

General Organic Chemistry - I

F-2.	(A) 0 (E) 0 (I) 3	(B) 2 (F) 0 (J) 10	(C) 0 (G) 6 (K) 0	(D) No hyperconjugation (H) 9 (L) 10
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- G-1. Those molecules are aromatic which have very high resonance energy. Only those molecules has sufficiently high amount of resonance energy to become aromatic which
 (a) are cyclic
 (b) are planar
 (c) contains $(4n + 2)$ number of π -electrons in ring.
 (d) must have cyclic resonance between $(4n + 2)$ number of π -electrons
 Where $n = 0, 1, 2, 3, 4 \dots$

- G-2. Aromatic : (a), (b), (c), (d), (e), (f), (h), (l)
 Antiaromatic : (g), (i), (j), (m)
 Nonaromatic : (k)

- G-3. Cyclooctatetraene is nonplanar to avoid its anti aromaticity and it becomes tub-shaped structure.

- H-1. (III) > (II) > (IV) > (I)
 +m group increases electron density and -m group decreases electron density in aromatic ring.

- H-2. p > q > r

PART - II

A-1. (B)	A-2. (B)	A-3. (D)	A-4. (B)	A-5. (D)
A-6. (A)	B-1. (A)	B-2. (D)	B-3. (D)	B-4. (D)
B-5. (A)	B-6. (A)	B-7. (C)	B-8. (C)	B-9. (B)
B-10. (A)	B-11. (B)	B-12. (B)	B-13. (A)	C-1. (C)
C-2. (B)	C-3. (A)	C-4. (D)	C-5. (B)	D-1. (B)
D-2. (D)	D-3. (D)	D-4. (B)	D-5. (A)	D-6. (C)
D-7. (C)	E-1. (C)	F-1. (D)	F-2. (D)	F-3. (B)
F-4. (C)	F-5. (A)	G-1. (C)	G-2. (B)	G-3. (D)
H-1. (A)	H-2. (B)	H-3. (D)	H-4. (A)	H-5. (C)
H-6. (C)				

PART - III

1. (A) - p,q,r,t ; (B) - p,q,r,t ; (C) - p,q,r,t ; (D) - p,q,s

EXERCISE - 2

1.	(C)	2.	(D)	3.	(A)	4.	(A)	5.	(C)
6.	(A)	7.	(C)	8.	(B)	9.	(B)	10.	(B)
11.	(C)	12.	(C)	13.	(D)	14.	(D)	15.	(B)
16.	(D)	17.	(A)	18.	(B)	19.	(D)	20.	(D)

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General Organic Chemistry - I

1.	5 (i, iii, iv, v, vii)	2.	8 (ii, iii, iv, vi, vii, viii, ix, xi)	3.	5 (i, ii, v, vi, ix)
4.	5 (i, iii, v, vi, viii)	5.	5 (i, ii, iv, vi, ix)	6.	3 (B, C & G).
7.	6 (i, iv, v, vi, viii, x)				

8.	3				
	Aromatic - a, c, g, h, i, j, k.				
9.	6				

10.	9				

PART - II

1.	5 (i, iii, iv, v, vii)	2.	8 (ii, iii, iv, vi, vii, viii, ix, xi)	3.	5 (i, ii, v, vi, ix)
4.	5 (i, iii, v, vi, viii)	5.	5 (i, ii, iv, vi, ix)	6.	3 (B, C & G).
7.	6 (i, iv, v, vi, viii, x)				

8.	3				
	Aromatic - a, c, g, h, i, j, k.				
9.	6				

10.	9				

PART - III

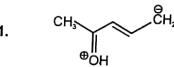
1.	(ABCD)	2.	(AB)	3.	(ABC)	4.	(BC)	5.	(BC)
6.	(C)	7.	(BD)	8.	(AD)	9.	(ABD)		

PART - IV

1.	(B)	2.	(C)				
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EXERCISE - 3

PART - I



2. (A) In the formation of first product the antiaromaticity due to the presence of three rings of the reactant is finished and the product becomes more stable. While in 2nd case the product is thermodynamically less stable.

3.	(A)	4.	(A)	5.	(B)	6.	(B)	7.	6
8.*	(BC)	9.	(A)	10.	9				

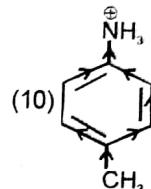
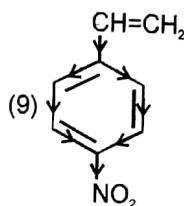
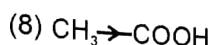
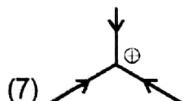
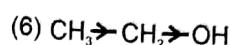
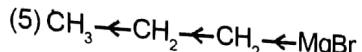
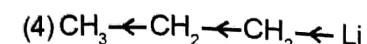
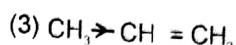
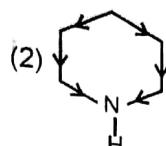
PART - II

1.	(1)	2.	(3)	3.	(4)
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Answers

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EXERCISE - 1**PART - I**

B-1. (P), (R), (S)

B-2. 8

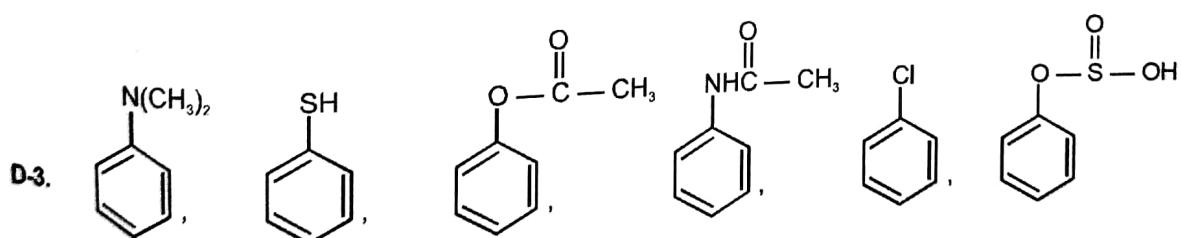
C-1. (P) I – minor, II – major ;
(R) I – minor, II – major ;

(Q) I – minor, II – major ;
(S) I – minor, II – major

C-2. (P) I > II ; (Q) II > I ; (R) I > II ; (S) II > I

D-1. (i) +m : – I < – Br < – Cl < – F (ii) +m : – OH < – NH₂ < – O[⊖]

D-2. (i) –m : – COOR < – COR < CHO < CN < NO₂ (ii) –m : – C=O[⊖] < – C-NH₂ < – C-F

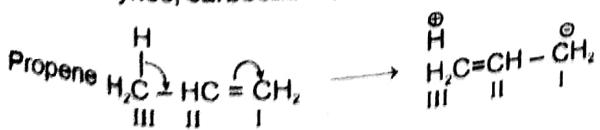


have + M group.

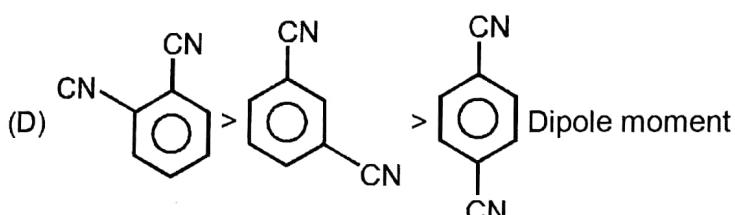
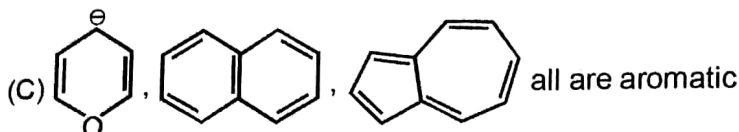
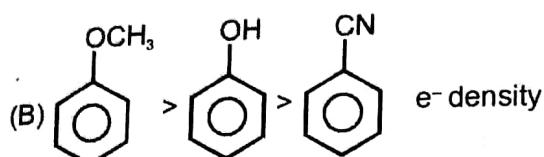
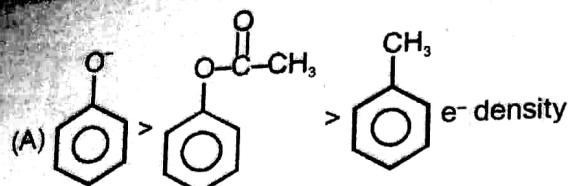
E-1. SIR effect increases with the size of ortho group. The order of SIR effect is o-iodo benzoic acid > o-bromo benzoic acid > o-chloro benzoic acid.

