Paper – II

Physical Sciences

Booklet Code **A**

TEST BOOKLET NO.

Subject Code : 0 5

Roll No. :

(Figures as per admission card)

Roll No. (in words) : ______________________________

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OMR Sheet No. :

Name and Signature of Invigilator/s

Signature : ______________________

Name : ______________________

Time : 2 Hours | Maximum Marks : 200

Number of Pages in this Booklet : 16 | Number of Questions in this Booklet : 100

Instructions for the Candidates

1. Write your roll number in the space provided on the top of this page.
2. This paper consists of hundred (100) multiple-choice type of questions.
3. At the commencement of examination, the test booklet will be given to you. In the first 5 minutes, you are requested **to open the booklet and compulsorily examine it as below** :
   (i) To have access to the Test Booklet, tear off the paper seal on the edge of the cover page. Do not accept a booklet without sticker seal or open booklet.
   (ii) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to pages/questions missing or duplicate or not in serial order or any other discrepancy should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Test Booklet will be replaced nor any extra time will be given.**
   (iii) After the verification is over, the Test Booklet Number should be entered in the OMR Sheet and the OMR Sheet Number should be entered on this Test Booklet.
4. Each item has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example : (A) (B) ● (D)
   where (C) is the correct response.
5. Your responses to the questions are to be indicated in the **OMR Sheet kept inside this Booklet**. If you mark at any place other than in the circles, the OMR Sheet will not be evaluated.
6. Read the instructions given in OMR Sheet carefully. Fill the Booklet Code of Paper – II in OMR Sheet **Compulsorily**.
7. Rough Work is to be done in the end of this booklet.
8. If you write your name or put any mark on any part of the OMR Answer Sheet, except for the space provided for the relevant entries, which may disclose your identity, you will render yourself liable to disqualification.
9. You have to return the OMR Answer Sheet to the invigilators at the end of the examination compulsorily and must NOT carry it with you outside the Examination Hall.
10. You can take away test booklet and carbon copy of OMR Answer Sheet after the examination.
11. **Use only Blue/Black Ball point pen.**
12. **Use of any calculator, electronic gadgets or log table, etc. is prohibited.**
13. **There is no negative mark for incorrect answer.**

PHYSICAL SCIENCES
Paper – II

1. A function f(x) is defined in the range $-1 \le x \le 1$ by

$$f(x) = \begin{cases} 1 - x & \text{for } x \ge 0 \\ 1 + x & \text{for } x < 0 \end{cases}$$

The first few terms in the Fourier series approximating of this function are

(A) $\frac{1}{2} + \frac{4}{\pi^2}\cos\pi x + \frac{4}{9\pi^2}\cos 3\pi x + \ldots$

(B) $\frac{1}{2} + \frac{4}{\pi^2}\sin\pi x + \frac{4}{9\pi^2}\sin 3\pi x + \ldots$

(C) $\frac{4}{\pi^2}\cos\pi x + \frac{4}{9\pi^2}\cos 3\pi x + \ldots$

(D) $\frac{1}{2} - \frac{4}{\pi^2}\cos\pi x + \frac{4}{9\pi^2}\cos 3\pi x + \ldots$

2. The Hamiltonian of a simple pendulum consisting of a mass 'm' attached to a massless string of length l is $H = \frac{p^2}{2ml^2} + mgl(1 - \cos\theta)$. If L denotes for Lagrangian, then the value of $\frac{dL}{dt}$ is

(A) $-\frac{2g}{l}\sin\theta p_\theta$ (B) $-\frac{g}{l}\sin 2\theta p_\theta$

(C) $\frac{g}{l}\cos\theta p_\theta$ (D) $l p_\theta^2 \cos\theta$

3. A plane electromagnetic wave travelling in free space is incident normally on a glass plate of refractive index 3/2. If there is no absorption by the glass, its reflectivity is

(A) 4% (B) 16%

(C) 20% (D) 50%

4. The instantaneous electric and magnetic field created at a distance r by a point source at the origin of given electric and magnetic field given by

$$\vec{E} = \frac{A\cos\omega t}{2\pi\epsilon_0 r}\hat{\theta} \text{ and } \vec{H} = \frac{B\cos\omega t}{\mu_0 r}\hat{\phi}$$

where, A and B are constants and the unit vectors $(\hat{r}, \hat{\theta}, \hat{\phi})$ form a orthonormal set. The time averaged power radiated by the sources is

