Physics

11P/218/30 Question Booklet No. **2172**

(To be filled up by the candidate by blue/black ball-point pen)

Roll No. | | | | | | | | |

Roll No.
(Write the digits in words) ....

Serial No. of OMR Answer Sheet ....

Day and Date .... (Signature of Invigilator)

INSTRUCTIONS TO CANDIDATES

(Use **only blue/black ball-point pen** in the space above and on both sides of the Answer Sheet)

1. **Within** 10 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that no page/question is missing. In case of faulty Question Booklet bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.
2. Do not bring any loose paper, written or blank, inside the Examination Hall *except the Admit Card without its envelope.*
3. A separate Answer Sheet is given. *It should not be folded or mutilated. A second Answer Sheet shall not be provided. Only the Answer Sheet will be evaluated.*
4. Write your *Roll Number and Serial Number of the Answer Sheet by pen* in the space provided above.
5. **On the front page of the Answer Sheet, write by pen your Roll Number in the space provided at the top, and by darkening the circles at the bottom. Also, wherever applicable, write the Question Booklet Number and the Set Number in appropriate places.**
6. No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) on OMR sheet and also Roll No. and OMR Sheet No. on the Question Booklet.
7. Any change in the aforesaid entries is to be verified by the invigilator, otherwise it will be taken as unfair means.
8. Each question in this Booklet is followed by four alternative answers. *For each question, you are to record the correct option on the Answer Sheet by darkening the appropriate circle* in the corresponding row of the Answer Sheet, by ball-point pen as mentioned in the guidelines given on the first page of the Answer Sheet.
9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circle or darken a circle partially, the answer will be treated as incorrect.
10. *Note that the answer once filled in ink cannot be changed.* If you *do not wish to attempt* a question, leave all the circles in the corresponding row blank (such question will be awarded zero mark).
11. For rough work, use the inner back page of the title cover and the blank page at the end of this Booklet.
12. Deposit *only the OMR Answer Sheet* at the end of the Test.
13. You are not permitted to leave the Examination Hall until the end of the Test.
14. If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.

[उपर्युक्त निर्देश हिन्दी में अन्तिम आवरण-पृष्ठ पर दिये गए हैं]

[No. of Printed Pages : 30+2

11P/218/30

No. of Questions/प्रश्नों की संख्या : 150

Time/समय : 2½ Hours/घण्टे **Full Marks/पूर्णांक** : 450

Note/नोट : (1) Attempt as many questions as you can. Each question carries **3** marks. **One** mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न **3** अंक का है। प्रत्येक गलत उत्तर के लिए **एक** अंक काटा जाएगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

1. The value of $\vec{\nabla}\times\vec{\nabla}\times\vec{A}$ is given by

(1) $\vec{\nabla}\cdot\vec{A}-\nabla^2\vec{A}$ (2) $\vec{\nabla}\cdot\vec{A}+\nabla^2\vec{A}$ (3) $\vec{\nabla}\cdot(\vec{\nabla}\cdot\vec{A})-\nabla^2\vec{A}$ (4) $\vec{\nabla}\cdot(\vec{\nabla}\cdot\vec{A})+\nabla^2\vec{A}$

2. The average value of the Poynting vector for a plane polarized electromagnetic wave in free space is given by

(1) $\frac{1}{2}\varepsilon_0 E^2$ (2) $\frac{1}{2}C\varepsilon_0 E^2$ (3) $\frac{1}{2}\mu_0 B^2$ (4) $\frac{1}{2}\mu_0\frac{B^2}{C}$

3. In metals, the skin depth for electromagnetic waves

(1) increases with increase in frequency

(2) decreases with increase in frequency

(3) does not depend on frequency

(4) increases with increase in conductivity

4. A plane polarized electromagnetic wave with $\vec{E}$ vector parallel to the plane of incidence is incident from air to glass. If it is found that $\theta_i + \theta_r = 90°$, where θ_i is the angle of incidence and θ_r is the angle of refraction, then

(1) the reflected wave will be in a direction normal to the incident wave

(2) there will not be any reflected wave

(3) the reflected wave will be plane polarized

(4) the refracted wave is in a direction normal to the incident ray

5. If V is the scalar potential and $\vec{A}$ is the vector potential, then indicate the relation which is not true

(1) $\vec{E} = -\vec{\nabla} V - \frac{\partial \vec{A}}{\partial t}$

(2) $\vec{B} = \vec{\nabla} \times \vec{A}$

(3) $\vec{\nabla} \cdot \vec{A} + \mu_0 \varepsilon_0 \frac{\partial \vec{A}}{\partial t} = 0$

(4) $\vec{E} = -\vec{\nabla} V$

6. If the angular frequency of an electromagnetic wave is greater than the plasma frequency, then the refractive index n for the wave propagating through the ionosphere is

(1) $n < 1$

(2) $n > 1$

(3) $n = 0$

(4) n is a complex number

7. The condition that any vector $\vec{C}$ should be the curl of any vector is

(1) $\vec{\nabla} \times \vec{C} = 0$ (2) $\vec{\nabla} \cdot \vec{C} = 0$ (3) $\vec{\nabla} \times \vec{C} - \vec{\nabla} \cdot \vec{C} = 0$ (4) $\nabla^2 \vec{C} = 0$

8. The Maxwell's equation derived from Faraday's law of electromagnetic induction is

(1) $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon}$

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

(3) $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(4) $\vec{\nabla} \times \vec{B} = \mu_0 \left(\vec{J} + \varepsilon \frac{\partial \vec{E}}{\partial t} \right)$

9. Indicate the false statement about the high frequency $(\omega > \omega_p)$ electromagnetic wave propagation through low pressure ionized gases

(1) Phase velocity is greater than the velocity of light in free space

(2) $\vec{E}$ and $\vec{H}$ vectors are in same phase

(3) $\vec{E}/\vec{H}$ in ionized gases is larger than in free space

(4) Waves are attenuated in passing through ionized gas

10. At frequencies above resonance frequency in an L-C-R series resonance circuit, the impedance of the circuit is

(1) inductive + resistive

(2) pure inductive

(3) capacitative + resistive

(4) pure capacitative

11. A solenoid has an inductance of 50 henry and a resistance of 30 Ω. If it is connected to 100 V battery, then how long will it take for the current to reach one-half of its final steady state value?

