SET 2013

PAPER – III

PHYSICAL SCIENCES

Signature of the Invigilator — Question Booklet No. ....

1. — OMR Sheet No.. ....

Subject Code 05 — **ROLL No.** | | | | | | | | |

Time Allowed : 150 Minutes — **Max. Marks : 150**

No. of pages in this Booklet : **15** No. of Questions : **75**

INSTRUCTIONS FOR CANDIDATES

1. Write your Roll No and the OMR Sheet No in the spaces provided on top of this page.
2. Fill in the necessary information in the spaces provided on the OMR response sheet.
3. This booklet consists of seventy five (75) compulsory questions each carrying 2 marks.
4. Examine the question booklet carefully and tally the number of pages/questions in the booklet with the information printed above. **Do not accept a damaged or open booklet**. Damaged or faulty booklet may be got replaced within the first **5** minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time given.
5. Each Question has four alternative responses marked (A), (B), (C) and (D) in the OMR sheet. You have to completely darken the circle indicating the most appropriate response against each item as in the illustration.

   (A) (B) ● (D)
6. All entries in the OMR response sheet are to be recorded in the original copy only.
7. Use only Blue/Black Ball point pen.
8. Rough Work is to be done on the blank pages provided at the end of this booklet.
9. If you write your Name, Roll Number, Phone Number or put any mark on any part of the OMR Sheet, except in the spaces allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
10. You have to return the Original OMR Sheet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. **You are, however, allowed to carry the test booklet and the duplicate copy of OMR Sheet** on conclusion of examination.
11. Use of any calculator, mobile phone or log table etc. is strictly prohibited.
12. **There is no negative marking.** **05-13**

PHYSICAL SCIENCES
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Note : This paper contains **seventy five (75)** objective type questions of **two (2)** marks each. **All** questions are compulsory.

1. The relation between alternate tensor ϵ_{ijk} of order 3 and Kronecker tensor δ_{ij} is :
   (A) $\epsilon_{ijk}\epsilon_{klm} = \delta_{ik}\delta_{jl} - \delta_{il}\delta_{jk}$
   (B) $\epsilon_{ijk}\epsilon_{klm} = \delta_{ij}\delta_{kl} - \delta_{jk}\delta_{lm}$
   (C) $\epsilon_{ijk}\epsilon_{klm} = \delta_{ik}\delta_{kl} - \delta_{il}\delta_{lm}$
   (D) $\epsilon_{ijk}\epsilon_{klm} = \delta_{ij}\delta_{kl} - \delta_{jk}\delta_{jk}$

2. If the differential equation is :
   $2xy' = 3(2y-1)$, $y(0) = ½$
   then the curve $y = f(x)$ has :
   (A) A unique solution
   (B) Infinite solutions
   (C) No solution
   (D) Indetermined solution

3. Using Taylor's series method, by obtaining the solution of $\frac{dy}{dx}=3x+y^2$ and $y=1$, when $x=0$, the value of y for $x = 0.1$, correct to three decimal places is :
   (A) 1.127
   (B) 1.125
   (C) 1.115
   (D) 1.112

4. The value of the residue of $\frac{\sin Z}{Z^6}$ is :
   (A) –1/5!
   (B) 1/5!
   (C) $2\pi i/5!$
   (D) $-2\pi i/5!$

5. Using Newton-Raphson method, the root of the equation $e^x = 3x$ lying between 0 and 1, upto two decimal figures is :
   (A) 0.62
   (B) 0.31
   (C) 0.06
   (D) 0.03

6. A low pass filter has an input signal to noise ratio (S/N) of 25. If the input voltage is 3mV, the noise voltage will be about :
   (A) 0.6 mV
   (B) 0.12 mV
   (C) 8.3 mV
   (D) 16.6 mV

7. Two amplifiers are cascaded in series. If the voltage gain of first amplifier and second amplifier is 10 and 20 respectively, then the output of cascade amplifier for an input voltage of 0.01V will be :
   (A) 0.3V
   (B) 0.02V
   (C) 3V
   (D) 2V