(A) $\frac{\omega\epsilon_0}{\mu_0}AB$ (B) $\frac{c^3}{2\pi}AB$

(C) $c^2 AB$ (D) $2\frac{\omega\pi}{c}AB$

5. A 1-D system is described by the Hamiltonian $H = p^2 + \lambda|x|$; (where $\lambda > 0$). The ground state energy varies as a function of λ as

(A) $\lambda^{5/3}$ (B) $\lambda^{2/3}$

(C) $\lambda^{4/3}$ (D) $\lambda^{1/3}$

6. In ^{14}O (Z = 8, N = 6), it is noticed to have a lifetime of 71 seconds, the main particle produced after this decay is

(A) Electron (B) Positron

(C) Photon (D) Muon

7. For the low energy electron-atom scattering interaction, the typical order of cross-section is

(A) 10^{-16} cm^2

(B) 10^{-24} cm^2

(C) 10^{-32} cm^2

(D) 10^{-40} cm^2

8. On interchange of the spatial coordinates of two electrons present in a state with total spin zero, the corresponding wave function
   (A) Changes sign
   (B) Remains unchanged
   (C) Changes to a completely different function
   (D) Gets destroyed

9. The Bohr radius of the Hydrogen atom when compared to the electron Compton wavelength is of the order (approximately)
   (A) 10000 times larger
   (B) 1000 times larger
   (C) 100 times larger
   (D) about the same

10. Charged leptons and neutral leptons both can undergo following interactions
   (A) Weak interactions
   (B) Electromagnetic interactions
   (C) Strong interactions
   (D) Electromagnetic and weak interactions

11. The energy of E.M. wave in vaccum is given by the relation
   (A) $\frac{E^2}{2\epsilon_0}+\frac{B^2}{2\mu_0}$
   (B) $\frac{1}{2}\epsilon_0 E^2+\frac{1}{2}\mu_0 B^2$
   (C) $\frac{(E^2+B^2)}{2\mu_0 c}$
   (D) $\frac{1}{2}\epsilon_0 E^2+\frac{B^2}{2\mu_0}$

12. A one dimensional harmonic oscillator is in state

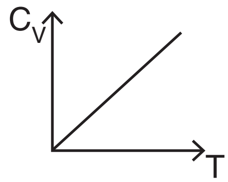
$$\psi(x)=\frac{1}{\sqrt{14}}[3\psi_0(x)-2\psi_1(x)+\psi_2(x)]$$

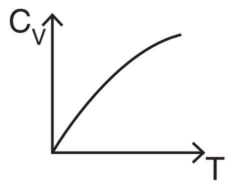
The probability of finding the oscillator in ground state
   (A) $\frac{1}{14}$ (B) $\frac{9}{14}$
   (C) $\frac{4}{14}$ (D) 1

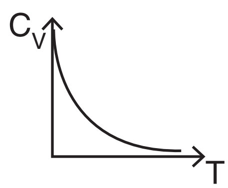
13. The energy of the free electron in the state (121) in the rectangular box of sides a = b ≠ c is
   (A) $\frac{h^2}{8m}\left[\frac{5}{a^2}+\frac{1}{C^2}\right]$
   (B) $\frac{h^2}{2m}\left[\frac{5}{a^2}+\frac{1}{C^2}\right]$
   (C) $\frac{h^2}{8m}\left[\frac{3}{a^2}+\frac{1}{C^2}\right]$
   (D) None of these

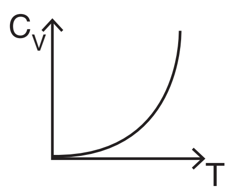
14. Given that $\sum_{n=0}^{\infty} H_n(x)\frac{t^n}{n!}=e^{-t^2+2tx}$ the value of $H_2(O)$ is
   (A) 1
   (B) 2
   (C) –1
   (D) –2

15. The specific heat of the three-dimensional Photon gas varies with the temperature as

(A) 

(B) 

(C) 

(D) 

16. Identify the type of interaction :
$K^- + p \to \Omega^- + K^+ + K^0$

(A) Weak interaction

(B) Strong interaction

(C) Electromagnetic interaction

(D) Not an allowed interaction

17. In a typical beta-decay, what is the energy of neutrino ?

(A) 100 KeV (B) 1 MeV

(C) 10 MeV (D) 100 MeV

18. Hyperfine structure of spectral lines is due to couplings of

(A) Electron spin S and orbital angular momentum L

(B) Total angular momentum J and nuclear spin I

(C) No such Hyperfine only fine structure exists

(D) Direct Electron spin S – S couplings

19. The binding energy per nucleon varies from ^{56}Fe to ^{238}U as

(A) Decreasing (B) Increasing

(C) Unchanged (D) Fluctuates

20. What is the approximate order of magnitude for the ratio of the energy released when 1 gm of Uranium undergoes fission to the energy released when 1 gm of TNT is exploded ?