F-1. It is delocalisation of sigma electron with p-orbital. It may take place in alkenes, alkynes, carbocations, free radicals, alkyl benzene.

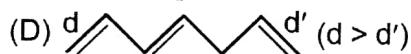
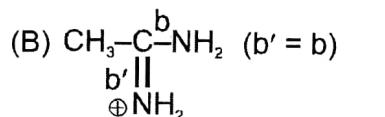
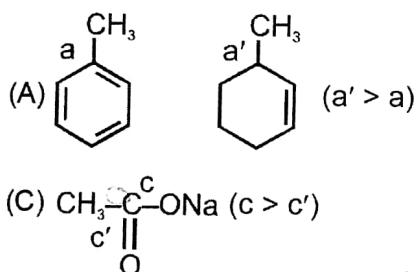
Necessary Condition : Presence of at least one hydrogen at saturated carbon which is α with respect to alkene, alkynes, carbocation, free radical, benzene nucleus.



Which of the following is/are correct statement:



- 9.** The correct orders for bond length are :

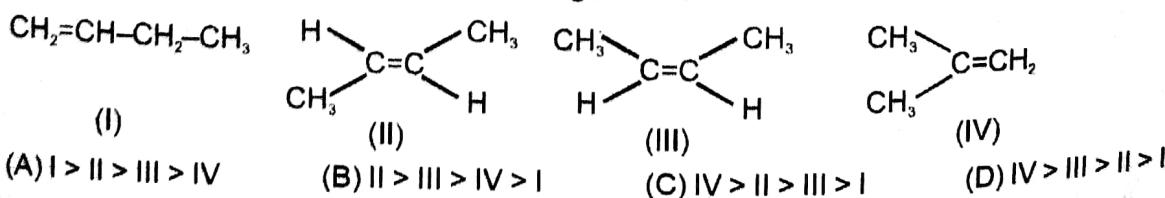


PART - IV : COMPREHENSION

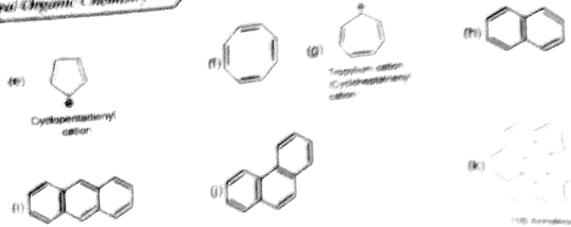
Read the following passage carefully and answer the questions.

Hydrogenation of unsaturated hydrocarbons is an exothermic reaction. Due to hyperconjugation and resonance the stability of unsaturated hydrocarbons increases and the increase in stability is more due to resonance. Compound with same number of π -bonds and more stability has lower heat of hydrogenation. Heat of formation is defined as the energy evolved when a molecule is formed from its atoms. For isomers the more stable compound has higher heat of formation.

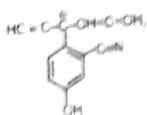
2. The order of heat of formation of the following molecules is :



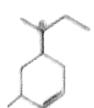
General Organic Chemistry - I



9. Find the number of carbon atoms including the given structure which can have negative charge in resonance structures. (The structure with charge repeating are not accepted)



10. Observe the following compound and write the number of hydrogen atom involved in hyperconjugation.



11. Find the total number of positions where positive charge can be delocalized by true resonance.

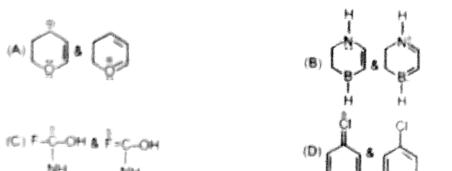


PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

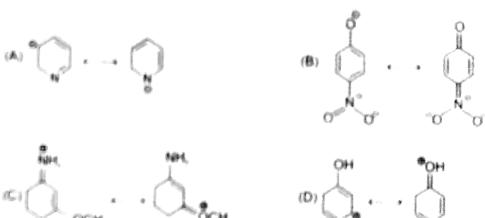
1. Which statement/s are true about resonance ?
 (A) It decreases the energy of system
 (B) The hybridisation of atoms do not change due to resonance
 (C) Resonance hybrid is more stable than any resonating structure
 (D) Resonating structures can not be isolated at any temperature
2. Which of the following statement is incorrect about resonance ?
 (A) The most stable structure explains all the characteristics of a species
 (B) All resonating structures remain in equilibrium
 (C) Resonance hybrid has maximum similarity with most stable resonating structure
 (D) Resonance hybrid is real

General Organic Chemistry - I

3. In which of the following pairs of compounds, will second structure have more contribution to resonance hybrid than first?



4. In which of the following pairs of resonating structures first resonating structure is more stable than second?



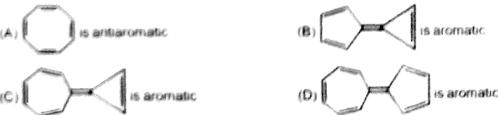
5. In which of the following compounds delocalisation of electrons and shifting of electron in the same direction?



6. Which of the following groups cannot participate in resonance with benzene



7. Which of the following is/are correct?



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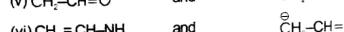
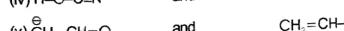
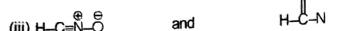
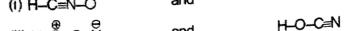
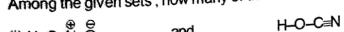
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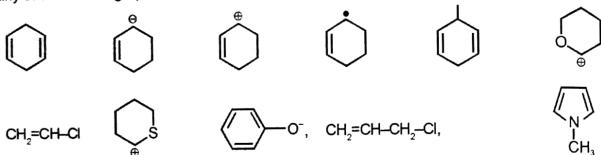
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PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

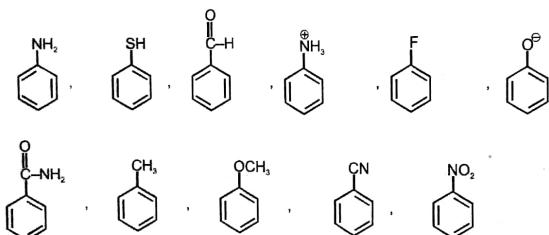
1. Among the given sets, how many of the following not represents the resonating structure :



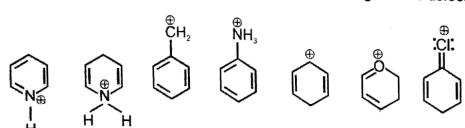
2. How many of the following species can show resonance.



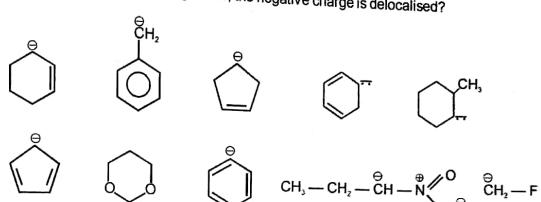
3. How many groups (attached with benzene ring) can show +M effect ?



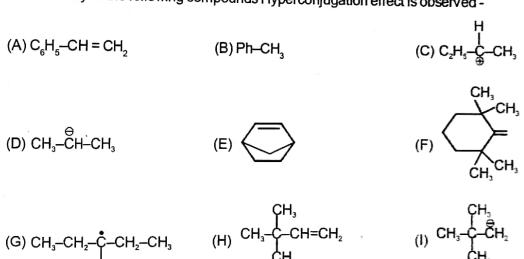
4. Identify the number of compounds in which positive charge will be delocalised ?



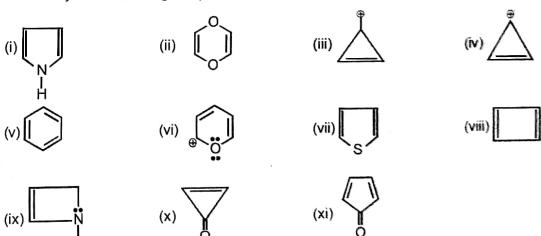
5. In how many of the following cases, the negative charge is delocalised?



