

CHEM-EH—101 (Syllabus-2015)

2015

(October)

CHEMISTRY

(Elective/Honours)

FIRST PAPER

(Inorganic, Organic, Physical)

Marks : 56

Time : 3 hours

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

SECTION—I

(Inorganic)

(Marks : 19)

1. (a) What is meant by 'dual character of matter'? Derive de Broglie relation. 1+2=3

(b) State group displacement law. What shall be the position in periodic table of the final daughter element obtained after the nuclide ${}_{84}^{218}\text{Po}$ undergoes α -emission followed by two successive β -emissions?

1+1½=2½

(2)

(c) Calculate the energy of a photon corresponding to (i) wavelength 140 nm and (ii) wave number 10 cm^{-1} ($h = 6.626 \times 10^{-34} \text{ J-s}$). $1\frac{1}{2} + 1\frac{1}{2} = 3$

(d) Why is the ionic radius of K^+ smaller than Cl^- , while both are isoelectronic? 1

OR

2. (a) Draw the shape of $d_{x^2-y^2}$ orbital. 1

(b) Write the set of four quantum numbers for the unpaired electron in aluminium atom. 2

(c) What is nuclear binding energy? Calculate the (i) total binding energy and (ii) binding energy per nucleon for $^{16}_8\text{O}$, given that the mass of ^{16}O from mass spectrograph measurement is 15.9949 a.m.u., and that of hydrogen atom and neutron are 1.00783 a.m.u. and 1.00867 a.m.u. respectively. $1 + 1\frac{1}{2} + \frac{1}{2} = 3$

(d) State moder. periodic law. What is the advantage of this law over Mendeleev's periodic law? $1 + 1 = 2$

(3)

(e) The electronic configuration of boron is $1s^2 2s^2 2p^1$. Which of these electrons between 2s and 2p orbitals are more likely to be closer to nucleus and why? $1\frac{1}{2}$

3. (a) Classify the following as either a p-type or an n-type semiconductor : $\frac{1}{2} \times 2 = 1$

(i) Ge doped with In

(ii) B doped with Si

(b) Giving reasons, state which cation in the following pairs will have greater polarizing power : 3

(i) Pb^{2+} and Pb^{4+}

(ii) Ca^{2+} and Cu^{2+}

(c) Draw the molecular orbital diagram of O_2^- and calculate the bond order. 3

(d) Explain the bonding and geometry of BO_3^{3-} ion. $2\frac{1}{2}$

OR

4. (a) The boiling points of HF and HCl are 293 K and 189 K respectively. Give reasons for the difference. 2

(4)

- (b) Discuss the geometry of PCl_5 on the basis of VSEPR theory and compare its bond angles with PCl_3 . 3
- (c) What is radius ratio? What will be the structural arrangement in ionic solid with radius ratio in the range 0.155-0.225? $1+1=2$
- (d) What is lattice energy? Mention the factors on which lattice energy of an ionic crystal is dependent. $1+1\frac{1}{2}=2\frac{1}{2}$

D16-3100/27

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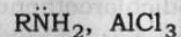
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SECTION—II

(Organic)

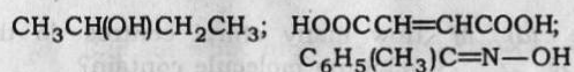
(Marks : 19)

5. (a) Draw the orbital picture of the following molecules and explain on the basis of their structures, their acidic or basic behaviour : 3

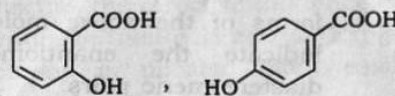


- (b) Write the resonance structures of $\text{CH}_2=\text{CH}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$ and indicate the relative stabilities of the contributing structures. 2

- (c) Indicate the type of stereoisomerism exhibited by the following molecules. Draw the isomers of each : 3



- (d) Which of the following will have higher melting point and why? $1\frac{1}{2}$



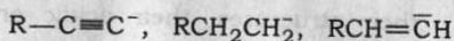
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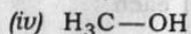
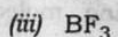
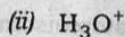
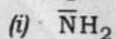
OR

6. (a) How is change in hybridization associated with change in electronegativity? Arrange the following carbanions in decreasing order of their stability with justification : 3

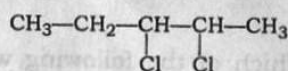


- (b) *Cis*-1,2-dichloroethene has a dipole moment but *trans*-1,2-dichloroethene has zero dipole moment. Explain. 1½

- (c) Classify the following as electrophiles and nucleophiles, and mention specifically the class to which they belong : 1



- (d) (i) How many chiral centres do the following molecule contain?