(1) 1·45 sec (2) 1·15 sec (3) 1·35 sec (4) 1·25 sec

12. On forward biasing of a P-N junction diode the depletion width

(1) decreases

(2) increases

(3) remains unchanged

(4) increases in the beginning, then becomes constant

13. CE amplifier is used in intermediate stages in a multistage amplifier because

(1) its voltage gain is high

(2) its current gain is high

(3) its current gain as well as voltage gain is high

(4) its output impedance is very low

14. If we apply a voltage $V = V_p \sin \omega t$ at the input of a half-wave rectifier, then the outpu DC voltage is

(1) $\frac{V_p}{\pi}$ (2) $\frac{2V_p}{\pi}$ (3) $\frac{V_p}{2}$ (4) $\frac{V_p}{2\pi}$

15. Hartley oscillator is not used for designing an audio frequency oscillator because

(1) it is not possible to design it

(2) component's (L and C) size used in the circuit increases so it becomes ver inconvenient

(3) amplitude of oscillations decreases

(4) its efficiency decreases in audio frequency range

16. Indicate the false statement about the need of modulation

(1) It decreases the antenna size

(2) It avoids interference between transmission from two radio stations

(3) It simplifies the design of transmission circuit

(4) It increases the range of transmission

17. An amplifier has a 40 dB gain. Its gain may change by 10% due to change in its parameters. Negative feedback is used to reduce this change only to 1%. Then the value of the feedback factor β is

(1) $\beta = 0 \cdot 1$ (2) $\beta \approx 10$ (3) $\beta = 0 \cdot 09$ (4) $\beta = 0 \cdot 001$

18. In radio receivers, the active device used for demodulation is

(1) diode (2) triode (3) transistor (4) pentode

19. Using the laws of Boolean algebra, the Boolean expression $AB + (A+B)(B+C)$ can be simplified to

(1) $A+BC$ (2) $B+AC$ (3) $C+AB$ (4) $AB+AC$

20. In electrical circuits, the analog of moment of inertia in rotational motion is

(1) resistance (2) inductance (3) capacitance (4) voltage

21. If a series L-C-R circuit is to be oscillatory, then

(1) $\frac{1}{LC} < \frac{R^2}{4L^2}$ (2) $\frac{1}{LC} > \frac{R^2}{4L^2}$ (3) $\frac{1}{LC} = \frac{R^2}{4L^2}$ (4) $\frac{L}{C} = \frac{R^2}{4L^2}$

22. Weirsacker's semi-empirical mass formula does not include

(1) pairing energy (2) magicity energy

(3) coulomb energy (4) asymmetry energy

23. Geiger-Nuttall law gives the relationship between

(1) energy and range of α particle

(2) half-life and decay constant of α particle

(3) half-life and energy of α particle

(4) half-life of α emitter and energy of α particle

24. Nuclear shell model fails to explain

(1) stability of closed shell nuclei

(2) spin and parities of nuclear ground state

(3) electric quadrupole moment of nuclei

(4) nuclear isomerism

25. Which of the following is not an exchange force?

(1) Heisenberg force (2) Barlett force

(3) Wagner force (4) Magorana force

26. The half-life of a radio isotope is 5 years. The fraction of atoms decayed in this isotope in a period of 20 years will be

(1) $\frac{1}{16}$ (2) $\frac{7}{8}$ (3) $\frac{1}{8}$ (4) $\frac{15}{16}$

27. What is the number of α decays that occur in a 1 gm sample of thorium in 1 year. The disintegration constant of thorium (232) is $1 \cdot 58 \times 10^{-18}$ sec^{-1} and Avogadro's number is $6 \cdot 023 \times 10^{23}$?

(1) 13×10^{12} (2) 13×10^{10} (3) 6×10^{11} (4) 11×10^{15}

28. What is the main drawback of liquid drop model of nucleus?

(1) It is not successful in describing the law lying excited states

(2) It is not able to explain nuclear fission

(3) It does not predict binding energy accurately

(4) It is not able to predict α and β emissions properly

29. The binding energy per nucleon is given by

(1) $\frac{Z}{A}(M_H - M_N) + M_N + (1+f)$ a.m.u.
(2) $\frac{Z}{A}(M_H - M_N) + M_H + (1+f)$ a.m.u.
(3) $\frac{Z}{A}(M_H - M_N) + M_H - (1+f)$ a.m.u.
(4) $\frac{Z}{A}(M_H - M_N) + M_N - (1+f)$ a.m.u.

30. If λ_1 and λ_2 are the decay constants for parent and daughter nuclei respectively and $N_1(0)$ is the number of parent nuclei at time $t=0$, then the number of atoms N_2 of daughter nuclei at time t is given by

(1) $N_2 = N_1(0)\frac{\lambda_1}{(\lambda_1 - \lambda_2)}[e^{-\lambda_2 t} - e^{-\lambda_1 t}]$
(2) $N_2 = N_1(0)\frac{\lambda_1}{(\lambda_1 - \lambda_2)}[e^{-\lambda_1 t} - e^{-\lambda_2 t}]$
(3) $N_2 = N_1(0)\frac{\lambda_2}{(\lambda_2 - \lambda_1)}[e^{-\lambda_2 t} - e^{-\lambda_1 t}]$
(4) $N_2 = N_1(0)\frac{\lambda_2}{(\lambda_1 - \lambda_2)}[e^{-\lambda_1 t} - e^{-\lambda_2 t}]$

31. In a nuclear reactor, the coolants are used

(1) to absorb neutrons
(2) to slow down neutrons
(3) to remove heat from reactor core
(4) to control the fission process in the reactor

32. If a nucleus of ${}^{235}_{92}U$ after absorbing a slow neutron undergoes nuclear fission to form a nucleus of ${}^{140}_{54}Xe$ and a nucleus of ${}^{94}_{38}Sr$, then the other particles produced are

(1) one proton and two neutrons
(2) two neutrons
(3) three neutrons
(4) one proton and one neutron

33. Consider the fusion reaction $6\,{}_1^2\mathrm{H} \rightarrow 2\,{}_2^4\mathrm{He} + 2p + 2n + Q$ (43 MeV). The total energy detained by fusing 1 kg for deuterium to form helium is

(1) $4{\cdot}3 \times 10^{27}$ MeV
(2) $8{\cdot}6 \times 10^{27}$ MeV
(3) $5{\cdot}2 \times 10^{27}$ MeV
(4) $2{\cdot}15 \times 10^{27}$ MeV

34. Two helium nuclei ${}_2^3\mathrm{He}$ fuse to give

(1) ${}_2^4\mathrm{He} + {}_1^2\mathrm{H}$
(2) ${}_2^4\mathrm{He} + 2\,{}_1^1\mathrm{H}$
(3) ${}_2^4\mathrm{He} + {}_1^2\mathrm{H} + n$
(4) ${}_2^4\mathrm{He} + 2e + 2n$

35. Cobalt 60 is used in hospitals as a radioactive source in medicines. It has a half-life of 5·25 years. After a use for certain period its activity has been found to decrease by a factor of 8. How is old the sample?

