $|H_n(x)| \leq |H_n(ix)| / 2$

(D) $|H_n(x)| \leq |H_n(ix)|$

9. The value of the integral $I = \int -(x^2 + y^2)\, dxdy$ is :

(A) π

(B) $\pi / 4$

(C) $\pi / 2$

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

10. A 2π periodic function f(x) on the interval $[-\pi, \pi]$ is defined as :

$$f(x) = \begin{cases} 0, \text{ if } -\pi \le x \le 0 \\ 1, \text{ if } 0 \le x \le \pi \end{cases}.$$

If the function f(x) is expanded in Fourier series given by f(x) = $\frac{a_0}{2} + \sum a_n \cos nx + b_n \sin nx$, then which of the following statements is true ?

(A) $a_0 = 1, a_n = 0, b_n = \frac{1-(-1)^n}{n\pi}$

(B) $a_0 = 1, a_n = 0, b_n = \frac{1+(-1)^n}{n\pi}$

(C) $a_0 = 1, a_n = 0, b_n = \frac{1}{n\pi}$

(D) $a_0 = 1, a_n = 0, b_n = -\frac{1}{n\pi}$

11. A one-dimesional coupled oscillator consists of two identical blocks, each of mass m, and three identical massless springs, each of spring constant k. The free ends of the last two springs are connected to two parallel walls. The blocks can move along a straight line on a frictionless horizontal surface. The frequencies of normal modes are :

(A) $\sqrt{k/m}$ and $\sqrt{2k/m}$

(B) $\sqrt{k/m}$ and $\sqrt{(\sqrt{2}+1)k/m}$

(C) $\sqrt{(\sqrt{2}+1)k/m}$ and $\sqrt{3k/m}$

(D) $\sqrt{k/m}$ and $\sqrt{3k/m}$

12. The Hamiltonian of a system with one degree of freedom is given as :

$H(x, p) = \frac{p^2}{2m} - m\gamma x$. The Poisson bracket $[[x, H], H]_{x, p}$ is equal to :

(A) γ

(B) 0

(C) 1

(D) 2γ

13. The Lagrangian of a system with one degree of freedom is $L(q, \dot{q}) = \frac{\dot{q}^2}{8} - \frac{q^2}{16}$. The expression for the Hamiltonian H(q, p) for the system is :

(A) $H(q, p) = \frac{p^2}{2} + \frac{q^2}{16}$

(B) $H(q, p) = \frac{p^2}{2} + \frac{q^2}{4}$

(C) $H(q, p) = p^2 + \frac{q^2}{16}$

(D) $H(q, p) = 2p^2 + \frac{q^2}{16}$

14. The Hamiltonian H of an oscillator is given as : $H(q, p) = \frac{1}{2}(p^2 + q^2)$. Consider coordinate transformations in the phase space of the system from (q, p) to (Q, P) in the form $p = \psi(P)\cos(Q)$ and $q = \psi(P)\sin Q$. The form of the function $\psi(P)$, which makes the transformation canonical is :

(A) $\psi(P) = \sqrt{P}$

(B) $\psi(P) = \sqrt{P/2}$

(C) $\psi(P) = \sqrt{2P}$

(D) $\psi(P) = 2\sqrt{P}$

15. The curve y(x) with y(0) = 0 and y(1) = 1 that gives the minimum value for the integral $J = \int_0^1 \frac{y'^2}{x^3} dx$ is :

(A) $y(x) = x^2$

(B) $y(x) = x^3$

(C) $y(x) = x^4$

(D) $y(x) = (x^2 + x^4)/2$

16. Using the value of the Gamma function $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$, the value of the integral $I = \int_0^\infty \sqrt{z} e^{-z^3} dz$ is :

(A) $\sqrt{\pi}/3$

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

(C) $\sqrt{\pi}$

(D) $2\sqrt{\pi}$

17. The Laplace transform of a function f(t) = sin hbt is :

(A) $\frac{s}{s^2 - b^2}$

(B) $\frac{b}{s^2 - b^2}$

(C) $\frac{s}{s^2 + b^2}$

(D) $\frac{b}{s^2 + b^2}$

18. A surface integral $I = \iint \vec{F} \cdot \vec{ds}$ is defined on a sphere $x^2 + y^2 + z^2 = 9$. If $\vec{F} = 2x\hat{i} + y\hat{j} + 2z\hat{k}$, then the value of the integral I is :

