

National Testing Agency

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Quantum Chemistry Spectroscopy and Photochemistry

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|------------------------------------|----------|
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Quantum Chemistry Spectroscopy and Photochemistry

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|---------------------------------------------|-----------|
| Section Id : | 41652998 |
| Section Number : | 1 |
| Section type : | Online |
| Mandatory or Optional: | Mandatory |
| Number of Questions: | 50 |
| Number of Questions to be attempted: | 50 |
| Section Marks: | 100 |
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|-------------------------------------|-----------|
| Sub-Section Number: | 1 |
| Sub-Section Id: | 416529103 |
| Question Shuffling Allowed : | Yes |

Question Number : 1 Question Id : 4165297801 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical
Correct Marks : 2 Wrong Marks : 0

Which of the function are eigen function of $\frac{d^2}{dx^2}$

- Sin 3x
- ln 2x
- 1/x

Question Number : 2 Question Id : 4165297802 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is NOT a linear operator?

- a. Integration
- b. $\frac{d^2}{dx^2}$
- c. Square root

Question Number : 3 Question Id : 4165297803 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is the quantum mechanical operator for momentum of a particle moving along x-axis?

- a) $-i\hbar d/dx$
- b) $+i\hbar d/dx$
- c) $(-i\hbar / 2\pi) d/dx$

Question Number : 4 Question Id : 4165297804 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The normalization constant for the wave function obtained for particle in one dimensional box problem is

- a) $\sqrt{l/2}$
- b) $\sqrt{2/l}$
- c) $l/\sqrt{l/2}$

Question Number : 5 Question Id : 4165297805 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The harmonic oscillator wave function $\psi_0(x)$ is equal to (where $\alpha = \frac{(k\mu)^{1/2}}{\hbar/2\pi}$)

- a) $\left(\frac{\alpha}{\pi}\right) e^{-\alpha x^2/2}$
- b) $\left(\frac{\alpha}{4\pi}\right) e^{-\alpha x^2/2}$
- c) $\left(\frac{4\alpha^3}{\pi}\right) e^{-\alpha x^2/2}$

Question Number : 6 Question Id : 4165297806 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The multiplication of raising operator (\hat{M}_+) and lowering operator (\hat{M}_-) is

- a) $\hat{M}^2 - \hat{M}_z^2$
- b) $\hat{M}^2 + \hat{M}_z^2$
- c) $\hat{M}^2 - \hat{M}_z^2 - \frac{h}{2\pi} \hat{M}_z$

Question Number : 7 Question Id : 4165297807 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The energy eigen value of rigid rotator is

- a) $E = \frac{l(l+1)h^2}{8\pi^2 I}$
- b) $E = \frac{l(l+1)I^2}{8\pi^2 h}$
- c) $E = \frac{l(l+1)h^2}{8\pi^2 I^2}$

Question Number : 8 Question Id : 4165297808 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The operator for kinetic energy for electron hydrogen like ions is (where ∇^2 is Laplacian operator)

- a) $-\frac{h^2}{8\pi^2 m_e} \nabla^2$
- b) $-\frac{h^3}{\pi^2 m_e} \nabla^2$
- c) $-\frac{h^2}{8\pi^2} \nabla^2$

Question Number : 9 Question Id : 4165297809 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following plots would refer to the radial probability curves?

- a) $R(r)$ versus r
- b) R versus r
- c) $R^2(r) \cdot 4\pi^2 r$ versus r

Question Number : 10 Question Id : 4165297810 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following statements is correct about the approximation methods?

- a) Both the variation theorem and the Perturbation method use trial wave functions
- b) Both the variation theorem and the Perturbation method use partial Hamiltonian
- c) Variation method uses trial wave function whereas the Perturbation method uses partial Hamiltonian

Question Number : 11 Question Id : 4165297811 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Gerade refers to

- a) the even parity of the wave function
- b) the odd parity of the wave function
- c) the grade or quality of wave function

Question Number : 12 Question Id : 4165297812 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The bond order for hydrogen molecule ion is

- a) 0.0
- b) 0.5
- c) 1.5

Question Number : 13 Question Id : 4165297813 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

For hydrogen molecule, the valence bond wave functions is equal to (where S_A and S_B represents the nuclei of hydrogen atoms and numbers in the bracket are the electron associated with hydrogen atoms)

- a) $1S_A(1).1S_B(2)-1S_A(2).1S_B(1)$
- b) $1S_A(1).1S_B(2) \times 1S_A(2).1S_B(1)$
- c) $1S_A(1).1S_B(2) + 1S_A(2).1S_B(1)$

Question Number : 14 Question Id : 4165297814 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following correctly represents the electromagnetic waves in order of decreasing wavelengths?