8. Which of the following is not a transducer ?
   (A) Keyboard
   (B) Microphone
   (C) CPU
   (D) Loudspeaker

9. The resolution of n-bit digital-to-analog converter (DAC) based on R-2R ladder network is :
   (A) $1/2^n$
   (B) $1/2^{n-1}$
   (C) $1/(2^n-1)$
   (D) $1-1/2^n$

10. The role of control unit in microprocessor is :
(A) To perform arithmetic and logic operations
(B) To store the data temporarily during execution of a program
(C) To provide necessary timing and control signals to all operations
(D) To control the signal and store the data temporarily

11. The total number of Zeeman components observed in an electronic transition $d^2_{5/2} \rightarrow p^2_{3/2}$ of an atom in a weak magnetic field are :
(A) 4
(B) 12
(C) 6
(D) 10

12. The pure rotational level of a molecule in the far-infrared region follows the relation F(J) = BJ(J+1), where F(J) is the energy of the rotational level with quantum number J and B is the rotational constant. The lowest rotational energy gap in rotational spectrum is :
(A) 2B
(B) 4B
(C) 6B
(D) 8B

13. In a Raman scattering experiment, light of frequency v from a laser is scattered by diatomic molecules having the moment of inertia I. The typical Raman shifted frequency depends on :
(A) v and I
(B) Only v
(C) Only I
(D) Neither v nor I

14. The frequencies of lines of a line spectrum of X-ray emission depends on the :
(A) Kinetic energy of the electron
(B) Metal used for the anti-cathode
(C) Deceleration of the electron
(D) Shape of the continuous spectrum

15. The direction of orbital magnetic moment in hydrogen atom is :
(A) Same as the direction of orbital angular momentum
(B) Opposite to that of orbital angular momentum
(C) Perpendicular to the direction of orbital angular momentum
(D) In a direction making some angle with the orbital angular momentum vector

16. If the Binding energies of ^1H, ^4He and ^7Li are B_1, B_4 and B_7 respectively, then the value of Q in the reaction $^1H + {}^7Li \rightarrow 2\,{}^4He + Q$ is given by :
(A) $2B_1+4B_7-6B_4$
(B) $B_1+B_7-2B_4$
(C) $B_4-B_1-B_7$
(D) $B_1+7B_7-8B_4$

17. There are 10^6 radioactive nuclei in a given radioactive element having half-life of 20 sec. Nuclei left after 10 sec will be :
(A) 5×10^5
(B) 7×10^5
(C) 8×10^5
(D) 9×10^5

18. The probability of electrons being captured by the nucleus is maximum for :
(A) K shell electrons
(B) L shell electrons
(C) M shell electrons
(D) Electrons in the outermost orbits, independent of which shell they come from

19. The nucleus of the atom $^9Be_4$ will consist of :
(A) 13 up quarks and 13 down quarks
(B) 13 up quarks and 14 down quarks
(C) 14 up quarks and 13 down quarks
(D) 14 up quarks and 14 down quarks

20. The ratio of the sizes of ${}^{216}_{92}X$ and ${}^{27}_{13}Al$ nuclei is approximately :
(A) 2
(B) 4
(C) 8
(D) 16

21. The following nuclear reactions will be completed by putting appropriate particle on the arrow as :

$${}^{238}_{92}U \rightarrow {}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa$$

(A) 2p, γ
(B) α, β
(C) α, γ
(D) 2p, β^-

22. A long solenoid of radius R has n turns of wire per unit length and carries a time-varying current that varies sinusoidally as $I = I_0 \cos\omega t$, where I_0 is the maximum current and ω is the angular frequency. The magnitude of the induced electric field outside the solenoid at a distance r > R from its central axis is :
(A) $(n\mu_0 I_0 \omega R^2/2r) \sin \omega t$
(B) $(n\mu_0 I_0 \omega R^2/2r) \cos \omega t$
(C) $(3 n\mu_0 I_0 \omega R^2/5r) \sin \omega t$
(D) $(3 n\mu_0 I_0 \omega R^2/5r) \cos \omega t$

