SET–"X"

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

(MPH/PHD/URS–EE–2020)

PHYSICS

Code **A**

Sr. No. 10005

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. _____ (in figure) _____ (in words)

Name : _____ Father's Name : _____

Mother's Name : _____ Date of Examination : _____

(Signature of the candidate) (Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/ INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

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7. Use only Black or Blue <u>BALL POINT PEN</u> of good quality in the OMR Answer-Sheet.
8. BEFORE ANSWERING THE QUESTIONS, THE CANDIDATES SHOULD ENSURE THAT THEY HAVE BEEN SUPPLIED CORRECT AND COMPLETE BOOK-LET. COMPLAINTS, IF ANY, REGARDING MISPRINTING ETC. WILL NOT BE ENTERTAINED 30 MINUTES AFTER STARTING OF THE EXAMINATION.

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Question No.	Questions
1.	For a Gaussian Wave packet described by $\psi(x) = A \exp\left(\frac{-x^2}{a^2}\right)$, the expectation value of the momentum operator is : (1) 0 (2) undefined (3) + a (4) − a
2.	The degeneracy of the n = 2 level for a three dimensional harmonic oscillator is : (1) 4 (2) 6 (3) 8 (4) 10
3.	Value of $[L_x, r^2]$ is : (1) $i\hbar y$ (2) $i\hbar p_y$ (3) $-i\hbar x$ (4) 0
4.	Which of the following is not a Fermion ? (1) electron (2) muon (3) neutron (4) photon
5.	In partial wave analysis, the expression for total cross-section of scattering is : (1) $\frac{4\pi}{k^2}\sum_\ell (2\ell+1)\sin^2\delta_\ell$ (2) $4\pi\sum_\ell (2\ell+1)\sin^2\delta_\ell$ (3) $\frac{2\pi}{k^2}\sum_\ell (2\ell+1)P_\ell^2(\cos\theta)$ (4) $2\pi k^2\sum_\ell (2\ell+1)P_\ell^2(\cos\theta)$

Question No.	Questions
6.	The energy of free electrons in the state (1, 2, 1) in a rectangular box of sides $a = b \neq c$ is : (1) $\frac{h^2}{8m}\left[\frac{5}{a^2}+\frac{1}{c^2}\right]$ (2) $\frac{8m}{h^2}\left[\frac{1}{a^2}+\frac{1}{c^2}\right]$ (3) $\frac{h^2}{8m}\left[\frac{3}{a^2}+\frac{1}{c^2}\right]$ (4) None of these
7.	The eigen functions of the operator $\frac{d^2}{dx^2}$ which vanishes at $x = 0$ and $x = L$ (A is constant and n is an integer) are : (1) $A \sin\left(\frac{n\pi}{\ell}x\right)$ (2) $A \cos\left(\frac{n\pi}{\ell}x\right)$ (3) $A\,x\,(\ell - x)$ (4) $A \exp\left(\frac{-n\pi}{\ell}x\right)$
8.	Selection rules for the electric dipole transitions are : (1) $\Delta\ell = 0, \pm 1$, $\Delta m = 0$ (2) $\Delta\ell = 0, \pm 1$, $\Delta m = 0, \pm 1$ (3) $\Delta\ell = \pm 1$, $\Delta m = 0, \pm 1$ (4) $\Delta\ell = \pm 1$, $\Delta m = \pm 1$
9.	The radial part of the waveform for the hydrogen atom is expressed in terms of : (1) Laguerre polynomial (2) Hermite polynomial (3) Legendre polynomial (4) Associated Laguerre polynomial

Question No.	Questions
10.	The expression $\psi = \exp(ikr) - \frac{m}{2\pi\hbar}\int G(r,r')\,V(r').\exp(ikr')\,dr.$ is called : (1) first Born approximation (2) first WKB approximation (3) Green's approximation (4) none of these
11.	The function $\frac{1}{\sqrt{2}}[\alpha(1)\,\beta(2) - \alpha(2)\,\beta(1)]$ represent a state in which : (1) $S = 1, m_s = 1$ (2) $S = 1, m_s = -1$ (3) $S = 1, m_s = 0$ (4) $S = 0, m_s = 0$
12.	Which of the following is an eigen function of L_z ? (1) $\cos\phi$ (2) $\sin\phi$ (3) $\exp(i\phi)$ (4) $\cos^2\phi$
13.	A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where magnetic induction will be $\frac{1}{8}$th of it's value at the centre of coil is : (1) $R/\sqrt{3}$ (2) $R.\sqrt{3}$ (3) $2R.\sqrt{3}$ (4) 4R

Question No.	Questions
14.	A long straight wire carrying current of 30 A is placed in a external magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction at a point 2.0 cm away from the wire is : (1) 10^{-4} T (2) 3×10^{-4} T (3) 5×10^{-4} T (4) 4.6×10^{-4} T
15.	The magnetic field at the point of intersection of diagonals of a square wire loop of side L, carrying a current I is : (1) $\frac{\mu_0 I}{\pi L}$ (2) $\frac{2\mu_0 I}{\pi L}$ (3) $\sqrt{2}\,\frac{\mu_0 I}{\pi L}$ (4) $2\sqrt{2}\,\frac{\mu_0 I}{\pi L}$
16.	If the electric field is given by $\vec{E} = 5\hat{i} + 4\hat{j} + 9\hat{k}$, the electric flux through a surface of area 20 unit lying in the yz plane will be : (1) 100 unit (2) 80 unit (3) 180 unit (4) 20 unit
17.	A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of sphere is : (1) 2 cm (2) 4 cm (3) 6 cm (4) 12 cm

Question No.	Questions
18.	A concave mirror of focal length f in vacuum is placed in a medium of refractive index 2. It's focal length in the medium is : (1) f/2 (2) f (3) 2f (4) 4f
19.	In the phenomenon of diffraction of light, when blue light is used in the experiment instead of red light, then : (1) fringes will become narrower (2) fringes will become broader (3) no change in fringe width (4) none of these
20.	The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n) is : (1) $\sin^{-1}(n)$ (2) $\sin^{-1}\left(\frac{1}{n}\right)$ (3) $\tan^{-1}\left(\frac{1}{n}\right)$ (4) $\tan^{-1}(n)$
21.	In a dielectric the polarization is : (1) linear function of applied field (2) square function of applied field (3) exponential function of applied field (4) logarithmic function of applied field

Question No.	Questions
22.	In a Fresnel biprism experiment the two positions of lens give separation between the slits as 16 cm and 9 cm respectively. The actual distance of separation is : (1) 12.5 cm (2) 12 cm (3) 7.5 cm (4) 15 cm
23.	Two solenoids of equal number of turns have their lengths and radii. in the same ratio 1:2. The ratio of their self inductances will be : (1) 1:2 (2) 2:1 (3) 1:1 (4) 1:4
24.	The power radiated by an electric dipole is proportional to the frequency given by : (1) W (2) W^2 (3) W^3 (4) W^4
25.	At the interface of two non-conducting medium the formula for reflection coefficient for normal incidence is given by : (1) $\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$ (2) $\frac{4n_1 . n_2}{(n_2 + n_1)^2}$ (3) $\frac{2n_1\ n_2}{(n_2 + n_1)^2}$ (4) None of these

Question No.	Questions
26.	The sinusoidally time varying vector field $\vec{F} = 2\cos(wt+30^\circ)\,\hat{a}_x + 2\cos(wt-30^\circ)\,\hat{a}_y$ is : (1) elliptically polarized (2) circularly polarized (3) linearly polarized (4) unpolarized
27.	An air filled rectangular waveguide has dimensions 6 cm×4 cm. The cut-off frequency for TE_{10} is : (1) 2.5 GHz (2) 25 GHz (3) 25 MHz (4) 5 GHz
28.	The length of Hydrogen-Hydrogen bond is : (1) 0.074 nm (2) 0.01 nm (3) 0.037 nm (4) 2 nm
29.	Transition temperature (T_C) and critical field (H_C) for a superconductor are related as : (1) $H_C = H_o(T_C - 1)$ (2) $H_C = H_o(T_C + 1)$ (3) $T_C = T_o\left[1-\left(\frac{H_o}{H_C}\right)^2\right]$ (4) $H_C = H_o\left[1-\left(\frac{T}{T_C}\right)^2\right]$
30.	The favourable condition both for superconductivity and high resistance is : (1) a weak electron-phonon interaction (2) a strong electron-phonon interaction (3) a weak phonon-phonon interaction (4) a strong phonon-phonon interaction

Question No.	Questions
31.	The Einstein relationship between the diffusion constant (D_n) and mobility (μ_n) for electron is : 1) $\frac{D_n}{\mu_n} = \frac{2k_B T}{e}$ (2) $\frac{D_n}{\mu_n} = \frac{e}{k_B T}$ (3) $\frac{D_n}{\mu_n} = \frac{k_B T}{e}$ (4) $\frac{D_n}{\mu_n} = k_B T - e$
32.	Cooper pair follows : (1) Bose-Einstein statistics (2) Fermi-Dirac statistics (3) Maxwell-Boltzmann statistics (4) None of these
33.	The density of carriers in a pure semiconductor is proportional to : (1) $\exp(-E_g / k_B T)$ (2) $\exp(-2E_g / k_B T)$ (3) $\exp(-E_g / k_B T^2)$ (4) $\exp(-E_g / 2k_B T)$
34.	Point defects in crystals can not be produced by : (1) elastic deformation (2) quenching from high temperature (3) plastic deformation (4) irradiation with X-rays

Question No.	Questions
35.	In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is : (1) 6 : 3 : 2 (2) 6 : 3 : $\sqrt{2}$ (3) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (4) $\sqrt{6} : \sqrt{3} : \sqrt{4}$
36.	In simple metals the phonon contribution to the electrical resistivity at temperature T is : (1) directly proportional to T above Debye temperature and to T^3 below it . (2) inversely proportional to T for all temperatures. (3) independent of T for all temperatures. (4) directly proportional to T above Debye temperature and to T^5 below it.
37.	The crystal lattice is a lattice in real ordinary space but the reciprocal lattice is a lattice in a : (1) Gaussian space (2) Laplacian space (3) Fourier space (4) Hypothetical space
38.	The packing factor of diamond cubic crystal structure is : (1) 60 % (2) 56 % (3) 90 % (4) none of these

Question No.	Questions
39.	In Debye's theory of specific heat of solids, the frequency of the lattice vibration has : (1) a fixed value (2) some discrete values (3) a continuous spectrum upto a finite value (4) a continuous spectrum upto infinity.
40.	At lower temperature the lattice specific heat varies as : (1) T^3 (2) $\frac{1}{T^3}$ (3) T (4) $\frac{1}{T}$
41.	$\nabla\left(\frac{\hat{r}}{r^3}\right)$ is equal to : (1) 0 (2) r^3 (3) r^2 (4) r
42.	If the vectors $\vec{A} = 2\hat{i}-\hat{j}+\hat{k}$, $\vec{B} = \hat{i}+2\hat{j}+3\hat{k}$ and $\vec{C} = 3\hat{i}+a\hat{j}+5\hat{k}$ are coplanar, then the value of a will be (1) 4 (2) -4 (3) 2 (4) -2

Question No.	Questions
43.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \end{bmatrix}$ is : (1) 0 (2) 1 (3) 2 (4) 3
44.	The integral of $\bar{z}$ along upper half of the circle $\lvert z \rvert = 1$ from $z = -1$ to $z = 1$ is : (1) $-i\pi$ (2) $i\pi$ (3) $2\pi i$ (4) $-2\pi i$
45.	The Cauchy–Riemann equation in polar form is given as : (1) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ (2) $\frac{\partial u}{\partial r} = \frac{r\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (3) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (4) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$
46.	The trace of 3×3 matrix is 2. Two of it's eigen values are 1 and 2. The third eigen value is : (1) –1 (2) 0 (3) 1 (4) 2

