DO NOT OPEN THE SEAL UNTIL INSTRUCTED TO DO SO

Question Booklet No.

QUESTION BOOKLET

APPLIED SCIENCE (PHYSICS)

Booklet Series

A

Roll No. | | | | | |

(Enter your Roll number in the above space)

Time Allowed : 2 Hours **Maximum Marks : 100**

INSTRUCTIONS FOR CANDIDATES

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS QUESTION BOOKLET **DOES NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR QUESTIONS ETC. IF SO, GET IT REPLACED BY A COMPLETE QUESTION BOOKLET.
2. Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Question Booklet Series Code A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the OMR Answer Sheet liable for rejection.
3. This Question Booklet contains **100** questions. Each question is printed in **English** only. Each question comprises four responses (answers). You will select the response which you want to mark on the OMR Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each question.
4. You have to mark all your responses **ONLY** on the separate OMR Answer Sheet provided. See Instructions at the backside of the OMR Answer Sheet.
5. **All** questions carry equal marks.
6. Before you proceed to mark in the OMR Answer Sheet the response to various questions in the Question Booklet, you have to fill in some particulars in the OMR Answer Sheet as per instructions mentioned on the OMR Answer Sheet.
7. After you have completed filling in all your responses on the OMR Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the OMR Answer Sheet**. You are permitted to take away with you the **Question Booklet**, along with candidate's copy of **OMR Answer Sheet**.
8. Sheets for rough work are appended in the Question Booklet at the end.
9. **Penalty for wrong answers :**

   THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE AS UNDER.

   (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **0.25 mark** assigned to that question will be deducted as penalty.

   (ii) If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above to that question.

   (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be no penalty for that question.

DO NOT OPEN THE SEAL UNTIL INSTRUCTED TO DO SO

1. A system exhibits invariance under translation in space and time. Which of the following quantities will remain conserved?

[A] Linear momentum and angular momentum

[B] Angular momentum and energy

[C] Linear momentum and energy

[D] Linear momentum, angular momentum and energy

2. If the Lagrangian of a system has only one term which has a linear dependence on velocity, then its Hamiltonian

[A] also has only one term depending on velocity

[B] is zero

[C] is not defined

[D] is constant and independent of velocity

3. Although mass-energy equivalence of special relativity allows conversion of photon to an electron-positron pair, such a process cannot occur in free space because

[A] the mass is not conserved

[B] the energy is not conserved

[C] the momentum is not conserved

[D] the charge is not conserved

4. An electron is accelerated from rest by 10·2 million volts. The percent increase in its mass is

[A] 20000

[B] 2000

[C] 200

[D] 20

5. The number of photons emitted per second by a 100 W source of monochromatic light of wavelength 5893 Å is

[A] $2{\cdot}96 \times 10^{20}$

[B] $2{\cdot}96 \times 10^{24}$

[C] $8{\cdot}24 \times 10^{24}$

[D] $8{\cdot}24 \times 10^{20}$

6. Assume that the uncertainty in the location of the particle is equal to its de Broglie wavelength. The uncertainty in the measurement of velocity v of the particle is

[A] $v / 2\pi$

[B] $v / 4\pi$

[C] v / π

[D] $v / 8\pi$

7. A proton is confined to a nucleus of radius 5×10^{-15} m. The minimum value of the kinetic energy of the proton is

[A] 46 keV

[B] 54 keV

[C] 74 keV

[D] 82 keV

8. Which of the following bonds will have directional character?

[A] Ionic

[B] Covalent

[C] Metallic

[D] van der Waals

9. The critical magnetic field for a solid in superconducting state

[A] is independent on temperature

[B] rises with temperature

[C] increases if temperature decreases

[D] does not depend on the transition temperature

10. N-type silicon is obtained by doping silicon with

[A] germanium

[B] aluminium

[C] boron

[D] phosphorus

11. For a perfect free-electron gas in a metal, the magnitudes of phase velocity and group velocity are such that

[A] $V_p = V_g$

[B] $V_p = V_g / 2$

[C] $V_p = 2^{1/2} V_g$

[D] $V_p = 2V_g$

12. Three point charges q, q and $-2q$ are located at $(0, -a, a)$, $(0, a, a)$ and $(0, 0, -a)$ respectively. The net dipole moment of this charge distribution is

