

**ASSIGNMENT BOOKLET****Spectroscopy****Bachelor's Degree Programme (B.Sc.)****(Valid from 1<sup>st</sup> January, 2022 to 31<sup>st</sup> December, 2022)****Please Note**

- You can take electives (56 to 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.
- You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.
- At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits should be from lab courses.
- You cannot appear in the Term-End Examination of any course without registering for the course. Otherwise, your result will not be declared and the onus will be on you.



**School of Sciences  
Indira Gandhi National Open University  
New Delhi  
(2022)**

Dear Student,

We hope, you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide that we sent you after your enrolment. A weightage of 30 percent, as you are aware, has been earmarked for continuous evaluation, which would consist of one tutor-marked assignment. The assignment is based on Blocks 1, 2, 3 and 4.

### Instructions for Formatting Your Assignments

Before attempting the assignments, please read the following instructions carefully.

- 1 On top of the first page of your answer sheet, please write the details exactly in the following format:

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ENROLMENT NO.....

NAME:.....

ADDRESS:.....

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COURSE CODE : .....

COURSE TITLE : .....

ASSIGNMENT NO.: .....

STUDY CENTRE : ..... DATE:.....  
(NAME AND CODE)

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**PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.**

- 2 Use only foolscap size writing paper (but not of very thin variety) for writing your answers.
- 3 Leave 4 cm margin on the left, top and bottom of your answer sheet.
- 4 Your answers should be precise.
- 5 While writing answers, clearly indicate the Question No. and part of the question being solved.
- 6 Please note that:
  - i) The Assignment is valid from 1<sup>st</sup>January, 2022 to 31<sup>st</sup>December, 2022.
  - ii) The response to this assignment is to be submitted to the Study Centre Coordinator within eight weeks of the receipt of this booklet in order to get the feedback and comments on the evaluated assignment.
  - iii) In any case, you have to submit the assignment response before appearing in the term end examination.

- 7 **We strongly suggest that you should retain a copy of your assignment responses.**

**Wishing you all good luck.**

## Tutor Marked Assignment CHE-10: Spectroscopy

Course Code: CHE-10  
Assignment Code: CHE-10/TMA/2022  
Maximum Marks: 100

- Note:**
- \* This assignment is based on all the four Blocks of the entire course.
  - \* All questions are compulsory. Marks for the questions are shown within brackets on the right hand side.
  - \* Please answer in your **own words**; do not copy from the course material.
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1. Draw and explain various series of spectral lines observed in the atomic spectrum of hydrogen atom. (5)
2. For the carbon atom, arrive at various possible energy states. Which one of these will be the lowest energy state? Justify? (5)
3. Define  $n$ -fold axis of symmetry. Draw various axes of symmetry present in the following molecules : (5)
  - (i)  $\text{NH}_3$  (5)
  - (ii)  $\text{BF}_3$  (5)
  - (iii) BenzeneAlso identify the principal axis in these molecules.
4. Name the symmetry elements present in the following molecules: (5)
  - (i)  $\text{SO}_2$
  - (ii)  $\text{CH}_4$
  - (iii)  $\text{PCl}_5$To which point group, each one of these molecules belong?
5. Derive the following expression for a rigid diatomic molecule: (5)
$$I = \mu r^2$$
6. Draw and explain the vibrational rotational spectrum of a diatomic molecule which is a rigid rotator and a harmonic oscillator. (5)
7. Discuss the IR spectrum of water molecule giving a suitable diagram for the vibrational levels. Also calculate the zero point energy of water molecule. (5)
8. In the infrared spectrum, discuss the structural units of different groups which absorb in the region  $1500\text{-}600\text{ cm}^{-1}$ . (5)
9. What are Stokes, anti-Stokes and Rayleigh spectral lines? Illustrate using a suitable diagram. (5)
10. State mutual exclusion principle. How will you arrive at the structure of  $\text{N}_2\text{O}$  molecule using this principle? You can discuss the same using the data given in the study material. (5)
11. Derive the terms symbols for the following: (5)
  - (i) Hydrogen molecule in the ground state
  - (ii) Hydrogen molecule in the first excited state
12. Define the following terms giving suitable examples: (5)
  - (i) Chromophore
  - (ii) Auxochrome

- (iii) Red shift
  - (iv) Hypsochromic shift
  - (v) Hyperchromic shift
13. Draw and explain the crystal field splitting of *d*-orbitals of a metal ion in a complex having octahedral and tetrahedral geometries. (5)
  14. Using a suitable diagram, explain the processes of fluorescence, inter-system crossing and phosphorescence. (5)
  15. Answer the following in two or three lines: (5)
    - (i) What is the role of lithium mirror in IR spectrometer?
    - (ii) What is the role of water jacket in Raman spectrometer?
    - (iii) Why cannot glass cell be used for IR spectroscopy?
    - (iv) What do you understand by the term resolving power?
    - (v) What are the source of the microwave and the infrared radiations?
  16. Discuss the phenomenon of relaxation in the context of NMR spectrum. (5)
  17. Using a suitable diagram, explain the number of signals and their splitting pattern observed in the NMR spectrum of 1,1,2-trichloroethane. (5)
  18. Discuss the ESR spectrum of methyl radical giving a suitable diagram. Also indicate the transitions involved. (5)
  19. What are the different methods of ionisation used in the mass spectrometry? Briefly explain. (5)
  20. What are the expected data for the molecule HO-CH<sub>2</sub>-CH<sub>2</sub>-NH<sub>2</sub> in different spectral regions? Justify your answer giving suitable explanation. (5)