- a) gamma rays, ultraviolet, infrared, microwave
- b) microwaves, visible light , ultraviolet, gamma rays
- c) radio waves, infrared, visible light, X-rays

Question Number : 15 Question Id : 4165297815 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following colour of visible light has the highest energy?

- a) blue
- b) red
- c) green

Question Number : 16 Question Id : 4165297816 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Irradiation of a given molecule with radiation in microwave region may cause,

- a) Rotational transition
- b) Vibrational transition
- c) Electronic transition

Question Number : 17 Question Id : 4165297817 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following does not affect the intensity of an absorption signal?

- a) The wavelength of the radiation absorbed
- b) The population of the initial energy level
- c) Concentration of absorbing species

Question Number : 18 Question Id : 4165297818 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is used a material for making a sample holder for taking spectrum of an aqueous solution in the UV range?

- a) Glass
- b) Quartz
- c) Potassium bromide

Question Number : 19 Question Id : 4165297819 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The Legendre and associated Legendre polynomials are included in the solution of

- a) Particle in one-dimensional box
- b) Particle in a sphere
- c) Particle having simple harmonic oscillation

Question Number : 20 Question Id : 4165297820 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following in the NMR spectrum provide information about different types of protons in the molecule?

- a) Number of signals in the spectrum
- b) Spin-spin coupling
- c) Area under the curves (integration trace)

Question Number : 21 Question Id : 4165297821 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The NMR spectrum for $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{O}$ and $(\text{CH}_3\text{CH}_2\text{CH}_2)_2\text{N}$ would differ in terms of

- a) the splitting pattern
- b) the chemical shifts
- c) integration ratios

Question Number : 22 Question Id : 4165297822 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The Shooley's additivity rules are based on the fact that,

- a) The proton chemical shifts and the electronegativity of the substituents are correlated
- b) The proton chemical shifts are independent of the electronegativity of the substituents
- c) The proton chemical shifts and the size of the substituents are correlated

Question Number : 23 Question Id : 4165297823 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The protons of acetylene molecule are most deshielded when the molecule is,

- a) Oriented randomly
- b) Oriented at an angle of 0° to the direction of the applied field
- c) Oriented at an angle of 90° to the direction of the applied field

Question Number : 24 Question Id : 4165297824 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Due to hydrogen bonding the protons in NMR will,

- a) get deshielded and are observed at high δ -value
- b) get shielded and are observed at high δ -value
- c) get deshielded and are observed at low δ -value

Question Number : 25 Question Id : 4165297825 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In CW- NMR,

- a) The sample is continuously varied at constant frequency
 - b) A constant width of radiofrequency is applied
 - c) The radiofrequency is varied at constant field
-

Question Number : 26 Question Id : 4165297826 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The precessional frequency (NMR) depends on,

- a) the applied radiofrequency
- b) the applied magnetic field
- c) Boltzmann coefficient

Question Number : 27 Question Id : 4165297827 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The NMR spectra are intrinsically weak, because

- a) the ground and the excited spin states for the nuclei are degenerate
 - b) the difference in the energies of ground and the excited spin states for the nuclei is zero
 - c) the difference in the energies of ground and the excited spin states for the nuclei is very small
-

Question Number : 28 Question Id : 4165297828 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following nuclei would be useful for NMR spectroscopy?

- a) C^{12}
- b) C^{13}
- c) N^{14}

Question Number : 29 Question Id : 4165297829 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The nuclear magnetic moment is proportional to the angular momentum for the nucleus. The proportionality constant is called

- a) Bohr magneton
- b) Spin ratio
- c) Gyromagnetic ratio

Question Number : 30 Question Id : 4165297830 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is true about the energies of the nuclear spins of the nuclei with $I = \frac{1}{2}$ in an applied magnetic field?

- a) The nuclear spins aligned with the applied field are of low energy
- b) The nuclear spins against the applied field are of low energy
- c) The nuclear spins aligned with the applied field have same energy as that of the spins aligned against the field

Question Number : 31 Question Id : 4165297831 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

If an unpaired electron interacts with n nuclei then the no. of lines in the EPR spectrum will be equal to

- a) $2nI+1$
- b) $2I+1$
- c) $2nI+2$
- d) $2n$

Question Number : 32 Question Id : 4165297832 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Read following two sentences. And choose most appropriate option concerning ESR spectroscopy.

(i) Creating Zeeman splitting, with application of magnetic field, is most important parameter in ESR spectroscopy

(ii) Resonance condition for EPR is $h\nu$ is equal to $g\mu_B B$

- a) Only sentence (i) is correct
- b) Only sentence (ii) is correct
- c) Both sentences (i) and (ii) are correct

Question Number : 33 Question Id : 4165297833 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The rotational spectroscopy is a consequence of the interaction between the molecules and _____

- a) UV radiation
- b) X-ray radiation
- c) Microwave radiation

Question Number : 34 Question Id : 4165297834 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following molecules would show rotational spectrum?