(A) 10^2 (B) 10^6

(C) 10^{10} (D) 10^{12}

Direction (Q.No. 21 – 25) : Based on the information given below, answer questions no. 21 to 25.

The electric field part of an electromagnetic wave in an medium is represented by

$$E_y = 2.5\frac{N}{C}\cos\left(2\pi\times10^6\frac{rad}{m}\right)t - \left(\pi.10^{-2}\frac{rad}{S}\right)$$

where the $\hat{x}$ component and the z component of electric field are zero.

21. The magnetic field is moving along

(A) +ve y direction

(B) +ve $\hat{z}$ direction

(C) –ve y direction

(D) –ve $\hat{z}$ direction

22. The magnetic field is given by

(A) $83.3\times A^{\circ}\frac{N}{C}\cos\left(\left(2\pi\times10^{6}\frac{rad}{m}\right)t-\left(\pi\times10^{-2}\frac{rad}{S}\right)x\right)$

(B) $83.3\times\frac{N}{C}\cos\left(\left(2\pi\times10^{6}\frac{rad}{m}\right)t-\left(\pi\times10^{-2}\frac{rad}{S}\right)x\right)$

(C) $8.33\times A^{\circ}\frac{N}{C}\cos\left(\left(2\pi\times10^{6}\frac{rad}{m}\right)t-\left(\pi\times10^{-2}\frac{rad}{S}\right)x\right)$

(D) $8.33\times\frac{N}{C}\cos\left(\left(2\pi\times10^{6}\frac{rad}{m}\right)t-\left(\pi\times10^{-2}\frac{rad}{S}\right)x\right)$

23. The wavelength of E.M. wave is given by

(A) 400 m (B) 100 m
(C) 200 m (D) 300 m

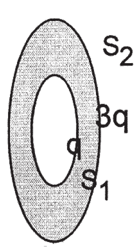
24. The frequency of E.M. wave is given by

(A) 10^{6} Hz (B) 10^{5} Hz
(C) 10^{-6} Hz (D) 10^{-5} Hz

25. The average value of Pognting vector is

(A) 83.3×10^{-3} (B) 83.3×10^{-2}
(C) 83.3×10^{-4} (D) 83.3×10^{-5}

26. S_1 and S_2 are two parallel concentric spherical surfaces enclosing charges q and 3q respectively, then the ratio of electric flux through S_1 and S_2 is



(A) $\frac{1}{3}$ (B) $\frac{1}{4}$
(C) 4 (D) 3

27. Consider an electric field $\bar{E}=3\sin(\omega t-kz)\hat{x}+2\sin(\omega t-kz+75^{\circ})\hat{y}$, what is the polarization ?

(A) Elliptically polarized
(B) Circularly polarized
(C) Linearly polarized
(D) Plane polarized

28. The ratio of radii of the nuclei Li^{7} and Fe^{56} is

(A) 2 (B) 3/2
(C) 1/2 (D) 4

29. Which of the following reaction is allowed or forbidden ?

i. $\pi^{-}+p\rightarrow\Lambda^{0}+\pi^{0}$
ii. $\pi^{+}+n\rightarrow K^{0}+K^{+}$

(A) (i) is forbidden (ii) is allowed
(B) both are allowed
(C) (i) is allowed (ii) is forbidden
(D) both are forbidden

30. Expression $A+\bar{A}B+\bar{A}\bar{B}C+\bar{A}\bar{B}\bar{C}D$ is equivalent to

(A) A + BC + CD
(B) A + AB + CD
(C) $A+\bar{A}B+CD$
(D) A + B + C + D

31. What was the main purpose of postulating the color quantum number ?

(A) To identify the different quarks
(B) To make colored quark states
(C) To allow three similar quarks in a state
(D) To overcome quark-quark interaction

32. The division of phase-space for distinguishable classical particles and indistinguishable quantum particles is governed by

