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(February)

CHEMISTRY

(Elective/Honours)

[Part—A (Theory)]

(Inorganic—I, Organic—I, Physical—I)

[Chem-EH-101]

Marks : 56

Time : 3 hours

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

SECTION—I

(Inorganic—I)

(Marks : 19)

1. (a) List two limitations of Bohr's atomic model. 2
- (b) Explain why orbitals like $1p$, $2d$ and $3f$ are not possible. 2

- (c) If the uncertainties in the measurement of position and momentum are equal, calculate the uncertainty in the measurement of velocity of a particle having mass 9.1×10^{-31} kg ($h = 6.626 \times 10^{-34}$ J). 2
- (d) What is meant by packing fraction? 1
- (e) What are the factors which influence the ionization energies? $1\frac{1}{2}$
- (f) State the modern periodic law. 1

OR

2. (a) Calculate the uncertainty in the momentum of an electron if it is confined to a linear region of length 1×10^{-10} metre. 2
- (b) Nickel atom can lose two electrons to form Ni^{2+} ion. The atomic number of Ni is 28. From which orbital will nickel lose two electrons and why? $1\frac{1}{2}$
- (c) Calculate the binding energy of an α -particle. Express the result in MeV : 2
- Mass of a proton = 1.0078 a.m.u.
Mass of a neutron = 1.0089 a.m.u.
Mass of an α -particle = 4.0084 a.m.u.

(3)

(d) Explain, why—

- (i) fluorine has a lower electron affinity than chlorine;
- (ii) the ionic radii decreases as we move across the period in the periodic table. 2+2=4

3. (a) Discuss the orbital structures of the following molecules on the basis of hybridization : 2

- (i) NH_3
- (ii) BeF_2

(b) State Fajan's rules to explain the covalent character in an ionic compound. 2

(c) Draw molecular orbital energy level diagram for oxygen molecule and calculate the bond order and also comment on its magnetic property. 2½

(d) Define hydrogen bond. What are the different types of hydrogen bond? Give one example of each type. 2

(e) Explain why LiCl has a higher melting point compared to KCl . 1

(4)

OR

4. (a) Using VSEPR theory, explain the geometry of the following molecules : 2

- (i) H_2O
- (ii) BF_3

(b) Using Born-Haber cycle, calculate the electron affinity of chlorine atom from the following data : 1½

Bond enthalpy of Cl_2
 $+240.0 \text{ kJ mole}^{-1}$
Enthalpy of formation of NaCl(s) =
 $-440.0 \text{ kJ mole}^{-1}$
Enthalpy of sublimation of Na(s) =
 $110.0 \text{ kJ mole}^{-1}$
Enthalpy of ionization of Na(g) =
 $+480.0 \text{ kJ mole}^{-1}$
Lattice energy of NaCl(s) =
 $-810.0 \text{ kJ mole}^{-1}$

(c) Define (i) polarizing power and (ii) polarizability. 2

(d) Why H_2O has a higher boiling point than H_2S ? 1

(e) Explain bond model of metallic bonding. 2

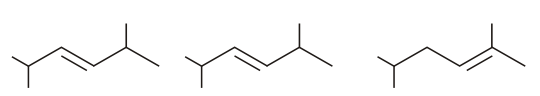
(f) Explain which of these two molecules CH_4 or CCl_4 has more dipole moment. 1

(5)

SECTION—II

(Organic—I)

(Marks : 19)

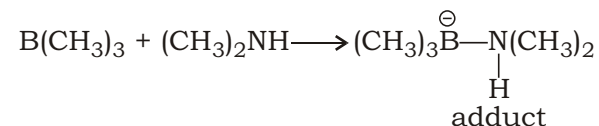
5. (a) Draw the molecular orbital picture of formaldehyde giving the shape and the bond angle. 1½
- (b) The C—C bond in ethane is longer and weaker whereas the C—C bond in acetylene is shorter and stronger. Explain the observation. 2
- (c) Arrange the following carbocations in order of decreasing stability giving justification : 1½
- 

(A) (B) (C)
- (d) Taking $\text{COOH}(\text{CHOH})_2\text{COOH}$ as an example, explain the terms diastereomers, enantiomers and meso-compounds. 3
- (e) What is a racemic mixture? Give any one method of resolution of a racemic mixture. 1½