(1) 15·75 years
(2) 10·5 years
(3) 21 years
(4) 42 years

36. Which of the following statements is not true about the binding energy per nucleon?

(1) It is maximum for iron
(2) Its average value is about 5·0 MeV
(3) It is almost constant for most of the nuclei
(4) It increases rapidly for low mass nuclei and then becomes almost constant

37. X-rays are used in the study of crystal structure because

(1) X-rays cannot be absorbed by the crystal
(2) X-rays can probe deepen into the crystal
(3) wavelength of X-rays is comparable to interatomic plane distances in the crystal
(4) X-ray wavelength is much longer than the interatomic plane distance

38. In the Kronig-Penney model, electrons are assumed to be moving in

(1) one-dimensional squarewell potential

(2) one-dimensional squarewell periodic potential

(3) three-dimensional coulomb potential

(4) a periodic harmonic potential

39. Electronic contribution to the specific heat C_V of metals varies as

(1) $C_V \propto T^3$ (2) $C_V \propto T^2$ (3) $C_V \propto T$ (4) C_V is constant

40. NaCl crystal has the following structure

(1) Simple cubic (2) Face-centred cubic

(3) Body-centred cubic (4) Hexagonal

41. According to Wiedemann-Franz law, the ratio of thermal conductivity to electrical conductivity of any metal is given by

(1) $\left(\frac{\pi^2}{3}\right)\left(\frac{k}{e}\right)^2 T$ (2) $\frac{\pi^2}{3}\left(\frac{kT}{e}\right)^2$ (3) $\left(\frac{\pi kT}{2e}\right)^2$ (4) $\left(\frac{\pi k}{e}\right)^2 T$

42. The spacing d_{hkl} of the planes (h, k, l) in a orthorhombic cubic crystal is

(1) $\frac{a}{(h^2 - k^2 + l^2)^{1/2}}$ (2) $\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right]^{1/2}$

(3) $\left[\frac{h^2 - k^2}{a^2} + \frac{l^2}{c^2}\right]^{1/2}$ (4) $\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right]^{-1/2}$

43. In a simple cubic lattice, the ratio $d_{100} : d_{110} : d_{111}$ is

(1) $6 : \sqrt{3} : 2$ (2) $6 : 3 : \sqrt{2}$ (3) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (4) $\sqrt{6} : \sqrt{3} : 1$

44. Zinc crystallizes in *hcp* structure. If *r* is the radius of the zinc atom, the height of the unit cell of zinc is

(1) $2r\left(\frac{8}{3}\right)^{1/2}$ (2) $r\left(\frac{8}{3}\right)^{1/2}$ (3) $2r\left(\frac{3}{8}\right)^{1/2}$ (4) $r\left(\frac{3}{8}\right)^{1/2}$

45. Thermal conductivity k of an insulator at low temperature depends on temperature T as

(1) $K \propto T^3$ (2) $K \propto T$ (3) $K \propto T^2$ (4) $K \propto \frac{1}{T}$

46. Indicate the false statement about the Moseley's law

(1) It explains the origin of characteristic X-rays

(2) It predicts the existence of scandium between calcium and titanium in the periodic table

(3) It helps in correcting the Mendeleyev's periodic table

(4) For any one material L radiations are much more penetrating than K radiations

47. If an X-ray tube operates at 50 kV, then the shortest wavelength of the X-rays produced (given that $C = 3 \times 10^8$ m/sec, $h = 6{\cdot}62 \times 10^{-34}$ J/sec) is

(1) 0·25 Å (2) 0·125 Å (3) 0·62 Å (4) 0·37 Å

48. Light of 2000 Å falls on an aluminium surface. In aluminium 4·2 eV energy is required to remove an electron. What is the kinetic energy of the fastest emitted photoelectron?

(1) 2 eV (2) 3 eV (3) 1 eV (4) 1·5 eV

49. Indicate the false statement about the semiconductors

(1) All intrinsic semiconductors are insulators at $T = 0\,°K$

(2) At very high temperature all semiconductors become intrinsic semiconductors

(3) The conductivity of all semiconductors always increases with temperature

(4) N-type semiconductors are obtained by doping arsenic into silicon

50. X-rays of 10·0 p.m. are scattered from a target. The maximum energy of the recoil electron (h/mc for electron is $2 \cdot 426 \times 10^{-12}$ m) is

(1) $3 \cdot 27 \times 10^{-15}$ joules (2) $6 \cdot 54 \times 10^{-15}$ joules

(3) $5 \cdot 64 \times 10^{-15}$ joules (4) $2 \cdot 37 \times 10^{-15}$ joules

51. The matrix

$$A = \begin{vmatrix} \cos\theta & i\sin\theta \\ i\sin\theta & \cos\theta \end{vmatrix}$$

is

(1) Hermitian (2) unitary (3) orthogonal (4) symmetric

52. Indicate the statement which is not true

(1) The diagonalizing matrix of a unitary matrix is Hermitian

(2) The diagonalizing matrix of a real symmetric matrix is orthogonal

(3) The non-zero elements of a diagonal matrix are its eigenvalues

(4) The diagonalizing matrix of a Hermitian matrix is unitary

53. The Lagrange's equation of motion for a simple pendulum of length l and bob of mass m making an angle θ with the vertical line is

(1) $\dot{\theta}+\frac{g}{l}\sin\theta=0$ (2) $\dot{\theta}+\frac{g}{l}\cos\theta=0$ (3) $\ddot{\theta}+\frac{g}{l}\sin\theta=0$ (4) $\ddot{\theta}+\frac{g}{l}\cos\theta=0$

54. Hamilton's canonical equations of motion are

(1) $\dot{q}_i=\frac{\partial H}{\partial p_i}$ and $\dot{p}_i=\frac{\partial H}{\partial q_i}$

(2) $\dot{q}_i=\frac{\partial H}{\partial p_i}$ and $\dot{p}_i=-\frac{\partial H}{\partial q_i}$

(3) $q_i=\frac{\partial H}{\partial \dot{p}_i}$ and $p_i=\frac{\partial H}{\partial \dot{q}_i}$

(4) $q_i=\frac{\partial H}{\partial \dot{p}_i}$ and $p_i=-\frac{\partial H}{\partial \dot{q}_i}$

55. The generating function for Legendre polynomial $P_n(x)$ is

(1) $(1-2xt+t^2)^{-1/2}$

(2) $(1+2xt-t^2)^{-1/2}$

(3) $(1-2xt+t^2)^{1/2}$

(4) $(1+2xt-t^2)^{1/2}$

56. The value of $\frac{d}{dx}[x^n J_n(x)]$ is

(1) $x^n J_{n+1}(x)$ (2) $-x^{-n} J_{n+1}(x)$ (3) $x^n J_{n-1}(x)$ (4) $x^{n-1} J_{n-1}(x)$