Question No.	Questions
47.	Residue of $f(z)=\frac{z^3}{(z-1)^4(z-2)(z-3)}$ at $z=3$ is : (1) $\frac{101}{16}$ (2) -8 (3) $\frac{27}{16}$ (4) 0
48.	The differential equation $x^2\frac{d^2y}{dx^2}+x.\frac{dy}{dx}+y=x$ is : (1) linear (2) homogeneous (3) homogeneous linear (4) none of these
49.	Solution of the differential equation $(x-y^2)\,dx+2xy\,dy=0$ is : (1) $y\exp\left(\frac{y^2}{x}\right)=A$ (2) $x\exp\left(\frac{y^2}{x}\right)=A$ (3) $y\exp\left(\frac{x}{y^2}\right)=A$ (4) $x\exp\left(\frac{x}{y^2}\right)=A$
50.	Which one of the following is tensor of order zero ? (1) $\vec{A}+\vec{B}$ (2) $\vec{A}-\vec{B}$ (3) $\vec{A}\bullet\vec{B}$ (4) $\vec{A}\times\vec{B}$
51.	The nature of series $1+\frac{3}{4}+\frac{9}{16}+\frac{27}{64}+-----\infty$ is : (1) convergent (2) divergent (3) oscillatory (4) none of these

Question No.	Questions
52.	Laplace transform of t sin at is (1) $\frac{2as}{(s^2+a^2)^2}$ (2) $\frac{2a}{(s^2+a^2)^2}$ (3) $\frac{2s}{(s^2+a^2)^2}$ (4) $\frac{a}{(s^2+a^2)^2}$
53.	The polynomial $2x^2+x+3$ in terms of Legendre polynomial is : (1) $\frac{1}{3}(4P_2-3P_1+11P_0)$ (2) $\frac{1}{3}(4P_2+3P_1-11P_0)$ (3) $\frac{1}{3}(4P_2+3P_1+11P_0)$ (4) $\frac{1}{3}(4P_2-3P_1-11P_0)$
54.	$J_3(x)$ can be written in terms of $J_0'(x)$ as : (1) $(8x^2+1)\ J_1-4x^{-1}J_0$ (2) $(8x^2-1)\ J_1-4x^{-1}J_0$ (3) $(8x^{-2}-1)\ J_1-4x^{-1}J_0$ (4) $(8x^{-2}+1)\ J_1+4x^{-1}J_0$
55.	The path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a : (1) sphere (2) sigmoid (3) cycloid (4) catenary of revolution
56.	The period of oscillation for compound pendulum is : (1) $2\pi\sqrt{\frac{(k^2+\ell^2)}{g\ell}}$ (2) $2\pi\sqrt{\frac{g\ell}{(k^2+\ell^2)}}$ (3) $2\pi\sqrt{\frac{(k^2+\ell^2)}{mg\ell}}$ (4) $2\pi\sqrt{\frac{mg\ell}{(k^2+\ell^2)}}$

Question No.	Questions
57.	Lagrange's equation of motion are second order equations. The degrees of freedom for this are : (1) $2n$ (2) $2n-1$ (3) $2n+1$ (4) $2n+2$
58.	Constraint in the case of a rigid body is : (1) Dynamic constraint (2) Seleronomous constraint (3) Rheonomous constraint (4) Static constraint
59.	The equation of motion for a small particle of mass m at position x is $m\ddot{x} + r\dot{x} - mg = 0$. Assuming initial speed to be v_0, the terminal speed of particle will be : (1) $\frac{mg}{r}$ (2) $\sqrt{v_0 + 2gx}$ (3) $v_0 + gt$ (4) $\frac{mg}{r^2 t}$
60.	The generalised velocity coordinate (q_k) of a classical system with Lagrangian (L) is said to be cyclic if : (1) $\frac{\partial L}{\partial q_k} = q_k^{\circ}$ (2) $\frac{\partial L}{\partial q_k} = \frac{d}{dt}\left(\frac{\partial L}{\partial q_k^{\circ}}\right)$ (3) $\frac{\partial L}{\partial q_k} = 0$ (4) $\frac{\partial L}{\partial q_k^{\circ}} = 0$

Question No.	Questions
61.	The Jacobi's form of the least action principle is : (1) $\Delta \int \sqrt{2[H-V(q)]}.d\rho = 0$ (2) $\Delta \int \sqrt{2[H+V(q)]}.d\rho = 0$ (3) $\Delta \int \sqrt{2[L-V(q)]}.d\rho = 0$ (4) $\Delta \int \sqrt{2[L+V(q)]}.d\rho = 0$
62.	In the case of elliptical orbits under the influence of a central force, the total energy depends on: (1) major axis (2) minor axis (3) both minor and major axis (4) neither of the above two
63.	Which of the following quantities is Lorentz invariant ? (1) $\lvert E \times B \rvert^2$ (2) $\lvert E \rvert^2 - \lvert B \rvert^2$ (3) $\lvert E \rvert^2 + \lvert B \rvert^2$ (4) $\lvert E \rvert^2 \cdot \lvert B \rvert^2$
64.	Hamiltons principle function S and the Hamiltons characteristic function W for conservative system with energy E and time t, are related as : (1) $S = W$ (2) $S = W - Et$ (3) $S = W + Et$ (4) S is not related to W
65.	Which one of the following is a first order phase transition ? (1) vaporization of a liquid at it's boiling point (2) ferromagnetic to paramagnetic (3) normal liquid He to super fluid He (4) superconductivity to normal state

Question No.	Questions
66.	The dimension of phase space of ten rigid diatomic molecules is : (1) 5 (2) 10 (3) 50 (4) 100
67.	In the process of phase transition : (1) Gibb's potential function remains constant (2) only entropy remains constant (3) only volume remains constant (4) only temperature remains constant
68.	In a canonical ensemble : (1) the energy and the temperature are constants (2) the energy and the entropy are constants (3) the temperature and the density are constants (4) the entropy and the density are constants
69.	The capacitance of a varactor diode can be varied by : (1) varying it's temperature (2) varying it's forward bias (3) varying it's reverse bias (4) varying it's doping level

Question No.	Questions
70.	In a full wave rectifier having R-L filter, the value of inductor is 2H and load is 1kΩ. If input frequency is 60 Hz, ripple factor is : (1) 50 % (2) 63 % (3) 33 % (4) 21 %
71.	Op–Amp when used as voltage follower has : (1) closed loop voltage gain of unity (2) open loop voltage gain of unity (3) closed loop bandwidth infinity (4) open loop bandwidth infinity
72.	In a class A push-pull amplifier, load R_L is connected to the secondary of output transformer. It's effective value as seen by device is : (1) R_L (2) $\frac{R_L}{2}$ (3) $\frac{R_L}{4}$ (4) $2R_L$
73.	A microprocessor trainer uses : (1) binary number code (2) hexadecimal number code (3) decimal number code (4) octal number code
74.	A diode that has a negative characteristic is the : (1) Schottky diode (2) Tunnel diode (3) Laser diode (4) Hot carrier cathode

Question No.	Questions
75.	The MOSFET switch in it's on–state may be considered equivalent to : (1) Resistor (2) Inductor (3) Capacitor (4) Battery
76.	In a microprocessor, the resistor which holds the address of the next instruction to be fetched is : (1) accumulator (2) program counter (3) stack counter (4) instructor register
77.	In a 4–bit weighted–resistor D/A converter, the resistor value corresponding to MSB is 2 kΩ. The resistor value corresponding to LSB will be : (1) 1 kΩ (2) 2 kΩ (3) 4 kΩ (4) 16 kΩ
78.	Absolute encoders are used where : (1) fast varying signals are not used (2) when position data is to be recovered (3) transient noise can be tolerated (4) all of these
79.	A linear displacement transducer (digital) normally uses : (1) straight binary code (2) BCD (3) Gray code (4) hexadecimal code

Question No.	Questions
80.	The D_1 and D_2 lines of sodium atom will split on application of a weak magnetic field into : (1) 4 and 6 lines (2) 3 lines each (3) 6 and 4 lines (4) 6 lines each
81.	For a diatomic molecule the frequency of rotation(υ) can be related with rotational quantum number (J) and rotational constant (B) as : (1) $\upsilon = 2B(J + 1)$ (2) $\upsilon = 3B(J + 1)$ (3) $\upsilon = 2B(J^2 + 1)$ (4) $\upsilon = 4B(J - 1)$
82.	In the Raman spectra, the molecule must undergo change in it's : (1) polarizability (2) shape (3) temperature (4) bonding
83.	As the temperature is increased the intensity of an anti-Stoke's Raman line : (1) increases (2) decreases (3) remain unchanged (4) increase and decrease depending upon the mode of vibration.
84.	The spectrum in which energy levels are equally spaced is : (1) vibrational spectra (2) rotational spectra (3) electronic spectra (4) vibrational-rotational spectra

Question No.	Questions
85.	The value of Lande g factor for a fine structure level defined by the quantum numbers L =1, J =2 and S =1 is : (1) $\frac{11}{6}$ (2) $\frac{3}{2}$ (3) $\frac{5}{2}$ (4) $\frac{7}{2}$
86.	The exciting line in an experiment is 5460 A^o and Stoke's line is at 5520 A^o. The wavelength of anti-Stoke's line is : (1) 5200 A^o (2) 4200 A^o (3) 5401 A^o (4) 5308 A^o
87.	Helium-Neon laser is a : (1) single level laser (2) two level laser (3) three level laser (4) four level laser
88.	In a Ruby laser, Ruby crystal is made of : (1) aluminium oxide with small percentage of chromium oxide (2) chromium oxide with small percentage of aluminium oxide (3) manganese oxide with small percentage of chromium oxide (4) aluminium oxide with small percentage of manganese oxide

Question No.	Questions
89.	In the Zeeman effect, the light emitted along and perpendicular to the applied magnetic field are respectively : (1) linearly and circularly polarized (2) circularly and linearly polarized (3) both linearly polarized (4) both circularly polarized
90.	The quadruple moment of the nucleus is : (1) tensor (2) scalar (3) vector (4) none of these
91.	Weak nuclear forces act on : (1) both hadrons and leptons (2) hadrons only (3) all particles (4) all charged particles
92.	An admissible potential between the proton and neutron in a deutron is : (1) coulomb (2) harmonic oscillator (3) finite square well (4) infinite square well

Question No.	Questions
93.	From meson field theory the potential energy of interaction between two nucleons is proportional to : (1) $\frac{e^{-\mu r}}{r^2}$ (2) $\frac{e^{-\mu r}}{r}$ (3) $\frac{e^{-\mu r}}{r}$ (4) $\frac{e^{-\mu r^2}}{r}$
94.	Nuclei which are β emitters lie : (1) below the line of β–stability (2) on the line of β–stability (3) above the line of β–stability (4) below the N = Z line
95.	Primary cosmic rays are composed of very energetic (1) electrons (2) mesons (3) protons (4) neutrons
96.	The ratio of the nuclear radii of elements with mass number 216 and 125 is : (1) 216 : 125 (2) 1 : 1 (3) 6 : 5 (4) 125 : 216
97.	A free neutron decays spontaneously into : (1) a proton, an electron and an anti-neutrino (2) a proton, an electron and a neutrino (3) a proton and an electron (4) a proton, an electron, a neutrino and an anti-neutrino

Question No.	Questions
98.	The mean momentum of a nucleon in nucleus with mass number A varies as : (1) A (2) A^2 (3) $A^{\frac{-2}{3}}$ (4) $A^{\frac{-1}{3}}$
99.	Nuclear forces are : (1) spin dependent and have no non-central part (2) spin dependent and have a non-central part (3) spin independent and have no non-central part (4) spin independent and have a non-central part
100.	The input in carbon-nitrogen cycle is : (1) four protons (2) four protons and two electrons (3) two protons and two electrons (4) two carbon nuclei, four nitrogen nuclei and an oxygen nucleus

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PHYSICS

Code **B**

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8. BEFORE ANSWERING THE QUESTIONS, THE CANDIDATES SHOULD ENSURE THAT THEY HAVE BEEN SUPPLIED CORRECT AND COMPLETE BOOK-LET. COMPLAINTS, IF ANY, REGARDING MISPRINTING ETC. WILL NOT BE ENTERTAINED 30 MINUTES AFTER STARTING OF THE EXAMINATION.

