

GENERAL ORGANIC CHEMISTRY-I

CONTENTS

Particular	Page No.
Theory	01 – 10
Exercise - 1	11 – 18
Part - I : Subjective Questions	
Part - II : Only One Option Correct Type	
Part - III : Match the Columns	
Exercise - 2	18 – 26
Part - I : Only One Option Correct Type	
Part - II : Single or Double Digit Integer Type Questions	
Part - III : One or More Than One Options Correct Type	
Part - IV : Comprehensions	
Exercise - 3	26 – 28
Part - I : JEE(ADVANCED) / IIT-JEE Problems (Previous Years)	
Part - II : JEE(MAIN) / AIEEE Problems (Previous Years)	
Answers	29 – 31
Additional Problems for Self Practice (APSP)	32 – 43
Part - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))	
Part - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I	
Part - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))	
APSP Answers	44
APSP Solutions	44 – 46

JEE (Advanced) Syllabus

Inductive, Resonance mesomeric and Hyperconjugation Effect, Applications of Electronic Effects, Aromaticity, Reaction Intermediates.

JEE(Main) Syllabus

Electronic displacement in a covalent bond; inductive effect, electromeric effect, resonance and hyperconjugation.



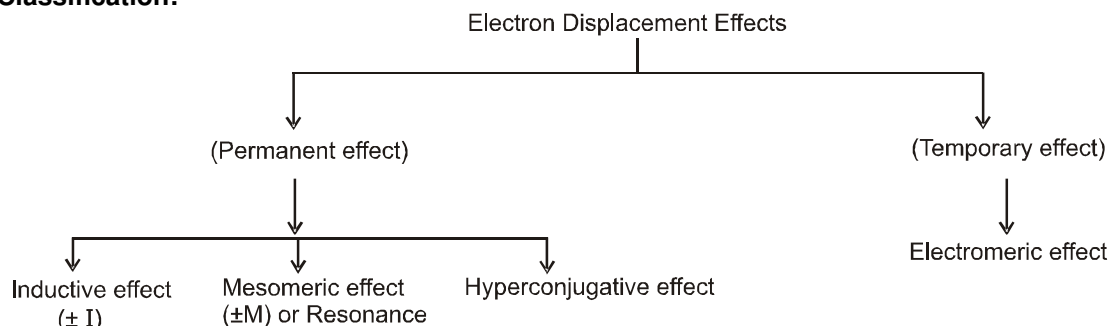
General Organic Chemistry (GOC)-I

Electronic effect:

Introduction

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

Classification:



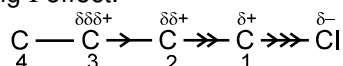
Section (A): Inductive effect

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 C–Cl bond pair is slightly displaced towards Cl atom hence creating partial negative (δ^-) charge over Cl atom and partial positive (δ^+) charge over C_1 atom.

Now since C_1 is slightly positive, it will also cause shifting of C_1 – C_2 bond pair electrons towards itself causing C_2 to acquire small positive charge. Similarly C_3 acquires slightly positive charge creating an induction of charge in carbon chain. Such an effect is called inductive effect.

Diagram showing I effect.



The arrow shows electron withdrawing nature of –Cl group.

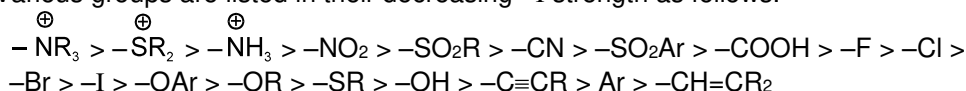
D1: Thus inductive effect may be defined as a permanent displacement of σ bond pair electrons due to a dipole. (Polar bond)

Some important points are:

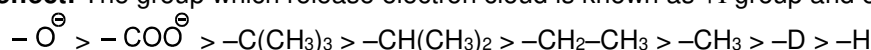
- It can also be defined as polarisation of one bond caused by polarisation of adjacent bond.
- It is also called transmission effect.
- It causes permanent polarisation in molecule, hence it is a permanent effect.
- The displacement of electrons takes place due to difference in electronegativity of the two atoms involved in the covalent bond.
- The electrons never leave their original atomic orbital.
- Its magnitude decreases with distance and it is almost negligible after 3rd carbon atom.
- 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.



