

# Model Question



## Dumkal College Basantapur Dumkal

Course Code: CHEMHT-2

Semester: I (Hons)

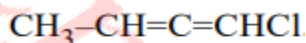
Name of the Teacher: Md Muttakin Sarkar

Name of the Department: Chemistry

## CHEMHT-2 (Organic chemistry -I)

### Bonding and Physical properties:

1. Draw the orbital picture of the following compound indicating the hybridisation state of the key atoms.  
2



2. Calculate the DBE (double bond equivalent) of  $\text{C}_8\text{H}_6\text{O}_4$ . 1  
3. Arrange the following groups in order of decreasing (-I) effect (No explanation needed):

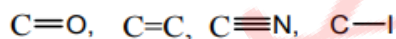


4. e) Compare the dipole moments of each of the following pairs with reasons:

- i) 1,2-dibromo ethane and 1,2-dihydroxy ethane  
ii) EtCN and EtNC

5. Boiling point of n-butanol is higher than that of tert-butanol. Give reason.

6. State which of the four types of bonds shown below has the highest and which one the lowest bond energy. Give reasons.



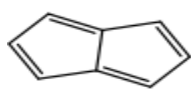
7. Why  $\text{C}_2 - \text{C}_3$  bond distance in propene is shorter than C-C bond in propane?

8. Cyclooctatetraene becomes planar on addition of two electrons to it- Explain.

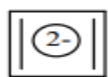
9. Why cyclopropanone is a stable compound while cyclopentadienone has not been prepared?

What is resonance energy? Calculate resonance energy of 1,3-butadiene, if its heat of hydrogenation is 57 kcal/mole and that of 1-butene is 30.3 kcal/mole.

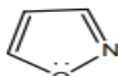
10. State Huckel's rule for aromaticity. By this rule which of the following species should be aromatic?



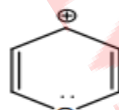
A



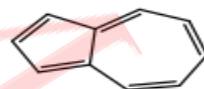
B



C



D

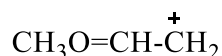


E

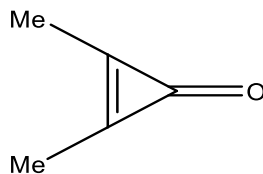
11. Calculate the double bond equivalent of the compound having molecular formula  $\text{C}_3\text{H}_7\text{N}$  and write down the structures that conform to this double bond equivalent.

12. n-butyl alcohol has much higher boiling point ( $118^\circ\text{C}$ ) than its isomers isobutyl alcohol ( $108^\circ\text{C}$ ) and diethyl ether ( $35^\circ\text{C}$ ) – explain.

13. Draw the different canonical forms of the following species indicating the most important contributor towards resonance. hybrid:



14. Compare C–O bond distance in



15. Write down the basic difference between resonance effect and electronic . Explain with suitable examples.

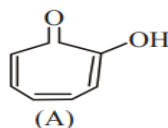
16. Draw the  $\pi$  – M. O pictures LUMO of 1,3,5-hexatriene and HOMO of allyl radical in the ground state.

17. Compare dipole moment of each of the following pairs -

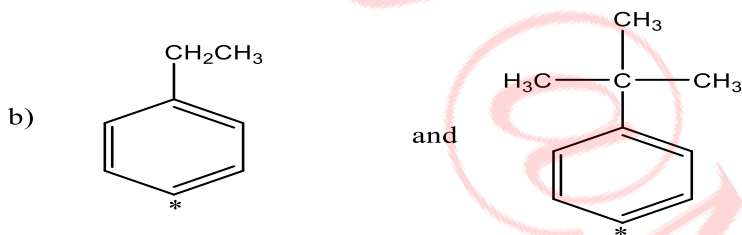
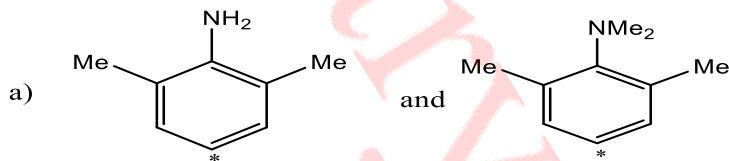
i) Butanal and 2-butenal

ii) vinyl chloride and ethyl chloride

18. 1,3,5-cycloheptatriene is not aromatic whereas its derivative tropolone (A) behaves like a typical phenol-why?



