CHE-01

ASSIGNMENT BOOKLET

Bachelor's Degree Programme (B.Sc.)

ATOMS AND MOLECULES

(Valid from 1st January, 2025 to 31st December, 2025)

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
Maidan Garhi, New Delhi-110068
(2025)

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 per cent, 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 and 2.

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:

ENROLMENT NO.:……..……

NAME:……...……

ADDRESS:…….....……

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COURSE CODE : ….....……

COURSE TITLE : ….....……

ASSIGNMENT NO.: ….....……

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

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 1st January, 2025 to 31st December, 2025.
   ii) The response to this assignment is to be submitted to the Study Centre Coordinator within eight weeks of the receipt of the course materials 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-01: Atoms and Molecules

Course Code: CHE-01
Assignment Code: CHE-01/TMA/2025
Maximum Marks: 100

Attempt all the questions. Each question carries 10 marks.

1. a) Describe the common features which can be explained by the theoretical model of Bohr? Briefly write the limitation of this model. (5)

   b) Calculate the ionization energy of hydrogen atom using Bohr's theory. (5)

2. a) Derive an expression for calculating energy values corresponding $n = 3$ for a particle in one dimensional box. (5)

   b) Write the values of four quantum numbers for 3*d* electrons. (5)

3. a) Explain the reason for the variation of the first ionization energies of the third period elements. (4)

   b) Calculate the lattice energy (in Units kJ mol^{-1}) for ZnO crystal using Eq. 3.4 based on electrostatic model and using a Born-Haber cycle. Compare the two answers and comment on any difference. (6)

   Useful data:

   Medelung constant (A) = 1.6411

   Born Constant (n) = 8

   Internuclear distance (a) = 199 pm

   $Zn(s) + \frac{1}{2} O_2(g) \rightarrow ZnO(s) \quad \Delta H_f = -350.5$ kJ mol^{-1}

   $Zn(s) \rightarrow Zn(g) \quad \Delta H_S = 130.4$ kJ mol^{-1}

   $Zn(g) \rightarrow Zn^+(g) \quad I(Zn) = 906.3$ kJ mol^{-1}

   $Zn^+(s) \rightarrow Zn^{2+}(g) \quad I(Zn^+) = 1733$ kJ mol^{-1}

   $\frac{1}{2} O_2(g) \rightarrow O(g) \quad \frac{1}{2}\Delta H_d = 248.5$ kJ mol^{-1}

   $O(g) \rightarrow O^-(g) \quad E_A(O) = 141$ kJ mol^{-1}

   $O^-(g) \rightarrow O^{2-}(g) \quad E_A(O^-) = -780$ kJ mol^{-1}

4. a) In carbonate ion, all the three C–O bonds have identical bond length. Explain. (4)

   b) Explain the type of hybridization in phosphorous pentafluoride. (6)

5. a) By writing molecular orbital configuration for each of following molecules calculate the bond order and also determine whether it is paramagnetic or diamagnetic. (6)

   (i) NO (ii) CO (iii) O_2^+

   b) Using suitable examples define gerade and ungerade orbitals. (4)

6. a) The dipole moment of HBr is 2.60×10^{-30} C m and interatomic distance 141 pm. What is the percentage ionic character of HBr? (6)

   b) Draw all of the stereoisomers of 2,3-butandiol, label meso compounds and pairs of enantiomer. (2)

   c) What is the predicted magnetic moment of Cu^+ and Cu^{2+} ions in μ_B Unit (Atomic number of Cu 29)? (2)

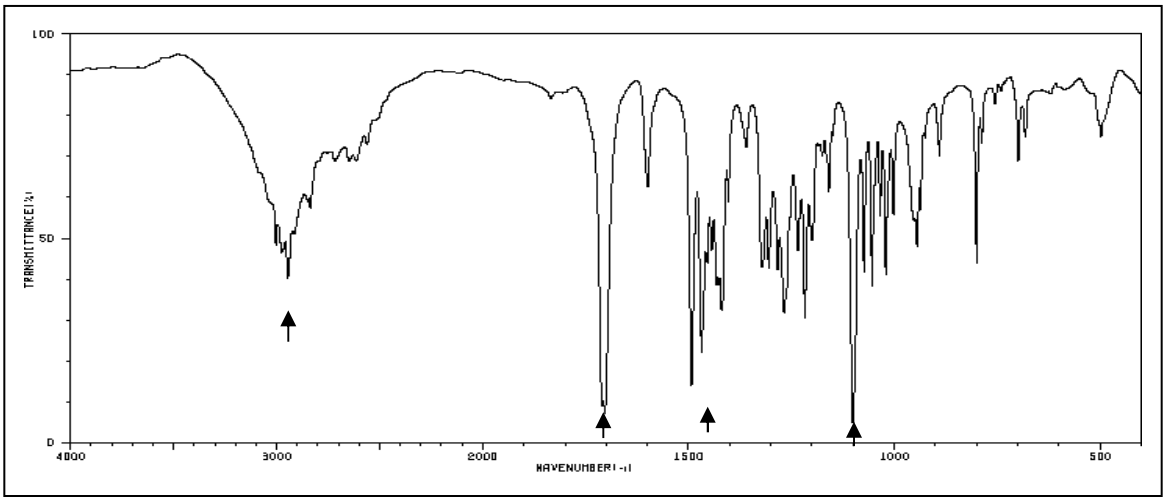
7. a) Given that the spacing of the lines in the microwave spectrum of $^{24}Al^1H$ is constant at 12.604 cm^{-1}. Calculate the moment of inertia and bond length of the molecule. (6)

b) Determine the wavelength for a transition from the $\nu = 0$ to the $\nu = 1$ level. Is this transition in the IR region of the electromagnetic spectrum? (2)

c) Which of the following molecules exhibit rotational and or vibrational spectra (2)

H_2, HF, CO, NO

8. a) From the infrared spectrum given below, identify the possible functional groups corresponding to the peaks indicated by the arrows. (4)



b) Explain why $\pi \rightarrow \pi^*$ transitions are the most useful transition in UV–VIS spectroscopy? (3)

c) UV–VIS absorption spectra are broad band spectra. Explain. (3)

9. a) Normal water contains isotope of hydrogen ^3H, tritium. It has a half-life of 12.3 years. Determine the age of a bottle of wine whose ^3H radiations is about 1/10 that present in new wine. (5)

b) Complete following equations: (5)

i) $^{30}P + ... \rightarrow {}^{30}Si$

ii) $^{10}B + n \rightarrow \quad ... \quad + \alpha$

iii) $^{20}Ne + {}^{136}Ba \rightarrow {}^{150}Dy + ...$

iv) $... + {}^{2}H \rightarrow {}^{22}Na + \alpha$

v) $^{241}Am + ... \rightarrow {}^{243}Bk + 2n$

10. a) Arrive at the Lewis structure of XeF_4 using the steps given in Unit 3. (4)

b) Predict the hybridization state of each carbon atom in allene which has the following structure: (3)

$CH_2 = C = CH_2$

c) Calculate the number of normal modes of vibration for the following compounds: (3)

i) H_2O

CH_4

ii) HBr