57. If the Rodrigue's formula for a polynomial is

$$(-1)^n e^{x^2} \frac{d^n}{dx^n}(e^{-x^2})$$

then the polynomial is

(1) Legendre (2) Hermite (3) Lagure (4) Bessel

58. A vector field $\vec{A}$ is said to be non-conservative if

(1) $\oint \vec{A}\cdot d\vec{l}=0$ (2) $\vec{\nabla}\times\vec{A}=0$ (3) $\vec{A}=\vec{\nabla}f$ (4) $\vec{\nabla}\cdot\vec{A}=0$

59. For an incompressible fluid $\vec{\nabla}(\rho\,\vec{v})$, where ρ is the density and $\vec{v}$ is the velocity, is

(1) always positive

(2) always negative

(3) always zero

(4) sometimes positive and sometimes negative

60. The vector $\vec{r}$ is directed from the point $P'(x', y', z')$ to the point $P(x, y, z)$. The point P' is fixed and P is allowed to move. If $\hat{r}$ is a unit vector in the direction of $\vec{r}$, then

(1) $\vec{\nabla}\left(\frac{1}{r}\right) = -\frac{\hat{r}}{r^2}$ (2) $\vec{\nabla}\left(\frac{1}{r}\right) = \frac{\hat{r}}{r^2}$ (3) $\vec{\nabla}'\left(\frac{1}{r}\right) = -\frac{\hat{r}}{r^2}$ (4) $\vec{\nabla}'\left(\frac{1}{r}\right) = \frac{\hat{r}}{r^2}$

61. The power developed by an AM wave across a resistance of $100\,\Omega$, when the peak voltage of carrier wave is 100 V and modulation index is 40%, is

(1) 58 W (2) 54 W (3) 46 W (4) 42 W

62. The Boolean expression $ABC + AB\overline{C} + BC\overline{A} + AC\overline{B}$ can be simplified as given below, using K map

(1) $AB + A\overline{C} + BC$ (2) $AB + BC + CA$ (3) $A\overline{B} + BC + CA$ (4) $AB + \overline{B}C + CA$

63. Indicate the false conclusion drawn from the Kronig-Penney model of band theory of solids

(1) The energy spectrum consists of a number of allowed energy bands separated by forbidden regions

(2) The width of allowed energy bands decreases with increasing energy

(3) The width of a particular energy band decreases with increasing binding energy of the solid

(4) The total number of possible wave functions in any energy band is equal to the number of unit cells

64. The ground state energy of a particle in an one-dimensional quantum well is 4·4 eV. If the width of the well is doubled, then the new ground state energy is

(1) 1·1 eV (2) 2·2 eV (3) 8·8 eV (4) 17·6 eV

65. The expectation value of the momentum p in one-dimensional motion is

(1) $\int \psi^* \left(-i\hbar \frac{\partial \psi}{\partial t}\right) dx$ (2) $\int \psi^* \left(-h^2 \frac{\partial^2 \psi}{\partial t^2}\right) dx$

(3) $\int \psi^* \left(-h^2 \frac{\partial^2 \psi}{\partial x^2}\right) dx$ (4) $\int \psi^* \left(-i\hbar \frac{\partial \psi}{\partial x}\right) dx$

66. If the uncertainty in the location of a particle is equal to its de Broglie wavelength, then the uncertainty in its velocity V is

(1) $\frac{V}{2}$ (2) V (3) $\frac{V}{4}$ (4) $\frac{V}{3}$

67. Consider an electron ($m = 9 \cdot 1 \times 10^{-31}$ kg) confined by electrical forces to move between two rigid walls separated by $1 \cdot 0 \times 10^{-9}$ metre. Then the quantized energy value for the second lowest energy state is

(1) 0·38 eV (2) 0·76 eV (3) 3·4 eV (4) 1·5 eV

68. The motion of the electron in the ground state of hydrogen atom is described by the wave function $\psi(r, t) = \frac{1}{\sqrt{\pi a^3}} e^{-r/a} \cos \omega t$. The probability $P(r)$ for the electron to lie in the spherical shell with radii r and $r + dr$ centred at the nucleus of the hydrogen atom is

(1) $\frac{r^2}{a^3} e^{-2r/a}$ (2) $2\frac{r^2}{a^3} e^{-r^2/a^2}$ (3) $2\frac{r^2}{a^3} e^{-2r/a}$ (4) $\frac{r^2}{2a^3} e^{-r^2/a^2}$

69. Transmission probability of a particle with energy E moving through a one-dimensional rectangular potential barrier of height U_0 $(U_0 < E)$

(1) is always 1

(2) is never 1

(3) varies from 0 to 1 periodically with increasing E/U_0

(4) becomes 1 periodically with increasing E/U_0 but never becomes 0

70. If $\psi(r, t)$ represents the wave function of a particle, then to which function it would collapse just after a precise measurement of momentum?

(1) $\delta(\vec{r} - \vec{r}')$ (2) $\delta(\vec{p} - \vec{p}')$

(3) $\psi'(r, t)$ with smaller Δp (4) $\psi'(r, t)$ with smaller Δx

71. Solution of the eigenvalue equation of momentum operator will not decay in case of

(1) hydrogen atom (2) free particle in a box

(3) harmonic oscillator (4) rigid rotator

72. Eigenfunctions for a linear harmonic oscillator pass

(1) even parity

(2) odd parity

(3) definite parity which may be even or odd

(4) no parity

73. The wave function of a particle is given by $\psi = Ce^{-\alpha^2 x^2}$ in the range $-\infty < x < \infty$, where C and a are constants. The probability of finding the particle in the range $0 < x < \infty$ is

(1) $\frac{1}{5}$ (2) $\frac{1}{4}$ (3) $\frac{1}{2}$ (4) $\frac{1}{3}$

74. Which of the following quantum mechanical operators is Hermitian?

(1) $i\frac{d}{dx}$ (2) $\frac{d}{dx}$ (3) $\frac{d^2}{dx^2}$ (4) $-\frac{d}{dx}$

75. The value of the commutation relation $[\hat{p}, (\hat{x}^2 + \hat{p}^2)]$ is

(1) $-i\hbar\,\hat{p}$ (2) $-i\hbar\,\hat{x}$ (3) $-i\hbar(\hat{x} + \hat{p})$ (4) $-2i\hbar\,\hat{x}$

76. The Schrödinger equation for a particle is $\frac{-\hbar^2}{2m}\nabla^2\psi = E\psi$. The energy E of the particle is

