1. Match List-I and List-II and select the correct answer from the codes given below:

List-I
(Ensembles)

P Microcanonical Ensembles
Q Canonical Ensembles
R Grand Canonical Ensembles
S None

List-II

1 Chemical Potential, Volume and Temperature remains constant
2 Number of particle, Volume and Energy remains constant
3 Number of Particle, Volume and Temperature remains constant
4 None

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	3	4
(C)	2	3	1	4
(D)	3	2	1	4

2. A 3 - bit analog-to-digital converter is designed to digitize analog signals ranging from 0V to 10V . For this converter, the binary output corresponding to an input of 6 V is

(A) 011
(B) 101
(C) 100
(D) 010

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

(A) 4%
(B) 16%
(C) 20%
(D) 50%

4. **Given below are two statements :**
Statement I: The strong nuclear force is responsible for binding protons and neutrons within atomic nuclei.
Statement II: The strong nuclear force is a long-range force that acts between all particles.
In light of the above statements, choose the most appropriate answer from the codes given below:

(A) Both Statement I and Statement II are correct.
(B) Both Statement I and Statement II are incorrect
(C) Statement I is correct and Statement II is incorrect.
(D) Statement I is incorrect and Statement II is correct.

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8. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) The reverse recovery time of a diode is an important parameter in high-frequency rectifier applications.

Reason (r): The reverse recovery time represents the time taken by the diode to switch from the conducting state to the blocking state when the polarity of the voltage across it is reversed.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)

(B) Both (a) and (r) are true and (r) is not correct explanation of (a)

(C) (a) is true, but (r) is false

(D) (a) is false, but (r) is true

9. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) : The conservation of baryon number is strictly observed in all particle interactions.

Reason (r) : Baryon number is defined as the sum of the number of protons and neutrons in a system.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)

(B) Both (a) and (r) are true and (r) is not correct explanation of (a)

(C) (a) is true, but (r) is false

(D) (a) is false, but (r) is true

10. The stopping potentials of 24, 100, 110 and 1.15 keV are measured for photoelectrons emitted from certain element after irradiating it with monochromatic X-rays. If the element is used as the target in X-ray tube, the wavelength of the emitted K_a line is

(A) 0.163 Å

(B) 1.630 Å

(C) 16.30 Å

(D) None of these

11. The L, S and J quantum numbers corresponding to the ground state electronic configuration of Boron (Z = 5) are

(A) $L = 1, S = 1/2, J = 3/2$

(B) $L = 1, S = 3/2, J = ½$

(C) $L = 1, S = 1/2, J = ½$

(D) $L = 0, S = 3/2, J = 3/2$

12. Assuming that L-S coupling scheme is valid, the number of permitted transitions from $^2P_{3/2}$ to $^2S_{1/2}$ due to a weak magnetic field is

(A) 8 (B) 4

(C) 2 (D) 6

13. Which one is not a correct thermodynamic Maxwell relation :

(A) $\left(\frac{\partial T}{\partial V}\right)_s = -\left(\frac{\partial P}{\partial S}\right)_v$

(B) $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_v$

(C) $\left(\frac{\partial T}{\partial P}\right)_s = \left(\frac{\partial V}{\partial S}\right)_P$

(D) $\left(\frac{\partial S}{\partial P}\right)_T = \left(\frac{\partial V}{\partial T}\right)_P$

14. The drain current in an n-channel FET is due to :

(A) Electron

(B) Holes

(C) Electrons and Holes

(D) None of these

15. The number of components in space time, electromagnetic tensor are

(A) 9

(B) 16

(C) 3

(D) 4

16. In power method patter for lead with radiation $l = 1.54$ Å, the (220) Bragg reflection angle is 32°, the radius of the atom will be :

(A) 1.54 Å

(B) 1.45 Å

(C) 5.42 Å

(D) 4.51 Å

17. Connecting a capacitor in parallel with a feedback resistor of an inverting amplifier causes :

(A) The dc gain to reduce

(B) Circuit to become a high pass filter

(C) An additional low frequency pole in the transfer function

(D) An additional low frequency zero in the transfer function

18. In case of a homomorphism from a group G_1 to another group G_2, which of the following statement is not correct

(A) Each element in A in G_1 correspond to a unique element $f(A)$ of G_2.

