Write the following information in the first page of Answer Script before starting answer

ODD SEMESTER EXAMINATION: 2020-21

Exam ID Number_____

Course_____ Semester_____

Paper Code _____Paper Title _____

Type of Exam: _____ (Regular/Back/Improvement)

Important Instruction for students:

1. Student should write objective and descriptive answer on plain white paper.
2. Give page number in each page starting from 1st page.
3. After completion of examination, Scan all pages, convert into a single PDF, rename the file with Class Roll No. **(2019MBA15)** and upload to the Google classroom as attachment.
4. Exam timing from 10am – 1pm (for morning shift).
5. Question Paper will be uploaded before 10 mins from the schedule time.
6. Additional 20 mins time will be given for scanning and uploading the single PDF file.
7. Student will be marked as ABSENT if failed to upload the PDF answer script due to any reason.

B.Sc. CHEMISTRY
FIFTH SEMESTER
PHYSICAL CHEMISTRY-V
BSC-502

Duration : 3 hrs. **Full Marks : 70**

(PART-A : Objective)

Time : 20 min. **Marks : 20**

Choose the correct answer from the following: ***1X20=20***

1. What formula best describes the emission spectrum of a blackbody?
a. Raleigh-Jeans formula **b.** Wein's formula
c. Planck's formula **d.** DeBroglie's formula

2. The square of the magnitude of the wave function is called_____.
a. Current density **b.** Probability density
c. Probability **d.** Zero

3. The operator ∇^2 is called_____ operator.
a. Hamiltonian **b.** Laplacian
c. Poisson **d.** Vector

4. Quantum mechanical operators are:
a. Square operators **b.** Square root operators
c. Hermitian operators **d.** None

5. The eigen function of a rigid rotor are:
a. Hermite polynomials **b.** Legendre polynomials
c. Spherical harmonics **d.** Tchebyshev polynomials

6. The value of the commuter [x, d/dx] is:
a. 1 **b.** -1
c. 2 **d.** 0

7. Which one of the following is true for angular momentum of a particle on a ring?
a. It is a vector **b.** It is resultant of cross product of linear momentum and radius
c. It is quantized **d.** All of the above

8. Which of the following is true with respect to energy of subshells in hydrogenic atoms?
a. 1s < 2s = 2p < 3s = 3p = 3d < 4s **b.** 1s < 2s < 2p < 3s < 3p < 4s < 3d
c. 1s < 2s < 2p < 3s < 3p < 3d < 4s **d.** None of the above

9. In photochemical reactions, the absorption of light takes place in:
a. Primary processes only **b.** Secondary processes only
c. Either primary or secondary process **d.** Both primary and secondary processes

10. Photochemical reaction takes place by the absorption of:
a. Visible and ultraviolet radiations **b.** Infrared radiations
c. Heat energy **d.** None of these

11. The wavelength of ultraviolet and visible regions of electromagnetic spectrum is:

a. Less than 2000 Å
b. More than 8000 Å
c. 2000° to 8000 Å
d. None of these

12. A species which can both absorb and transfer radiant energy for activation of the reactant molecule is called:

a. A photosensitizer
b. An ioniser
c. A photochemical substance
d. Radioactive substance

13. _____stops as soon as the incident radiation is cut off.

a. Phosphorescence
b. Fluorescence
c. Chemiluminescence
d. None of these

14. Which of the following has highest frequency?

a. Microwave
b. UV-Visible
c. Infra-Red
d. X-ray

15. The unit of frequency is:

a. cm^{-1}
b. sec^{-1}
c. m^{-1}
d. $m\ sec^{-1}$

16. Which of the following is true for prolate symmetry?

a. $I_{\perp} > I_{\parallel}$
b. $I_{\perp} < I_{\parallel}$
c. $I_{\perp} = I_{\parallel}$
d. None of these

17. Choose the correct answer for Raman spectra.

a. $\Delta J = 0, +1$ etc.
b. $\Delta J = +1$
c. $\Delta J = +2$
d. $\Delta J = +1, +2$ etc.

18. With the increase in vibrational quantum number of an anharmonic oscillator, the energy gap will be:

a. Decreased
b. Increased
c. Remain same
d. None of these

19. The microwave spectrum of a molecule yields three rotational constants. The molecule is:

a. Prolate symmetric top
b. Spherically top
c. Oblate symmetric top
d. Assymetric top

20. For rotational quantum number J = 1, the rotational energy will be:

a. 0
b. 2B
c. 6B
d. 12B

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PART-B : Descriptive

Time : 2 hrs. 40 min. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. **a.** Write the properties of the wavefunctions for particle in 1D box. 5
b. Find a state (n1, n2) for a particle in a rectangular box with sides of length L1 = L and L2 = 2L that is accidentally degenerate with the state (4,4). 3
c. Wavefunction of a harmonic oscillator is combination of which two types of functions? 2

2. **a.** What is Ritz Combination Principle? 2
b. β-Carotene is a linear polyene in which 10 single and 11 double bonds alternate along a chain of 22 carbon atoms. If we take C-C bond length to be about 140pm, then the length L of the molecule box of β-Carotene is L = 2.94 nm. Estimate the wavelength of the light absorbed by this molecule from its ground state to the next higher excited state. 3
c. Elaborately derive how to separate internal and external motion in Schrodinger equation of hydrogen atom. 5

3. **a.** Distinguish between photochemical and thermal reactions. 5
b. A monochromatic light is incident on solution of 0.05 molar concentration of an absorbing substance. The intensity of the radiation is reduced to one-fourth of the initial value after passing through 10 cm length of the solution. Calculate the molar extinction coefficient of the substance. 5

4. **a.** Define quantum yield. 2
b. Explain fluorescence and phosphorescence. 3
c. Derive the Lambert-Beer law. 5

5. **a.** Depending on moment of inertia, how many top molecules were observed? Explain with suitable examples. 5
b. Define singlet and triplet states 3
c. Why does electronic spectroscopy is also known as UV-visible spectroscopy? 2

6. **a.** State and Explain Franck-Condon principle. 5
b. Determine the moment of between two molecules separated by distance ''r'' having masses m_1 and m_2. 5

7. **a.** Sketch the energy level for anharmonic oscillator. Under what condition the frequency of harmonic oscillator become equal to that of anharmonic oscillator. 4
b. Determine the energy for fundamental overtone, first overtone and hot band. 6

8. Write some of the characteristic of electromagnetic radiation. What happen when an electromagnetic radiation interact with matter. Explain with suitable example. 10

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