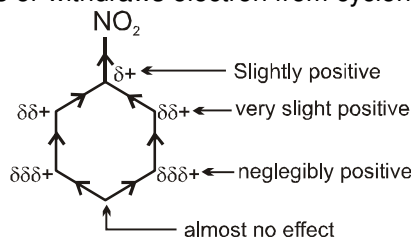
D3: (b) +I effect: The group which release electron cloud is known as +I group and effect is +I effect.



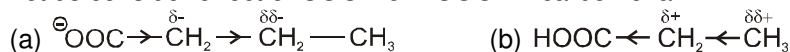
The hydrogen atom is reference for +I and –I series. The inductive effect of hydrogen is assumed to be zero.



Ex. Since $-\text{NO}_2$ is $-I$ group it pulls or withdraws electron from cyclohexane ring making it electron deficient

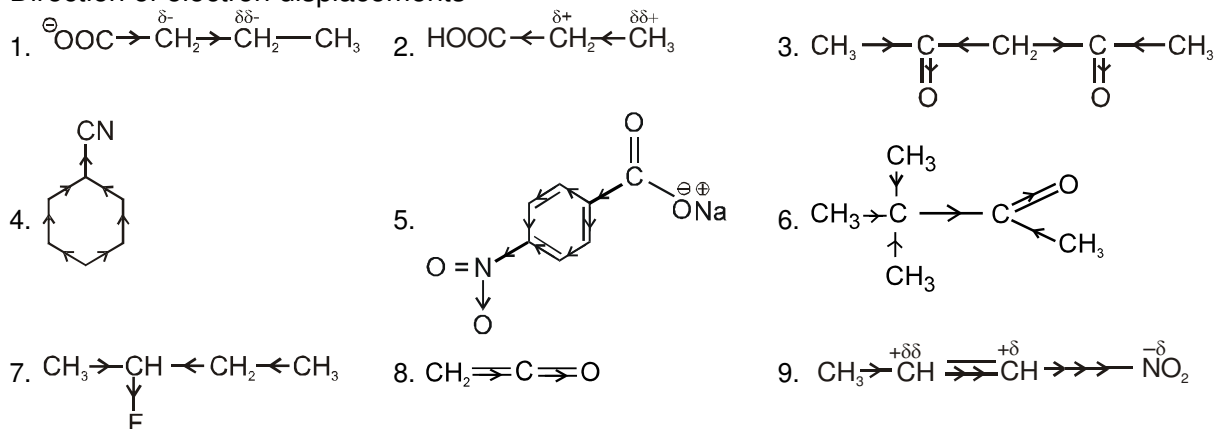


Ex. Let us consider effect of COOH & $-\text{COO}^-$ in carbon chain



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

Ex. Direction of electron displacements



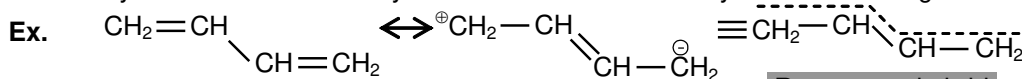
Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