(A) 180π

(B) 150π

(C) 120π

(D) 90π

19. The value of the integral $I = \int_{-\infty}^{\infty} \frac{1}{1+x^4} dx$ is :

(A) 2π

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

(C) π

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

20. The dimensionality of the phase variables of a coplanar double pendulum is :

(A) 1

(B) 2

(C) 3

(D) 4

21. Among the options given below, which one is **not** a scalar quantity ?

(A) Charge density

(B) Current density

(C) Potential energy

(D) Electromagnetic energy density

22. A Faraday cage is usually useful to shield :

(A) Any static electric field as well as electromagnetic radiation

(B) Any static magnetic field as well as electromagnetic radiation

(C) Only static electric and static magnetic field

(D) Only electromagnetic radiation

23. Capacitance of a parallel plate capacitor is :

(A) Inversely proportional to the area of the plates

(B) Proportional to the separation between two plates

(C) Proportional to the area of the plates as well as the separation between plates

(D) Proportional to the area of plates but inversely proportional to the separation

24. Which of the following statement is **not** true ?

(A) Any charged particle moving at a non-zero velocity produces a magnetic field

(B) Any current carrying wire produces a magnetic field

(C) Force on a charged particle is non-zero if the particle moves along the magnetic field direction

(D) A changing magnetic flux across a conducting wire loop induces an electric field along the conducting wire and hence it generates a current

25. A rheostat :

(A) Can be used in high voltage and / or high power dc circuits

(B) Is ideal for tuning a radio receiver

(C) Is better than a potentiometer for low-power audio

(D) Offers the advantage of having no inductance

26. A current loop has magnetic moment μ. The torque, τ, in a magnetic field B is given by :

(A) $\tau = \mu \times B$

(B) $\tau = \mu \cdot B$

(C) $\tau = 0$

(D) $\tau = \mu / B$

27. Which of the following should be minimized in an RF transmission line ?

(A) The load impedance

(B) The load resistance

(C) The line loss

(D) The tansmitter power

28. At the Brewster's angle, the angle between the reflected and refracted rays is :

(A) 45°

(B) 90°

(C) 180°

(D) 0°

29. Suppose a transformer has a primary-to-secondary turns ratio of exactly 9 : 1. The ac voltage at the primary is 117 V rms. What is the voltage across the secondary ?

(A) 1053 V

(B) 13V

(C) 351V

(D) 39V

30. From a point source the intensity of the light is proportional to the :

(A) Distance from the source

(B) Square of the distance from the source

(C) Inverse square of the distance from the source

(D) Inverse of the distance from the source

31. Vector potential, $A_x = -Hy$, $A_y = 0$ and $A_z = 0$ (H = const), will describe a :

(A) Uniform magnetic field

(B) Non-uniform magnetic field

(C) Magnetic field along y-direction

(D) Magnetic field along x-direction

32. A 10 eV electron is circulating in a plane at right angles to a uniform field of magnetic induction of 1.0 gauss (1.0×10^{-4} weber / m^2). Radius of its orbit is approximately :

(A) 18 mm

(B) 1.3 m

(C) 11 cm

(D) 5.6 mm

33. Hamiltonian for a non-relativistic particle of mass m and charge q moving in an electromagnetic field with scalar potential φ and vector potential A is (p is the momentum and c is the speed of light) :

(A) $p^2 / (2m) + q\varphi$

(B) $p^2 / (2m) + q\varphi + q^2A^2 / (2mc^2)$

(C) $(p - qA / c)^2 / (2m) + q\varphi$

(D) $p^2 / (2m) + q^2A^2 / (2mc^2)$

34. Two electrons leave a radioactive sample in opposite directions each having a speed of 0.67c (c = speed of light) with respect to the sample. The relative speed of one electron to the other is :

