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(February)

CHEMISTRY

(Elective/Honours)

(General Chemistry—I)

[Chem-EH-101]

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 limitations of the Bohr's atomic model. 2
- (b) Mention the physical significance of n^2 . How many corresponding radial nodes are possible for 1s, 2s and 3s orbitals? 2

- (c) Calculate the binding energy per nucleon in helium atom ${}^2\text{He}^4$ which has a mass of 4.00260 a.m.u.
Mass of 1 neutron 1.008665 a.m.u.
Mass of 1 hydrogen atom 1.007825 a.m.u.
Express the results in joules.
(1 MeV = 1.602×10^{-13} J) 2
- (d) Write down the first-order rate equation of radioactive disintegration mentioning the terms involved in it. 1
- (e) Define the terms 'atomic' and 'ionic radii'. Explain why the ionic radius of K is smaller than that of Cl, although both are isoelectronic. $2\frac{1}{2}$

OR

2. (a) State and explain Pauli's exclusion principle. For a given shell $n = 2$, write down the possible values of l and m . $1+1=2$
- (b) Calculate the effective nuclear charge experienced by the s electron in potassium atom. 2
- (c) Half-life of radium (atomic mass 226) is 1580 years. Show that 1 g of radium gives 3.70×10^{10} disintegration per second. 2

(3)

- (d) Mention the unit expressed for radioactivity. $1\frac{1}{2}$
- (e) Define the term 'diagonal relationship'. Explain how the similarities between Li and Mg arise. $\frac{1}{2}+1\frac{1}{2}=2$
3. (a) What are the limitations of the valence bond theory? $1\frac{1}{2}$
- (b) Discuss the hybridization state and geometry of the following molecules : $1+1=2$
- (i) SF_4
- (ii) H_2S
- (c) Draw the molecular orbital energy-level diagram for O_2 molecule and discuss the magnetic behaviour of O_2 , O_2^+ , O_2^{2+} and O_2^- . $1\frac{1}{2}+1\frac{1}{2}=3$
- (d) Giving appropriate reasons, state whether Pb^{2+} or Pb^{4+} will have greater polarizing power. $1\frac{1}{2}$
- (e) Discuss metallic bonding with the help of band theory. $1\frac{1}{2}$

(4)

OR

4. (a) On the basis of VSEPR theory, predict the shape of the following molecules : $1+1=2$
- (i) BeF_2
- (ii) BF_3
- (b) CO_2 has a net zero dipole moment but H_2O has some values of dipole moment. Explain. $1\frac{1}{2}$
- (c) What is radius ratio? For an ionic solid with radius ratio in the range $0.155-0.225$, write down the probable geometry or structural arrangement and the coordination number. $1+1=2$
- (d) "The boiling points of HF and HCl are 293 K and 189 K respectively." Explain the above observations. 2
- (e) What is lattice energy of an ionic solid? Mention the factors on which the lattice energy is dependent. $1+1=2$

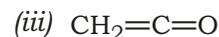
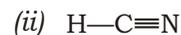
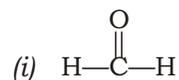
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SECTION—II

(Organic)

(Marks : 19)

5. (a) Indicate the type of hybridization of the carbon atoms in each of the following compounds : 2



- (b) Draw the molecular orbital picture of BF_3 and explain its acidic character on this basis. 1½

- (c) Explain why $\text{p}K_a$ of 2-chloroacetic acid is less than that of 3-chloropropanoic acid. 2

- (d) Explain the optical inactivity of mesotartaric acid. 2

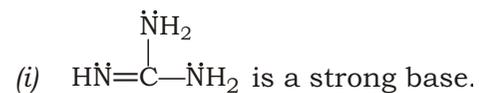
- (e) Which of the following carbocations is more stable and why? 2



(6)

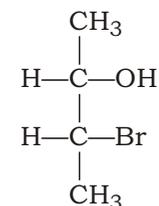
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6. (a) Account for the following facts : 1½×2=3

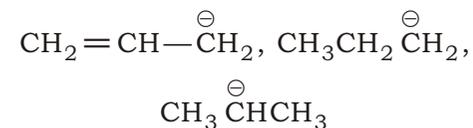


- (ii) *p*-hydroxybenzoic acid has a higher melting point than *o*-hydroxybenzoic acid.