19. Compare the electron density at the marked carbon atoms of each of the following pairs and rationalize:



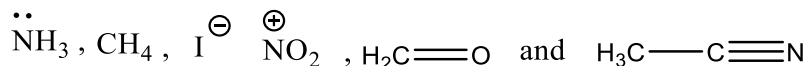
15. Comment on the aromaticity of the following compounds



### General Treatment of reaction mechanism-1

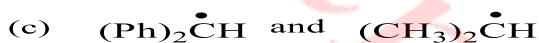
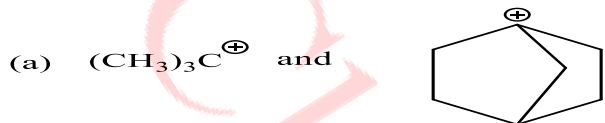
1. What do you mean by nucleophilic carbene? Illustrate with one example. 2

3. Which of the following species behave as (i) nucleophile, (ii) electrophile, (iii) both, (iv) Neither



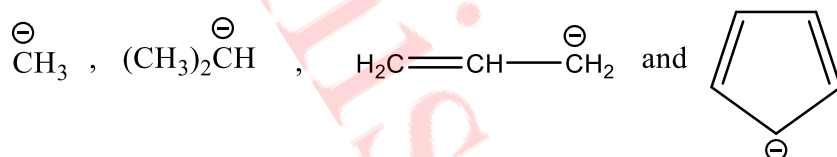
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1. Which one is more stable in each of the following pairs and why?

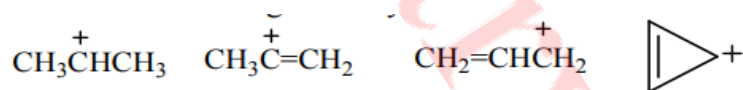


1+1+1

4. Arrange the following carbanions in order of their increasing stability



5. Arrange the following in the order of increasing stability:

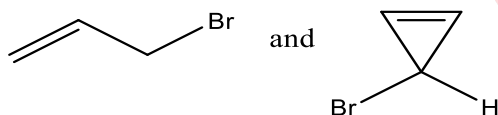


6. Benzyl chloride gives a precipitate with alcoholic silver nitrate solution but none of o-, m-, p-tolyl chlorides does not - explain.

7. Arrange the following in order of decreasing nucleophilicity with proper reasons:



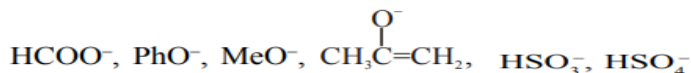
8. Which of the following compounds would undergo  $\text{Ag}^+$  ion assisted hydrolysis at a faster rate and why?



9. Dimethoxy carbene is reluctant to add to isobutene explain.

10. A good base is not necessarily a good nucleophile explain.

11. Which of the following ions are ambident nucleophiles:



12. Chloride ion in  $\text{Bu}_4\text{N}^+\text{Cl}^-$  in acetone is a better nucleophile than that in  $\text{LiCl}$  in the same solvent- explain.

13. Why acyl halides are more reactive towards water than alkyl halides?

1.i) How carbene is formed? What is the shape, bond angle and state of hybridization of triplet carbene?

ii) The structure of both  $\text{CH}_3$  radical and cation is similar but those of  $\text{CF}_3$  radical and cation are different.- Explain with reason.

3+2

2. Butadiene is more reactive than ethylene towards nucleophilic and electrophilic addition reactions. Explain in terms of molecular orbital theory.

3.i) What is benzyne? Give chemical evidence in favour of formation of the benzyne as reactive intermediate.

ii) Show that cyclopentadienyl cation is a diradical.

