Examination: **Ph.D Physics**

SECTION 1 - SECTION 1

Question No.1

If the electric flux of a electric field through a closed surface S due to a system of charges is **non-zero**, then which of the following is a correct state

- The surface charge on the sphere must be zero everyhere on the sphere;
- The electric field itself must zero everywhere outside the surface.
- The electric field itself must zero everywhere inside the surface.
- The net charge inside the sphere must not be zero.

Question No.2

If a laser light of wavelength 532 nm is sent through water which has a vibrational mode at 3400 cm^{-1}, the first Stokes and anti-Stokes lines will be respectively at

- 650 nm and 450 nm
- 635 nm and 459 nm
- 683 nm and 436 nm
- 730 nm and 355 nm

Question No.3

A linear operator T on the real vector space R^3 in three dimensions is defined by

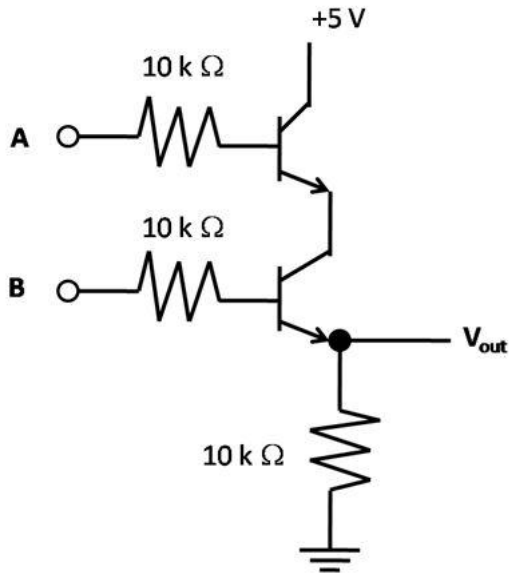
$$\begin{aligned} T(1,1,0) &= (2,5,3) \\ T(1,0,1) &= (5,2,3) \\ T(0,1,1) &= (3,-3,0) \end{aligned}$$

Then $T(1,1,1)$ is given by

- (3, 5, 2)
- (5, 2, 3)
- (5, 3, 2)
- (2, 3, 5)

Question No.4

For the circuit shown below Vout= 5 V, if _____



- A= +5 V and B= +5 V
- A= 0 V and B= 0 V
- A= - 5 V and B= +5 V
- A= 0 V and B= +5 V

Question No.5

The AC output V_{out} of an Op-Amp (between collector to GND), if A= 1000, $V_{non\text{-}inverting}$= 3 mV and $V_{inverting}$= 2 mV is

- 15V
- 1 V
- 10V
- 5 V

Question No.6

Multiplicity function of a 1-D quantum harmonic oscillator is

- $\frac{(N+n-1)!}{(N-1)!}$
- $\frac{(N+n-1)!}{N!}$
- $\frac{(N+n-1)!}{n!}$
- $\frac{(N+n-1)!}{n!(N-1)!}$

Question No.7

Which of the following methods converges quickly to the solution, while finding the roots of equations of the form f(x) = 0.

- The Bisection method
- Newton – Raphson method
- The iteration method
- The method of false position

Question No.8

A plane in a cubic lattice makes intercepts of a, a/2 and 2a/3 with the three crystallographic axes, respectively. The Miller indices for this plane are:

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

Question No.9

The energy contained in a small volume through electromagnetic wave is passing oscillates with

- double the frequency of the wave
- the frequency of the wave
- zero frequency
- half the frequency of the wave

Question No.10

How many normal modes of vibration are possible for SO_2 and CH_3I respectively?

- 4 and 7
- 3 and 9
- 4 and 6
- 6 and 7

Question No.11

The specific heat of a two dimensional solid at low temperature according to Debye theory varies with temperature as

- T^4
- T^2
- T
- T^3

Question No.12

The Fourier transform

$$F(\omega) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(x) e^{-i\omega x} dx$$

of $f(x) = \exp(-2|x|)$ is given by

- $\frac{1}{\sqrt{2\pi}} \frac{2i\omega}{4+\omega^2}$
- $\frac{1}{\sqrt{2\pi}} \frac{4}{\omega^2-4}$
- $\frac{1}{\sqrt{2\pi}} \frac{2i\omega}{4-\omega^2}$
- $\frac{1}{\sqrt{2\pi}} \frac{4}{4+\omega^2}$

Question No.13

Logarithm of the pressure of a degenerate ideal Fermi gas at T=0K, versus logarithm of the number density n is plotted. It is a straight line, the slop line is

- 1/3
- 3/2
- 2/3
- 5/3

Question No.14

For an atomic nucleus with atomic number Z and mass number A, which of the following is (are) correct?