Th2: Resonance

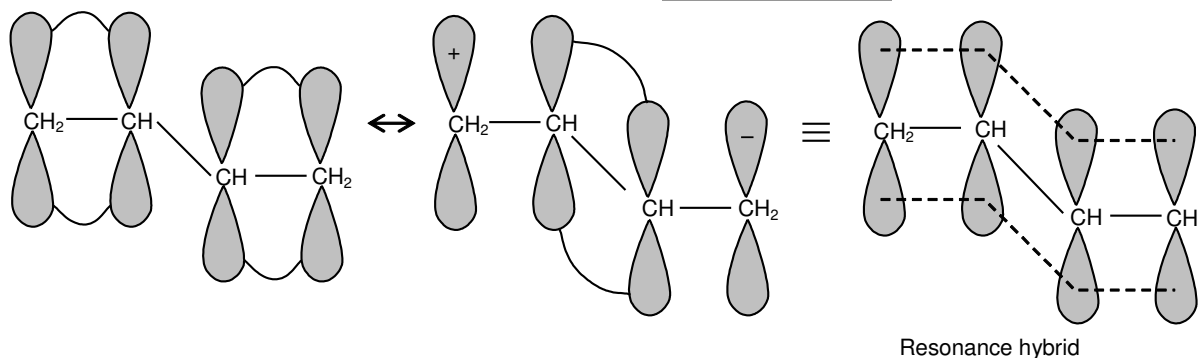
When two or more structures that differ only in the distribution of electrons can be written for a molecule, no single Lewis structure is sufficient to describe its true electron distribution. The true structure is said to be a resonance hybrid of the various Lewis formulas.

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.

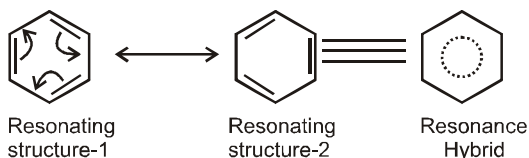


Resonance hybrid





Ex.



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:-

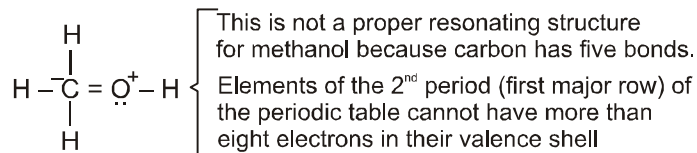
- It is directly linked to one of the atoms of the multiple bond through a single bond.
- It has bond, positive charge, negative charge, odd electron or lone pair electrons.

2.2 Types of Conjugation:

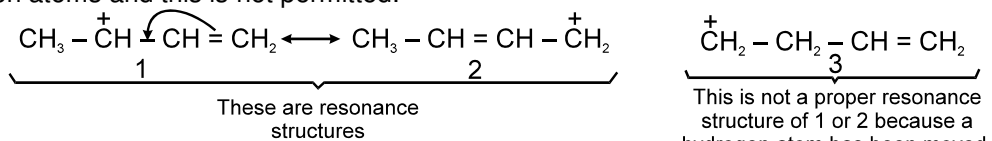
- Conjugation between C=C and C=C ($\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2 \longleftrightarrow \overset{+}{\text{C}}\text{H}_2-\text{CH}=\text{CH}-\overset{-}{\text{C}}\text{H}_2$)
- Conjugation between +ve charge and C=C ($\text{CH}_2=\text{CH}-\overset{+}{\text{C}}\text{H}_2 \longleftrightarrow \overset{+}{\text{C}}\text{H}_2-\text{CH}=\text{CH}_2$)
- Conjugation between lone pair and C=C ($:\ddot{\text{Cl}}-\text{CH}=\text{CH}_2 \longleftrightarrow \overset{+}{\text{Cl}}=\text{CH}-\overset{-}{\text{C}}\text{H}_2$)
- Conjugation between odd electron and C=C ($\text{CH}_2=\text{CH}-\dot{\text{C}}\text{H}_2 \longleftrightarrow \dot{\text{C}}\text{H}_2-\text{CH}=\text{CH}_2$)
- Conjugation between negative charge and C=C ($\text{CH}_2=\text{CH}-\overset{-}{\text{C}}\text{H}_2 \longleftrightarrow \overset{-}{\text{C}}\text{H}_2-\text{CH}=\text{CH}_2$)

2.3 The Rules of Resonance:

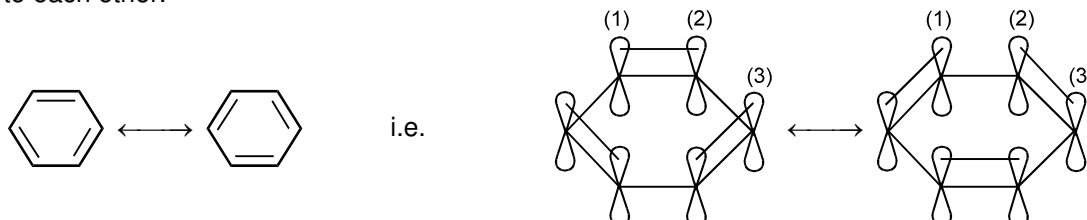
(a) All the canonical forms (resonating structure) must have proper lewis structure. For instance none of them may have a carbon atom with five bonds.



