

10P/218/31

Question Booklet No.....

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

Roll No.

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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 *both the Question Booklet and the 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.

10P/218/31

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. Which one of the following pairs does not represent quantities of identical dimension?

- (1) Angular momentum and Planck's constant
- (2) Moment of inertia and moment of force
- (3) Work and torque
- (4) Impulse and momentum

2. The radius of curvature of the path of a charged particle in a uniform magnetic field is directly proportional to

- | | |
|----------------------------|------------------------------------|
| (1) charge of the particle | (2) momentum of the particle |
| (3) energy of the particle | (4) strength of the magnetic field |

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(P.T.O.)

3. The equation $\vec{\nabla} \times \vec{B} = \mu_0 \epsilon_0 \vec{J}(\vec{r}, t)$, where \vec{B} is the magnetic field and $\vec{J}(\vec{r}, t)$ is the current density
- (1) does not hold because it violates equation of continuity
 - (2) does not hold because magnetic monopoles do not exist
 - (3) will hold if $\vec{\nabla} \cdot \vec{J}(\vec{r}, t)$ is constant
 - (4) will hold if $\vec{J}(\vec{r}, t)$ is time independent
4. A 50 gm bullet moving with velocity 10 m/sec strikes a block of 950 gm at rest and gets embedded in it. The loss in kinetic energy will be
- (1) 100%
 - (2) 95%
 - (3) 5%
 - (4) zero
5. The escape velocity on the surface of the earth is v_0 . If M and R are the mass and radius of the earth, respectively, then the escape velocity on another planet of mass $2M$ and radius $\frac{R}{2}$ will be
- (1) $4v_0$
 - (2) $2v_0$
 - (3) v_0
 - (4) $\frac{v_0}{2}$
6. The earth's radius is 6.37×10^6 m and the earth is 1.5×10^8 km away from the sun. The fraction of the radiation emitted by sun as intercepted by the earth is
- (1) 4.5×10^{-6}
 - (2) 18.12×10^{-8}
 - (3) 4.51×10^{-10}
 - (4) 3.12×10^{-9}
7. A monochromatic light is travelling from one medium to another. Which of the following property remains unaltered?
- (1) Velocity
 - (2) Amplitude
 - (3) Wavelength
 - (4) Frequency
8. The time required for the light to travel 60 cm in a medium of refractive index 1.5 is
- (1) 1.2×10^{-8} sec
 - (2) 3×10^{-9} sec
 - (3) 2×10^{-10} sec
 - (4) 7×10^{-12} sec

9. If the total energy of a particle is thrice its rest mass energy, then the velocity of particle in terms of velocity of light c is

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

10. The half life of certain particle in its rest frame is 36μ sec. Its half-life for an observer, moving at constant velocity of $0.8c$ with respect to the particle will be

- (1) 36μ sec (2) 50μ sec (3) 60μ sec (4) 100μ sec

11. If \vec{F} is a conservative force, then

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

12. If $\phi = \frac{Q}{4\pi\epsilon_0 r}$, where Q is the charge and r is the distance of the point from Q , then $\nabla^2 \phi$ is

- (1) zero (2) $\frac{Q}{2\pi\epsilon_0 r^2}$ (3) $\frac{Q}{2\pi\epsilon_0 r^3}$ (4) $\frac{Q}{4\pi\epsilon_0} \frac{r}{r^3}$

13. If ρ is the charge density in a closed volume having a surface S , \vec{E} is the electric field and Q is the total charge on the surface, then the value of $\oiint_S \vec{E} \cdot \vec{n} dS$ is

- (1) ρ (2) $\frac{\rho}{\epsilon_0}$ (3) $\frac{Q}{\epsilon_0}$ (4) zero

14. Maxwell equation in a free medium $\vec{\nabla} \times \vec{E}$ is

- (1) $\frac{\partial \vec{B}}{\partial t}$ (2) $\frac{1}{c} \frac{\partial \vec{B}}{\partial t}$ (3) $-\frac{1}{c} \frac{\partial \vec{H}}{\partial t}$ (4) $\frac{1}{c} \frac{\partial \vec{E}}{\partial t}$

15. In order to determine uniquely a vector field, it is necessary to specify

- (1) its divergence only (2) its curl only
(3) curl of its curl (4) its divergence and curl both

16. If a matrix is $A = \begin{pmatrix} 1 & 3 \\ 2 & 1 \end{pmatrix}$, 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) $-\frac{1}{3} \begin{pmatrix} -1 & 3 \\ 2 & -1 \end{pmatrix}$