[A] $4qa$ along z-axis

[B] $2qa$ along z-axis

[C] $-4qa$ along x-axis

[D] $-2qa$ along y-axis

13. A charge q moves in a combined electric field E and magnetic induction B. Then, as the charge moves

[A] both the electric field and magnetic induction work on it

[B] electric field does work magnetic induction doesn't

[C] magnetic induction works electric field doesn't

[D] neither of them work

14. The electric field due to a charge q is given by $E = q/r^2$ along outward radial direction. The value of the closed surface integral of electric field depends only on

[A] area of surface

[B] radial distance r

[C] charge

[D] shape of the surface

15. The vector potential of a moving charge depends upon

[A] velocity only

[B] charge only

[C] momentum only

[D] velocity and charge

16. Which of the following statements is correct in relation to the distribution functions in statistical mechanics?

[A] In the high temperature limit, the Boltzmann distribution function will be very different from the Bose and Fermi distribution functions

[B] Bose and Boltzmann distribution functions are the same at high temperature but differ from Fermi distribution function

[C] In the high temperature limit, Bose and Fermi distribution functions approach the Boltzmann distribution function

[D] Both statements [A] and [C] are wrong

17. Consider C atom (mass number = 12). Which of the following is ***true*** for atom?

[A] It will follow classical statistics

[B] It will follow Fermi-Dirac statistics

[C] It will follow Bose-Einstein statistics

[D] None of the above

18. In a Stern-Gerlach experiment, the atomic beam whose angular momentum state is to be determined, must travel through

[A] homogeneous radio frequency magnetic field

[B] homogeneous static magnetic field

[C] inhomogeneous static magnetic field

[D] inhomogeneous radio frequency magnetic field

19. If the wavelength of the first line of the Balmer series in the hydrogen spectrum is λ, then the wavelength of the first line of the Lyman series is

[A] $(27/5)\,\lambda$

[B] $(5/27)\,\lambda$

[C] $(32/27)\,\lambda$

[D] $(27/32)\,\lambda$

20. The hyperfine splitting of the spectral lines of an atom is due to the

[A] coupling between the spins of two or more electrons

[B] coupling between the spins and the orbital angular momenta of the electron

[C] coupling between the electron spins and the nuclear spin

[D] effects of external electromagnetic field

21. In the Zeeman effect, the light emitted along and perpendicular to the applied magnetic field are

[A] respectively linearly and circularly polarized

[B] respectively circularly and linearly polarized

[C] both linearly polarized

[D] both circularly polarized

22. Which one of the following ***would not*** cause the broadening in spectral lines?

[A] Doppler effect

[B] Heisenberg's uncertainty

[C] Absorption of EM radiations

[D] Collisions

23. Moving clock loses 1 minute in each hour. The speed of the clock is

[A] $5{\cdot}4 \times 10^7$ ms^{-1}

[B] $2{\cdot}7 \times 10^7$ ms^{-1}

[C] $5{\cdot}4 \times 10^8$ ms^{-1}

[D] $2{\cdot}7 \times 10^8$ ms^{-1}

24. Consider a potential of the form $U(r) = K\dfrac{e^{-\alpha r}}{r}$. If the particle of mass m moves in a circular path, its period is

[A] $\dfrac{2\pi Ke^{-\alpha r}}{mr^3}$

[B] $2\pi\left\{\dfrac{Ke^{-\alpha r}}{mr^3}(1+\alpha r)\right\}^{-1/2}$

[C] $2\pi\left\{\dfrac{Ke^{-\alpha r}}{mr^3}(1+\alpha r)\right\}^{1/2}$

[D] $2\pi\left\{\dfrac{Ke^{-\alpha r}}{mr^3}(1+\alpha r)\right\}$

25. The Hamiltonian corresponding to Lagrangian $\frac{1}{2}\dot{x}^2 - \frac{1}{2}\omega^2 x^2 - \alpha x^3 + \beta x\dot{x}^2 b$ is