(A) Uncertainty principle

(B) Total phase space volume available

(C) Inter-particle interactions

(D) Conditions of temperature and pressure

33. Which of the following statement is true for Photo-diodes used in electronic circuits ?

(A) p-n junction is connected in reverse bias

(B) it is a photo-voltaic cell

(C) no need to apply external voltage

(D) electron-hole pairs generated by impurity in depletion layer

34. An ideal Operational Amplifier has the following characteristics

(A) $R_{in} = \infty$, $A = \infty$, $R_o = 0$

(B) $R_{in} = 0$, $A = \infty$, $R_o = 0$

(C) $R_{in} = \infty$, $A = \infty$, $R_o = \infty$

(D) $R_{in} = 0$, $A = \infty$, $R_o = \infty$

35. Invariance under time displacements of Lagrangian, leads to

(A) Conservation of Total Energy

(B) Conservation of Linear momentum

(C) Conservation of Angular momentum

(D) Nothing conserved

36. Can a photon convert into an e^+e^- pair in vacuum ?

(A) Yes it can

(B) No it can not

(C) Only if photon energy = 0.51 MeV

(D) Only if photon energy > 1.02 MeV

37. Which one of the following is not a magic number in Shell Model of Nuclear Physics ?

(A) 82 (B) 50

(C) 20 (D) 130

38. A wave function (Ψ) which obeys : $\int_{-\infty}^{\infty} |\psi|^2 \, dV = 1$ is called

(A) Single valued

(B) Infinite valued

(C) Continuous

(D) Normalizable

39. The electrostatic force between the earth and the moon can be neglected because

(A) It is much smaller than the gravitational force

(B) The bodies are electrically neutral

(C) Due to the presence of tidal effect

(D) The effect cancels out midway at the earth-moon distance

40. For 10 MW reactor, what is the number of fission per second in it ? (each uranium fission releases about 200 MeV)

(A) 10^5 (B) 10^{11}

(C) 10^{17} (D) 10^{23}

41. An astronomer studies the Doppler shift of light from two stars, A and B. He finds that the Doppler shift of light from A is more than that from B. On the other hand, the broadening of a particular spectral line is more in the case of B. Which of the following statements is correct ?

(A) The surface temperature of A is higher than that of B

(B) The surface temperature of A is higher but it is moving away from earth

(C) The surface temperature of both the stars is the same but A is moving more rapidly with respect to B

(D) B is hotter than A but is moving more slowly than A with respect to earth

42. δQ is not a perfect differential because

(A) It depends on U, p and V

(B) It involves an irreversible process

(C) It depends on entropy

(D) The cyclic integral $\oint dQ$ can be non-zero

43. If the velocity of the following particles is taken to be same, which particle is going to have the longest wavelength ?

(A) An electron

(B) A proton

(C) A neutron

(D) An α-particle

44. If $\lambda_{\text{de-Broglie}}$ is the uncertainty in the location of a particle, the corresponding uncertainty in its velocity will be

(A) Same as its velocity

(B) Half of its velocity

(C) Twice its velocity

(D) Four times its velocity

45. Invariance of a system under Parity operation (P) means

(A) Unmeasurability of position

(B) Unmeasurability of left and right

(C) Unmeasurability of angle

(D) Unmeasurability of motion

46. The fundamental forces, namely, strong force, weak force and the electromagnetic force are distinguished by the time-scale on which these take place in the following correct order respectively

(A) 10^{-23}s, 10^{-10}s, 10^{-19}s

(B) 10^{-39}s, 10^{-20}s, 10^{-10}s

(C) 1s, 10^{-7}s, 10^{-2}s

(D) 10^{-10}s, 10^{-19}s, 10^{-23}s

47. The spectroscopic term arising from non-equivalent optical electrons $3d^1$ and $3p^1$ having multiplicity '3' is

(A) $^3P_3$ (B) $^3D_2$

(C) $^3D_0$ (D) $^3F_1$

48. Which of the following sets corresponds to fundamental particles ?

(A) Proton, electron and neutrino

(B) Proton, electron and photon

(C) Electron, photon and meson

(D) Electron, neutrino and photon

49. Magnetic vector potential due to magnetic dipole is proportional to

(A) r (B) r^{-1}

(C) r^{-2} (D) r^{-3}

50. When a dynamical system can exist in many macrostates, then its equilibrium state is that macrostate for which

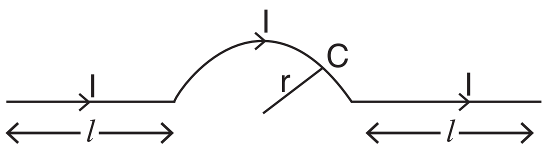
(A) The potential energy of the system is the highest