(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 atom 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.

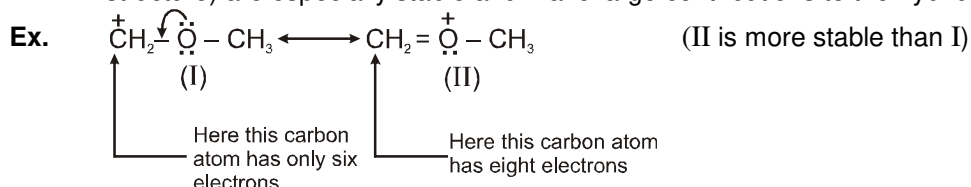
(f) All canonical forms do not contribute equally to the true molecule. The more stable structure is the greater contributor to its resonance hybrid.



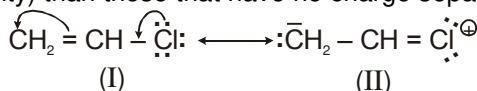
Section (C) : Stability of Resonating Structures and different species

2.4 How to compare stability of resonating structure:

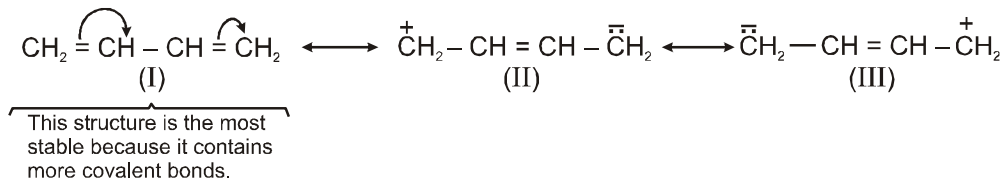
(a) Structures in which all of the atoms have a complete valence shell of electrons (i.e., the noble gas structure) are especially stable and make large contributions to the hybrid.



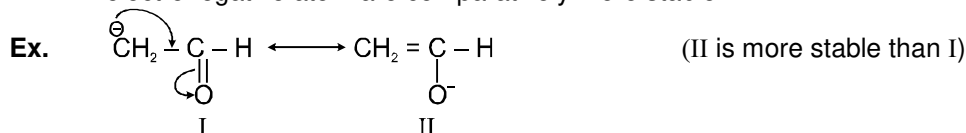
(b) Nonpolar (uncharged) structures are most stable. Charge separation decreases stability. Separating opposite charges requires energy. Therefore, structures in which opposite charges are separated have greater energy (lower stability) than those that have no charge separation.



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

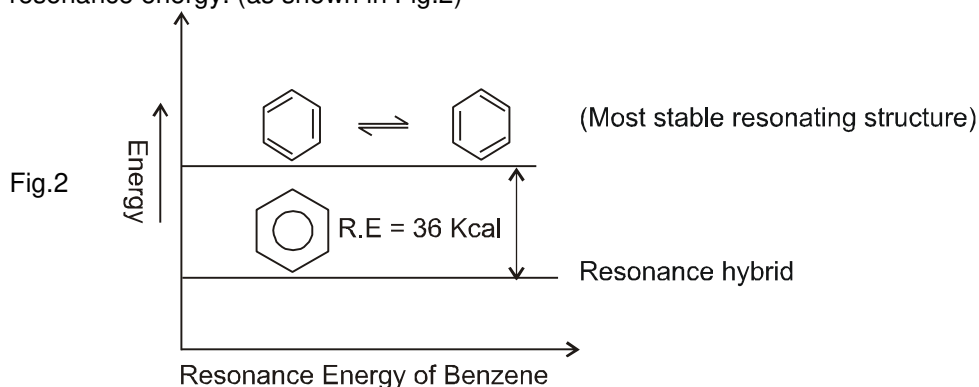


(d) Structure that carry negative charge on a more electronegative atom and positive charge on less electronegative atom are comparatively more stable.