[A] $H = \dfrac{p^2}{2(1+2\beta x)} - \dfrac{1}{2}\omega^2 x^2 + \alpha x^3$

[B] $H = \dfrac{p^2}{2(1+2\beta x)} + \dfrac{1}{2}\omega^2 x^2 + \alpha x^3$

[C] $H = \dfrac{p^2}{2(1+2\beta x)^2} + \dfrac{1}{2}\omega^2 x^3 + \alpha x^2$

[D] $H = \dfrac{p^2}{2(1+2\beta x^2)} + \dfrac{1}{2}\omega^2 x + \alpha x^3$

26. Velocity of light in a medium, for which relative permittivity and relative permeability are 3 and 2 respectively, is

[A] $\dfrac{\sqrt{3}}{2} \times 10^8$ m/s

[B] $\dfrac{\sqrt{3}}{4} \times 10^8$ m/s

[C] $\sqrt{\dfrac{3}{2}} \times 10^8$ m/s

[D] $\sqrt{2} \times 10^8$ m/s

27. A plane electromagnetic wave $E = 100 \cos(6 \times 10^8 t + 4x)$ V/m propagates in a medium of dielectric constant

[A] 1·5

[B] 2·0

[C] 2·4

[D] 4·0

28. If $\Psi = 3\cos\theta e^{-i\phi}$, then the commutator $\left[\dfrac{\partial}{\partial\phi}, \dfrac{\partial}{\partial\theta}\right]$ is

[A] $i6 \sin\theta e^{-i\phi}$

[B] $-i6 \sin\theta e^{-i\phi}$

[C] $i3 \sin\theta e^{-i\phi}$

[D] zero

29. A particle constrained to move along the x-axis is described by the wave-function

$$\phi(x) = 2x;\ 0 < x < 1$$
$$= 0;\ \text{elsewhere.}$$

What is the probability of finding the particle within the interval (0, 0·4)?

[A] 0·8

[B] 0·08

[C] 0·008

[D] 0·0008

30. Which of the following is correct set of eigenvalues of the Hermitian matrix $\begin{pmatrix} 2 & i \\ -i & 2 \end{pmatrix}$?

[A] 2, 2

[B] $1, -i$

[C] 1, 3

[D] 1, 0

31. An ensemble of N three-level systems with energies $\varepsilon = -\varepsilon_0$, 0, $+\varepsilon_0$ is in thermal equilibrium at temperature T. Let $\beta = (k_B T)^{-1}$. If $\varepsilon_0 = 2$, the probability of finding the system in the level $\varepsilon = 0$ is

[A] $\frac{\cosh x}{2}$

[B] $(\cosh x)^{-1}$

[C] $(2\cosh x)^{-1}$

[D] $(1 + 2\cosh x)^{-1}$

32. A system containing 10 distinguishable spin $-1/2$ particles is kept in a magnetic field $\vec{B}$. The system has an energy $-2\mu_B B$. The distinct possible configurations are

[A] 210

[B] 720

[C] 1024

[D] 10

33. A black body is at temperature of 527 °C. To radiate twice as much energy per second, its temperature must be increased to the value of

[A] 1600 K

[B] 951 K

[C] 200 K

[D] 12800 K

34. The numbers of accessible states per unit energy are given by $g(\varepsilon) = \frac{2\pi V (2m)^{\frac{3}{2}}}{h^3} \varepsilon^x$ (for non-relativistic gas) and $g(\varepsilon) = \frac{4\pi V}{h^3 c^3} \varepsilon^y$ (for massless or relativistic gas). Then x and y will be

