

1/EH-23 (i) (Syllabus-2015)

2 0 1 6

(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) State Heisenberg's uncertainty principle and write its mathematical form. 1½
- (b) Mention the limitations of Bohr atomic model. 2
- (c) Calculate the uncertainty of velocity of an electron if the uncertainty of its position is 10^{-10} m ($h = 6.6 \times 10^{-34}$ kg m² s⁻¹ and $m_e = 9.1 \times 10^{-31}$ kg). 2

(2)

- (d) For the principal quantum number $n=4$, what are the permitted values of azimuthal quantum numbers (l)? Show that for $n=4$, the maximum number of electrons in this level is equal to 32. 4

OR

2. (a) Draw the shapes of various d -orbitals. $2\frac{1}{2}$
(b) What is Aufbau principle? Arrange the orbitals of an atom in increasing order of their energies. 2
(c) What is packing fraction? Draw a plot of packing fraction against the corresponding mass numbers of elements. 2
(d) Write the electronic configuration of the elements belonging to period-4 and group-3 of the long form of periodic table. Identify the element. $1\frac{1}{2}$
(e) Give reason for the fact that ionization energies of C, N and O follow the order $C < N > O$. $1\frac{1}{2}$
3. (a) Explain why NH_3 has a higher boiling point than that of PH_3 . 2

(3)

- (b) Arrange the following molecules in increasing order of their dipole moments and justify : $2\frac{1}{2}$
(i) CH_3Cl
(ii) CH_2Cl_2
(iii) CHCl_3
(iv) CCl_4
- (c) What is meant by limiting radius ratio? Discuss the effect of radius ratio on the geometry of an ionic solid. $2\frac{1}{2}$
- (d) With the help of band theory, differentiate between a conductor and a semiconductor. $2\frac{1}{2}$

OR

4. (a) On the basis of VSEPR theory, predict the shapes of the following species. Indicate the bond angles : 3
(i) BeF_2
(ii) BO_3^{3-}
(iii) SF_4
- (b) Draw the potential energy curve showing the variation of energy with internuclear distance in the formation of hydrogen molecule (H_2). 2

(4)

- (c) Using MO theory, explain why O_2 has a lower bond dissociation energy than that of O_2^+ , but N_2 has a higher bond dissociation energy as compared to N_2^+ . 2
- (d) Draw Born-Haber cycle for the formation of CaF_2 and write an expression for the lattice energy equating it with the various energy terms involved in the cycle. $2\frac{1}{2}$

SECTION—II

(Organic)

(Marks : 19)

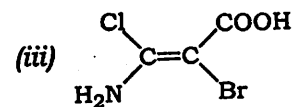
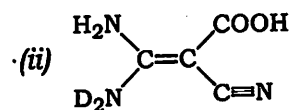
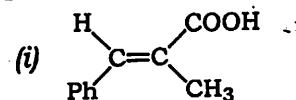
5. (a) Give two examples where carbon atom is sp^2 and sp hybridized. Explain these hybridizations with the help of orbital pictures. 2
- (b) What is hyperconjugation? Taking a suitable example, illustrate why the phenomenon of hyperconjugation is called as no bond resonance. 2

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(5)

- (c) Assign the symbol E or Z to each of the following with proper numbering of each substituent according to their priorities : $1\frac{1}{2}$



- (d) 1,2-dibromoethene has two geometrical isomers. Dipole moment of one is $1.35D$ and that of the other is zero. Write down their structures. 2
- (e) Draw the Newman projection formula of all the conformers of n -butane and arrange them in decreasing order of stability. 2

OR

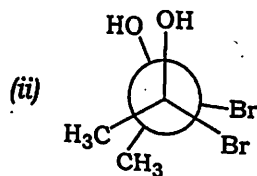
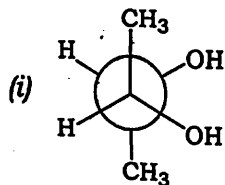
6. (a) n -butylalcohol and the isomeric diethyl-ether have the same mass, but the boiling point of n -butylalcohol is $118^\circ C$ and that of ether is $35^\circ C$. Account for this fact. 2