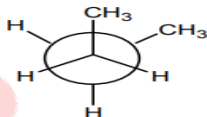
3+2

## Stereochemistry-1

1. Draw the Fischer projection formula of each of the following:

- 2R, 3R-2, 3-dihydroxy-3-methylpentanoic acid
- S-2, 3-Dihydroxypropanal

2. The following conformer of butane is chiral, then why is butane optically inactive?



3. The optical rotation of lactic acid disappears on treatment with a base. - Explain.

4. Distinguish the terms with suitable examples in each of the following cases:

- Asymmetric and dissymmetric compounds
- Racemic modification and racemization

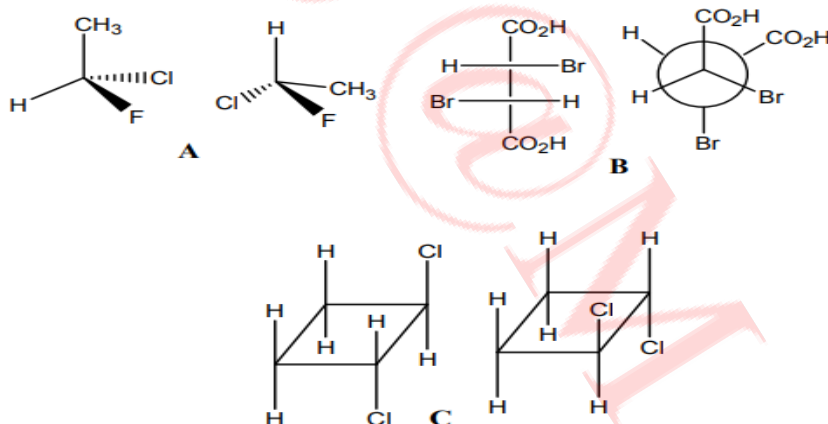
5. (+) 1-Phenyl ethyl alcohol loses its optical activity in presence of acid- explain.

6.

1. Give one example for each of the following:

- An optically active compound possessing a  $C_2$  axis
- An optically inactive compound possessing a twofold alternating axis of symmetry. 2+3

2.i) Identify whether the following pairs of compounds represent homomers, enantiomers or diastereoisomers:



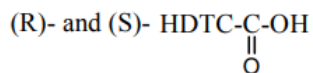
ii) A solution of 22 mg of an optically active compound in 1 cc methanol showed an optical rotation of  $-4.4^\circ$  in a 10 cm long polarimeter cell. What is the specific rotation of the compound?  $3+2=5$

3.i) Define the terms 'stereogenic centre' and 'chiral centre'. Are centres of stereogenicity always centres of chirality? Explain with suitable examples.

ii)  $\alpha$ -Hydrogen of (R)- $\alpha$ -chloropropionic acid is substituted by bromine with retention of configuration. Write the structure of the product.

iii) How would you show that all hydrogen atoms of cyclopentadienyl anion are equivalent?

iv) Chiral acetic acid is a compound in which two hydrogen atoms of methyl group are replaced by deuterium (D) and tritium. (T). Write down the three-dimensional formulae for



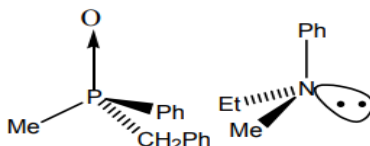
4. i) Why the dipole moment of chlorobenzene is greater than fluorobenzene even though fluorine is more electronegative than chlorine?

ii) How does the inductive effect differ from the field effect? 2+2

5.i) Draw the molecular orbitals of HOMO and LUMO of (2E,4Z,6E)-octa-2,4,6-triene in the ground state.

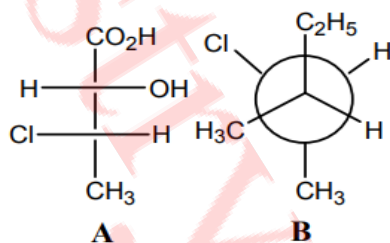
ii) How heat of hydrogenation is related to the stabilities of alkenes? Compare the stabilities of 1-pentene, cis- and trans- 2- pentene and 2-methyl-2-butene in terms of heats of hydrogenations. 3+2

6. Explain whether the following compounds are resolvable or not. Give R, S- descriptors wherever possible:

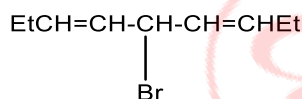


7. Draw the Fischer projection formulas of all dichlorinated compounds resulting from free radical chlorination of (R)-2-methyl-3-chlorobutane and comment on their optical activity with proper stereochemical assignments.