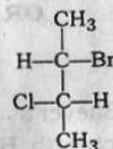
Draw all the possible stereoisomeric forms of the above molecule and indicate the enantiomeric and diastereomeric pairs. 3

D16-3100/27

(Continued)

(7)

- (ii) Draw the Newman projection formula for the following compound : 1



7. (a) How are alkanes prepared through Wurtz reaction? Explain why alkanes with odd number of carbon atoms cannot be prepared by Wurtz reaction. 2
- (b) What happens when cyclopentanone is treated with zinc amalgam and HCl? 1
- (c) What product is obtained when propyne is treated with dilute H_2SO_4 in the presence of $HgSO_4$ as catalyst? 1
- (d) Explain what happens when benzene is treated with acetyl chloride in the presence of a Lewis acid. Explain with mechanism. 2
- (e) Discuss the directive influence of $-CH_3$ group in methylbenzene. Explain why toluene is nitrated more easily than benzene. 2

D16-3100/27

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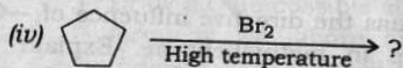
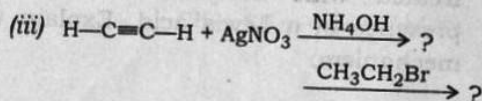
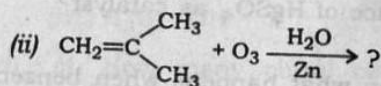
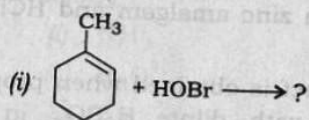
- (f) Explain why peroxide effect is shown by HBr only and not by HCl or HI. 1½

OR

8. (a) What is Baeyer's reagent? How does ethene react with Baeyer's reagent? 1½

- (b) Explain why electrophilic addition in alkynes are slower than in alkenes. 2

- (c) Write the product(s) of the following reactions : 1×4=4

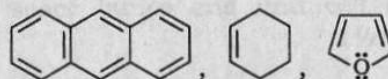


D16-3100/27

(Continued)

(9)

- (d) What is Hückel's rule? Which of the following molecules are aromatic and why? 2



10. (a) Derive the van der Waals' equation of state for real gases and mention the significance of the parameters in the equation. (10)

(b) Explain the types of liquid crystals with an example. (5)

(c) Define viscosity of a liquid. (5)

D16-3100/27

(Turn Over)

(10)

SECTION—III

(Physical)

(Marks : 18)

9. (a) State the postulates of kinetic theory of gases. 3
- (b) Calculate the root-mean-square velocity of oxygen molecule at NTP. 2
- (c) Write short notes on the following : $2 \times 2 = 4$
- (i) Surface tension
- (ii) Refractive index

OR

10. (a) Derive the van der Waals' equation of state for real gases and mention the significance of the parameters in the equation. 4
- (b) Explain the types of liquid crystals with examples. 4
- (c) Define viscosity of a liquid. 1

D16—3100/27

(Continued)

(11)

11. (a) State the law of constancy of interfacial angles. 2
- (b) Explain space lattice and unit cell of crystals. $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (c) What are colloids? How would you prepare the colloidal solution of (i) $\text{Fe}(\text{OH})_3$ and (ii) gold? $1 + 1\frac{1}{2} + 1\frac{1}{2} = 4$

OR

12. (a) Write short notes on the following : $2 \times 2 = 4$
- (i) Tyndall effect
- (ii) Protective colloids
- (b) Explain Schottky and Frenkel defects in crystals. $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (c) Calculate the Miller indices of crystal planes which cut through the crystal axes at $(2a, 3b, c)$. The terms have their usual meanings. 2

D16—3100/27

CHEM—EH—101 (Syllabus—2015)

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

2016

(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. 2½
(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. 1½
(e) Give reason for the fact that ionization energies of C, N and O follow the order $C < N > O$. 1½
3. (a) Explain why NH_3 has a higher boiling point than that of PH_3 . 2

D7/17

(Continued)

(3)

- (b) Arrange the following molecules in increasing order of their dipole moments and justify : 2½
(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. 2½
- (d) With the help of band theory, differentiate between a conductor and a semiconductor. 2½

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

D7/17

(Turn Over)

(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

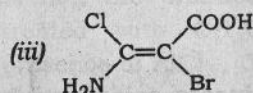
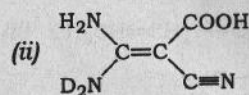
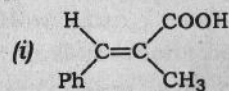
(b) What is hyperconjugation? Taking a suitable example, illustrate why the phenomenon of hyperconjugation is called as no bond resonance. 2

D7/17

(Continued)