- β-decay occurs when the proton to neutron ratio is large, but not when it is small
- Nuclei with Z > 83 and A >209 emit α -radiation
- The surface contribution to the binding energy is proportional to $A^{2/3}$
- Nuclear matter and nuclear charge are distributed identically in the nuclear volume

Question No.15

Which one of the following defines scalar products on complex vector space in three dimensions

- $(x,y) = 3x_1^* x_1 - x_1 y_2 + x_2^* y_1 + 3x_2^* y_2$
- $(x,y) = x_1^* y_1 + x_2 y_2 + x_3^* y_3$
- $(x,y) = x_1^* y_1 + 2x_2^* y_2 + x_3^* y_3$
- $(x,y) = x_1^* y_1 - 2x_2^* y_2 + x_3^* y_3$

Question No.16

The first excited state of the He atom lies at an energy 19.82 eV above the ground state. If this excited state is three-fold degenerate while the grou is non-degenerate, find the relative populations of the first excited state and the ground state for helium gas in thermal equilibrium at 10,000 K. Wh following numbers is closest to the correct answer?

- 3.1×10^{-10}
- 1.04×10^{-11}
- 1.04×10^{-10}
- 3.1×10^{-9}

Question No.17

The dimension of the Schrodinger wave function of a particle in three space dimensions is

- L^3T
- $TM^{3/2}$
- L^{-3}
- $L^{-3/2}$

Question No.18

The Laurent series expansion of $\frac{1}{(\sin z)(4+z^4)}$ in powers of $z-1$ converges

- all $|z-1| < \pi - 1$
- all complex z
- for all real z only
- all $|z-1| < 1$

Question No.19

If the stiffness constants of elasticity $C_{11} = C_{12} = k$ for a cubic crystal, then bulk modulus is

- k
- 1/k
- 2k/3
- 3k/2

Question No.20

For an electron with $\ell = 2$ the allowed values of $\vec{L} \cdot \vec{S}$ are

- $-\frac{3}{2}, \frac{5}{2}$
- $-\frac{3}{2}, 1$
- $-\frac{3}{4}, \frac{1}{4}$
- $-\frac{2}{4}, \frac{3}{4}$

Question No.21

In stable nuclides up to Z = 20, the n/p ratio

- 1
- >1
- None of these
- <1

Question No.22

For a system with Hamiltonian

$$H = e^{-\gamma t}\left(\frac{p^2}{2m} + \frac{1}{2}kq^2\right)$$

the equation of motion is

- $m\frac{d^2q}{dt^2} + \gamma\frac{dq}{dt} + kq = 0$
- $m\frac{d^2q}{dt^2} + 2\gamma\frac{dq}{dt} + kq = 0$
- $m\frac{d^2q}{dt^2} - 2\gamma\frac{dq}{dt} + kq = 0$
- $m\frac{d^2q}{dt^2} - \gamma\frac{dq}{dt} + kq = 0$

Question No.23

The real and imaginary parts of $\cosh^2 z$ are

- $\frac{1}{2}(1 + \cosh 2x \cos 2y) + \frac{i}{2}\sinh 2x \sin 2y$
-

$\frac{1}{2}(1+\cos 2x\cosh 2y)+\frac{i}{2}\sin 2x\sinh 2y$

$\frac{1}{2}(1+\cos 2x\cosh 2y)-\frac{i}{2}\sin 2x\sinh 2y$

$\frac{1}{2}(1+\cosh 2x\cos 2y)-\frac{i}{2}\sinh 2x\sin 2y$

Question No.24

For electron in an H atom the degeneracy of an energy level with principal quantum number n and angular momentum ℓ is

- $2n^2$
- $2\ell^2$
- $(2\ell + 1)$
- (2n + 1)

Question No.25

A spin half particle is described by the wave function

$$\begin{pmatrix} 3 \\ 7 \end{pmatrix}$$

the ratio of probabilities the the particle will have spin up to the probability that it will have spin down along the $z-$ axis is

- 2/5
- 3/7
- 9/49
- 5/2

Question No.26

For an electron moving in spherically symmetric potential V (r) and a uniform magnetic field along the z- axis, the constants of motion are

