CHE-01

ASSIGNMENT BOOKLET

Bachelor's Degree Programme (B.Sc.)

ATOMS AND MOLECULES

(Valid from 1st January, 2024 to 31st December, 2024

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
(2024)

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:……

……

……

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, 2024 to 31st December, 2024.
   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
Atoms and Molecules

Course Code: CHE-01
Assignement Code: CHE-01/TMA/2024
Maximum Marks: 100

Attempt all the questions. Each question carries 10 marks.

Use the following data:

Permittivity in vacuum = 8.854×10^{-12} C^2 N^{-1} m^{-2}

Planck's constant = 6.626×10^{-34} J s

Mass of electron = 9.109×10^{-31} kg

Magnitude of the charge on the electron = 1.602×10^{-19} C

Avogadro constant = 6.022×10^{23} mol^{-1}

Velocity of light = 2.998×10^{8} m s^{-1}

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1. a) Calculate the ionisation energy of rubidium per atom, if light of wavelength 5.84×10^{-8} m produces electrons with a speed of 2.450×10^{6} ms^{-1}. (5)

   [*Hint:* Assume that the threshold frequency refers to the frequency corresponding to the ionisation energy.]

   b) Assume that the electron in Li^{2+} ion is in third orbit. Calculate (5)

      i) the radius of the orbit, and

      ii) the total energy of the electron

      [Hint: Li^{2+} ion also has atomic spectra similar to hydrogen atom. while applying relevant equations, use $Z = 3$.]

2. Using steps 1 to 5 given in Sec. 3.7 of Unit 3, draw the Lewis structures of BrF_5 and XeF_2. Using VSEPR theory, predict their shapes. (10)

3. Calculate the number of normal modes of vibration of BrF_5 and XeF_2. Draw diagrams to illustrate the symmetric stretching, asymmetric stretching and bending vibrations of XeF_2. (10)

4. a) You are provided with pure copper sulphate crystal. Using Beer-Lambert law, how can you determine the concentration of a test solution of copper sulphate? Explain in a detailed way. (5)

   b) What is the essential condition for a molecule to be microwave active? Classify the following molecules as microwave active or microwave inactive and state the reason in each case. (5)

      NO, Br_2, N_2O, XeF_2

      [Hint: N_2O is a linear molecule and one of the nitrogen atoms is at the centre.]

5. a) For $^1H^{19}F$, the lowest wave number absorption line in its rotational spectrum occurs at 41.11 cm^{-1}. Calculate the wave numbers corresponding to its second, third and fourth absorption lines. Explain the term, rotational spacing using these values. (5)

   b) i) Based on Subsec. 6.6.3, draw a rough sketch of P_M *vs.* T^{-1} curves for BF_3 and NH_3. (5)

ii) Which of the two, BF_3 and NH_3, has a nonzero value for orientation polarization? State the reason.

6. Explain the following terms: (5×2)

a) Moderator
b) Breeder reactor
c) Nuclear fusion
d) Transmutation reaction
e) Tracer technique

7. a) Draw the enantiomers for 2, 3-dibromopentane. Identify at least one pair of diastereomers among these structures. Can it form meso form? State the reason for your answer. (5)

b) Explain one application each for the study of paramagnetic and diamagnetic substances using magnetic susceptibility measurements. Comment on their dependence of these values of temperature. (5)

8. a) State the modification that was needed for Bohr's atom model in view of Heisenberg's uncertainty principle. (3)

b) Explain the need to introduce normalization constant and, complex conjugate of wave function. (3)

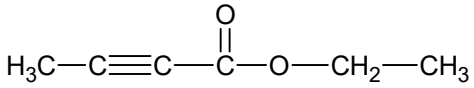
c) Using Table 2.2, and the equation given in Eq. 2.54 of Unit 2, explain the directorial characteristics of $2p_x$ and $3d_{xz}$ orbitals of a species with one electron. (4)

9. a) On the basis of molecular orbital theory, draw the energy pattern for N_2^+ ion. Comment on the bond order. Is it paramagnetic? Explain. (4)

b) He_2^+ ion has less stable arrangement that H_2 molecule. Explain using molecular orbital theory. (3)

c) Explain with an example, the term, nonbonding molecular orbitals. (3)

10. a) In the following compound, indicate the type of hybridization of each carbon atom. Also predict the carbon-carbon bond lengths using Table 4.4. (5)



b) Explain, using hybridization theory and diagram, the structure of allene, $CH_2 = C = CH_2$. (5)