# 2022

( November )

## CHEMISTRY

( Elective/Honours )

**[ Part—A (Theory) ]**

( Chem-EH-101 )

**( Inorganic—I, Organic—I, Physical—I )**

*Marks* : 56

*Time* : 3 hours

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

**SECTION—I**

**( Inorganic—I )**

( *Marks* : 19 )

**1.** *(a)* Differentiate between matter wave and electromagnetic wave. 2

*(b)* Draw and explain the probability distribution curve of 3s and 3*d* orbital. 2½

(c) The kinetic energy of an electron was found to be $5{\cdot}76 \times 10^{-15}$ J. Calculate the wavelength associated with the electron. (Mass of electron = $9{\cdot}1 \times 10^{-31}$ kg and $h = 6{\cdot}626 \times 10^{-34}$ Js). 1

(d) Explain the term $n/p$ ratio in an atomic nucleus. 2

(e) State and explain Pauli's exclusion principle. 2

**OR**

**2.** (a) Using $(n+l)$ rule, which of the following orbitals will have the lowest energy and why?

$3d$ and $4s$ 2

(b) Define half-life and average life period and give its mathematical expression. 2

(c) Explain the following, giving appropriate reasons : 1+1=2

(i) Ionization potential of N is greater than that of O

(ii) Size of $Na^+$ is smaller than that of Na





(d) Calculate the mass defect and the binding energy of the helium nucleus having a mass of 4·0039 a.m.u. Given that masses of proton and neutron are 1·00758 a.m.u. and 1·00893 a.m.u. respectively. 1½

(e) Write the Schrödinger wave equation of H atom. 1

(f) Write the electronic configuration of an element with atomic No. 24 and name the element. ½+½=1

**3.** (a) Using VSEPR theory, predict the shape of the following molecules and mention the hybridization state of the central atom. 2½

(i) $NH_3$

(ii) $H_3O^+$

(b) Explain the following and give reason to your answer : 1+1=2

(i) $SnCl_4$ is more covalent than $SnCl_2$

(ii) NaCl is more ionic than CuCl

(c) What is meant by hydrogen bonding? Why do $H_2O$ and HF have abnormally high boiling point? 1+1=2

(d) The internuclear distance in HI is 1·62 Å. Assuming complete transfer of electron for H to I, calculate the % ionic character of HI, if the measured dipole moment is 0·38D. Given $e$ (charge of electron) = $4{\cdot}8 \times 10^{-10}$ e.s.u. 1

(e) What is meant by $n$-type and $p$-type semiconductor? 1+1=2

**OR**

4. (a) On the basis of molecular orbital (MO) theory, explain why $O_2$ is paramagnetic while $O_2^{2-}$ is diamagnetic. 2

(b) What is Born-Haber cycle? Calculate the heat of formation ($\Delta H_f$) of KF from its elements using Born-Haber cycle. Given : 1½

Sublimation energy of
K[S] = 87·8 kJ $mol^{-1}$

Dissociation energy of
$F_2$(g)[D] = 158·9 kJ $mol^{-1}$

Ionization energy of
K(g)[I] = 414·2 kJ $mol^{-1}$

Electron affinity for
F(g)[E] = −334·7 kJ $mol^{-1}$

Lattice energy of
KF[$U_0$] = −807·5 kJ $mol^{-1}$



( Continued )



(c) Discuss the energy band obtained in—

(i) metals;

(ii) semi-conductors. 2

(d) Why are $CO_2$ and $CCl_4$ molecules non-polar while $CHCl_3$ molecule is polar? 2

(e) The central atom in $CH_4$ and $NH_3$ involves $sp^3$ hybridization, but their bond angles are different. Why? 2

## SECTION—II

## ( Organic—I )

( *Marks* : 19 )

5. (a) Draw the molecular orbital picture of the given molecules and mention the hybridization, shape and bond angles. 1½+1½=3

(i) $C_2H_2$

(ii) $\overset{+}{C}H_3$

(b) What are Lewis acids and Lewis bases? Give examples. 2

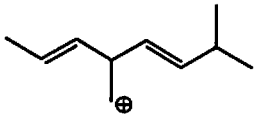
(c) Arrange the following compounds in order of decreasing order of acidity : 1

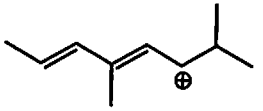
$CH_3COOH$, $ClCH_2COOH$,
$Cl_2CHCOOH$, $Cl_3CCOOH$