17. 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

18. Consider the solution $y(t)$ of the equation

$$\frac{d^2y}{dt^2} + 2k \frac{dy}{dt} + k^2y = \exp(-kt)$$

where k is a constant and whose value and derivative with respect to t are zero at $t = 0$. Then $y(t)$ is

(1) $\frac{1}{2} \exp(-kt)$ (2) $\frac{1}{2} t \exp(-kt)$ (3) $\frac{1}{2} t^2 \exp(-kt)$ (4) $\frac{1}{2} \exp(-kt^2)$

19. If a Lagrangian of a system is $L = \frac{1}{2} q\dot{q}^2$, then solution of Lagrange's equation yields (if $q = 0$ at $t = 0$)

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

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

21. Lagrangian for a charged particle with charge e and mass m moving in an electromagnetic field with scalar potential $\phi(x, y, z)$ and vector potential $\vec{A}(x, y, z)$ is given as

$$\vec{L} = \frac{1}{2} m v^2 - e\phi + \frac{e}{c} \vec{A} \cdot \vec{v}$$

Expression for generalised momentum is

- (1) zero (2) $m \vec{v}$ (3) $m \vec{v} + \frac{e}{c} \vec{A}$ (4) $m \vec{v} - e\phi + \frac{e}{c} \vec{A}$

22. The Lagrangian of a system is given as $L = \frac{1}{2} m (\dot{x}^2 + \dot{y}^2 + \dot{z}^2) - mgz$, then system has symmetry about

- (1) x axis only (2) y axis only (3) z axis only (4) x and y axes both

23. 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 θ such that $\cos \theta = \frac{E_1}{E_2}$

(4) u_1 and u_2 are degenerate states

24. If an operator satisfies the equation $\hat{O}\psi = a\psi$, then measurement of \hat{O} will give

(1) a in the state ψ

(2) the value $= \int \psi^* \hat{O} \psi d^3x$ in the state ψ

(3) any value of several values greater than a

(4) zero

25. The value of the commutation relation $[\hat{p}, (\hat{x}^2 + \hat{p}^2)]$ is
- (1) $-i\hbar$ (2) $-i\hbar \hat{x}$ (3) $-i\hbar (\hat{x} + \hat{p})$ (4) $-2i\hbar \hat{x}$
26. A free particle Schrödinger equation is written as $-\frac{\hbar^2}{2m} \nabla^2 \psi = E\psi$. Then the energy of the particle E is
- (1) $\frac{n^2 \pi^2 \hbar^2}{2mL^2}$
- (2) $n\hbar$
- (3) $n\hbar\omega$
- (4) E varies continuously from zero to infinity
27. If ψ_1, ψ_2 are eigenvectors of an operator \hat{A} with eigenvalues as $\frac{1}{2}$ and $-\frac{1}{2}$ respectively, then $a\psi_1 + b\psi_2$ (where a, b are complex numbers) is an
- (1) eigenvector of \hat{A} with eigenvalue $\frac{a-b}{2}$
- (2) eigenvector of \hat{A} with eigenvalue zero
- (3) eigenvector of \hat{A}^2 with eigenvalue $\frac{a+b}{4}$
- (4) eigenvector of \hat{A}^2 with eigenvalue $\frac{1}{4}$
28. If wave function in coordinate space is $\psi(x) = \delta(x)$, then momentum space wave function is
- (1) $\frac{1}{\sqrt{2\pi}}$ (2) $\delta(p)$ (3) $\frac{1}{\sqrt{2\pi}} \delta(p)$ (4) zero
29. 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 corresponds to the state
- (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) $\frac{1}{\sqrt{2}} (\psi_2 + \psi_1)$

30. The probability of drawing two aces in succession from a pack of 52 cards is
 (1) $\frac{2}{26}$ (2) $\frac{2}{13}$ (3) $\frac{1}{221}$ (4) $\frac{1}{169}$
31. Two non-interacting particles are distributed in three distinct states. Let P_c be the probability for both of them in the same state in case particles are distinguishable and P_b the probability for them to be in the same state in case they are indistinguishable bosons. The ratio $\frac{P_c}{P_b}$ is
 (1) $\frac{3}{2}$ (2) 1 (3) $\frac{2}{3}$ (4) $\frac{1}{3}$
32. A perfect mono-atomic gas undergoes reversible adiabatic expansion. The relationship between its volume V and the internal energy U at any stage of expansion is given by
 (1) $UV^{1/3} = \text{constant}$ (2) $UV = \text{constant}$
 (3) $UV^{2/3} = \text{constant}$ (4) $UV^{4/3} = \text{constant}$
33. A system A interacting with a reservoir R undergoes a reversible transformation of its thermodynamic state. If ΔS_A is the change of entropy of A and ΔS_R that of R during the transformation, then in general
 (1) $\Delta S_A = \Delta S_R = 0$ (2) $\Delta S_A = \Delta S_R$ (3) $\Delta S_A = -\Delta S_R$ (4) $\Delta S_A = 0, \Delta S_R > 0$
34. Compared with the ionization potential of the hydrogen atom, the ionization potential of the deuterium atom is
 (1) lower by a factor of 2 (2) exactly same
 (3) slightly lower (4) slightly higher
35. 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