- total energy E and only z component of momentum
- total energy E and all components of angular momentum
- total energy E and all components of momentum
- total energy E and only z component of angular momentum

Question No.27

Polar coordinate of a particle moving on a planar are $r = (t^4\text{-}2t^3\text{-}2t^2)^{1/3}$, $\theta = \tan^{-1}(1\text{-}t)$, acceleration of a particle at $t = ½$ is

- 2
- 0
- 1
- 1/2

Question No.28

Let q, p be position and momentum operators for a particle in one dimension. Let $Q = aq + bp, P = cq + dp$, then $[Q, P] = i\hbar$ if the matrix

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

- unitary
- is hermitian
- real antisymmetric
- has determinant one

Question No.29

The nearest neighbour distance in the case of body centered cubic structure with side a is

- $\frac{a\sqrt{2}}{2}$

- $\frac{a\sqrt{3}}{2}$
- $\frac{2\,a}{\sqrt{3}}$
- $\frac{2\,a}{\sqrt{2}}$

Question No.30

The set of all possible values of total angular momentum J, when two angular momenta J1 = 1/2, j2 = 2 are added, is

- J = 3/2, 1/2
- J = 3/2
- J= 3/2, 1/2,−1/2,−3/2
- J = 3/2, 1/2, 0,−1/2,−3/2

Question No.31

A series LCR circuit has resonant frequency ω_0 and a large quality factor Q. Its impedan at the half-power points and at sufficiently high frequencies are, respectively

- $R(1\pm i);\ iQR\omega/\omega_0$
- $2R;\ QR\omega/\omega_0$
- $R/2i;\ -iQR\omega_0/\omega$
- $R,\ -QR\omega_0/\omega$

Question No.32

Following the Ehrenfest's theorem $\frac{d\langle p\rangle}{dt} =$

- $\pi/2$
- $\langle -\frac{\partial V}{\partial x}\rangle$
- $\langle \frac{\partial V}{\partial x}\rangle$
- $\langle \frac{dV}{dx}\rangle$

Question No.33

For a distribution of $\rho(x) = (hx)^{-1/2}$ $(0 \le x \le h)$; <x> is

- h
- 2h/3
- h/3
- h/2

Question No.34

In the X-ray diffraction pattern recorded for a simple cubic solid (lattice parameter a = 1Å) using X-rays of wavelength 1 Å .The first order diffractior would appear for the

- (112) planes
- (220) planes

- (100) planes
- (210) planes

Question No.35

A system has energy levels E, 2E, 3E, ..., where the excited states are doubly degenerate. Four non interacting Bosons are placed in this system total energy of these bosons is 5E, the number of microstates is

- 2
- 3
- 4
- 1

Question No.36

A gas containing equal number densities of two isotopes having masses of 349 m_u and 352 m_u is passed through a porous membrane in which the are smaller than the mean free path. How many minimum successive passages through similar membranes would be needed to produce a pure is contaminated by less than 1%?

- 701
- 293
- 1074
- 1273

Question No.37

A particle moves on a plane in such a way that its radial and transverse speeds are always equal and transverse acceleration is zero. Force acting particle varies with radial distance (r) as

- $F \propto \frac{1}{r^2}$
- $F \propto \frac{1}{r^3}$
- $F \propto r$
- $F \propto \frac{1}{r^4}$

Question No.38

The equivalent component of an optical beam splitter with R:T = 50:50 in the microwave domain is

- Directional Coupler
- Magic Tee
- Horn Antenna
- Waveguide

Question No.39

The eigen values of the matrix $\begin{pmatrix} 2 & 0 & -2 \\ -2i & i & 2i \\ 1 & 0 & -1 \end{pmatrix}$ are

- -1, 0, ±i
- 0, -1, -i
- 0, 1, i
- 1, -1, i

Question No.40

Ideal Bose gas exhibits Bose Einstein condensation.
(i) Chemical potential has a lower bound
(ii) Excited state occupancy has an upper bound
(iii) Chemical potential has an upper bound
Which of the above statements are correct?

- (i) and (iii)
- (ii) and (iii)
- (i) and (ii)
- (i), (ii) and (iii)

Question No.41

Which of the following is not a group

- The set of all powers 17^n under multiplication, where n is any integer
- The set of integers under multiplication modulo 17
- The set of all numbers $17^{m/n}$,under multiplication, where m, n are nonzero integers
- The set of 17th roots of unity under multiplication

Question No.42

Which of the following properties of a macroscopic system of N particles cannot be expressed as a dynamical function (a function on 6N dimensior space)?