(1) $\frac{n^2\pi^2\hbar^2}{2mL^2}$

(2) $n\hbar$

(3) $n\hbar\omega$

(4) E varies continuously in the range 0 to ∞

77. The Hamiltonian H of a system having two states ψ_1 and ψ_2 is such that $H\psi_1 = iE\psi_2$ and $H\psi_2 = -iE\psi_1$. The lowest energy of the system correspond to the state is

(1) $\frac{1}{\sqrt{2}}(\psi_2 - i\psi_1)$ (2) $\frac{1}{\sqrt{2}}(\psi_2 - \psi_1)$ (3) $\frac{1}{\sqrt{2}}(\psi_2 + i\psi_1)$ (4) $\frac{1}{\sqrt{2}}(\psi_2 + \psi_1)$

78. If the wave function for a particle in coordinate space is $\psi(x) = \delta(x)$, then that wave function in the momentum space will be

(1) $\psi(p) = \frac{1}{\sqrt{2\pi}}\, e^{\frac{i}{\hbar}px}$ (2) $\psi(p) = \delta(p)$

(3) $\psi(p) = \frac{1}{\sqrt{2\pi}}\delta(p)$ (4) $\psi(p) = 0$

79. For which value of $\frac{v}{c}$ for a particle will the relativistic mass of the particle exceed its rest mass by a given fraction f ?

(1) $\frac{\sqrt{f(1+f)}}{(2+f)}$ (2) $\frac{\sqrt{f(2+f)}}{(1+f)}$ (3) $\frac{\sqrt{2f(1+f)}}{(2+f)}$ (4) $\frac{\sqrt{f(2+f)}}{2(1+f)}$

80. A radioactive particle with proper mean life of $1\,\mu$ sec moves through the laboratory at a speed of $2 \cdot 7 \times 10^8$ metres/sec. What will be its lifetime observed by an observer in the laboratory?

(1) $10\,\mu s$ (2) $0 \cdot 1\,\mu s$ (3) $2 \cdot 30\,\mu s$ (4) $0 \cdot 43\,\mu s$

81. The velocity of an object whose length appears to be contracted to half of its proper length is

(1) $\frac{1}{\sqrt{2}}c$ (2) $\frac{2}{\sqrt{3}}c$ (3) $\frac{1}{2}c$ (4) $\frac{\sqrt{3}}{2}c$

82. A galaxy is moving away from earth at such a speed that the blue light ($\lambda = 400$ nm) appears to be of wavelength $\lambda = 600$ nm. The speed of the galaxy is

(1) $\frac{3}{5}c$ (2) $\frac{5}{13}c$ (3) $\frac{5}{9}c$ (4) $\frac{4}{9}c$

83. If the total energy of the particle is thrice its rest mass energy, then the velocity of the particle is

(1) $\frac{c}{3}$ (2) $\frac{2c}{3}$ (3) $\frac{\sqrt{2}}{3}c$ (4) $\frac{2\sqrt{2}}{3}c$

84. Indicate the false statement about the Bosons

(1) Wave functions are symmetrical to interchange of particle labels

(2) These particles obey Pauli exclusion principle

(3) The distribution function of Bosons has higher value than the distribution function of Fermions at all energies

(4) Number of Boson per state is more than that predicted by Maxwell-Boltzmann distribution at low energies

85. A collection of independent ensembles having the same temperature T, volume V and chemical potential μ is known as

(1) microcanonical ensemble (2) macrocanonical ensemble

(3) canonical ensemble (4) grand canonical ensemble

86. One mole of a perfect gas at volume V_A, temperature T_A and pressure P_A changes from state A to state B, where volume is V_B, temperature is T_B and pressure is P_B. The change in entropy is

(1) $C_V \ln \frac{V_B}{V_A} + R \ln \frac{T_B}{T_A}$ (2) $C_V \ln \frac{T_B}{T_A} + R \ln \frac{V_B}{V_A}$

(3) $C_V \ln \frac{V_A}{V_B} + R \ln \frac{T_A}{T_B}$ (4) $C_V \ln \frac{T_A}{T_B} + R \ln \frac{V_A}{V_B}$

87. A system A interacting with a reservoir R undergoes a reversible transformation of its thermodynamic state. If ΔS_A is the change in the entropy of A and ΔS_R that of reservoir R during the transformation, then in general

(1) $\Delta S_A = \Delta S_R = 0$ (2) $\Delta S_A = \Delta S_R$ (3) $\Delta S_A + \Delta S_R = 0$ (4) $\Delta S_A + \Delta S_R > 0$

88. An ideal gas undergoes a process during which $P\sqrt{V}$ is constant, where P is the pressure and V is the volume of the gas. If volume of the gas decreases to $\frac{1}{4}$th of its initial value, then the temperature of the gas will become

(1) decrease to half of its initial value

(2) increase to double of its initial value

(3) remain constant

(4) increase by four times

89. If the binding energy of the hydrogen atom is $-13 \cdot 6$ eV, then the lowest wavelength in the Balmer series of hydrogen spectrum is ($h = 6 \cdot 63 \times 10^{-34}$ J-sec)

(1) 8220 Å (2) 912 Å (3) 1216 Å (4) 3650 Å

90. If the exiting line in the Raman effect experiment is 5460 Å and the Stokes' line is at 5520 Å, then the wavelength of the corresponding anti-Stokes line is

(1) 5400 Å (2) 5490 Å (3) 5580 Å (4) 5550 Å

91. The photoelectric threshold for tungsten is 2300 Å. The energy of the electrons emitted from the surface by the ultraviolet light of wavelength 1800 Å incident on the tungsten ($h = 6 \cdot 63 \times 10^{-34}$ J-sec) is

(1) $2 \cdot 39 \times 10^{-12}$ joule (2) $2 \cdot 39 \times 10^{-19}$ joule

(3) $1 \cdot 48 \times 10^{-19}$ joule (4) $3 \cdot 56 \times 10^{-19}$ joule

92. The wave function of a particle confined in a box of length L is $\psi(x) = \sqrt{\frac{2}{L}} \sin \frac{\pi x}{L}$. The probability of finding the particle in the range $0 < x < \frac{L}{2}$ will be

(1) 1 (2) $\frac{1}{2}$ (3) $\frac{1}{4}$ (4) $\frac{1}{3}$

93. The energy of a linear harmonic oscillator in third excited state is 4·1 eV. The frequency of vibration is ($\mu = 6 \cdot 62 \times 10^{-34}$ J-sec)

(1) $3 \cdot 3 \times 10^{13}$ Hz (2) $2 \cdot 8 \times 10^{13}$ Hz (3) $3 \cdot 9 \times 10^{13}$ Hz (4) $4 \cdot 2 \times 10^{13}$ Hz

94. The Miller indices of the plane parallel to the X-Y axis are

(1) (1, 0, 0) (2) (0, 1, 0) (3) (0, 0, 1) (4) (1, 1, 0)