36. A generator produces 100 A of current at 4000 V. By using a transformer, the voltage is stepped up to 2.4×10^5 V so that it can be sent to a village on high voltage lines. If the effective resistance of the line is 30 ohms, the power lost in communication is
- (1) 63.7 W (2) 83.7 W (3) 33.7 W (4) 93.7 W
37. A $40 \mu\text{F}$ capacitor is connected to a 50Ω resistor and a generator whose r.m.s. output is 30 volts at 60 Hz. The r.m.s. current is
- (1) 0.182 A (2) 0.061 A (3) 0.361 A (4) 0.421 A
38. The energy density in the electric field created by a point charge falls off with the distance from the point charge as
- (1) $\frac{1}{r}$ (2) $\frac{1}{r^2}$ (3) $\frac{1}{r^3}$ (4) $\frac{1}{r^4}$
39. A hydrogen and a helium nucleus moving with equal kinetic energy enter separately and perpendicularly into a magnetic field. The ratio of radii of circular paths i.e., $\frac{r_{\text{H}}}{r_{\text{He}}}$ will be
- (1) $\frac{1}{4}$ (2) $\frac{1}{2}$ (3) $\frac{1}{\sqrt{2}}$ (4) 1
40. The work done in carrying a charge q around a circle of radius r with a charge Q at the centre is
- (1) $\frac{qQ}{4\pi\epsilon_0} \frac{1}{r}$ (2) $\frac{qQ}{4\pi\epsilon_0} \frac{1}{\pi r}$ (3) $\frac{qQ}{2\epsilon_0} \frac{1}{r}$ (4) zero
41. The magnetic field inside a current-carrying solenoid is B . If its radius is doubled and the current through it also doubled, the magnetic field will be
- (1) B (2) $2B$ (3) $4B$ (4) $\frac{B}{2}$

42. A positively charged particle of mass m kg and charge Q coulomb travels from rest through a potential difference of V volts. Its kinetic energy in Joules is

- (1) $\frac{mQ}{V}$ (2) mQV (3) $\frac{mV}{Q}$ (4) QV

43. A charged capacitor of $0.1 \mu\text{F}$ is discharged through a resistance of 10^7 ohms. The charge will reduce to 36.8% of the original value in a time of

- (1) 4 sec (2) 3 sec (3) 2 sec (4) 1 sec

44. A charge q is placed at the centre of the line joining two equal charges Q . The system of these charges will be in equilibrium if q is equal to

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

45. In a purely inductive a.c. source circuit $L = 25$ mH. The inductive reactance of the circuit when the frequency of a.c. source is 60 Hz, will be

- (1) 9.43Ω (2) 6.31Ω (3) 7.31Ω (4) 3.62Ω

46. The electric field vector of a plane wave in free space is given by $\vec{E} = \cos(\omega t - kz) \cdot [\hat{e}_x E_{0x} + \hat{e}_y E_{0y}]$. Its magnetic field vector will be given as

- (1) $\vec{B} = \frac{1}{c} \sin(\omega t - kz) [-E_{0y} \hat{e}_x + E_{0x} \hat{e}_y]$ (2) $\vec{B} = \frac{1}{c} \cos(\omega t - kz) [-E_{0y} \hat{e}_x + E_{0x} \hat{e}_y]$
 (3) $\vec{B} = \frac{1}{c} \sin(\omega t - kz) [-E_{0x} \hat{e}_x + E_{0y} \hat{e}_y]$ (4) $\vec{B} = \frac{1}{c} \cos(\omega t - kz) [-E_{0x} \hat{e}_x + E_{0y} \hat{e}_y]$

47. If V_p is the sinusoidal peak voltage in the secondary of the transformer, the average d.c. output voltage of half-wave rectifier is

- (1) $\frac{V_p}{2}$ (2) $\frac{2V_p}{3.14}$ (3) $\frac{V_p}{3.14}$ (4) $3.14 V_p$