- Temperature
- Internal energy
- Enthalpy
- Pressure

Question No.43

A particle moves along the curve $x = 2t^2+1$, $y = t^4$, $z = t+5$ where 't' is the time. The component of its velocity at t = 1 in the direction i + j + 3k is

- √14
- √11
- 7
- 3

Question No.44

The ground state energy is to be computed for λx^4 potential using the variation method. A trial wave function which is least suited for this purpose i where N is a constant.

- $\frac{N}{(1+\alpha^2 x^2)}$
- $N\exp(-ax^4+bx^2) \qquad a>0, b>0$
- $N\exp(-ax^4), \qquad a>0$
- $N(x^2-1)\exp(-ax^2)$

Question No.45

For the operator $\hat{Q} \equiv i\frac{d}{d\emptyset}$ where Ø is the usual polar coordinate in two dimensions, the spectrum of this operator is

- Set of all odd integers and non-degenerate
- Set of all integers and degenerate
- Set of all even integers and non-degenerate
- Set of all integers and non-degenerate

Question No.46

Let 'R' be the region in space defined by $4 \leq x^2+y^2+z^2 \leq 9$ and $Z \geq 0$. The value the integral $\iiint (x^2+y^2)\,dV$ is

- 844π/15
- 13/824π
- 824π/15
- 13/844π

Question No.47

The square root of frequency of a spectral line in an X-ray spectrum is proportional to the atomic number of the element emitting it. This statement

- Stark law

- Compton law
- Bragg law
- Mosely law

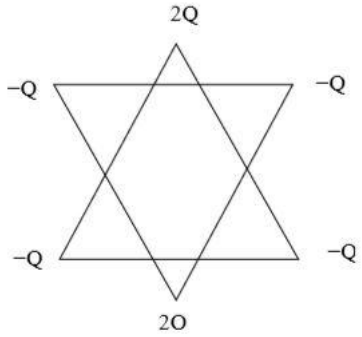
Question No.48

Critical evidence for CP violation first came from experimental data on

- Decay of K mesons into a pion, an electron, and a neutrino;
- Decays of a meson other than K mesons.
- Decay of K mesons into pions;
- Decays of $K^{\pm}$ into $e^{\pm}$ and neutrino;

Question No.49

A set of point charges are arranged on two equilateral triangle as shown in figure. The electrostatic potential at a distance *r* from the centre. for large distance behaves as



Where K is a constant.

- Kr^{-3}
- Kr^{-1}
- Kr^{-2}
- Kr^{-4}

Question No.50

A parallel plate capacitor is made from two plates of area 2000 cm^2 separated by 1 cm. It is charged to a potential difference of 3 kV. When a diele introduced by completely filling the space between them, the voltage dropped to 1 kV. What is the capacitance of the capacitor after the dielectric is introduced?

- 531 pF
- 485 pF
- 107 pF
- 832 pF

Question No.51

The frequency of oscillation of an HCl molecule of dipole moment $3.4X10^{-30}$ C m and moment of inertia $2.7X10^{-47}$ kgm^{-2} oscillating in an electric fi kV/m is

- 8.85 GHz
- 2.20 GHz
- 6.10 GHz
- 4.90 GHz

Question No.52

The relation between the nuclear radius (R) and the mass number (A), given by $R = 1.2\ A^{1/3}$ fm, implies that

- The nuclear force is charge dependent
- The attractive part of the nuclear force has a long range
- The central density of nuclei is independent of A
- The volume energy per nucleon is a constant

Question No.53

The integral

$$\int_{-1}^{1} x^4 P_n(x) dx$$

(where $P_n(x)$ denotes the Legendre polynomial vanishes for all n if

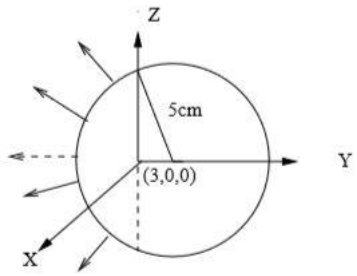
- $n \geq 5$
- $n \leq 3$
- $n = 4$
- $n \leq 4$