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Question No.	Questions
1.	Op–Amp when used as voltage follower has : (1) closed loop voltage gain of unity (2) open loop voltage gain of unity (3) closed loop bandwidth infinity (4) open loop bandwidth infinity
2.	In a class A push-pull amplifier, load R_L is connected to the secondary of output transformer. It's effective value as seen by device is : (1) R_L (2) $\frac{R_L}{2}$ (3) $\frac{R_L}{4}$ (4) $2R_L$
3.	A microprocessor trainer uses : (1) binary number code (2) hexadecimal number code (3) decimal number code (4) octal number code
4.	A diode that has a negative characteristic is the : (1) Schottky diode (2) Tunnel diode (3) Laser diode (4) Hot carrier cathode
5.	The MOSFET switch in it's on–state may be considered equivalent to : (1) Resistor (2) Inductor (3) Capacitor (4) Battery

Question No.	Questions
6.	In a microprocessor, the resistor which holds the address of the next instruction to be fetched is : (1) accumulator (2) program counter (3) stack counter (4) instructor register
7.	In a 4–bit weighted–resistor D/A converter, the resistor value corresponding to MSB is 2 kΩ. The resistor value corresponding to LSB will be : (1) 1 kΩ (2) 2 kΩ (3) 4 kΩ (4) 16 kΩ
8.	Absolute encoders are used where : (1) fast varying signals are not used (2) when position data is to be recovered (3) transient noise can be tolerated (4) all of these
9.	A linear displacement transducer (digital) normally uses : (1) straight binary code (2) BCD (3) Gray code (4) hexadecimal code
10.	The D_1 and D_2 lines of sodium atom will split on application of a weak magnetic field into : (1) 4 and 6 lines (2) 3 lines each (3) 6 and 4 lines (4) 6 lines each

Question No.	Questions
11.	The nature of series $1+\frac{3}{4}+\frac{9}{16}+\frac{27}{64}+-----\infty$ is : (1) convergent (2) divergent (3) oscillatory (4) none of these
12.	Laplace transform of t sin at is (1) $\frac{2as}{(s^2+a^2)^2}$ (2) $\frac{2a}{(s^2+a^2)^2}$ (3) $\frac{2s}{(s^2+a^2)^2}$ (4) $\frac{a}{(s^2+a^2)^2}$
13.	The polynomial $2x^2+x+3$ in terms of Legendre polynomial is : (1) $\frac{1}{3}(4P_2-3P_1+11P_0)$ (2) $\frac{1}{3}(4P_2+3P_1-11P_0)$ (3) $\frac{1}{3}(4P_2+3P_1+11P_0)$ (4) $\frac{1}{3}(4P_2-3P_1-11P_0)$
14.	$J_3(x)$ can be written in terms of $J_0(x)$ as : (1) $(8x^2+1)\ J_1-4x^{-1}J_0$ (2) $(8x^2-1)\ J_1-4x^{-1}J_0$ (3) $(8x^{-2}-1)\ J_1-4x^{-1}J_0$ (4) $(8x^{-2}+1)\ J_1+4x^{-1}J_0$
15.	The path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a : (1) sphere (2) sigmoid (3) cycloid (4) catenary of revolution

Question No.	Questions
16.	The period of oscillation for compound pendulum is : (1) $2\pi\sqrt{\frac{(k^2+\ell^2)}{g\ell}}$ (2) $2\pi\sqrt{\frac{g\ell}{(k^2+\ell^2)}}$ (3) $2\pi\sqrt{\frac{(k^2+\ell^2)}{mg\ell}}$ (4) $2\pi\sqrt{\frac{mg\ell}{(k^2+\ell^2)}}$
17.	Lagrange's equation of motion are second order equations. The degrees of freedom for this are : (1) $2n$ (2) $2n-1$ (3) $2n+1$ (4) $2n+2$
18.	Constraint in the case of a rigid body is : (1) Dynamic constraint (2) Seleronomous constraint (3) Rheonomous constraint (4) Static constraint
19.	The equation of motion for a small particle of mass m at position x is $m\ddot{x} + r\dot{x} - mg = 0$. Assuming initial speed to be v_0, the terminal speed of particle will be : (1) $\frac{mg}{r}$ (2) $\sqrt{v_0 + 2gx}$ (3) $v_0 + gt$ (4) $\frac{mg}{r^2 t}$

Question No.	Questions
20.	The generalised velocity coordinate (q_k) of a classical system with Lagrangian (L) is said to be cyclic if : (1) $\frac{\partial L}{\partial q_k} = q_k^o$ (2) $\frac{\partial L}{\partial q_k} = \frac{d}{dt}\left(\frac{\partial L}{\partial q_k^o}\right)$ (3) $\frac{\partial L}{\partial q_k} = 0$ (4) $\frac{\partial L}{\partial q_k^o} = 0$
21.	The Einstein relationship between the diffusion constant (D_n) and mobility (μ_n) for electron is : 1) $\frac{D_n}{\mu_n} = \frac{2k_B T}{e}$ (2) $\frac{D_n}{\mu_n} = \frac{e}{k_B T}$ (3) $\frac{D_n}{\mu_n} = \frac{k_B T}{e}$ (4) $\frac{D_n}{\mu_n} = k_B T - e$
22.	Cooper pair follows : (1) Bose-Einstein statistics (2) Fermi-Dirac statistics (3) Maxwell-Boltzmann statistics (4) None of these
23.	The density of carriers in a pure semiconductor is proportional to : (1) $\exp(-E_g / k_B T)$ (2) $\exp(-2E_g / k_B T)$ (3) $\exp(-E_g / k_B T^2)$ (4) $\exp(-E_g / 2k_B T)$

Question No.	Questions
24.	Point defects in crystals can not be produced by : (1) elastic deformation (2) quenching from high temperature (3) plastic deformation (4) irradiation with X-rays
25.	In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is : (1) 6 : 3 : 2 (2) 6 : 3 : $\sqrt{2}$ (3) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (4) $\sqrt{6} : \sqrt{3} : \sqrt{4}$
26.	In simple metals the phonon contribution to the electrical resistivity at temperature T is : (1) directly proportional to T above Debye temperature and to T^3 below it . (2) inversely proportional to T for all temperatures. (3) independent of T for all temperatures. (4) directly proportional to T above Debye temperature and to T^5 below it.
27.	The crystal lattice is a lattice in real ordinary space but the reciprocal lattice is a lattice in a : (1) Gaussian space (2) Laplacian space (3) Fourier space (4) Hypothetical space

Question No.	Questions
28.	The packing factor of diamond cubic crystal structure is : (1) 60 % (2) 56 % (3) 90 % (4) none of these
29.	In Debye's theory of specific heat of solids, the frequency of the lattice vibration has : (1) a fixed value (2) some discrete values (3) a continuous spectrum upto a finite value (4) a continuous spectrum upto infinity.
30.	At lower temperature the lattice specific heat varies as : (1) T^3 (2) $\frac{1}{T^3}$ (3) T (4) $\frac{1}{T}$
31.	The function $\frac{1}{\sqrt{2}}[\alpha(1)\,\beta(2) - \alpha(2)\,\beta(1)]$ represent a state in which : (1) $S = 1, m_s = 1$ (2) $S = 1, m_s = -1$ (3) $S = 1, m_s = 0$ (4) $S = 0, m_s = 0$
32.	Which of the following is an eigen function of L_z ? (1) $\cos\phi$ (2) $\sin\phi$ (3) $\exp(i\phi)$ (4) $\cos^2\phi$

Question No.	Questions
33.	A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where magnetic induction will be $\frac{1}{8}$th of it's value at the centre of coil is : (1) $R/\sqrt{3}$ (2) $R.\sqrt{3}$ (3) $2R.\sqrt{3}$ (4) 4R
34.	A long straight wire carrying current of 30 A is placed in a external magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction at a point 2.0 cm away from the wire is : (1) 10^{-4} T (2) 3×10^{-4} T (3) 5×10^{-4} T (4) 4.6×10^{-4} T
35.	The magnetic field at the point of intersection of diagonals of a square wire loop of side L, carrying a current I is : (1) $\frac{\mu_0 I}{\pi L}$ (2) $\frac{2\mu_0 I}{\pi L}$ (3) $\sqrt{2}\,\frac{\mu_0 I}{\pi L}$ (4) $2\sqrt{2}\,\frac{\mu_0 I}{\pi L}$
36.	If the electric field is given by $\vec{E} = 5\hat{i} + 4\hat{j} + 9\hat{k}$, the electric flux through a surface of area 20 unit lying in the yz plane will be : (1) 100 unit (2) 80 unit (3) 180 unit (4) 20 unit

Question No.	Questions
37.	A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of sphere is : (1) 2 cm (2) 4 cm (3) 6 cm (4) 12 cm
38.	A concave mirror of focal length f in vacuum is placed in a medium of refractive index 2. It's focal length in the medium is : (1) f/2 (2) f (3) 2f (4) 4f
39.	In the phenomenon of diffraction of light, when blue light is used in the experiment instead of red light, then : (1) fringes will become narrower (2) fringes will become broader (3) no change in fringe width (4) none of these
40.	The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n) is : (1) $\sin^{-1}(n)$ (2) $\sin^{-1}\left(\frac{1}{n}\right)$ (3) $\tan^{-1}\left(\frac{1}{n}\right)$ (4) $\tan^{-1}(n)$

Question No.	Questions
41.	Weak nuclear forces act on : (1) both hadrons and leptons (2) hadrons only (3) all particles (4) all charged particles
42.	An admissible potential between the protor and neutron in a deutron is : (1) coulomb (2) harmonic oscillator (3) finite square well (4) infinite square well
43.	From meson field theory the potential energy of interaction between two nucleons is proportional to : (1) $\frac{e^{-\mu r}}{r^2}$ (2) $\frac{e^{-\mu r}}{r}$ (3) $\frac{e^{-\mu r}}{r}$ (4) $\frac{e^{-\mu r^2}}{r}$
44.	Nuclei which are β emitters lie : (1) below the line of β–stability (2) on the line of β–stability (3) above the line of β–stability (4) below the N = Z line

Question No.	Questions
45.	Primary cosmic rays are composed of very energetic (1) electrons (2) mesons (3) protons (4) neutrons
46.	The ratio of the nuclear radii of elements with mass number 216 and 125 is : (1) 216 : 125 (2) 1 : 1 (3) 6 : 5 (4) 125 : 216
47.	A free neutron decays spontaneously into : (1) a proton, an electron and an anti-neutrino (2) a proton, an electron and a neutrino (3) a proton and an electron (4) a proton, an electron, a neutrino and an anti-neutrino
48.	The mean momentum of a nucleon in nucleus with mass number A varies as : (1) A (2) A^2 (3) $A^{\frac{-2}{3}}$ (4) $A^{\frac{-1}{3}}$
49.	Nuclear forces are : (1) spin dependent and have no non-central part (2) spin dependent and have a non-central part (3) spin independent and have no non-central part (4) spin independent and have a non-central part

Question No.	Questions
50.	The input in carbon-nitrogen cycle is : (1) four protons (2) four protons and two electrons (3) two protons and two electrons (4) two carbon nuclei, four nitrogen nuclei and an oxygen nucleus
51.	The Jacobi's form of the least action principle is : (1) $\Delta \int \sqrt{2[H-V(q)]}.d\rho = 0$ (2) $\Delta \int \sqrt{2[H+V(q)]}.d\rho = 0$ (3) $\Delta \int \sqrt{2[L-V(q)]}.d\rho = 0$ (4) $\Delta \int \sqrt{2[L+V(q)]}.d\rho = 0$
52.	In the case of elliptical orbits under the influence of a central force, the total energy depends on: (1) major axis (2) minor axis (3) both minor and major axis (4) neither of the above two
53.	Which of the following quantities is Lorentz invariant ? (1) $\lvert E \times B \rvert^2$ (2) $\lvert E \rvert^2 - \lvert B \rvert^2$ (3) $\lvert E \rvert^2 + \lvert B \rvert^2$ (4) $\lvert E \rvert^2 \bullet \lvert B \rvert^2$

Question No.	Questions
54.	Hamiltons principle function S and the Hamiltons characteristic function W for conservative system with energy E and time t, are related as : (1) S = W (2) S = W–Et (3) S = W+Et (4) S is not related to W
55.	Which one of the following is a first order phase transition ? (1) vaporization of a liquid at it's boiling point (2) ferromagnetic to paramagnetic (3) normal liquid He to super fluid He (4) superconductivity to normal state
56.	The dimension of phase space of ten rigid diatomic molecules is : (1) 5 (2) 10 (3) 50 (4) 100
57.	In the process of phase transition : (1) Gibb's potential function remains constant (2) only entropy remains constant (3) only volume remains constant (4) only temperature remains constant
58.	In a canonical ensemble : (1) the energy and the temperature are constants (2) the energy and the entropy are constants (3) the temperature and the density are constants (4) the entropy and the density are constants

Question No.	Questions
59.	The capacitance of a varactor diode can be varied by : (1) varying it's temperature (2) varying it's forward bias (3) varying it's reverse bias (4) varying it's doping level
60.	In a full wave rectifier having R-L filter, the value of inductor is 2H and load is 1kΩ. If input frequency is 60 Hz, ripple factor is : (1) 50 % (2) 63 % (3) 33 % (4) 21 %
61.	For a diatomic molecule the frequency of rotation(υ) can be related with rotational quantum number (J) and rotational constant (B) as : (1) $\upsilon = 2B(J+1)$ (2) $\upsilon = 3B(J+1)$ (3) $\upsilon = 2B(J^2+1)$ (4) $\upsilon = 4B(J-1)$
62.	In the Raman spectra, the molecule must undergo change in it's : (1) polarizability (2) shape (3) temperature (4) bonding
63.	As the temperature is increased the intensity of an anti-Stoke's Raman line : (1) increases (2) decreases (3) remain unchanged (4) increase and decrease depending upon the mode of vibration.