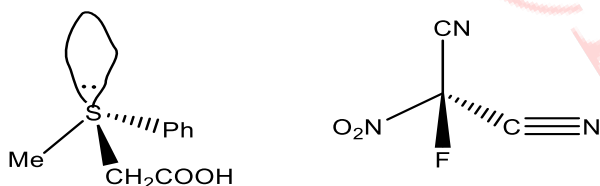
8. Reproduce the Fischer structure A as a staggered Sawhorse and the Newman structure B as a Fischer structure:



9.i) Draw all possible stereoisomers of given compound and comment on their optical activity



ii) Assign R/S designation to the following compounds



3+2

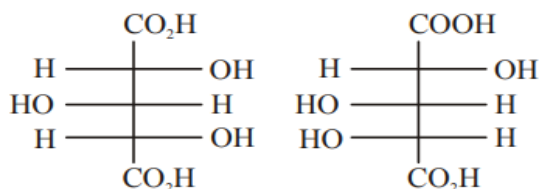
10.i) Depict the symmetry elements of the following molecules in terms of  $\sigma$  and  $C_n$ :

a) Cis-1,3-dimethyl cyclobutene

b) trans-1,2-dibromo ethene

ii) Outline the reaction steps you would employ to carry out the resolution of a racemic alcohol. 3+2

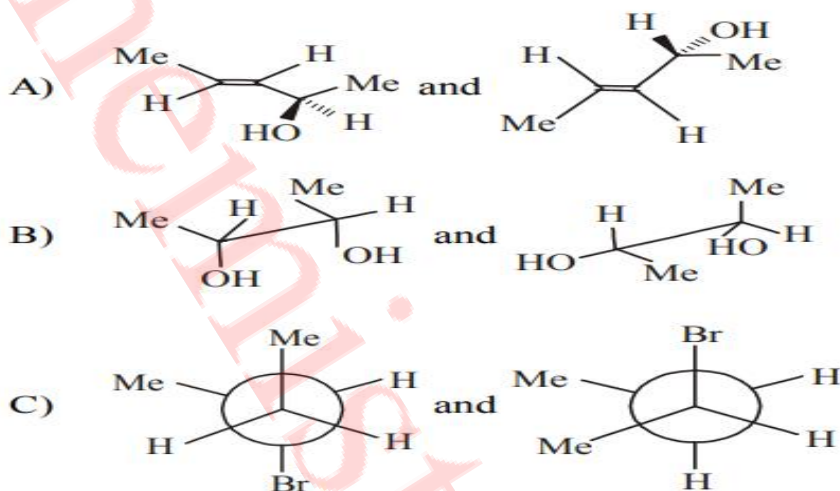
11.i) Label the C-3 centres of the following molecules as stereogenic/non-stereogenic and chirotopic/achirotopic. Justify your answer.



ii) Justify the statement-  $s_2$  and  $i$  are equivalent operations.

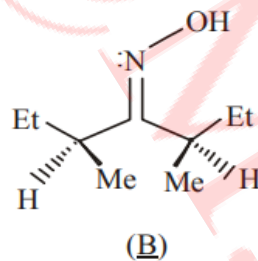
3+2

12.i) Identify whether the following pairs of compounds represent enantiomers, diastereoisomers and homomers:



ii) Calculate enantiomeric excess (ee) and the specific rotation of a mixture containing 12gm of (+)-2-butanol and 8gm of (-)-2-butanol. The specific rotation of enantiomerically pure (+)-2-butanol is  $+13.5^\circ$ . 3+2

13.i) Does the following oxime(B) show optical activity and E-Z isomerism? Label the configurations of the chiral centres of B



ii) Is it possible to separate the carbanion  $\ominus\text{EtCHMe}$  into enantiomers.

3+2