COMMON P. G. ENTRANCE TEST – 2025 (CPET-2025)

Test Booklet No. : 2781

Subject Code : 34

Hall Ticket No. :

Subject : PHYSICS

TEST BOOKLET

Time Allowed : 80 Minutes

Full Marks : 100

: INSTRUCTIONS TO CANDIDATES :

1. The Test Booklet contains **24** pages including the cover page and **100** (Question Nos. 1 to 100) multiple choice questions.
2. DO NOT break open the seal of the Test Booklet until the invigilator instructs to do so.
3. The candidates must check discrepancy, if any (like up-printed or torn or missing pages or missing questions) in the Test Booklet immediately after breaking the seal of the Test Booklet. If detected, the invigilator may be requested to replace the same.
4. Candidates are required to fill up and darken the **Hall Ticket No., Test Booklet Serial No.** and OMR Answer Sheet Serial No. in attendance sheet carefully. Wrongly filled in OMR Answer Sheet is liable for rejection.
5. Each question has four choices / answers marked (A), (B), (C), (D). Candidate has to select the most appropriate choice / answer to each question and darken the oval completely against the question number provided in the OMR Answer Sheet. More than one response to a question shall be treated as a wrong answer.
6. Use only **Black Ball Point Pen** for darkening the oval for answering.
7. All the questions are compulsory and they carry equal marks. The total marks scored by a candidate depends on the number of correct choices / answers darkened in the OMR Answer Sheet. There will be +1 mark for each correct answer and –0.25 for each wrong answer.
8. No candidate shall be allowed to leave the Examination Hall / Room till all OMR Answer Sheets have been collected by the invigilator.
9. On completion of the entrance test, the original copy of OMR Answer Sheet be handed over to the invigilator. Candidates are allowed to take the Candidates copy of the OMR Answer Sheet along with the used Test Booklet for reference.
10. Candidates are not allowed to carry any personal belongings including electronic devices such as scientific calculator, cell phones, headphones, earbuds, or any other type of devices that allow any kind of communication inside the Examination Room / Hall.
11. The candidates are advised not to scribble or make any mark on the OMR Answer Sheet except marking the answers at the appropriate places and filling up the details required. Rough work (if any) may be done in the blank sheet(s) provided at the end of the Test Booklet.
12. Any malpractice / use of unfair means will lead to your disqualification from the entrance test / admission process and may also lead to appropriate legal action as deemed fit.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

2781

1. The value of a, b and c such that $\vec{F} = (3x - 4y + az)\hat{i} + (cx - 5y - 2z)\hat{j} + (x - by + 7z)\hat{k}$, is irrotational, are respectively :

(A) 1, 2, –4 (B) –4, 2, 1

(C) 2, 1, –4 (D) –4, 1, 2

2. The condition that the vector $\vec{A}$, should be a gradient of a scalar function is :

(A) $\vec{\nabla} \cdot \vec{A} = 0$ (B) $\vec{\nabla}\vec{A} = 0$

(C) $\vec{\nabla} \times \vec{A} = 0$ (D) $\vec{\nabla} \times \vec{A} - \nabla^2 \vec{A} = 0$

3. An atomic transition line with a wavelength of 350 nm is observed to be split into three components in a spectrum of light from a sunspot. Adjacent components are separated by 1.7 pm. The strength of the magnetic field in the sunspot is :

(A) 3T (B) 0.03T

(C) 3.3T (D) 0.3T

4. Which one of the following is correct with respect to an electron and a proton having the same de-Broglie wavelength of 0 2A ?

(A) Both have the same kinetic energy

(B) Both have the same velocity

(C) Both have the same momentum

(D) The kinetic energy of the proton is more than that of the electron

5. If r_p and r_H are the radius and E_p and E_H are the energy of an electron in the n orbit of positronium atom and hydrogen atom, respectively, then :

(A) $r_p = 2r_H$ and $E_p = E_H/2$ (B) $r_p = 2r_H$ and $E_p = 2E_H$

(C) $r_p = 2r_H$ and $E_p = E_H/4$ (D) $r_p = r_H$ and $E_p = 2E_H$

6. An *X*-ray beam of wavelength 0.16 nm is incident on a set of planes of a certain crystal. The first Bragg reflection is observed for an incidence angle of 30°. What is the corresponding interplanar spacing ?