[A] $x = ½, y = ½$

[B] $x = ½, y = 0$

[C] $x = ½, y = 2$

[D] $x = ½, y = 1$

35. The selection rule for Paschen-Back effect is

[A] $\Delta(M_L + 2M_S) = 0, \pm 1$

[B] $\Delta(M_L - 2M_S) = 0, \pm 1$

[C] $\Delta(M_L + M_S) = 0, \pm 1$

[D] $\Delta(2M_L + 2M_S) = 0, \pm 1$

36. In Stark effect $\Delta M_J = 0$ gives

[A] σ-component

[B] π-component

[C] both σ- and π-components

[D] None of the above

37. The first Stokes line of a rotational Raman Spectra is observed at $12{\cdot}96\ \text{cm}^{-1}$. Considering the rigid rotor approximation, the rotational constant is given by

[A] $6{\cdot}48\ \text{cm}^{-1}$

[B] $3{\cdot}24\ \text{cm}^{-1}$

[C] $2{\cdot}16\ \text{cm}^{-1}$

[D] $1{\cdot}62\ \text{cm}^{-1}$

38. In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is

[A] $6 : 3 : 2$

[B] $6 : 3 : \sqrt{2}$

[C] $\sqrt{6} : \sqrt{3} : \sqrt{2}$

[D] $\sqrt{6} : \sqrt{3} : \sqrt{4}$

39. A superconducting ring is cooled in the presence of a magnetic field below its critical temperature (T_c). The total magnetic flux that passes through the ring is

[A] zero

[B] $n\frac{h}{2e}$

[C] $\frac{nh}{4\pi e}$

[D] $\frac{ne^2}{hc}$

40. Calculate mobility of electrons in copper, if number of electrons per unit volume is 9×10^{28} and conductivity of copper is $6 \times 10^7\ (\Omega m^{-1})$.

[A] 5×10^{-3} m/V·s

[B] 4×10^{-3} m/V·s

[C] $4{\cdot}16 \times 10^{-3}$ m/V·s

[D] $5{\cdot}16 \times 10^{-3}$ m/V·s

41. In a band structure calculation, the dispersion relation for electrons is found to be

$$E_k = \beta(\cos k_x a + \cos k_y a + \cos k_z a)$$

where β is constant and a is lattice constant. The effective mass at the boundary of the first Brillouin zone is

[A] $\frac{2\hbar^2}{5\beta a^2}$

[B] $\frac{4\hbar^2}{5\beta a^2}$

[C] $\frac{\hbar^2}{2\beta a^2}$

[D] $\frac{\hbar^2}{3\beta a^2}$

42. If p and q are the position and momentum variables, which one of the following is ***not*** canonical transformation?

[A] $Q = \alpha q$ and $P = \frac{p}{\alpha}$, for $\alpha \neq 0$

[B] $Q = \alpha q + \beta p$ and $P = \beta q + \alpha p$, for α, β real and $\alpha^2 - \beta^2 = 1$

[C] $Q = p$ and $P = q$

[D] $Q = p$ and $P = -q$

43. A space station moving in a circular orbit around the earth goes into a new bound orbit by firing its engine radially outwards. The orbit is

[A] large circle

[B] smaller circle

[C] an ellipse

[D] a parabola

44. A hoop is pivoted at a point on circumference. The period of small oscillations in the plane of loop is

[A] $2\pi\sqrt{\frac{2R}{g}}$

[B] $2\pi\sqrt{\frac{R}{4g}}$

[C] $2\pi\sqrt{\frac{R}{g}}$

[D] $2\pi\sqrt{\frac{9R}{7g}}$

45. The mass m of a moving particle is $\frac{2m_0}{\sqrt{3}}$, where m_0 is rest mass. The linear momentum of the particle is

[A] $2m_0C$

[B] $\frac{2m_0}{\sqrt{3}}$

[C] $\frac{m_0C}{\sqrt{3}}$

[D] m_0C

46. If, in a Kepler potential, the pericentre distance of particle in a parabolic orbit is r_p while the radius of the circular orbit with the same angular momentum is r_c, then