- a) Methane
- b) Hydrogen
- c) Hydrogen bromide

Question Number : 35 Question Id : 4165297835 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following best represents a rotating diatomic molecule?

- a) Harmonic oscillator
- b) Vibrating rotator
- c) Rotating particle

Question Number : 36 Question Id : 4165297836 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The selection rule for a rigid rotor is _____

- a) $\Delta J = 0$
- b) $\Delta J = \pm 1$
- c) $\Delta J = \pm 2$
- d) $\Delta V = \pm 1$

Question Number : 37 Question Id : 4165297837 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is responsible for the variation in the intensity of rotation spectral line?

- a) The degeneracy of energy levels
- b) The bond length of the molecule
- c) Moment of inertia

Question Number : 38 Question Id : 4165297838 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following correctly gives the expression for the zero point energy for a vibrating diatomic molecule?

- a) $E_0 = 0 \omega_{osc}$
- b) $E_0 = \frac{1}{2} \omega_{osc}$
- c) $E_0 = \omega_{osc}$

Question Number : 39 Question Id : 4165297839 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

For a vibrating molecule to absorb radiation a requirement is that the

- a) The vibration is symmetric in nature
- b) The vibration is asymmetric in nature
- c) The vibration is accompanied by an oscillating dipole moment

Question Number : 40 Question Id : 4165297840 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is the prerequisite for molecule to show Raman effect?

- a) The molecule should be polar
- b) The molecule should be covalent
- c) The molecule should be anisotropically polarizable

Question Number : 41 Question Id : 4165297841 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following correctly gives the selection rule for pure rotation Raman spectrum?

- a) $\Delta J = 0, \pm 1, \pm 2 \dots$
- b) $\Delta V = 0, \pm 1, \pm 2 \dots$
- c) $\Delta V = 0, \pm 1, \pm 2 \dots$ and $\Delta J = \pm 2$

Question Number : 42 Question Id : 4165297842 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Polarization induces three distinct frequencies which are

- (i) $\nu = \nu_0$ Rayleigh line
- (ii) $\nu = \nu_0 - \nu_m$ Raman Stokes line
- (iii) $\nu = \nu_0 + \nu_m$ Raman anti-Stokes line

On the basis of above statements, choose correct option

- a) Only (i) and (ii) are correct
- b) Only (i) and (iii) are correct
- c) All (i), (ii) and (iii) are correct

Question Number : 43 Question Id : 4165297843 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is a prerequisite for a molecule to show rotational spectrum?

- a) The molecule must be homonuclear
- b) The molecule must be polar
- c) The molecule must have a carbon atom

Question Number : 44 Question Id : 4165297844 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is a good model for the vibration of a diatomic molecule?

- a) Harmonic oscillator
- b) Rigid rotor
- c) Anharmonic oscillator

Question Number : 45 Question Id : 4165297845 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In a photochemical reaction, Quantum yield will not change if reaction is

- a) reversible
- b) spontaneous
- c) primary

Question Number : 46 Question Id : 4165297846 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

In following reaction backward process happens in the dark. Out of the four statements, which statement is not correct?



- a) Ag^+ is reduced while Cu^+ oxidized
- b) Forward reaction has to be photochemical
- c) ΔG for forward reaction should be -ve while +ve for backward reaction
- d) is an example of photochromism

Question Number : 47 Question Id : 4165297847 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is not a photophysical process?

- a) Fluorescence
- b) Isomerisation
- c) Intersystem crossing
- d) Internal conversion

Question Number : 48 Question Id : 4165297848 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following correctly defines fluorescence quenching?

- a) The decrease in the fluorescence intensity due to different non-radiative processes
- b) The decrease in the fluorescence intensity due to different radiative processes
- c) The increase in the reaction yield due to different non-radiative processes
- d) None of the option

Question Number : 49 Question Id : 4165297849 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is a correct statement? (Here line means Lorentzian, and band means Gaussian)

- a) Fluorescence spectra are band spectra whereas phosphorescence spectra are line spectra
- b) Absorption spectra are band spectra whereas Fluorescence spectra are line spectra
- c) Absorption, Fluorescence and phosphorescence spectra are all band spectra
- d) Absorption, fluorescence and phosphorescence are line spectra

Question Number : 50 Question Id : 4165297850 Question Type : MCQ Option Shuffling : No Display Question Number : Yes
Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Which of the following is a radiative process?

- a) Vibrational relaxation
- b) Intersystem crossing
- c) Fluorescence
- d) Absorption