139277

Hall Ticket Number

Q.B. No. | | | | | | |

Marks : 100
Time : 120 minutes

JL-414-PHY

Booket : A

A

Signature of the Invigilator

Signature of the Candidate

Total No. of Questions : 100]

[Total No. of Printed Pages : 32

INSTRUCTIONS TO THE CANDIDATE

(Read the Instructions carefully before Answering)

1. Separate Optical Mark Reader (OMR) Answer Sheet is supplied to you alongwith Question Paper Booklet. Please read and follow the instructions on the OMR Answer Sheet for marking the responses and the required data.
2. The candidate should ensure that the Booklet Code printed on OMR Answer Sheet and Booklet Code supplied are same.
3. **Immediately on opening the Question Paper Booklet by tearing off the paper seal, please check for (i) The same booklet code (A/B/C/D) on each page, (ii) Serial Number of the questions (1-100), (iii) The number of pages and (iv) Correct Printing.** In case of any defect, please report to the invigilator and ask for replacement of booklet with same code within five minutes from the commencement of the test.
4. Electronic gadgets like Cell Phone, Calculator, Watches and Mathematical/Log Tables are not permitted into the examination hall.
5. **There will be 1/4 negative mark for every wrong answer.** However, if the response to the question is left blank without answering, there will be no penalty of negative mark for that question.
6. Record your answer on the OMR answer sheet by using Blue/Black ball point pen to darken the appropriate circles of (1), (2), (3) or (4) corresponding to the concerned question number in the OMR answer sheet. Darkening of more than one circle against any question automatically gets invalidated and will be treated as wrong answer.
7. Change of an answer is **NOT** allowed.
8. Rough work should be done only in the space provided in the Question Paper Booklet.
9. **Return the OMR Answer Sheet and Question Paper Booklet to the invigilator before leaving the examination hall.** Failure to return the OMR sheet and Question Paper Booklet is liable for criminal action.

1. If $\vec{A} = 3\hat{i} - \hat{j} + 2\hat{k}$ and $\vec{B} = \hat{i} - 2\hat{j} + 2\hat{k}$, what is $\vec{A} \cdot \vec{B}$?

(1) 9

(2) 5

(3) 12

(4) 8

2. If $\vec{C} = \vec{A} - \vec{B}$, what is C^2?

(1) $A^2 + B^2 - 2AB$

(2) $A^2 + B^2 + 2AB$

(3) $A^2 + B^2 - 2AB\cos\theta$

(4) $A^2 + B^2 + 2AB\cos 0$

3. A 3×3 matrix A has eigen values 1, – 1 and 2. Then which of the following relation is obeyed by the matrix ?

(1) $A^2 - 2A + 3 = 0$

(2) $A^2 - 3A + 2 = 0$

(3) $A^2 + 3A - 2 = 0$

(4) $A^2 + 2A - 3 = 0$

4. What is the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}$

(1) 1

(2) 2

(3) 3

(4) 0

5. The necessary conditions for a function $f(z) = u + iv$ to be analytic at a point z is,

(1) $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$ and $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$

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

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

(4) $\frac{\partial u}{\partial x} = \frac{\partial u}{\partial y}$ and $\frac{\partial v}{\partial x} = \frac{\partial v}{\partial y}$

6. What is the general solution of the differential equation

$\frac{d^2 y}{d x^2} + 36a^2 y = 0$?

(1) $y = A \sin 6ax$

(2) $y = A \cos 6ax$

(3) $y = A \sin 6ax + B \cos 6ax$

(4) $y = A\ e^{-6ax} + B\ e^{6ax}$

7. For the Legendre functions $p_n(x)$, what is $p'_{n+1}(x) - p'_{n-1}(x)$

(1) $2n\ p_n(x)$

(2) $(2n+1)\ p_n(x)$

(3) $(2n-1)\ p_n(x)$

(4) $2(n-1)\ p_n(x)$

8. Given $J_0(2) = 0.22389$, $J_1(2) = 0.57672$, calculate $J_2(2)$.

(1) 0.35283

(2) 0.400305

(3) 0.12894

(4) 0.030400

9. A pair of (distinguishable) dice is tossed once. Each dice can give a score of 1, 2, 3, 4, 5 or 6. 's' denotes the total score of the pair of dice. What is the most probable value of s ?

