CHE-01

ASSIGNMENT BOOKLET

Bachelor's Degree Programme (B.Sc.)

ATOMS AND MOLECULES

(Valid from 1st January, 2013 to 31st December, 2013)

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
(2013)

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, 2013 to 31st December, 2013.

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
Assignment Code; CHE-01/TMA/2013
Maximum Marks: 100

Attempt all the questions. Each question carries 10 marks.

Use the following data:

Permittivity in vacuum = 8.854×10^{-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}

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1. a) Using Bohr atom model, show that the radius of the first three orbits in hydrogen atom are in the ratio 1 :4:9. (5)

   b) Calculate the wave number (m^{-1}), frequency (Hz) and energy (kJ mol^{-1}) of visible light of wavelength 400 nm. (5)

2. a) Calculate the wavelength (λ) of light required to eject photoelectrons from a metal, X, with a velocity of $1/100^{th}$ of light (ν_o for X = 3×10^{14} Hz). (5)

   b) Some authors mention ionization energies in eV units. Show that 1 eV = 96.49 kJ mol^{-1}. (5)

3. a) Arrive at the Lewis structure of BrF_5, and using VSPER theory predict its shape. (5)

   b) Draw the structures of propanoic acid and propyne, and predict C–C and $C \equiv C$ bond lengths based on Table 4.4 of Unit 4 of Block 1 of Atoms and Molecules course. (5)

4. a) The lattice enthalpies of NaCl, KCl and AgCl are 787, 717 and 916 kJ mol^{-1} respectively; based on these values, arrange them in the increasing order of water solubility and explain your answer. (3)

   b) Using hybridization concept, explain the structure of PF_5. What is its shape? (7)

5. a) Calculate the energy required to exite a particle in a cubic box of length a 1 Å, from its ground state to its second exited state. (5)

   b) Draw the shapes of *p* and *d* orbitals. (5)

6. Write the molecular orbital configuration for

a) He_2^+ ion (2)

b) Be_2 (3)

c) C_2 (3)

d) HF (2)

7. a) How will you classify various substances according to the magnetic behaviour? (3)

b) Define molar polarisation. Write the equations for three types of polarisation constituting the total molar polarisation. Also, specify the significance of the terms appearing in these equations. (7)

8. The lowest wave number absorption line in the rotational spectrum of nitric oxide molecule is found at 3.440 cm^{-1}.

a) Calculate the corresponding frequency of absorption. (1)

b) Which are the two energy levels involved in the transition? (1)

c) What is the value of the rotational constant (*B*) in m^{-1} unit? (1)

d) Calculate the moment of inertia for nitric oxide molecule. (1)

e) Calculate the reduced mass of nitric oxide molecule. (1)

f) Calculate the bond length (*r*) of nitric oxide molecule in pm units. (2)

g) Comment on the value of *r*, if the estimated N=O and N≡O bond length values are 118 and 106 pm, respectively. (1)

h) State the molecular orbital representation of nitric oxide molecule. (1)

i) Does your answer agree with the theoretical bond order value calculated on the basis of molecular orbital theory? (1)

9. a) Calculate the fundamental frequency of $^{1}H^{35}Cl$ bond if its force constant value is 516 N m^{-1}. (5)

b) State Beer-Lambert law along with its limitations. Explain its application. (5)

10. a) A sample of rock is analysed and found to contain 2.32×10^{-4} kg of ^{206}Pb and 1.605×10^{-3} kg of ^{238}U. Assuming that all the ^{206}Pb now present came from the decay of ^{238}U, calculate the age of the rock. The half-life period for ^{238}U decay is 4.50×10^{-9} year. (5)

b) Give five applications of nuclear chemistry studies. (5)