Question No.	Questions
64.	The spectrum in which energy levels are equally spaced is : (1) vibrational spectra (2) rotational spectra (3) electronic spectra (4) vibrational-rotational spectra
65.	The value of Lande g factor for a fine structure level defined by the quantum numbers L =1, J =2 and S =1 is : (1) $\frac{11}{6}$ (2) $\frac{3}{2}$ (3) $\frac{5}{2}$ (4) $\frac{7}{2}$
66.	The exciting line in an experiment is 5460 A^o and Stoke's line is at 5520 A^o. The wavelength of anti-Stoke's line is : (1) 5200 A^o (2) 4200 A^o (3) 5401 A^o (4) 5308 A^o
67.	Helium-Neon laser is a : (1) single level laser (2) two level laser (3) three level laser (4) four level laser
68.	In a Ruby laser, Ruby crystal is made of : (1) aluminium oxide with small percentage of chromium oxide (2) chromium oxide with small percentage of aluminium oxide (3) manganese oxide with small percentage of chromium oxide (4) aluminium oxide with small percentage of manganese oxide

Question No.	Questions
69.	In the Zeeman effect, the light emitted along and perpendicular to the applied magnetic field are respectively : (1) linearly and circularly polarized (2) circularly and linearly polarized (3) both linearly polarized (4) both circularly polarized
70.	The quadruple moment of the nucleus is : (1) tensor (2) scalar (3) vector (4) none of these
71.	$\nabla\left(\frac{\hat{r}}{r^3}\right)$ is equal to : (1) 0 (2) r^3 (3) r^2 (4) r
72.	If the vectors $\vec{A} = 2\hat{i}-\hat{j}+\hat{k}$, $\vec{B} = \hat{i}+2\hat{j}+3\hat{k}$ and $\vec{C} = 3\hat{i}+a\hat{j}+5\hat{k}$ are coplanar, then the value of a will be (1) 4 (2) -4 (3) 2 (4) -2

Question No.	Questions
73.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \end{bmatrix}$ is : (1) 0 (2) 1 (3) 2 (4) 3
74.	The integral of $\bar{z}$ along upper half of the circle $\lvert z \rvert = 1$ from $z = -1$ to $z = 1$ is : (1) $-i\pi$ (2) $i\pi$ (3) $2\pi i$ (4) $-2\pi i$
75.	The Cauchy–Riemann equation in polar form is given as : (1) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ (2) $\frac{\partial u}{\partial r} = \frac{r\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (3) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (4) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$
76.	The trace of 3×3 matrix is 2. Two of it's eigen values are 1 and 2. The third eigen value is : (1) –1 (2) 0 (3) 1 (4) 2

Question No.	Questions
77.	Residue of $f(z)=\frac{z^3}{(z-1)^4(z-2)(z-3)}$ at $z=3$ is : (1) $\frac{101}{16}$ (2) -8 (3) $\frac{27}{16}$ (4) 0
78.	The differential equation $x^2\frac{d^2y}{dx^2}+x.\frac{dy}{dx}+y=x$ is : (1) linear (2) homogeneous (3) homogeneous linear (4) none of these
79.	Solution of the differential equation $(x-y^2)\,dx+2xy\,dy=0$ is : (1) $y\exp\left(\frac{y^2}{x}\right)=A$ (2) $x\exp\left(\frac{y^2}{x}\right)=A$ (3) $y\exp\left(\frac{x}{y^2}\right)=A$ (4) $x\exp\left(\frac{x}{y^2}\right)=A$
80.	Which one of the following is fensor of order zero ? (1) $\vec{A}+\vec{B}$ (2) $\vec{A}-\vec{B}$ (3) $\vec{A}\bullet\vec{B}$ (4) $\vec{A}\times\vec{B}$
81.	In a dielectric the polarization is : (1) linear function of applied field (2) square function of applied field (3) exponential function of applied field (4) logarithmic function of applied field

Question No.	Questions
82.	In a Fresnel biprism experiment the two positions of lens give separation between the slits as 16 cm and 9 cm respectively. The actual distance of separation is : (1) 12.5 cm (2) 12 cm (3) 7.5 cm (4) 15 cm
83.	Two solenoids of equal number of turns have their lengths and radii. in the same ratio 1:2. The ratio of their self inductances will be : (1) 1:2 (2) 2:1 (3) 1:1 (4) 1:4
84.	The power radiated by an electric dipole is proportional to the frequency given by : (1) W (2) W^2 (3) W^3 (4) W^4
85.	At the interface of two non-conducting medium the formula for reflection coefficient for normal incidence is given by : (1) $\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$ (2) $\frac{4n_1 \cdot n_2}{(n_2 + n_1)^2}$ (3) $\frac{2n_1\ n_2}{(n_2 + n_1)^2}$ (4) None of these

Question No.	Questions
86.	The sinusoidally time varying vector field $\vec{F} = 2\cos(wt + 30°)\,\hat{a}_x + 2\cos(wt - 30°)\,\hat{a}_y$ is : (1) elliptically polarized (2) circularly polarized (3) linearly polarized (4) unpolarized
87.	An air filled rectangular waveguide has dimensions 6 cm×4 cm. The cut-off frequency for TE_{10} is : (1) 2.5 GHz (2) 25 GHz (3) 25 MHz (4) 5 GHz
88.	The length of Hydrogen-Hydrogen bond is : (1) 0.074 nm (2) 0.01 nm (3) 0.037 nm (4) 2 nm
89.	Transition temperature (T_C) and critical field (H_C) for a superconductor are related as : (1) $H_C = H_o(T_C - 1)$ (2) $H_C = H_o(T_C + 1)$ (3) $T_C = T_o\left[1 - \left(\frac{H_o}{H_C}\right)^2\right]$ (4) $H_C = H_o\left[1 - \left(\frac{T}{T_C}\right)^2\right]$
90.	The favourable condition both for superconductivity and high resistance is : (1) a weak electron-phonon interaction (2) a strong electron-phonon interaction (3) a weak phonon-phonon interaction (4) a strong phonon-phonon interaction

Question No.	Questions
91.	For a Gaussian Wave packet described by $\psi(x) = A \exp\left(\frac{-x^2}{a^2}\right)$, the expectation value of the momentum operator is : (1) 0 (2) undefined (3) $+a$ (4) $-a$
92.	The degeneracy of the $n=2$ level for a three dimensional harmonic oscillator is : (1) 4 (2) 6 (3) 8 (4) 10
93.	Value of $[L_x, r^2]$ is : (1) $i\hbar y$ (2) $i\hbar p_y$ (3) $-i\hbar x$ (4) 0
94.	Which of the following is not a Fermion ? (1) electron (2) muon (3) neutron (4) photon
95.	In partial wave analysis, the expression for total cross-section of scattering is : (1) $\frac{4\pi}{k^2}\sum_\ell (2\ell+1)\sin^2\delta_e$ (2) $4\pi\sum_\ell (2\ell+1)\sin^2\delta_e$ (3) $\frac{2\pi}{k^2}\sum_\ell (2\ell+1)P_\ell^2(\cos\theta)$ (4) $2\pi k^2\sum_\ell (2\ell+1)P_\ell^2(\cos\theta)$

Question No.	Questions
96.	The energy of free electrons in the state (1, 2, 1) in a rectangular box of sides $a = b \neq c$ is : (1) $\frac{h^2}{8m}\left[\frac{5}{a^2}+\frac{1}{c^2}\right]$ (2) $\frac{8m}{h^2}\left[\frac{1}{a^2}+\frac{1}{c^2}\right]$ (3) $\frac{h^2}{8m}\left[\frac{3}{a^2}+\frac{1}{c^2}\right]$ (4) None of these
97.	The eigen functions of the operator $\frac{d^2}{dx^2}$ which vanishes at $x = 0$ and $x = L$ (A is constant and n is an integer) are : (1) $A \sin\left(\frac{n\pi}{\ell}x\right)$ (2) $A \cos\left(\frac{n\pi}{\ell}x\right)$ (3) $A\,x\,(\ell - x)$ (4) $A \exp\left(\frac{-n\pi}{\ell}x\right)$
98.	Selection rules for the electric dipole transitions are : (1) $\Delta\ell = 0, \pm 1$, $\Delta m = 0$ (2) $\Delta\ell = 0, \pm 1$, $\Delta m = 0, \pm 1$ (3) $\Delta\ell = \pm 1$, $\Delta m = 0, \pm 1$ (4) $\Delta\ell = \pm 1$, $\Delta m = \pm 1$
99.	The radial part of the waveform for the hydrogen atom is expressed in terms of : (1) Laguerre polynomial (2) Hermite polynomial (3) Legendre polynomial (4) Associated Laguerre polynomial

Question No.	Questions
100.	The expression $\psi = \exp(ikr) - \frac{m}{2\pi\hbar}\int G(r,r')\,V(r').\exp(ikr')\,dr.$ is called : (1) first Born approximation (2) first WKB approximation (3) Green's approximation (4) none of these

SET–"X"

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(MPH/PHD/URS–EE–2020)

PHYSICS

Code **C**

Sr. No. 10011

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. _____ (in figure) _____ (in words)

Name : _____ Father's Name : _____

Mother's Name : _____ Date of Examination : _____

(Signature of the candidate) (Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/ INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates must return the Question booklet as well as OMR answer-sheet to the Invigilator concerned before leaving the Examination Hall failing which a case of use of unfair-means / mis-behaviour will be registered against him / her in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A,B,C and D code will be got uploaded on the university website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing/through E-Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate MUST NOT do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question book-let itself. Answers MUST NOT be ticked in the Question Book-let.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
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Question No.	Questions
1.	$\nabla\left(\frac{\hat{r}}{r^3}\right)$ is equal to : (1) 0 (2) r^3 (3) r^2 (4) r
2.	If the vectors $\vec{A} = 2\hat{i}-\hat{j}+\hat{k}$, $\vec{B} = \hat{i}+2\hat{j}+3\hat{k}$ and $\vec{C} = 3\hat{i}+a\hat{j}+5\hat{k}$ are coplanar, then the value of a will be (1) 4 (2) -4 (3) 2 (4) -2
3.	The rank of the matrix $\begin{bmatrix}1 & 2 & 3\\ 2 & 4 & 5\end{bmatrix}$ is : (1) 0 (2) 1 (3) 2 (4) 3
4.	The integral of $\vec{z}$ along upper half of the circle $\lvert z\rvert = 1$ from $z = -1$ to $z = 1$ is : (1) $-i\pi$ (2) $i\pi$ (3) $2\pi i$ (4) $-2\pi i$.
5.	The Cauchy–Riemann equation in polar form is given as : (1) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ (2) $\frac{\partial u}{\partial r} = \frac{r\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (3) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (4) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$