(A) 0.16 nm (B) 0.67 nm

(C) 1.02 nm (D) 0.89 nm

7. What is the velocity of the conduction electron of silver having Fermi energy 5.52 eV ?

(A) 1.39×10^6 m / s (B) 2.39×10^6 m/s

(C) 0.89×10^6 m/s (D) 0

8. Given for an FET, g_m = 95mA/volt, total capacitance = 500pF. For voltage gain of – 30, the band width will be :

(A) 100 kHZ (B) 630 kHZ

(C) 3 MHZ (D) 19 MHZ

9. The dispersion relation for a one-dimensional monoatomic lattice chain is given by the equation, $\omega = \frac{2}{a}\vartheta_s \left|\sin\left(\frac{ka}{a}\right)\right|$ where 'a' is the interatomic spacing $k = \frac{2\pi}{\lambda}$, and ϑ_s, has the dimension of velocity. The relation between the phase velocity V_p and group velocity V_g in the long wavelength limit is given by :

(A) $V_p = V_g$ (B) $V_p = 2V_g$

(C) $V_p = V_g / 2$ (D) $V_p = 4V_g$

10. The largest wavelength of light falling on double slits separated by 1.5 μm, for which there is a first-order maximum, is in the :

(A) Ultraviolet range (B) Visible range

(C) Infrared range (D) X-ray range

11. A sinusoidal carrier voltage of frequency 1 MHz and amplitude 100 Volts is amplitude modulated by sinusoidal voltage of frequency 5 kHz producing 50% modulations. The frequency and amplitude of lower and upper sideband terms will be :

(A) 995 Hz, 1005 Hz and 25 V (B) 995 Hz, 1005 Hz and 50 V

(C) 995 Hz, 1005 Hz and 75 V (D) 995 Hz, 1005 Hz and 0 V

12. An AM transmitter is coupled to an aerial. The input current is found to be 5A. With modulation, the current value increases to 5.9 A. The depth of modulation is :

(A) 83.4 % (B) 88.6 %

(C) 78.2 % (D) 62.6 %

13. The hexadecimal equivalent of a digital number 10011101 is :

(A) H913 (B) 9D

(C) AE (D) 157

14. If the doping concentration in a Si – Zener diode is increased, the Zener breakdown voltage :

(A) Decreases (B) Increases

(C) Remains unchanged (D) Becomes broader

15. Which one of the following is an example of doubly magic nuclei ?

(A) ^{18}O (B) ^{48}Ca

(C) ^{124}Sn (D) ^{204}Pb

16. Which radiation has maximum ionization power ?

(A) Alpha (B) Beta

(C) Neutron (D) Gamma

17. For beta-minus decay, which statement is **TRUE** ?

(A) The daughter nuclide atomic mass (A_D) is more than that of the parent nuclide atomic mass (A_P)

(B) The daughter nuclide atomic number (Z_D) is the same that of the parent nuclide atomic number (Z_P)

(C) The daughter nuclide neutron number (N_D) is less than that of the parent nuclide neutron number (N_P)

(D) The daughter nuclide neutron number (N_D) is the same that of the parent nuclide neutron number (N_P)

18. Student A's probability of solving the problem is 1/2, and B's is 2/3. What is the probability that the problem is solved ?

(A) 4/6 (B) 1/3

(C) 5/6 (D) None of these

19. Are the three points whose position vectors are $2i + 3j - 4k$, $i - 2j + 3k$ and $-7j + 10k$ collinear ?

(A) Yes (B) No

(C) Cannot be determined (D) None of these

20. Two Carnot engines, X and Y, are operating in series. The engine X receives heat at 1200 K and rejects to a reservoir at a temperature T. The second engine, Y, receives the heat rejected by X and, in turn, rejects to a heat reservoir at 300 K . What is the temperature T (in Kelvin) for the situation when the efficiency of the engines is the same ?

(A) 600 K (B) 750 K

(C) 0 (D) 450 K

21. A square conducting loop of mass m, side l and resistance R is dropped into a region with a uniform horizontal magnetic field B whose direction is perpendicular to the plane of the falling loop. The loop will reach a terminal velocity v given by :

(A) $V = \frac{mgR}{(Bl)^2}$ (B) $V = \frac{2mgR}{(Bl)^2}$

(C) $V = \frac{mgR}{2(Bl)^2}$ (D) None of these

2781

22. An ideal inductor, a resistor of resistance R Ohms and a capacitor with adjustable capacitance are connected in series to an alternating voltage with an effective value of V Volts and frequency of f Hz. The current flowing through the circuit when the capacitance of the capacitor is set to C_1 is the same as when the capacitance of the capacitor is set to C_2, $C_2 > C_1$. The inductance of the inductor L is given by :