(1) 6

(2) 7

(3) 2

(4) 12

10. Variance is given by,

(1) $<n>^2 - <n^2>$

(2) $<n>^2 - <\left(\frac{n}{2}\right)^2>$

(3) $<n^2> - <n>^2$

(4) $<\left(\frac{n}{2}\right)^2> - <n>^2$

11. Fourier transform of $\frac{\sin ax}{x}$ is

(1) $\pi\,[\theta\,(k-a) - \theta\,(k+a)]$

(2) $\pi\,[\theta\,(k+a) - \theta\,(k-a)]$

(3) $\pi\,[\theta\,(k+a)]$

(4) $\pi\,[\theta\,(k-a)]$

12. Laplace transform of e^{-at} is

(1) $\frac{1}{s+a}$

(2) $\frac{1}{s-a}$

(3) $\frac{1}{s^2+a^2}$

(4) $\frac{a^2}{s^2+a^2}$

13. Find the centre of mass of three identical particles with position vectors $\vec{r}_1$, $\vec{r}_1$ and $\vec{r}_3$ respectively.

(1) $\frac{\vec{r}_1 - \vec{r}_2 + \vec{r}_3}{3}$

(2) $\frac{\vec{r}_1 + \vec{r}_2 - \vec{r}_3}{3}$

(3) $-\frac{\vec{r}_1 + \vec{r}_2 + \vec{r}_3}{3}$

(4) $\frac{\vec{r}_1 + \vec{r}_2 + \vec{r}_3}{3}$

14. An elevator cable has snapped and the elevator and its contents are falling under uniform gravity 'g'. One of the passengers takes a ball from his pocket and throws it to another passenger. Select the correct statement.

(1) Relative to the elevator, the ball moves with constant acceleration.

(2) Relative to the elevator, the ball moves in a parabolic paths.

(3) Relative to the elevator, the ball moves down with an acceleration g.

(4) Relative to the elevator, the ball moves with constant velocity.

15. Select the non - holonomic constraint.

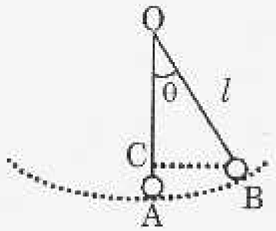
(1) The distance between any two particles of a rigid body is fixed.

(2) The distance of the bob of a simple pendulum from the point of suspension is fixed.

(3) A sphere rolls down an inclined plane without sliding.

(4) A double pendulum.

16. For a simple pendulum as shown in the figure below, calculate the Lagrangian.



(1) $\frac{1}{2}ml^2\theta^2 - mgl(1-\cos\theta)$

(2) $\frac{1}{2}ml^2\theta^2 - mgl(1-\sin\theta)$

(3) $\frac{1}{2}ml^2\theta^2 - mgl\sin\theta$

(4) $\frac{1}{2}ml\theta^2 - mgl\cos\theta$

17. If the Largrangian of a system remains invariant under rotations about any axis then which of the following quantity is conserved ?

(1) Linear momentum

(2) Angular momentum

(3) Kinetic energy

(4) Potential energy

18. For repulsive square forces, the shape of the orbit would be

(1) elliptic

(2) parabolic

(3) hyperbolic

(4) circular

19. The frequency of vibration of a molecule with two component atoms with masses m_1 and m_2 is (k is the spring constant of vibration of the molecule).

(1) $\sqrt{\frac{k(m_1+m_2)}{m_1 m_2}}$

(2) $\sqrt{\frac{k(m_1-m_2)}{m_1 m_2}}$

(3) $\sqrt{\frac{k(m_1^2+m_2^2)}{(m_1^2+m_2^2)^2}}$

(4) $\sqrt{\frac{2k(m_1+m_2)}{m_1 m_2}}$

20. What is the Lorentz gauge condition ?

(1) $\nabla \cdot \bar{A} = -\mu_0 \epsilon_0 \frac{\partial v}{\partial t}$

(2) $\nabla \cdot \vec{A} = +\mu_0 \epsilon_0 \frac{\partial v}{\partial t}$

(3) $\nabla \cdot \bar{A} = -\mu_0 \epsilon_0 \frac{\partial^2 v}{\partial t^2}$

(4) $\nabla \cdot \vec{A} = +\mu_0 \epsilon_0 \frac{\partial^2 v}{\partial t^2}$

21. Two electrons move towards each other with a speed of 0.9 c for each in a Galilean frame of reference. What is their speed relative to each other?