[A] $r_p = r_c/2$

[B] $r_c = r_p$

[C] $2r_c = r_p$

[D] $r_c = \sqrt{2}\, r_p$

47. The electric field of a travelling wave is given by $E = 100\cos(10^9 t - 4x)$, where t is in seconds and x in metres. The speed of the wave is

[A] $3{\cdot}0 \times 10^8$ m/s

[B] $2{\cdot}5 \times 10^8$ m/s

[C] $3{\cdot}0 \times 10^7$ m/s

[D] $5{\cdot}0 \times 10^7$ m/s

48. A wire carrying a current of 2 A is bent into the shape of a two semi-circles, one with a radius 1 m and the other with radius 2 m. The two semi-circles are connected at their ends, that is along the two radii. The magnetic field at the centre of the semi-circles is

[A] 10^{-7} T

[B] 16×10^{-7} T

[C] 2×10^{-7} T

[D] 3×10^{-7} T

49. A sphere of radius R carries polarization $\vec{P}(r) = k\vec{r}$, where k is constant and $\vec{r}$ is vector from centre. What would be the volume bound charge density of the sphere?

[A] $3k\,r^2$

[B] $-3k$

[C] $k\,r^{-2}$

[D] $\frac{\pi k}{4} r^4$

50. If a charged particle of charge q and mass m moving with speed v enters a magnetic field B perpendicular to its direction of motion, it will move in a circular orbit of radius R. Then,

[A] R is directly proportional to q/m and $|B|$

[B] R is inversely proportional to q/m and $|B|$

[C] R is directly proportional to q/m and inversely proportional to $|B|$

[D] R is inversely proportional to q/m and directly proportional to $|B|$

51. A cube has a constant electric potential V on its surface. If there are no charges inside the cube, the potential at the centre of the cube is

[A] V

[B] $V/8$

[C] 0

[D] $V/6$

52. The wavelength of red helium-neon laser in air is 6328 Å. What happens to its frequency in glass that has a refractive index of 1·50?

[A] Increases by a factor of 3

[B] Decreases by a factor of 1·5

[C] Remains the same

[D] Decreases by a factor of 0·5

53. A particle of mass m is confined in a 3-D box of edges a, $2a$ and $2a$. The potential inside the box is zero and infinite outside. The energy of first excited level is

[A] $\frac{3h^2}{4\,ma^2}$

[B] $\frac{3h^2}{16\,ma^2}$

[C] $\frac{9h^2}{32\,ma^2}$

[D] $\frac{17h^2}{32\,ma^2}$

54. Pauli spin matrices satisfy

[A] $\sigma_\alpha\sigma_\beta - \sigma_\beta\sigma_\alpha = i\varepsilon_{\alpha\beta\gamma}\sigma_\gamma$

[B] $\sigma_\alpha\sigma_\beta - \sigma_\beta\sigma_\alpha = 2i\varepsilon_{\alpha\beta\gamma}\sigma_\gamma$

[C] $\sigma_\alpha\sigma_\beta + \sigma_\beta\sigma_\alpha = \varepsilon_{\alpha\beta\gamma}\sigma_\gamma$

[D] $\sigma_\alpha\sigma_\beta - \sigma_\beta\sigma_\alpha = 2\delta_{\alpha\beta}$

55. A fermion of mass m moving in two-dimensions is strictly confined inside a square box of side l. The potential inside is zero. A measurement of the energy of the fermion yields the result $E = \frac{65\pi^2\hbar^2}{2ml^2}$. The degeneracy of this energy state is

[A] 2

[B] 4

[C] 8

[D] 16

56. The momentum operator $-i\hbar\frac{d}{dx}$ acts on a wave function $\psi(x)$. This operator is Hermitian

[A] provided the wave function $\psi(x)$ in normalized

[B] provided the wave function $\psi(x)$ and derivative $\psi^*(x)$ are continuous everywhere