(A) $\frac{1}{8\pi^2 f^2}\frac{C_1 + C_2}{C_1 C_2}$ (B) $\frac{1}{8\pi^2 f^2}\frac{C_1 C_2}{C_1 + C_2}$

(C) $\frac{1}{8\pi^2 f^2}\frac{C_1 - C_2}{C_1 C_2}$ (D) $\frac{1}{2\pi^2 f^2}\frac{1}{R(C_1 - C_2)}\frac{C_1 + C_2}{C_1 C_2}$

23. A small block of mass m is kept on a rough inclined surface of inclination θ fixed in an elevator. The elevator rises with a uniform velocity v, and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be :

(A) 0 (B) $mgvt\cos^2\theta$

(C) $mgvt\sin^2\theta$ (D) $mgvt\sin 2\theta$

24. In a gamma decay process, the internal energy of the nucleus of mass M decreases, a gamma photon of energy E and linear momentum $\frac{E}{C}$ is emitted, and the nucleus recoils, the decrease of internal energy is :

(A) E

(B) $E + \frac{E^2}{2Mc^2}$

(C) $E - \frac{E^2}{2Mc^2}$

(D) $\frac{E^2}{2Mc^2}$

25. The moment of inertia of pairs of spheres, each having mass m and radius r, kept in contact about the tangent passing through the point of contact is :

(A) $\frac{4mr^2}{5}$

(B) $\frac{7mr^2}{5}$

(C) $\frac{14mr^2}{5}$

(D) $\frac{5mr^2}{14}$

26. A solid sphere rolling on a rough horizontal surface with linear speed v collides elastically with a fixed, smooth vertical wall. The speed of the sphere after it has started pure rolling in the backward direction is :

(A) $\frac{5v}{7}$

(B) $\frac{2v}{7}$

(C) 7v/5

(D) 3v/7

2781

27. The gravitational field in a region is given by $E = (2\hat{i} + 3\hat{j})$ N / kg. The amount of work done by the gravitational field when a particle is moved on the line $3y + 2x = 5$ is :

(A) 4

(B) 30

(C) 25

(D) 0

28. Three simple harmonic motions of equal amplitudes : A and equal time periods in the same direction combine. The phase of the second motion is 60° ahead of the first and the phase of the third motion is 60° ahead of the second. The amplitude of the resultant motion will be :

(A) A

(B) 2A

(C) $\sqrt{2}$ A

(D) 3A

29. A spherical ball of mass m and radius r rolls without slipping on a rough concave surface of large radius R. It makes small oscillations about the lowest point. The time period is :

(A) $2\pi\sqrt{\frac{7(R-r)}{5g}}$ (B) $2\pi\sqrt{\frac{5(R-r)}{7g}}$

(C) $2\pi\sqrt{\frac{2(R-r)}{5g}}$ (D) $2\pi\sqrt{\frac{2(R-r)}{7g}}$

30. A U-tube containing liquid is accelerated horizontally with a constant acceleration a_0. If the separation between the vertical limbs is l, then difference in the heights of the liquid in the two arms is :

(A) $\frac{a_0 l}{g}$ (B) $\frac{l}{g}$

(C) $\frac{gl}{a_0}$ (D) l

31. Water and mercury are filled in two cylindrical vessels up to the same height. Both the vessels have a hole in the wall near the bottom. The velocity of water and mercury coming out of the holes are V_1 and V_2 respectively, then the relation between V_1 and V_2 is :

(A) $V_1 = V_2$ (B) $V_1 = 13.6V_2$

(C) $V_1 = \frac{V_2}{13.6}$ (D) $V_1 = \sqrt{13.6}\,V_2$

32. A uniform heavy rod of weight W, cross-sectional area A, and length L is hanging from a fixed support. Young's modulus of the material of the rod is Y. Neglect the lateral contraction. The elongation of the rod is :

(A) 0 (B) $\frac{WL}{2AY}$

(C) $\frac{3WL}{2AY}$ (D) $\frac{WL}{4AY}$

33. Two mercury drops each of radius r merge to form a bigger drop. If the surface tension of mercury is S, the surface energy released :

(A) $1.65\pi r^2 S$ (B) $1.33\pi r^2 S$

(C) $1.44\pi r^2 S$ (D) $1.22\pi r^2 S$

34. What is the terminal velocity of the raindrop of a radius of 0.01mm, where the coefficient of viscosity is $1.8 \times 10^{-5} N - s/m^2$ and its density is $1.2 kg/m^3$, density of water = $1000 kg/m^3$? (Take $g = 10 m/s^2$)

(A) 1.2cm/s (B) 2.4cm/s

(C) 2.1m/s (D) 2.1cm/s

35. A guitar string is 90 cm long and has a fundamental frequency of 124 Hz. Where should it be pressed to produce a fundamental frequency of 186 Hz ?