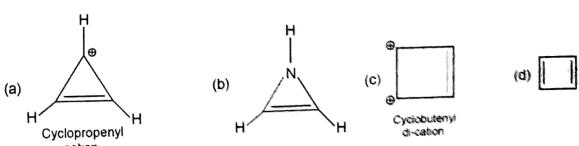
6. In how many of the following compounds Hyperconjugation effect is observed -



7. How many of the following compounds is/are aromatic ?

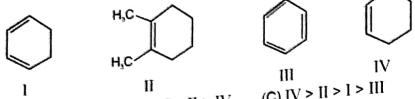


8. Total number of molecules which are antiaromatic ?



General Organic Chemistry - I

9. The decreasing order of bond length of C=C bond in the following compounds is:



- (A) II > I > IV > III (B) III > I > II > IV (C) IV > II > I > III (D) IV > I > II > III

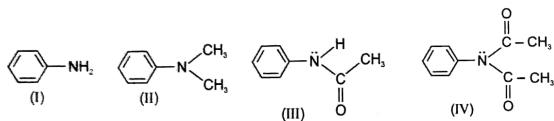
10. Which of the following is correct about the following compound



(Naphthalene)

- (A) All the C-C bond length are same
 (B) C₁-C₂ bond length is shorter than C₂-C₃ bond length
 (C) C₁-C₂ bond length is greater than C₂-C₃ bond length
 (D) All the C-C bond length are equal to C-C bond length of benzene

11. The correct order of +M effect of 'N' containing functional group on benzene ring, amongst the given compounds is

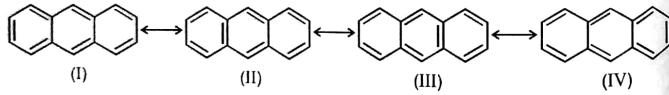


- (A) I > II > IV > III (B) II > I > III > IV (C) I > II > III > IV (D) IV > III > II > I

12. In which case the α -bond pair and π bond pair of electrons both are attracted in the same direction, (towards same atom):

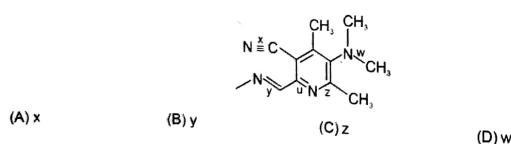
- (A) H₂C=CH-Cl (B) CH₃-CH₂-NH₂ (C) H₂C=CH-CH=O (D) H₂C=CH-OCH₃

13. The correct stability order of given resonating structures is:



- (A) I > II > III > IV (B) IV > III > II > I (C) I = II = III = IV (D) II = III > I = IV

14. The longest C — N bond length in the given compound is :



- (A) x

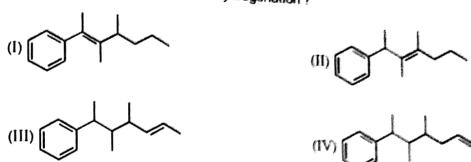
- (B) y

- (C) z

- (D) w

General Organic Chemistry - I

15. Select the correct order of heat of hydrogenation?

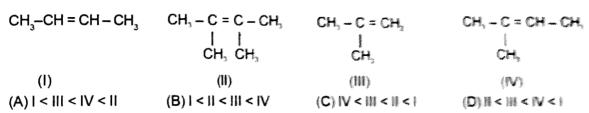


- (A) I > II > III > IV (B) IV > III > II > I (C) II > III > IV > I (D) II > III > I > IV

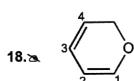
16. H₃C— $\overset{\oplus}{\text{C}}\text{H}=\text{CH}_2$ does not involve:

- (A) σ -p overlap (B) σ - π^* overlap (C) π -p overlap (D) π -d π overlap

17. Stability of π -bond in following alkenes in the increasing order is:



- (A) I < III < IV < II (B) I < II < III < IV (C) IV < III < II < I (D) II < III < IV < I



In this molecules, π -electron density is more on:

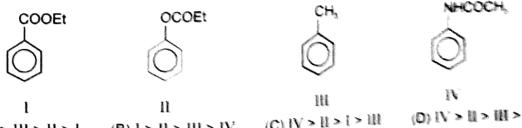
- (A) C₁ and C₃ (B) C₂ and C₄ (C) C₂ and C₅ (D) C₁ and C₅

19. If the given compound is planar. Select the correct statement.



- (A) The boron is sp^2 hybridized and the p-orbital contains an unshared pair of electron
 (B) The boron is sp^3 hybridized and a hybrid orbital contains an unshared pair of electron
 (C) The boron is sp^2 hybridized and hybrid orbital is vacant
 (D) The boron is sp^3 hybridized and the p-orbital is vacant

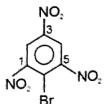
20. The correct order of electron density in aromatic ring of following compounds is:



- (A) IV > III > II > I (B) I > II > III > IV (C) IV > II > I > III (D) IV > II > III > I

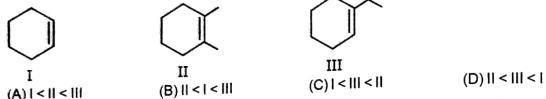
General Organic Chemistry - I

H-5. Select the correct statement about this compound.



- (A) All three C–N bond length are same.
 (B) C₁–N and C₂–N bonds length are same but shorter than C₃–N bond length.
 (C) C₁–N and C₂–N bonds length are same but longer than C₃–N bond length.
 (D) C₁–N and C₂–N bonds length are different but both are longer than C₃–N bond length.

H-6. Arrange the stability of following



PART - III : MATCH THE COLUMN

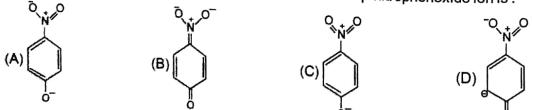
1. Match the following Column-I (Compounds)		Column-II (Characteristics)	
(A)		(p)	Mesomeric effect / resonance
(B)		(q)	Inductive effect.
(C)		(r)	Hyperconjugative effect
(D)		(s)	Nonpolar
		(t)	Polar

Exercise-2

Marked Questions may have for Revision Questions.

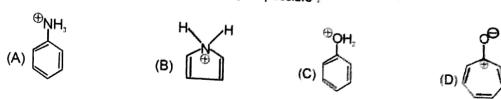
PART - I : ONLY ONE OPTION CORRECT TYPE

1. The most unlikely representation of resonance structures of p-nitrophenoxide ion is :

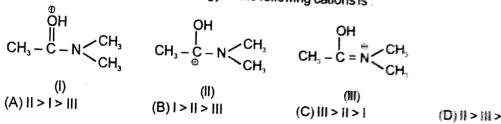


General Organic Chemistry - I

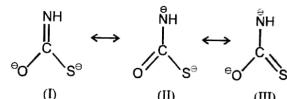
2. In which delocalisation of positive charge is possible ?



3. Decreasing order of potential energy of the following cations is :



4. Stability order of the following species ?

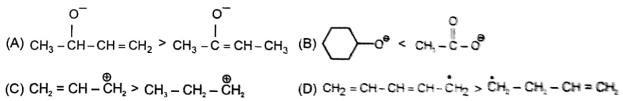


- (A) I > II > III (B) III > I > II (C) III > II > I (D) I > III > II

5. In which of the following first resonating structure is more stable than the second ?



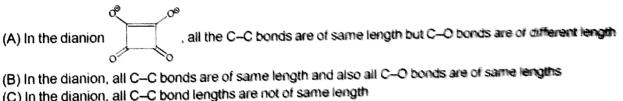
6. Which of the following is incorrect for stability of structures.



7. Least contributing resonating structure of nitroethene is :

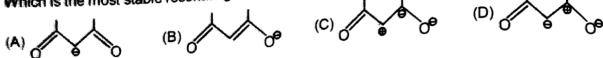


8. Which of the following statement is correct ?



General Organic Chemistry - I

C-5. Which is the most stable resonating structure?



Section (D) : Mesomeric Effect

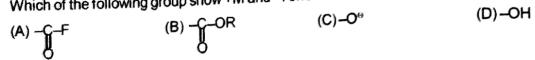
D-1. Which of the following group show +M effect?

- (A) --CN (B) --O--NO_2 (C) --CCl_3 (D) --CHO

D-2. Which of the following group show -M effect?



D-3. Which of the following group show +M and -I effect?



D-4. Which of the following group show +M > -I effect?



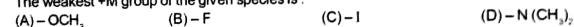
D-5. Which of the following group show -M and -I effect?



