

## ASSIGNMENT BOOKLET

CHE-01

### Bachelor's Degree Programme (B.Sc.)

#### Atoms and Molecules

(Valid from July 1, 2011 to March 31, 2012)

It is compulsory to submit the assignment before filling in the exam form

#### 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  
(For July, 2011 cycle)

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:

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ENROLMENT NO:.....

NAME:.....

ADDRESS:.....

.....

.....

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) Last date for submission of Assignment is March 31, 2012.
  - 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/2011-12  
Maximum Marks: 100

- Note:**
- \* This assignment is based on all the two 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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Use the following at the appropriate places:

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

Planck's constant =  $6.626 \times 10^{-34} \text{ J s}$

Velocity of light =  $2.998 \times 10^8 \text{ m s}^{-1}$

Mass of electron =  $9.109 \times 10^{-31} \text{ kg}$

Numerical value of electronic charge =  $1.602 \times 10^{-19} \text{ C}$

- Q.1 a) For the electron revolving in the third orbit of hydrogen atom, calculate
- the velocity of the electron and (5)
  - its number of revolutions per second (2)
- Hint: Number of revolutions per second = Velocity/Circumference.
- b) The wavelength corresponding to the threshold frequency to tungsten surface is 230 nm. Calculate the kinetic energy of the photoelectron ejected from the surface of tungsten metal, if it is irradiated with ultraviolet light of wavelength 180 nm. (4)
- c) Write the electronic configuration of  $\text{He}^+$  and  $\text{Li}^{2+}$  ions. Use Eq. 1.26 of Unit 1 and calculate the ionization energy per atom or ion in J unit for (i) hydrogen atom (ii)  $\text{He}^+$  ion and (iii)  $\text{Li}^{2+}$  ion. (4)
- Q.2 a) Calculate the de Broglie wavelength of a neutron moving with a speed of  $6.0 \times 10^4 \text{ m s}^{-1}$ . The mass of neutron is  $1.675 \times 10^{-27} \text{ kg}$ . (3)
- b) Indicate the maximum number of electrons that may be found in each of the  $l$  orbitals for  $n=4$ . (2)
- c) State the possible values of quantum numbers,  $n$ ,  $l$ ,  $m_l$  and  $m_s$  for the electron in (i)  $3d$  orbital and (ii)  $4f$  orbital. (4)
- d) Specify the names of the orbital with the following quantum numbers: (1)
- $n = 3$  and  $l = 0$
  - $n = 4$  and  $l = 1$
- Q.3 a) Assume the  $\text{Br}^-(\text{g})$  ion is to be converted to  $\text{Br}^+(\text{g})$  ion by electron removal. Represent this conversion in two steps involving one electron removal each time. Relate the energy change in each stage to the first electron affinity or first ionization energy of bromine. (4)