48. Characteristic impedance of a transmission line in high frequency region is

- (1) $\left(\frac{L}{C}\right)^{1/2}$ (2) $\left(\frac{C}{L}\right)^{1/2}$ (3) $(LC)^{1/2}$ (4) $\left(\frac{L}{C}\right)^2$

49. When a $P-N$ junction is formed what happens in the P and N regions?

- (1) The top of valence bands are aligned
 (2) The bottom of conduction bands are aligned
 (3) The majority carrier concentrations are equalized
 (4) The Fermi levels are aligned

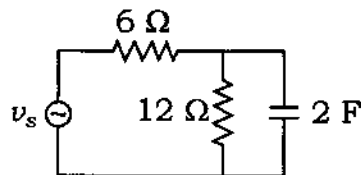
50. If two 100 W bulbs are connected in series across 230 V supply, then total power consumed by both the bulbs is

- (1) 200 W (2) 100 W (3) 50 W (4) 25 W

51. If two coils having self-inductances L_1 and L_2 and mutual inductance M are connected in series with opposite polarity, then the total inductance of the series combination is

- (1) $L_1 + L_2 + 2M$ (2) $L_1 - L_2 + 2M$ (3) $L_1 + L_2 - 2M$ (4) $L_1 - L_2 - 2M$

52. In the network of figure shown below, $v_s = 6$ V. The time constant of the network is



- (1) 8 sec (2) 12 sec (3) 24 sec (4) 36 sec

53. Following cannot be used as a core of a transformer

- (1) Air (2) Steel (3) Aluminium (4) Ferrite

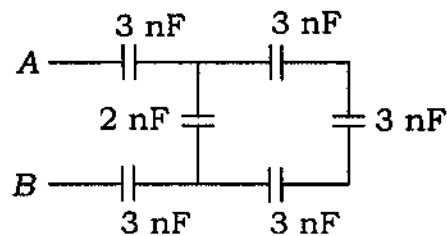
54. A vector field \vec{A} is said to be non-conservative if

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

55. If the common base current amplification factor α is 0.98, its common emitter current amplification factor β is

- (1) 100 (2) 98 (3) 50 (4) 49

56. Capacitance between A and B in the following circuit is



- (1) 9 nF (2) 3 nF (3) 2 nF (4) 1 nF

57. In the nuclear process $n \rightarrow p + e^- + X$, X stands for

- (1) neutrino (2) antineutrino (3) γ -rays (4) positron

58. In Compton scattering, wavelength shift is towards
- (1) shorter wavelength
 - (2) longer wavelength
 - (3) shorter or longer depending on the angle of scattering
 - (4) shorter or longer side depending on photon energy
59. The annihilation of electron and positron in vacuum produces
- (1) a neutron
 - (2) a neutrino
 - (3) a photon
 - (4) two photons
60. Nuclear fission in reactors is sustained by
- (1) fission fragments
 - (2) charged particles
 - (3) Gamma rays
 - (4) neutrons
61. The reaction $\pi^- p \rightarrow \Lambda^0 \pi^0$ in strong interaction is not possible because
- (1) it does not conserve charge
 - (2) it does not conserve baryon number
 - (3) it does not conserve strangeness
 - (4) it does not conserve isospin
62. Electromagnetic force between two electrons does not depend on
- (1) electronic charge
 - (2) fine structure constant α
 - (3) photon exchange
 - (4) pion exchange

63. The common property between neutron and gamma radiation to induce nuclear reaction is
- (1) zero Coulomb barrier
 - (2) low cross-section
 - (3) high cross-section
 - (4) formation of same compound nucleus
64. Which of the following is not true?
- (1) Photon is a boson
 - (2) Proton is a fermion
 - (3) K-meson is a boson
 - (4) μ -meson is a boson
65. A sample contains N number of atoms a whose nuclei decay to stable nuclei b . If the half-life of a is T , then the number of nuclei b at the end of time $3T$ will be
- (1) zero
 - (2) $2N/3$
 - (3) $7N/8$
 - (4) $9N/10$
66. Bohr radius for hydrogen is 0.53 \AA . The ground state Bohr radius for He^+ is
- (1) 1.06 \AA
 - (2) 0.53 \AA
 - (3) 0.265 \AA
 - (4) 0.134 \AA
67. In the hydrogen atom ground state, the velocity of electron in terms of fine structure constant α and velocity of light c is
- (1) $\alpha^2 c$
 - (2) αc
 - (3) $2\alpha c$
 - (4) $\frac{\alpha^2 c}{4}$
68. The number of photons of ultraviolet light with wavelength $\lambda = 3 \times 10^{-7} \text{ m}$ which will have same energy as one gamma ray photon of $\lambda = 1.5 \times 10^{-13} \text{ m}$, is
- (1) 3×10^5
 - (2) 2×10^6
 - (3) 4×10^4
 - (4) 5×10^5