[C] provided the wave function $\psi(x)$ vanishes as $x \to \pm\infty$

[D] by its very definition

57. The energy of the system of 19 electrons in 3-D isotropic harmonic oscillator potential is

[A] 3 $\hbar\omega$

[B] 57·5 $\hbar\omega$

[C] 56·52 $\hbar\omega$

[D] 9·5 $\hbar\omega$

58. A random walker takes a step of unit length in the positive X direction with probability $\frac{2}{3}$ and a step of unit length in negative X direction with probability $\frac{1}{3}$. The mean displacement of walker after n steps is

[A] 0

[B] n

[C] $\frac{n}{9}$

[D] $\frac{n}{3}$

59. A box of volume V containing N molecules of an ideal gas is divided by a wall with a hole into two compartments. If the volume of smaller compartment is $\frac{v}{3}$, then find the variance of number of particles present in it.

[A] $\frac{2}{9}N$

[B] $\frac{N}{4}$

[C] $\sqrt{N}$

[D] $\frac{\sqrt{N}}{3}$

60. In an assembly of N non-interacting particles in equilibrium at temperature T, each of the particles can be in any of the three non-degenerate energy levels with energies 0, K_BT and $2K_BT$. If the mean energy is 100 K_BT, find N. Assume that particles are identical but distinguishable.

[A] 130

[B] 290

[C] 236

[D] 480

61. At temperature _____, the r.m.s. speed of gaseous hydrogen molecules is equal to that of oxygen molecules at 47 °C.

[A] –253 °C

[B] –289 °C

[C] –324 °C

[D] –198 °C

62. Consider the transition of liquid water to steam as it boils at 100 °C under the pressure of 1 atm. Which of the following quantities ***does not*** discontinue at the transition?

[A] Gibbs free energy

[B] The internal energy

[C] The entropy

[D] The specific heat

63. Given that the ground state energy of Hydrogen atom is –13·6 eV, then the ground state energy of positronium (which is a bound state of an electron and a positron) is

[A] 6·8 eV

[B] –6·8 eV

[C] –13·6 eV

[D] 13·6 eV

64. Which of the following transitions is ***not*** allowed in case of an atom according to the electric dipole radiation selection rule?

[A] 2s-1s

[B] 2p-1s

[C] 2p-2s

[D] 3d-2p

65. A crystal system whose unit cell is specified by $a \neq b \neq c$, $a = \gamma = 90° \neq \beta$ is known as

[A] monoclinic

[B] rhombohedral

[C] tetragonal

[D] orthorhombic

66. A plane in a cubic lattice makes intercepts of a, $a/2$ and $2a/3$ with the three crystallographic axes respectively. The Miller indices for this plane are

[A] (2 4 3)

[B] (3 4 2)

[C] (6 3 4)

[D] (1 2 3)

67. Cooper pair forms when two

[A] phonons interact with an electron

[B] electrons interact with a phonon

[C] polarons interact with an electron

[D] electrons interact with an polaron

68. Consider a two-dimensional crystal with 3 atoms in the basis. The number of allowed optical branches (n) and acoustic branches (m) due to lattice vibrations are

[A] $(n, m) = (2, 4)$

[B] $(n, m) = (3, 3)$

[C] $(n, m) = (4, 2)$

[D] $(n, m) = (1, 5)$

69. Evaluate the following integral, where C is the unit circle and centre is around $|z|=0$, using Cauchy's residue theorem :

$$\oint_c \frac{4z^3+8}{4z+\pi}dz$$

[A] $\pi i(6-\frac{\pi^3}{32})$

[B] $2\pi i(6-\frac{\pi^3}{32})$

[C] $\pi i(4-\frac{\pi^3}{32})$

[D] $\pi i(4-\frac{\pi^3}{64})$

70. The ordinary differential equation $(1-X^2)y''-Xy'+9Y=0$ has a regular singularity at

[A] −1 and +1

[B] 0

[C] 2

[D] No finite value of X

71. The ideal Op-amp with input resistance R_i, output resistance R_o and gain A has

[A] $R_i=\infty, A=\infty, R_o=0$

[B] $R_i=0, A=\infty, R_o=0$

[C] $R_i=\infty, A=\infty, R_o=\infty$

[D] $R_i=0, A=\infty, R_o=\infty$

72. An amplifier with negative feedback has a voltage gain of 100. It is found that with feedback an input signal of 0·6 V is required to produce a given output whereas without feedback the input signal must be only 50 mV for the same output. Then the voltage gain without feedback A and feedback factor β are

