OMR Answer Sheet No.

40204

B.Sc. (Semester Fourth) Examination, 2024-25

CHEMISTRY

Paper : B-054

(Quantum Mechanics and Analytical Techniques)

| समय : 2 घण्टे
| Time : 2 Hours

| अधिकतम अंक : 75
| Maximum Marks : 75

अनुक्रमांक (अंकों में)
Roll No. (in figures)

कक्ष निरीक्षक के हस्ताक्षर
Signature of Invigilator

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. केवल 75 प्रश्नों के उत्तर दीजिए। निम्नलिखित बहुविकल्पीय प्रश्नों के सही विकल्प अपने उत्तर पत्रक (ओ.एम.आर.) पर अंकित कीजिए। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR उत्तर-पत्रक को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका, जिसमें कुछ भाग छपने से छूट गये हों या प्रश्न एक से अधिक बार छप गये हों या किसी भी प्रकार की कमी हो, उसे तुरन्त बदल लें।

(शेष निर्देश अन्तिम पृष्ठ पर)

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. Attempt any 75 questions. Write the correct alternative of the following multiple choice questions on your answer (OMR) sheet. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be immediately replaced.

(Remaining Instructions on last page)

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1. The first use of quantum theory to explain the structure of atom was made by:
   (A) Heisenberg
   (B) Bohr
   (C) Planck
   (D) Einstein

2. For each value of 'l', the number of 'm' values are :
   (A) 2l
   (B) nl
   (C) 2l + 1
   (D) n - 1

3. For 5s-orbital, the magnetic quantum number has the value-
   (A) 2
   (B) 4
   (C) - 1
   (D) 0

4. The designation of an orbital with n=4 and l=3 is:
   (A) 4p
   (B) 4s
   (C) 4f
   (D) 4d

5. The maximum number of electrons in a subshell is given by the relation-
   (A) 2l+1
   (B) 2l-2
   (C) 4l+2
   (D) $2n^2$

6. A subshell with n=5, l=2 can accomodate maximum electrons:
   (A) 10
   (B) 12
   (C) 36
   (D) 54

7. Which quantum number distinguishes the two electrons occupying the same orbitals?
   (A) Azimuthal quantum number
   (B) Spin quantum number
   (C) Principal quantum number
   (D) Magnetic quantum number

8. Which of the following is not possible?
   (A) n=4, l=3, m=-3
   (B) n=3, l=3, m=2
   (C) n=1, l=0, m=0
   (D) n=2, l=1, m=0

9. Which of the following represents the correct set of quantum number of a 3p electron?
   (A) 3, 2, 1, + 1/2
   (B) 3, 2, -1, +1/2
   (C) 3, 1, 1, 0
   (D) 3, 1, 1, -1/2

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10. What does the Kirchoff's identity state:

(A) The emissivity and the absorptivity of the black body are same and always less than 1.

(B) The emissivity and the absorptivity of the black body are same and always more than one.

(C) The emissivity and the absorptivity of the black body are same and always equal to one.

(D) None of the above

11. Stefan-Boltzmann law states that the energy radiated per unit area per unit time by the black body is:

(A) Directly proportional to the square of the temperature of the black body.

(B) Inversely proportional to the square of the temperature of the black body.

(C) Directly proportional to the fourth power of the temperature of the black body.

(D) Inversely proportional to the fourth power of the temperature of the black body.

12. Wein's displacement law gives the relationship between-

(A) The wavelength of the radiation at which total emissive power is maximum and the temperature

(B) The wavelength of the radiation at which emissive power is minimum and the temperature

(C) The wavelength of the radiation at which emissive power does not change and the temperature.

(D) None of the above

13. Quantum of electromagnetic energy is called:

(A) Particles

(B) Photons

(C) Waves

(D) Energy

14. Planck's constant has unit-

(A) J

(B) s

(C) J/s

(D) J.s

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15. Frequency below which no electrons are emitted from metal surface is :

(A) Minimum frequency

(B) Maximum frequency

(C) Threshold frequency

(D) Angular frequency

16. In photoelectric effect, electrons should be removed from the :

(A) Inner shells

(B) Core

(C) Surface

(D) Nucleus

17. 1eV is equal to:

(A) 1.6×10^{19}C

(B) 2.0×10^{-20}J

(C) 5J

(D) 1.0×10^{-20}J

8. In the photoelectric experiment, on the graph of the stopping potential v_0 versus frequency ν, different materials show (parallel) straight lines all having same slope equal to:

(A) h/e

(B) h

(C) w/h

(D) e/h

(Where h=planck's constant, w=work, function, e=charge on the electron)

19. Bohr's theory was not able to explain:

(A) Mono electron systems

(B) Li ions

(C) Multi electron systems

(D) Hydrogen atom

20. Splitting of spectral lines due to magnetic effect is called:

(A) Zeeman effect

(B) Electromagnetic effect

(C) Condensation effect

(D) Spark effect

21. The wavelength associated with a particle of mass 'm' moving with a velocity 'v' is (h=Planck's constant):

(A) hmv

(B) h/mv

(C) mv/h

(D) h/v

22. The de Broglie's wavelength of an electron with a kinetic energy of 1.00eV is:

(A) 1.23 nm

(B) 1.00 nm

(C) 3.00 nm

(D) 0.5 nm

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23. In electron diffraction, rings behave as :

(A) Particles

(B) Waves

(C) Both (A) and (B)

(D) Rays

24. The mathematical expression for Heisenberg uncertainty principle is:

(A) $\Delta x . \Delta p_x \geq \frac{h}{\partial \pi}$

(B) $\Delta x . \Delta p_x \geq \frac{h}{2\pi}$

(C) $\Delta x . \Delta p_x \geq \frac{h^2}{2\pi}$

(D) $\Delta x . \Delta p_x \geq \frac{h}{4\pi}$

25. In Compton scattering experiment, shift in wavelength ($\lambda' - \lambda$):

(A) is dependent of the scatterer but varries with scattering mode.

(B) depends upon mass of the recoiling electron in the scatterer.

(C) depends upon the angle of scattering of photon and also on the scatterer

(D) depends on the Compton wavelength of the electron.

26. Which of the following is known as Schrödinger equation.

(A) $E=mc^2$

(B) $E=h\nu$

(C) $\lambda=h/p$

(D) $\hat{H}\psi = E\psi$

27. These quantum mechanical entities (with some exceptions) must be- (i) single valued (and their derivatives too) (ii) finite (and their derivatives too) (iii) continuous (and their derivatives too) (iv) normalizable They are :

(A) observables

(B) wavelengths

(C) wave functions

(D) expectation values

28. In the probabilistic interpretation of wave function ψ, the quantity $|\psi|^2$ is:

(A) a probability density

(B) a probability amplitude

(C) a negative probability

(D) Zero

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29. The momentum operator in one dimension is :

(A) $\frac{h\partial}{2\pi\partial x}$

(B) $\frac{2\pi i\partial}{h\partial x}$

(C) $\frac{h}{2\pi i}\frac{\partial}{\partial x}$

(D) $\frac{2\pi i}{h}\frac{\partial}{\partial t}$

30. The expression for Hamiltonian operator H is:

(A) $\frac{h^2}{8\pi^2 m}\nabla^2 + V$

(B) $-\frac{h^2}{8\pi^2 m}\nabla^2 + V$

(C) $\frac{h^2}{8\pi^2 m}\nabla^2 - V$

(D) $-\frac{h^2}{8\pi^2 m}\nabla^2 - V$

31. The wave function associated with the motion of an electron in a hydrogen atom can be expressed conveniently as a function of:

(A) Cartesian Coordinates

(B) Spherical Coordinates

(C) Cylindrical Coordinates

(D) None of the above

32. In hydrogen atom, the reduced mass μ is:

(A) m_e

(B) m_p

(C) $\approx m_p$

(D) $< m_e$

33. Spherical polar coordinates are used in the solution of hydrogen atom Schrödinger equation because:

(A) Cartesian coordinates would give particle in a box wave functions.

(B) The Laplacian operator has its simplest form in spherical polar coordinates.

(C) The Schrödinger equation is then separable into three ordinary differential equations.

(D) Otherwise the atomic orbitals would violate the Pauli's exclusion principle.