(1) 0.9 c

(2) 0.95 c

(3) 0.995 c

(4) 0.98 c

22. For a moving particle which of the following is a correct statement?

(1) Displacement is not invariant to Galilean transformation.

(2) Velocity is not invariant to Galilean transformation.

(3) Velocity is invariant to Galilean transformation.

(4) Acceleration is not invariant to Galilean transformation.

23. A rod has a length of 100 cm when it is in a satellite moving with a velocity of 0.8c relative to laboratory. What is the length of the rod as determined by an observer in the laboratory?

(1) 64 cm

(2) 60 cm

(3) 36 cm

(4) 80 cm

24. An ordinary light is reflected from glass of refractive index 1.5 at an angle of incidence of 45°. Angle of refraction = 28.1°, reflection coefficients for perpendicular and parallel components of reflected light are 0.09337 and 0.00852 respectively. Calculate the degree of polarisation.

(1) 91.6%

(2) 83.3%

(3) 8.36%

(4) 90.87%

25. Which of the following is an impossible electrostatic field?

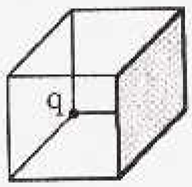
(1) $9x^2yz\ \hat{i} + 3x^3z\ \hat{j} + 3x^3y\ \hat{k}$

(2) $(2y+3z^2)\ \hat{i} + 2x\ \hat{j} + 6xz\ \hat{k}$

(3) $xy\ \hat{i} + 2yz\ \hat{j} + 3xz\ \hat{k}$

(4) $y^2\ \hat{i} + (2xy + z^2)\ \hat{j} + 2yz\ \hat{k}$

26. A charge q sits at the back corner of a cube as shown in the figure below. What is the flux of $\vec{E}$ through the shaded side ?



(1) $\frac{q}{\epsilon_0}$

(2) $\frac{q}{8\epsilon_0}$

(3) $\frac{q}{16\epsilon_0}$

(4) $\frac{q}{24\epsilon_0}$

27. v_1 and v_2 are the solutions of the Laplaces equation in a particular volume satisfying the same boundary conditions. Then,

(1) $v_1 = v_2$ inside v.

(2) $v_1 \neq v_2$.

(3) v_1 and v_2 can be any two potentials.

(4) $v_1 = v_2$, only at the boundary.

28. The magnetic field at a point $\vec{r}$ due to a steady line current is given by,

(1) $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{I}}{R^2}\, dl'$

(2) $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{I} \times \vec{R}}{R^2}\, dl'$

(3) $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{I} \times \hat{R}}{R^2}\, dl'$

(4) $\vec{B}(\vec{r}) = \frac{\mu_0}{4\pi}\int \frac{\vec{I} \times \hat{R}}{R^3}\, dl'$

Where $\vec{R} = (\vec{r}' - \vec{r})\infty$

29. 1 tesla = ?

(1) $1\frac{N}{(Am^2)}$

(2) $1\frac{N}{(Am)}$

(3) $1\frac{N.m}{(A)}$

(4) $1\frac{(NA)}{m}$

30. The direction of the magnetic field of a long straight wire carrying current is

(1) in the direction of the current.

(2) radially outward.

(3) radially inward.

(4) along concentric circles circling the current.

31. What is the magnetic field due to a long cable carrying 30,000 A steady current at a distance of 1 m ?

(1) 3×10^{-3} T

(2) 6×10^{-3} T

(3) 3×10^{-4} T

(4) 6×10^{-4} T

32. A uniform cylindrical coil in vacuum has $r_1 = 1m$, $\ell_1 = 1\ m$ and 100 turns. Co axial and at the center of this coil is a smaller coil of $r_2 = 10$ cm, $\ell_1 = 10$ cm and 10 turns. What is the mutual inductance of the two coils?

(1) 39.5 μH

(2) 1.257×10^{-3} H

(3) 39.5 mH

(4) 1.257 μH

33. Select the correct statement.

(1) The torque acting on a dipole kept in a uniform electric field is always zero.

(2) The total force acting on a dipole kept in a uniform electric field is always zero.

(3) The torque acting on a dipole kept in a non uniform electric field is always zero.