(A) 20 cm from an end (B) 40 cm from an end

(C) 50 cm from an end (D) 60 cm from an end

36. If the sound level in a room is increased from 50dB to 60 dB, what factor is the pressure amplitude increased ?

(A) $\sqrt{5}$ (B) $\sqrt{10}$

(C) $\sqrt{2}$ (D) $\sqrt{3}$

37. A source emitting a sound of frequency 'v' is placed at a large distance from an observer. The source starts moving towards the observer with uniform acceleration 'a'. The speed of sound in the medium is 'v'. The frequency the observer hears, corresponds to the wave emitted just after the source starts is :

(A) $\left(\frac{2vv^2}{2vv - a}\right)$ (B) $\frac{2vv}{2vv - a}$

(C) $\frac{2vv^2}{2vv^2 - a}$ (D) $\frac{vv^2}{2vv - a}$

38. A Young's double slit apparatus has slits separated by 0.28 mm and a screen 48 cm away from the slits. The whole apparatus is immersed in water, and the slits are illuminated by the red light $\lambda = 700$ nm in vacuum. The fringe width of the pattern formed on the screen is :

(A) 0.90 mm (B) 0.60 mm

(C) 0.80 mm (D) 0.40 mm

39. An ideal gas is taken through a process in which the pressure and volume change according to the equation P = kV. The molar heat capacity of the gas for the process is given by :

(A) $C = C_v + \frac{R}{3}$ (B) $C = C_v + R$

(C) $C = C_v + \frac{R}{2}$ (D) $C = C_v + 2R$

40. Two thin metallic spherical shells of radii r_1 and r_2 ($r_1 < r_2$) are placed with their centres coinciding. A thermal conductivity material, K, fills the space between the shells. The inner shell is maintained at a temperature θ_1 and the outer shell at temperature θ_2 ($\theta_1 < \theta_2$). The rate at which heat flows radially through the material $\frac{dQ}{dt}$, is :

2781

(A) $\frac{4\pi K r_1 r_2 (\theta_2 - \theta_1)}{r_2 - r_1}$ (B) $\frac{8\pi K r_1 r_2 (\theta_2 - \theta_1)}{r_2 - r_1}$

(C) $\frac{\pi K r_1 r_2 (\theta_2 - \theta_1)}{r_2 - r_1}$ (D) $\frac{\pi K r_1 r_2 (\theta_2 - \theta_1)}{4(r_2 - r_1)}$

41. A non-conducting sheet of large surface area and thickness 'd' contains uniform charge distribution of density 'ρ'. What is the electric field at a point P inside the plate, at a distance 'x' from the central plane ?

(A) $\frac{\rho x}{2 \epsilon_0}$ (B) $\frac{\rho x}{3 \epsilon_0}$

(C) $\frac{\rho x}{\epsilon_0}$ (D) $\frac{2\rho x}{\epsilon_0}$

42. A capacitor of capacitance C is given a charge Q. At t = 0, it is connected to an uncharged capacitor of equal capacitance through a resistance R. The charge on the second capacitor as a function of time is :

(A) $\frac{Q}{2}\left(1 - e^{-\frac{2t}{RC}}\right)$ (B) $Q\left(1 - e^{-\frac{2t}{RC}}\right)$

(C) $3Q\left(1 - e^{-\frac{2t}{RC}}\right)$ (D) $\frac{Q}{3}\left(1 - e^{-\frac{2t}{RC}}\right)$

43. The magnetic field that exists in a region is given by $\vec{B} = B_0\left[1 + \frac{x}{l}\right]\hat{k}$. A square loop of edge l carrying a current I is placed with its edges parallel to the X-Y axis. The magnitude of the net magnetic force experienced by the loop is :

(A) $2iB_0l$ (B) $4iB_0l$

(C) $5iB_0l$ (D) iB_0l

44. A long wire carrying a current i is bent to form a plane angle α. The magnetic field B at a point on the bisector of this angle situated at a distance x from the vertex as :

(A) $\frac{\mu_0 i}{2\pi x}\cot\left(\frac{\alpha}{4}\right)$ (B) $\frac{\mu_0 i}{2\pi x}\cos\left(\frac{\alpha}{4}\right)$

(C) $\frac{\mu_0 i}{2\pi x}\tan\left(\frac{\alpha}{4}\right)$ (D) $\frac{\mu_0 i}{2\pi x}\cot(\alpha)$

2781

45. Two parallel wires separated by a distance of 10 cm carry currents of 10A and 40A along the same direction. Where should a third current be placed to experience no magnetic force?