(B) The element $f(A)$ of G_2 is called the image of the element A of G_1.

(C) Both G_1 and G_2 of the same order and there exists a one to one correspondence between the element of G_1 and G_2.

(D) The mapping f must be defined for all element of G_1.

19. In Dirac's Bra and Ket notation is equal to

(A) $|Q><P|$

(B) $|P><Q|$

(C) $<P|Q>$

(D) $<Q, P>$

20. In case of superconductor, the transition temperature depends of the isotropic mass M as :

(A) $T_C \propto \frac{1}{\sqrt{M}}$ (B) $T_C \propto \frac{1}{M^2}$

(C) $T_C \propto \frac{1}{M}$ (D) Do not depend

21. Given two $n \times n$ matrices P and Q such that P is Hermitian and Q is skew (anti) Hermitian. Which one of the following combinations of P and Q is necessarily a Hermitian matrix?

(A) QP (B) iQP

(C) P + iQ (D) P + Q

22. A matrix is given by $P = \frac{1}{\sqrt{2}}\begin{bmatrix} i & 1 \\ 1 & i \end{bmatrix}$.

The eigenvalues of P are :

(A) real and positive

(B) purely imaginary with real modulus

(C) complex with real modulus

(D) real and negative

23. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) : If the net external force on the body is zero, then its acceleration is zero.

Reason (r) : Acceleration does not depend on force.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)

(B) Both (a) and (r) are true and (r) is not correct explanation of (a)

(C) (a) is true, but (r) is false

(D) (a) is false, but (r) is true

24. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) : P- type semiconductor is formed via doping with trivalent elements in silicon.

Reason (r) : Trivalent element create more electron than holes.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)

(B) Both (a) and (r) are true and (r) is not correct explanation of (a)

(C) (a) is true, but (r) is false

(D) (a) is false, but (r) is true

25. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) : Hall effect is used to determine the type of semiconductor material.

Reason (r) : Hall voltage is proportional to the magnetic field and current.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)

(B) Both (a) and (r) are true and (r) is not correct explanation of (a)

(C) (a) is true, but (r) is false

(D) (a) is false, but (r) is true

26. In the BCS theory :

I The Electron -Electron attract each other

II The electron attraction overcomes the coulomb force

III Explain both type I and type II super conductivity.

IV BCS stand for the Bardeen, Cooper and Schrieffer.

Choose the correct answer from below option

(A) (ii) and (iii)

(B) (i), (iii) and (iv)

(C) (i), (ii) and (iv)

(D) None of these

27. Which statement/statements are true for Hermitian operator?

I Flipped over to the other side in inner product

II Hermitian operatore have only real eign values

III Hermitian operators have a complete set of the orthonormal eign function

IV -d/dx is Hermitian operator

V d/dx is Hermitian operator

Choose the correct answer from below option :

(A) (i), (ii) and (iii)

(B) (ii), (iii) and (iv)

(C) (i), (ii) and (v)

(D) (i), (iii) and (iv)

28. Match List-I and List-II and select the correct answer from the codes given below:

List-I

P Harmonic Oscillator Q Hydrogen atom

R Particle in a box

S Free Particle in motion

List-II

1 E_n is proportional to 2n+1/2

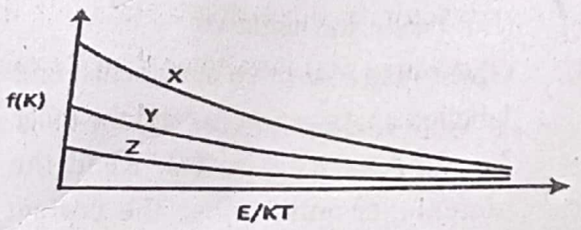
2 E_n is proportional to n^2

3 E_n is continuous

4 E_n is proportional to n^{-2}

	P	Q	R	S
(A)	2	1	4	3
(B)	2	3	1	4
(C)	1	4	2	3
(D)	3	1	2	4

29. Which of the following is the curve for the Bose-Einstein statistics



(A) X

(B) Y

(C) Z

(D) None of these

30. The potential of a diatomic molecule as a function of the distance r between the atoms is given by $V(r) = -\frac{a}{r^6} + \frac{b}{r^{12}}$ .The value of equilibrium separation of the atom is :