95. If there are N atoms in monoatomic solids vibrating with frequency ν, its specific heat at high temperatures would be

(1) $3\ Nk_B/2$ (2) $3\ Nk_B$ (3) $5\ Nk_B$ (4) $5\ Nk_B/2$

96. The reciprocal lattice of an FCC crystal is

(1) tetragonal (2) BCC (3) hexagonal (4) orthorhombic

97. Lasers are more useful for holography because of

(1) directionality (2) coherence (3) brightness (4) monochromaticity

98. The blue colour of sky is explained by

(1) Raman effect (2) Rayleigh scattering

(3) Bohr's theory (4) Rutherford scattering

99. If the Lagrangian of a system is $L = \frac{1}{2} q \dot{q}^2$, then the solution of Lagrange's equation for boundary condition $q = 0$ at $t = 0$ yields

(1) $q \propto t$ (2) $q \propto t^{1/2}$ (3) $q \propto t^2$ (4) $q \propto t^{3/2}$

100. A particle of mass m moves along X-axis under the action of a force $F = -\frac{2k}{x^3}$. Its motion is described by the Lagrangian

(1) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 + \frac{k}{x^2}$ (2) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 + \frac{2k}{x^3}$

(3) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 - \frac{k}{x^2}$ (4) $\frac{m}{2}\left(\frac{dx}{dt}\right)^2 - \frac{2k}{x^3}$

101. If a matrix $A = \begin{pmatrix} 1 & 3 \\ 2 & 1 \end{pmatrix}$, then A^{-1} will be

(1) $-\frac{1}{5}\begin{pmatrix} 1 & -3 \\ -2 & 1 \end{pmatrix}$ (2) $\frac{1}{5}\begin{pmatrix} 1 & 3 \\ 2 & 1 \end{pmatrix}$ (3) $\frac{1}{4}\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ (4) $-\frac{1}{3}\begin{pmatrix} -1 & 3 \\ 2 & -1 \end{pmatrix}$

102. If a matrix is $A = \begin{pmatrix} 3 & 1 \\ 2 & 2 \end{pmatrix}$ its eigenvalues are

(1) 1 and 2 (2) 2 and 4 (3) 1 and 3 (4) 1 and 4

103. If u_1 and u_2 are eigenstates corresponding to energy eigenvalues E_1 and E_2 ($E_1 \neq E_2$) of a Hamiltonian, then in the state space

(1) u_1 and u_2 are parallel

(2) u_1 and u_2 are orthogonal

(3) u_1 and u_2 are at an angle such that $\cos\theta = \frac{E_1}{E_2}$

(4) u_1 and u_2 are degenerate states

104. When the Zeeman lines are observed perpendicular to the magnetic field they will be

(1) plane polarized (2) circularly polarized

(3) elliptically polarized (4) unpolarized

105. In a purely inductance AC source circuit $L = 50$ mH. The inductive reactance of the circuit when the frequency of AC source is 60 Hz, will be

(1) $18 \cdot 85\,\Omega$ (2) $3 \cdot 8\,\Omega$ (3) $6 \cdot 31\,\Omega$ (4) $12 \cdot 62\,\Omega$

106. The width of the interference fringes in Young's double-slit experiment increases

(1) on increasing the slit width

(2) on decreasing the wavelength of light used

(3) on decreasing the distance between the slit and the screen

(4) on decreasing the distance between the slits

107. On placing a thin sheet of mica of thickness 12×10^{-5} cm in the path of the one of the two interfering beams in Fresnel's biprism experiment it is found that the central fringe is shifted by a distance equal to the width of a bright fringe of $\lambda = 6 \times 10^{-5}$ cm, then the refractive index of mica is

(1) 1·33 (2) 1·42 (3) 1·5 (4) 1·45

108. A drop of water is placed between the lens and glass plate in Newton's ring experiment. What will happen to the size of the rings?

(1) Rings will increase in diameter

(2) Rings will decrease in diameter

(3) Rings will disappear

(4) Diameter of rings will remain unchanged

109. We wish to use a plate of glass ($\mu = 1 \cdot 5$) as a polarizer. What must be the angle of incidence so that the reflected light is completely polarized?

(1) 56·3° (2) 65·4° (3) 36·5° (4) 45·6°

110. The sodium source of light has a doublet whose components are 5890 Å and 5896 Å. The minimum number of lines in a grating to resolve this doublet in the first-order spectrum is

(1) 796 (2) 982 (3) 856 (4) 490

111. A beam of light is observed by a Nicol prism after passing through a quarter-wave plate. Two positions of maximum intensity and two positions of zero intensity are found on one complete rotation of Nicol prism. The light is

(1) unpolarized (2) plane polarized

(3) circularly polarized (4) elliptically polarized

112. If the proper mean lifetime τ of π^+ meson is $2 \cdot 5 \times 10^{-8}$ sec, then the distance travelled by a burst of π^+ mesons travelling with $v = 0 \cdot 73c$ is

(1) 800 cm (2) 600 cm (3) 500 cm (4) 300 cm

113. What is the momentum of a proton having kinetic energy 1 BeV, if the velocity of light is c?

(1) $\frac{1 \cdot 5 \text{ BeV}}{c}$ (2) $\frac{1 \cdot 0 \text{ BeV}}{c}$ (3) $\frac{2 \cdot 0 \text{ BeV}}{c}$ (4) $\frac{1 \cdot 7 \text{ BeV}}{c}$

114. What is the mass equivalent of the energy from an antenna radiating 1000 watts of radio energy for 12 hour?

(1) 9·6 milligrams (2) 1·2 milligrams

(3) 4·002 milligrams (4) 6·03 milligrams

115. In an inertial frame a body moves freely with a constant velocity v_0 along X-axis. What is its trajectory in a frame rotating with constant angular velocity ω about Z-axis of inertial frame?

(1) Circle with fixed radius in X-Y plane

(2) Circle with radius changing at a constant rate in X-Y plane

(3) Straight line in X-Y plane

(4) Straight line in X-Z plane

116. The interaction between neutrons and protons may be represented by the Yukawa potential $u(r) = -\left(\frac{r_0}{r}\right)u_0 e^{-r/r_0}$, then the force $F(r)$ between neutrons and protons is

(1) $-\left(\frac{r_0}{r}\right)u_0 e^{-r/r_0}\left[\frac{1}{r}-\frac{1}{r_0}\right]\hat{r}$

(2) $-\left(\frac{r_0}{r}\right)u_0 e^{-r/r_0}\left[\frac{1}{r}-\frac{1}{r_0}\right]\hat{r}$

(3) $-\left(\frac{r_0}{r_2}\right)u_0 e^{-r/r_0}\left[\frac{1}{r_0}\right]\hat{r}$

(4) $-\frac{r_0}{r^2}u_0 e^{-r/r_0}\left[\frac{1}{r}-\frac{2}{r_0}\right]$

117. Two protons each of energy 500 MeV approach each other from opposite direction. If the only interaction is the electrostatic interaction, how close could the protons come to each other?