[A] $A = 1000, \beta = \frac{9}{1000}$

[B] $A = 1100, \beta = \frac{10}{1100}$

[C] $A = 1400, \beta = \frac{13}{2000}$

[D] $A = 1200, \beta = \frac{11}{1200}$

73. Reduce $AB + ABC + \bar{A}B + A\bar{B}C$ using law's of Boolean algebra.

[A] $A + BC$

[B] $B + AC$

[C] $C + AB$

[D] $A + B + C$

74. If particle X has isospin I = (3/2), Baryon number B = 1 and strangeness number S = 0, then the possible values of electric charges of particle X are

[A] 1, 0 and 1

[B] 1, 0 and –1

[C] 2, 1, 0 and –1

[D] 1·0, –1 and –2

75. The spin parity of ${}_8O^{17}$ is

[A] $\frac{5^+}{2}$

[B] $\frac{3^+}{2}$

[C] $\frac{5^-}{2}$

[D] $\frac{3^-}{2}$

76. The characteristic equation $|A - \lambda I| = 0$ is $\lambda^3 + 2\lambda^2 - 3\lambda + 4 = 0$. The characteristic equation for A^{-1} is

[A] $\lambda^3 - 2\lambda^2 + 3\lambda - 4 = 0$

[B] $\lambda^3 + \frac{1}{2}\lambda^2 - \frac{1}{3}\lambda + \frac{1}{4} = 0$

[C] $\lambda^3 - \lambda^2 - \frac{3}{2}\lambda - 2 = 0$

[D] $\lambda^3 - \frac{3}{4}\lambda^2 + \frac{1}{2}\lambda + \frac{1}{4} = 0$

77. Find the nature and location of singular point of $(z+1)\sin\left(\frac{1}{z-2}\right)$.

[A] Essential singularity at z = 2

[B] Removable singularity at z = 2

[C] Essential singularity z = –1

[D] Removable singularity z = –1

78. The points, where the series solution of the Legendre's differential equation

$$(1-x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + \frac{3}{2}\left(\frac{3}{2}+1\right)y = 0$$

will diverge, are located at

[A] 0 and 1

[B] 0 and –1

[C] –1 and 1

[D] 3/2 and 5/2

79. For a BJT (Bipolar Junction Transistor), the current amplification factor is 0·9. This transistor is connected in CE (Common Emitter) configuration. When the base current changes by 0·4 mA, the change in collector current will be

[A] 36 mA

[B] 9 mA

[C] 4 mA

[D] 3·6 mA

80. The Common Mode Rejection Ratio (CMRR) of a differential amplifier using an operational amplifier is 100 dB. The output voltage for a differential input of 200 μV is 2 V. The common mode gain is

[A] 10

[B] 0·1

[C] 30

[D] 10

81. Number of flip-flops needed to divide the input frequency by 32 is

[A] 2

[B] 4

[C] 5

[D] 8

82. The Boolean expression,

$\overline{\overline{AB} + \bar{A} + AB}$ is equivalent to

[A] A

[B] $\bar{A}$

[C] 1

[D] zero

83. Ten diodes; each of them provides 0·7 V drop when the current through it is 20 mA. They are connected in parallel and operate at a total current of 0·1A. What is the current flow in each diode?