(4) The total force acting on a dipole kept in a non uniform electric field is always zero.

34. Select the correct form of the Ampere's law with Maxwell's modification.

(1) $\nabla \times \vec{H} = \mu_0 \vec{J} + \frac{\partial \vec{D}}{\partial t}$

(2) $\nabla \times \vec{H} = \mu_0 \vec{J} + \frac{\partial \vec{E}}{\partial t}$

(3) $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$

(4) $\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{E}}{\partial t}$

35. For a particle in state ψ , the expectation value of kinetic energy is given by,

(1) $\frac{h^2}{2m}\int_{-\infty}^{\infty} |\nabla\psi(x,t)|^2\, dx$

(2) $\frac{h^2}{2m}\int_{0}^{\infty} |\nabla\psi(x,t)|^2\, dx$

(3) $\frac{h^2}{2m}\int_{-\infty}^{\infty} \psi^*(x,t)\nabla^2\psi(x,t)\, dx$

(4) $\frac{h^2}{2m}\int_{0}^{\infty} \psi^*(x,t)\nabla^2\psi(x,t)\, dx$

36. For any two (normalizable) solutions, to the time dependent Schrödinger equation, ψ_1 and ψ_2.

(1) $\int_{-\infty}^{\infty} \psi_1{*}\ \psi_2\, dx = 0$

(2) $\frac{d}{dt}\int_{-\infty}^{\infty} \psi_1{*}\ \psi_2\, dx = 0$

(3) $\frac{d}{dt}\int_{-\infty}^{\infty} \psi_1{*}\psi_2\, dx \neq 0$

(4) $\frac{d^2}{dt^2}\int_{-\infty}^{\infty} (\psi_1{*} + \psi_2)\, dx = 0$

37. The wave function of a certain particle is $\psi = A\sin^2 x$ for $\frac{-\pi}{2}$ to $\frac{\pi}{2}$, then what would be the value of A ?

(1) $\sqrt{\frac{8}{3\pi}}$

(2) $\sqrt{\frac{3}{8\pi}}$

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

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

38. A particle of mass m is confined to move inside an infinitely deep asymmetric

potential well $v(x) = \begin{cases} +\infty, x < 0 \\ 0, 0 \leq x \leq a, \\ +\infty, x > a \end{cases}$

The energy of the particle is given by, (where $n = 1, 2, 3, ...$)

(1) $\frac{n^2\pi^2h^2}{ma^2}$

(2) $\frac{n^2\pi^2h^2}{8ma^2}$

(3) $\frac{n^2\pi^2h^2}{4ma^2}$

(4) $\frac{n^2\pi^2h^2}{2ma^2}$

39. Calculate the commutator $\left[\hat{P}_x, \hat{L}_y\right]$.

(1) 0

(2) $i\hbar\hat{P}_z$

(3) $-i\hbar\hat{P}_z$

(4) $i\hbar$

40. Which of the following is a symmetric function?

(1) $\psi(x_1, x_2) = 4(x_1 - x_2)^2 + \frac{10}{x_1^2 + x_2^2}$

(2) $\psi(x_1, x_2) = -\frac{3(x_1 - x_2)}{2(x_1 - x_2) + 7}$

(3) $\psi(x_1, x_2) = 5\,exp\,(x_1 - x_2) + 10\,exp\,(x_2 - x_1)$

(4) $\psi(x_1, x_2) = -\frac{10\log(x_1x_2) - 5\log(x_1 + x_2)}{exp\,(x_1 - x_2)}$

41. A particle is in a cubical shaped box with infinitely hard walls whose edges are a, b and c respectively. One corner of the cube is at the origin and edges parallel to the axes. The wave function of the particle is,

(1) $\frac{\sqrt{2}}{\sqrt{abc}} \sin\frac{n_x \pi x}{a} \sin\frac{n_y \pi y}{b} \sin\frac{n_z \pi z}{c}$

(2) $\frac{\sqrt{2}}{\sqrt{abc}} \cos\frac{n_x \pi x}{a} \cos\frac{n_y \pi y}{b} \cos\frac{n_z \pi z}{c}$

(3) $\frac{2\sqrt{2}}{\sqrt{abc}} \sin\frac{n_x \pi x^2}{a^2} \sin\frac{n_y \pi y^2}{b^2} \sin\frac{n_z \pi z^2}{c^2}$

(4) $\frac{\sqrt{2}}{\sqrt{abc}} \sin\frac{n_x^2 \pi x}{a} \sin\frac{n_y^2 \pi y}{b} \sin\frac{n_z^2 \pi z}{c}$

42. A particle in an infinite well has a wave function

$$\Psi(x, 0) = \begin{cases} Ax(a-x), & 0 \le x \le a \\ 0, & \text{Otherwise} \end{cases}$$

Find the value of A.