Question No.54

A sphere of radius 5cm and center at (3,0,0) is placed in uniform electric field

$$\vec{E} = (3\hat{i} + 4\hat{j} - 5\hat{k})E_0,$$

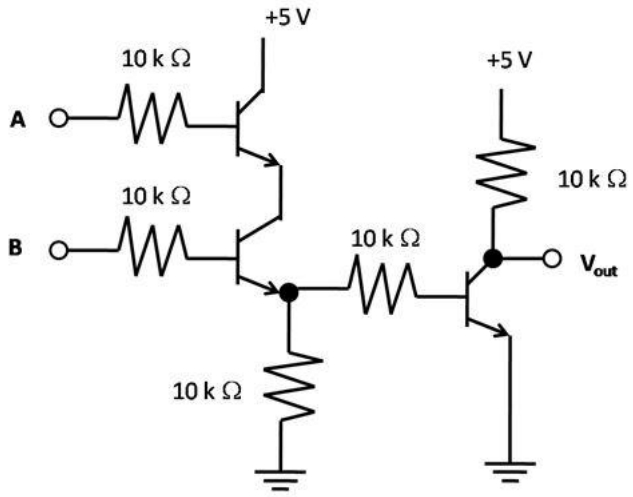
The sphere is cut into two parts by by the $X - Z$ plane, The flux of the electric field through the smaller cap away from the center is



- $100\pi E_0$
- $-64\pi E_0$
- $64\pi E_0$
- $-100\pi E_0$

Question No.55

In the circuit shown below if A=B=+5V, then Vout= _____?



- 5 V
- 2.5 V
- 0 V
- 1.0 V

Question No.56

Which of the following order is obeyed by chemical potentials of an ideal gas obeying Bose (BE), Einstein, Fermi Dirac (FD) and Maxwell Boltzmar statistics respectively at a given small non zero temperature?

- μ(FD) > μ(BE) > μ(MB)
- μ(BE) > μ(FD) > μ(MB)
- μ(MB) > μ(FD) > μ(BE)
- μ(MB) > μ(BE) > μ(FD)

Question No.57

The Fourier series for the function

$$f(x) = \begin{cases} -1, & -\pi \le x \le 0 \\ +1 & 0 < x \le \pi \end{cases}$$

is given by

- $\frac{4}{\pi}\left(\cos x + \frac{\cos 3x}{3} + \frac{\cos 5x}{5} + \ldots\right)$
- $\frac{4}{\pi}\left(\sin x + \frac{\sin 3x}{3} + \frac{\sin 5x}{5} + \ldots\right)$
- $\frac{1}{\pi}\left(\sin x - \frac{\sin 3x}{3} + \frac{\sin 5x}{5} - \ldots\right)$
- $\frac{1}{\pi}\left(\cos x - \frac{\cos 3x}{3} + \frac{\cos 5x}{5} - \ldots\right)$

Question No.58

What is the common mode rejection ratio of a differential amplifier with A= 200 and A_{cm}= 0.5?

- -200
- -100
- -400
- - 2.5 X 10^{-3}

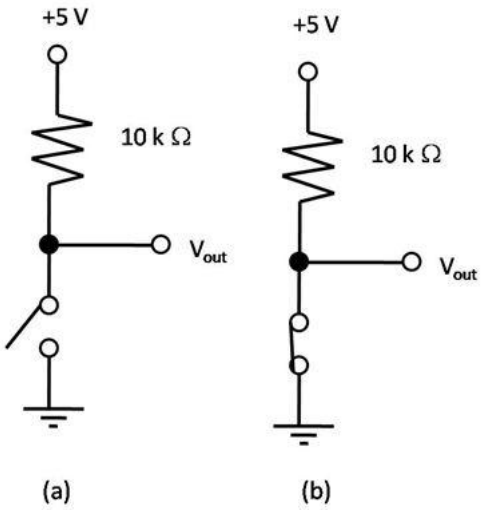
Question No.59

The total energy per particles of a collection of fermions is 1.5 eV. The Fermi energy of the system is

- 2.5 eV
- 3.0 eV
- 1.5 eV
- 5.0 eV

Question No.60

Two switches showing two logic states in figure shown below. Which of the following states are represented by these SWITCHES?



- Switch (a) representing logic 1 and switch (b) representing logic 0
- Switch (a) representing logic 1 and switch (b) also representing logic 1
- Switch (a) representing logic 0 and switch (b) also representing logic 0
- Switch (a) representing logic 0 and switch (b) representing logic 1

Question No.61

Which of the following molecules show both microwave and an infrared spectrum?