23. If an electric field is given in a region by $E_x = 0$, $E_y = 0$, $E_z = kz$, then :
(A) There is a time varying magnetic field
(B) There is a charge density in the region
(C) Electric field cannot be constant with time
(D) There is no charge density in the region

24. Two point charges with same charge Q are fixed along the x-axis and are apart at a distance of 2r. A small particle with mass m and charge-q is placed at the mid-point between them. The angular frequency ω of small oscillations of this particle along the y direction will be :
(A) $\left(\frac{2Qq}{\pi\varepsilon_0 mR^2}\right)^{1/2}$
(B) $\left(\frac{Qq}{4\pi\varepsilon_0 mR^3}\right)^{1/2}$
(C) $\left(\frac{Qq}{2\pi\varepsilon_0 mR^3}\right)^{1/2}$
(D) $\left(\frac{Qq}{\pi\varepsilon_0 mR^3}\right)^{1/2}$

25. The power radiated by an electric dipole is proportional to the frequency by :
(A) ω
(B) ω^2
(C) ω^3
(D) ω^4

26. For the dominant mode, in a rectangular waveguide with length 20cm and breadth 10cm, the guide wavelength for a signal of 2.5GHz will be about :
(A) 12 cm
(B) 15cm
(C) 18 cm
(D) 20cm

27. A parallel plate capacitor, at rest in system S_0 and titled at 45° angle to the x_0 axis, carries charge densities $\pm\sigma_0$ on the two plates. Another system S is moving towards right at a constant speed v relative to S_0. The fields E_0 in S_0 and E in S are :

(A) $\frac{\sigma_0}{\sqrt{2}\epsilon_0}(-\hat{x}+\hat{y}), \frac{\sigma_0}{\sqrt{2}\epsilon_0}(-\hat{x}+\gamma\hat{y})$

(B)

(C)

(D)

28. A spherically symmetric charge distribution is given by :

$$\rho(r)=\rho_0\frac{r^2}{a^2}, \quad \text{for } 0 \le r \le a$$
$$=0, \quad \text{for } r>a$$

the electric field intensity outside the charge distribution is :

(A) 0

(B) $\frac{2a^3\rho_0}{15\varepsilon_0 r^2}$

(C) $\frac{a^3\rho_0}{\varepsilon_0 r^2}$

(D) $\frac{a^3\rho_0}{r^2}$

29. Two positive charges q and 2q are located on x axis at x=0.5a and 1.5a respectively and a grounded infinitely long sheet is present at the origin. The magnitude of net force on the charge q is :

(A) $(1/4\pi\varepsilon_0)q^2/2a^2$

(B) $(1/4\pi\varepsilon_0)3q^2/2a^2$

(C) $(1/4\pi\varepsilon_0)q^2/a^2$

(D) $(1/4\pi\varepsilon_0)7q^2/2a^2$

30. A square loop (side 'a') of wire lies on a table, at a distance 's' from a very long straight wire, which carries a current 'I'. If someone pulls the loop directly away from the wire, at speed v, the emf generated is :

(A) $\frac{\mu_0 Iva^2}{2\pi s^2}$

(B) $\frac{\mu_0 Iva^2}{2\pi s(s+a)}$

(C) $\frac{\mu_0 Iva^2}{s(s+a)}$

(D) 0

31. In an electromagnetic wave in free space, the direction of $\vec{E}$, $\vec{B}$ fields and the poynting vector are related by :

(A)

(B)

(C) $\frac{\vec{E}\times\vec{S}}{|\vec{E}\times\vec{S}|}=\frac{\vec{B}}{|\vec{B}|}$

(D) $\frac{\vec{E}\times\vec{S}}{|\vec{E}\times\vec{S}|}=-\frac{\vec{E}}{|\vec{E}|}$

32. The classical partition function Z gives :
(A) Sum of states of the system
(B) Sum of momentum of the system
(C) Sum of energy of the system
(D) Sum of both energy and state of the system

33. Maximum probability distribution of particles in Fermi Dirac distribution is :
(A) $\frac{1}{e^{(\alpha+\beta E_i)}+1}$
(B) $\frac{1}{e^{(\alpha+\beta E_i)}-1}$
(C) $\frac{1}{e^{(\alpha+\beta E_i)}}$
(D) $\frac{1}{e^{(\alpha+\beta E_i)}+e^{-\beta E_i}}$