(1) $\frac{a^5}{30}$

(2) $\frac{30}{a^5}$

(3) $\sqrt{\frac{a^5}{30}}$

(4) $\sqrt{\frac{30}{a^5}}$

43. The unperturbed wave functions for the infinite square well are

$$\Psi_n^0(x) = \sqrt{\frac{2}{a}} \sin\left(\frac{n\pi}{a} x\right)$$

If the system is perturbed by raising the 'floor' of the well by a constant amount v_0, find the first - order correction to the energies.

(1) v_0

(2) $\frac{v_0}{2}$

(3) $2\frac{v_0}{3}$

(4) $\frac{v_0}{8}$

44. If $\hat{A}$ and $\hat{B}$ are vector operators such that $\left[\hat{\sigma}\cdot\hat{A}\right]\left[\hat{\sigma}\cdot\hat{B}\right]=\hat{0}$ (where $\hat{\sigma}$ denote the Pauli spin matrix), then what is $\left(\hat{\sigma}\cdot\hat{A}\right)\left(\hat{\sigma}\cdot\hat{B}\right)$?

(1) $\left(\hat{A}\cdot\hat{B}\right)+i\,\hat{\sigma}\cdot\left(\hat{A}\times\hat{B}\right)$

(2) $\left(\hat{A}\cdot\hat{B}\right)-i\,\hat{\sigma}\cdot\left(\hat{A}\times\hat{B}\right)$

(3) $-\left(\hat{A}\cdot\hat{B}\right)-i\,\hat{\sigma}\cdot\left(\hat{A}\times\hat{B}\right)$

(4) $-\left(\hat{A}\cdot\hat{B}\right)+i\,\hat{\sigma}\cdot\left(\hat{A}\times\hat{B}\right)$

45. Consider any function $k(x)$. What is $[k(x), p_x]$?

(1) 1

(2) $-i\hbar\dfrac{dk}{dx}$

(3) 0

(4) $i\hbar\dfrac{dk}{dx}$

46. The enthalpy (H) of a system is defined as,

(1) H = U – PV

(2) H = U + PV

(3) H = U + TS

(4) H = U – TS

(Where U = internal energy, P = Pressure, V = Volume, T = absolute temperature, and S = entropy of the system).

47. Calculate the change in the melting point of ice when it is subjected to a pressure of 100 atmosphere. Density of ice = 0.917 g/cm^3 and latent heat of ice = 336 J/g.

(1) 73.26 k

(2) – 72.74 k

(3) – 0.7326 k

(4) 0.7326 k

48. Which of following statement is true for perfect as well as non-perfect gases during an adiabatic process?

(1) $\Delta Q = 0$

(2) $\Delta W = 0$

(3) $\Delta T = 0$

(4) $\Delta U = 0$

49. Five particles are distributed in two cells. The number of macrostates is -

(1) 10

(2) 32

(3) 6

(4) 5

50. The entropy of a pattern is given by $S = k \ ln \ (w)$, where

(1) W is number of macrostates with energy E.

(2) W is number of microstates with energy E.

(3) W is canonical partition function.

(4) W is grand canonical partition function.

51. Four macrostates of a system have 2, 6, 16 and 2 microstates respectively. A physical quantity x was measured to be 1, 3, 4 and 7 in those states respectively. Find $<x>$.