(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

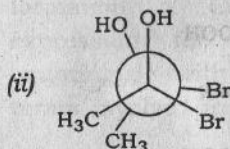
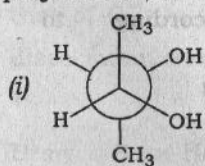
6. (a) *n*-butylalcohol and the isomeric diethyl-ether have the same mass, but the boiling point of *n*-butylalcohol is 118 °C and that of ether is 35 °C. Account for this fact. 2

D7/17

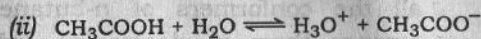
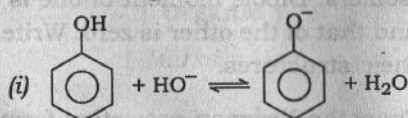
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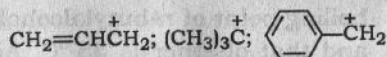
(b) Convert the following Newman projections to Fischer projections : 1



(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



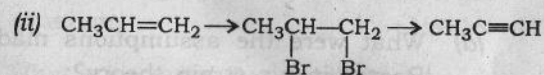
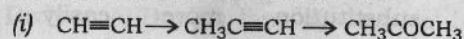
D7/17

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(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

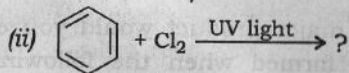
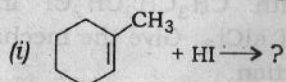
8. (a) Write a step-by-step reaction mechanism for the light induced monochlorination of methane. 2

D7/17

(Turn Over)

(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 $PV = \frac{1}{3} mNC^2$, 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

D7/17

(Continued)

(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. 1½+1½+1½=4½
- (b) What is viscosity of a liquid? How does it vary with temperature? 1+½=1½
- (c) What are (i) smectic liquid crystals and (ii) nematic liquid crystals? 1½+1½=3
11. (a) Point out the differences between lyophilic and lyophobic colloids. 2
- (b) Write notes on the following : 2×2=4
- (i) Electrophoresis
- (ii) Gold number
- (c) Define the following : 1½×2=3
- (i) Space lattice
- (ii) Unit cell

OR

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

D7/17

(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 $(2a, -3b, -3c)$. $1 + 2 = 3$

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

2017

(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) Write down the Schrodinger wave equation for an electron propagating in three dimension in space and explain the terms involved. Write down the physical significance of ψ and ψ^2 .

1+1½+1=3½

- (b) Derive the de Broglie's equation for the wave-duality of electron.

2

(2)

- (c) Define nuclear binding energy. Calculate the packing fraction, mass defect and energy released in the formation of argon atom ${}^{40}_{18}\text{Ar}$.

[Isotopic mass of Ar = 39.96238 a.m.u.;
mass of proton = 1.007825 a.m.u.;
mass of neutron = 1.008665 a.m.u.;
mass of electron = 9.1×10^{-31} kg]

$$\frac{1}{2} + 1\frac{1}{2} = 2$$

- (d) What is meant by periodicity of elements? Explain why alkali elements have larger radii than alkaline earth elements.

$$1 + 1 = 2$$

OR

2. (a) Write down the complete wave function for s-orbitals and draw the shape of 3s-orbital. 1+1=2
- (b) What is the effective nuclear charge felt by a 2p-electron of a nitrogen atom? What will be the effective nuclear charge felt by its 1s-electron? $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (c) Comparatively differentiate between fusion and fission. 2
- (d) Explain Diagonal Relationship with suitable examples. $1\frac{1}{2}$

8D/20

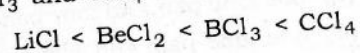
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(3)

- (e) Write down the electronic configuration of chromium (At. No. = 24) and nickel (At. No. = 28). 1

3. (a) What is VSEPR theory? Write down the main points of this theory. $\frac{1}{2} + 2\frac{1}{2} = 3$

- (b) The covalent character of LiCl, BeCl₂, BCl₃ and CCl₄ is in the order



Explain. 1

- (c) Differentiate between n-type and p-type semiconductors. 2

- (d) What is radius-ratio rule? How can it help to predict the structure of an ionic crystal? $1 + 2\frac{1}{2} = 3\frac{1}{2}$

OR

4. (a) Differentiate between inter- and intra-molecular hydrogen bonding, giving suitable examples. 2

- (b) Explain the metallic properties of elements on the basis of free electron theory. 2

8D/20

(Turn Over)

(4)

- (c) Discuss the Born-Haber cycle for experimental determination of lattice energy. 2½
- (d) Discuss the geometry of the molecules having (on the basis of VSEPR theory)—
- (i) two lone pairs and two bond pairs;
 - (ii) one lone pair and three bond pairs;
 - (iii) one lone pair and four bond pairs;
 - (iv) one lone pair and five bond pairs. 2
- (e) On the basis of hybridization, discuss the geometry of PCl_5 . 1