69. Two electrons leave a radioactive sample in opposite directions each having a speed of $0.5c$ with respect to the sample. The speed of one electron relative to the other is
- (1) c (2) $\frac{4}{5}c$ (3) $\frac{3}{4}c$ (4) $\frac{c}{2}$
70. The kinetic energy of an electron moving with speed of $0.6c$ and rest mass energy 0.511 MeV, is
- (1) 0.224 MeV (2) 0.128 MeV (3) 0.64 MeV (4) 0.540 MeV
71. Momentum of a photon of frequency f and rest mass zero is
- (1) hf (2) hf/c^2 (3) hf/c (4) zero
72. If two deuterons are at a distance of 10^{-12} cm, the nuclear force between them just overcomes the repulsive electrostatic force. The height of the electrostatic potential barrier is
- (1) zero (2) 0.14 MeV (3) 0.31 MeV (4) 0.49 MeV
73. A transformer is used to change
- (1) power (2) frequency (3) inductance (4) voltage
74. The SI unit of inductance times capacitance is
- (1) second (2) ohm (3) hertz (4) square second
75. Which one of the following is a constant for light waves of different frequencies in vacuum?
- (1) $\frac{f}{\lambda}$ (2) $f^2\lambda$ (3) $f\lambda$ (4) $\lambda^2 f$

76. The ratio of repulsive Coulomb force and the attractive gravitational force between two protons is

- (1) 1.24×10^{36} (2) 2.31×10^{39} (3) 3.21×10^{26} (4) 1.91×10^{32}

77. The approximate ratio of the radius of ${}_{98}^{252}\text{Cf}$ to the radius of ${}_{26}^{56}\text{Fe}$ is

- (1) 2.12 (2) 1.65 (3) 0.62 (4) 3.19

78. Naturally occurring gallium contains two isotopes ${}_{31}^{71}\text{Ga}$ and ${}_{31}^{69}\text{Ga}$ with relative abundance of 40% and 60% respectively. The average number of neutrons in a mixture of gallium nucleus is

- (1) 39.2 (2) 37.8 (3) 38.8 (4) 40

79. The magnetic vector potential is given by

$$\vec{A} = e^y \cos x \vec{e}_x + (1 + \sin^2 x) \vec{e}_y$$

\vec{e}_x and \vec{e}_y are unit vectors along x and y -axes. The magnetic field \vec{B} at the origin is

- (1) $-\vec{e}_x$ (2) $-\vec{e}_y$ (3) $-\vec{e}_z$ (4) zero

80. An ideal gas undergoes a process during which $P\sqrt{V} = \text{constant}$, where P is the pressure and V is the volume of the gas. If volume of the gas decreases, the temperature will

- (1) remain constant (2) increase
(3) decrease (4) increase and then become constant

81. If 100 gm of steam at 150 °C is cooled and frozen into 100 gm of ice at 0 °C. Specific heat of steam is 2.01 kJ/kg K and specific heat of water is 4.18 kJ/kg K. The total heat removed during the process is

- (1) 211 kJ (2) 311 kJ (3) 351 kJ (4) 401 kJ

88. A ray of unpolarized light is incident on a plane surface at the Brewster angle. The reflected light is
- (1) polarized with its electric vector perpendicular to the plane of incidence
 - (2) polarized with its electric vector in the plane of incidence
 - (3) unpolarized
 - (4) extinguished
89. A spherical air bubble is embedded in a glass slab. It will behave like a
- (1) positive spherical lens
 - (2) negative spherical lens
 - (3) positive cylindrical lens
 - (4) negative cylindrical lens
90. Stern-Gerlach apparatus breaks up the atomic beam of silver atoms into following number of components
- (1) One
 - (2) Two
 - (3) Three
 - (4) Four
91. The ground state of nitrogen atom would be
- (1) $^4S_{3/2}$
 - (2) $^2D_{3/2}$
 - (3) $^2D_{5/2}$
 - (4) $^2P_{3/2}$
92. The fine structure splitting will be highest in the state
- (1) 3^2D
 - (2) 3^2P
 - (3) 3^2S
 - (4) 4^2P
93. Infrared spectrum of a molecule arises due to
- (1) a change in molecular polarizability
 - (2) a change in the shape of molecule
 - (3) a change in the size of molecule
 - (4) a change in the dipole moment