[A] 0·1 A

[B] 0·01 A

[C] 10 A

[D] 20 mA

84. The reaction which has the same transition probability is $\pi^+ + p \to \pi^+ + p$ is

[A] $\pi^+ + n \to \pi^+ + n$

[B] $\pi^- + p \to \pi^0 + n$

[C] $\pi + n \to \pi + n$

[D] $\pi^0 + p \to \pi^+ + n$

85. Half-life of a radioactive material is 4 days. After 20 days, the fraction which remains undecayed will be

[A] 1/32

[B] 1/20

[C] 1/16

[D] 1/8

86. The nucleus ^{41}Ca can be described by the single particle shell model. The single particle states occupied by the last proton and the last neutron respectively are given by

[A] $d_{5/2}$ and $f_{7/2}$

[B] $d_{3/2}$ and $f_{5/2}$

[C] $d_{5/2}$ and $f_{5/2}$

[D] $d_{3/2}$ and $f_{7/2}$

87. The difference in the coulomb energy between the mirror nuclei $_{24}Cr^{49}$ and $_{25}Mn^{49}$ is 6·0 MeV. Assuming that the nuclei have a spherically symmetric charge distribution and e^2 is approximately 1·0 MeV-fm and $k = \frac{1}{4\pi\varepsilon_0} = 1$ unit, then the radius of the $_{25}Mn^{49}$ nucleus is

[A] $4{\cdot}9 \times 10^{-13}$ m

[B] $4{\cdot}9 \times 10^{-15}$ m

[C] $5{\cdot}1 \times 10^{-15}$ m

[D] $45{\cdot}1 \times 10^{-13}$ m

88. In semi-empirical mass formula, the surface energy term (S) is

[A] proportional to $A^{2/3}$

[B] proportional to $A^{-2/3}$

[C] proportional to $A^{1/3}$

[D] proportional to $A^{-1/3}$

89. Which of the following phenomena can be explained by quantum mechanical tunneling through the barrier?

1. Alpha decay

2. Field emission of electron from metal surface

3. Beta decay

[A] 1, 2 and 3

[B] 1 only

[C] 1 and 2 only

[D] 1 and 3 only

90. Nuclear force is

[A] spin dependent

[B] charge invariant

[C] saturated

[D] All of the above

91. The reaction $e^- + e^+ \rightarrow \gamma$ is forbidden because

[A] lepton number is not conserved

[B] charge is not conserved

[C] angular momentum is not conserved

[D] None of the above

92. The quark structure of Δ^{++} is

[A] uuu

[B] udd

[C] ddd

[D] uds

93. Inverse Laplace transform of $\frac{s+1}{s^2-4}$ is

[A] cos $2x$ + ½ sin $2x$

[B] cos x + ½ sin x

[C] cosh x + ½ sinh x

[D] cosh $2x$ + ½ sinh $2x$

94. Fourier transform of the derivative of the Dirac delta-function, is proportional to

[A] 0

[B] –1

[C] sin(k)

[D] ik

95. A current amplifier is characterized by

[A] low input impedance and high output impedance

[B] high input impedance and low output impedance

[C] low impedance at both input and output terminals

[D] high impedance at both input and output terminals

96. A transistor is said to be in saturation region when

[A] both collector and emitter junctions are forward biased

[B] both collector and emitter junctions are reverse biased

[C] the collector junction is forward biased but the emitter junction is reverse biased

[D] the collector junction is reverse biased but the emitter junction is forward biased

97. A J-K flip-flop with $J = 1$ and $K = 1$ has a 10 kHz clock input. The Q output is

[A] a 10 kHz square wave

[B] a 5 kHz square wave

[C] always low

[D] always high

98. Five panelists are required to elect a sixth member to the panel. If any of the panelists votes against a member, the member is disqualified. What would be the appropriate electronic circuit to be used in the electronic voting machine to implement the above rule?

[A] XOR

[B] XNOR

[C] OR

[D] AND

99. The voltage resolution of a 12-bit digital to analog converter (DAC), whose output varies from –10 V to +10 V is approximately

[A] 1 mV

[B] 5 mV

[C] 20 mV

[D] 100 mV

100. The isospin and the strangeness of omega baryon are

[A] 1, –3

[B] 0, –3

[C] 1, 3

[D] 0, 3

SPACE FOR ROUGH WORK

★ ★ ★