Question No.	Questions
6.	The trace of 3×3 matrix is 2. Two of it's eigen values are 1 and 2. The third eigen value is : (1) –1 (2) 0 (3) 1 (4) 2
7.	Residue of $f(z)=\frac{z^3}{(z-1)^4(z-2)(z-3)}$ at z = 3 is : (1) $\frac{101}{16}$ (2) –8 (3) $\frac{27}{16}$ (4) 0
8.	The differential equation $x^2\frac{d^2y}{dx^2}+x.\frac{dy}{dx}+y=x$ is : (1) linear (2) homogeneous (3) homogeneous linear (4) none of these
9.	Solution of the differential equation $(x-y^2)\,dx + 2xy\,dy = 0$ is : (1) $y\exp\left(\frac{y^2}{x}\right)=A$ (2) $x\exp\left(\frac{y^2}{x}\right)=A$ (3) $y\exp\left(\frac{x}{y^2}\right)=A$ (4) $x\exp\left(\frac{x}{y^2}\right)=A$
10.	Which one of the following is fensor of order zero ? (1) $\vec{A}+\vec{B}$ (2) $\vec{A}-\vec{B}$ (3) $\vec{A}\bullet\vec{B}$ (4) $\vec{A}\times\vec{B}$

Question No.	Questions
11.	In a dielectric the polarization is : (1) linear function of applied field (2) square function of applied field (3) exponential function of applied field (4) logarithmic function of applied field
12.	In a Fresnel biprism experiment the two positions of lens give separation between the slits as 16 cm and 9 cm respectively. The actual distance of separation is : (1) 12.5 cm (2) 12 cm (3) 7.5 cm (4) 15 cm
13.	Two solenoids of equal number of turns have their lengths and radii. in the same ratio 1:2. The ratio of their self inductances will be : (1) 1:2 (2) 2:1 (3) 1:1 (4) 1:4
14.	The power radiated by an electric dipole is proportional to the frequency given by : (1) W (2) W^2 (3) W^3 (4) W^4

Question No.	Questions
15.	At the interface of two non-conducting medium the formula for reflection coefficient for normal incidence is given by : (1) $\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$ (2) $\frac{4n_1 . n_2}{(n_2 + n_1)^2}$ (3) $\frac{2n_1\ n_2}{(n_2 + n_1)^2}$ (4) None of these
16.	The sinusoidally time varying vector field $\vec{F} = 2\cos(wt + 30°)\,\hat{a}_x + 2\cos(wt - 30°)\,\hat{a}_y$ is : (1) elliptically polarized (2) circularly polarized (3) linearly polarized (4) unpolarized
17.	An air filled rectangular waveguide has dimensions 6 cm×4 cm. The cut-off frequency for TE_{10} is : (1) 2.5 GHz (2) 25 GHz (3) 25 MHz (4) 5 GHz
18.	The length of Hydrogen-Hydrogen bond is : (1) 0.074 nm (2) 0.01 nm (3) 0.037 nm (4) 2 nm

Question No.	Questions
19.	Transition temperature (T_C) and critical field (H_C) for a superconductor are related as : (1) $H_C = H_o(T_C - 1)$ (2) $H_C = H_o(T_C + 1)$ (3) $T_C = T_o\left[1-\left(\frac{H_o}{H_C}\right)^2\right]$ (4) $H_C = H_o\left[1-\left(\frac{T}{T_C}\right)^2\right]$
20.	The favourable condition both for superconductivity and high resistance is : (1) a weak electron-phonon interaction (2) a strong electron-phonon interaction (3) a weak phonon-phonon interaction (4) a strong phonon-phonon interaction
21.	For a Gaussian Wave packet described by $\psi(x) = A \exp\left(\frac{-x^2}{a^2}\right)$, the expectation value of the momentum operator is : (1) 0 (2) undefined (3) + a (4) – a
22.	The degeneracy of the n=2 level for a three dimensional harmonic oscillator is : (1) 4 (2) 6 (3) 8 (4) 10
23.	Value of $[L_x, r^2]$ is : (1) $i\hbar y$ (2) $i\hbar p_y$ (3) $-i\hbar x$ (4) 0

Question No.	Questions
24.	Which of the following is not a Fermion ? (1) electron (2) muon (3) neutron (4) photon
25.	In partial wave analysis, the expression for total cross-section of scattering is : (1) $\frac{4\pi}{k^2}\sum_{\ell}(2\ell+1)\sin^2\delta_e$ (2) $4\pi\sum_{\ell}(2\ell+1)\sin^2\delta_e$ (3) $\frac{2\pi}{k^2}\sum_{\ell}(2\ell+1)P_\ell^2(\cos\theta)$ (4) $2\pi k^2\sum_{\ell}(2\ell+1)P_\ell^2(\cos\theta)$
26.	The energy of free electrons in the state (1, 2, 1) in a rectangular box of sides $a = b \neq c$ is : (1) $\frac{h^2}{8m}\left[\frac{5}{a^2}+\frac{1}{c^2}\right]$ (2) $\frac{8m}{h^2}\left[\frac{1}{a^2}+\frac{1}{c^2}\right]$ (3) $\frac{h^2}{8m}\left[\frac{3}{a^2}+\frac{1}{c^2}\right]$ (4) None of these
27.	The eigen functions of the operator $\frac{d^2}{dx^2}$ which vanishes at $x = 0$ and $x = L$ (A is constant and n is an integer) are : (1) $A\sin\left(\frac{n\pi}{\ell}x\right)$ (2) $A\cos\left(\frac{n\pi}{\ell}x\right)$ (3) $Ax(\ell-x)$ (4) $A\exp\left(\frac{-n\pi}{\ell}x\right)$

Question No.	Questions
28.	Selection rules for the electric dipole transitions are : (1) $\Delta\ell = 0, \pm 1$, $\Delta m = 0$ (2) $\Delta\ell = 0, \pm 1$, $\Delta m = 0, \pm 1$ (3) $\Delta\ell = \pm 1$, $\Delta m = 0, \pm 1$ (4) $\Delta\ell = \pm 1$, $\Delta m = \pm 1$
29.	The radial part of the waveform for the hydrogen atom is expressed in terms of : (1) Laguerre polynomial (2) Hermite polynomial (3) Legendre polynomial (4) Associated Laguerre polynomial
30.	The expression $\psi = \exp(ikr) - \frac{m}{2\pi\hbar} \int G(r,r') V(r') . \exp(ikr') dr.$ is called : (1) first Born approximation (2) first WKB approximation (3) Green's approximation (4) none of these
31.	For a diatomic molecule the frequency of rotation(υ) can be related with rotational quantum number (J) and rotational constant (B) as : (1) $\upsilon = 2B(J+1)$ (2) $\upsilon = 3B(J+1)$ (3) $\upsilon = 2B(J^2+1)$ (4) $\upsilon = 4B(J-1)$
32.	In the Raman spectra, the molecule must undergo change in it's : (1) polarizability (2) shape (3) temperature (4) bonding

Question No.	Questions
33.	As the temperature is increased the intensity of an anti-Stoke's Raman line : (1) increases (2) decreases (3) remain unchanged (4) increase and decrease depending upon the mode of vibration.
34.	The spectrum in which energy levels are equally spaced is : (1) vibrational spectra (2) rotational spectra (3) electronic spectra (4) vibrational-rotational spectra
35.	The value of Lande g factor for a fine structure level defined by the quantum numbers L =1, J =2 and S =1 is : (1) $\frac{11}{6}$ (2) $\frac{3}{2}$ (3) $\frac{5}{2}$ (4) $\frac{7}{2}$
36.	The exciting line in an experiment is 5460 A^o and Stoke's line is at 5520 A^o. The wavelength of anti-Stoke's line is : (1) 5200 A^o (2) 4200 A^o (3) 5401 A^o (4) 5308 A^o
37.	Helium-Neon laser is a : (1) single level laser (2) two level laser (3) three level laser (4) four level laser

Question No.	Questions
38.	In a Ruby laser, Ruby crystal is made of : (1) aluminium oxide with small percentage of chromium oxide (2) chromium oxide with small percentage of aluminium oxide (3) manganese oxide with small percentage of chromium oxide (4) aluminium oxide with small percentage of manganese oxide
39.	In the Zeeman effect, the light emitted along and perpendicular to the applied magnetic field are respectively : (1) linearly and circularly polarized (2) circularly and linearly polarized (3) both linearly polarized (4) both circularly polarized
40.	The quadruple moment of the nucleus is : (1) tensor (2) scalar (3) vector (4) none of these
	41. The Jacobi's form of the least action principle is : (1) $\Delta \int \sqrt{2[H-V(q)]}.d\rho = 0$ (2) $\Delta \int \sqrt{2[H+V(q)]}.d\rho = 0$ (3) $\Delta \int \sqrt{2[L-V(q)]}.d\rho = 0$ (4) $\Delta \int \sqrt{2[L+V(q)]}.d\rho = 0$

Question No.	Questions
42.	In the case of elliptical orbits under the influence of a central force, the total energy depends on: (1) major axis (2) minor axis (3) both minor and major axis (4) neither of the above two
43.	Which of the following quantities is Lorentz invariant ? (1) $\lvert E \times B \rvert^2$ (2) $\lvert E \rvert^2 - \lvert B \rvert^2$ (3) $\lvert E \rvert^2 + \lvert B \rvert^2$ (4) $\lvert E \rvert^2 \bullet \lvert B \rvert^2$
44.	Hamiltons principle function S and the Hamiltons characteristic function W for conservative system with energy E and time t, are related as : (1) $S = W$ (2) $S = W - Et$ (3) $S = W + Et$ (4) S is not related to W
45.	Which one of the following is a first order phase transition ? (1) vaporization of a liquid at it's boiling point (2) ferromagnetic to paramagnetic (3) normal liquid He to super fluid He (4) superconductivity to normal state
46.	The dimension of phase space of ten rigid diatomic molecules is : (1) 5 (2) 10 (3) 50 (4) 100

Question No.	Questions
47.	In the process of phase transition : (1) Gibb's potential function remains constant (2) only entropy remains constant (3) only volume remains constant (4) only temperature remains constant
48.	In a canonical ensemble : (1) the energy and the temperature are constants (2) the energy and the entropy are constants (3) the temperature and the density are constants (4) the entropy and the density are constants
49.	The capacitance of a varactor diode can be varied by : (1) varying it's temperature (2) varying it's forward bias (3) varying it's reverse bias (4) varying it's doping level
50.	In a full wave rectifier having R-L filter, the value of inductor is 2H and load is 1kΩ. If input frequency is 60 Hz, ripple factor is : (1) 50 % (2) 63 % (3) 33 % (4) 21 %

Question No.	Questions
51.	The Einstein relationship between the diffusion constant (D_n) and mobility (μ_n) for electron is : 1) $\frac{D_n}{\mu_n} = \frac{2k_B T}{e}$ (2) $\frac{D_n}{\mu_n} = \frac{e}{k_B T}$ (3) $\frac{D_n}{\mu_n} = \frac{k_B T}{e}$ (4) $\frac{D_n}{\mu_n} = k_B T - e$
52.	Cooper pair follows : (1) Bose-Einstein statistics (2) Fermi-Dirac statistics (3) Maxwell-Boltzmann statistics (4) None of these
53.	The density of carriers in a pure semiconductor is proportional to : (1) $\exp(-E_g / k_B T)$ (2) $\exp(-2E_g / k_B T)$ (3) $\exp(-E_g / k_B T^2)$ (4) $\exp(-E_g / 2k_B T)$
54.	Point defects in crystals can not be produced by : (1) elastic deformation (2) quenching from high temperature (3) plastic deformation (4) irradiation with X-rays

Question No.	Questions
55.	In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is : (1) 6 : 3 : 2 (2) 6 : 3 : $\sqrt{2}$ (3) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (4) $\sqrt{6} : \sqrt{3} : \sqrt{4}$
56.	In simple metals the phonon contribution to the electrical resistivity at temperature T is : (1) directly proportional to T above Debye temperature and to T^3 below it. (2) inversely proportional to T for all temperatures. (3) independent of T for all temperatures. (4) directly proportional to T above Debye temperature and to T^5 below it.
57.	The crystal lattice is a lattice in real ordinary space but the reciprocal lattice is a lattice in a : (1) Gaussian space (2) Laplacian space (3) Fourier space (4) Hypothetical space
58.	The packing factor of diamond cubic crystal structure is : (1) 60 % (2) 56 % (3) 90 % (4) none of these

