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(October)

CHEMISTRY

(Elective/Honours)

(General Chemistry—I)

(Chem–EH–101)

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

SECTION—I

(Inorganic)

(*Marks* : 19)

1. *(a)*   Mention the limitations of Bohr's atomic model. State the Heisenberg's uncertainty principle and write its mathematical form.   2+1+½=3½

   (b)   The kinetic energy of an electron has been found to be 5.76×10^{-15} J. Calculate the wavelength associated with the electron. (Mass of electron $= 9.1 \times 10^{-31}$ kg, $h = 6.626 \times 10^{-34}$ J-s)   2

(c) Write notes on the following :   1½×2=3

    (i) Group displacement law

    (ii) Periodic variation of ionization enthalpy in the periodic table

(d) Write down two important applications of radioisotopes.   1

OR

2. (a) Draw the three-dimensional plot of the five radial wave functions of d-orbital.   1½

(b) Explain effective nuclear charge.   1

(c) Derive the first-order rate equation of a radioactive disintegration.   2

(d) Half-life of radium (molar mass = 226 g mol^{-1}) is 1580 years. Show that 1 gm of radium gives $3.70×10^{10}$ disintegrations per second.   2

(e) Write down the modern periodic law.   1

(f) Explain with example why cations are smaller and anions are larger in radii than their corresponding parent atom.   2

3. (a) Write down the limitations of valence bond theory for covalently bonded molecules.   1½

(b) Write down the postulates of VSEPR theory. On the basis of this theory, draw the structures of H_3O^+, O_3, PCl_5 and SF_6.   1½+2=3½

(c) Classify the following as either a p-type semiconductor or an n-type semiconductor :   ½+½=1

    (i) Ge doped with In

    (ii) B doped with Si

(d) Explain why H_2O is a liquid while H_2S is a gas at room temperature.   1

(e) Define lattice energy. Mention the factors on which lattice energy of ionic crystal depends.   1+1½=2½

OR

4. (a) Draw the molecular orbital diagram of $O_2^{\oplus}$ and calculate the bond order.   2

(b) What is radius ratio? What will be the coordination number of each ion in NaCl, if the ionic radius of Na^+ is 0.95 Å and that of Cl^- is 1.81 Å?   1+1=2
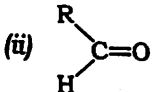
(c) What are the factors on which the polarization power of an ion depends? Which of the Cu_2Cl_2 and NaCl is more covalent and why? $1\frac{1}{2}+1\frac{1}{2}=3$

(d) Explain the electrical and thermal conductivities of sodium (Na) on the basis of bond theory of metallic bonding. $2\frac{1}{2}$

SECTION—II

(Organic)

(Marks : 19)

5. (a) Draw the molecular orbital picture of the following molecules emphasizing the type of hybridization, shape and bond angles : $1+1=2$

   (i) C_2H_6

   (ii) $\begin{array}{c} R \\ \diagdown \\ C=O \\ \diagup \\ H \end{array}$

(b) Define acid and base according to Brönsted-Lowry concept. Give examples. 2

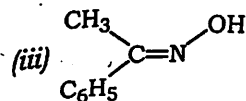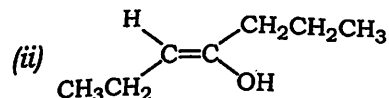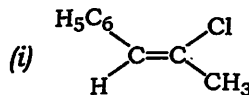(c) What is bond fission? Describe the different types of bond fission. $1+1=2$

(Continued)

(d) Both $CHCl_3$ and CCl_4 have polar bonds, but $CHCl_3$ is a polar molecule while CCl_4 is a non-polar molecule. Explain. $1\frac{1}{2}$

(e) What are electrophiles and nucleophiles? Give examples. 2

OR

6. (a) Assign E or Z for the following geometrical isomers : $\frac{1}{2}\times3=1\frac{1}{2}$

   (i) $\begin{array}{c} H_5C_6 \qquad Cl \\ \diagdown \qquad \diagup \\ C=C \\ \diagup \qquad \diagdown \\ H \qquad CH_3 \end{array}$

   (ii) $\begin{array}{c} H \qquad CH_2CH_2CH_3 \\ \diagdown \qquad \diagup \\ C=C \\ \diagup \qquad \diagdown \\ CH_3CH_2 \qquad OH \end{array}$