94. Rotational Raman spectra will show an alternation of intensity in the case of
(1) HD (2) D₂ (3) OH (4) NO
95. For precise measurements of wavelengths which laser will be more useful?
(1) Ruby laser (2) Nitrogen laser
(3) He-Ne laser (4) Semiconductor laser
96. Zeeman effect for a line arising in the following transitions would show a normal triplet
(1) $^1P \rightarrow ^1S$ (2) $^2P \rightarrow ^2S$ (3) $^2D \rightarrow ^2P$ (4) $^3P \rightarrow ^3S$
97. Microwave spectrum of a molecule is usually attributed to the following type of energy levels of the molecule
(1) Electronic (2) Vibrational (3) Rotational (4) Vibronic
98. Which of the following transitions is allowed?
(1) $^2S_{1/2} \rightarrow ^2D_{3/2}$ (2) $^2P_{1/2} \rightarrow ^2D_{3/2}$
(3) $^2S_{1/2} \rightarrow ^2S_{1/2}$ (4) $^2D_{5/2} \rightarrow ^2P_{1/2}$
99. Lasers are more suitable for holography because they have
(1) brightness (2) directionality (3) coherence (4) monochromaticity
100. The most important cause for the width of spectral line broadening in absorption experiments is
(1) Doppler broadening (2) natural broadening
(3) pressure broadening (4) Stark broadening

- 101.** The sky is blue. It is explained by
- (1) Raman effect (2) Rayleigh scattering
(3) Bohr's theory (4) Planck's theory
- 102.** A monochromatic light wave is travelling from one medium to another. Which one of the following remains unchanged?
- (1) Velocity (2) Amplitude (3) Wavelength (4) Frequency
- 103.** If a Brownian particle executing a random motion in a liquid travels a distance R in time t , then
- (1) $R \propto t^{1/2}$ (2) $R \propto t$ (3) $R \propto \frac{1}{t}$ (4) $R \propto t^2$
- 104.** Three identical particles are distributed in three different energy levels. For bosons this is possible in following number of ways
- (1) 10 (2) 8 (3) 6 (4) 3
- 105.** A visible light does not pass through a metal because
- (1) phonons absorb light
(2) metal atoms absorb light
(3) the light frequency is higher than the metal plasma frequency
(4) the light frequency is lower than the metal plasma frequency
- 106.** The reciprocal lattice of an hexagonal crystal is
- (1) f.c.c. (2) b.c.c. (3) hexagonal (4) orthorhombic

107. Bragg's law of X-ray diffraction is based on

- (1) reflection of X-rays
- (2) interference of X-rays
- (3) particle nature of X-rays
- (4) coherence of X-rays

108. If there are N atoms in a monatomic solid vibrating with frequency ν , its specific heat at high temperature would be

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

109. Two solids A and B are such that a structural unit of A contributes an even number of valence electrons whereas that of B contributes odd number of electrons. In that case which of the following is true?

- (1) Solid A is insulator
- (2) Solid B is metal
- (3) Solid A is metal
- (4) Solid B is insulator

110. In an insulator, the Fermi level is

- (1) at the bottom of conduction band
- (2) on top of valence band
- (3) in the middle of energy gap
- (4) determined by carrier concentration

111. In intrinsic germanium at room temperature the numbers of

- (1) electrons are more than holes
- (2) electrons and holes are equal
- (3) holes are more than electrons
- (4) There are no holes and electrons

- 112.** Meissner effect can be used to distinguish between
- (1) metal and insulator (2) metal and semiconductor
 (3) superconductor and perfect metal (4) semiconductor and insulator
- 113.** A permanent magnet when heated above a critical temperature becomes
- (1) diamagnetic (2) ferromagnetic (3) ferrimagnetic (4) paramagnetic
- 114.** The Hall effect used to measure the sign of charge carriers, involves measurement of transverse voltage under application of
- (1) electric field only
 (2) magnetic field only
 (3) mutually perpendicular electric and magnetic fields
 (4) parallel electric and magnetic field
- 115.** If the Debye temperature of a metal is 450 °K, the Debye frequency is
- (1) 10^{13} Hz (2) 10^{20} Hz (3) 10^{10} Hz (4) 10^{23} Hz
- 116.** At lower temperatures, the lattice specific heat varies as
- (1) T^3 (2) $\frac{1}{T^3}$ (3) T (4) $\frac{1}{T}$
- 117.** Ohm's law relates to the electrical field \vec{E} , conductivity σ and current density \vec{J} as
- (1) $\vec{J} = \frac{\vec{E}}{\sigma}$ (2) $\vec{J} = \sigma^2 \vec{E}$ (3) $\vec{J} = \sigma \vec{E}$ (4) $\vec{J} = \frac{\vec{E}}{\sigma^2}$