34. In the ground state energy of H-atom is -13.60 eV, then the ground state energy of Li^{2+} is approximately:

(A) -40.80 eV

(B) -54.4 eV

(C) +122.40 eV

(D) -122.40 eV

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35. Which of the following statement about hydrogen atom in ground state is incorrect-

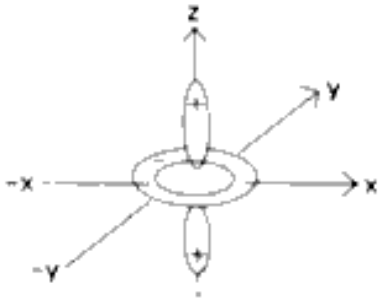
(A) It is described by the quantum number n=1, l=0, m=0.

(B) The electron's angular momentum equals to $h/2\pi$

(C) The radial distribution function has its maximum at the Bohr radius.

(D) The wave function is spherically symmetrical

36. The atomic orbital given on right is of what type:



(A) 3s

(B) 2p

(C) 3p

(D) $3d_{z^2}$

37. The wave functions which are the solutions of the wave equation which describe the behaviour of the electron in the hydrogen atom are described by how many quantum numbers?

(A) 3

(B) 2

(C) 1

(D) 4

38. For the hydrogen atom, which of the following orbitals has the lowest energy:

(A) 4s

(B) 4p

(C) 4d

(D) They all have the same energy

39. For reals atomic orbital with quantum numbers n, l, the total number of nodal surfaces are

(A) n

(B) n-1

(C) n-l-1

(D) n+l

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40. The Hamiltonian for hydrogen molecular ion (H_2^+) ion :

(A) $\hat{H} = -\frac{h^2}{8\pi^2 m}\nabla^2$

(B) $\hat{H} = -\frac{h^2}{8\pi^2 m}\nabla^2 - \frac{e^2}{r_A} + \frac{e^2}{r_B}$

(C) $\hat{H} = -\frac{h^2}{8\pi^2 m}\nabla^2 + \frac{e^2}{r_A} + \frac{e^2}{r_B}$

(D) $\hat{H} = -\frac{h^2}{8\pi^2 m}\nabla^2 - \frac{e^2}{r_A} - \frac{e^2}{r_B} + \frac{e^2}{R}$

41. According to molecular orbital theory:

(A) The atomic orbitals interact leading to the formation of molecular orbitals.

(B) The number of molecular orbitals formed are equal to number of combining atomic orbitals.

(C) Electrons fill the molecular orbitals in the same way as they fill the atomic orbitals.

(D) All of the above

42. Which of the following statements is not correct regarding bonding molecular orbital?

(A) Bonding molecular orbitals are formed when the electron wave functions undergo constructive interference.

(B) Bonding molecular orbital possess less energy than atomic orbitals from which they are formed.

(C) Bonding molecular orbitals have low electron density between the two nuclei.

(D) Every electron in the bonding molecular orbital contributes to the attraction between atoms.

43. When the 1s orbital of two hydrogen atom combine to form a hydrogen molecule, how many molecular orbitals are formed?

(A) One

(B) Two

(C) Three

(D) Four

44. Electromagnetic radiation is characterized by :

(A) Electric and magnetic field

(B) Wave and particle character

(C) Wavelength and wave number

(D) All of the above

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45. Radiation of wavelength 200 nm is equivalent in wave number to :

(A) $5\times10^{4}cm^{-1}$

(B) $5\times10^{2}cm^{-1}$

(C) $5\times10^{5}cm^{-1}$

(D) $5\times10^{12}cm^{-1}$

46. In the Born-Oppenheimer approximation:

(A) $E_{tr}>E_{rot}>E_{vib}>E_{el}$

(B) $E_{vib}>E_{el}>E_{rot}>E_{tr}$

(C) $E_{el}>E_{vib}>E_{rot}>E_{tr}$

(D) None of the above

47. The total number of normal modes of vibration of a linear molecule consisting of N atom is given by:

(A) (3N-5)

(B) (3N-6)

(C) (3N-2)

(D) (3N-7)

48. Which of the following molecules are microwave active:

(A) CO_2

(B) HCl

(C) O_2

(D) N_2

49. The rotational spectrum of a rigid diatomic rotor consists of equally spaced lines with spacing equal to

(A) 3B/2

(B) B

(C) B/2

(D) 2B

50. The vibrational transitions exist in:

(A) Microwave

(B) Visible

(C) Infrared

(D) Radioactive region of the spectrum

51. The vibrational stretching frequency of diatomic molecule depends on:

(A) Masses of two atom

(B) Force constant

(C) Both (A) and (B)