34. Ising model is used to study the characteristic behavior of :
(A) Paramagnetic materials
(B) Ferromagnetic materials
(C) Diamagnetic materials
(D) Nonmagnetic materials

35. Which of the following is a ferromagnetic material ?
(A) Nickel
(B) Zinc
(C) Tin
(D) Aluminum

36. For an antiferromagnetic material, the magnetic susceptibility (χ) varies with temperature as :
(A) $\chi = C/T$
(B) $\chi = C/(T+\theta)$
(C) $\chi = C/(T-\theta)$
(D) χ is independent of temperature

37. In Bose Einstein Condensation, large number of bosons are accumulated in the quantum state of :
(A) $\varepsilon = 3$
(B) $\varepsilon = 2$
(C) $\varepsilon = 1$
(D) $\varepsilon = 0$

38. If a gas molecule having mean free path of 2×10^{-7} m, moves with the average speed of 500m/s, then number of collisions per second will be about :
(A) 2.5×10^{9}
(B) 4.0×10^{9}
(C) 4.0×10^{-10}
(D) 6.4×10^{-10}

39. Two massless sticks of length 2r, each with a mass m fixed at its middle, are hinged at an end. One stick stands on top of the other. The bottom end of the lower stick is hinged at the ground. They are held such that the lower stick is vertical, and the upper one is tilted at a very small angle θ with respect to the vertical. Both the sticks are then released. At this instant, the angular accelerations of the two sticks are :
(A) $2g\theta/r$, $3g\theta/r$
(B) $3g\theta/r$, $5g\theta/r$
(C) $2g\,\theta/r$, $5g\theta/r$
(D) $5g\theta/r$, $3g\theta/r$

40. A particle slides on the inside surface of a frictionless cone. The cone is fixed with its tip on the ground and its vertical axis is normal to ground. The half-angle at the tip of cone is μ. Let r be the distance of the particle from the vertical axis, and θ be the angle around the cone, then the Lagrangian will be :
(A) $L = \frac{1}{2}m(\dot{r}^2/\sin^2\mu) + r^2\dot{\theta}^2) - \frac{mgr}{\tan\mu}$
(B) $L = \frac{1}{2}m(\dot{r}^2/\sin^2\mu) - r^2\dot{\theta}^2) + \frac{mgr}{\tan\mu}$
(C) $L = \frac{1}{2}m(\dot{r}^2/\sin^2\mu) - r^2\dot{\theta}^2) - \frac{mgr}{\sin\mu}$
(D) $L = \frac{1}{2}m(\dot{r}^2/\sin^2\mu) - r^2\dot{\theta}^2) + \frac{mgr}{\sin\mu}$

41. A bead is constrained to slide on a frictionless rod that is fixed at an angle θ with the vertical axis. The rod is rotating with angular frequency ω about the axis. Taking the distance s along the rod variable, the Lagrangian for the bead is equal to :

(A) $\frac{1}{2}m\dot{s}^2 - mgs\cos\theta$

(B) $\frac{1}{2}m\dot{s}^2 + \frac{1}{2}m(\omega s)^2 - mgs$

(C) $\frac{1}{2}m(\dot{s}\sin\theta)^2 - mgs\cos\theta$

(D) $\frac{1}{2}m\dot{s}^2 + \frac{1}{2}m(\omega s\sin\theta)^2 - mgs\cos\theta$

42. The Lagrangian for a mechanical system is $L = a\dot{r}^2 + br^4$,
where, r is a generalized coordinate and a and b are constants. The equation of motion for this system is :

(A) $\dot{r} = r^2\sqrt{\frac{b}{a}}$

(B) $\dot{r} = \frac{2b}{a}r^3$

$X(\theta,q) = q_1^2 + q_2^2$ $\psi(\theta,\phi) = (5Y_4^3 + Y_6^3 - 2Y_6^0)/\sqrt{30}$