(A) c

(B) 1.34c

(C) 0.67c

(D) 0.92c

35. In Rayleigh scattering the cross section is proportional to (λ : wavelength of light) :

(A) λ^2

(B) λ

(C) λ^{-1}

(D) λ^{-4}

36. Field due to an electric dipole for large distance r from the dipole is proportional to (approximately) :

(A) r^{-1}

(B) r^{-3}

(C) r^{-2}

(D) r^{-4}

37. For a uniform electric field $\vec{E}$:

(A) $\nabla \times \vec{E} = 0$ and $\nabla \cdot \vec{E} \neq 0$

(B) $\nabla \times \vec{E} \neq 0$ and $\nabla \cdot \vec{E} \neq 0$

(C) $\nabla \times \vec{E} \neq 0$ and $\nabla \cdot \vec{E} = 0$

(D) $\nabla \times \vec{E} = 0$ and $\nabla \cdot \vec{E} = 0$

38. For a vector potential $\vec{A}$ and scalar potential φ, a valid gauge transformation with a scalar function λ :

(A) $\vec{A}' = \vec{A} + \nabla\lambda$ and $\varphi' = \varphi - \partial\lambda/\partial t$

(B) $\vec{A}' = \vec{A} + \nabla\lambda$ and $\varphi' = \varphi + \partial\lambda/\partial t$

(C) $\vec{A}' = \vec{A} - \nabla\lambda$ and $\varphi' = \varphi - \partial\lambda/\partial t$

(D) $\vec{A}' = \vec{A} + 2\nabla\lambda$ and $\varphi' = \varphi - \partial\lambda/\partial t$

39. For an electric dipole radiator the total radiated power is proportional to :

(A) ω^3

(B) ω^4

(C) ω^2

(D) ω

40. When an LCR series circuit driven with an AC voltage is compared to a forced horizontal spring-mass oscillator with a viscous damping (proportional to velocity), then :

(A) R is equivalent to the spring and L is equivalent to the mass

(B) R is equivalent to the mass and L is equivalent to the spring

(C) C is equivalent to the mass and R is equivalent to the spring

(D) L is equivalent to the mass and C is equivalent to the spring

41. Energy eigenvalue (E_n), where n denotes the level of excited state for a particle in a box is proportional to :

(A) n^2

(B) n^{-2}

(C) n

(D) n^{-1}

42. The three Pauli spin matrices satisfy the relation $\sigma_x \sigma_y \sigma_z =$

(A) $i\hbar I$

(B) $-i\hbar I$

(C) iI

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

where I is the 2×2 unit matrix.

43. If the radial wave functions of the Hydrogen atom are $R_{n\ell}(r)$, the number of radial nodes in $R_{52}(r)$ is :

(A) 3

(B) 2

(C) 7

(D) 4

44. If a hydrogen atom has its electron in the n = 4 state. The minimum energy needed to ionise it is :

(A) 13.6 eV

(B) 3.4 eV

(C) 0.85 eV

(D) 0.25 eV

45. The energy levels are equi-spaced in which of the following one dimensional potential ?

(A) Harmonic oscillator

(B) Particle in a box

(C) Finite potential well

(D) Infinite potential well

46. If L_x, L_y and L_z are the x, y and z-components of the orbital angular momentum operator and $L^2 = L_x^2 + L_y^2 + L_z^2$, then the value of $[L^2, L_z]$ is :

(A) Zero

(B) $2i\ L_z$

(C) $-2i\ L_z$

(D) $i\ L_z$

47. For a particle of mass m in a one-diemsional box of side L, the energy levels are :

(A) Directly proportional to m and directly proportional to L^2

(B) Directly proportional to m and inversely proportional to L^2

(C) Inversely proportional to m and inversely proportional to L^2

(D) Inversely proportional to m and directly proportional to L^2

48. A particle limited to x-axis has the wave function $\psi(x) = a\,x$, between x = 0 and x = 1, where a is a constant. The value of $\psi(x)$ is zero otherwise. The expectation value of $< x >$ is :

(A) $\frac{a^2}{8}$

(B) $\frac{a^2}{4}$

(C) $\frac{a^2}{2}$

(D) a^2

49. A hydrogen atom is subjected to an external uniform electric field $\vec{E}$. The first order correction to the ground state energy is :