2.5 Resonance Energy:

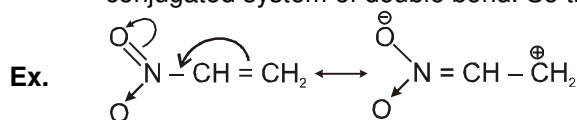
D5: The P.E. difference between the most stable resonating structure and resonance hybrid is called resonance energy. The stability of molecule is directly proportional to resonance energy. The difference in energy between the hybrid and the most stable canonical structure is referred as the resonance energy. (as shown in Fig.2)



Section (D) : Mesomeric Effect

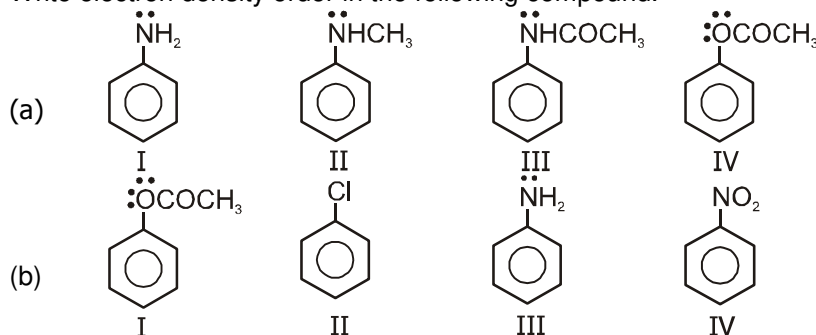
Th3: Mesomeric effect (or Resonance effect)

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.





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):

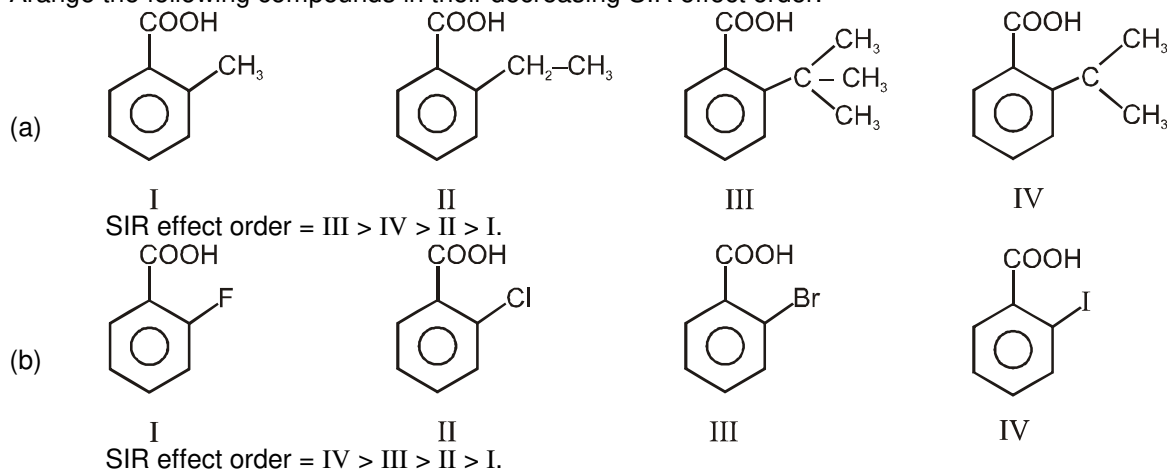
Restriction in exhibition of resonance due to steric hindrance is known as SIR effect.

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.



