

1/EH-23 (i) (Syllabus-2019)

2019

(October)

CHEMISTRY

(Elective/Honours)

(Chem-EH-101)

Full Marks : 56

Time : 3 hours

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

SECTION—I

(Inorganic)

(Marks : 19)

1. (a) Explain the term dual character of matter and radiation. Derive de Broglie's equation. 2+1=3
- (b) An electron has a speed of 300 ms^{-1} accurate up to 0.001%. What is the uncertainty in locating its position? (Mass of an electron = $9.1 \times 10^{-31} \text{ kg}$ and Planck's constant (h) = $6.626 \times 10^{-34} \text{ Js}$). 2½

(Turn Over)

(2)

- (c) What are the significance of the neutron/proton (N/P) ratio in an atomic nucleus?
- (d) Explain with examples the basis of diagonal relationship.

OR

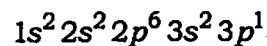
2. (a) Define electron affinity and explain why the electron affinity of oxygen and fluorine are less than sulphur and chlorine in their respective groups.
- (b) Write down the three-dimensional Schrödinger wave equation in Cartesian coordinates and explain the terms involved in it. What are the physical significance of ψ^2 , where ψ is the wave function of the electron? $2+1=3$
- (c) Calculate the packing fraction and mass defect in the formation of argon atom $^{40}_{18}\text{Ar}$.
(Isotopic mass of Ar = 39.96238 a.m.u.,
mass of 1 neutron = 1.008665 a.m.u.,
mass of 1 hydrogen atom = 1.007825 a.m.u.) $1+1=2$

20D/19

(Continued)

(3)

- (d) What is nuclear fusion? Give one example of nuclear fusion reaction. $1\frac{1}{2}$
- (e) Name the element and to which block in the periodic table the element with the following electronic configuration belongs : 1



3. (a) Discuss the potential energy diagram for the formation of hydrogen molecule on the basis of the valence bond theory. 2
- (b) Predict the structures of the following molecule and ion with the help of VSEPR theory and also mention the hybridisation of the central atom : $1+1=2$
- (i) SF_4
- (ii) BO_3^{3-}
- (c) The dipole moment of NH_3 is 1.49 D while the dipole moment of NF_3 is 0.2 D. Draw their structures and explain the above observation. 2

(Turn Over)

20D/19

(4)

(d) What are the limitations of radius ratio rule? 2

(e) Write a short note on free electron theory of metallic bonding. 1½

OR

4. (a) Draw the molecular orbital diagram of O_2 and O_2^+ and also calculate their bond order. 2

(b) State Fajan's rules. Explain why cations with smaller size have high polarizing power and anions with larger size have high polarizability. 3

(c) What are the differences between inter-molecular hydrogen bonding and intra-molecular hydrogen bonding? Give examples. 2

(d) What are semiconductors? Explain the various types of semiconductor on the basis of bond theory. 2½

20D/19

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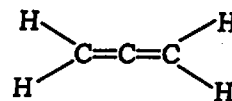
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SECTION—II

(Organic)

(Marks : 19)

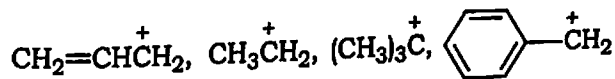
5. (a) Draw the molecular orbital picture of



and explain the shape of the molecule. Is this molecule optically active? Justify your answer. 1½+1=2½

(b) The C=C bond length in $CH_3CH=CH_2$ is larger than that of C=C bond length in $CH_2=CH_2$. Explain. 1½

(c) Arrange the following carbocations in their decreasing order of stability. Give reasons : 2



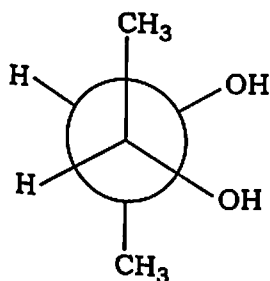
(d) What are the essential conditions for the formation of a H—bond? Explain the effect of H—bonding on the melting point of the *ortho*- and *para*-isomers of hydroxy benzoic acid. 2½