- HBr
- H_2
- Br_2
- CS_2

Question No.62

At point $z = 3/2$, the function $\frac{\cos 2\pi z}{(2z-3)^3}$ has

- has a pole of order 3 and the residue is $\frac{\pi^2}{4}$
- has a pole of order 3 and the residue is $4\pi^2$
- has a pole of order 2 and the residue is $\frac{\pi^2}{4}$
- has a pole of order 2 and the residue is $4\pi^2$

Question No.63

Assuming air molecules behaving like an ideal gas at a temperature of 25□C, at what height the atmospheric pressure becomes half of its value at level?

- 11.0 km
- 3.4 km
- 5.5 km
- 9.8 km

Question No.64

A perfectly elastic ball of mass 200g moves with velocity 200cm/s along positive x axis. The ball has an elastic collision with a wall moving with velo 20cm/s in the negative x direction. Assuming the collision to be perfectly elastic, after the collision the ball will rebound back with speed

- 200 cm/s;

- 240 cm/s;
- 180 cm/s.
- 220 cm/sec;

Question No.65

The Lagrangian for a symmetric top, in terms of Euler angles θ, ϕ, ψ is given by

$$L = \frac{1}{2} I_1 \left(\dot{\theta}^2 + \dot{\phi}^2 \sin^2 \theta \right) + \frac{1}{2} I_3 (\dot{\psi} + \dot{\phi} \cos \theta)^2 - mgL \cos \theta.$$

The set of all constants of motion is

where H is the Hamiltonian of the system and p_θ, p_ψ, p_ϕ are canonical momenta conjugate to θ, ψ, ϕ, respectively.

- $H, p_\theta, p_\psi,$ and p_ϕ
- $H, p_\psi,$ and p_ϕ
- $H, p_\theta,$ and p_ϕ
- $H, p_\theta,$ and p_ψ

Question No.66

The Q-value of the decay $^{233}U \rightarrow ^{229}Th + \alpha$ is 4.909 MeV. Calculate the kinetic energy o particle emitted in this decay if the daughter nucleus is in ground state.

- 2.45 MeV
- 0.909 MeV
- 4.82 MeV
- 4.909 MeV

Question No.67

Assume Earth to be uniform solid sphere of radius R. If gravitational pressure at the centre of Earth is P_0, then pressure at distance $r = \frac{R}{2}$ from centre will be

- $\frac{P_0}{2}$
- $\frac{P_0}{4}$
- $\frac{3P_0}{4}$
- $\frac{2P_0}{3}$

Question No.68

A wood sample from an ancient civilization showed a specific activity of 1.2 X 10^2 Bq/kg. If a comparable living wood gave a specific activity of 2.0 Bq/kg, what is the approximate time of the civilization's existence? The half-life of carbon-14 is 5700 years

- 8850 years
- 2400 years
- 4200 years
- 3140 years

Question No.69

Consider a practical Operational Amplifier (Op-Amp) with open loop gain of A_{OL} = 200,000, input impedance of $Z_{in[OL]}$ = 1 MΩ and output impedan $Z_{out[OL]}$ = 100 Ω. Determine the values of effective input impedance ($Z_{in[VF]}$) and output impedance ($Z_{out[VF]}$) of a voltage follower that is construct this Op-Amp.

- 100 MΩ and 500 MΩ
- Infinity and Zero
- 1 MΩ and 100 Ω
- 200 GΩ and 500 μΩ

Question No.70

The dispersion relation for the electromagnetic waves travelling in a plasma is given as $\omega^2 = c^2k^2 + \omega_p^2$ where c and ω_p are constants. In this plasma, the group velocity is:

- Inversely proportional to the phase velocity
- Equal to the phase velocity
- A constant
- Proportional to but not equal to the phase velocity

Question No.71

30. The current I(t) in the LCR circuit with zero initial current and charge with R = 6 Ohm, E = 24 cos5t Volts, L = 1 Henry, C = 0.04 Farad is

- e^{-5t}(3 sin5t – 5 cos4t) + 5 cos3t
- e^{-5t}(5 sin3t – 3 cos5t) + 5 sin3t
- e^{-3t}(3 sin4t – 4 cos4t) + 4 cos5t
- e^{-4t}(4 sin3t – 5 cos3t) + 3 cos5t

Question No.72

The numerical aperture of an optical fiber cable is 0.6 and the refractive index of the core is 1.55. Find the refractive index of the cladding.

- 1.43
- 1.53
- 1.46
- 1.5

Question No.73

At what distance from a long, straight wire carrying a current of 5.0 A is the magnetic field due to the wire equal to the strength of earth's field (approximately 5.0 ×10^{-5} T)?