D-6. +M and +I both effects are shown by :

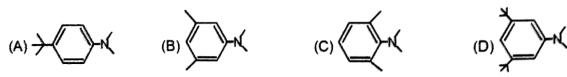


D-7. The weakest +M group of the given species is :



Section (E) : Steric Inhibition of Resonance (SIR Effect)

E-1. Maximum extent of steric inhibition of resonance can be expected in

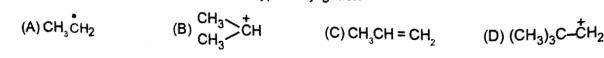


Section (F) : Hyperconjugation

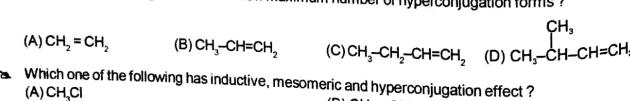
F-1. In hyperconjugation there is overlap between :

- (A) p and π -orbitals (B) 2π -orbitals (C) d-and- π -orbital (D) σ -and p - orbitals

F-2. Which of the following cannot exhibit hyperconjugation -



F-3. Which of the following alkenes will show maximum number of hyperconjugation forms?



F-4. Which one of the following has inductive, mesomeric and hyperconjugation effect?



General Organic Chemistry - I

F-5. Which of the following group has the maximum hyperconjugation effect when attached to benzene ring?

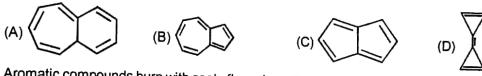
- (A) CH_3- (B) CH_3CH_2- (C) $(\text{CH}_3)_2\text{CH}-$ (D) $(\text{CH}_3)_3\text{C}-$

Section (G) : Concept of Aromaticity

G-1. Which out of the following is aromatic hydrocarbon?



G-2. Identify the aromatic compound?

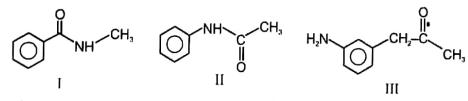


G-3. Aromatic compounds burn with sooty flame because :

- (A) They have a ring structure of carbon atoms.
(B) They have a relatively high percentage of hydrogen.
(C) They resist reaction with oxygen of air.
(D) They have a relatively high percentage of carbon.

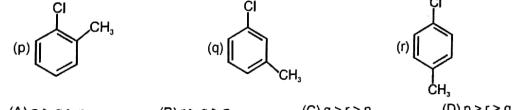
Section (H) : Applications of electronic effect

H-1. The decreasing order of electron density on the ring is :



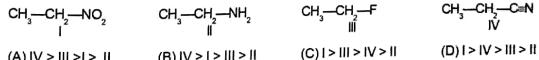
- (A) III > II > I (B) II > III > I (C) I > III > II (D) III > I > II

H-2. Correct dipole moment order is



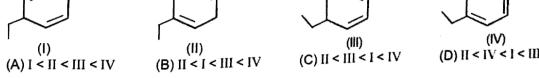
- (A) p > q > r (B) r > q > p (C) q > r > p (D) p > r > q

H-3. Arrange following compounds in decreasing order of their dipole moment.



- (A) IV > III > I > II (B) IV > I > III > II (C) I > III > IV > II (D) I > IV > III > II

H-4. The stability order of alkene in following compounds is.



- (A) I < II < III < IV (B) II < I < III < IV (C) II < III < I < IV (D) II < IV < I < III

General Organic Chemistry - I

- A-4.** Which of the following alkyl group has the maximum +I effect ?
 (A) $(\text{CH}_3)_2\text{CH}-$ (B) $(\text{CH}_3)_3\text{C}-$ (C) CH_3CH_2- (D) CH_3-
- A-5.** Decreasing -I effect of given groups is :
 (i) $-\text{CN}$ (ii) $-\text{NO}_2$ (iii) $-\text{NH}_2$ (iv) $-\text{F}$
 (A) iii > ii > i > iv (B) ii > iii > iv > i (C) iii > ii > iv > i (D) ii > i > iv > iii
- A-6.** Which of the following is the strongest - I group :
 (A) $-\overset{+}{\text{N}}(\text{CH}_3)_3$ (B) $-\overset{+}{\text{NH}_3}$ (C) $-\overset{+}{\text{S}}(\text{CH}_3)_2$ (D) $-\text{F}$

Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

- B-1.** Resonance is delocalisation of :
 (A) π electrons (B) σ electrons (C) $\sigma-\pi$ electrons (D) None
- B-2.** Resonance involves :
 (A) Delocalization of π -electrons along a conjugated system.
 (B) Delocalization of lone pair along a conjugated system.
 (C) Delocalization of negative charge along a conjugated system.
 (D) All are correct.
- B-3.** During delocalization, which statement is incorrect :
 (A) Net charge remains same (B) Number of paired electrons remain same
 (C) Number of unpaired electrons remain same (D) Energy of resonating structures always remains same
- B-4.** Resonance structure of the molecule does not have
 (A) higher energy than their hybrid structure. (B) identical arrangement of atoms.
 (C) the same number of paired electrons. (D) always equal contribution to the resonance hybrid.
- B-5.** Which of the following species can not show resonance?
 (A) (B) (C) (D)

- B-6.** Resonance is not possible in :
 (A) (B) (C) $\text{CH}_2=\text{CH}-\text{Cl}$ (D)

- B-7.** Which does not have conjugate system ?
 (A) $\text{CH}_2=\text{CHCl}$ (B) $\text{CH}_2=\text{CHCHO}$ (C) $\text{CH}_3\text{CH}=\text{CH}_2$ (D)

- B-8.** The compound which is not resonance stabilised

- (A) $\text{CH}_2=\text{CH}-\text{Cl}$ (B) (C) $\text{CH}_2=\text{CH}-\text{CH}_2\text{Cl}$ (D)

- B-9.** Which of the following is not acceptable as resonating structure :
 (A) (B) $\text{CH}_2=\overset{+}{\text{N}}=\text{O}$
 (C) $\text{CH}_2=\overset{+}{\text{N}}-\overset{-}{\text{O}}$ (D) None of these

General Organic Chemistry - I

- B-10.** Which of the following pair is not pair of resonating structures?
 (A) & (B) $\text{CH}_2=\text{CH}-\overset{\oplus}{\text{O}} \text{ & } \text{CH}_2-\text{CH}=\overset{\ominus}{\text{O}}$
 (C) $\text{CH}_2=\text{CH}-\text{O}-\text{CH}_3 \text{ & } \text{CH}_2-\text{CH}=\overset{\oplus}{\text{O}}-\text{CH}_3$ (D) $\text{CH}_3-\overset{\oplus}{\text{C}}=\text{O} \text{ & } \text{CH}_3-\overset{\ominus}{\text{C}}=\overset{\oplus}{\text{O}}$
- B-11.** Which of the following structures are resonance structures ?
 (A) & (B) &
 (C) $(\text{CH}_3)_2\text{CO}$ & (D) $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ &

- B-12.** Among the given sets, which represents the resonating structure ?

- (A) $\text{H}-\overset{\oplus}{\text{C}}=\overset{\ominus}{\text{N}}:$ and $\text{H}-\overset{\ominus}{\text{O}}-\text{C}\equiv\text{N}:$ (B) $\text{H}-\overset{\oplus}{\text{O}}=\text{C}=\overset{\ominus}{\text{N}}:$ and $\text{H}-\overset{\ominus}{\text{O}}-\text{C}=\overset{\oplus}{\text{N}}:$
 (C) $\text{H}-\overset{\oplus}{\text{C}}=\overset{\ominus}{\text{N}}:$ and $\text{H}-\overset{\oplus}{\text{C}}-\overset{\ominus}{\text{N}}:$ (D) $\text{H}-\overset{\ominus}{\text{O}}-\text{C}=\overset{\oplus}{\text{N}}:$ and $\text{H}-\overset{\oplus}{\text{N}}=\text{C}=\overset{\ominus}{\text{O}}:$

- B-13.** In which of the following resonance is not possible?
 (A) $\text{CH}_2=\text{C}=\text{CH}_2$ (B) $\text{CH}_2=\text{C}=\text{CH}^+$ (C) $\text{CH}_2=\text{C}=\text{CH}^-$ (D) $\text{CH}_2=\text{C}=\text{CH}^\ddagger$