SECTION—II

(Organic)

(Marks : 19)

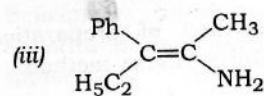
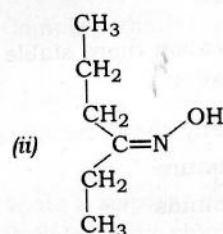
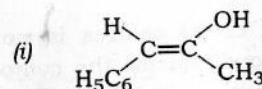
5. (a) Draw the molecular orbital pictures of the following molecules/species, mentioning the types of hybridization, bond angles and shapes in each case : 2
- (i) $\overset{\ominus}{\text{C}}\text{H}_3$
 - (ii) $\text{H}_2\text{C}=\text{C}=\text{CH}_2$

8D/20

(Continued)

(5)

- (b) Why is Lewis concept of acids and bases more comprehensive than Bronsted-Lowry concept? Explain with suitable example. 2
- (c) Alpha-halogenated carboxylic acids are more acidic than simple carboxylic acids. Explain. 2
- (d) Using sequence rule, designate *E* or *Z* Syn or Anti for the following molecules : ½×3=1½



- (e) Draw the different conformers of ethane. Which conformer is most stable and why? 2

8D/20

(Turn Over)

(6)

OR

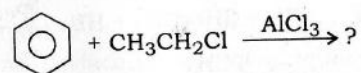
6. (a) The melting point *o*-nitrophenol is 44 °C while that of the *para*-isomer is 114 °C. Explain. 2
- (b) Classify the following into electrophiles and nucleophiles : 2
- $\overset{\ominus}{\text{O}}\text{H}, \text{H}_2\overset{\ominus}{\text{O}}, \overset{\cdot\cdot}{\text{N}}\text{H}_3, \text{H}^{\oplus}, \overset{\oplus}{\text{C}}\text{H}_3,$
 $\text{H}_3\overset{\oplus}{\text{O}}, \text{R}\overset{\oplus}{\text{O}}\text{H}, \text{AlCl}_3$
- (c) Presence of chiral centres is not the necessary condition for the compound to be optically active. Explain with a suitable example. 2
- (d) Why is benzyl cation more stable than tertiary butyl cation? 2
- (e) Write a note on any *one* of the following : 1½
- (i) Racemic mixture
- (ii) *Meso*-compounds
7. (a) Write the method of preparation of alkanes by Corey-House method. 2½
- (b) State Markownikov's rule and give an example. 2

8D/20

(Continued)

(7)

- (c) Complete the following reaction with mechanism : 2



- (d) What are activating and deactivating groups? State whether —CHO group is activating or deactivating group and why. 3

OR

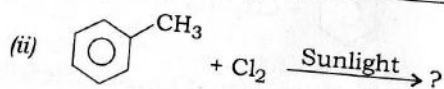
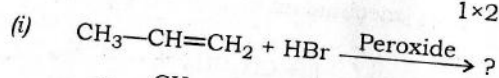
8. (a) Explain Baeyer's strain theory of cycloalkanes. 2
- (b) Complete the following reactions : 2
- $$\begin{array}{c} \text{R} \quad \text{R}^2 \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{R}' \quad \text{R}^3 \end{array} + \text{O}_3 \xrightarrow[\text{Low temp.}]{\text{CCl}_4} ? \xrightarrow[\text{Zn}]{\text{H}_2\text{O}/} ?$$
- (c) Write a stepwise reaction mechanism of induced light chlorination of methane. 2
- (d) Benzene undergoes electrophilic substitution reactions whereas ethylene undergoes electrophilic addition reactions. Explain. 1½

8D/20

(Turn Over)

(8)

(e) Suggest the products of the following reactions : 1×2=2



SECTION—III

(Physical)

(Marks : 18)

9. (a) Mention the conditions under which the real gases tend to obey the ideal gas law. Write down the van der Waals equation of state and explain the terms therein. 1½+1½=3

(b) Deduce Boyle's law and Graham's law from the gas law expression obtained from kinetic theory of gases. 1½+1½=3

(c) What are liquid crystals? Why are they so called? Classify them. 1+1+1=3

OR

10. (a) Mention the factors introduced by van der Waals to modify the ideal gas equation. Write down the van der Waals equation for 0.1 mole of a real gas. 2+1=3

8D/20

(Continued)

(9)

(b) What is coefficient of viscosity? Express its dimension and its SI unit. 1+1+1=3

(c) Mention the factors that affect viscosity and surface tension of a liquid. 1½

(d) What are the applications of liquid crystals? 1½

11. (a) Define (i) crystal and (ii) unit cell. 1½+1½=3

(b) State and explain the laws of constancy of interfacial angles and law of rational indices. 1+2=3

