ASSIGNMENT BOOKLET

Bachelor's Degree Programme (B.Sc.)

ATOMS AND MOLECULES

(Valid from January 1, 2022 to December 31, 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
Maidan Garhi, New Delhi-110068
(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 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, 2022 to 31st 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

Each question carries 10 marks

Use the following data

Permittivity in vacuum = $8.854 \times 10^{-12} \, C^2N^{-1}m^{-2}$

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}

Relative atomic masses: Hydrogen = 1; Deuterium = 2; Iodine = 127

1. a) Calculate the energy values of the electron in second and third orbits of hydrogen atom. (2+2)

    b) Calculate the ionisation energy of hydrogen atom using Bohr's theory. (4)

    c) For the first two lines of Balmer series, identify the values of n_1 and n_2. (2)

2. a) The first ionisation energies of silicon and sulphur are lower than that of phosphorus. Explain. (2)

    b) Explain use of cation to anion radius ratio. (2)

    c) Arrive at the Lewis structures of $SnCl_5^-$ and IF_4^+ using the steps indicated in Sec. 3.7 of Unit 3. (2+2)

    d) The bond enthalpies of N–N, N=N and N≡N bonds are not in the ratio 1:2:3. Explain the reason. (2)

3. a) Using Pauli's exclusion principle, work out the total number of electrons in the level $n=3$. (3)

    b) For a particle in one-dimensional box, write the equations for calculating the energy values corresponding to
        i) $n = 1$
        ii) $n = 2$
        iii) $n = 3$ (3)

    c) Calculate the de Broglie wavelength associated with a ball of mass 0.50 kg moving with a velocity of 20 m s^{-1}. (2)

    d) What is a well-behaved wave function? (2)

4. a) State the definitions of bonding, anti-bonding and nonbonding orbitals. Draw the molecular orbitals obtained by the linear combination of two $1s$ orbitals. (3+2)

    b) Write down the molecular orbital configurations of C_2 and N_2. Calculate their bond orders. Which of these two is expected to have higher bond energy? (5)

5. a) Assuming that the covalent radius of hydrogen is 28 pm when it is bonded to other atoms, and using Table 3.10, calculate the bond lengths of the bonds in

$$CH_2 = CH-CH_2-NH_2.$$ (3)

b) Alkyl halides are more reactive than alkanes. Explain the reason. (2)

c) I_3^- ion is known to exist but not F_3^- ion. Explain the reason after assigning Lewis structures for both the ions. (5)

6. a) Write down the structures of stereoisomers of 2, 3–pentanediol. Identify the enantiomeric pairs. (6)

b) State the difference between the racemic mixture and meso form. (2)

c) Suggest a method of determination of molar extinction coefficient. (2)

7. a) Write the resonance structures of formate ion. What do you infer regarding the relative bond length values of two C−O bonds in it? Explain the reason. (4)

b) Predict the hybridisation state of each carbon atom in the following compounds:

(6)
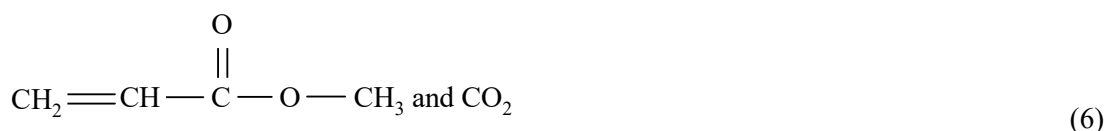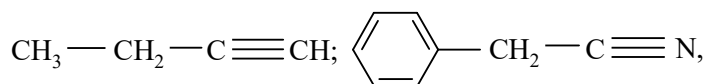
8. a) The rate constant for Cr decay is 2.89×10^{-7} s^{-1}. Calculate the time required for 87.5% decay. (4)

b) Explain the method of determining the age of an organic material. (2)

c) Explain the following terms:
i) Moderator and
ii) Breeder reactor. (2+2)

9. a) Among the molecules given below, identify those which are microwave active.

Br_2, HF, CO_2 and CO (2)

b) Write down the values of two characteristic frequencies for each of the following compounds:

(6)
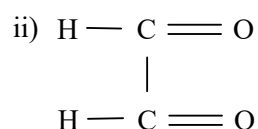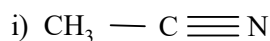
c) State the condition to be satisfied for a molecule to absorb in the microwave region. (2)

10. a) Give an example for each of the following types of nuclear transmutation reactions:

   (p, α), (n, p), (n, α) and (p, n).   (4)

   b) An analyst is asked to oxidize a secondary alcohol to ketone. What single characteristic feature in IR spectra should the analyst look for in order to verify the feasibility of the reaction?   (2)

   c) Which of the following has higher λ_{max} value?

       1-butene or 1, 3 – butadiene.

   State the reason.   (2)

   d) Calculate the molar diamagnetic susceptibility value of acetophenone.   (2)