(A) 2 cm from the 10 A current (B) 8 cm from 10A current

(C) 6 cm from 10A current (D) 5 cm from 10A current

46. A paramagnetic material is kept in a magnetic field. The field is increased till the magnetization becomes constant. If the temperature is now decreased, the magnetization :

(A) Will increase (B) Will decrease

(C) Remains constant (D) May increase or decrease

47. The residue of $\frac{z}{(z-a)(z-b)}$ at infinity is :

(A) $\frac{a}{b}$ (B) $-\frac{b}{a}$

(C) 1 (D) -1

48. The value of the integral $I = \int_0^{2\pi} \frac{\cos 2\theta d\theta}{5 + 4\cos\theta}$ is :

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{4}$

(C) π (D) $\frac{\pi}{6}$

49. Using the Fourier series, the value of $\sum_0^{\infty} \frac{1}{(2n-1)^2}$ is :

(A) $\frac{1}{2}$ (B) $\frac{\pi^2}{8}$

(C) $\frac{\pi}{8}$ (D) $\frac{\pi^2}{2}$

50. Find $\nabla\phi$ if $\phi = \log r$:

(A) $\frac{\vec{r}}{r}$ (B) $\frac{\vec{r}}{r^2}$

(C) $\frac{\vec{r}}{r^3}$ (D) 0

51. The Laplace transform of e^{-at} is :

(A) $\frac{1}{s-a}$ (B) $\frac{1}{s+a}$

(C) $\frac{1}{s}$ (D) $\left(\frac{s}{s+a}\right)$

52. The value $\Gamma\left(\frac{5}{2}\right)$ is :

(A) $\frac{3}{4}\sqrt{\pi}$ (B) $\frac{3}{8}\sqrt{\pi}$

(C) $\frac{3}{2}\sqrt{\pi}$ (D) $\frac{\sqrt{\pi}}{2}$

53. Find the value of the integral $\int_{-1}^{1} x P_n(x) P_{n-1}(x)\, dx$:

(A) Zero

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

(C) $\frac{1}{4n^2-1}$

(D) $\frac{2}{4n^2-1}$

54. A particle of mass 'm' moves under a potential V(x). The Lagrangian of the system is given by : $L = \frac{1}{2}mx^2 - V(x)$. According to Lagrange's equation of motion, which of the following is the correct equation of motion for the particle ?

(A) $mx + V(x) = 0$

(B) $mx = -\frac{dV(x)}{dx}$

(C) $mx = \frac{dV(x)}{dx}$

(D) $mx + V(x) = 0$

55. A coordinate q_i, is called cyclic (or ignorable) if :

(A) $\frac{\partial L}{\partial q_i} = 0$

(B) $\frac{\partial L}{\partial \dot{q}_i} = 0$

(C) $\frac{d}{dt}\left(\frac{\partial L}{\partial q_i}\right) = 0$

(D) $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) = 0$

2781

56. A meter stick is at an angle of 45° to the x-axis in its rest frame. The rod moves with a speed of $\frac{c}{\sqrt{2}}$ along the + x-direction w. r. t. a frame S. The length of the rod in S is :

(A) $\frac{\sqrt{3}}{2}$

(B) $\frac{\sqrt{3}}{4}$

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

(D) $\sqrt{3}$

57. The rank of the following matrix $\begin{pmatrix} 1 & 5 & 1 \\ 2 & 1 & 1 \\ 5 & 6 & 2 \end{pmatrix}$ is :

(A) 1

(B) 2

(C) 3

(D) 4

58. A cylinder of length L is made up of an inner core of steel of radius, r and an outer a sheath of copper of thickness r. The resistivities of steel and copper are ρ_1 and ρ_2 respectively. The total resistance of the cylinder is :