(1) $1{\cdot}6\times10^{-10}$ cm (2) $1{\cdot}8\times10^{-12}$ cm (3) $1{\cdot}4\times10^{-14}$ cm (4) $1{\cdot}4\times10^{-16}$ cm

118. For a physical system composed of N identical particles confined in space V having energy E and entropy S, the pressure P is given by

(1) $-\left(\frac{\partial E}{\partial V}\right)_{S,\,N}$ (2) $\left(\frac{\partial E}{\partial N}\right)_{V,\,S}$ (3) $\left(\frac{\partial E}{\partial S}\right)_{N,\,V}$ (4) $-\left(\frac{\partial S}{\partial N}\right)_{V,\,E}$

119. If E is the energy, G is the Gibbs free energy, A is the Helmholtz free energy and H is the enthalpy for a physical system (N, V, E), then the specific heat at constant pressure is given by

(1) $\left(\frac{\partial G}{\partial T}\right)_{N,\,P}$ (2) $\left(\frac{\partial A}{\partial T}\right)_{N,\,P}$ (3) $\left(\frac{\partial H}{\partial T}\right)_{N,\,P}$ (4) $\left(\frac{\partial E}{\partial T}\right)_{N,\,P}$

120. Which one of the following relations is true for chemical potential μ for the physical system (N, V, E) ?

(1) $\mu = \frac{H}{N}$ (2) $\mu = \frac{G}{N}$ (3) $\mu = \frac{A}{N}$ (4) $\mu = \frac{E}{N}$

121. During reversible adiabatic process the effective ratio of the two specific heats for a mixture of any two ideal gases with mol fractions f_1 and f_2 and specific heat ratios r_1 and r_2 is given by

(1) $\frac{1}{r} = \frac{f_1}{r_1} + \frac{f_2}{r_2}$

(2) $\frac{1}{r-2} = \frac{f_1}{r_1-2} + \frac{f_2}{r_2-2}$

(3) $\frac{1}{r-1} = \frac{f_1}{r_1-1} + \frac{f_2}{r_2-1}$

(4) $r = f_1 r_1 + f_2 r_2$

122. On mixing the two samples of the same gas at a common initial temperature T the change in entropy of the system is given by

(1) $\Delta S = k\left[N_1 \ln\left(\frac{V_1+V_2}{V_1}\right) + N_2 \ln\left(\frac{V_1+V_2}{V_2}\right)\right]$

(2) $\Delta S = k\left[V_1 \ln\left(\frac{N_1+N_2}{N_1}\right) + V_2 \ln\left(\frac{N_1+N_2}{N_2}\right)\right]$

(3) $\Delta S = k\left[(N_1+N_2)\ln\left(\frac{V_1+V_2}{N_1+N_2}\right) - N_1 \ln\frac{V_1}{N_1} - N_2 \ln\frac{V_2}{N_2}\right]$

(4) $\Delta S = k\left[(V_1+V_2)\ln\left(\frac{N_1+N_2}{V_1+V_2}\right) - V_1 \ln\frac{N_1}{V_1} - V_2 \ln\frac{N_2}{V_2}\right]$

123. An ensemble, for which the density function $\rho(p, q, t) \propto \exp[-H(q, p)/kT]$, where $H(q, p)$ is the Hamiltonian for that ensemble, is

(1) microcanonical (2) canonical

(3) grand canonical (4) macrocanonical

124. If the Hamiltonian for one-dimensional harmonic oscillator in phase space is given by $H(q, p) = \frac{1}{2}kq^2 + \frac{p^2}{2m}$, then the phase trajectory of the representative point (q, p) of this system will be

(1) ellipse (2) circle (3) parabola (4) hyperbola

125. Virial theorem states that for a canonical ensemble consisting of an ideal gas of non-interacting N particles the quantity $\left(\sum_i q_i \dot{p}_i\right)$ is equal to

(1) $3NkT$ (2) $-3NkT$ (3) $-2pV$ (4) $2pV$

126. The quantity $\sum_{r, S} e^{-\beta(E_r - \mu N_S)}$ is known as

(1) partition function (2) special partition function

(3) semipartition function (4) grand partition function

127. Lieuville's theorem states that

(1) $\frac{\partial \rho}{dt} + \text{div}(\rho v) = 0$ (2) $\frac{\partial \rho}{dt} + [\rho, H] = 0$

(3) $\frac{\partial \rho}{dt} - \text{div}(\rho v) = 0$ (4) $\frac{\partial \rho}{dt} - [\rho, H] = 0$

128. Nernst heat theorem is another way of stating

(1) first law of thermodynamics (2) second law of thermodynamics

(3) third law of thermodynamics (4) fourth law of thermodynamics

129. An ideal gas consisting of N particles undergoes isothermal change of state from initial state (P_i, V_i, T) to final state (P_f, V_f, T), then the increase in entropy is

(1) $Nk \ln\left(\frac{V_f}{V_i}\right)$ (2) $Nk \ln\left(\frac{P_f}{P_i}\right)$ (3) $Nk \ln\left(\frac{V_f P_i}{V_i P_f}\right)$ (4) $Nk \log\left(\frac{V_f}{V_i}\right)$

130. Imagine a light planet revolving round a very massive star in a circular orbit of radius R with a period of revolution T. If the gravitational force of attraction between the planet and star is proportional to $R^{-5/2}$, then

(1) $T^2 \propto R^3$ (2) $T^2 \propto R^{7/2}$ (3) $T^2 \propto R^{3/2}$ (4) $T^2 \propto R^{7/4}$

131. A transistor having $\alpha = 0 \cdot 975$ and reverse saturation current $I_{CO} = 10\,\mu A$ is operated in CE configuration. If the base current is $250\,\mu A$, then the collector current is

(1) 10·15 mA (2) 9·75 mA (3) 11·64 mA (4) 8·56 mA

132. Which one of the following is not a correct boundary condition at the interface of two different media?

(1) Tangential component of $\vec{E}$ is always continuous

(2) Tangential component of $\vec{H}$ is always continuous

(3) Normal component of $\vec{B}$ is always continuous

(4) Normal component of $\vec{D}$ is always continuous

133. Which one of the following media can be considered to be a conductor at 8 MHz?

(1) Soil with $\varepsilon_r = 15$ and $\sigma = 10^{-2}\,(\Omega m)^{-1}$

(2) Germanium with $\varepsilon_r = 16$ and $\sigma = 0 \cdot 1 (\Omega m)^{-1}$

(3) Seawater with $\varepsilon_r = 80$ and $\sigma = 25 (\Omega m)^{-1}$

(4) Wood with $\varepsilon_r = 2$ and $\sigma = 10^{-6}\,(\Omega m)^{-1}$

134. If $C_{r.m.s.}, \overline{C}$ and C_m denote respectively the r.m.s. speed, average speed and most probable speed molecules in a gas obeying Maxwell-Boltzmann distribution law for molecular speeds, then