(A) $\left(\frac{b}{a}\right)^{\frac{1}{6}}$ (B) $\left(\frac{2b}{a}\right)^{\frac{1}{6}}$

(C) $\left(\frac{2b}{3a}\right)^{\frac{1}{6}}$ (D) $\left(\frac{2b}{a}\right)^{\frac{1}{3}}$

31. If the Lagrangian of a particle moving in one dimensions is given by $L=\frac{\dot{q}^2}{2q} - v(x)$, the Hamiltonian is :

(A) $\frac{1}{2}qp^2 + v(x)$

(B) $\frac{1}{2}qp^2 - v(x)$

(C) $qp^2 + v(x)$

(D) $\frac{1}{2}qp^2 + 2v(x)$

32. If S is the closed surface enclosing a volume V and $\hat{n}$ is the unit normal vector to the surface and $\vec{r}$ is the positive position vector, then the value of following integral $\iint_s \vec{r}.\hat{n}\,dS$ is :

(A) V

(B) 2V

(C) 3V

(D) 0

33. Consider the following statements :

I. The Eigenvalue of anti-symmetric matrix is pure imaginary

II. The Eigenvalue of symmetric matrix is always real

III. The Eigenvalue of nilpotent matrix is always Zero

IV. The Eigenvalue of idempotent matrix is always zero

Based on the following statement, choose the correct one

(A) Only I is correct

(B) II, III and IV are correct

(C) I, II and III are correct

(D) All are correct

34. The complete solution for the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{5x}$ is :

(A) $2C_1e^x + C_2e^{2x} + \frac{e^{5x}}{12}$

(B) $C_1e^x + 2C_2e^{2x} + \frac{e^{5x}}{12}$

(C) $C_1e^x + C_2e^{2x} + \frac{e^{5x}}{12}$

(D) $C_1e^x + C_1e^{2x} + \frac{e^{5x}}{10}$

35. The value of the integral $\oint \frac{4-3z}{z(z-1)(z-3)}dz$ where $|z|=\frac{3}{2}$ is:

(A) $\frac{5\Pi i}{3}$ (B) $\frac{5\Pi i}{9}$

(C) $\frac{10\Pi i}{3}$ (D) $\frac{5\Pi i}{2}$

$m^2 - 3m + 2$ 05

$m^2 - 2m - m + 2$

$m(m-2) - 1(m$

$m=1, m=2$

$D^2 - 3D + 2$ $C_1e^x + C_2e^{2x}$

$25 - 15 + 2$ $10+x$

36. If one of the inputs of a J-K flip flop is high and the other is low, then the outputs Q and $\bar{Q}$

(A) oscillate between low and high in race around condition

(B) toggle and the circuit acts like a T flip flop

(C) are opposite to the inputs

(D) follow the inputs and the circuit acts like an S-R flip flop

37. Match the Volume of the unit cell with their structural unit :

List-I		List-II	
P (2)	Simple cubic	1	$a^3/2$
Q (3)	Face centered cubic	2	a^3
R (1)	Body centered cubic	3	$a^3/4$
S (4)	Hexagonal	4	$3\sqrt{2}\,a^3$

	P	Q	R	S
(A)	2	3	1	4
(B)	2	4	3	1
(C)	2	1	4	3
(D)	2	4	1	3

38. Consider the following statement :

Statement-I : Only odd number values of h, k, l are allowed in (h, k, l) for simple cubic structure

Statement-II : All planes of (h, k, l) are allowed for body centered cubic structure

Choose the correct option:

(A) Only statement-I is correct.

(B) Only statement-II is correct.

(C) Both statements-I and II are correct.

(D) Neither statement-I nor statement-II is correct

39. Consider a Carnot engine operating between temperature of 600K and 400K. The engine performs 1000J of work per cycle. The heat (in Joules) extracted per cycle from the high temperature reservoir is..... J.

(A) 6000 (B) 3000

(C) 2000 (D) 1000

40. Let ΔW be the work done in a quasistatic reversible thermodynamic process. Which of the following statements about ΔW is correct?

