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(November)

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)* Write down the Schrödinger wave equation for an electron propagating in three dimensions in space and explain the terms involved. Mention the physical significance of ψ and ψ^2.

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

    (b) State Heisenberg uncertainty principle and write its mathematical form. 2

(Turn Over)

(2)

(c) Calculate the uncertainty of velocity of an electron if the uncertainty of its position is 10^{-10} m.

$(h = 6 \cdot 6 \times 10^{-34}$ kg m^2 s^{-1}

and $m_e = 9 \cdot 1 \times 10^{-31}$ kg)   2

(d) Exactly half-filled and completely filled orbitals are more stable than other filled orbitals. Explain.   2

OR

2. (a) What are the significances of neutron-proton ratio in an atomic nucleus?   2

(b) What is Aufbau principle? Arrange the orbitals of an atom in increasing order of their energies.   2

(c) Derive the first-order rate equation of a radioactive disintegration.   2

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

(e) Explain diagonal relationship with suitable examples.   1½

3. (a) Explain on the basis of molecular orbital theory that oxygen molecule is paramagnetic while nitrogen molecule is diamagnetic.   3

(b) Write down the limitations of valence bond theory for covalently bonded molecules.   1½

(3)

(c) Predict the structure of the following molecules with the help of VSEPR theory and also mention the hybridization of the central atom :   1+1+1=3

(i) BeF_2

(ii) H_2O

(iii) SF_6
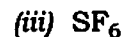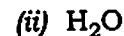
(d) The dipole moment of NH_3 is $1 \cdot 49$ D while that of NF_3 is $0 \cdot 2$ D. Draw their structures and explain the above observation.   2

OR

4. (a) What is lattice energy? Mention the factors on which lattice energy of an ionic crystal is dependent.   1+1½=2½

(b) What are the factors on which the polarization power of an ion depends? Which of the following pairs will have greater polarizing power?   2+1=3

Pb^{2+} and Pb^{4+}

(c) Differentiate between intermolecular and intramolecular H-bonding, giving suitable examples.   2

(d) Classify the following as either a p-type or an n-type semiconductor :   1+1=2
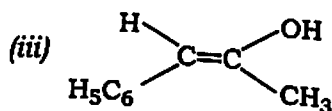
(i) Ge doped with In

(ii) B doped with Si
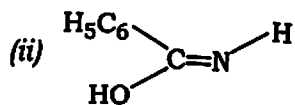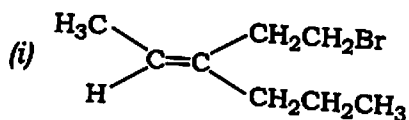
SECTION—II

### (Organic)

(*Marks* : 19)

5. (a) Draw the molecular orbital picture of the following molecules/species, mentioning the types of hybridization, bond angles and shapes in each case :   2

    (i) $CH_2=C=CH_2$

    (ii) $\overset{\oplus}{CH_3}$

(b) pK_a value of acetic acid is 4·76 whereas formic acid is 3·77. Which one of these is more acidic and why?   2

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

(d) Explain why *p*-nitrophenol is soluble in water.   2

(e) Using sequence rule, designate *E* or *Z*, syn or anti for the following molecules :   ½×3=1½

(i)

$$H_3C\diagdown \underset{H\diagup}{C}=C\underset{\diagdown CH_2CH_2CH_3}{\diagup CH_2CH_2Br}$$

(ii)

$$H_5C_6\diagdown \underset{HO\diagup}{C}=N\diagup H$$

(iii)

$$H\diagdown \underset{H_5C_6\diagup}{C}=C\underset{\diagdown CH_3}{\diagup OH}$$

OR

6. (a) What is bond fission? Describe the different types of bond fission.   2

(b) What are the criteria for a molecule to be optically active?   2

(c) How will you account for larger dipole moment of NH_3 (1·46 D) as compared to that of NF_3 (0·24 D)?   2

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

$$CH_3\overset{\bullet}{C}H_2, \ \overset{\bullet}{C}H_3, \ (CH_3)_2\overset{\bullet}{C}H, \ (CH_3)_3\overset{\bullet}{C}$$

(e) What is inductive effect? How does inductive effect increase or decrease the acidic and basic characters of organic acids and bases?   1+1½=2½

7. (a) Explain Hückel's (4n+2) rule of aromaticity.   1½

(b) What is Corey-House synthesis? Give its mechanism.   2
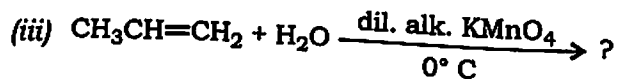
(c) Complete the following reaction with mechanism :   2

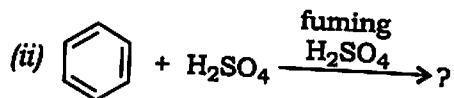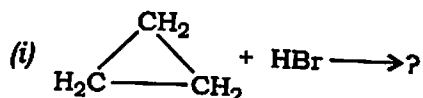$$\bigcirc + CH_3-\overset{\overset{O}{\|}}{C}-Cl \xrightarrow{AlCl_3} \ ?$$
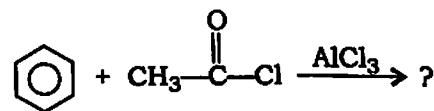
(d) Explain Baeyer's strain theory of cycloalkane. 2

(e) Complete the following reactions : 2

(i) $CH_3—CH=CH_2 + HBr \xrightarrow{\text{Peroxide}} ?$

(ii) $CH_3—C\equiv C—CH_3 \xrightarrow{O_3} A \xrightarrow{H_2O} B$

OR

8. (a) What is the directive influence of an —OH (phenolic) group? Give example. 2

(b) Complete the following reactions : 3

(i)

$$\underset{\underset{H_2C———CH_2}{\overset{CH_2}{\diagup\diagdown}}}{} + HBr \longrightarrow ?$$

(ii) $\bigcirc + H_2SO_4 \xrightarrow[\quad\quad]{\text{fuming } H_2SO_4} ?$

(iii) $CH_3CH=CH_2 + H_2O \xrightarrow[0°C]{\text{dil. alk. KMnO}_4} ?$

(c) Give the method of preparation of alkanes by Wurtz method. Give one of its limitations. $1\frac{1}{2}+1=2\frac{1}{2}$

(d) Alkynes are less reactive than alkenes towards electrophilic addition reactions. Explain. $1\frac{1}{2}$

(e) Arrange the following in order of increasing acidic strength : $\frac{1}{2}$

Ethane, Ethene, Ethyne

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) Mention the condition under which real gases tend to obey the ideal gas law. Write down the van der Waals equation of state and explain the terms therein. $1\frac{1}{2}+1\frac{1}{2}=3$

(c) What are liquid crystals? Classify them. $1+1=2$

OR

10. (a) Define Miller indices. Calculate Miller indices of crystal planes which cut through the crystal axis at $(2a, -3b, -3c)$. 3

(b) Mention the factor affecting viscosity of a liquid. 1

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

(d) How would you prepare ferric hydroxide sol? $1\frac{1}{2}+\frac{1}{2}=2$

(**8**)

11. *(a)* Give the postulates of kinetic theory of gases. 4

   (b) What is surface tension of a liquid? What is the effect of temperature on surface tension? 1+2=3

   (c) Write a short note on refractive index. 2

OR

12. *(a)* Calculate the temperature at which the root mean square velocity of oxygen gas is equal to 1500 m/s. 2

   (b) State the law of constancy of inter-facial angle. 2

   (c) Explain Schottky and Frenkel defects in crystal. 1½+1½=3

   (d) Write a short note on electrophoresis. 2

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