(A) $\frac{\rho_1\rho_2 L}{\pi r^2(3\rho_1+\rho_2)}$

(B) $\frac{(3\rho_1+\rho_2)L}{\pi r^2(\rho_1\rho_2)}$

(C) $\frac{(3\rho_1+\rho_2)L}{\pi r^2}$

(D) $\frac{(\rho_1+\rho_2)L}{\pi r^2}$

59. An AC generator with output and frequency is connected to the plates of an air-filled parallel plate capacitor of plate area and plate separation. The maximum value of the displacement current is :

(A) $\frac{2\pi \in_0 fVA}{d}$

(B) $\frac{\pi \in_0 fVA}{d}$

(C) $\frac{2\pi \in_0 fA}{Vd}$

(D) $\frac{2\pi \in_0 VA}{fd}$

60. An electron enters a uniform magnetic field of flux density $1.2 Wb/m^2$. The energy difference in (eV) between electrons having spins parallel and anti-parallel to the field is :

(Given : $\mu_B = 9.3 \times 10^{-24} J/T$)

(A) 3.95×10^{-5} eV

(B) 13.95×10^{-5} eV

(C) 23.95×10^{-5} eV

(D) 33.95×10^{-5} eV

61. Using the vector atom model, the possible values of the magnitude of angular momentum of an electron in *f* shell are :

(A) $\frac{3\sqrt{7}\hbar}{2}, \frac{\sqrt{35}\hbar}{2}$

(B) $\frac{2\sqrt{7}\hbar}{2}, \frac{\sqrt{25}\hbar}{2}$

(C) $\frac{5\sqrt{7}\hbar}{2}, \frac{\sqrt{15}\hbar}{2}$

(D) $\frac{\sqrt{7}\hbar}{2}, \frac{\sqrt{5}\hbar}{2}$

62. The two eigenvalues of the matrix $\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ are :

(A) 2, 0 (B) 1, 1

(C) 1, 2 (D) 1, 0

63. Einstein's law and Debye's law of specific heat merges with Dulong-Petit's law at :

(A) High T (B) Low T

(C) All T (D) $T \rightarrow 0K$

64. The average energy of Planck's oscillator is given by :

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

(C) $\frac{h\nu}{e^{\frac{h\nu}{kT}}-1}$ (D) $\frac{kT}{2}$

65. De-Broglie wavelength for thermal Neutrons :

(A) $\lambda = \frac{h}{3mkT}$ (B) $\lambda = h/\sqrt{2mkT}$

(C) $\lambda = \frac{h}{mkT}$ (D) $\lambda = \frac{h}{\sqrt{mkT}}$

66. The expectation value of p_x of the momentum of a particle trapped in a one-dimensional box is :

(A) Zero (B) $\frac{p_x}{2}$

(C) $\frac{p_x}{4}$ (D) $\frac{p_x}{\sqrt{2}}$

67. The quantum operator for energy is :

(A) $i\hbar\nabla$ (B) $-i\hbar\nabla$

(C) $i\hbar\partial / \partial t$ (D) $-i\hbar\partial / \partial t$

68. The wave function of a particle in a region classically forbidden region is _____.

(A) A sine function (B) A cosine function

(C) A positive exponential (D) A negative exponential

69. Probability Density is :

(A) $\frac{i\hbar}{2m}\left(\psi\frac{\partial\psi^*}{\partial x} - \psi^*\frac{\partial\psi}{\partial x}\right)$

(B) $\frac{i\hbar}{2m}\left(\psi^*\frac{\partial\psi}{\partial x} - \psi^*\frac{\partial\psi}{\partial x}\right)$

(C) $-\frac{i\hbar}{2m}\left(\psi\frac{\partial\psi^*}{\partial x} - \psi^*\frac{\partial\psi}{\partial x}\right)$

(D) $-\frac{i\hbar}{2m}\left(\psi^*\frac{\partial\psi}{\partial x} - \psi^*\frac{\partial\psi}{\partial x}\right)$

70. The value of electric charge and strangeness of the d-quark is :

(A) $\frac{2}{3}e, 0$

(B) $-\frac{2}{3}e, 0$

(C) $\frac{-1}{3}e, 0$

(D) $\frac{1}{3}e, -1$

71. A long wire carries a current of 4.00 A. The energy stored in the magnetic field inside the volume of $1mm^3$ at a distance of 10 cm from the wire is given by :

(A) 2.55×10^{-14} J

(B) 5.10×10^{-14} J

(C) 7.65×10^{-14} J

(D) Zero J

2781

72. The magnetic field at a point inside the 2.0mH inductor coil becomes 0.80 of its maximum value in 20 μs when the inductor is joined to a battery, and then the resistance of the circuit is :

(A) 120 ohm

(B) 440 ohm

(C) 260 ohm

(D) 160 ohm

73. A Transformer has 50 turns in the primary and 100 in the secondary. What will the voltage across the secondary be if the primary is connected to the 220 V DC supply ?