(C) $\ddot{r} = -\frac{2b}{a}r^3$

(D) $\ddot{r} = \frac{2b}{a}r^3$

43. A mass, m, is attached to a massless spring fixed at one end. The mass is confined to move in a horizontal plane, and its position is given by the polar coordinates r and θ. Both r and θ can vary. If the relaxed length of the spring is s and the force constant is k, the Lagrangian, L, for the system is :

(A) $L = \frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 - \frac{1}{2}k(r\cos\theta - s)^2$

(B) $L = \frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 - \frac{1}{2}k(r\sin\theta - s)^2$

(C) $L = \frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 + \frac{1}{2}k(r - s)^2$

(D) $L = \frac{1}{2}m\dot{r}^2 + \frac{1}{2}mr^2\dot{\theta}^2 - \frac{1}{2}k(r - s)^2$

44. If Lagrangian for a three particle system (η_1, η_2, η_3) is given by :

$$L = \frac{1}{2}\left(\dot{\eta}_1^2 + \dot{\eta}_2^2 + \dot{\eta}_3^2\right) - a^2\left(\eta_1^2 + \eta_2^2 + \eta_3^2 - \eta_1\eta_3\right),$$

where, a is real, then one of the normal coordinates has a frequency ω given by :

(A) $\omega^2 = a^2$

(B) $\omega^2 = \frac{a^2}{2}$

(C) $\omega^2 = 2a^2$

(D) $\omega^2 = \sqrt{2}a^2$

45. A particle moves in a centre force field $\vec{F} = -k/r^n\,\hat{r}$, where k is a constant r is the distance of the particle from the origin and is the unit vector in the direction of position vector . Closed stable orbits are possible for :

(A) n <2

(B) n <1

(C) n >2

(D) n <3

46. q_1 and q_2 are generalized coordinates and p_1 and p_2 are the corresponding generalized moments. The poisson bracket {X,Y} of and $Y = 2p_1 + p_2$ is :

(A) $(q_1^2 + q_2^2)p_1$

(B) $3(q_1^2 + q_2^2)$

(C) $4q_1 + 2q_2$

(D) 0

47. A system is known to be in normalized state described by the wave function-

where, Y_l^m is a spherical harmonic. The probability of finding the system in the state m=3 is :

(A) 0

(B) 1/15

(C) 1/6

(D) 13/15

48. Consider a particle of mass m moving in 2-D square box whose sides are given by equations x=0, x=L, y=0, y=*l*. The lowest eigen value of the eigen state which changes its sign under exchange of x and y is :

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

(B) $\frac{3\hbar^2}{2ml^2}$

(C) $\frac{5\hbar^2}{2ml^2}$

(D) $\frac{7\hbar^2}{2ml^2}$

49. Two ions 1 and 2 at fixed separation with spin angular momentum operator S_1 and S_2 have the interaction Hamiltonian H= -J $S_{1.}S_2$. The value of S_1^2 and S_2^2 are fixed at $S_1(S_1+1)$ and $S_2(S_2+1)$ respectively. The energy of ground state is :

(A) 0

(B) –J $S_{1.}S_2$

(C) –J $[S_1(S_1+1)-S_2(S_2+1)]$

(D) –(J/2) $[(S_1+S_2)(S_1+S_2+1)-S_1(S_1+1)-S_2(S_2+1)]$

50. The lowest bound on the ground state of hydrogen using Gaussian trial wave function :

$\psi(r) = Ae^{-br^2}$ is

(given that $\int_0^\infty x^{2n}e^{-ax^2}dx = \frac{1.3...(2n+1)}{a^n 2^{n+1}}\sqrt{\frac{\pi}{a}}$) :

(A) –11.5eV

(B) –13.5eV

(C) –23eV

(D) –1eV

51. A particle of mass m moves in a one-dimensional box with a small potential dip,
V = ∞ for x<0 and x>*l*
V = -b for 0<x <(*l*/2)
V = 0 for (*l*/2)<x<*l*
Treating the potential dip as a perturbation to a regular rigid box, the first order energy of the ground state is :