(B) The number of microstates is the highest

(C) The number of microstates is the lowest

(D) The system is at the atmospheric pressure

51. A long wire having a semi-circular loop of radius r carries a current I as shown



The magnetic field at C due to entire wire is

(A) $\frac{\mu_0 I}{4\pi r^2}$ (B) $\frac{\mu_0 I}{4r}$

(C) $\frac{\mu_0 I}{4r^2}$ (D) $\frac{\mu_0 I}{4\pi r}$

52. If the Lagrangian is given by $L = q\dot{q} - V(q)$ then the equation of motion is

(A) $\dot{q} + \frac{\partial V(q)}{\partial q} = 0$

(B) $\frac{\partial V(q)}{\partial q} = 0$

(C) $2\dot{q} + \frac{\partial V(q)}{\partial q} = 0$

(D) None of the above

53. For 2-dimensional free electron gas, the electronic density n and the Fermi energy E_f are related by

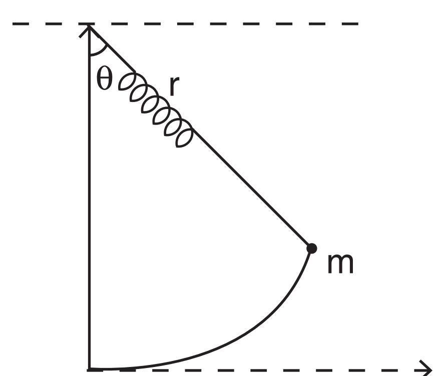
(A) $n = m \in_f / \pi\hbar^2$

(B) $n = \frac{m \in_f^2}{\pi\hbar}$

(C) $n = \frac{2(m \in_f)^{\frac{1}{3}}}{\pi^2\hbar^2}$

(D) $n = \frac{(2m \in_f)^{\frac{3}{2}}}{3\pi^2\hbar^3}$

54. Find the equations of motion of a pendulum bob suspended by a spring and allowed to swing in a vertical plane.



(A) $mr^2\ddot{\theta} + 2mr\dot{r}\dot{\theta} + mgr\sin\theta = 0$

(B) $mr^2\ddot{\theta}^2 + 2mr\dot{r}\dot{\theta} + mgr\sin\theta = 0$

(C) $mr^2\ddot{\theta} + 2mr\dot{r}\dot{\theta} - mgr\sin\theta = 0$

(D) $mr^2\ddot{\theta} + 2m\dot{r}^2\dot{\theta} - mgr\sin\theta = 0$

55. Atomic packing fraction of Zinc Blende Structure (ZnS) is

(A) $\dfrac{\frac{\pi}{4}\left(1+\frac{r_{Zn}^3}{r_S^3}\right)}{\left(1+\frac{r_{Zn}}{r_S}\right)^3}$ (B) $\dfrac{\frac{3\pi}{4}\left(1+\frac{r_{Zn}^3}{r_S^3}\right)}{\left(1+\frac{r_{Zn}}{r_S}\right)^3}$

(C) $\dfrac{\frac{\sqrt{3}\pi}{4}\left(1+\frac{r_{Zn}^3}{r_S^3}\right)}{\left(1+\frac{r_{Zn}}{r_S}\right)^3}$ (D) $\dfrac{\frac{3\pi}{16}\left(1+\frac{r_{Zn}^3}{r_S^3}\right)}{\left(1+\frac{r_{Zn}}{r_S}\right)^3}$

56. Rutherford planetary model suffer from following deficiencies

(A) Atoms are unstable and atoms radiate energy over a continuous range of frequency