Question No.	Questions
59.	In Debye's theory of specific heat of solids, the frequency of the lattice vibration has : (1) a fixed value (2) some discrete values (3) a continuous spectrum upto a finite value (4) a continuous spectrum upto infinity.
60.	At lower temperature the lattice specific heat varies as : (1) T^3 (2) $\frac{1}{T^3}$ (3) T (4) $\frac{1}{T}$
61.	Op–Amp when used as voltage follower has : (1) closed loop voltage gain of unity (2) open loop voltage gain of unity (3) closed loop bandwidth infinity (4) open loop bandwidth infinity
62.	In a class A push-pull amplifier, load R_L is connected to the secondary of output transformer. It's effective value as seen by device is : (1) R_L (2) $\frac{R_L}{2}$ (3) $\frac{R_L}{4}$ (4) $2R_L$

Question No.	Questions
63.	A microprocessor trainer uses : (1) binary number code (2) hexadecimal number code (3) decimal number code (4) octal number code
64.	A diode that has a negative characteristic is the : (1) Schottky diode (2) Tunnel diode (3) Laser diode (4) Hot carrier cathode
65.	The MOSFET switch in it's on–state may be considered equivalent to : (1) Resistor (2) Inductor (3) Capacitor (4) Battery
66.	In a microprocessor, the resistor which holds the address of the next instruction to be fetched is : (1) accumulator (2) program counter (3) stack counter (4) instructor register
67.	In a 4–bit weighted–resistor D/A converter, the resistor value corresponding to MSB is 2 kΩ. The resistor value corresponding to LSB will be : (1) 1 kΩ (2) 2 kΩ (3) 4 kΩ (4) 16 kΩ
68.	Absolute encoders are used where : (1) fast varying signals are not used (2) when position data is to be recovered (3) transient noise can be tolerated (4) all of these

Question No.	Questions
69.	A linear displacement transducer (digital) normally uses : (1) straight binary code (2) BCD (3) Gray code (4) hexadecimal code
70.	The D_1 and D_2 lines of sodium atom will split on application of a weak magnetic field into : (1) 4 and 6 lines (2) 3 lines each (3) 6 and 4 lines (4) 6 lines each
71.	Weak nuclear forces act on : (1) both hadrons and leptons (2) hadrons only (3) all particles (4) all charged particles
72.	An admissible potential between the proton and neutron in a deutron is : (1) coulomb (2) harmonic oscillator (3) finite square well (4) infinite square well
73.	From meson field theory the potential energy of interaction between two nucleons is proportional to : (1) $\frac{e^{-\mu r}}{r^2}$ (2) $\frac{e^{-\mu r}}{r}$ (3) $\frac{e^{-\mu r}}{r}$ (4) $\frac{e^{-\mu r^2}}{r}$

Question No.	Questions
74.	Nuclei which are β emitters lie : (1) below the line of β–stability (2) on the line of β–stability (3) above the line of β–stability (4) below the N = Z line
75.	Primary cosmic rays are composed of very energetic (1) electrons (2) mesons (3) protons (4) neutrons
76.	The ratio of the nuclear radii of elements with mass number 216 and 125 is : (1) 216 : 125 (2) 1 : 1 (3) 6 : 5 (4) 125 : 216
77.	A free neutron decays spontaneously into : (1) a proton, an electron and an anti-neutrino (2) a proton, an electron and a neutrino (3) a proton and an electron (4) a proton, an electron, a neutrino and an anti-neutrino
78.	The mean momentum of a nucleon in nucleus with mass number A varies as : (1) A (2) A^2 (3) $A^{\frac{-2}{3}}$ (4) $A^{\frac{-1}{3}}$

Question No.	Questions
79.	Nuclear forces are : (1) spin dependent and have no non-central part (2) spin dependent and have a non-central part (3) spin independent and have no non-central part (4) spin independent and have a non-central part
80.	The input in carbon-nitrogen cycle is : (1) four protons (2) four protons and two electrons (3) two protons and two electrons (4) two carbon nuclei, four nitrogen nuclei and an oxygen nucleus
81.	The function $\frac{1}{\sqrt{2}}[\alpha(1)\,\beta(2) - \alpha(2)\,\beta(1)]$ represent a state in which : (1) $S = 1, m_s = 1$ (2) $S = 1, m_s = -1$ (3) $S = 1, m_s = 0$ (4) $S = 0, m_s = 0$
82.	Which of the following is an eigen function of L_z ? (1) $\cos\phi$ (2) $\sin\phi$ (3) $\exp(i\phi)$ (4) $\cos^2\phi$

Question No.	Questions
83.	A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where magnetic induction will be $\frac{1}{8}$th of it's value at the centre of coil is : (1) $R/\sqrt{3}$ (2) $R.\sqrt{3}$ (3) $2R.\sqrt{3}$ (4) 4R
84.	A long straight wire carrying current of 30 A is placed in a external magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction at a point 2.0 cm away from the wire is : (1) 10^{-4} T (2) 3×10^{-4} T (3) 5×10^{-4} T (4) 4.6×10^{-4} T
85.	The magnetic field at the point of intersection of diagonals of a square wire loop of side L, carrying a current I is : (1) $\frac{\mu_0 I}{\pi L}$ (2) $\frac{2\mu_0 I}{\pi L}$ (3) $\sqrt{2}\,\frac{\mu_0 I}{\pi L}$ (4) $2\sqrt{2}\,\frac{\mu_0 I}{\pi L}$
86.	If the electric field is given by $\vec{E} = 5\hat{i} + 4\hat{j} + 9\hat{k}$, the electric flux through a surface of area 20 unit lying in the yz plane will be : (1) 100 unit (2) 80 unit (3) 180 unit (4) 20 unit

Question No.	Questions
87.	A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of sphere is : (1) 2 cm (2) 4 cm (3) 6 cm (4) 12 cm
88.	A concave mirror of focal length f in vacuum is placed in a medium of refractive index 2. It's focal length in the medium is : (1) f/2 (2) f (3) 2f (4) 4f
89.	In the phenomenon of diffraction of light, when blue light is used in the experiment instead of red light, then : (1) fringes will become narrower (2) fringes will become broader (3) no change in fringe width (4) none of these
90.	The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n) is : (1) $\sin^{-1}(n)$ (2) $\sin^{-1}\left(\frac{1}{n}\right)$ (3) $\tan^{-1}\left(\frac{1}{n}\right)$ (4) $\tan^{-1}(n)$

Question No.	Questions
91.	The nature of series $1+\frac{3}{4}+\frac{9}{16}+\frac{27}{64}+-----\infty$ is : (1) convergent (2) divergent (3) oscillatory (4) none of these
92.	Laplace transform of t sin at is (1) $\frac{2as}{(s^2+a^2)^2}$ (2) $\frac{2a}{(s^2+a^2)^2}$ (3) $\frac{2s}{(s^2+a^2)^2}$ (4) $\frac{a}{(s^2+a^2)^2}$
93.	The polynomial $2x^2+x+3$ in terms of Legendre polynomial is : (1) $\frac{1}{3}(4P_2-3P_1+11P_0)$ (2) $\frac{1}{3}(4P_2+3P_1-11P_0)$ (3) $\frac{1}{3}(4P_2+3P_1+11P_0)$ (4) $\frac{1}{3}(4P_2-3P_1-11P_0)$
94.	$J_3(x)$ can be written in terms of $J_0(x)$ as : (1) $(8x^2+1)\ J_1-4x^{-1}J_0$ (2) $(8x^2-1)\ J_1-4x^{-1}J_0$ (3) $(8x^{-2}-1)\ J_1-4x^{-1}J_0$ (4) $(8x^{-2}+1)\ J_1+4x^{-1}J_0$
95.	The path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a : (1) sphere (2) sigmoid (3) cycloid (4) catenary of revolution

Question No.	Questions
96.	The period of oscillation for compound pendulum is : (1) $2\pi\sqrt{\frac{(k^2+\ell^2)}{g\ell}}$ (2) $2\pi\sqrt{\frac{g\ell}{(k^2+\ell^2)}}$ (3) $2\pi\sqrt{\frac{(k^2+\ell^2)}{mg\ell}}$ (4) $2\pi\sqrt{\frac{mg\ell}{(k^2+\ell^2)}}$
97.	Lagrange's equation of motion are second order equations. The degrees of freedom for this are : (1) 2n (2) 2n –1 (3) 2n + 1 (4) 2n + 2
98.	Constraint in the case of a rigid body is : (1) Dynamic constraint (2) Seleronomous constraint (3) Rheonomous constraint (4) Static constraint
99.	The equation of motion for a small particle of mass m at position x is $m\ddot{x} + r\dot{x} - mg = 0$. Assuming initial speed to be v_0, the terminal speed of particle will be : (1) $\frac{mg}{r}$ (2) $\sqrt{v_0 + 2gx}$ (3) $v_0 + gt$ (4) $\frac{mg}{r^2 t}$

Question No.	Questions
100.	The generalised velocity coordinate (q_k) of a classical system with Lagrangian (L) is said to be cyclic if : (1) $\frac{\partial L}{\partial q_k} = q_k^\circ$ (2) $\frac{\partial L}{\partial q_k} = \frac{d}{dt}\left(\frac{\partial L}{\partial q_k^\circ}\right)$ (3) $\frac{\partial L}{\partial q_k} = 0$ (4) $\frac{\partial L}{\partial q_k^\circ} = 0$

SET–"X"

(DO NOT OPEN THIS QUESTION BOOKLET BEFORE TIME OR UNTIL YOU ARE ASKED TO DO SO)

(MPH/PHD/URS–EE–2020)

PHYSICS

Code **D**

Sr. No. 10012

Time : 1¼ Hours **Total Questions : 100** **Max. Marks : 100**

Roll No. _____ (in figure) _____ (in words)

Name : _____ Father's Name : _____

Mother's Name : _____ Date of Examination : _____

(Signature of the candidate) (Signature of the Invigilator)

CANDIDATES MUST READ THE FOLLOWING INFORMATION/ INSTRUCTIONS BEFORE STARTING THE QUESTION PAPER.

1. **All questions are compulsory.**
2. The candidates must return the Question book-let as well as OMR answer-sheet to the Invigilator concerned before leaving the Examination Hall, failing which a case of use of unfair-means / mis-behaviour will be registered against him / her, in addition to lodging of an FIR with the police. Further the answer-sheet of such a candidate will not be evaluated.
3. Keeping in view the transparency of the examination system, carbonless OMR Sheet is provided to the candidate so that a copy of OMR Sheet may be kept by the candidate.
4. Question Booklet along with answer key of all the A,B,C and D code will be got uploaded on the university website after the conduct of Entrance Examination. In case there is any discrepancy in the Question Booklet/Answer Key, the same may be brought to the notice of the Controller of Examination in writing/through E-Mail within 24 hours of uploading the same on the University Website. Thereafter, no complaint in any case, will be considered.
5. The candidate MUST NOT do any rough work or writing in the OMR Answer-Sheet. Rough work, if any, may be done in the question book-let itself. Answers MUST NOT be ticked in the Question book-let.
6. **There will be no negative marking. Each correct answer will be awarded one full mark. Cutting, erasing, overwriting and more than one answer in OMR Answer-Sheet will be treated as incorrect answer.**
7. Use only Black or Blue BALL POINT PEN of good quality in the OMR Answer-Sheet.
8. BEFORE ANSWERING THE QUESTIONS, THE CANDIDATES SHOULD ENSURE THAT THEY HAVE BEEN SUPPLIED CORRECT AND COMPLETE BOOK-LET. COMPLAINTS, IF ANY, REGARDING MISPRINTING ETC. WILL NOT BE ENTERTAINED 30 MINUTES AFTER STARTING OF THE EXAMINATION.