(A) $\frac{\hbar^2\pi^2}{2ml^2} - \frac{b}{2}$

(B) $\frac{\hbar^2\pi^2}{2ml^2} + \frac{b}{2}$

(C) $\frac{\hbar^2\pi^2}{8ml^2} + \frac{b}{2}$

(D) $\frac{\hbar^2\pi^2}{8ml^2} + \frac{b}{4}$

52. For a particle of mass m in a one-dimensional box of length *l*, the eigen functions and energies are respectively :

$$\psi_n(x) = \sqrt{\frac{2}{\ell}}\sin\frac{n\pi x}{\ell}, 0 \le x \le \ell$$

$$E_n = \frac{1}{2m}\left(\frac{n\pi\hbar}{\ell}\right)^2, n = \pm1, \pm2...$$

Suppose the particle is originally in a state|n> and the box length is increased to a length of 2*l* (0 < x < 2*l*) in a time t << h/E_n. Afterwards the probability that the particle will be found in an energy eigenstate with energy E_n will be :

(A) 1

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

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

(D) 0

53. For a spin half particle the expectation value of $s_x s_y s_z$ is :

(A) $i\hbar^3/8$

(B) $-i\hbar^3/8$

(C) $i\hbar^3/16$

(D) $-i\hbar^3/16$

54. A phase transition of second order is characterized by a discontinuous change in :

(A) Specific heat

(B) Entropy

(C) Volume

(D) Gibb's function

55. In Bose Einstein condensation, the number of particles in lower energy levels :

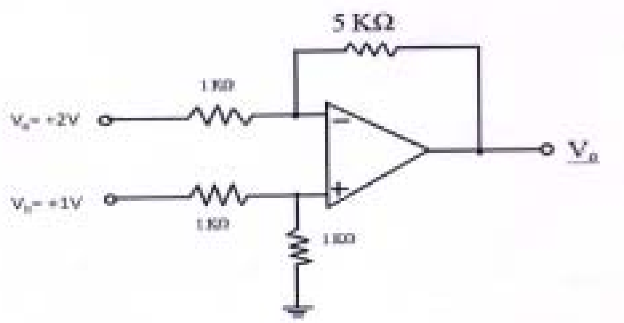
(A) Decreases at low T and high P

(B) Decreases at high T and low P

(C) Increases at low T and high P

(D) Increases at high T and low P

56. The output V_0 in the following circuit having ideal op-amp is :



(A) –7V

(B) –5V

(C) +5V

(D) +7V

57. The base current in a photo-transistor is :

(A) Fixed by the applied bias voltage

(B) Directly proportional to light intensity

(C) Inversely proportional to light intensity

(D) Independent of both the light intensity and applied bias voltage

58. The frequency at which the open loop gain of an amplifier is equal to 1 is known as :

(A) Upper critical frequency

(B) Lower cut off frequency

(C) Unity gain frequency

(D) Half power frequency

59. In a system of 2 identical particles, each can have any one of 3 single particle states. The number of possible states in B-E statistics is :

(A) 2

(B) 5

(C) 6

(D) 12

60. The number of lattice points in a primitive cell are :

(A) 1

(B) 1/2

(C) 2

(D) 3/2

61. The hall coefficient of a Si wafer was found to be $-7.35\times10^{-5}\ m^3C^{-1}$ in the temperature range from 100 to 400 K. The type of charge carrier and approximate carrier density will be :

(A) n-type; $8.5\times10^{22}\ m^{-3}$

(B) p-type; $8.5\times10^{22}\ m^{-3}$

(C) n-type; $4.2\times10^{22}\ m^{-3}$

(D) p-type; $4.2\times10^{22}\ m^{-3}$

62. The monoclinic Bravais lattice has the axial relationship as :

(A) $a \neq b \neq c;\ \alpha \neq \beta \neq \gamma$

(B) $a \neq b \neq c;\ \alpha = \beta = \gamma = 90°$

(C) $a \neq b \neq c;\ \alpha = \gamma = 90° \neq \beta$

(D) $a = b \neq c;\ \alpha = \beta = \gamma = 90°$

63. The maximum radius of the sphere that can just fit into the void at the body centre of fcc structure coordinated by the facial atoms of radius r is :