(B) Atoms are only unstable

(C) Atoms radiate energy over a continuous range of frequencies only

(D) None of the above

57. In quantum mechanics, following properties are true

(A) Orthogonality, completeness and eigenvalues are real

(B) Orthogonality, completeness and eigenvalues are not real

(C) Orthonormality, completeness and eigenvalues are not real

(D) None of the above

58. The reverse saturation current becomes double for

(A) Every 10°C fall in temperature

(B) Every 1°C rise in temperature

(C) Every 1°C fall in temperature

(D) Every 10°C rise in temperature

59. Which of the following is not true for simple harmonic motion ?

(A) Restoring force is proportional to displacement from the mean position

(B) Kinetic energy is maximum at the mean position

(C) Potential energy is minimum at the point of maximum displacement

(D) Acceleration will be minimum at mean position

60. What is the wavelength of an electron with mass = 9.1×10^{-31}kg moving at 1×10^7 m/s ?

(A) 0.017 nm (B) 0.073 fm

(C) 0.073 nm (D) 0.17 nm

61. The energy carried by α – particle in terms of Q – value in α – disintegration process is

A $\rightarrow$ mass number of parent particle

(A) $k_\alpha = \dfrac{AQ}{4}$

(B) $k_\alpha = \left(\dfrac{A-4}{A}\right)Q$

(C) $k_\alpha = \left(\dfrac{A}{A-4}\right)^Q$

(D) $\dfrac{4Q}{A}$

62. The wave function of a hydrogen atom is given by the following super position of energy eigen function $\psi_{nlm}(\bar{r})$ ($\hbar$, l, m are quantum number)

$$\varphi_{nlm}(r) = \frac{\sqrt{2}}{\sqrt{7}}\psi_{100} - \frac{3}{\sqrt{14}}\psi_{210} + \frac{1}{\sqrt{14}}\psi_{322}$$

the expectation value of L_Z and L^2 are

(A) $\frac{h}{7}$ and $\frac{12h^2}{7}$

(B) $\frac{5h}{7}$ and $\frac{12h^2}{7}$

(C) $\frac{h}{7}$ and h^2

(D) $\frac{5h}{7}$ and h^2

63. If $\bar{k}$ is the wave vector of incident light $\left(|\bar{k}| = \frac{2\pi}{\lambda}, \lambda \text{ is the wavelength of light}\right)$ and $\bar{G}$ is the reciprocal lattice vector then the Bragg's law can be written as

(A) $\bar{K} + \bar{G} = 0$

(B) $2\,\overline{K.G} + G^2 = 0$

(C) $(2\,\overline{K.G})^2 + G^2 = 0$

(D) $\bar{K} \cdot \bar{G} = 0$

64. A plane e.m. travelling along + Z direction has its electric field given by $E_x = 2\cos t$ and $E_y = 2\cos(t + 90)$ wave is

(A) Linearly polarised

(B) Right circularly polarised

(C) Left circularly polarised

(D) Eliptically polarised

65. The potential of a diatomic molecular as a function of distance r between the atom is $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$. The value of potential at equilibrium separation between atom is

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

(C) $-\frac{a^2}{2b}$ (D) $-\frac{a^2}{4b}$

66. In the Born approximation, the scattering amplitude for scattering from the spherical potential $V(r) = -V_0$ for $0 < r < r_0$ and $V(r) = 0$ for $r > r_0$ will be

(A) $\frac{2\mu V_0}{q^3\hbar^2}(\cos qr_0 - qr_0 \cos qr_0)$

(B) $\frac{2\mu V_0}{q^3\hbar^2}(\sin qr_0 - qr_0 \sin qr_0)$

(C) $\frac{2\mu}{V_0 q^3\hbar^2}(\sin qr_0 - qr_0 \cos qr_0)$

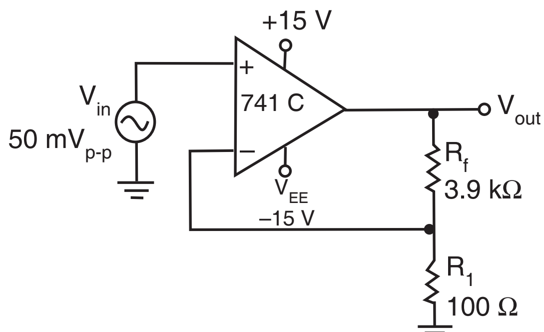
(D) $\frac{2\mu V_0}{q^3\hbar^2}(\sin qr_0 - qr_0 \cos qr_0)$

67. Consider a system of two Ising spins S_1 and S_2 taking values ± 1 with interaction energy given by $\in = -JS_1S_2$ when it is in thermal equilibrium at temperature T. For larger T, the average energy of the system varies as $\frac{C}{k_B T}$. The value of C is

(A) $-J^3$ (B) $-2J^3$

(C) $-2J^2$ (D) $-J^2$

68. In the following Fig., what is the ideal closed-loop voltage gain ?



(A) 50 (B) 60

(C) 40 (D) 25

69. An electron confined inside a hollow spherical cavity with radius R exerts pressure on the walls of the cavity which varies as (consider electron in its ground state)