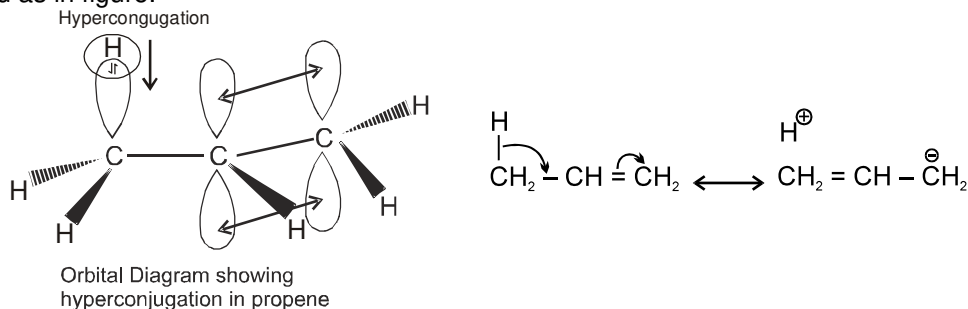
Section (F) : Th5: Hyperconjugation

D9: It is delocalisation of sigma electron with p-orbital. Also known as σ - π -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.

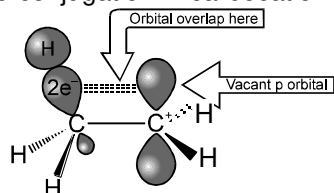
(i) Hyperconjugation in alkenes

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





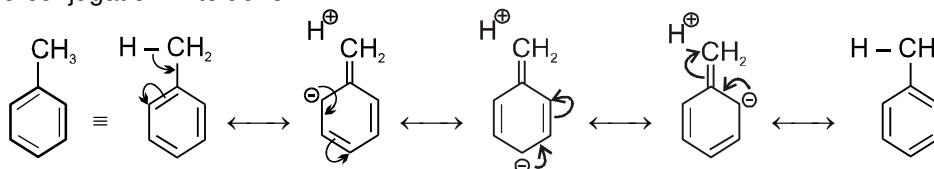
(ii) Hyperconjugation in carbocation



(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.

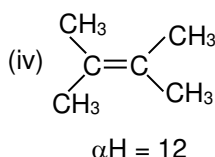
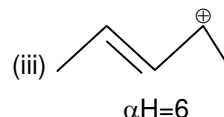
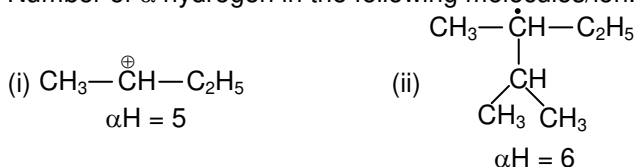
(c) These resonating structures only suggest that

* 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.



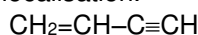
Th6 Comparision between electronic effects :

Inductive effect	Mesomeric effect	Hyperconjugative effect
(1) It is found in saturated and unsaturated compounds.	(1) It is found in unsaturated 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.



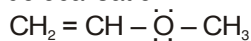
Th7 Important points :

(a) If any group has more than one π bond in conjugation, then only one π bond will take part in delocalisation.



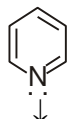
Out of two π bonds only one π bond will take part in delocalisation.

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



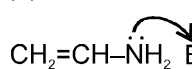
Out of the two lone pair's only one will take part in delocalisation.

(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.

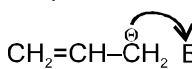


Nitrogen has π bond as well as lone pair, but only π bond of nitrogen will take part in delocalisation.

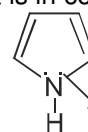
(d) Electrons of negative charge or lone pair behave as 2π electrons if it is in conjugation to π bond.