(A) 440

(B) 220

(C) 110

(D) Zero Volts

74. If a laser beam has an intensity of 2.5×10^{14} W/m^2. Then, the amplitude of the electric field and magnetic field in the beam is :

(A) 4.3×10^8 N / C. 1.44T

(B) 3×10^8 N / C. 1.44T

(C) 43×10^8 N / C. 1.44T

(D) 4.3×10^8 N / C. 14.4T

75. The point source of light is placed at the centre of curvature of a hemispherical surface. The radius of curvature is r, and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it if the source emits a power W is :

(A) Wc

(B) $\frac{W}{c}$

(C) $\frac{W}{2c}$

(D) $\frac{2W}{c}$

76. A Small metal plate (work function φ) is kept at a distance 'd' from a single ionized fixed ion. A monochromatic light beam is incident on the metal plate, and photoelectrons are emitted. What is the maximum wavelength of the light beam, so that some of the photoelectrons may go around the ion along a circle ?

(A) $\frac{8\pi \in_0 dhc}{e^2 + 8\pi \in_0 \phi d}$

(B) $\frac{8\pi \in_0 dhc}{e^2 - 8\pi \in_0 \phi d}$

2781

(C) $\frac{8\pi \in_0 dhc + e^2}{8\pi \in_0 \phi d}$

(D) $\frac{8\pi \in_0 dhc - e^2}{8\pi \in_0 \phi d}$

77. The average lifetime of a hydrogen atom excited to n = 2 state is 10^{-8} s. The average number of revolutions the electron makes before it jumps to the ground state is :

(A) 8.2×10^6

(B) 2×10^6

(C) 82×10^6

(D) 8.2×10^5

78. The light emitted in that transition n = 3 to n = 2 in hydrogen is called H_α light. The maximum work function a metal can have so that H_α light can emit photoelectrons from it as :

(A) 3eV

(B) 1.9 eV

(C) 5.1 eV

(D) 7.5eV

79. Suppose the angular momentum is quantized as even integral multiples of $h/2\pi$ in an imaginary world. According to Bohr's model, what do hydrogen atoms emit the longest possible wavelength in the visible range in such a world ?

(A) 387nm (B) 487nm

(C) 510nm (D) 760nm

80. The cut-off wavelength for the continuous X-rays coming from an X-ray tube operating at 30kV is :

(A) 41.4 nm (B) 41.4Å

(C) 41.4 pm (D) 41.4 μm

81. The wavelength of k_α and L_α X-rays of a material are 21.3 p.m. and 141 p.m., respectively. Then, the wavelength of k_β x-ray of the material is given by :

(A) 18.5 μm (B) 18.5 μm

(C) 0.5 pm (D) 18.5 pm

82. When the base current in a transistor is changed from 30 μA to 80 μA, the collector current is changed from 1.0 mA to 3.5 mA. Then, the current gain β is :

(A) 100 (B) 200

(C) 75 (D) 50

83. What is the energy released by 1 gram of natural Uranium, assuming 200 MeV is released, in which fission event and the reasonable isotope, ^{235}U has an abundance of 0.7% by weight in natural Uranium ? Choose the correct answer. (Take Avogadro's number, $N_A = 6.022 \times 10^{23}$ mole^{-1}) :

(A) 5.7×10^8 J (B) 7.5×10^8 J

(C) 5.7×10^{18} J (D) 5.7×10^{10} J

84. A radioactive sample decays with an average life of 20 ms. A capacitor of capacitance 100 μF is charged to some potential. Then, the plates are connected through a resistance R. What should be the value of R so that the ratio of the charge on the capacitor to the activity of the radioactive sample remains constant in time ? Choose the correct answer.