(A) Directly proportional to $|\vec{E}|$

(B) Inversely proportional to $|\vec{E}|$

(C) Directly proportional to $\sqrt{|\vec{E}|}$

(D) Zero

50. An electron collides with a hydrogen atom in its ground state and excites it to a state n = 2. The energy given to the hydrogen atom is :

(A) 13.4 eV

(B) 10.2 eV

(C) 6.4 eV

(D) 3.2 eV

51. If σ_x, σ_y and σ_z are the Pauli σ matrices, then :

(A) $[\sigma_x, \sigma_y] = \sigma_z$

(B) $[\sigma_x, \sigma_y] = 2\sigma_z$

(C) $[\sigma_x, \sigma_y] = i\sigma_z$

(D) $[\sigma_x, \sigma_y] = 2i\,\sigma_z$

52. If $P_n(x)$ is the Legendre's polynomial, then the value of $\int_{-1}^{1} P_4^2(x)\,dx$ is :

(A) 2/9

(B) 1/9

(C) 1/11

(D) 2/11

53. An eigen function of an operator $\frac{d^2}{dx^2}$ is e^{2x}. The corresponding eigen value is :

(A) 1

(B) 2

(C) 3

(D) 4

54. Which of the following operator is Hermitian ?

(A) $\frac{d}{dx}$

(B) $-i\frac{d}{dx}$

(C) $i\frac{d^2}{dx^2}$

(D) $-i\frac{d^2}{dx^2}$

55. J_x, J_y, J_z are the components of the current density vector $\vec{J}$ and ρ is the charge density. Which of the following represents current density four vector ?

(A) $(J_x, J_y, J_z, i\rho)$

(B) $\left(J_x, J_y, J_z, \frac{i\rho}{c}\right)$

(C) $\left(J_x, J_y, J_z, -\frac{i\rho}{c}\right)$

(D) $(J_x, J_y, J_z, ic\rho)$

56. The electromagnetic field tensor $F_{\mu\nu}$ is defined as $F_{\mu\nu} = \frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial A_\mu}{\partial x_\nu}$, $\mu, \nu = 1, 2, 3, 4$, where A_ν represents the components of the four vector potential and x_μ is the space-time four vector. If (B_1, B_2, B_3) and (E_1, E_2, E_3) represent the x-, y- and z-components of the magnetic and electric fields respectively, then F_{12} represents :

(A) B_1

(B) B_2

(C) B_3

(D) $-\frac{iE_2}{c}$

57. In a Compton scattering process maximum energy is transferred by a photon to an electron. The angle of scattering is :

(A) 0°

(B) 45°

(C) 90°

(D) 180°

58. Addition of two spin $\frac{1}{2}$ particles will give rise to a total spin of :

(A) One

(B) Zero

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

(D) Either spin 0 or spin 1

59. The number of components of a tensor of rank 3 in four dimensional space is :

(A) 12

(B) 27

(C) 64

(D) 128

60. The average speed of an electron in the first Bohr orbit of a Hydrogen like atom of atomic number Z is, in units of the velocity of light :

(A) $Z^{1/2}$

(B) Z

(C) Z^2

(D) Z / 137

61. Time constant in an LR-circuit is :

(A) 1 / LR

(B) LR

(C) L / R

(D) R / L

62. Which of the following is a "universal" gate ?

(A) OR

(B) NOT

(C) AND

(D) NAND

63. How many atoms per unit cell does an FCC lattice have ?

(A) 1

(B) 3

(C) 2

(D) 4

64. A crystal with hexagonal symmetry looks the same after a rotation by :

(A) 60 degrees

(B) 45 degrees

(C) 270 degrees

(D) 30 degrees

65. Which of the following represents the Dirac delta function ?

(A) $\lim_{n\to\infty} \frac{\sin^2 \pi nx}{\pi nx^2}$

(B) $\lim_{k\to\infty} \frac{\sin kx}{\pi x}$, k is real positive

(C) $\lim_{\sigma\to 0} \frac{e^{-x^2/\sigma^2}}{\sigma\sqrt{2\pi}}$

(D) $\lim_{m\to 0} \frac{m}{x^2+m^2}$

66. The output of a logic gate is '1' when all its inputs are at logic '0'. The gate is :

(A) XOR

(B) NOR

(C) OR

(D) AND

67. Indicate which of the following logic gates can be used to realize all possible combinational Logic functions ?

(A) OR and NOT gates

(B) NAND and NOR gates

(C) EX-OR and OR gates

(D) NOR and EX-OR gates

68. The function f(z) of a complex variable z is given by $f(z) = \frac{1}{(z^2+1)^3}$. The residue of f(z) at the pole z = i is :