(1) $\frac{15}{26}$

(2) $\frac{49}{13}$

(3) $\frac{2}{13}$

(4) $\frac{1}{13}$

52. According to Fermi-Dirac statistics, the number of electrons with energy $\in_r$ is given by,

(1) $\dfrac{g_r}{e^{[(\in r-\in F)/KT]}+1}$

(2) $\dfrac{g_r}{e^{\{(\in r-\in F)/KT\}}-1}$

(3) $\dfrac{g_r}{e^{((\in F-\in r)/KT)}-1}$

(4) $\dfrac{g_r}{e^{((\in F-\in r)/KT)}+1}$

53. Partition function Z for a canonical ensemble is given by,

(1) $Z(V,T)=\Sigma g_i\, e^{+\in i/KT}$

(2) $Z(V,T)=\Sigma g_i\, e^{-\in i/KT}$

(3) $Z(V,T)=\Sigma g_i\left(e^{+\in i/KT}-1\right)$

(4) $Z(V,T)=\Sigma g_i\left(e^{\in i/KT}-1\right)$

54. Which is the correct form of Planck's formula for the distribution of energy over a black body spectrum?

(1) $u(\omega)d\omega=\dfrac{\hbar}{\pi^2 c^3}\,\dfrac{\omega^3 d\omega}{e^{\frac{\hbar\omega}{KT}}+1}$

(2) $u(\omega)d\omega=\dfrac{\hbar}{\pi^2 c^3}\,\dfrac{\omega^{3/2} d\omega}{e^{\hbar\omega/KT}+1}$

(3) $u(\omega)d\omega=\dfrac{\hbar}{\pi^2 c^3}\,\dfrac{\omega^{3/2} d\omega}{e^{\hbar\omega/KT}-1}$

(4) $u(\omega)d\omega=\dfrac{\hbar}{\pi^2 c^3}\,\dfrac{\omega^3 d\omega}{e^{\hbar\omega/KT}-1}$

55. In a common base connection, $I_C = 0.9$ mA and $I_B = 0.1$ mA. What is the value of current amplification factor α ?

(1) 0.1

(2) 0.9

(3) 0.8

(4) 1.0

56. The output impedance of a Bipolar Junction Transistor (BJT) is

(1) Zero

(2) High

(3) Low

(4) Infinite

57. Doping of collector region of a transistor is

(1) Low in comparison to other regions.

(2) Equal to other regions.

(3) High in comparison to other regions.

(4) Moderate in comparison to other regions.

58. In which operating region, a transistor is used as an amplifier?

(1) Cut-off region

(2) Active region

(3) Saturation region

(4) Super saturation region

59. Which type of feedback is used in a bistable multi vibrator?

(1) Negative feedback.

(2) Positive feedback.

(3) Both positive and negative feedback.

(4) No feedback.

60. The op-amp may be used to amplify

(1) ac signals only.

(2) dc signals only.

(3) neither ac signals nor dc signals.

(4) both ac signals and dc signals.

61. The equivalent Boolean expression for $X = \overline{A}\,\overline{B}\,C + A\overline{B}\,C + AB\,\overline{C} + ABC$ is

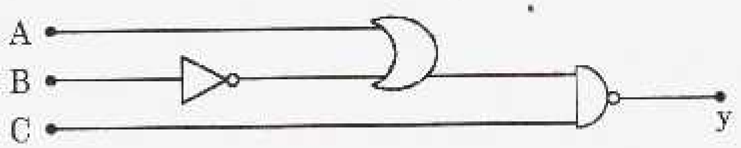
(1) $X = AB + \overline{B}C$

(2) $X = AC + \overline{B}C$

(3) $X = A\overline{B} + \overline{B}C$

(4) $X = A\overline{C} + \overline{B}C$

62. What is the Boolean expression for the given digital circuit?



(1) $(A + \overline{B})C$

(2) $\overline{(A + \overline{B})C}$

(3) $\overline{(A + \overline{B})} + C$

(4) $\overline{(A \cdot \overline{B})} + C$

63. $(B2F)_{16}$ in octal form is equal to

(1) $(5357)_8$

(2) $(5456)_8$

(3) $(5457)_8$

(4) $(5458)_8$

64. An optic fibre has the following characteristics. Fibre refractive index, $n_1 = 1.36$ and relative refractive index difference $(\Delta) = 0.025$. Calculate the value of the numerical aperture.

(1) 0.2

(2) 0.25

(3) 0.3

(4) 0.35

65. The flip-flops in a 4-bit ripple counter each introduces a maximum delay of 50 ns. Calculate the maximum clock frequency.

