Odd Semester, 2020

(Held in March, 2021)

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)* Explain the dual character of matter on the basis of the de Broglie concept. 1½

(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 = $9{\cdot}11 \times 10^{-31}$ kg, $h = 6{\cdot}626 \times 10^{-34}$ Js) 2

(c) Mention the various types of nuclear particles that are known to be present in the nucleus of an atom. 3

(d) Explain the term 'electronegativity'. What are the factors affecting the magnitude of electronegativity? How does it vary across the period and down the group? 3

OR

2. *(a)* Draw the different shapes of the *d*-orbitals. How many radial nodes are present in 5*d*, 4*d* and 3*d* orbitals? 3

(b) Explain the term 'radioactive series'. Discuss in brief the disintegration process by a 4*n* series. 2½

(c) Differentiate the terms 'nuclear fusion' and 'nuclear fission'. Give examples. 2

(d) Nitrogen has higher value of ionization enthalpy than oxygen. Give reasons. 2

3. *(a)* Using the VSEPR theory, predict the shape of the following molecules and also mention the hybridization of the central atom : 1½+1½=3

(i) H_2S

(ii) SF_4

(b) Explain with example, the polarity in a covalent bond. 1

(c) The dipole moment of H_2O is 1·84 D while that of CO_2 is zero, although both are triatomic molecules. Explain the observation. 1½

(d) Arrange the following in order of their increasing covalent character by giving reasons : 2

$BeCl_2$, $MgCl_2$, $CaCl_2$, $BaCl_2$

(e) What are semiconductors? Explain the *n*-type and *p*-type conductors with examples. 2

OR

4. *(a)* Draw the molecular orbital energy-level diagram for O_2 molecule. Discuss bond length, bond order and magnetic behaviour for O_2^{2-}, O_2^- and O_2^+ ions. 3

(b) What is Born-Haber cycle? Discuss the determination of the lattice energy for the formation of an ionic solid KCl with the help of Born-Haber cycle. 2½

(c) Define the terms 'polarizing power' and 'polarizability' of ions. How do the size and charge of ions affect the polarizing power and polarizability of ions? 2

(d) While H_2S is a gas, H_2O on the other hand is a high boiling liquid. Explain. 2

SECTION—II

(Organic)

(*Marks* : 19)

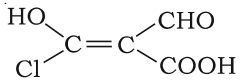
5. *(a)* Predict the hybridization of the following molecules and also give the approximate bond angles : 1×2=2

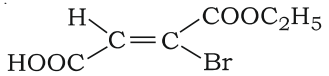
(i) $H_3\overset{\oplus}{O}$

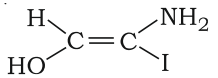
(ii) BF_3

(b) Why is 2-chloroacetic acid a more stronger acid than acetic acid? 2

(c) Assign *E* or *Z* for the following geometrical isomers : ½×3=1½

(i) 

(ii) 

(iii) 

(d) Define Lewis concept of acids and bases with suitable examples. 2

(e) Draw the various hyperconjugative structures of propene. 2

OR

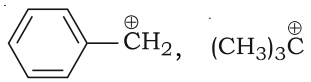
6. *(a)* Why is propanol a liquid while *n*-butane a gas at ordinary temperature? 2

(b) Draw the molecular orbital structure of BCl_3 and explain why it is a Lewis acid. 2

(c) Draw the Newman and sawhorse structures of butane and predict which conformer is more stable and why. ½×3=1½

(d) Arrange the following carbocations in their increasing order of stability. Give suitable reasons : 2

$CH_2=CH-\overset{\oplus}{C}H_2$, $CH_3-\overset{\oplus}{C}H_2$,



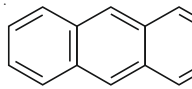
$(CH_3)_3\overset{\oplus}{C}$

(e) "Inspite of $CHCl_3$ and CCl_4 containing polar bonds, CCl_4 is a non-polar molecule while $CHCl_3$ is a polar." Justify the observation with appropriate reasons. 2

7. *(a)* What is the main disadvantage of preparing an alkane containing odd number of carbon atoms by the Wurtz reaction method? Illustrate your answer. 2

(b) Give the suitable mechanism for the bromination of ethene. 2

(c) What is Huckel's $(4n+2)\,\pi e^-$ rule? Based on this rule, which of the following compounds will be aromatic and which is not? 1+½+½=2



(d) Between alkenes and alkynes, which hydrocarbon will be more reactive towards elecrophilic addition reactions? Give proper reasons for your answer. 1½

(e) Complete the following reactions : 1+1=2

(i) $CH_3-\underset{H}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-CH_3 \xrightarrow{H_2SO_4/\Delta} A + B$

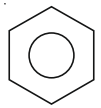
(ii)  $+ Cl_2 \xrightarrow{\text{uv light}} C$

OR

8. *(a)* Write the product for the following reaction with mechanism : 2

 $+$ conc. $HNO_3 \xrightarrow{\text{conc. } H_2SO_4} ?$

(b) Complete the following reactions : 1×3=3

(i)  $+ CH_3COCl \xrightarrow{\text{anh. } AlCl_3} ?$

(ii) $CH_3—CH=CH_2 + HBr \xrightarrow[\text{peroxide}]{\text{organic}}$ major product

(iii) $H—C\equiv C—H + H_2O \xrightarrow[H_2SO_4]{HgSO_4} ?$

(c) The —OH group attached to a benzene ring is ortho-and para-directing towards electrophilic substitution reactions, but a $—NO_2$ group is metadirecting. Explain giving suitable reason. 1½

(d) Giving correct chemical reactions, write what happens when—

(i) ethane is treated with HOCl;

(ii) ethane is treated with oxygen in the presence of silver catalyst at 200–400 °C;

(iii) ethyne reacts with hydrogen in the presence of $Pd/BaSO_4/S$. 1×3=3

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) What are the reasons that led to the deviation of real gases from ideal behaviour? Define compressibility factor. 2+1=3

(c) Calculate the root-mean-square speed of oxygen gas at 27 °C. 2

OR

10. *(a)* Using the kinetic gas equation, deduce the following : 1½+1½+1½=4½

(i) Boyle's law

(ii) Charles' law

(iii) Avogadro's law

(b) What is surface tension of a liquid? Mention the factors affecting surface tension. 1+1=2

(c) What are liquid crystals? Mention few applications of liquid crystals. 1+1½=2½

11. *(a)* State and explain the law of constancy of interfacial angles. 2

(b) What are colloids? How would you prepare the colloidal solution of *(i)* $Fe(OH)_3$ and *(ii)* Gold? 1+1½+1½=4

(c) Explain space lattice and unit cell of crystals. 1½+1½=3

OR

12. *(a)* Explain Brownian movement. Why is it caused? 2+1=3

(b) Write notes on the following : 2×2=4

(i) Electrophoresis

(ii) Gold number

(c) 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. 2

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