118. The general expression for the Fermi energy of a metal at 0 °K (if n is the number of free electrons/ m^3) is

- (1) $3.65 \times 10^{-19} n^{2/3} \text{ eV}$ (2) $3.65 \times 10^{19} n^2 \text{ eV}$
 (3) $3.65 \times 10^{19} n^{1/3} \text{ eV}$ (4) $3.65 \times 10^{19} n^{3/2} \text{ eV}$

119. The energy of a particle constrained to move in a cube of side a is given by

$$E = \frac{h^2}{8ma^2} (n_x^2 + n_y^2 + n_z^2)$$

if n_x, n_y, n_z may have either values out of 1, 2, 3; the degree of degeneracy of this energy level is

- (1) 2 (2) 3 (3) 6 (4) 8

120. A proton and an alpha particle have the same kinetic energy, then the relation between their de Broglie wavelength is

- (1) $\lambda_p = \frac{\lambda_a}{2}$ (2) $\lambda_p = \frac{\lambda_a}{4}$ (3) $\lambda_p = 2\lambda_a$ (4) $\lambda_p = 4\lambda_a$

121. X-rays are produced when an element of high atomic weight is bombarded by high energy

- (1) protons (2) neutrons (3) photons (4) electrons

122. Which of the following metals crystallizes in f.c.c. structure?

- (1) Aluminium (2) Zinc (3) Sodium (4) Caesium chloride

123. The Miller indices of the plane parallel to the x and y axes are

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

124. Which of the following elements is covalently bonded crystal?

- (1) Aluminium (2) Sodium chloride
(3) Germanium (4) Lead

125. Kinetic energy of an electron in an atom is

- (1) half of its potential energy (2) twice its potential energy
(3) equal to its potential energy (4) thrice its potential energy

126. If R_H is the Rydberg constant for hydrogen, the shortest wavelength of Balmer series in hydrogen spectrum is given as

- (1) $\frac{1}{\lambda} = R_H \left(\frac{1}{4} - \frac{1}{9} \right)$ (2) $\frac{1}{\lambda} = R_H \left(\frac{1}{2} - \frac{1}{\infty} \right)$
(3) $\frac{1}{\lambda} = R_H \left(\frac{1}{1} - \frac{1}{\infty} \right)$ (4) $\frac{1}{\lambda} = R_H \left(\frac{1}{4} - \frac{1}{\infty} \right)$

127. The magnetic material in which permanent magnetic dipoles arising due to electron spins are already aligned due to bonding forces is known as

- (1) paramagnetic material (2) ferromagnetic material
(3) ferrimagnetic material (4) diamagnetic material

128. If X is the width of the depletion layer, the transition capacitance in a junction diode is proportional to

- (1) $\frac{1}{X}$ (2) X (3) X^2 (4) $\frac{1}{X^2}$

129. The depletion region in an open circuited $p-n$ junction contains

- (1) electrons (2) holes
(3) neutralized impurity atoms (4) uncovered immobile impurity ions

130. Where a monatomic gas atom is placed in a uniform electric field E , the resulting induced dipole moment is proportional to

- (1) E (2) E^2 (3) E^3 (4) independent of E

131. A proton of mass 1.67×10^{-27} kg and charge 1.6×10^{-19} C is accelerated from rest through an electrical potential of 400 kV. Its final velocity is

- (1) 4.2×10^6 m/sec (2) 8.8×10^6 m/sec
(3) 6.6×10^6 m/sec (4) 12.1×10^6 m/sec

132. A 120 V motor draws a current of 2 A while lifting a load at a speed of 0.65 m/sec. If the efficiency of the motor for transforming electrical energy into mechanical energy is 62%, the mass being lifted is

- (1) 33 kg (2) 23 kg (3) 42 kg (4) 50 kg

133. When the moon is near horizon, it appears bigger in size due to

- (1) atmospheric refraction (2) diffraction
(3) scattering of light (4) reflection