Section (C) : Stability of Resonating Structures and different species

- C-1.** Which one of the following is least stable resonating structure ?
 (A) $\text{NH}_2-\overset{\oplus}{\text{C}}=\text{O}-\text{CH}_3$ (B) $\overset{\oplus}{\text{NH}}-\text{C}=\overset{\ominus}{\text{O}}-\text{CH}_3$ (C) $\text{NH}_2-\overset{\oplus}{\text{C}}-\overset{\ominus}{\text{O}}-\text{CH}_3$ (D) $\text{NH}_2-\overset{\ominus}{\text{C}}=\overset{\oplus}{\text{O}}-\text{CH}_3$
- C-2.** Which of the following resonating structure is the least contributing structure ?
 (A) (B) (C) (D)
- C-3.** HNCO (isocyanic acid) has following resonating structures :

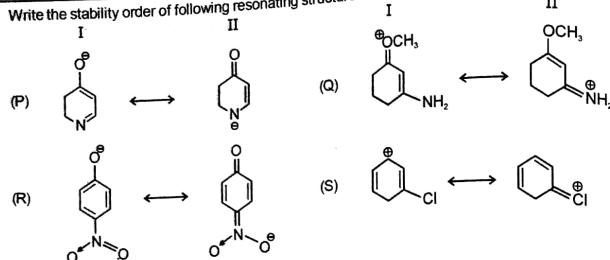
$$\begin{array}{c} \text{H}-\overset{\oplus}{\text{N}}=\text{C}=\text{O} \\ | \\ \text{II} \end{array} \longleftrightarrow \begin{array}{c} \overset{\ominus}{\text{H}}-\overset{\oplus}{\text{N}}-\text{C}\equiv\overset{\oplus}{\text{O}} \\ | \\ \text{III} \end{array} \longleftrightarrow \begin{array}{c} \text{H}-\overset{\oplus}{\text{N}}\equiv\overset{\ominus}{\text{C}}-\overset{\oplus}{\text{O}} \\ | \\ \text{I} \end{array}$$
- The order of stability is :
 (A) I > III > II (B) I > II > III (C) II > III > I (D) II > I > III
- C-4.** The correct stability order of the following resonating structures is :

$$\begin{array}{cccc} \text{CH}_2=\text{C}=\text{O} & \text{H}_2\overset{\oplus}{\text{C}}=\overset{\ominus}{\text{O}} & \text{H}_2\overset{\oplus}{\text{C}}=\overset{\ominus}{\text{O}} & \text{H}_2\overset{\oplus}{\text{C}}=\overset{\ominus}{\text{O}} \\ (\text{I}) & (\text{II}) & (\text{III}) & (\text{IV}) \end{array}$$

 (A) (IV) > (I) > (III) > (II) (B) (II) > (IV) > (I) > (III) (C) (III) > (II) > (IV) > (I) (D) (I) > (IV) > (III) > (II)

General Organic Chemistry - I

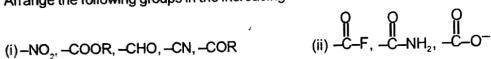
C-2. Write the stability order of following resonating structures:



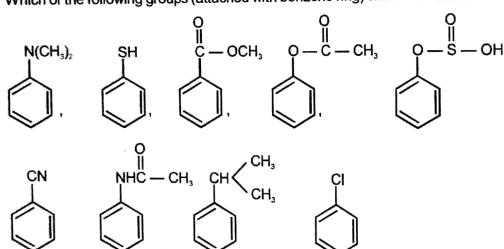
Section (D) : Mesomeric Effect

D-1. Arrange the following groups in the increasing order of $+M$:
 (i) $-I$, $-Cl$, $-F$, $-Br$ (ii) $-NH_2$, $-OH$, $-O^-$

D-2. Arrange the following groups in the increasing order of $-M$:



D-3. Which of the following groups (attached with benzene ring) show $+M$ effect?



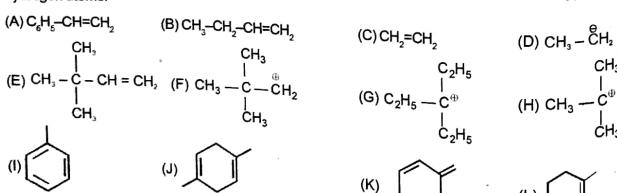
Section (E) : Steric Inhibition of Resonance (SIR Effect)

E-1. Compare the SIR effect between orthochloro benzoic acid, orthobromobenzoic acid and orthoiodo benzoic acid.

Section (F) : Hyperconjugation

F-1. Define hyperconjugation by taking an example of propene.

F-2. In which molecules or ions hyperconjugation effect is observed and write the number of hyperconjugable hydrogen atoms.

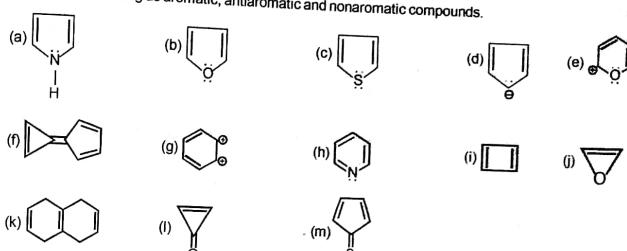


General Organic Chemistry - I

Section (G) : Concept of Aromaticity

G-1. What is aromaticity?

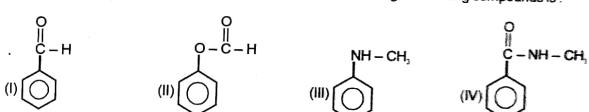
G-2. Classify the following as aromatic, antiaromatic and nonaromatic compounds.



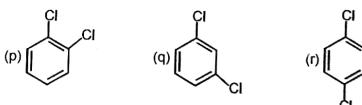
G-3. Why cyclooctatetraene is nonplanar.

Section (H) : Applications of electronic effect

H-1. The correct decreasing order of electron density in aromatic ring of following compounds is:



H-2. Correct dipole moment order is



PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Inductive effect

A-1. Inductive effect involves:

- (A) Delocalisation of σ -electrons
- (B) Partial displacement of σ -electrons
- (C) Delocalisation of π -electrons
- (D) Displacement of lone pair electrons

A-2. Select correct statement about I effect?

- (A) I effect transfers electrons from one carbon atom to another.
- (B) I effect is the polarisation of σ bond electrons.
- (C) I effect creates net charge in the molecule.
- (D) I effect is distance independent.

A-3. Which of the following group shows $+I$ -effect:

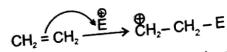
- (A) $-Br$
- (B) $-COOH$
- (C) $-OR$
- (D) $-COO^-$

General Organic Chemistry - I

Th10: Electromeric effects

It is a temporary effect. The organic compound having a multiple bond (double or triple bond) show this effect in the presence of an attacking reagent only. It is defined as the complete transfer of a shared pair of π -electrons to one of the atoms joined by a multiple bond on the demand of an attacking reagent. It is represented by E and the shifting of electrons is shown by a curved arrow. There are two types of electromeric effect,

D11: (i) +E effect : In this effect π -electron of the multiple bond are transferred to that atom to which the reagent gets attached.



D12: (ii) - E effect : In this effect the π -electron of the multiple bond are transferred to that atom to which the attacking reagent does not get attached. $\text{CN} + >\text{C}=\text{O} \longrightarrow \text{NC}->\text{C}-\delta^-$.

Note : When inductive and electromeric effects operate in opposite directions then the electromeric effect dominates.

CHECK LIST

Definitions (D)

Theories (Th)

- | | | | |
|---|--------------------------|--|--------------------------|
| D1 Inductive Effect | <input type="checkbox"/> | Th1: Inductive Effect | <input type="checkbox"/> |
| D2 - I Effect | <input type="checkbox"/> | Th2: Resonance | <input type="checkbox"/> |
| D3 + I Effect | <input type="checkbox"/> | Th3: Mesomeric Effect (or Resonance Effect) | <input type="checkbox"/> |
| D4 Resonance | <input type="checkbox"/> | Th4: SIR (Steric Inhibition of Resonance) | <input type="checkbox"/> |
| D5 Resonance Energy | <input type="checkbox"/> | Th5: Hyperconjugation | <input type="checkbox"/> |
| D6 Mesomeric Effect (or Resonance Effect) | <input type="checkbox"/> | Th6: Comparison Between Electronic Effects | <input type="checkbox"/> |
| D7 +M Effect | <input type="checkbox"/> | Th7: Important Points | <input type="checkbox"/> |
| D8 -M Effect | <input type="checkbox"/> | Th8: Aromatic Character (The Hückel $4n+2$ Rule) | <input type="checkbox"/> |
| D9 Hyperconjugation | <input type="checkbox"/> | Th9: Applications Of Electronic Effects | <input type="checkbox"/> |
| D10 Aromaticity | <input type="checkbox"/> | Th10: Electromeric Effects | <input type="checkbox"/> |
| D11 +E Effect | <input type="checkbox"/> | | |
| D12 - E Effect | <input type="checkbox"/> | | |

General Organic Chemistry - I

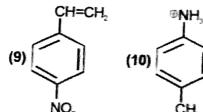
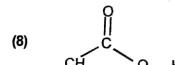
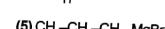
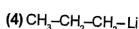
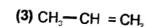
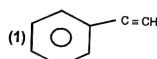
Exercise-1

Marked Questions may have for Revision Questions.