(c) What are the different ways of purifying colloids? Discuss them briefly. 1+2=3

OR

12. (a) Discuss briefly the different types of packing in crystals. 3

(b) A crystal plane has intercepts on the three axes of crystal in the ratio $\frac{3}{2} : 2 : 1$. Find the Miller indices of the plane. 3

(c) Discuss briefly the peptization and Bredig's method of preparation of colloids. 3

8D—4000/20

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

2018

(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. $2+1+\frac{1}{2}=3\frac{1}{2}$

- (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 = 9.1×10^{-31} kg, $h = 6.626 \times 10^{-34}$ J-s) 2

(2)

- (c) Write notes on the following : $1\frac{1}{2} \times 2 = 3$
(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. $1\frac{1}{2}$

- (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

D9/10

(Continued)

(3)

3. (a) Write down the limitations of valence bond theory for covalently bonded molecules. $1\frac{1}{2}$

- (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 . $1\frac{1}{2} + 2 = 3\frac{1}{2}$

- (c) Classify the following as either a *p*-type semiconductor or an *n*-type semiconductor : $\frac{1}{2} + \frac{1}{2} = 1$

(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. $1 + 1\frac{1}{2} = 2\frac{1}{2}$

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 \AA and that of Cl^- is 1.81 \AA ? $1 + 1 = 2$

D9/10

(Turn Over)


(4)

- (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) 
- (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. $1+1=2$

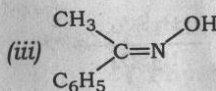
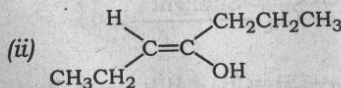
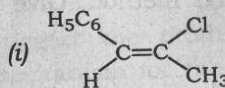
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(5)

- (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 : $\frac{1}{2}\times 3=1\frac{1}{2}$



- (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

D9/10

(Turn Over)

(6)

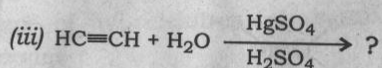
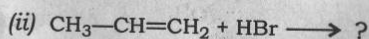
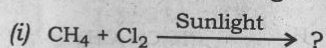
(e) Write a short note on any one of the following : 2

- (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 : $1\times 3=3$



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

- (i) Cyclobutane
- (ii) Cyclohexane

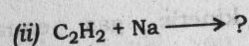
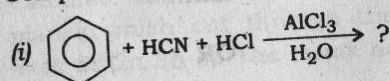
OR

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

(7)

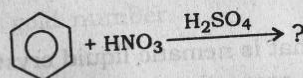
(b) State Kharasch effect with example. 2

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



(d) Prove that an $-\text{OH}$ (phenolic) group is an activating group. Give example. 2

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



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)

(8)

- (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. $1\frac{1}{2}+1\frac{1}{2}=3$
- (c) What is nematic liquid crystal? Mention its properties. $1\frac{1}{2}+1\frac{1}{2}=3$
11. (a) State the law of constancy of interfacial angles and define the plane of symmetry. $1\frac{1}{2}+1\frac{1}{2}=3$
- (b) Define the following : $1 \times 2 = 2$
- (i) Space lattice
- (ii) Unit cell
- (c) How would you prepare ferric hydroxide sol? 2
- (d) Explain Tyndall effect. 2

D9/10

(Continued)

(9)

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? $1\frac{1}{2}$
- (c) Explain Brownian movement and mention the cause. $2+1=3$
- (d) What is protective action of a colloid? Define gold number. $1\frac{1}{2}+1=2\frac{1}{2}$

D9-3800/10

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

1/EH-23 (i) (Syllabus-2019)

2019

(October)

CHEMISTRY

(Elective/Honours)

(Chem-EH-101)

Full Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—I

(Inorganic)

(Marks : 19)

- (a) Explain the term dual character of matter and radiation. Derive de Broglie's equation. 2+1=3

(b) An electron has a speed of 300 ms^{-1} accurate up to 0.001%. What is the uncertainty in locating its position? (Mass of an electron = $9.1 \times 10^{-31} \text{ kg}$ and Planck's constant (h) = $6.626 \times 10^{-34} \text{ Js}$). 2½

20D/19

(Turn Over)

(2)

- (c) What are the significance of the neutron/proton (N/P) ratio in an atomic nucleus? 2
- (d) Explain with examples the basis of diagonal relationship. 2

OR

2. (a) Define electron affinity and explain why the electron affinity of oxygen and fluorine are less than sulphur and chlorine in their respective groups. 2
- (b) Write down the three-dimensional Schrödinger wave equation in Cartesian coordinates and explain the terms involved in it. What are the physical significance of ψ^2 , where ψ is the wave function of the electron? 2+1=3

- (c) Calculate the packing fraction and mass defect in the formation of argon atom ${}_{18}\text{Ar}^{40}$.