- (b) Convert the following Fischer projection formula to Sawhorse and Newman projection formula : 2



- (c) Arrange the following carbanions in order of increasing stability with appropriate reasons : 1½

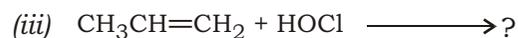
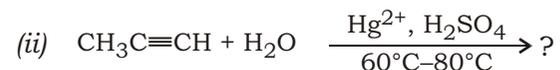
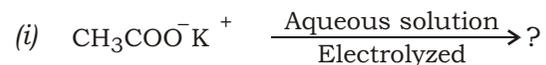


- (d) Draw the *E* and *Z* isomers of methyl phenyl ketoxime. 2

- (e) Arrange ethane, ethene and ethyne in order of increasing C—C bond strength. 1

(7)

7. (a) Complete the following reactions : 1×4=4



(b) Discuss the relative reactivities of methane and ethane in halogenation. 1½

(c) How is benzene converted to acetophenone? Discuss the mechanism involved in the conversion. 2

(d) Explain why cyclohexane unlike lower cycloalkanes is resistant to hydrogenation reaction. 1

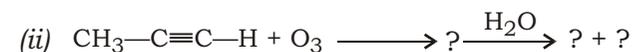
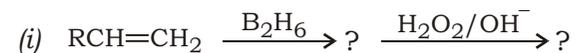
(e) What happens when *n*-heptane is passed over Cr_2O_3 supported over alumina at 600°C ? Give the relevant chemical equation. 1

OR

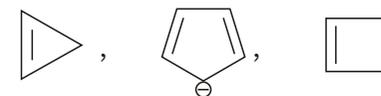
8. (a) Explain why peroxide effect is for HBr and not for HCl. 1½

(8)

(b) Complete the following reactions : 1½×2=3



(c) What is Hückel's ($4n + 2$) rule? Using this rule, indicate whether the following species are aromatic or non-aromatic : 1½



(d) Complete the following reaction with mechanism : 2



(e) Explain why $\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—H}$ group is meta-directing in electrophilic substitution reaction. 1½

(9)

SECTION—III

(Physical)

(Marks : 18)

9. (a) Derive the kinetic gas equation $PV = \frac{1}{3} mn\bar{c}^2$ from kinetic theory of gases. 4
- (b) Define surface tension of a liquid. What is its unit in SI system? 1+1=2
- (c) Calculate the root-mean-square speed of oxygen gas at 27 °C. Express it in SI and CGS units. 2+1=3

OR

10. (a) What are the reasons that led to the deviation of real gases from ideal behaviour? What is meant by compressibility factor Z ? 2+1=3
- (b) Deduce Boyle's law and Charles' law from kinetic gas equation. $1\frac{1}{2}+1\frac{1}{2}=3$
- (c) Explain the following terms : $1\frac{1}{2}+1\frac{1}{2}=3$
- (i) Liquid crystals
- (ii) Viscosity

(10)

11. (a) State and explain the law of rational indices. 2
- (b) What are meant by space lattice and unit cell? 1+1=2
- (c) Explain Schottky defect and Frenkel defect in crystals. 2+2=4
- (d) A crystal plane has intercepts on the three axes of crystal in the ratio of $\frac{3}{2}:2:1$. Calculate the Miller indices of the plane. 1

OR

12. (a) What are colloids? Differentiate between lyophilic and lyophobic colloids. 1+2=3
- (b) Explain the phenomenon of Tyndall effect in colloidal solution. 3
- (c) Explain the following : $1\frac{1}{2}+1\frac{1}{2}=3$
- (i) Protective colloids
- (ii) Dialysis