PART - I : SUBJECTIVE QUESTIONS

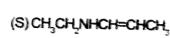
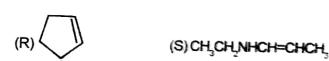
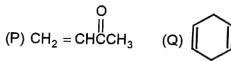
Section (A) : Inductive effect

A-1. Show the direction of inductive effect in following compounds

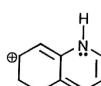


Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

B-1. Which of the following compounds have delocalized electrons ?

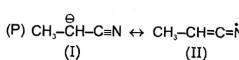


B-2. Number of π electrons in resonance in the following structure is.

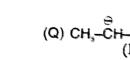


Section (C) : Stability of Resonating Structures and different species

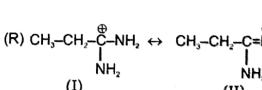
C-1. In the following sets of resonating structure, label the major and minor contributors towards resonance hybrid.



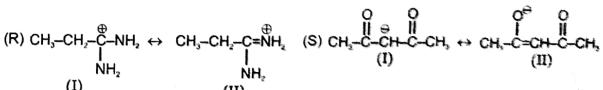
(I) (II)



(I) (II)



(I) (II)



(I) (II)

General Organic Chemistry - I

Section (G) : Concept of Aromaticity

Th8: Aromatic character [The Huckel 4n + 2 rule]

D10 Definition: Aromatic compounds are characterized by a special stability and that they undergo substitution reactions more easily than addition reactions.

The following rules are useful in predicting whether a particular compound is aromatic or non-aromatic. Aromatic compounds are cyclic and planar. Each atom in an aromatic ring is sp^2 hybridised. The cyclic π molecular orbital (formed by overlap of p-orbitals) must contain $(4n+2)\pi$ electrons, i.e., 2, 6, 10, 14, ..., π electrons. Where n = an integer 0, 1, 2, 3,

Aromatic compounds have characteristic smell, have extra stability and burn with sooty flame.

Comparison between aromatic, anti aromatic and non-aromatic compounds.

Characteristics	Aromatic compounds (A)	Anti Aromatic compounds (B)	Non-Aromatic compounds (C)
Example			
1. Structure	Cyclic, planar all atoms of ring sp^2 hybridised	Cyclic, planar all atoms of ring sp^2 hybridised	Cyclic or acyclic planar, non planar sp or sp^2 or sp^3
2. No. of πe^- s in the ring	$(4n+2)\pi e^-$ (Hückle's rule)	$(4n)\pi e^-$	Any no. of πe^- s
3. MOT	Unpaired e^- s in B.M.O.	Some πe^- s in non-bonding M.O.	B.M.O. / Non-bonding M.O.
4. Overlapping	Favourable over lapping of p orbital	Unfavourable over lapping of p orbital	Simple overlapping like alkenes
5. Resonance energy (R.E.)	Very high R.E. > 20-25 kcal/mol	Zero	-4-8 kcal/mol like alkenes
6. Stability	Have extra stability due to close conjugation of πe^- s	Unstable not exist at room temperature	Normal stability like a conjugated system
7. Characteristic Reactions	Electrophilic substitution Reaction	Dimersisation reaction to attain stability	Electrophilic addition reaction like alkenes

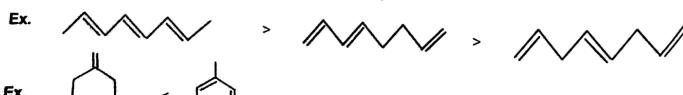
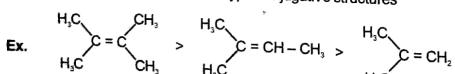
Stability of compounds : Aromatic > Non-Aromatic > Anti-Aromatic
(For compounds with same number of atoms and similar type of bonding)

Section (H) : Applications of electronic effect

Th9 Applications of Electronic effects

(a) Stability of Alkenes : More is the number of hyperconjugative structures more stable is the alkene.
"More alkylated alkenes are more stable".

Stability of alkenes \propto delocalisation of π electrons
 \propto no. of hyperconjugative structures



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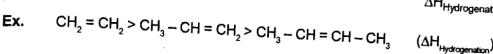
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General Organic Chemistry - I

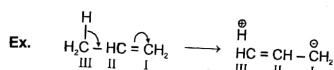
(b) Heat of hydrogenation

Thus greater extent of hyperconjugation results lower value of heat of hydrogenation

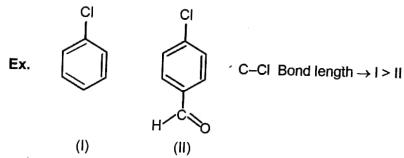
Stability of alkenes \propto no. of hyperconjugative structures $\propto \frac{1}{\Delta H_{\text{Hydrogenation}}}$



(c) Bond Length : Bond length is also affected by hyperconjugation



- (i) Bond length of C(II)-C(III) bond is less than normal C-C bond.
- (ii) Bond length of C(II)-C(I) bond is more than normal C=C bond.
- (iii) C-H bond is longer than normal C-H bond.



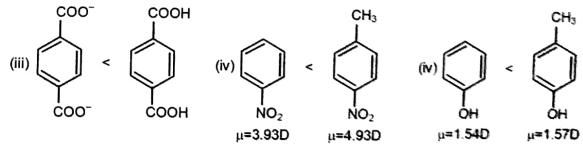
(d) Stability of reaction intermediates :

- (i) Stability of carbocation $\propto +M, +H, +I$ groups.
- (ii) Stability of carbon free radical $\propto +I$ groups.
- (iii) Stability of carbanion $\propto -M, -I$ groups.

Note: Resonance effect or delocalisation of electrons increases the stability of overall system.
For example carbocation, carbon free radical, carbanion & Alkenes.

(e) Dipole moment : Since hyperconjugation causes the development of charge, it also affects the dipole moment of the molecule.

Ex. (i) $\text{CH}_2=\text{CH}_2 < \text{CH}_3-\text{CH}=\text{CH}_2$ (Dipole moment)
(ii) $\text{H}-\text{CH}=\text{O} < \text{CH}_3-\text{CH}=\text{O} < \text{CH}_3-\text{CH}=\text{CH}-\text{CH}=\text{O}$ (Dipole moment)



(f) Acidic & Basic strength of organic compounds :

- (i) Acidity (K_a) $\propto -M, -I$ groups.
- (ii) Basicity (K_b) $\propto +M, +H, +I$ groups and solvation effect in aqueous solution.

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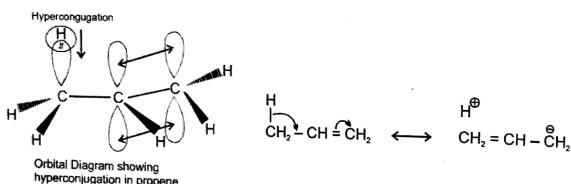
Section (F) : Th5: Hyperconjugation

D9: It is delocalisation of sigma electron with p-orbital. Also known as $\sigma - \pi$ -conjugation or no bond resonance. It may take place in alkenes, alkynes, carbocations, free radicals and benzene nucleus.

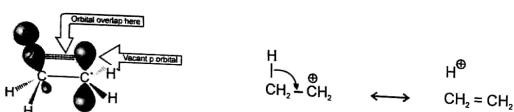
Necessary Condition : Presence of at least one hydrogen at saturated carbon which is α with respect to alkenes, alkynes, carbocations, free radicals and benzene nucleus.