(Isotopic mass of Ar = 39.96238 a.m.u.,
mass of 1 neutron = 1.008665 a.m.u.,
mass of 1 hydrogen atom = 1.007825 a.m.u.)

1+1=2

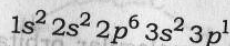
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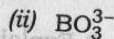
(3)

- (d) What is nuclear fusion? Give one example of nuclear fusion reaction. 1½

- (e) Name the element and to which block in the periodic table the element with the following electronic configuration belongs : 1



3. (a) Discuss the potential energy diagram for the formation of hydrogen molecule on the basis of the valence bond theory. 2
- (b) Predict the structures of the following molecule and ion with the help of VSEPR theory and also mention the hybridisation of the central atom : 1+1=2



- (c) The dipole moment of NH_3 is 1.49 D while the dipole moment of NF_3 is 0.2 D. Draw their structures and explain the above observation. 2

20D/19

(Turn Over)

(4)

- (d) What are the limitations of radius ratio rule? 2
- (e) Write a short note on free electron theory of metallic bonding. 1½

OR

4. (a) Draw the molecular orbital diagram of O_2 and O_2^+ and also calculate their bond order. 2
- (b) State Fajan's rules. Explain why cations with smaller size have high polarizing power and anions with larger size have high polarizability. 3
- (c) What are the differences between intermolecular hydrogen bonding and intramolecular hydrogen bonding? Give examples. 2
- (d) What are semiconductors? Explain the various types of semiconductor on the basis of bond theory. 2½

20D/19

(Continued)

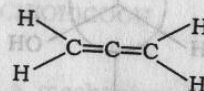
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SECTION—II

(Organic)

(Marks : 19)

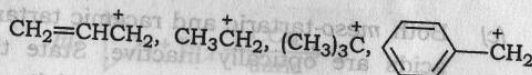
5. (a) Draw the molecular orbital picture of



and explain the shape of the molecule. Is this molecule optically active? Justify your answer. 1½+1=2½

- (b) The C=C bond length in $CH_3CH=CH_2$ is larger than that of C=C bond length in $CH_2=CH_2$. Explain. 1½

- (c) Arrange the following carbocations in their decreasing order of stability. Give reasons : 2



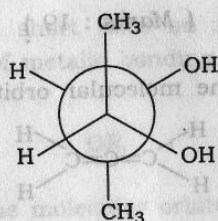
- (d) What are the essential conditions for the formation of a H-bond? Explain the effect of H-bonding on the melting point of the *ortho*- and *para*-isomers of hydroxy benzoic acid. 2½

20D/19

(Turn Over)

(6)

- (e) Convert the following Newman projection to Fischer and sawhorse projections : 1



OR

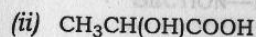
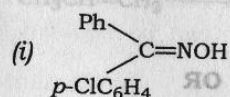
6. (a) Draw the molecular orbital picture of AlCl_3 and explain why AlCl_3 is a Lewis acid. 1½
- (b) Arrange the following oxyanions in order of increasing nucleophilicity with appropriate reasons : 1½
- CH_3O^- , $\text{C}_6\text{H}_5\text{O}^-$, $(\text{CH}_3)_3\text{CO}^-$
- (c) Both *meso*-tartaric and racemic tartaric acids are optically inactive. State the reasons for the optical inactivity in each case. 2
- (d) $\text{H}_2\text{N}-\overset{\text{NH}}{\parallel}{\text{C}}-\text{NH}_2$ is an extremely strong base. Explain. 1½

20D/19

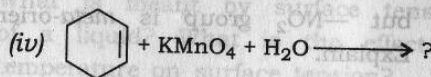
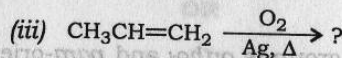
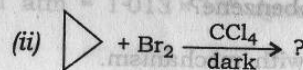
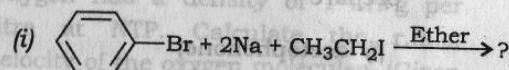
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(7)

- (e) What type of isomerism is shown by the following compounds? Draw the isomers for each : 1½×2=3



7. (a) Propose a mechanism for the reaction of methane and chlorine in the presence of sunlight. 1½
- (b) Discuss the mechanism of addition of HBr to $\text{CH}_3\text{CH}=\text{CH}_2$ in the absence of peroxides. 2
- (c) Write down the products of the following reactions : 1×4=4



20D/19

(Turn Over)

(8)

(d) What are the fundamental concepts of the modern theory of aromaticity? Illustrate with an example. 2

OR

8. (a) Explain why—

(i) alkynes are less reactive than alkenes towards electrophilic addition;

(ii) benzene undergoes electrophilic substitution more easily than nucleophilic substitution. $1\frac{1}{2} \times 2 = 3$

(b) Starting from benzene how would you prepare—

(i) acetophenone;

(ii) nitrobenzene?