- b) A container has one mole of bromine atoms in the gaseous state. To transfer one electron from each of the half mole atoms of  $\text{Br}(g)$  to the other half, 409 kJ energy is required. If all the  $\text{Br}^-(g)$  ions so formed are to be converted to  $\text{Br}^+(g)$  ions, 733 kJ energy is required. Find out the first ionization energy and the first electron affinity of bromine. (5)
- Hint:  $\text{Br}(g) \rightarrow \text{Br}^+(g) + e^- \rightarrow \text{Br}^-(g)$  is energy requiring process whereas  $\text{Br}(s) + e^- \rightarrow \text{Br}^-(s)$  is energy releasing process
- c) i) Write down Born-Haber cycle for  $\text{CaCl}_2$  formation. (3)
- ii) Calculate the heat of formation of calcium chloride using the following data: (2)
- Heat of sublimation of calcium =  $193 \text{ kJ mol}^{-1}$
- First ionization energy of calcium =  $590 \text{ kJ mol}^{-1}$
- Second ionization energy of calcium =  $1145 \text{ kJ mol}^{-1}$
- Heat of dissociation of chlorine =  $242 \text{ kJ mol}^{-1}$
- Electron affinity of chlorine =  $-348 \text{ kJ mol}^{-1}$
- Lattice energy of calcium chloride =  $-2253 \text{ kJ mol}^{-1}$
- d) Follow the steps given in Sec. 3.7 of Unit 3 and arrive at the shapes of  $\text{NO}_2^+$  and  $\text{NO}_2^-$  ions. (6)
- Q.4 a) 1, 2-Butadiene has the following structure: (6)
- $$\text{CH}_3-\text{CH}=\text{C}=\text{CH}_2$$
- Indicate each of the  $\sigma$  and  $\pi$  bonds in it. Identify the type of hybridization of each carbon atom.
- b) Write the valence bond structures of  $\text{HBr}$  molecule and indicate the structure of least importance using the electronegativity values given in Table 3.4 of Unit 3. (2)
- c) Write resonance structure of  $\text{CO}_3^{2-}$  ions. (2)
- Q.5 a)  $\text{NO}^+$  ion is known as nitrosonium ion. It is readily formed from its salts. Draw an energy pattern for  $\text{NO}^+$  ion indicating the filling up of its molecular orbital. Assume that an electron is lost from nitrogen atom during the formation of  $\text{NO}^+$  ion. (3)
- b) Is  $\text{NO}^+$  ion paramagnetic? Explain. (1)
- c) Calculate the bond order values of  $\text{NO}^+$  ion and  $\text{NO}$  molecule. (4)
- d) N-O stretching frequency is  $2.20 \times 10^5 \text{ m}^{-1}$  in  $\text{NO}^+$  ion whereas it is  $1.84 \times 10^5 \text{ m}^{-1}$  in  $\text{NO}$  molecule. Calculate the force constant of N-O in
- i)  $\text{NO}^+$  ion and
- ii)  $\text{NO}$  molecule.
- Assume that the reduced mass of  $\text{NO}^+$  or  $\text{NO}$  is  $1.24 \times 10^{-26} \text{ kg}$ . (5)
- e) Do the relative values obtained in (d) (i) and (ii) agree with your answer in (c) above? (1)

- f) CO absorbs at  $2.143 \times 10^5 \text{ m}^{-1}$  which is similar to the absorption of  $\text{NO}^+$  ion. Can you give any reason for this similarity? (2)
- Q.6 a) Calculate the percentage ionic character in HBr gas. Use the following data: (3)  
 The dipole moment of HBr =  $2.635 \times 10^{-30} \text{ C m}$   
 Bond length of HBr = 141 pm
- b) Give an example for each of the following: (2)  
 i) Racemic mixture  
 ii) Meso form
- c) Predict the magnetic moment of  $\text{Cr}^{3+}$  ion in  $\mu_{\text{B}}$  unit. (2)
- d) State the effect of conjugation on  $\lambda_{\text{max}}$  value. Give an example. (2)
- Q.7 The lowest wave number absorption line in the rotational spectrum of  $^1\text{H}^{127}\text{I}$  molecule is at  $12.8 \text{ cm}^{-1}$ . Calculate the following for it
- i) Rotational constant (1)  
 ii) Moment of inertia (3)  
 iii) Reduced mass and (2)  
 iv) Bond length. (2)
- Q.8 a) The half-life of a radioactive element is 4.8 minutes. (2)  
 i) Calculate its decay constant (2)  
 ii) Out of  $1.0 \times 10^{-3} \text{ kg}$  of the element present initially, how much would remain after 24 minutes? (3)
- b) Find the total number of  $\alpha$  and  $\beta$  particles emitted in the decay of  $^{232}_{90}\text{Th}$  to  $^{208}_{82}\text{Pb}$  (3)
- c) The observed mass of  $^{16}_8\text{O}$  is 15.9491 u. Calculate the average binding energy per nucleon in MeV for the isotope. (4)  
 Mass of proton = 1.00728 u  
 Mass of neutron = 1.00867 u  
 Also  $1 \text{ u} = 932 \text{ MeV nucleus}^{-1}$