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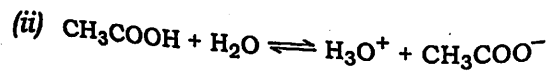
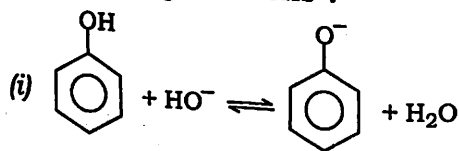
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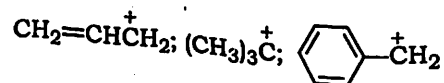
- (b) Convert the following Newman projections to Fischer projections : 1



- (c) What are conjugate acids and bases? Label the conjugate acid-base pairs in the following reactions : 2½



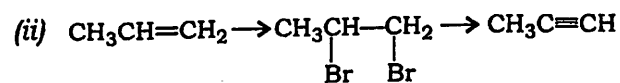
- (d) Arrange the following carbocations in their decreasing order of stability with appropriate reasons : 2



(7)

- (e) Presence of chiral centres is not the necessary condition for a compound to be optically active. Justify. 2

7. (a) How can each of the following transformations be carried out? 2+2=4



- (b) Predict the product when benzene is treated with $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ in the presence of AlCl_3 . Give the mechanism of the reaction. 1½

- (c) What major product would you expect to be formed when the following are subjected to nitration? 1+1=2

(i) Nitrobenzene

(ii) Chlorobenzene

- (d) Cyclopropane undergoes ring opening reactions to give open-chain addition compounds but cyclopentane does not. Explain. 2

OR

8. (a) Write a step-by-step reaction mechanism for the light induced mono-chlorination of methane. 2

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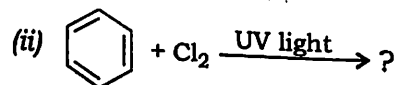
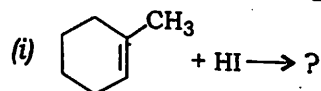
(8)

(b) What is hydroboration? Show how propene can be converted to propan-1-ol by the method of hydroboration with mechanism. 2½

(c) Why does benzene undergo electrophilic substitution more easily than nucleophilic substitution? 1

(d) What were the assumptions made by Baeyer in his strain theory? 2

(e) Complete the following reactions : 2



SECTION—III

(Physical)

(Marks : 18)

9. (a) Derive the kinetic gas equation $PV = \frac{1}{3} mN\bar{C}^2$, where the terms have their usual meanings. 4

(b) (i) What is compressibility factor Z of a gas? 1

(ii) Write van der Waals' equation of state. Name the terms in the equation. 1+1=2

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(9)

(c) Calculate the temperature at which the root-mean-square velocity of oxygen gas is equal to 1500 ms^{-1} . 2

OR

10. (a) Deduce (i) Boyle's law, (ii) Charles' law and (iii) Avogadro's law from kinetic gas equation. $1\frac{1}{2} + 1\frac{1}{2} + 1\frac{1}{2} = 4\frac{1}{2}$

(b) What is viscosity of a liquid? How does it vary with temperature? $1 + \frac{1}{2} = 1\frac{1}{2}$

(c) What are (i) smectic liquid crystals and (ii) nematic liquid crystals? $1\frac{1}{2} + 1\frac{1}{2} = 3$

11. (a) Point out the differences between lyophilic and lyophobic colloids. 2

(b) Write notes on the following : $2 \times 2 = 4$
(i) Electrophoresis
(ii) Gold number

(c) Define the following : $1\frac{1}{2} \times 2 = 3$
(i) Space lattice
(ii) Unit cell

OR

12. (a) Explain the origin of charge on colloidal particles. 2

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(Turn Over)

(b) Write notes on the following : $2 \times 2 = 4$

(i) Brownian movement

(ii) Dialysis

(c) Define Miller indices. Calculate the Miller indices of crystal planes which cut through the crystal axes at $(2a, -3b, -3c)$. $1 + 2 = 3$