Explain with mechanism. $1\frac{1}{2} \times 2 = 3$

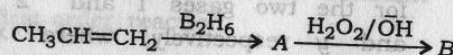
(c) —OH group is *ortho*- and *para*-orienting but —NO₂ group is *meta*-orienting. Explain. 2

20D/19

(Continued)

(9)

(d) Complete the following reaction : 1½



SECTION—III

(Physical)

(Marks : 18)

9. (a) Give the postulates of kinetic theory of gases. 3

(b) Deduce Charles law from kinetic gas equation. 3

(c) Oxygen has a density of 1.429 g per litre at NTP. Calculate the r.m.s. velocity of the oxygen molecules. (Given 1 atm = 1.013×10^6 dynes/cm².) 3

OR

10. (a) What is meant by surface tension of a liquid? What is the effect of temperature on surface tension? 2+1

20D/19

(Turn Over)

(10)

- (b) The values of van der Waals' constant a for the two gases 1 and 2 are x and y respectively, where $x \gg y$. Which of these can be liquified easily? Explain. 3
- (c) Explain the terms—
(i) refractive index;
(ii) molar refraction. $1\frac{1}{2}+1\frac{1}{2}$
11. (a) Explain the law of rational indices. 2
(b) A crystal plane has intercepts on the three axes of crystal in the ratio $\frac{3}{2}:2:1$. What are the Miller indices of the plane? 2
(c) Differentiate between molecularity and order of a reaction. 3
(d) Define energy of activation. 2

OR

12. (a) Discuss the effect of catalyst on the rate of the reaction. 3

20D/19

(Continued)

(11)

- (b) What is first-order reaction? Derive an expression for rate constant of first-order reaction. 1+3
(c) Define Frenkel and Schottky defects in crystals. 2

20D—4200/19

1/EH-23 (i) (Syllabus-2019)

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

2019

(October)

CHEMISTRY

(Elective/Honours)

(Chem-EH-101)

(**General Chemistry—I**)

Marks : 56

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—I

(**Inorganic**)

(Marks : 19)

1. (a) Find the wavelength of a 100 g particle moving with a velocity of 100 ms^{-1} [$h = 6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$]. 1½
- (b) The unpaired electrons in Al (13) and Si (14) are present in 3P-orbital. Which electrons with experience more effective nuclear charge from the nucleus? 1
- (c) What is meant by packing fraction? How does it predict the stability or otherwise of a nucleus? 3

20D/20

(Turn Over)

- (d) Explain the term ionization energy. What are the factors on which it depends upon? 2
- (e) Explain carefully why exactly half-filled and completely filled orbitals are more stable than other filled orbitals. Illustrate with an example. 2

OR

2. (a) Calculate the binding energy per nucleon of $^{17}_8\text{O}$ isotope having mass 15.994910 a.m.u.
[Mass of neutron = 1.008665 a.m.u.
Mass of electron = 0.0005486 a.m.u.] 3
- (b) Explain the term electron affinity. Why are electron affinities of halogens higher than other elements? 2
- (c) What is meant by screening effect? Describe Slater's rules. 2
- (d) Discuss Hund's rule of maximum multiplicity. 1
- (e) Explain which one has bigger ionic radius Al^+ or Al^{3+} . 1½
3. (a) Draw a potential energy diagram of hydrogen molecule using valence bond theory. 1½

- (b) Explain on the basis of molecular orbital theory that oxygen molecule is paramagnetic while nitrogen molecule is diamagnetic. 3
- (c) Discuss metallic bonding with the help of band theory. 2
- (d) On the basis of hybridization, discuss the geometry of the following molecules :
(i) PCl_5
(ii) NH_3 2
- (e) Define lattice energy. 1

OR

4. (a) On the basis of VSEPR theory, account for the geometry of the following molecules :
(i) BF_3
(ii) H_2O 2
- (b) State Fajan's rule with regards to polarization of ions. 3
- (c) Explain why the boiling point of NH_3 is higher than PH_3 . 1
- (d) Discuss the radius ratio rule and how it helps to determine the shape of the ionic crystal. 2½
- (e) Indicate which of the following molecules will have a net dipole moment :
 NH_3 or CCl_4 1

(4)

SECTION—II

(Organic)

(Marks : 19)