(1) $C_m > \overline{C} > C_{r.m.s.}$ (2) $\overline{C} > C_{r.m.s.} > C_m$

(3) $C_{r.m.s.} > \overline{C} > C_m$ (4) $C_{r.m.s.} > C_m > \overline{C}$

135. The short term frequency stability of a He-Ne gas to Laser at $\lambda = 1153$ nm is approximately 8 parts in 10^{14} then the coherence time is

(1) 28 ms (2) 96 ms (3) 48 ms (4) 64 ms

136. A sample of certain element is placed in a 0·300 tesla magnetic field and suitably excited. How far apart are the Zeeman components of the 450 nm spectral line of this element?

(1) $5 \cdot 66 \times 10^{-12}$ metre (2) $2 \cdot 83 \times 10^{-12}$ metre

(3) 0·0014 nm (4) 0·0042 nm

137. An electron has a speed of 300 metres/sec accurate up to 0·01%. With what fundamental accuracy can locate the position of this electron ($m_e = 9 \cdot 1 \times 10^{-31}$ kg, charge $e = 1 \cdot 6 \times 10^{-19}$ coulomb and Planck's constant $h = 6 \cdot 64 \times 10^{-34}$ joules/sec) ?

(1) 2·4 cm (2) 1·2 cm (3) 1·8 cm (4) 3·6 cm

138. A diffraction grating has 10^4 lines per inch. It is illuminated at normal incidence by sodium light ($\lambda_1 = 5890$ Å and $\lambda_2 = 5896$ Å). What is the angular separation between the first-order maxima of these lines?

(1) $1 \cdot 2 \times 10^{-4}$ rad (2) $2 \cdot 4 \times 10^{-4}$ rad (3) $0 \cdot 6 \times 10^{-4}$ rad (4) $1 \cdot 8 \times 10^{-4}$ rad

139. In a common emitter amplifier, the voltage gain depends mainly on

(1) h_{fe} and h_{re} (2) h_{fe} and h_{ie} (3) h_{fe} and h_{oe} (4) h_{re} and h_{ie}

140. An atom of magnetic quantum number m_l and mass m is placed in a magnetic field B, then magnetic energy is

(1) $m_l\left(\frac{e\hbar}{2m}\right)B^2$ (2) $m\left(\frac{e\hbar}{2m_l}\right)B$ (3) $m_l\left(\frac{e\hbar}{2m}\right)B$ (4) $m\left(\frac{e\hbar}{2m_l}\right)B^2$

141. For an electron in a one electron atomic system the possible orientations of the total angular momentum $\vec{J}$ for the states that correspond to orbital quantum number $l=1$ are

(1) 2 (2) 4 (3) 6 (4) 3

142. The anomalous Zeeman effect was explained by introducing the concept of

(1) orbital angular momentum

(2) magnetic moment due to orbital angular momentum

(3) skin angular momentum

(4) magnetic moment due to total angular momentum

143. Which one of the following statements is not true about the Laser light beam?

(1) It is nearly monochromatic (2) It is coherent

(3) It is extremely intense (4) It converges hardly at all

144. Which of the following gates is known as equality comparator?

(1) AND gate (2) OR gate (3) XNOR gate (4) XOR gate

145. If an electron ($m = 9 \cdot 1 \times 10^{-31}$ kg) is confined by an electrical force to move between two rigid walls separated by $1 \cdot 0 \times 10^{-9}$ metre. The quantized energy value for the second lowest energy state is

(1) 0·38 eV (2) 0·76 eV (3) 1·5 eV (4) 3·0 eV

146. If the number of quantum states $g(\varepsilon)\, d\varepsilon$ available to electron in a metal with energies between ε and $\varepsilon + d\varepsilon$ is $g(\varepsilon)\, d\varepsilon = (3N/2)\, \varepsilon_F^{-3/2} \sqrt{\varepsilon}\, d\varepsilon$, where ε_F is Fermi energy and N is the number of electrons present, then the average electron energy at $T = 0$ °K is

(1) $\frac{3}{5}\varepsilon_F$ (2) $\frac{1}{5}\varepsilon_F$ (3) $\frac{2}{5}\varepsilon_F$ (4) ε_F

147. The atomic number Z of the element which has a K_α X-ray line of wavelength 0·180 nm (given that Rydberg constant $R = 1 \cdot 097 \times 10^7$ m^{-1}) is

(1) 27 (2) 26 (3) 52 (4) 54

148. At a given temperature any semiconductor has the minimum conductivity given by

(1) $2en_i \frac{\mu_n^2}{\mu_p}$ (2) $2en_i \frac{\mu_p^2}{\mu_n}$ (3) $2en_i \sqrt{\mu_n \mu_p}$ (4) $2en_i \sqrt{\mu_n / \mu_p}$

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

(1) monoclinic (2) orthorhombic (3) tetragonal (4) rhombohedral

150. Which one of the following particles cannot be accelerated by cyclotron?

(1) Electron (2) Proton (3) α particle (4) Deuteron

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अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण-पृष्ठ पर तथा उत्तर-पत्र के दोनों पृष्ठों पर केवल नीली या काली बाल-प्वाइंट पेन से ही लिखें)

1. प्रश्न पुस्तिका मिलने के 10 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष-निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।
2. परीक्षा भवन में *लिफाफा रहित प्रवेश-पत्र के अतिरिक्त*, लिखा या सादा कोई भी खुला कागज साथ में न लायें।
3. उत्तर-पत्र अलग से दिया गया है। ***इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा, केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।***
4. अपना *अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ पर पेन* से निर्धारित स्थान पर लिखें
5. **उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।**
6. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न-पुस्तिका पर अनुक्रमांक सं० और ओ० एम० आर० पत्र सं० की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।
7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।
8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। ***प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।***
9. प्रत्येक प्रश्न के उत्तर के लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का ***उत्तर नहीं देना चाहते हैं,*** तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।
11. रफ़ कार्य के लिये प्रश्न-पुस्तिका के मुखपृष्ठ के अन्दर वाले पृष्ठ तथा अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त केवल ***ओ०एम०आर० उत्तर-पत्र*** परीक्षा भवन में जमा कर दें।
13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।
14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित दंड का/की, भागी होगा/होगी।