(A) R^{-2} (B) R^{-5}

(C) R^{-1} (D) R

70. A proton is in a box of width 1×10^{-14} m. What will be the lowest energy for the proton ?

(A) 13.6 eV (B) 2.05 MeV

(C) 240.6 eV (D) 6.51 MeV

71. Magnetic field and electric field are (respectively)

(A) Non-conservative and conservative

(B) Both are conservative

(C) Both are non-conservative

(D) None of the above

72. The eigenvalue of orthogonal matrix

$$B = \frac{1}{6}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ 2 & -2 & 1 \end{bmatrix} \text{ is}$$

(A) 4, 4, – 4 (B) 3/2, 3/2, – 3/2

(C) 1, 1, – 1 (D) 1/2, 1/2, – 1/2

73. Cricket ball is moving with value of 50 m/s uncertainty associated with this ball is

(A) $\Delta x \Delta p \geq h$ (B) $\Delta x \Delta p = 0$

(C) $\Delta x \Delta p = \infty$ (D) $\Delta x \Delta p < 0$

74. Quantum statistics gives the same results as classical statistics only when

(A) Particles of the system obey Pauli exclusion principle

(B) Particles of the system have integral spins

(C) The temperature of the system is close to 0K

(D) The number of the available phase space cells is much more than the number of particles

75. Which of the following statements is false ?

(A) Radiations inside a hollow enclosure at constant temperature are called black body radiations

(B) The total energy of photons inside a hollow constant temperature enclosure is constant

(C) The number of photons inside a hollow constant temperature enclosure is constant

(D) The photons have integral spins

76. A radiation has a spectrum corresponding to a blackbody at 2.7K. Find the wavelength at which the energy density of this radiation is maximum.

(A) 1.1 mm (B) 1.1 nm

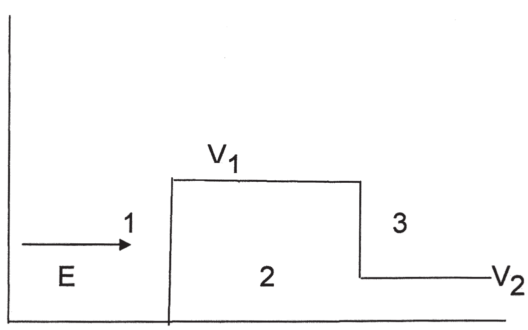
(C) 0.1 nm (D) 0.1 mm

77. If $[x, p] = i\hbar$, the value of $[x^2, p]$ is

(A) $2i\hbar x$ (B) $-2i\hbar x$

(C) $i\hbar p$ (D) $-2i\hbar p$

78. A particle is incident with a constant energy E on a one-dimensional potential barrier as shown in the figure, where $V_2 < E < V_1$. The wave functions in regions 1, 2 and 3 are respectively



(A) Decaying, oscillatory, decaying

(B) Oscillatory, oscillatory, decaying

(C) Decaying, decaying, oscillatory

(D) Oscillatory, decaying, oscillatory

79. For any operator A, $i(A^* - A)$ is

(A) Hermitian

(B) Anti-hermitian

(C) Unitary

(D) Orthogonal

80. Seven car accidents occur in a week, what is the probability that they all occurred on the same day ?

(A) $\frac{1}{7^7}$ (B) $\frac{1}{7^6}$

(C) $\frac{1}{2^7}$ (D) $\frac{7}{2^7}$

81. Photons interact with matter mainly via three processes. Which is the correct order based on photon energy (low to high) for these processes to start ?

(A) Photoelectric effect, Pair Production, Compton Scattering

(B) Pair Production, Compton Scattering, Photoelectric effect

(C) Compton Scattering, Photoelectric effect, Pair Production

(D) Compton Scattering, Pair Production, Photoelectric effect

82. What is the order of Cosmic ray flux at ground level ? (in cm^{-2} $sterad^{-1}$)

(A) 1 per year

(B) 1 per min

(C) 1 per ms

(D) 1 per μs

83. In the reaction : $\pi^- + p \rightarrow K^0 + X$, the probable name of the unknown particle X is

(A) K^+ (B) Σ°

(C) π^+ (D) Λ°

84. The damped simple harmonic oscillator equation of motion gives the quadratic equation :

$m\omega^2 - ik\omega - \lambda = 0$, giving various conditions for ω in terms of k^2 and 4 $m\lambda$.

Which ones are the correct damped cases ?