5. (a) Why is the bond angle of water lower than that of methane, though both are sp^3 -hybridized? 2
- (b) What is the difference between the terms 'configuration' and 'conformation' in stereochemistry? 2
- (c) Why is the boiling point of *p*-nitrophenol much higher than that of *o*-nitrophenol? 1½
- (d) What are the conditions for a molecule to undergo hyperconjugation? Draw the hyperconjugation structures of toluene. 2
- (e) Classify the following compounds into electrophiles and nucleophiles : ½×4=2
- (i) $AlCl_3$
- (ii) $(CH_3)_2NH$
- (iii) NO_2^+
- (iv) I^-

OR

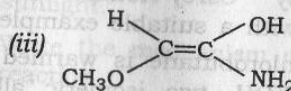
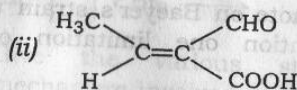
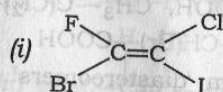
6. (a) Draw the various conformers of *n*-butane. Construct an energy-level diagram and from that deduce the most stable isomer. 1½+1+½=3

20D/20

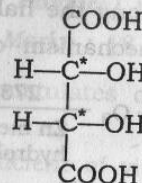
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(5)

- (b) Assign *E* or *Z* for the following geometrical isomers : ½+½+½=1½



- (c) Given below is the structure of *meso*-tartaric acid :



Justify why the compound is optically inactive in spite of the presence of two asymmetric carbon atoms. 1½

20D/20

(Turn Over)

(6)

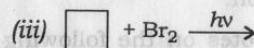
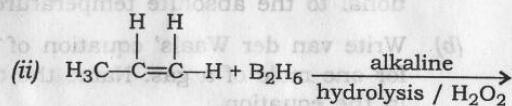
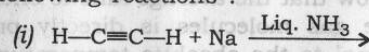
- (d) Arrange the following molecules in order of increasing acid strength with proper justification : 2
 $\text{CH}_3-\text{CH}(\text{Cl})-\text{COOH}$, $\text{CH}_3-\text{C}(\text{Cl}_2)-\text{COOH}$,
 $\text{CH}_3-\text{CH}(\text{Br})-\text{COOH}$
- (e) Define the term 'diastereomers' with a suitable example. 1½
7. (a) Write a note on Baeyer's strain theory and mention one limitation of the theory. 1½+½=2
- (b) What is the advantage of preparing an alkane by Corey-House reaction? Illustrate with a suitable example. 2
- (c) When 2-chlorobutane is warmed with alcoholic KOH, two isomeric alkenes are produced. Give the structure of the alkenes and state the rule which governs the formation of the major product. ½+½+1=2
- (d) Assign proper reason as to why only HBr undergoes anti-Markownikoff's addition among the haloacids. 2
- (e) Give the mechanism of the following reaction : 1½
$$\text{CH}_2=\text{CH}_2 + \text{O}_3 \xrightarrow[\text{Zn metal/hydrolysis}]{273 \text{ K}} 2 \text{ HCHO}$$
- OR**
8. (a) Arrange ethane, ethene and ethyne in order of increasing acid character with proper justification. 1½

20D/20

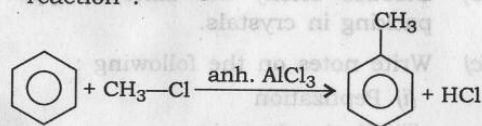
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(7)

- (b) Predict the correct products of the following reactions : 1+1+1=3



- (c) Give the various steps of the mechanism involved in the chlorination of methane in the presence of diffused sunlight. 3
- (d) Write the mechanism of the following reaction : 2



SECTION—III

(Physical)

(Marks : 18)

9. (a) State the postulates of kinetic theory of gases. 3
- (b) Define coefficient of viscosity. Express its dimension and its SI unit. 1+1+1=3
- (c) What is Boltzmann constant? 1
- (d) Calculate the root mean square speed of CO_2 molecule at 27°C . 2

20D/20

(Turn Over)

(8)

OR

10. (a) Show that the average kinetic energy of the gas molecules is directly proportional to the absolute temperature. 3
- (b) Write van der Waals' equation of state for one mole of a gas. Name the terms in the equation. 1+1=2
- (c) Write short notes on the following : 2×2=4
- (i) Refractive index
- (ii) Liquid crystals
11. (a) State and explain the law of rational indices. 2
- (b) Discuss briefly the different types of packing in crystals. 3
- (c) Write notes on the following : 2×2=4
- (i) Peptization
- (ii) Electrophoresis

OR

12. (a) What are colloids? Point out the differences between lyophilic and lyophobic colloids. 1+2=3
- (b) Explain Schottky and Frenkel defects in crystals. 2+2=4
- (c) Discuss the origin of charge on colloidal particles. 2