(A) ΔW is a perfect differential if the process is isothermal

(B) ΔW is a perfect differential if the process is adiabatic

(C) ΔW is always a perfect differential

(D) ΔW cannot be a perfect differential

41. Three identical spin-1/2 fermions are to be distributed in two non-degenerate distinct energy levels. The number of ways this can be done is

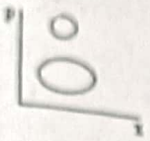
(A) 5

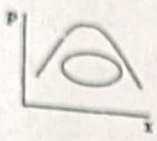
(B) 4

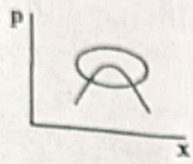
(C) 3

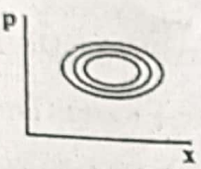
(D) 1

42. Which of the following set of phase space trajectories which one is not possible for a particle obeying Hamilton's equation of motion (for a time-independent Hamiltonian)?

(A) 

(B) 

(C) 

(D) 

43. **Given below are two statements:**

Statement-I: All piezo-electrics are ferroelectric.

Statement-II: All ferroelectrics are piezoelectric.

In light of the above statements, choose the most appropriate answer from the codes given below:

(A) Both Statement-I and Statement-II are correct.

(B) Both Statement-I and Statement-II are incorrect

(C) Statement-I is correct and Statement-II is incorrect.

(D) Statement-I is incorrect and Statement-II is correct

44. Given below are two statements:

Statement-I: In Einstein theory of specific heat the atoms can be considered as classical harmonic oscillator oscillating with same frequency

Statement-II: In Debye model of specific heat of solid the phonon frequencies are taken to have the sound wave like dispersion and low temperature specific heat behaves as C_v proportional to T^3

In light of the above statements, choose the most appropriate answer from the codes given below:

(A) Both Statement-I and Statement-II are correct.

(B) Both Statement- I and Statement-II are incorrect

(C) Statement-I is correct and Statement-II is incorrect.

(D) Statement-I is incorrect and Statement-II is correct.

45. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a): Iorn, cobalt and nickel are ferromagnetic materials.

Reason (r): The unpaired d-orbital electrons are the source of magnetism in these materials.

Codes:

(A) Both (a) and (r) are correct

(B) (a) is correct and (r) is not correct

(C) (a) is not correct and (r) is correct.

(D) Both (a) and (r) are not correct

46. Given below are two statements :

Statement-I: The structure factor of an atom is proportional to atomic number.

Statement-II: Heavy elements show strong X-ray diffractions.

(A) Both statement-I and statement- II are correct

(B) Both statement-I and statement-II are not correct

(C) Statement-I is correct and statement-II is not correct

(D) Statement-I is not correct and statement-II is correct

47. Match the correct density of states from the given list

P	3D	1	proportion to a constant
Q	2D	2	proportional to $E^{1/2}$
R	1D	3	Discrete
S	0D	4	proportional to $E^{-1/2}$

Code

	P	Q	R	S
(A)	4	3	1	2
(B)	2	1	4	3
(C)	3	4	2	1
(D)	4	3	2	1

48. Match the correct answers from the given list

P	Fermi-Dirac Distribution
Q	Bose-Einstein Distribution
R	Planck Distribution
S	Boltzmann Distribution
1	$\exp(-E/K_BT)$
2	$1/\exp(-h\nu/K_BT)-1$
3	$1/\exp((E-\mu)/K_BT)+1$
4	$1/\exp((E-\mu)/K_BT)-1$

	P	Q	R	S
(A)	4	3	1	2
(B)	1	2	3	4
(C)	3	4	2	1
(D)	4	3	2	1

9. Consider the following statements :

I The radius of the nucleus varies with the mass number as $A^{1/3}$

II The total energy of the nucleus is directly proportional to $A^{-2/3}$

III The Density of the nucleus depend on the mass number A

IV The Density of nucleus is independent of A

Based on the following statement , choose the correct one

(A) Only I is correct

(B) I, II and III are correct

(C) I , II and IV are correct

(D) All are correct

. The spin parity for the even-even nucleus in shell model is :

(A) $1/2^+$ (B) 1^-

(C) 1^+ (D) 0

. The correct Boltzmann probability entropy relation is :

$S=K_B \log\Omega$ (B) $S=2K_B \log\Omega$

$S=K_B \log 2\Omega$ (D) $S= 0.5\, K_B \log\Omega$

The dispersion relation for electromagnetic waves travelling in a plasma is given as $W^2 = C^2K^2 + W_p^2$, where c and W_p are constants. In this plasma, the group velocity is:

(A) $\frac{C}{V_p}$ (B) CV_p

(C) $\frac{C^2}{V_p}$ (D) 0

53. For a system at constant temperature and volume, which of the following statements is correct at equilibrium?

(A) The Helmholtz free energy attains a local minimum.