(i) Hyperconjugation in alkenes

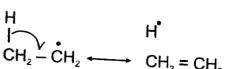
Delocalisation of σ bond electrons in π^* orbital by hyperconjugation in the case of alkene can be depicted as in figure.



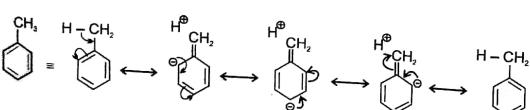
(ii) Hyperconjugation in carbocation



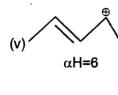
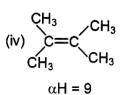
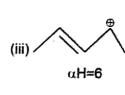
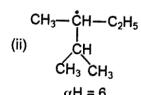
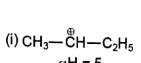
(iii) Hyperconjugation in radical



(iv) Hyperconjugation in toluene



- (a) The effect of electron displacement due to this type of resonance is called hyperconjugative effect.
- (b) Since canonical forms of this resonance may not contain any bond between H and C so hyperconjugation is also known as no bond resonance.
- (c) These resonating structures only suggest that
 - * There is some ionic character between C-H bond.
 - * Carbon-carbon double bond acquires some single bond character.
- (d) Number of no bond resonating structures due to hyperconjugation = Number of α -hydrogens (In aliphatic systems)

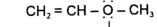
Number of α hydrogen in the following molecules/ion.**Th6 Comparison between electronic effects :**

Inductive effect	Mesomeric effect	Hyperconjugative effect
(1) It is found in saturated and unsaturated compounds.	(1) It is found in unsaturated and conjugated compounds especially having conjugated system.	(1) It is found in carbocation, carbon free radical and unsaturated compounds.
(2) It involves partial shifting of sigma electrons.	(2) It involves complete shifting of pi-electrons of pi-bonds or lone pair of electrons.	(2) It involves partial shifting of sigma-electrons into adjacent p-orbital.
(3) The electron pair is slightly displaced from its position and thus partial charges are developed.	(3) The electron pair is completely transferred and thus full positive and negative charges are developed.	(3) The electron pair is partially transferred.
(4) It is transmitted over a quite short distance. The effect becomes negligible after third atom in the chain (distance dependent).	(4) It is transmitted from one end to other end of the chain provided conjugation is present. It is distance independent.	(4) It is transmitted from one end to other end of the chain provided conjugation is present. It is distance independent.

Th7 Important points :

- (a) If any group has more than one π bond in conjugation, then only one π bond will take part in delocalisation.
 $\text{CH}_2 = \text{CH} - \overset{\oplus}{\text{C}} = \text{CH}$
 \downarrow
 Out of two π bonds only one π bond will take part in delocalisation.

- (b) If any conjugate position has more than one lone pair then only one lone pair will take part in the delocalisation.

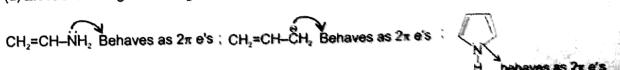


Out of the two lone pair's only one will take part in delocalisation.
(c) If any conjugate position has π bond and any of the positive charge, negative charge, odd electron, lone pair electrons then only π bond will take part in delocalisation on priority.



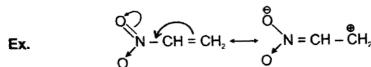
Nitrogen has π bond as well as lone pair, but only π bond of nitrogen will take part in delocalisation.

- (d) Electrons of negative charge or lone pair behave as 2π electrons if it is in conjugation to π bond.



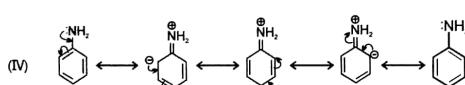
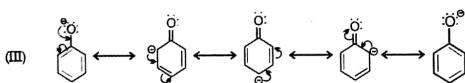
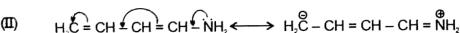
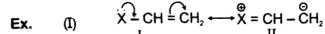
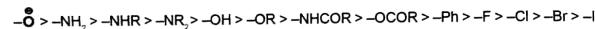
Section (D) : Mesomeric Effect**Th3: Mesomeric effect (or Resonance effect)**

D6: Mesomeric effect is defined as permanent effect of π electron shifting from multiple bond to atom or from multiple bond to single bond or from lone pair to single bond. This effect mainly operates in conjugated system of double bond. So that this effect is also known as conjugate effect.

**Types of Mesomeric effects :****(a) Positive Mesomeric effect (+M effect) :**

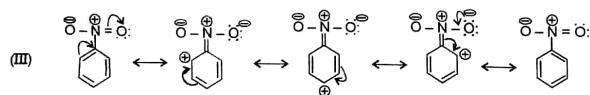
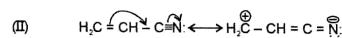
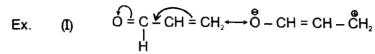
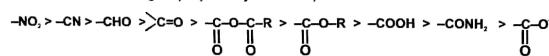
When the group donates electron to the conjugated system it shows + M effect.

Relative order of +M groups (usually followed):

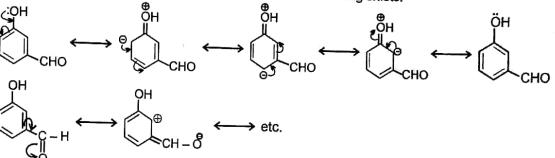
**D8: (b) Negative Mesomeric effect (-M effect) :**

When the group withdraws electron from the conjugated system, it shows - M effect

Relative order of -M groups (usually followed):

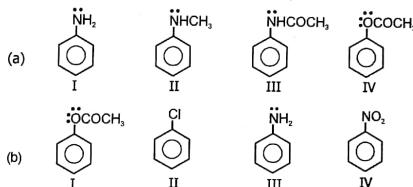
**Note :**

1. When a +M group and -M group are at meta-positions with respect to each other then they are not in conjugation with each other, but conjugation with benzene ring exists.



2. +M group increases electron density in benzene ring, called activating group while -M group decreases electron density in the benzene ring, called deactivating group.

Ex. Write electron density order in the following compound.



Ans. (a) I > II > III > IV (b) III > I > II > IV

Section (E) : Steric Inhibition of Resonance (SIR Effect)**Th4: SIR (Steric Inhibition of Resonance):**

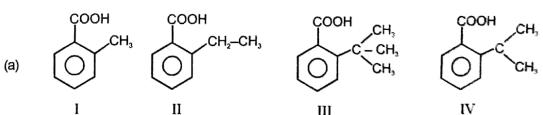
Restriction in exhibition of resonance due to steric hindrance is known as SIR effect.

In case of 1,2-Disubstituted benzene if the substituents are bulky then due to steric repulsion (vander wall repulsion) the group go out of plane with respect to benzene ring.

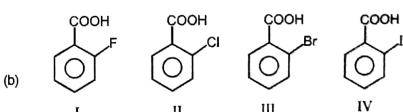
Due to this change in planarity the conjugation between the substituents on benzene is slightly diminished.

SIR effect \propto Size of group.

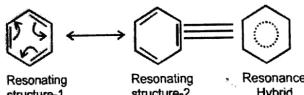
Ex. Arrange the following compounds in their decreasing SIR effect order.



SIR effect order = III > IV > II > I.



SIR effect order = IV > III > II > I.



The most stable resonating structure contribute maximum to the resonance hybrid and less stable resonating structure contribute minimum to resonance hybrid.

2.1 Conjugation:

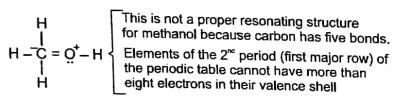
A given atom or group is said to be in conjugation with an unsaturated system if:-
 (i) It is directly linked to one of the atoms of the multiple bond through a single bond.
 (ii) It has π bond, positive charge, negative charge, odd electron or lone pair electrons.