(A) 100 Ohm (B) 200 Ohm

(C) 300 Ohm (D) 10 Ohm

85. A radioactive nucleus can decay by two different processes. The half-life for the first process is t_1, and that for the second process is t_2. The effective half-life of the nucleus is given by :

2781

(A) $\frac{1}{\tau} = \frac{1}{t_1} + \frac{1}{t_2}$ (B) $\tau = t_1 + t_2$

(C) $\tau = t_1 - t_2$ (D) $\tau = t_1 t_2$

86. The commutator, $\pi[x^2, p_x]$, is equal to

(A) ihx (B) 2ihx

(C) $2ihp_x$ (D) Zero

87. A particle of mass m is confined in the ground state of a one-dimensional box extending from $x = -2L$ to $x = +2L$. The wave function of the particle in this state is $\psi = \psi_0 \cos\frac{\pi x}{4L}$, where ψ_0, is a constant. The energy eigenvalue corresponding to this state is :

(A) $\hbar^2\pi^2/2mL^2$ (B) $\hbar^2\pi^2/32mL^2$

(C) $\hbar^2\pi^2/16mL^2$ (D) $\hbar^2\pi^2/4mL^2$

88. The normalized wave functions ψ_1, and ψ_2, corresponding to the ground state and the first excited states of particles in a potential. The operator $\hat{A}$ acts on the wave functions as $\hat{A}\psi_1 = \psi_2$ and $\hat{A}\psi_2 = \psi_1$. The expectation value of the operator $\hat{A}$ for the state $\psi = (3\psi_1 + 4\psi_2) / 5$ is :

(A) 0.96 (B) –0.32

(C) 0.75 (D) 0

89. The primitive translation vector of a two-dimensional lattice is $a = 2\hat{i} + \hat{j}$, $b = 2\hat{j}$. The primitive translation vector of its reciprocal lattice in x – direction is given by :

(A) $a^* = 2\pi\hat{i}$ (B) $a^* = \pi\hat{i}$

(C) $a^* = 3\pi\hat{i}$ (D) $a^* = \pi\hat{j}$

90. According to the uncertainty principle, what does a quantum harmonic oscillator occupy the minimum possible phase space volume?

(A) $\frac{\hbar}{4}$ (B) $\frac{\hbar}{2}$

(C) $\hbar$ (D) $\frac{\hbar\omega}{2}$

2781

91. A particle constrained to move on a paraboa $y = kx^2$. The number of degrees of freedom is :

(A) 1 (B) 2

(C) 3 (D) 4

92. The Lagrangian of a system is given by $L = \frac{1}{2}q^2 + qq - \frac{1}{2}q^2$, it describes the motion of :

(A) A harmonic oscillator (B) A damped harmonic oscillator

(C) An anharmonic oscillator (D) A system with unbound motion

93. A particle with rest mass 'm' is at rest and decays into two particles of equal rest mass $\frac{3}{10}m$, which move along the z-axis. Their velocities are given by :

(A) $v_1 = v_2 = 0.8\,c\hat{z}$ axis

(B) $v_1 = -v_2 = 0.8\,c\hat{z}$ axis

(C) $v_1 = -v_2 = 0.8\,c\hat{z}$

(D) $v_1 = 0.6c\hat{z}, -v_2 = 0.8\,c\hat{z}$

94. The recoil momentum of an atom is p_A, when it emits an infrared photon of wavelength 1500 nm and when it emits a photon of visible wavelength 500 nm. The p_A/p_B is :

(A) 1 : 1

(B) $1 : \sqrt{3}$

(C) 1 : 3

(D) 3 : 2

95. The combination of one u-quark and two d-quarks is called :

(A) Positron

(B) Electron

(C) Proton

(D) Neutron

96. The atomic packing factor of a diamond cube structure is :

(A) 78%

(B) 68%

(C) 34%

(D) 52%

97. Which of the following is Debye temperature ?

(A) $\theta_D = \frac{\hbar\omega_D}{2k_B}$

(B) $\frac{\hbar\omega_D}{k_B}$

(C) $\frac{\hbar^2\omega_D}{k_B}$

(D) $\frac{\hbar^2\omega_D^2}{k_B}$

98. What is the shape of the phase space trajectory for a harmonic oscillator ?

(A) A straight line

(B) A circle

(C) An ellipse

(D) A parabola

99. A relation connecting isotropic mass M of a superconductor with critical temperature T_c is given by :

(A) $M = kT_c$

(B) $M^{\frac{1}{2}}T_c$ = a constant

(C) $M_c^{\frac{1}{2}}$ = a constant

(D) M_c^2 = a constant

100. $\frac{n\alpha}{3\epsilon_0} = \frac{(\varepsilon_r - 1)}{(\varepsilon_r + 2)}$ is known as _____ relation.

(A) Debye

(B) Clausius-Mossotti

(C) Einstein – Debye

(D) Bose – Einstein

2781

SPACE FOR ROUGH WORK

2781

SPACE FOR ROUGH WORK

2781

SEAL