(D) None of the above

52. Raman effect is:

(A) Absorption of light

(B) Emission of light

(C) Elastic scattering of light

(D) Inelastic scattering of light

53. Raman lines on the low frequency side of the excitation frequency are called:

(A) Stokes lines

(B) Anti-Stokes lines

(C) Rayleigh lines

(D) All of the above

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54 The cause of Raman Spectrum of a molecule is:

(A) Change in polarizability of the molecule

(B) No effect on polarizability of the molecule

(C) Change in dipole moments of the molecule

(D) None of the above

55 Which of the following is IR-inactive but Raman active?

(A) Protein

(B) SO_2

(C) HCl

(D) N_2

56 Movement of nuclei is negligible during the time taken by an electronic transition, it is called:

(A) Born - Oppenheimer approximation

(B) Franck - Condon principle

(C) Lambert - Beer law

(D) None of the above

57 The shift of an absorption maximum towards longer wavelength is known as

(A) Hyperchromic shift

(B) Hypochromic shift

(C) Bathochromic shift

(D) Hypsochromic shift

58 In an UV spectrum, increase in conjugation of double bond causes:

(A) Bathochromic and hypochromic shift

(B) Hypsochromic and hypochromic shift

(C) Hypsochromic and hyperchromic shift

(D) Bathochromic and hyperchromic shift

59. Which one of the followings has highest value of λ_{max}?

(A) Aniline

(B) Benzene

(C) Phenol

(D) Anilinium ion

60. The unit of molar absorptivity is:

(A) Nanometer

(B) Area per mole

(C) Moles per litre

(D) Centimeter per mole

61. The calculation of λ_{max} value of conjugated dienes by Woodward-Fischer Rule, the value added for one alkyl substituent is :

(A) 30 nm

(B) 15 nm

(C) 10 nm

(D) 05 nm

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62 The most suitable solvent for UV spectroscopy is:

(A) Benzene

(B) Cyclohexane

(C) Iodoethane

(D) Acetone

63. Compound A with molecular formula C_4H_6 shows an intense peak at 217 nm in its UV spectrum A is:

(A) Alkene

(B) Alkane

(C) Alkyne

(D) Conjugated diene

64. Lowest energy transition in UV spectroscopy is:

(A) $\sigma-\sigma^*$

(B) $\pi-\pi^*$

(C) $n-\pi^*$

(D) $n-\sigma^*$

65. What is the λ_{max} of $(CH_3)_2C=CHCOCH_3$ in alcohol?

(A) 253 nm

(B) 249 nm

(C) 239 nm

(D) 268 nm

66 Which one is the correct basic value of λ_{max} for homoannular diene?

(A) 214 nm

(B) 217 nm

(C) 253 nm

(D) 215 nm

67. Find the correct statement:

(A) Absorption of radiation shifts to longer wavelength with increase in conjugation

(B) Absorption of radiation shifts to higher energy region with increase in conjugation

(C) Intensities of $n\rightarrow\pi^*$ transition decreases on conjugation

(D) Intensities of $\pi\rightarrow\pi^*$ transition decreases on conjugation

68. Saturated aliphatic acids show a strong C=O stretching band at 1720 cm^{-1}, corresponding band for α,β unsaturated acids will occur at

(A) 1800 cm^{-1}

(B) 1680 cm^{-1}

(C) 3000 cm^{-1}

(D) 3500 cm^{-1}

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69. Acetic acid in carbon tetrachloride solution shows a very broad and intense O–H stretching band around:

(A) 3500 cm^{-1}

(B) 1700 cm^{-1}

(C) 3000 cm^{-1}

(D) 1250 cm^{-1}

70. The molecule which will absorb in the IR region is:

(A) N_2

(B) $(CH_3)_2C=C(CH_3)_2$

(C) $ClCH_2COCH_2Cl$

(D) H_2

71. The bond with maximum value for frequency of stretching vibration in an IR spectrum is:

(A) C–C

(B) C=C

(C) C C

(D) None of the above

72. Which of the following spectroscopy is known as electromagnetic radiation absorption spectroscopy?

(A) MS

(B) NMR

(C) IR

(D) None of these

73. Which one of the following region in IR is known as functional group region?

(A) 1400–4000 cm^{-1}

(B) 900–1300 cm^{-1}

(C) 650–900 cm^{-1}

(D) None of these

74. What is the $>C=O$ stretching band in IR of $H_2C=CHCOCH_3$?

(A) 1700 cm^{-1}

(B) 1710 cm^{-1}

(C) 1680 cm^{-1}

(D) 1780 cm^{-1}

75. An alcohol having mol formula $C_4H_{10}O$ gives C–O stretching band at 1210 cm^{-1} will be:

(A) 1-Butanol

(B) 2-Butanol

(C) 2-methyl-2-propanol

(D) None of these

76. Which one of the following spectroscopy is based on the magnetic properties of the nucleus of the atom?

(A) IR

(B) UV

(C) NMR

(D) MS

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77. Which one of the following compound will give single NMR signal due to equivalent proton?

(A) $H_3C-O-CH_3$

(B) $CH_3CH_2OCH_3$

(C) CH_3COOCH_3

(D) $CH_2=CH-Cl$

78. Which proton of Br_2CH-CH_2Br give triplet splitting in NMR?

(A) $\rangle C-H$

(B) $-CH_2$

(C) Both of these

(D) None of these

79. How many NMR signals will be given by Vinyl chloride?

(A) 1

(B) 2

(C) 3

(D) 4

80. How many NMR signals you will get for methylene?

(A) 1

(B) 2

(C) 3

(D) 4

81. How many NMR signals you will get for 2-methyl butane?

(A) 1

(B) 2

(C) 3

(D) 4

82. How many NMR signals you will get for allyl bromide?

(A) 1

(B) 2

(C) 3

(D) 4

83. How many NMR signals you will get for neo-pentane?

(A) 1

(B) 2

(C) 3

(D) 4

84. Which one of the following spectroscopy involves bombardment of a beam of high energy electrons in vacuum?

(A) MS

(B) UV

(C) IR

(D) PMR

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85. Compounds containing an odd number of nitrogen will have a parent ion with :

(A) Even mass number

(B) Odd mass number

(C) Mass number may be even or odd

(D) None of the above

86. In a mass spectrum an ion of m/e 31 can be:

(A) C H

(B) C_2N

(C) CH_3O^+

(D) All of above

87. Elimination of neutral molecule to form new radical cations is called:

(A) Odd electron fragments

(B) Even electron fragments

(C) Nitrogen rule

(D) None of the above

88. If a parent ion contains C, H and O only its m/e value will be:

(A) Odd no.

(B) Even no.

(C) May be an even or odd no.

(D) None of the above

89. Elimination of a free radical to form ions is called:

(A) Odd electron fragments

(B) Even electron fragments

(C) Nitrogen Rule

(D) None of the above

90. In which spectroscopic techniques the sample is destroyed?

(A) UV

(B) IR

(C) NMR

(D) MS

91. In mass spectroscopy the peak with 100% abundance is :

(A) Base peak

(B) Molecular ion peak

(C) Parent ion peak

(D) None of the above

92. What is the structure of a compound whose m/e values in the mass spectrum are 100, 85, 71, 57, 43 (base), 41, 29 & 27?

(A) $C_5H_{12}CHO$

(B) n-hexane

(C) n-heptane

(D) None of the above

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93. The mass spectrum is a plot of

(A) Intensity vs wavelength

(B) Abundance vs m/e

(C) Wavelength vs frequency

(D) Wavelength vs m/e

94. Solvent extraction is basically known as :

(A) Gas-liquid extraction

(B) Liquid-liquid extraction

(C) Liquid-solvent extraction

(D) None of the above

95. Which among the following is not a membrane separation technique?

(A) Ultrafiltration

(B) Microfiltration

(C) Reverse osmosis

(D) Solvent extraction

96. Liquid-liquid mixture is separated with solvent extraction by adding ____ solvent.

(A) Miscible solvent

(B) Immiscible solvent

(C) Partially miscible solvent

(D) All of the above

97. In solvent extraction technique solvent lean phase is known as

(A) Extract

(B) Raffinate

(C) Residue

(D) None of the above

98. Fractional extraction is also known as:

(A) Double solvent extraction

(B) Single solvent extraction

(C) Triple solvent extraction

(D) Both (A) and (B)

99. What is the representation of distribution co-efficient?

(A) S

(B) H

(C) D

(D) K_D

100. Which of the following factors is responsible for extraction?

(A) Salting out agents

(B) Masking agents

(C) Synergistic agents

(D) All of the above

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