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Question No.	Questions
1.	The function $\frac{1}{\sqrt{2}}[\alpha(1)\,\beta(2) - \alpha(2)\,\beta(1)]$ represent a state in which : (1) $S = 1, m_s = 1$ (2) $S = 1, m_s = -1$ (3) $S = 1, m_s = 0$ (4) $S = 0, m_s = 0$
2.	Which of the following is an eigen function of L_z ? (1) $\cos\phi$ (2) $\sin\phi$ (3) $\exp(i\phi)$ (4) $\cos^2\phi$
3.	A circular current carrying coil has a radius R. The distance from the centre of the coil on the axis where magnetic induction will be $\frac{1}{8}$th of it's value at the centre of coil is : (1) $R/\sqrt{3}$ (2) $R.\sqrt{3}$ (3) $2R.\sqrt{3}$ (4) 4R
4.	A long straight wire carrying current of 30 A is placed in a external magnetic field of induction 4×10^{-4} T. The magnetic field is acting parallel to the direction of current. The magnitude of the resultant magnetic induction at a point 2.0 cm away from the wire is : (1) 10^{-4} T (2) 3×10^{-4} T (3) 5×10^{-4} T (4) 4.6×10^{-4} T

Question No.	Questions
5.	The magnetic field at the point of intersection of diagonals of a square wire loop of side L, carrying a current I is : (1) $\frac{\mu_0 I}{\pi L}$ (2) $\frac{2\mu_0 I}{\pi L}$ (3) $\sqrt{2}\,\frac{\mu_0 I}{\pi L}$ (4) $2\sqrt{2}\,\frac{\mu_0 I}{\pi L}$
6.	If the electric field is given by $\vec{E} = 5\hat{i} + 4\hat{j} + 9\hat{k}$, the electric flux through a surface of area 20 unit lying in the yz plane will be : (1) 100 unit (2) 80 unit (3) 180 unit (4) 20 unit
7.	A point object is placed at the centre of a glass sphere of radius 6 cm and refractive index 1.5. The distance of the virtual image from the surface of sphere is : (1) 2 cm (2) 4 cm (3) 6 cm (4) 12 cm
8.	A concave mirror of focal length f in vacuum is placed in a medium of refractive index 2. It's focal length in the medium is : (1) f/2 (2) f (3) 2f (4) 4f

Question No.	Questions
9.	In the phenomenon of diffraction of light, when blue light is used in the experiment instead of red light, then : (1) fringes will become narrower (2) fringes will become broader (3) no change in fringe width (4) none of these
10.	The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n) is : (1) $\sin^{-1}(n)$ (2) $\sin^{-1}\left(\frac{1}{n}\right)$ (3) $\tan^{-1}\left(\frac{1}{n}\right)$ (4) $\tan^{-1}(n)$
11.	Weak nuclear forces act on : (1) both hadrons and leptons (2) hadrons only (3) all particles (4) all charged particles
12.	An admissible potential between the proton and neutron in a deutron is : (1) coulomb (2) harmonic oscillator (3) finite square well (4) infinite square well

Question No.	Questions
13.	From meson field theory the potential energy of interaction between two nucleons is proportional to : (1) $\frac{e^{-\mu r}}{r^2}$ (2) $\frac{e^{-\mu r}}{r}$ (3) $\frac{e^{-\mu r}}{r}$ (4) $\frac{e^{-\mu r^2}}{r}$
14.	Nuclei which are β emitters lie : (1) below the line of β–stability (2) on the line of β–stability (3) above the line of β–stability (4) below the N = Z line
15.	Primary cosmic rays are composed of very energetic (1) electrons (2) mesons (3) protons (4) neutrons
16.	The ratio of the nuclear radii of elements with mass number 216 and 125 is : (1) 216 : 125 (2) 1 : 1 (3) 6 : 5 (4) 125 : 216
17.	A free neutron decays spontaneously into : (1) a proton, an electron and an anti-neutrino (2) a proton, an electron and a neutrino (3) a proton and an electron (4) a proton, an electron, a neutrino and an anti-neutrino

Question No.	Questions
18.	The mean momentum of a nucleon in nucleus with mass number A varies as : (1) A (2) A^2 (3) $A^{\frac{-2}{3}}$ (4) $A^{\frac{-1}{3}}$
19.	Nuclear forces are : (1) spin dependent and have no non-central part (2) spin dependent and have a non-central part (3) spin independent and have no non-central part (4) spin independent and have a non-central part
20.	The input in carbon-nitrogen cycle is : (1) four protons (2) four protons and two electrons (3) two protons and two electrons (4) two carbon nuclei, four nitrogen nuclei and an oxygen nucleus
21.	Op–Amp when used as voltage follower has : (1) closed loop voltage gain of unity (2) open loop voltage gain of unity (3) closed loop bandwidth infinity (4) open loop bandwidth infinity

Question No.	Questions
22.	In a class A push-pull amplifier, load R_L is connected to the secondary of output transformer. It's effective value as seen by device is : (1) R_L (2) $\frac{R_L}{2}$ (3) $\frac{R_L}{4}$ (4) $2R_L$
23.	A microprocessor trainer uses : (1) binary number code (2) hexadecimal number code (3) decimal number code (4) octal number code
24.	A diode that has a negative characteristic is the : (1) Schottky diode (2) Tunnel diode (3) Laser diode (4) Hot carrier cathode
25.	The MOSFET switch in it's on–state may be considered equivalent to : (1) Resistor (2) Inductor (3) Capacitor (4) Battery
26.	In a microprocessor, the resistor which holds the address of the next instruction to be fetched is : (1) accumulator (2) program counter (3) stack counter (4) instructor register

Question No.	Questions
27.	In a 4–bit weighted–resistor D/A converter, the resistor value corresponding to MSB is 2 kΩ. The resistor value corresponding to LSB will be : (1) 1 kΩ (2) 2 kΩ (3) 4 kΩ (4) 16 kΩ
28.	Absolute encoders are used where : (1) fast varying signals are not used (2) when position data is to be recovered (3) transient noise can be tolerated (4) all of these
29.	A linear displacement transducer (digital) normally uses : (1) straight binary code (2) BCD (3) Gray code (4) hexadecimal code
30.	The D_1 and D_2 lines of sodium atom will split on application of a weak magnetic field into : (1) 4 and 6 lines (2) 3 lines each (3) 6 and 4 lines (4) 6 lines each
31.	The nature of series $1+\frac{3}{4}+\frac{9}{16}+\frac{27}{64}+\text{------}\infty$ is : (1) convergent (2) divergent (3) oscillatory (4) none of these

Question No.	Questions
32.	Laplace transform of t sin at is (1) $\frac{2as}{(s^2+a^2)^2}$ (2) $\frac{2a}{(s^2+a^2)^2}$ (3) $\frac{2s}{(s^2+a^2)^2}$ (4) $\frac{a}{(s^2+a^2)^2}$
33.	The polynomial $2x^2+x+3$ in terms of Legendre polynomial is : (1) $\frac{1}{3}(4P_2-3P_1+11P_0)$ (2) $\frac{1}{3}(4P_2+3P_1-11P_0)$ (3) $\frac{1}{3}(4P_2+3P_1+11P_0)$ (4) $\frac{1}{3}(4P_2-3P_1-11P_0)$
34.	$J_3(x)$ can be written in terms of $J_0(x)$ as : (1) $(8x^2+1)\ J_1-4x^{-1}J_0$ (2) $(8x^2-1)\ J_1-4x^{-1}J_0$ (3) $(8x^{-2}-1)\ J_1-4x^{-1}J_0$ (4) $(8x^{-2}+1)\ J_1+4x^{-1}J_0$
35.	The path followed by a particle in sliding from one point to another in the absence of friction in the shortest time is a : (1) sphere (2) sigmoid (3) cycloid (4) catenary of revolution
36.	The period of oscillation for compound pendulum is : (1) $2\pi\sqrt{\frac{(k^2+\ell^2)}{g\ell}}$ (2) $2\pi\sqrt{\frac{g\ell}{(k^2+\ell^2)}}$ (3) $2\pi\sqrt{\frac{(k^2+\ell^2)}{mg\ell}}$ (4) $2\pi\sqrt{\frac{mg\ell}{(k^2+\ell^2)}}$

Question No.	Questions
37.	Lagrange's equation of motion are second order equations. The degrees of freedom for this are : (1) $2n$ (2) $2n-1$ (3) $2n+1$ (4) $2n+2$
38.	Constraint in the case of a rigid body is : (1) Dynamic constraint (2) Seleronomous constraint (3) Rheonomous constraint (4) Static constraint
39.	The equation of motion for a small particle of mass m at position x is $m\ddot{x} + r\dot{x} - mg = 0$. Assuming initial speed to be v_0, the terminal speed of particle will be : (1) $\frac{mg}{r}$ (2) $\sqrt{v_0 + 2gx}$ (3) $v_0 + gt$ (4) $\frac{mg}{r^2 t}$
40.	The generalised velocity coordinate (q_k) of a classical system with Lagrangian (L) is said to be cyclic if : (1) $\frac{\partial L}{\partial q_k} = q_k^{\circ}$ (2) $\frac{\partial L}{\partial q_k} = \frac{d}{dt}\left(\frac{\partial L}{\partial q_k^{\circ}}\right)$ (3) $\frac{\partial L}{\partial q_k} = 0$ (4) $\frac{\partial L}{\partial q_k^{\circ}} = 0$

Question No.	Questions
41.	The Einstein relationship between the diffusion constant (D_n) and mobility (μ_n) for electron is : 1) $\frac{D_n}{\mu_n} = \frac{2k_B T}{e}$ (2) $\frac{D_n}{\mu_n} = \frac{e}{k_B T}$ (3) $\frac{D_n}{\mu_n} = \frac{k_B T}{e}$ (4) $\frac{D_n}{\mu_n} = k_B T - e$
42.	Cooper pair follows : (1) Bose-Einstein statistics (2) Fermi-Dirac statistics (3) Maxwell-Boltzmann statistics (4) None of these
43.	The density of carriers in a pure semiconductor is proportional to : (1) $\exp(-E_g / k_B T)$ (2) $\exp(-2E_g / k_B T)$ (3) $\exp(-E_g / k_B T^2)$ (4) $\exp(-E_g / 2k_B T)$
44.	Point defects in crystals can not be produced by : (1) elastic deformation (2) quenching from high temperature (3) plastic deformation (4) irradiation with X-rays

Question No.	Questions
45.	In a simple cubic lattice $d_{100} : d_{110} : d_{111}$ is : (1) 6 : 3 : 2 (2) 6 : 3 : $\sqrt{2}$ (3) $\sqrt{6} : \sqrt{3} : \sqrt{2}$ (4) $\sqrt{6} : \sqrt{3} : \sqrt{4}$
46.	In simple metals the phonon contribution to the electrical resistivity at temperature T is : (1) directly proportional to T above Debye temperature and to T^3 below it . (2) inversely proportional to T for all temperatures. (3) independent of T for all temperatures. (4) directly proportional to T above Debye temperature and to T^5 below it.
47.	The crystal lattice is a lattice in real ordinary space but the reciprocal lattice is a lattice in a : (1) Gaussian space (2) Laplacian space (3) Fourier space (4) Hypothetical space
48.	The packing factor of diamond cubic crystal structure is : (1) 60 % (2) 56 % (3) 90 % (4) none of these

Question No.	Questions
49.	In Debye's theory of specific heat of solids, the frequency of the lattice vibration has : (1) a fixed value (2) some discrete values (3) a continuous spectrum upto a finite value (4) a continuous spectrum upto infinity
50.	At lower temperature the lattice specific heat varies as : (1) T^3 (2) $\frac{1}{T^3}$ (3) T (4) $\frac{1}{T}$
51.	In a dielectric the polarization is : (1) linear function of applied field (2) square function of applied field (3) exponential function of applied field (4) logarithmic function of applied field
52.	In a Fresnel biprism experiment the two positions of lens give separation between the slits as 16 cm and 9 cm respectively. The actual distance of separation is : (1) 12.5 cm (2) 12 cm (3) 7.5 cm (4) 15 cm

Question No.	Questions
53.	Two solenoids of equal number of turns have their lengths and radii. in the same ratio 1:2. The ratio of their self inductances will be : (1) 1:2 (2) 2:1 (3) 1:1 (4) 1:4
54.	The power radiated by an electric dipole is proportional to the frequency given by : (1) W (2) W^2 (3) W^3 (4) W^4
55.	At the interface of two non-conducting medium the formula for reflection coefficient for normal incidence is given by : (1) $\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2$ (2) $\frac{4n_1 \cdot n_2}{(n_2 + n_1)^2}$ (3) $\frac{2n_1\ n_2}{(n_2 + n_1)^2}$ (4) None of these
56.	The sinusoidally time varying vector field $\vec{F} = 2\cos(wt + 30°)\,\hat{a}_x + 2\cos(wt - 30°)\,\hat{a}_y$ is : (1) elliptically polarized (2) circularly polarized (3) linearly polarized (4) unpolarized