- 2 cm
- 3 m
- 2 m
- 3 cm

Question No.74

The fine structure of atomic spectral lines arises due to

- Electronic transitions
- Electron spin-orbit coupling
- Nuclear spin
- Interaction between electron and nucleus

Question No.75

The solution of ordinary differential equation

$$\frac{dy}{dx} + 2y = \cos x$$

subject to the condition $y(0) = 1$ is given by

- $y(x) = \frac{2}{5}\sin x - \frac{1}{5}\cos x + \frac{4}{5}e^{-3x}$
-

$y(x) = \frac{1}{5}\sin x + \frac{2}{5}\cos x + \frac{3}{5}e^{-2x}$

$y(x) = \frac{1}{5}\sin x + \frac{2}{5}\cos x + \frac{3}{5}e^{-3x}$

$y(x) = \frac{1}{5}\sin x + \frac{2}{5}\cos x - \frac{3}{5}e^{-2x}$

Question No.76

A particle in one dimensional rigid box of length L, moves freely for $0 < x < L$. If its wave function is given to be

$$\psi(x) = N \sin\left(\frac{2\pi x}{L}\right) \cos\left(\frac{\pi x}{L}\right)$$

The average value of energy is

where $E_0 = \frac{\hbar^2}{2mL^2}$

E_0

$15E_0$

$10E_0$

$5E_0$

Question No.77

Electrons are accelerated through two coaxial plane coils of 'n' turns each of radius 10 cm and separated by 10 cm with a uniform combined magn between the plates. If the potential difference between the coils is 25 kV and the maximum current available for the coils is 2 A, how many number 'n' the coils should have?

628
314
210
450

Question No.78

For carbon atom with electron configuration $1s^2\ 2s^2\ 2p^2$ the following energy levels are not allowed if the two electrons have same principal quantu number

$^3D_3$

$^3P_1$

$^3S_1$

$^3P_2$

Question No.79

A state of a particle in a three dimensional cubical box with sides of length L has energy $\frac{66\hbar^2}{2mL^2}$, is

twelve fold degenerate
non-degenerate
eight fold degenerate
six fold degenerate

Question No.80

A one dimensional random walker takes a step to the left with probability 1/3 or right with probability 2/3. After 4 steps, what is the probability that h reaches his initial position?

8/27

- 3/8
- 4/81
- 2/9

Question No.81

The Laplace transform of second derivative of a function f(t) is

- $s^2f(s) + sf(0) - f'(0)$
- $s^2f(s) - sf(0) + f'(0)$
- $s^2f(s) - sf(0) - f'(0)$
- $s^2f(s) + sf(0) + f'(0)$

Question No.82

A hyperon is found to have strangeness S = −3, isospin zero and baryon number B = 1, its charge will be

- -1
- -2
- 0
- -3

Question No.83

A positive charge Q is placed in vacuum at the point $(d, 0, 0)$, where $d > 0$. The region $x < 0$ is filled uniformly with a metal. The electric field at the point $(\frac{d}{2}, 0, 0)$ is

- $\frac{Q}{\pi\epsilon_0 d^2}(1, 0, 0)$ towards positive X axis
- $\frac{10Q}{9\pi\epsilon_0 d^2}(1, 0, 0)$ towards negative X axis
- $\frac{Q}{\pi\epsilon_0 d^2}(1, 0, 0)$ towards negative X axis
- $\frac{10Q}{9\pi\epsilon_0 d^2}(1, 0, 0)$ towards positive X axis

Question No.84

The quantized lattice vibration is known as

- Phonon
- Graviton
- Quanta
- Photon

Question No.85

Given the Lagrangian of a point particle is

$$L = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}\omega^2x^2 - \alpha x^4 + \beta x\dot{x}^2,$$

the canonical momentum is given by

- $m\dot{x}$
- $m\dot{x} + \beta x\dot{x}$
- $m\dot{x} + 2\beta x\dot{x}$
- $m\dot{x} - \beta x\dot{x}$

Question No.86

An atomic nucleus X with half-life T_X decays to a nucleus Y, which has half-life T_Y. The condition(s) for secular equilibrium is (are)

- $T_X < T_Y$
- $T_X << T_Y$
- $T_X = T_Y$
- $T_X >> T_Y$

Question No.87

Consider two particles and four degenerate energy levels of energy ε=0. What are the respective values of canonical partition function if the particle distinguishable and indistinguishable?

