

B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, OCTOBER 2014**Fifth Semester****Core Course—QUANTUM MECHANICS AND SPECTROSCOPY**

(Common for B.Sc. Chemistry Model I and Model II, B.Sc. Petrochemical and B.Sc. Chemistry Environment and Water Management)

Time : Three Hours

Maximum Weight : 25

Section A*Answer all questions.**Each bunch of four questions carries a weight of 1.*

- I. 1 What is Stark effect ?
2 What is fermi resonance ?
3 How many kinds of protons are there in $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}_2\text{CH}_3$?
4 What is meant by bathochromic shift ?
- II. 5 The force constant of a diatomic $\delta\text{H. O}$ is equal to _____.
6 If two operators commute then they are _____.
7 The Hamiltonian for H_2 molecule is _____.
8 The Magnitude of angular momentum of a 3d electron in units of \hbar is _____.
- III. State whether the following statements are True or False :
9 For a nucleus of spin quantum number 'I' there are $(2I+1)$ allowed spin states.
10 The band order of N_2 molecule is 2.5.
11 The radius of an orbit of an electron in the first excited state of hydrogen atom is $4a_0$.
12 The eigen functions of rigid rotator are spherical harmonics.
- IV. 13 What is the value of the commutator $\left[x, \frac{d}{dx}\right]$?
14 What are the number of translational, rotational and vibrational degrees of freedom in CO_2 ?
15 Explain briefly the isomerization of 2 butene-2
16 Calculate the bond order of H_2 molecule.

(4 × 1 = 4)

Turn over

Section B

*Answer any five questions.
Each question carries a weight of 1.*

- 17 What is a normalized wave function ?
- 18 How many vibrational modes are possible for SO_2 ?
- 19 What are the permitted values of quantum number n ? Explain, why a value of zero is not permitted ?
- 20 Sketch the NMR spectrum of methanol.
- 21 Of the following molecules which are IR inactive but Raman active (a) HCl ; and (b) N_2 .
- 22 What is zeropoint energy ?
- 23 State Beer-Lambert Law.
- 24 What is Compton effect ?

(5 × 1 = 5)

Section C

*Answer any four questions.
Each question carries a weight of 2.*

- 25 Discuss the principle of mass spectrometry.
- 26 What are (a) Chromophore; and (b) Auxochrome. Give example of each .
- 27 What is the speed of an electron whose de-Broglie wavelength is 0.1 nm ?
- 28 How many rotational and vibrational modes are possible for HCN ?
- 29 Sketch and explain the radial distribution plots for 2s and 2p orbitals.
- 30 What are the different types of electronic transitions in molecules ? Arrange them in increasing order of energy.

(4 × 2 = 8)

Section D

*Answer any two questions.
Each question carries a weight of 4.*

- 31 (a) Discuss Frank Condon principle.
(b) Explain chemical shift with adequate illustrations.
- 32 (a) Explain briefly primary and secondary process.
(b) Discuss phosphorescence and fluorescence.
- 33 (a) Compare MO and VB theories of covalent bonding.
(b) Discuss the characteristics of σ , σ^* , π and π^* Orbitals.

(2 × 4 = 8)