Question No.	Questions
57.	An air filled rectangular waveguide has dimensions 6 cm×4 cm. The cut-off frequency for TE_{10} is : (1) 2.5 GHz (2) 25 GHz (3) 25 MHz (4) 5 GHz
58.	The length of Hydrogen-Hydrogen bond is : (1) 0.074 nm (2) 0.01 nm (3) 0.037 nm (4) 2 nm
59.	Transition temperature (T_C) and critical field (H_C) for a superconductor are related as : (1) $H_C = H_o(T_C - 1)$ (2) $H_C = H_o(T_C + 1)$ (3) $T_C = T_o\left[1-\left(\frac{H_o}{H_C}\right)^2\right]$ (4) $H_C = H_o\left[1-\left(\frac{T}{T_C}\right)^2\right]$
60.	The favourable condition both for superconductivity and high resistance is : (1) a weak electron-phonon interaction (2) a strong electron-phonon interaction (3) a weak phonon-phonon interaction (4) a strong phonon-phonon interaction
61.	$\nabla\left(\frac{\hat{r}}{r^3}\right)$ is equal to : (1) 0 (2) r^3 (3) r^2 (4) r

Question No.	Questions
62.	If the vectors $\vec{A} = 2\hat{i}-\hat{j}+\hat{k}$, $\vec{B} = \hat{i}+2\hat{j}+3\hat{k}$ and $\vec{C} = 3\hat{i}+a\hat{j}+5\hat{k}$ are coplanar, then the value of a will be (1) 4 (2) -4 (3) 2 (4) -2
63.	The rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \end{bmatrix}$ is : (1) 0 (2) 1 (3) 2 (4) 3
64.	The integral of $\bar{z}$ along upper half of the circle $\lvert z \rvert = 1$ from $z = -1$ to $z = 1$ is : (1) $-i\pi$ (2) $i\pi$ (3) $2\pi i$ (4) $-2\pi i$
65.	The Cauchy–Riemann equation in polar form is given as : (1) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ (2) $\frac{\partial u}{\partial r} = \frac{r\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (3) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$ (4) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}$ and $\frac{1}{r}\frac{\partial u}{\partial \theta} = \frac{-\partial v}{\partial r}$

Question No.	Questions
66.	The trace of 3×3 matrix is 2. Two of it's eigen values are 1 and 2. The third eigen value is : (1) –1 (2) 0 (3) 1 (4) 2
67.	Residue of $f(z)=\frac{z^3}{(z-1)^4(z-2)(z-3)}$ at z = 3 is : (1) $\frac{101}{16}$ (2) –8 (3) $\frac{27}{16}$ (4) 0
68.	The differential equation $x^2\frac{d^2y}{dx^2}+x.\frac{dy}{dx}+y=x$ is : (1) linear (2) homogeneous (3) homogeneous linear (4) none of these
69.	Solution of the differential equation $(x-y^2)\,dx + 2xy\,dy = 0$ is : (1) $y\exp\left(\frac{y^2}{x}\right)=A$ (2) $x\exp\left(\frac{y^2}{x}\right)=A$ (3) $y\exp\left(\frac{x}{y^2}\right)=A$ (4) $x\exp\left(\frac{x}{y^2}\right)=A$
70.	Which one of the following is fensor of order zero ? (1) $\vec{A}+\vec{B}$ (2) $\vec{A}-\vec{B}$ (3) $\vec{A}\bullet\vec{B}$ (4) $\vec{A}\times\vec{B}$

Question No.	Questions
71.	The Jacobi's form of the least action principle is : (1) $\Delta \int \sqrt{2[H-V(q)]}.d\rho = 0$ (2) $\Delta \int \sqrt{2[H+V(q)]}.d\rho = 0$ (3) $\Delta \int \sqrt{2[L-V(q)]}.d\rho = 0$ (4) $\Delta \int \sqrt{2[L+V(q)]}.d\rho = 0$
72.	In the case of elliptical orbits under the influence of a central force, the total energy depends on: (1) major axis (2) minor axis (3) both minor and major axis (4) neither of the above two
73.	Which of the following quantities is Lorentz invariant ? (1) $\lvert E \times B \rvert^2$ (2) $\lvert E \rvert^2 - \lvert B \rvert^2$ (3) $\lvert E \rvert^2 + \lvert B \rvert^2$ (4) $\lvert E \rvert^2 \bullet \lvert B \rvert^2$
74.	Hamiltons principle function S and the Hamiltons characteristic function W for conservative system with energy E and time t, are related as : (1) $S = W$ (2) $S = W - Et$ (3) $S = W + Et$ (4) S is not related to W
75.	Which one of the following is a first order phase transition ? (1) vaporization of a liquid at it's boiling point (2) ferromagnetic to paramagnetic (3) normal liquid He to super fluid He (4) superconductivity to normal state

Question No.	Questions
76.	The dimension of phase space of ten rigid diatomic molecules is : (1) 5 (2) 10 (3) 50 (4) 100
77.	In the process of phase transition : (1) Gibb's potential function remains constant (2) only entropy remains constant (3) only volume remains constant (4) only temperature remains constant
78.	In a canonical ensemble : (1) the energy and the temperature are constants (2) the energy and the entropy are constants (3) the temperature and the density are constants (4) the entropy and the density are constants
79.	The capacitance of a varactor diode can be varied by : (1) varying it's temperature (2) varying it's forward bias (3) varying it's reverse bias (4) varying it's doping level

Question No.	Questions
80.	In a full wave rectifier having R-L filter, the value of inductor is 2H and load is 1kΩ. If input frequency is 60 Hz, ripple factor is : (1) 50 % (2) 63 % (3) 33 % (4) 21 %
81.	For a Gaussian Wave packet described by $\psi(x) = A \exp\left(\frac{-x^2}{a^2}\right)$, the expectation value of the momentum operator is : (1) 0 (2) undefined (3) + a (4) − a
82.	The degeneracy of the n=2 level for a three dimensional harmonic oscillator is : (1) 4 (2) 6 (3) 8 (4) 10
83.	Value of $[L_x, r^2]$ is : (1) $i\hbar y$ (2) $i\hbar p_y$ (3) $-i\hbar x$ (4) 0
84.	Which of the following is not a Fermion ? (1) electron (2) muon (3) neutron (4) photon

Question No.	Questions
85.	In partial wave analysis, the expression for total cross-section of scattering is : (1) $\frac{4\pi}{k^2}\sum_{\ell}(2\ell+1)\sin^2\delta_e$ (2) $4\pi\sum_{\ell}(2\ell+1)\sin^2\delta_e$ (3) $\frac{2\pi}{k^2}\sum_{\ell}(2\ell+1)P_\ell^2(\cos\theta)$ (4) $2\pi k^2\sum_{\ell}(2\ell+1)P_\ell^2(\cos\theta)$
86.	The energy of free electrons in the state (1, 2, 1) in a rectangular box of sides $a = b \neq c$ is : (1) $\frac{h^2}{8m}\left[\frac{5}{a^2}+\frac{1}{c^2}\right]$ (2) $\frac{8m}{h^2}\left[\frac{1}{a^2}+\frac{1}{c^2}\right]$ (3) $\frac{h^2}{8m}\left[\frac{3}{a^2}+\frac{1}{c^2}\right]$ (4) None of these
87.	The eigen functions of the operator $\frac{d^2}{dx^2}$ which vanishes at $x = 0$ and $x = L$ (A is constant and n is an integer) are : (1) $A\sin\left(\frac{n\pi}{\ell}x\right)$ (2) $A\cos\left(\frac{n\pi}{\ell}x\right)$ (3) $A\,x\,(\ell-x)$ (4) $A\exp\left(\frac{-n\pi}{\ell}x\right)$
88.	Selection rules for the electric dipole transitions are : (1) $\Delta\ell = 0, \pm1$, $\Delta m = 0$ (2) $\Delta\ell = 0, \pm1$, $\Delta m = 0, \pm1$ (3) $\Delta\ell = \pm1$, $\Delta m = 0, \pm1$ (4) $\Delta\ell = \pm1$, $\Delta m = \pm1$

Question No.	Questions
89.	The radial part of the waveform for the hydrogen atom is expressed in terms of : (1) Laguerre polynomial (2) Hermite polynomial (3) Legendre polynomial (4) Associated Laguerre polynomial
90.	The expression $\psi = \exp(ikr) - \frac{m}{2\pi\hbar}\int G(r,r')\,V(r').\exp(ikr')\,dr.$ is called : (1) first Born approximation (2) first WKB approximation (3) Green's approximation (4) none of these
91.	For a diatomic molecule the frequency of rotation(υ) can be related with rotational quantum number (J) and rotational constant (B) as : (1) $\upsilon = 2B(J+1)$ (2) $\upsilon = 3B(J+1)$ (3) $\upsilon = 2B(J^2+1)$ (4) $\upsilon = 4B(J-1)$
92.	In the Raman spectra, the molecule must undergo change in it's : (1) polarizability (2) shape (3) temperature (4) bonding
93.	As the temperature is increased the intensity of an anti-Stoke's Raman line : (1) increases (2) decreases (3) remain unchanged (4) increase and decrease depending upon the mode of vibration.

Question No.	Questions
94.	The spectrum in which energy levels are equally spaced is : (1) vibrational spectra (2) rotational spectra (3) electronic spectra (4) vibrational-rotational spectra
95.	The value of Lande g factor for a fine structure level defined by the quantum numbers L =1, J =2 and S =1 is : (1) $\frac{11}{6}$ (2) $\frac{3}{2}$ (3) $\frac{5}{2}$ (4) $\frac{7}{2}$
96.	The exciting line in an experiment is 5460 A^o and Stoke's line is at 5520 A^o. The wavelength of anti-Stoke's line is : (1) 5200 A^o (2) 4200 A^o (3) 5401 A^o (4) 5308 A^o
97.	Helium-Neon laser is a : (1) single level laser (2) two level laser (3) three level laser (4) four level laser
98.	In a Ruby laser, Ruby crystal is made of : (1) aluminium oxide with small percentage of chromium oxide (2) chromium oxide with small percentage of aluminium oxide (3) manganese oxide with small percentage of chromium oxide (4) aluminium oxide with small percentage of manganese oxide

Question No.	Questions
99.	In the Zeeman effect, the light emitted along and perpendicular to the applied magnetic field are respectively : (1) linearly and circularly polarized (2) circularly and linearly polarized (3) both linearly polarized (4) both circularly polarized
100.	The quadruple moment of the nucleus is : (1) tensor (2) scalar (3) vector (4) none of these

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Answer Key

Sr. No.	Code A	Code B	Code C	Code D
1	1	1	1	4
2	2	3	2	3
3	4	2	3	2
4	4	2	1	3
5	1	3	3	4
6	1	2	1	1
7	1	4	3	3
8	3	4	3	2
9	1	3	2	1
10	1	1	3	4
11	4	1	1	1
12	3	1	2	3
13	2	3	1	2
14	3	3	4	1
15	4	3	1	3
16	1	1	1	3
17	3	3	1	1
18	2	2	1	4
19	1	1	4	2
20	4	3	2	1
21	1	3	1	1
22	2	1	2	3
23	1	4	4	2
24	4	1	4	2
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26	1	4	1	2
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35	3	4	2	3
36	4	1	3	1
37	3	3	4	3
38	4	2	1	2
39	3	1	2	1
40	1	4	1	3
41	1	1	1	3
42	2	3	1	1
43	3	2	1	4
44	1	1	2	1
45	3	3	1	3
46	1	3	4	4
47	3	1	1	3
48	3	4	3	4
49	2	2	3	3
50	3	1	3	1

Sr. No.	Code A	Code B	Code C	Code D
51	1	1	3	1
52	1	1	1	2
53	3	1	4	1
54	3	2	1	4
55	3	1	3	1
56	1	4	4	1
57	3	1	3	1
58	2	3	4	1
59	1	3	3	4
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65	1	2	3	3
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83	2	1	2	4
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85	2	1	4	1
86	3	1	1	1
87	4	1	3	1
88	1	1	2	3
89	2	4	1	1
90	1	2	4	1
91	1	1	1	1
92	3	2	1	1
93	2	4	3	2
94	1	4	3	2
95	3	1	3	2
96	3	1	1	3
97	1	1	3	4
98	4	3	2	1
99	2	1	1	2
100	1	1	3	1