(1) 5 mHz

(2) 20 mHz

(3) 10 mHz

(4) 2.5 mHz

66. How many degrees of freedom a rigid body has?

(1) 3

(2) 6

(3) 9

(4) $3n$

67. A substance with face centred cubic lattice has density 6250 kg/m^3 and molecular weight 60.2. Calculate the lattice constant. (Avogadro number = 6.02×10^{23})

(1) 6 Å

(2) 8 Å

(3) 4 Å

(4) 10 Å

68. Identify the crystal structure with $\alpha = \beta = 90^0$, $\gamma = 120^0$ and $a = b \neq c$.

(1) Trigonal

(2) Monoclinic

(3) Triclinic

(4) Hexagonal

69. The reciprocal lattice of an fcc lattice is,

(1) an fcc lattice.

(2) a simple cubic lattice.

(3) a bcc lattice.

(4) a triclinic lattice.

70. Quasi crystals are,

(1) Amorphous materials like glass.

(2) Highly ordered crystals.

(3) Nano structures.

(4) An ordered structure but lacks a translational symmetry.

71. What is the inter planar spacing between (1 1 0) planes in a simple cubic lattice with lattice constant 2.813 Å ?
(1) 1.989 Å
(2) 2.884 Å
(3) 1.442 Å
(4) 4.078 Å

72. The scattering factor of a crystal (f), the geometrical structure factor (F), and the lattice structure factor (S) are related as,
(1) $f = \frac{F^2}{S}$
(2) $f = FS$
(3) $f = \sqrt{FS}$
(4) $f = \frac{F}{S}$

73. Calculate the glancing angle on the cube with $d_{hkl} = 1.989$ Å corresponding to the second order diffraction maximum for the x-rays of wavelength 0.9945 Å.
(1) 30°
(2) 45°
(3) 50°
(4) 60°

74. The quantum unit of a crystal vibration is called -
(1) Photon
(2) Polariton
(3) Exciton
(4) Phonon

75. There are p atoms in the primitive cell of a substance. Then select the correct one.
(1) There are 3 optical phonon branches and $3p$-3 acoustical phonon branches.
(2) There are 3 acoustical phonon branches and $3p$-3 optical phonon branches.
(3) There are $3p$ acoustical phonon branches.
(4) There are $3p$ optical phonon branches.

76. As per Einstein, model, the specific heat (C_v) is given by,

(1) $C_v = 3R\left(\frac{\hbar\omega_E}{kT}\right)^2 \frac{e^{\hbar\omega_E/kT}}{\left(e^{\hbar\omega_E/kT}-1\right)^2}$

(2) $C_v = 3R\left(\frac{\hbar\omega_E}{kT}\right)^2 \frac{e^{\hbar\omega_E/kT}}{\left(e^{\hbar\omega_E/kT}+1\right)^2}$

(3) $C_v = 3R\left(\frac{\hbar\omega_E}{kT}\right)^2 \frac{\left(e^{\hbar\omega_E/kT}-1\right)^2}{e^{\hbar\omega_E/kT}}$

(4) $C_v = 3R\left(\frac{\hbar\omega_E}{kT}\right)^2 \frac{\left(e^{\hbar\omega_E/kT}+1\right)^2}{e^{\hbar\omega_E/kT}}$

(Where R = Universal gas constant, $\hbar = \frac{h}{2\pi}$, ω_E = Einstein frequency, k = Bottzman constant, T = absolute temperature).

77. The Hall coefficient is,

(1) directly proportional to the carrier concentration.

(2) inversely proportional to the carrier concentration.

(3) directly proportional to the square root of carrier concentration.

(4) inversely proportional to the square root of carrier concentration.

78. Which is NOT correct about a type I Superconductor?

(1) They show complete Meisner effect.

(2) Their behaviour can not be complained by London theory and can only be understood using BCS theory.

(3) The magnetisation of these materials drops before reaching the critical field B_C.

(4) They behave almost as ideal super conductors.

79. The longest wave length in the Balmer Series is,

(Rydberg constant = $1.097 \times 10^7 \text{ m}^{-1}$)

(1) 364 nm

(2) 729 nm

(3) 656 nm

(4) 457 nm

80. The selection rule for transitions between vibrational states is

(1) $\Delta v = 0$

(2) $\Delta v = \pm 1$

(3) $\Delta v = 0, \pm 1$

(4) $\Delta v = 0, \pm 1, \pm 2$

81. In CO, J = 0 to J = 1 absorption line occurs at a frequency of 1.15×10^{11} Hz What is the bond length of CO molecule? ($m_{co} = 1.14 \times 10^{-26}$ kg)

(1) 113 nm

(2) 11.3 nm

(3) 1.13 nm

(4) 0.113 nm

82. The physical dimension of Planck's constant is, same as than of

(1) linear momentum.