(A) $\frac{3}{8}$

(B) $\frac{3}{16}$

(C) $\frac{3}{32i}$

(D) $\frac{3}{16i}$

69. An R-S latch is :

(A) Combinatorial circuit

(B) Synchronous sequential circuit

(C) One bit memory element

(D) One clock delay element

70. Fermi energy is the energy of electrons :

(A) At the top most filled level at zero Kelvin

(B) At the top most filled level at room temperature

(C) At the conduction band at room temperature

(D) At the valence band room temperature

71. Identify the direct band gap semiconductor material :

(A) Silicon

(B) Gallium oxide

(C) Gallium arsenide

(D) Silicon arsenide

72. The effective mass of electrons is calculated from :

(A) Energy versus concentration

(B) Energy versus mass

(C) Energy versus momentum

(D) Energy versus structural design

73. In superconductors, the Fermi energy level is :

(A) Below the ground state

(B) Midway between the ground state and first excited state

(C) Above first excited state

(D) At first excited state

74. The susceptibility of paramagnetic materials is :

(A) Positive and small

(B) Negative and small

(C) Positive and large

(D) Negative and large

75. According to Stefan-Boltzmann law, the radiation density inside a cavity is proportional to which power of Temperature (T) ?

(A) T

(B) T^2

(C) T^3

(D) T^4

76. In single slit diffraction experiment, the width of central maximum increases with :

(A) Increasing slit width

(B) Decreasing slit width

(C) Does not depend on slit width

(D) It first increases and then decreases

77. Which of the following represents $J_5(x) + J_3(x)$, where $J_n(x)$ is the Bessel function ?

(A) $2xJ_4(x)$

(B) $\frac{2x}{3}J_4(x)$

(C) $\frac{8}{x}J_4(x)$

(D) $8xJ_4(x)$

78. The wavelength of x-rays is smaller than that of visible light. The speed of x-rays in vacuum is :

(A) Larger than that of visible light

(B) Smaller than that of visible light

(C) Same as that of visible light

(D) Independent of the speed of visible light

79. If the mobility of electrons in a metal increases, the resistivity :

(A) Increases proportionately

(B) Increases disproportionately

(C) Remains constant

(D) Decreases

80. If both ends of a string of length ℓ are fixed, then the wavelengths of the standing wave is :

(A) ℓ/n

(B) $2\ell/n$

(C) $n/(2\ell)$

(D) n/ℓ

where n is an integer.

81. A material with a high dielectric constant :

(A) Acts to increase capacitance per unit volume

(B) Acts to decrease capacitance per unit volume

(C) Has no effect on capacitance

(D) Causes a capacitor to become polarized

82. How many degrees of freedom does a rigid body have in 3-dimensions ?

(A) ∞

(B) 6

(C) 3

(D) 12

83. Which of the following statements are true ?

(i) β^- decay occurs only from the ground state of a nucleus and γ decay from excited states.

(ii) β^- and γ decays can take place from an excited state.

(iii) β^- decay and γ decay both can occur from the ground state of a nucleus.

(iv) In γ decay mass number does not change but atomic number changes by one unit.

(v) In electron capture process mass number does not change but atomic number changes by one unit.