(A) $k^2 < 4m\lambda$: under; $k^2 << 4m\lambda$: lightly; $k^2 > 4m\lambda$: over

(B) $k^2 > 4m\lambda$: under; $k^2 << 4m\lambda$: lightly; $k^2 < 4m\lambda$: over

(C) $k^2 < 4m\lambda$: under; $k^2 << 4m\lambda$: critical; $k^2 > 4m\lambda$: over

(D) $k^2 < 4m\lambda$: over; $k^2 << 4m\lambda$: critical; $k^2 > 4m\lambda$: under

85. A coin of mass 10 gm rolls along a horizontal table with a velocity of 6 cm/s. What is its kinetic energy ?

(A) 7 μJ (B) 17 μJ
(C) 27 μJ (D) 37 μJ

86. The function y(x) satisfies the differential equation $x\dfrac{dy}{dx} = y(\ln y - \ln x + 1)$ with the initial condition y(1) = 3. What will be the value of y(3) ?

(A) 27 (B) 1
(C) 81 (D) 9

87. The variation in β causes

(A) Bias unstability
(B) Bias stability
(C) Zero bias
(D) None of these

88. The input offset voltage in an OPAMP is due to

(A) Mismatch in transistor parameters
(B) Voltage irregularity
(C) Ground is not perfect
(D) None of these

89. For the linear operation of OPAMP, it is required that

(A) Output voltage should be 2-3 volt lower than power supply
(B) Output voltage should be equal to the power supply
(C) Output voltage should be 2-3 volt greater than power supply
(D) None of these

90. Superconductors are

(A) Paramagnetic
(B) Ferromagnetic
(C) Perfect diamagnetic
(D) None of the above

91. What is the order of Doppler width of an optical line from an atom in a flame at room temperature ?

(A) 10^{13} Hz (B) 10^{16} Hz
(C) 10^{6} Hz (D) 10^{9} Hz

92. Diode can be used as

(A) Amplifier
(B) Demodulator
(C) Oscillator
(D) None of the above

93. A function n(x) satisfies the differential equation $\frac{d^2n(x)}{dx^2} - \frac{n(x)}{L^2} = 0$ where L is a constant. The boundary conditions are n(0) = k and n(∞) = 0. The solution to this equation is

(A) $n(x) = k\exp\left(\frac{-x}{\sqrt{L}}\right)$

(B) $n(x) = k\exp\left(\frac{-x}{L}\right)$

(C) $n(x) = k^2\exp\left(\frac{-x}{L}\right)$

(D) $n(x) = k^2\exp\left(\frac{-x}{\sqrt{L}}\right)$

94. Transistor is a

(A) Current-controlled current device

(B) Current-controlled voltage device

(C) Voltage-controlled current device

(D) Voltage-controlled voltage device

95. The wave function of 2 particle system in Bose Einstein statistics can be written as

(A) $\psi\varphi_{ns}(r_1 r_2) = \phi_n(r_1)\phi_s(r_2)$

(B) $\psi_{ns}(r_1 r_2) = \frac{1}{\sqrt{2}}[\phi_n(r_1)\phi_s(r_2) + \phi_n(r_2)\phi_s(r_1)]$

(C) $\psi_{ns}(r_1 r_2) = \frac{1}{\sqrt{2}}[\phi_n(r_1)\phi_s(r_2) - \phi_n(r_2)\phi_s(r_1)]$

(D) $\psi_{ns}(r_1 r_2) = \frac{1}{\sqrt{2}}[\phi_n(r_1)\phi_n(r_2) + \phi_s(r_2)\phi_s(r_1)]$

96. Which of the following statements is incorrect in the case of a free electron gas in a conductor at 0K ?

(A) The electrons are at rest

(B) The electrons have energies of the order of several electron volts

(C) No electron has energy greater than Fermi energy

(D) The occupation index is equal to 1

97. Heat death of the universe means that

(A) The universe will become very cold

(B) The universe will become very hot

(C) All the objects in the universe will be at the same temperature

(D) The nuclear processes in stars will become very slow

98. An excited atom has a typical lifetime of the order of

(A) 10^{-1} s (B) 10^{-8} s

(C) 10^{-12} s (D) 10^{-23} s

99. A mountainous region with a pass, a hill and a valley corresponds to these stationary values under constraints respectively

(A) A minima, a maxima and a point of inflection

(B) A point of inflection, a minima and a maxima

(C) A point of inflection, a maxima and a minima

(D) A maxima, a minima and a point of inflection

100. Low level of radiation dosage (in humans) is measured in

(A) Becquerel (Bq)

(B) Curie (Ci)

(C) Sieverts (Sv)

(D) None of the above

Space for Rough Work

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