(2) dimension less.

(3) angular momentum.

(4) energy.

83. Lifting of degeneracy in the presence of magnetic field is called,

(1) Stork effect.

(2) Zeeman effect.

(3) Paschen - Bach effect.

(4) Population inversion.

84. The degeneracy of hydrogen atom in $n = 4$ level is, (without considering the electronic spin)

(1) 16

(2) 8

(3) 24

(4) 4

85. What are the possible orientations of $j = \frac{3}{2}$?

(1) 3

(2) 2

(3) 1

(4) 4

86. The term symbol for the ground state of Sodium is $3\ ^2S_{\frac{1}{2}}$. The possible quantum number $n,\ l,\ j$ and m_j of the outer electron is

(1) $n = 3, \ell = 0, j = \frac{1}{2}, m_j = \pm\frac{1}{2}$

(2) $n = 3, \ell = 1, j = \frac{1}{2}, m_j = \pm\frac{1}{2}$

(3) $n = 3, \ell = 1, j = \frac{3}{2}, m_j = \pm 1$

(4) $n = 3, \ell = 0, j = \frac{3}{2}, m_j = \pm 1$

87. Frank - Condon principle states that electronic transition takes place much faster compared to nuclear translations because,

(1) nucleus is positively charged.

(2) nucleus is much massive.

(3) size of the nucleus is very less.

(4) electrons are negatively charged.

88. Blue lasers are difficult to achieve at room temperature, because the ratio of stimulated emission to spontaneous emission coefficients is directly proportional to,

(1) $e^{E_{21}/kT}+1$

(2) $e^{E_{21}/kT}-1$

(3) $\dfrac{1}{e^{E_{21}/kT}-1}$

(4) $\dfrac{1}{e^{-E_{21}/kT}-1}$

89. The importance of a meta stable state in a lasing medium is that

(1) an atom can exist for a longer time in a metastable state.

(2) an atom immediately undergoes a transition to the ground state from a metastable state.

(3) The metastable state enhances the absorption.

(4) The metastable state can directly be reached from the ground state.

90. What is the purpose of He atom is a He–Ne laser?

(1) The laser transition takes place between the energy levels of He.

(2) He atoms help achieve a population inversion in the Ne-atoms.

(3) He atoms help achieve high power.

(4) He atoms helps achieve saturation intensity.

91. The nuclear density is proportional to,

(1) A

(2) A^2

(3) $A^{\frac{1}{3}}$

(4) A^0

92. Find the repulsive electric force on a proton whose centre is 2.5 femtometre from the centre of another Proton. Assume the protons are uniformly charged spheres of positive change.

(1) 40 N

(2) 20 N

(3) 45 N

(4) 50 N

93. The binding energy of Neon isotope $_{10}Ne^{20}$ is 160.647 *Mev*. Find its atomic mass. (mass of Proton = 1.007825 u), (mass of Neutron = 1.008665 u)

(1) 16 u

(2) 18 u

(3) 20 u

(4) 22 u

94. The range of nuclear radius is,

(1) 1 – 100 fm

(2) 1 – 10 fm

(3) 1 – 50 fm

(4) 1 – 250 fm

95. The surface term in semi-empirical binding energy formula is proportional to,

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

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

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

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

96. Nuclei with same number of neutrons are known as,

(1) Isotopes

(2) Isobars

(3) Mirror nuclei

(4) Isotones

97. Find the number of neutrons in $_{40}Zr^{94}$

(1) 40

(2) 94

(3) 54

(4) 134

98. How long does it take 60% of a sample of radon to decay?

(Half life of radon = 3.28 days)

(1) 1.968 days

(2) 5.05 days

(3) 3.936 days

(4) 4.035 days

99. In a β^- emission, $n \rightarrow P + \beta^- + ?$

(1) neutrino

(2) antineutrino

(3) pion

(4) photon

100. A neutron with a kinetic energy of 10^4 eV has a wage length of,

(1) 2.87×10^{-13} m

(2) 2.87 fm

(3) 2.87×10^{-11} m

(4) 2.87 nm

(Space for Rough Work)

(Space for Rough Work)

(Space for Rough Work)