(B) The Helmholtz free energy attains a local maximum.

(C) The Gibbs free energy attains a local minimum.

(D) The Gibbs free energy attains a local maximum.

54. The number of different components in D_1 and D_2 lines of the anomalous Zeeman effect is :

(A) 2, 3 (B) 4, 6

(C) 6, 4 (D) 1, 2

55. An atom with one outer shell electron having orbital angular momentum l is placed in a weak magnetic field. The number of energy levels into which the higher total angular momentum state splits, is :

(A) $2l + 2$ (B) $2l + 1$

(C) $2l$ (D) $2l - 1$

56. The poison bracket of $\{x, p\} = -1$, then the poison bracket of $\{x^2 + p, p\} = ?$

(A) 2p (B) p

(C) x (D) $-2x$

57. The number of optical branches in 2-D solid with n as the effective number of atom in a solid is :

(A) 1 (B) 2n-1

(C) 2n-2 (D) 2

$d\omega = 2C^2K^2$. $\omega^2 = C^2k^2 + \omega_p^2$

58. Match the following values of centre of mass :

List-I		List-II	
P	Uniform half ring	1.	$\frac{4R}{3\Pi}$
Q	Uniform half disc	2.	$\frac{3R}{8}$
R	Solid hemisphere	3.	$\frac{R}{2}$
S	Hemispherical shell	4.	$\frac{2R}{\Pi}$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	4	1	3	2
(C)	1	3	4	2
(D)	4	1	2	3

59. The Lagrangian of a system with one degree of freedom q is given by $l = \alpha\dot{q}^2 + \beta q$, where α and β are non-zero constants. If P_q denotes the canonical momentum conjugate to q then which one of the following statements is correct ?

(A) $P_q = \beta$ and it is a conserved quantity.

(B) $P_q = \beta$ and it is not a conserved quantity.

(C) $P_q = 2\alpha\dot{q}$ and it is a conserved quantity.

(D) $P_q = 2\beta\dot{q}$ and it is not a conserved quantity.

60. Match the following values of eccentricity with their path :

List-I		List-II	
P	Circular	1.	$e = 1$
Q	Elliptical	2.	$e = 0$
R	Parabola	3.	$e < 1$
S	Hyperbola	4.	$e > 1$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	4	1	3	2
(C)	1	3	4	2
(D)	4	1	2	3

61. If the half-life of an elementary particle moving with speed 0.9c in the laboratory frame is 5×10^8 s then the proper half-life is approx.____ 10^{-8} s ($c = 3 \times 10^8$ m/s)

(A) 2.2

(B) 2.15

(C) 5

(D) 5.8

62. Given that the linear transformation of a generalized coordinate q and the corresponding momentum p, $Q = q + 4ap$ and $P = q + 2p$ is canonical, the value of the constant a is ____

(A) 0.25

(B) 1

(C) 0.5

(D) 2

63. Given below are two statements :

I Fermi surface in one dimension is line.

II Fermi surface in two dimension is sphere.

In light of the above statements, choose the correct options

(A) Both statement-I and statement-II are correct

(B) Bother statement-I and statement-II are incorrect

(C) Statement-I is correct and statement-II is incorrect

(D) Statement-I is incorrect and statement-II is correct

Answer questions from 96 to 100 from the following

Copper has a mass density 8.95 g/cm^3 and electrical resistivity is 1.55x10^{-8} Ohm-m at room temperature.