   (iii) $\begin{array}{c} CH_3 \qquad OH \\ \diagdown \qquad \diagup \\ C=N \\ \diagup \\ C_6H_5 \end{array}$

(b) Draw the conformers of ethane both in Newman and sawhorse models. Which conformer is more stable and why? $2\frac{1}{2}$

(c) Explain hyperconjugation with a suitable example. Why is it also known as no-bond resonance? $1+\frac{1}{2}=1\frac{1}{2}$

(d) What are the conditions for a molecule to be optically active? 2

(Turn Over)

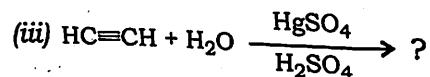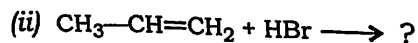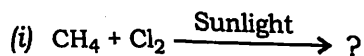(e) Write a short note on any *one* of the following : 2

  (i) Racemization

  (ii) Resolution

7. (a) Cyclopropane undergoes addition reaction with halogen acid. Explain. 2

  (b) Give the method of preparation of alkanes by Wurtz method. Give one of its limitation. $1\frac{1}{2}+1=2\frac{1}{2}$

  (c) Complete the following reactions : $1\times3=3$

    (i) $CH_4 + Cl_2 \xrightarrow{\text{Sunlight}}$?

    (ii) $CH_3-CH=CH_2 + HBr \longrightarrow$?

    (iii) $HC\equiv CH + H_2O \xrightarrow[H_2SO_4]{HgSO_4}$?

  (d) Calculate the angle strain of the following molecules. State which is more stable : $1\times2=2$

    (i) Cyclobutane

    (ii) Cyclohexane

OR

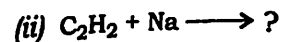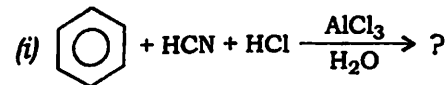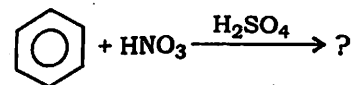8. (a) Explain Hückel's $(4n+2)$ rule of aromaticity. $1\frac{1}{2}$

(Continued)

(b) State Kharasch effect with example. 2

(c) Complete the following reactions : $1\times2=2$

  (i) [benzene ring] $+ HCN + HCl \xrightarrow[H_2O]{AlCl_3}$?

  (ii) $C_2H_2 + Na \longrightarrow$?

(d) Prove that an —OH (phenolic) group is an activating group. Give example. 2

(e) Suggest the product with a suitable mechanism for the following reaction : 2

  [benzene ring] $+ HNO_3 \xrightarrow{H_2SO_4}$?

SECTION—III

(**Physical**)

(*Marks* : 18)

9. (a) What are the reasons that led to the deviation of real gases from ideal behaviour? What is meant by compressibility factor Z ? 3

  (b) Deduce Graham's law of diffusion using kinetic gas equation. 3

(*Turn Over*)

(c) Find the root-mean-square speed of oxygen gas at 27 °C. Express it in SI unit and CGS unit. 2+1=3

OR

10. (a) Derive the kinetic gas equation $PV = \frac{1}{3}mn\bar{c}^2$ from kinetic theory of gases. 3.

(b) What is surface tension of a liquid? Suggest the factors affecting surface tension. 1½+1½=3

(c) What is nematic liquid crystal? Mention its properties. 1½+1½=3

11. (a) State the law of constancy of interfacial angles and define the plane of symmetry. 1½+1½=3

(b) Define the following : 1×2=2
   (i) Space lattice
   (ii) Unit cell

(c) How would you prepare ferric hydroxide sol? 2

(d) Explain Tyndall effect. 2

(Continued)

OR

12. (a) Calculate the Miller indices of crystal planes which cut through the crystal axes at (2a, 3b, c). The terms have their usual meanings. 2

(b) How would you purify colloids by dialysis? 1½

(c) Explain Brownian movement and mention the cause. 2+1=3

(d) What is protective action of a colloid? Define gold number. 1½+1=2½

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1/EH–23 (i) (Syllabus–2015)