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} [$h = 6.626 \times 10^{-34}$ kg m^2 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

   (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 $^{17}_{8}O$ 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

(Continued)

(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

(Turn Over)

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) $\overset{\oplus}{N}O_2$

(iv) $I^{\ominus}$

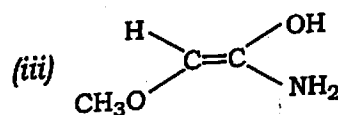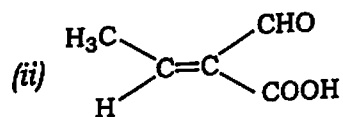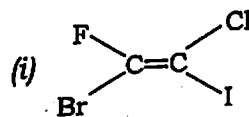**OR**

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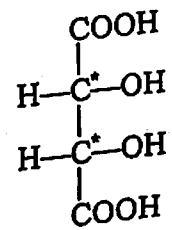
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(b) Assign E or Z for the following geometrical isomers : **½+½+½=1½**

(i)

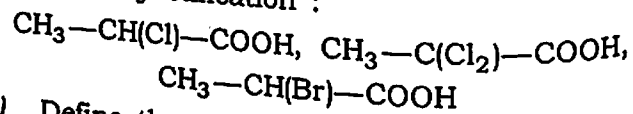

(ii)

(iii)

(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**

(d) Arrange the following molecules in order of increasing acid strength with proper justification : 2

$$CH_3—CH(Cl)—COOH, \quad CH_3—C(Cl_2)—COOH,$$
$$CH_3—CH(Br)—COOH$$

(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
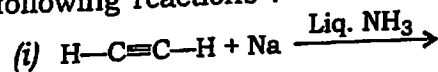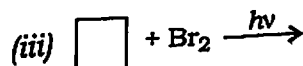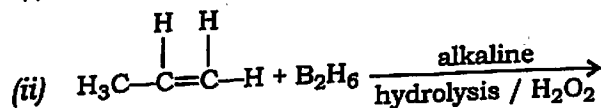
(e) Give the mechanism of the following reaction : 1½

$$CH_2=CH_2 + O_3 \xrightarrow[\text{Zn metal/hydrolysis}]{273\ K} 2\ HCHO$$
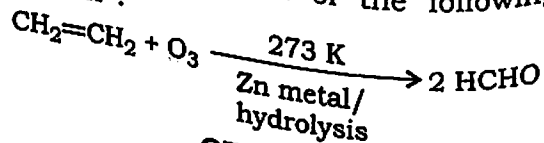
OR

8. (a) Arrange ethane, ethene and ethyne in order of increasing acid character with proper justification. 1½
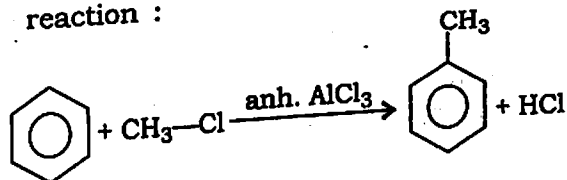
(b) Predict the correct products of the following reactions : 1+1+1=3

(i) $H—C\equiv C—H + Na \xrightarrow{\text{Liq. } NH_3}$

(ii) $H_3C—\overset{\overset{H}{|}}{C}=\overset{\overset{H}{|}}{C}—H + B_2H_6 \xrightarrow[\text{hydrolysis / } H_2O_2]{\text{alkaline}}$

(iii) $\square + Br_2 \xrightarrow{h\nu}$

(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

$$\bigcirc + CH_3—Cl \xrightarrow{\text{anh. } AlCl_3} \bigcirc^{CH_3} + HCl$$

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

(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

20D—3700/20

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1/EH–23 (i) (Syllabus–2015)