64. The concentration of conduction electrons in copper is

(A) 84.7×10^{22} cm^{-3}

(B) 8.47×10^{22} cm^{-3}

(C) 0.847×10^{22} cm^{-3}

(D) None of these

65. The mean free time of the electrons in copper is :

(A) 2.68×10^{-14} s

(B) 2.68×10^{-13} s

(C) 2.68×10^{-15} s

(D) 2.68×10^{-11} s

66. The Fermi energy of electrons in Copper is :

(A) 7 eV

(B) 8 eV

(C) 6 eV

(D) 5 eV

67. The Fermi velocity of electrons in copper is

(A) 1.57×10^7 cm/s

(B) 1.57×10^{10} cm/s

(C) 1.57×10^9 cm/s

(D) 1.57×10^8 cm/s

68. The mean free path of electrons at Fermi surface of copper is :

(A) 10 nanometer

(B) 10 micrometer

(C) 5 micrometer

(D) 5 nanometer

$\frac{1}{\sqrt{2\pi r d^2}} = \frac{1}{2x}$

69. An unbiased dice is thrown three times successively. The probability that the number of dots on the uppermost surface add up to 16 is:

(A) 1/16

(B) 1/36

(C) 1/108

(D) 1/4

70. Given below are two statements:

Statement-I: By restricting the variation of both q and p to be zero at the end points of varied paths, the modified Hamilton's principle provides an independent and general way of setting up Hamilton's equations of motion without a prior Lagrangian formulation.

Statement-II: The requirement of independent variation of q and p are so essential for obtaining the Hamilton's equations highlights the fundamental difference between the Lagrangian and Hamiltonian formulations.

Choose the most appropriate answer from the option given below:

(A) Both statement-I and statement- II are correct

(B) Both statement- I and statement-II are incorrect

(C) Statement-I is correct and statement-II is incorrect

(D) Statement-I is incorrect and statement-II is correct

71. Consider the following statement :

Statement- I : The width of depletion layer is directly proportional to the doping concentration

Statement-II : The transition capacitance is proportional to the cube of reverse bias voltage

Choose the correct option:

(A) Only statement -I is correct.

(B) Only statement -II is correct.

(C) Both statements-I and II are correct.

(D) Neither statement-I nor statement-II is correct.

72. A live music broadcast consists of a radio-wave of frequency 7 MHz, amplitude modulated by a microphone output consisting of signals with a maximum frequency of 10 kHz. The spectrum of modulated output will be zero outside the frequency band :

(A) 7.00 MHz to 7.01 MHz

(B) 6.99 MHz to 7.01 MHz

(C) 6.99 MHz to 7.00 MHz

(D) 6.995 MHz to 7.005 MHz

73. Match the Expectation value of linear harmonic oscillator :

P	$\langle x \rangle$	1. 0
Q	$\langle p^2 \rangle$	2. $\frac{h}{2mw}(2n+1)$
R	$\langle p^4 \rangle$	3. $\frac{\hbar mw}{2}(2n+1)$
S	$\langle x^2 \rangle$	4. $\frac{\hbar^2}{4m^2w^2}(6n^2+6n+3)$

Codes:

	P	Q	R	S
(A)	1	4	3	2
(B)	2	3	4	1
(C)	1	3	4	2
(D)	4	1	2	3

74. Consider the following statement :

Statement-I : According to Bohr atomic model, possible number of spectral lines emitted by a H-atom is $n(n-1)/2$

Statement-II : The maximum number of photons emitted during the emission is 2n.

Choose the correct option:

(A) Only statement-I is correct

(B) Only statement-II is correct

(C) Both statements-I and II are correct

(D) Neither statement-I nor statement-II is correct

75. The isospin (I) and baryon number (B) of the up quark is :

(A) 1 and 1 (B) 1 and ½

(C) 1/2 and 1/3 (D) 0 and 1

76. The decay $\tau^+ \rightarrow \mu^+\mu^+\mu^-$

I	All violated
II	Total Lepton number
III	Electric charge
IV	Tau number

Which one of the following conservation laws is violated in the decay :

(A) Only I

(B) II, III and IV

(C) Only IV

(D) All of the above

77. Match the following particle to its quark content :

P	n	1.	udd
Q	Π^+	2.	$u\bar{u}$
R	Σ^+	3.	$\bar{d}u$
S	Π^0	4.	uus

Codes

	P	Q	R	S
(A)	1	4	3	2
(B)	2	3	4	1
(C)	1	4	2	3
(D)	4	1	2	3

78. The strangeness of K^+ particle is :

(A) 1

(B) -1

(C) 2

(D) 0

79. Energy per unit time per unit area transferred by the electromagnetic field is expressed as

(A) $S=\frac{1}{\mu_0}(E\times B)$ (B) $S=E\times B$

(C) $S=\mu_0(E\times B)$ (D) $S=\frac{1}{\varepsilon_0}(E\times B)$

Read the statement and answer the following questions from 80 to 84.