- 134.** The charge on one proton is 1.6×10^{-19} C and bond length of HCl molecule is 1.28 Å. Magnitude of its electrical dipole moment is
 (1) 1.6×10^{-19} (2) 2.05×10^{-29} (3) 1.28×10^{-11} (4) 2.05×10^{-31}
- 135.** One mole of a diatomic gas $\left(C_V = \frac{5}{2}R\right)$ and one mole of a monatomic gas $\left(C_V = \frac{3}{2}R\right)$ are mixed together. The value of $\gamma \left(= \frac{C_P}{C_V}\right)$ of the mixture is
 (1) 1.33 (2) 1.4 (3) 1.5 (4) 1.66
- 136.** The sun's radius is 6.96×10^8 m and it rotates with a period of 25.3 days. If the sun collapses into a neutron star of radius 5 km without any loss of mass, the new period of rotation is
 (1) 1.5×10^{-9} days (2) 1.3×10^{-9} days
 (3) 2.4×10^{-9} days (4) 3.2×10^{-9} days
- 137.** An electron enters a metallic cylindrical cavity that supports electromagnetic modes. To accelerate the electron along the axis of cavity, the cavity must support
 (1) TE modes (2) TM modes (3) TEM (4) Any of the these
- 138.** Width of any resonance
 (1) is directly proportional to quality factor
 (2) is inversely proportional to quality factor
 (3) does not depend on the quality factor
 (4) does not depend on the natural frequency of the vibrating object

139. Poynting vector in the electromagnetic field is

- (1) $\frac{\vec{E} \cdot \vec{B}}{4\pi}$ (2) $\frac{\epsilon \vec{E}^2}{2}$ (3) $\vec{E} \times \vec{B}$ (4) $\frac{\vec{E} \times \vec{B}}{\mu}$

140. The total outward electric flux going from a cube with $0 \leq x \leq 1$, $0 \leq y \leq 1$, $0 \leq z \leq 1$ metres containing a volume charge density $\rho = 16xyz \mu\text{C}/\text{m}^3$, will be

- (1) $16 \mu\text{C}$ (2) $8 \mu\text{C}$ (3) $4 \mu\text{C}$ (4) $2 \mu\text{C}$

141. The spiral galaxy is 2×10^9 km away from us. In light years, this distance is

- (1) 2.1×10^6 (2) 2.6×10^6 (3) 3.2×10^6 (4) 4.2×10^6

142. If two non-null vectors \vec{A} and \vec{B} are such that $|\vec{A} + \vec{B}| = |\vec{A} - \vec{B}|$, then the angle between the two vectors is

- (1) 0° (2) $\frac{\pi}{2}$ (3) π (4) $\frac{\pi}{3}$

143. The refractive index of a given piece of transparent quartz is largest for

- (1) red light (2) violet light (3) yellow light (4) green light

144. A neutron is confined within a nucleus of radius 5×10^{-15} m. The minimum uncertainty in the momentum of nucleon [$m = 1.67 \times 10^{-27}$ kg, $\hbar = 1.05 \times 10^{-34}$ J sec] is

- (1) 1.25×10^{-15} kg m/sec (2) 4.12×10^{-18} kg m/sec
 (3) 1.05×10^{-28} kg m/sec (4) 1.65×10^{-21} kg m/sec

145. 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 domain $0 < x < \frac{L}{2}$ is

- (1) 1 (2) $\frac{1}{4}$ (3) $\frac{1}{2}$ (4) 0

146. The energy of a linear harmonic oscillator in third excited state is 0.1 eV. The frequency of vibration [$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ and $h = 6.62 \times 10^{-34} \text{ J sec}$] is

- (1) $3.3 \times 10^{13} \text{ Hz}$ (2) $2.8 \times 10^{13} \text{ Hz}$
 (3) $3.9 \times 10^{13} \text{ Hz}$ (4) $4.2 \times 10^{13} \text{ Hz}$

147. A neutrino has

- (1) zero charge and zero spin
 (2) positive charge and zero spin
 (3) zero charge and spin half
 (4) negative charge and spin half

148. A pulsar is

- (1) a rotating quasi-stable radio source
 (2) a rotating black hole
 (3) a rotating white dwarf
 (4) a rotating neutron star

149. Electromagnetic field tensor is a tensor of rank

- (1) four (2) three (3) two (4) one

150. Two successive Lorentz transformations with velocities v_1 and v_2 in same direction are equivalent to a single Lorentz transformation with a velocity

- (1) $v_1 + v_2$ (2) $\frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}}$ (3) $\frac{v_1 + v_2}{1 - \frac{v_1 v_2}{c^2}}$ (4) $\frac{v_1 - v_2}{1 - \frac{v_1 v_2}{c^2}}$

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 प्रश्न-पुस्तिका एवं 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।