(6)

OR

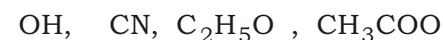
6. (a) Identify (giving justification) the Lewis acid and Lewis base in the following reaction : 2



- (b) Arrange the following compounds in order of increasing $\text{p}K_a$ value with justification : 1½

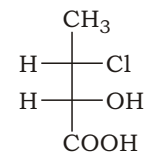


- (c) Amongst the following species, identify the strongest and weakest nucleophile : 1½



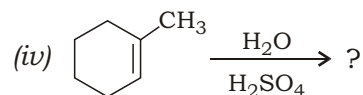
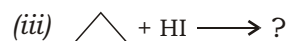
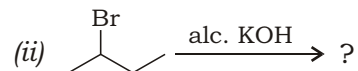
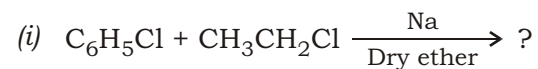
- (d) “A chiral compound may not be optically active but an optically active compound is always chiral.” Explain. 2½

- (e) Convert the following Fischer projection into Sawhorse and Newman projections : 2

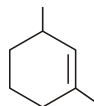


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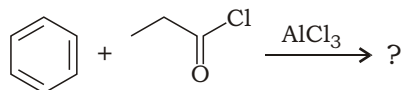
7. (a) Predict the products of the following reactions : 1×4=4



- (b) What is Baeyer's strain theory? What are its limitations? 2
- (c) Give the product obtained and the steps involved on ozonolysis of the following compound : 2



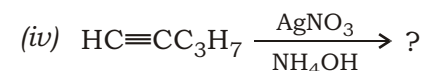
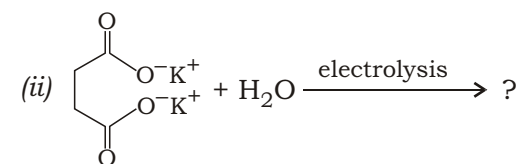
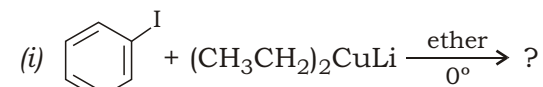
- (d) Complete the following reaction with mechanism : 1½



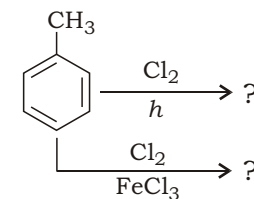
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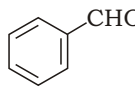

OR

8. (a) Discuss the consequences of the presence of either $-\text{NH}_2$ or the $-\text{OME}$ group on the electrophilic substitution of the benzene ring. 2
- (b) Predict the products of the following reactions : 1×4=4



- (c) Complete the following reactions giving mechanism : 2



- (d) How is  obtained from  ? 1½
- Give mechanism.

(9)

SECTION—III

(Physical—I)

(Marks : 18)

9. (a) Derive van der Waals' equation of state for real gases. 4
- (b) Deduce Boyle's law from kinetic gas equation. 2
- (c) Define (i) Boltzmann constant and (ii) compressibility factor. $1\frac{1}{2}+1\frac{1}{2}=3$

OR

10. (a) Define coefficient of viscosity. What is the effect of temperature on viscosity? $2+1=3$
- (b) What are liquid crystals? Mention the types of liquid crystals. $1+3=4$
- (c) Write down the expression for virial equation of state of a real gas. 2

11. (a) Explain the law of constancy of interfacial angles. 2

(10)

- (b) Derive the expression for rate constant of second-order reaction where both the reactants are same. 4
- (c) Define (i) vacancy defects and (ii) interstitial defects with examples. $1\frac{1}{2}+1\frac{1}{2}=3$

OR

12. (a) Discuss the effect of temperature on reaction rates. 2
- (b) A crystal plane has intercepts on the three axes of crystal in the ratio of $1:2:\frac{3}{2}$. What are the Miller indices of the plane? 2
- (c) Define pseudo-unimolecular reactions with suitable example. 2
- (d) Explain how an order of a reaction is experimentally determined (any one method). 3