An electric magnetic wave going through vacuum is described by –

$E=E_0 \text{ Sin } (kx-\omega t)$

$B=B_0 \text{ Sin } (kx-\omega t)$

80. Which of the following is true

(A) $E_0 k = B_0 \omega$

(B) $E_0 B_0 = \omega k$

(C) $E_0 \omega = B_0 t$

(D) None of these

81. In the terms of the electromagnetic potential (A & φ) field vectors E and B are given as

(A) $B=\text{curl } A$ and $E=\text{grad } p-\frac{\partial A}{\partial T}$

(B) $B=\text{curl } A$ and $E=-\text{grad } p+\frac{\partial A}{\partial T}$

(C) $B=\text{curl } A$ and $E=\text{grad } p+\frac{\partial A}{\partial T}$

(D) $B=\text{curl } A$ and $E=-\text{grad } p-\frac{\partial A}{\partial T}$

82. Lorentz Condition and Coulomb Gauge condition, respectively

(A) $\text{Div } A+\mu\in\frac{\partial\varphi}{\partial T}=0$ and $\text{Div } A=0$

(B) $\text{Div } A-\mu\in\frac{\partial\varphi}{\partial T}=0$ and $\text{Div } A=0$

(C) $\text{Div } A+\mu\in\frac{\partial\varphi}{\partial T}=0$ and $\text{Div } A=\mu j$

(D) $\text{Div } A+\mu\in\frac{\partial\varphi}{\partial T}=0$ and $\text{Div } A=\mu j$

83. The total; energy stored in electromagnetic field as :

(A) $\frac{\in_0}{2}\int E^2 dV$

(B) $\frac{1}{2\mu_0}\int B^2 dV$

(C) $\frac{1}{2}\int\left(\in_0 E^2+\frac{1}{\mu_0}B^2\right)dV$

(D) $\frac{\in_0 \mu_0}{2}\int E^2B^2 dV$

84. The value of integral $\int_{-\infty}^{+\infty} dx/(x^2+4)^2$.

(A) $\Pi/16$

(B) $\Pi/2$

(C) $\Pi/4$

(D) $\Pi/8$

85. The electric field at a distance "r" from the centre of the uniformly charged ring of radius "a" and charge "Q" is given as :

(A) $\frac{KQr}{(r^2+a^2)^{\frac{3}{2}}}$

(B) $\frac{3KQr}{(r^2+a^2)^{\frac{3}{2}}}$

(C) $\frac{KQr}{2(r^2+a^2)^{\frac{3}{2}}}$

(D) $\frac{2KQr}{2(r^2+a^2)^{\frac{3}{2}}}$

86. The energy stored in a capacitor per unit volume, with the electric field E is :

(A) $\varepsilon_0 E^2$ (B) $\frac{1}{4}\varepsilon_0 E^2$

(C) $\frac{1}{2}\varepsilon_0 E^2$ (D) $\frac{1}{2}\varepsilon_0 E$

87. Consider the following statements :

I. The propagation vector K is perpendicular to the electric field of the electromagnetic waves

II. The propagation vector K is parallel to the magnetic field of the electromagnetic waves

III. Electromagnetic wave cannot travel in a vacuum

IV. The magnetic field vector and the electric field vector are parallel to each other.

Bases on the following statement, choose the correct one:

(A) Only I is correct

(B) II and III are correct

(C) I and IV are correct

(D) All are correct

88. A specific heat of solid at high temperature range varies with the temperature as :

(A) Linearly vary

(B) Cube of temperature

(C) Do not vary

(D) Inversely vary

89. Consider the following statements :

Statement- I: The capacity to store the charge of the capacitor depend on the breakdown strength of the surrounding medium.