(Turn Over)

20D/19

(6)

- (e) Convert the following Newman projection to Fischer and sawhorse projections :



OR

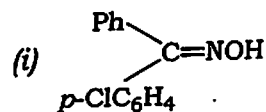
6. (a) Draw the molecular orbital picture of AlCl_3 and explain why AlCl_3 is a Lewis acid. 1½
- (b) Arrange the following oxyanions in order of increasing nucleophilicity with appropriate reasons : 1½
 CH_3O^- , $\text{C}_6\text{H}_5\text{O}^-$, $(\text{CH}_3)_3\text{CO}^-$
- (c) Both meso-tartaric and racemic tartaric acids are optically inactive. State the reasons for the optical inactivity in each case. 2
- (d) $\text{H}_2\text{N}-\text{C}(\text{NH})=\text{NH}_2$ is an extremely strong base. Explain. 1½

20D/19

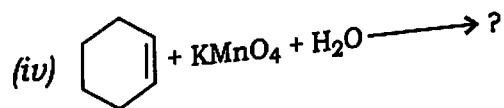
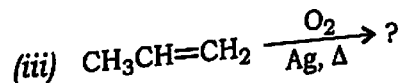
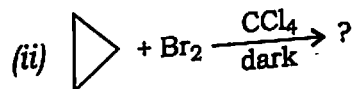
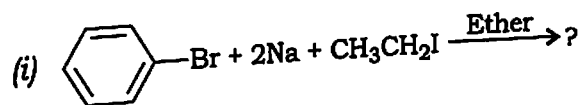
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(7)

- (e) What type of isomerism is shown by the following compounds? Draw the isomers for each : 1½×2=3



7. (a) Propose a mechanism for the reaction of methane and chlorine in the presence of sunlight. 1½
- (b) Discuss the mechanism of addition of HBr to $\text{CH}_3\text{CH}=\text{CH}_2$ in the absence of peroxides. 2
- (c) Write down the products of the following reactions : 1×4=4



(Turn Over)

20D/19

(8)

- (d) What are the fundamental concepts of the modern theory of aromaticity? Illustrate with an example.

2

OR

8. (a) Explain why—

(i) alkynes are less reactive than alkenes towards electrophilic addition;

(ii) benzene undergoes electrophilic substitution more easily than nucleophilic substitution. $1\frac{1}{2} \times 2 = 3$

- (b) Starting from benzene how would you prepare—

(i) acetophenone;

(ii) nitrobenzene?

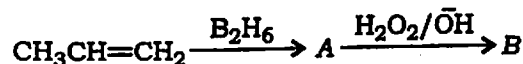
Explain with mechanism. $1\frac{1}{2} \times 2 = 3$

- (c) —OH group is *ortho*- and *para*-orienting but —NO₂ group is *meta*-orienting. Explain.

2

(9)

- (d) Complete the following reaction : $1\frac{1}{2}$



SECTION—III

(Physical)

(Marks : 18)

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

- (b) Deduce Charles law from kinetic gas equation. 3

- (c) Oxygen has a density of 1.429 g per litre at NTP. Calculate the r.m.s. velocity of the oxygen molecules. (Given $1 \text{ atm} = 1.013 \times 10^6 \text{ dynes/cm}^2$.) 3

OR

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

(10)

- (b) The values of van der Waals' constant a for the two gases 1 and 2 are x and y respectively, where $x \gg y$. Which of these can be liquified easily? Explain.

3

- (c) Explain the terms—

(i) refractive index;

(ii) molar refraction.

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

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

2

- (b) A crystal plane has intercepts on the three axes of crystal in the ratio $\frac{3}{2} : 2 : 1$. What are the Miller indices of the plane?

2

- (c) Differentiate between molecularity and order of a reaction.

3

- (d) Define energy of activation.

2

OR

12. (a) Discuss the effect of catalyst on the rate of the reaction.

3

(11)

- (b) What is first-order reaction? Derive an expression for rate constant of first-order reaction.

1+3

- (c) Define Frenkel and Schottky defects in crystals.

2