- 16 and 8
- 16 and 10
- 12 and 8
- 10 and 16

Question No.88

The equation $\frac{k}{\sigma T}=\frac{3}{J}(\frac{K_B}{e})^2$= constant gives the law of

- Wiedemann and Franz
- Bio savart law
- Franz law
- None of these

Question No.89

Two arbitrary vectors $|\psi\rangle$ and $|\phi\rangle$, which may or may not be normalized, represent the same state if and only if

- $|\langle\psi|\phi\rangle| = \|\psi\|\|\phi\|$
- $\langle\psi|\phi\rangle = 1$
- $\langle\psi|\phi\rangle = 0$
- $|\langle\psi|\phi\rangle| = \langle\psi|\psi\rangle\langle\phi|\phi\rangle$

Question No.90

The half-life of radium if 1600 years. After how many years 25% of radium block remains undecayed?

- 400 years
- 6400 years
- 800 years
- 3200 years

Question No.91

A part of a long straight conducting wire is bent to form a circular loop of radius R as shown in the figure. The magnitude of the magnetic field at the center due to a current I in the wire is

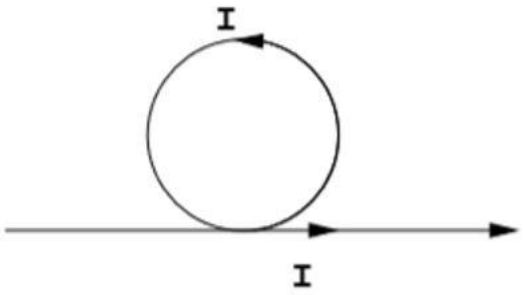


Fig. 1

- $\frac{\mu_0 I}{2R}\left(1+\frac{1}{\pi}\right)$
- $\frac{\mu_0 I}{2R}\left(1-\frac{1}{\pi}\right)$
- $\frac{\mu_0 I}{2R}\left(2+\frac{1}{\pi}\right)$
- $\frac{\mu_0 I}{2R}\left(\pi+\frac{2}{\pi}\right)$

Question No.92

Assuming that the electron states in a He atom can be approximated by hydrogen like wave functions how many different states are possible if the have quantum numbers N1 = N2 = 1, ℓ1 = 1, ℓ2 = 1 and the spin state is singlet state.

- Six
- One
- Nine
- Three

Question No.93

A string of length l is fixed at both ends. It is vibrating in its 3rd overtone with maximum amplitude a'. The amplitude at s distance l/3 from one side i

- 0
- a
- $\frac{a}{2}$
- $\frac{\sqrt{3}}{2}a$

Question No.94

Consider N free and non-interacting diatomic molecules in a volume V. What is the molar specific heat at very high temperature in terms of gas cor

- R
- 3R/2
- 5R/2
- 7R/2

Question No.95

The temperature of a black body is raised from 50 K to 2000 K. By how much does the amount of energy radiated by the object increase?

- 1.57×10^9
- 4.52×10^7
-

2.56 X 10^6

3.14 X 10^8

Question No.96

Let $ABCD$ be the rectangle with corners at (0,0,0), (1,0,0),(1,1,0),(0,1,0) and $\vec{F}$ be the vector field given by

$$\vec{F} = (2xy + y^2)\hat{i} + (2yz + x^2)\hat{j} + (2zx + z^2)\hat{k}.$$

The value of line integral $\oint_{\text{ABCDA}} \vec{F}.\vec{dl}$ is

- 1/2
- 0
- 1
- -1/2

Question No.97

The drift velocity of the charge carrier is measured by

- Joule-Thompson effect
- Joule effect
- Hall effect
- Peltier effect

Question No.98

For a quantum particle confined inside a cubic box of side L, the ground state energy is given by E_0. The energy of the first excited state is

- $2E_0$
- $6E_0$
- $\sqrt{2}E_0$
- $3E_0$

Question No.99

The frequency of the radiative transition from n=3 to n=2 in the Hydrogen atom in the units of 10^{14}Hz is

- 8.92
- 4.06
- 5.64
- 4.56

Question No.100

Which of the following statements(s) is/are true?

- Newton's laws of motion are invariant under Lorentz transformations and Maxwell's equations are invariant under Galilean transformations
- Newton's laws of motion and Maxwell's equation are both invariant under Galilean transformations
- Newton's laws of motion and Maxwell's equations are both invariant under Lorentz transformations
- Newton's laws of motions are invariant under Galilean transformations and Maxwell's equations are invariant under Lorentz transformation