Statement- II : The sharp edge of the capacitor has less capacity to store the charge as compare to broader edge

Choose the correct option:

(A) Only statement-I is correct.

(B) Only statement-II is correct.

(C) Both statements I and II are correct.

(D) Neither statement-I nor statement-II is correct

90. Match List-I and List-II and select the correct answer from the codes given below:

List-I
(Experiment)

P Stern-Gerlach experiment (3)
Q Zeeman effect
R Frank-Hertz experiment (2)
S Davisson-Germer experiment (1)

List-II
(Inferences)

1 Wave nature of particles
2 Quantization of energy of electrons in the atoms
3 Existence of electron spin
4 Space Quantization of angular momentum

Codes:

	P	Q	R	S
(A)	2	3	4	1
(B)	1	3	2	4
(C)	3	4	2	1
(D)	2	1	4	3

91. A 10mV, 2KHz sinusoidal signal is applied the inverting input terminal of an op-amp integrator for which R= 100Ω and C= 10 μf Determine the output voltage.

(A) $0.0013\cos(4000t - 1)$mV
(B) $0.0026\cos(4000t - 1)$mV
(C) $0.0013\sin(4000t - 1)$mV
(D) $0.0026\sin(4000t - 1)$mV

92. Arrange the wavelengths in decreasing order.

I Cosmic rays
II Red light
III Ultra violet
IV Visible light

(A) IV, III, II, I
(B) II, IV, III, I
(C) IV, I, II, III
(D) I, IV, III, II

93. Which of the following singularities are found in an analytic function?

I Isolated singularity
II Removable singularity
III Poles
IV Non-essential singularity

Codes:

(A) I, II, and III are correct
(B) II, III and IV are correct
(C) I and IV are correct
(D) II and III are correct

94. Given below are two statements, one labelled as Assertion (a) and the other labelled as Reason (r). Read the statements and choose the correct answer from the code given below:

Assertion (a) : The Coriolis force arises due to the rotation of the Earth and affects the motion of objects on its surface.

Reason (r) : The Coriolis force is a conservative force that acts in the direction opposite to the motion of an object.

(A) Both (a) and (r) are true and (r) is correct explanation of (a)
(B) Both (a) and (r) are true and (r) is not correct explanation of (a)
(C) (a) is true, but (r) is false
(D) (a) is false, but (r) is true

95. Consider the following statement :

Statement-I : In n type semiconductor the Fermi level lies near the conduction band

Statement-II : At the higher temperature the semiconductor behave as the intrinsic semiconductor as the Fermi level move towards the middle of the band gap

Choose the correct option:

(A) Only statement-I is correct.

(B) Only statement-II is correct.

(C) Both statements-I and II are correct.

(D) Neither statement-I nor statement-II is correct

96. In low density oxygen gas at low temperature, only the translational and rotational modes of the molecules are excited. The classical specific heat per molecule of the gas is

(A) K_B (B) $\frac{5}{2}K_B$

(C) $2K_B$ (D) $3K_B$

97. Which of the following statements is correct?

I. Photoelectric effect takes place in visible light

II. Gamma rays are used for crystal structure defeminations

III. X-ray is generally used in Mossbauer spectroscopy

IV. X rays are used for crystal structure determination

(A) Only I and IV is correct

(B) II, III and IV are correct

(C) I, II and III are correct

(D) All are correct

98. Consider two particles and two non-degenerate quantum levels 1 and 2. Level 1 always contains a particle. Hence, what is the probability that level 2 also contains a particle for each of the two case :

(i) when the two particles are distinguishable

(ii) when the two particles are bosons

(A) (i) 1 /2 and (ii) 0

(B) (i) 1 and (ii) 1

(C) (i) 2/3 and (ii) 1/2

(D) (i) 1 /2 and (ii) 1/2

99. In case of the finite square well in Q.M. how many even bound state exist between 0 to $\Pi/2$.

(A) 2 (B) 4

(C) 0 (D) 1

100. In case of attractive delta potential function $V(x) \sim \lambda\delta(x)$, the product of the uncertainty in position and momentum i.e. $\Delta x . \Delta p$ is :

(A) $\frac{\hbar}{2}$ (B) $\frac{\hbar}{3}$

(C) $\frac{\hbar}{\sqrt{2}}$ (D) 0