2.2 Types of Conjugation :

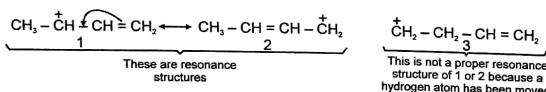
1. Conjugation between C = C and C = C ($\text{CH}_2 = \text{CH} \rightleftharpoons \text{CH} = \text{CH}_2 \longleftrightarrow \text{CH}_2^+ - \text{CH} = \text{CH} = \text{CH}_2^-$)
2. Conjugation between +ve charge and C = C ($\text{CH}_2^+ - \text{CH} = \text{CH}_2 \longleftrightarrow \text{CH}_2^+ - \text{CH} = \text{CH}_2$)
3. Conjugation between lone pair and C = C ($\text{Cl}^- - \text{CH} = \text{CH}_2 \longleftrightarrow \text{Cl}^- = \text{CH} - \text{CH}_2$)
4. Conjugation between odd electron and C = C ($\text{CH}_2 = \text{CH} - \dot{\text{C}}\text{H}_2 \longleftrightarrow \dot{\text{C}}\text{H}_2 - \text{CH} = \text{CH}_2$)
5. Conjugation between negative charge and C = C ($\text{CH}_2 = \text{CH} \rightleftharpoons \text{CH}_2^- \longleftrightarrow \text{CH}_2^+ - \text{CH} = \text{CH}_2$)

2.3 The Rules of Resonance :

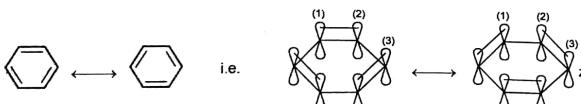
(a) All the canonical forms (resonating structure) must have proper Lewis structure. For instance none of them may have a carbon atom with five bonds.



(b) The positions of the nuclei of the atoms must remain the same in all of the structures. Structures 3 is not a resonance structure of 1 or 2, for example, because in order to form it we would have to move a hydrogen atoms and this is not permitted :



(c) All atoms taking part in the delocalisation must lie in a plane so that orbitals overlapping become parallel to each other.



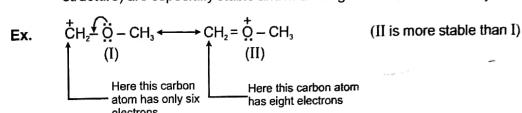
(d) All canonical forms must have the same number of unpaired electron.

- (e) The energy of actual molecule is lower than of any form. Therefore delocalisation is a stabilizing phenomenon.
 (f) All canonical forms do not contribute equally to the true molecule. The more stable structure is the greater contributor to its resonance hybrid.

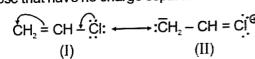
Section (C) : Stability of Resonating Structures and different species

2.4 How to compare stability of resonating structure:

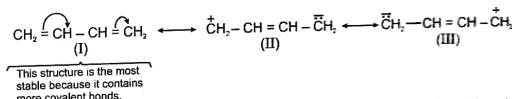
- (a) Structures in which all of the atoms have a complete valence shell of electrons (i.e., the noble gas structure) are especially stable and make large contributions to the hybrid.



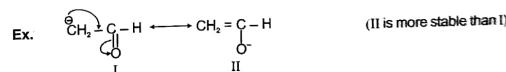
(b) Nonpolar (uncharged) structure are most stable. Charge separation decreases stability. Separating opposite charges requires energy. Therefore, structures in which opposite charges are separated have greater energy (lower stability) than those that have no charge separation.



(c) Structures with more covalent bonds are more stable than other structures

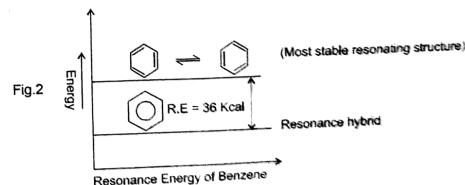


(d) Structure that carry negative charge on a more electronegative atom and positive charge on less electronegative atom are comparatively more stable.



2.5 Resonance Energy:

The P.E. difference between the most stable resonating structure and resonance hybrid is called resonance energy. The stability of molecule is directly proportional to resonance energy. The difference in energy between the hybrid and the most stable canonical structure is referred as the resonance energy. (as shown in Fig.2)



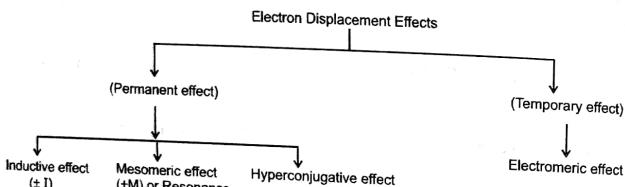
General Organic Chemistry (GOC)-I

Electronic effect :

Introduction

The effect which appears due to electronic distribution is called electronic effect.

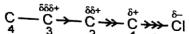
Classification :



Section (A) : Inductive effect

Th1: Inductive effect

The normal C-C bond has no polarity as two atoms of same electronegativity (EN) value are connected to each other. Hence the bond is nonpolar. Consider a carbon chain in 1-Chloro butane, here due to more EN of Cl atom and partial positive (δ^+) charge over C₁ atom hence creating partial negative (δ^-) charge over C₁ atom. Now since C₁ is slightly positive, it will also cause shifting of C₁ – C₂ bond pair electrons towards itself causing C₂ to acquire small positive charge. Similarly C₃ acquires slightly positive charge creating an induction of charge in carbon chain. Such an effect is called inductive effect.



The arrow shows electron withdrawing nature of –Cl group.

D1: Thus inductive effect may be defined as a permanent displacement of σ bond pair electrons due to a dipole. (Polar bond)

Some important points are:

- (a) It can also be defined as polarisation of one bond caused by polarisation of adjacent bond.
- (b) It is also called transmission effect.
- (c) It causes permanent polarisation in molecule, hence it is a permanent effect.
- (d) The displacement of electrons takes place due to difference in electronegativity of the two atoms involved.
- (e) The electrons never leave their original atomic orbital.
- (f) Its magnitude decreases with distance and it is almost negligible after 3rd carbon atom.
- (g) The inductive effect is always operative through σ bond, does not involve π bond electron.

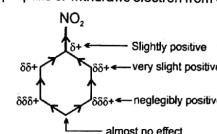
1.1 Types of inductive effects :

- D2:**
- (a) $-I$ Effect : The group which withdraws electron cloud is known as $-I$ group and its effect is called $-I$ effect. Various groups are listed in their decreasing $-I$ strength as follows.
- | | | | | | | | | | |
|-----------|-----------|-----------|-----------|------------|---------|-------------|-----------|------------|---------|
| $-NR_3 >$ | $-SR_2 >$ | $-NH_2 >$ | $-NO_2 >$ | $-SO_2R >$ | $-CN >$ | $-SO_2Ar >$ | $-COOH >$ | $-F >$ | $-Cl >$ |
| $-Br >$ | $-I >$ | $-OAr >$ | $-OR >$ | $-SR >$ | $-OH >$ | $-C=CR >$ | $-Ar >$ | $-CH=CR_2$ | |

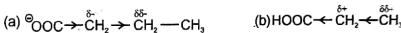
D3: (b) $+I$ effect : The group which release electron cloud is known as $+I$ group and effect is $+I$ effect.

$-O^\ominus > -COO^\ominus > -C(CH_3)_3 > -CH(CH_3)_2 > -CH_2-CH_3 > -CH_3 > -D > -H$
The hydrogen atom is reference for $+I$ and $-I$ series. The inductive effect of hydrogen is assumed to be zero.

Ex. Since $-NO_2$ is $-I$ group it pulls or withdraws electron from cyclohexane ring making it electron deficient

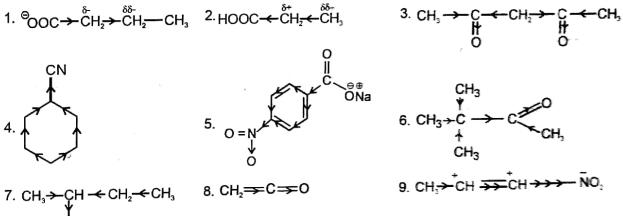


Ex. Let us consider effect of COO^- & COO^- in carbon chain



Due to e^- donating nature of $-COO^-$ carbon chain has become partially negative but $-COO^-$ is $-I$ group therefore carbon chain has become partially positive.

Ex. Direction of electron displacements



Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

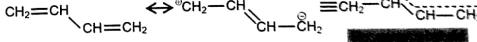
Th2: Resonance

When two or more structures that differ only in the distribution of electrons can be written for a molecule, no single Lewis structure is sufficient to describe its true electron distribution. The true structure is said to be a resonance hybrid of the various Lewis formulas.

The various Lewis formulas called resonating structure/contributing structure/canonical structure, that can be written for a molecule.

D4: Resonating structures are hypothetical but contribute to the real structure, which is called resonance hybrid.

The resonance hybrid is more stable than any other resonating structures.



Ex.