(A) 0.414r

(B) 1.414r

(C) 0.732r

(D) 1.732r

64. According to Dulong-Petit's law, the specific heat of a solid :

(A) Is proportional to the temperature

(B) Does not depend on temperature

(C) Follows T^3 behaviour

(D) Is inversely proportional to temperature

65. The quanta of energy in elastic wave is :

(A) Photon

(B) Phonon

(C) Plasmon

(D) Fluxoid

66. The packing factor of the fcc structure is about :

(A) 52%

(B) 68%

(C) 74%

(D) 92%

67. At $t = 0$ the inverse Laplace transform of the function $\frac{1}{9s^2+6s+1}$ equals to :

(A) $te^{-t/3}/9$

(B) $te^{-t/3}$

(C) $te^{t/3}/9$

(D) $te^{t/3}$

68. The value of $\int_{-1}^{1} P_n(x)\,dx$ is :

(A) 0

(B) 1

(C) x

(D) $\frac{1}{2n+1}$

69. If 'y' is a function of 'x' only and given by $y = ax^2 + bx$. Then y is a solution of :

(A) $\frac{d^2y}{dx^2} + \frac{2dy}{xdx} + \frac{2y}{x^2} = 0$

(B) $\frac{d^2y}{dx^2} - \frac{1dy}{xdx} + \frac{2y}{x^2} = 0$

(C) $\frac{d^2y}{dx^2} - \frac{2dy}{xdx} + \frac{2y}{x^2} = 0$

(D) $\frac{d^2y}{dx^2} + \frac{1dy}{xdx} + \frac{2y}{x^2} = 0$

70. Consider a heavy nucleus of spin $\frac{1}{2}$. The magnitude of ratio of the intrinsic magnetic moment of nucleus to that of an electron is :

(A) Greater than 1, because the nucleus contains many protons

(B) Greater than 1, because the nucleus is so much larger in diameter than the electron

(C) Less than 1, because of the strong interactions among the nucleons in a nucleus

(D) Less than 1, because the nucleus has a mass much larger than that of the electron

71. Two horizontal scintillation counters are located near the earth's surface. One is 3.0 m directly above the other. Of the following, the largest scintillator resolving time that can be used to distinguish downward going relativistic muons using the relative time of the scintillator signal is :

(A) 1 picosecond
(B) 1 nanosecond
(C) 1 microsecond
(D) 1 millisecond

72. When the beta decay of ^{60}Co nuclei is observed at low temperatures in a magnetic field that aligns the spins of the nuclei, it is found that the electrons are emitted preferentially in a direction opposite to the ^{60}Co spin direction. The invariance that is violated by this decay is :

(A) Gauge invariance
(B) Time invariance
(C) Reflection invariance
(D) Rotation invariance

73. A hypothetical monoatomic substance crystallizes in a centred tetragonal structure. The conventional unit cell can be described by primitive vectors (a, 0, 0), (0, a, 0), (0, 0, c) with c = 3a/2 and a basis consisting of two atoms at positions (0, 0, 0) and (a/2, a/2, c/2). The lattice constant, a = 4.2 Å. The maximum space filling for this lattice is

(A) 69.8%
(B) 56.7%
(C) 72.1%
(D) 45.5%

74. A particle has the wave function $\psi(x) = Ne^{-kr}$. If k is real, the normalization factor N is :

(A) $\left(\frac{\alpha^2}{\pi}\right)^{\frac{1}{2}}$

(B) $\left(\frac{2\alpha^2}{\pi}\right)^{\frac{1}{2}}$

(C) $\left(\frac{\alpha^3}{\pi}\right)^{\frac{1}{2}}$

(D) $\left(\frac{2\alpha^3}{\pi}\right)^{\frac{1}{2}}$

75. If the kinetic energy of an electron is 100 eV, the de Broglie wavelength λ will be about ,
($m_e = 9.1 \times 10^{-31}$ kg)

(A) 2.7 nm
(B) 38 nm
(C) 184 nm
(D) 265 nm

ROUGH WORK

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