(A) (i), (iv) and (v)

(B) (ii) and (v)

(C) (ii) and (iv)

(D) (i) and (iii)

84. Which of these statements are correct for β^+ decay and electron capture processes ?

(i) The higher the Q value the higher is the transition rate

(ii) Energy available for β^+ is always higher than that for electron capture

(iii) Electron capture is always possible whenever β^+ is allowed

(iv) Neutrino does not come out in EC process

(A) (i) and (iii)

(B) (i) and (iv)

(C) (ii) and (iv)

(D) (ii) and (iii)

85. Which of the properties of neutrino and anti-neutrino are correct ?

(i) Neutrino is a particle with spin $+\frac{1}{2}$ and anti-neutrino is of $-\frac{1}{2}$

(ii) Both of them are spin $+\frac{1}{2}$ particles

(iii) Neutrino is a left-handed particle but anti-neutrino is right-handed

(iv) Both of them are left-handed particles

(A) (i) and (iv)

(B) (ii) and (iv)

(C) (ii) and (iii)

(D) (i) and (iii)

86. If the up quark is denoted by u, down quark is denoted by d, then the quark structure of a proton is denoted by :

(A) uuu + ddd

(B) uud

(C) udd

(D) uud + udd

87. Frictional force is an example of which interaction ?

(A) Gravitational

(B) Strong Nuclear

(C) Weak Nuclear

(D) Electromagnetic

88. The interaction responsible for β decay in nucleus is :

(A) Strong

(B) Weak

(C) Electromagnetic

(D) Gravitation

89. The differential equation $\frac{d^2y}{dx^2} + \frac{1}{x}\frac{dy}{dx} - \left(1 + \frac{9}{x^2}\right)y = 0$ represents :

(A) Spherical Bessel equation

(B) Hermite equation

(C) Modified Bessel equation

(D) Associated Legendre equation

90. A statistical ensemble representing an isolated system in equilibrium is called :

(A) Canonical ensemble

(B) Grand canonical ensemble

(C) Micro canonical ensemble

(D) Ideal ensemble

91. If $\vec{A} = 3\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{B} = 4\hat{i} + 9\hat{j} + 2\hat{k}$, then $\vec{A} \times \vec{B}$ is :

(A) $5\hat{i} - 2\hat{j} + 39\hat{k}$

(B) $-15\hat{i} - 2\hat{j} + 39\hat{k}$

(C) $-15\hat{i} + 9\hat{j} + 62\hat{k}$

(D) $-15\hat{i} + 2\hat{j} - 17\hat{k}$

92. The dimension of the product of a generalized coordinate and its canonically conjugate momentum is equal to the dimension of :

(A) Energy

(B) Linear momentum

(C) Angular momentum

(D) Moment of inertia

93. According to Debye theory, the heat capacity of a solid at very low temperature is proportional to :

(A) T^2

(B) T^3

(C) $\sqrt{T}$

(D) T^4

where T is the absolute temperature.

94. If one interchanges the spatial coordinates of two electrons in a state of total spin zero :

(A) The wave function changes sign

(B) The wave function is unchanged

(C) The wave function changes to a completely different function

(D) The wave function vanishes

95. The quark model follows from :

(A) Lorentz symmetry

(B) SU(3) symmetry

(C) Spherical symmetry

(D) U(1) symmetry

96. The direction of the magnetic field for a long straight wire carrying current is :

(A) In the direction of current

(B) Radially outward

(C) Along lines circling the current

(D) Opposite to the direction of current

97. Which of the following is correct ?

(A) Classical particles obey Maxwell-Boltzmann distribution and boson particles obey Fermi-Dirac distribution

(B) Integral spin particles obey Bose-Einstein distribution and half integral spin particles obey Fermi-Dirac distribution

(C) Boson particles follow Fermi-Dirac statistics and Fermionic particles follow Bose-Einstein statistics

(D) Photons in a cavity follow Fermi-Dirac statistics and free electrons follow Bose-Einstein statistics

98. For a nucleus having mass number A, the surface energy contribution to the binding energy is proportional to :

(A) A

(B) A^2

(C) $A^{2/3}$

(D) A^3

99. If Q is the electronic charge of an elementary particle, Y is the hypercharge and I_3 is the z-component of the isospin, the correct relationship among them is :

(A) $Q = I_3 + Y$

(B) $Q = I_3 - Y$

(C) $Q = I_3 + \frac{Y}{2}$

(D) $Q = I_3 - \frac{Y}{2}$

100. Which of the following is not a property of nuclear force ?

(A) Saturation

(B) Short range

(C) Strong

(D) Charge dependent

(FOR ROUGH WORK ONLY)

(FOR ROUGH WORK ONLY)

(FOR ROUGH WORK ONLY)

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