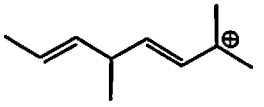


( Turn Over )

(d) Which carbocation is the most stable and why? 1½

(i) 

(ii) 

(iii) 

(e) What do you understand by the term 'resolution'? Distinguish between enantiomers and diastereomers. 2

**OR**

**6.** (a) Compare the acidity of ethane, ethene, and ethyne. Explain on the basis of hybridization. 1½

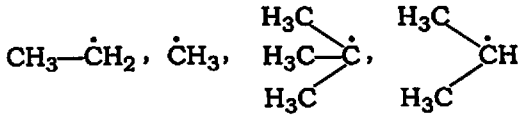
(b) *p*-hydroxybenzaldehyde is more soluble in water compare to its ortho-isomer. Explain. 1½

(c) What do you understand by the term 'resonance effect'? Illustrate by giving a suitable example. 2



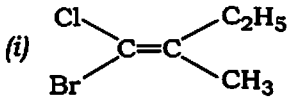


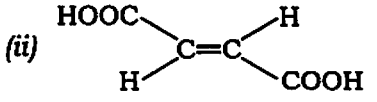
(d) Arrange the following in the order of stability : 1

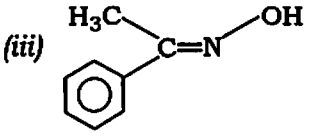


(e) What are electrophiles and nucleophiles? Give examples. 2

(f) Assign *E*- and *Z*-nomenclature for the following molecules : 1½

(i) 

(ii) 

(iii) 

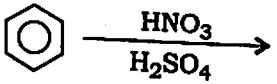
**7.** (a) Explain Baeyer's strain theory of cycloalkane. 2

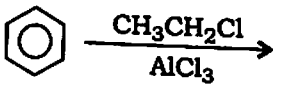
(b) How are alkanes prepared by Corey-House method? Give one advantage of Corey-House method over Wurtz reaction for the preparation of alkanes. 1½+1=2½

(c) Write a suitable mechanism for the given reaction : 2

$$CH_3-CH=CH_2 + HBr \xrightarrow{\text{peroxide}}$$

(d) Complete the following reactions with mechanism : 1½+1½=3

(i)  $\xrightarrow[H_2SO_4]{HNO_3}$

(ii)  $\xrightarrow[AlCl_3]{CH_3CH_2Cl}$

**OR**

8. (a) What is Hückel's rule? Write the structure of two compounds that follow this rule. 2

(b) Write the stepwise reaction mechanism for the light induced monochlorination of methane. 2





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

(i) $CH_3CH_3 \xrightarrow[\text{absence of air}]{500\ ^\circ C}$

(ii) $CH_3-CH=CH_2 \xrightarrow[H_2O]{KMnO_4}$

(iii) $CH_3-C\equiv CH \xrightarrow[\text{ammoniacal } Cu_2Cl_2]{Cu^{\oplus}}$

(d) What happens when benzene reacts with excess of concentrated sulphuric acid? Give reactions. 1

(e) Explain why benzene undergoes electrophilic substitution reaction whereas alkenes undergo addition reaction. 1½

## SECTION—III

## ( Physical—I )

( *Marks* : 18 )

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

(b) Deduce Charles' law and Avogadro's law from kinetic gas equation. 2+2=4

(c) What are liquid crystals? Why are they so called? 1+1=2

**OR**

**10.** *(a)* What is meant by surface tension of a liquid? What is the effect of temperature on surface tension? 2+1=3

*(b)* Calculate the root mean square velocity of oxygen molecule at NTP. 2

*(c)* Write short notes on the following : 2+2=4

*(i)* Refractive index

*(ii)* Viscosity

**11.** *(a)* Explain the law of rational indices. 2

*(b)* Explain Schottky and Frenkel defects in crystals. 1½+1½=3

*(c)* What is first-order reaction? Derive an expression for rate constant of first-order reaction. 1+3=4

**OR**

**12.** *(a)* Define order and molecularity of a reaction with one example for each. 1½+1½=3

*(b)* Discuss the effect of catalyst on the rate of a reaction. 2





*(c)* Calculate the Miller indices of crystal planes which cut through the crystal axes at $(2a, 3b, \alpha c)$. 2

*(d)* Define the following : 1+1=2

*(i)* Space lattice

*(ii)* Unit cell

★★★