Behaves as 2π e's;



Behaves as 2π e's;



behaves as 2π e's

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 $(4n + 2)$ π 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, or non planar sp or sp^2 or sp^3
2	No. of πe^- in the ring	$(4n + 2)$ πe^- (Huckle's rule)	$(4n)$ πe^-	Any no. of πe^-
3	MOT	Unpaired e^- in B.M.O.	Some πe^- 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^-	Unstable not-exist at room temperature	Normal stability like a conjugated system
7	Characteristic Reactions	Electrophilic substitution Reaction	Dimerisation 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)



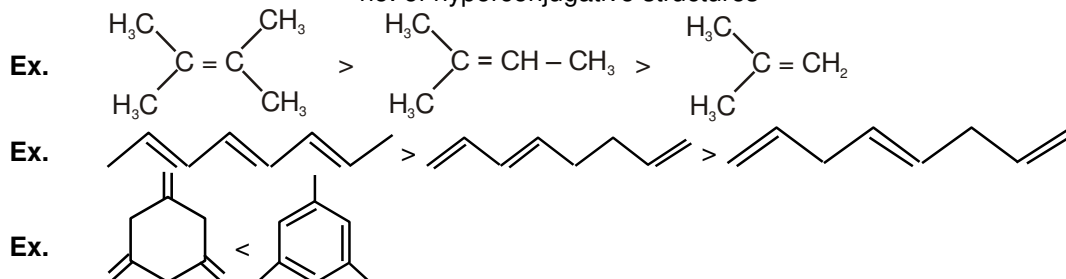
Section (H) : Applications of electronic effect

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".

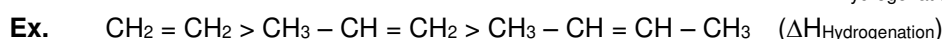
Stability of alkenes \propto delocalisation of π electrons

\propto no. of hyperconjugative structures

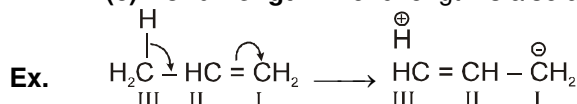


(b) **Heat of hydrogenation :** Greater the number of α hydrogen results greater stability of alkene. Thus greater extent of hyperconjugation results lower value of heat of hydrogenation

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



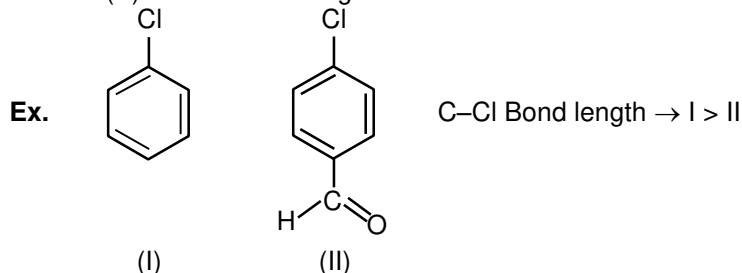
(c) **Bond Length :** Bond length is also affected by hyperconjugation



(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.

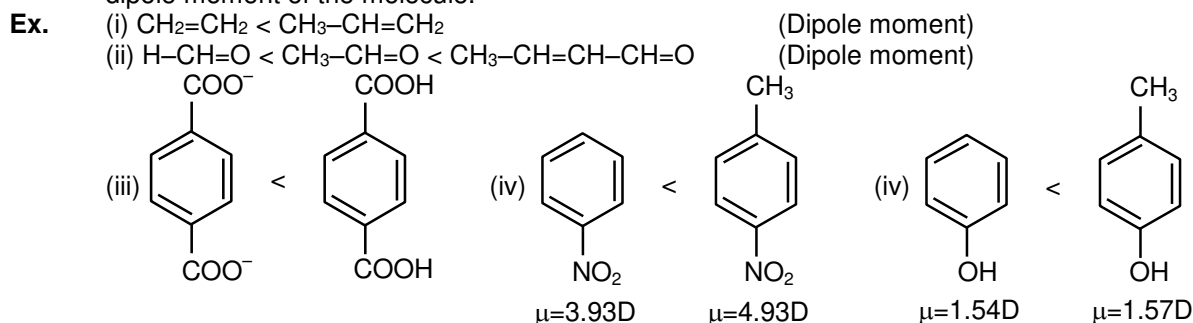
(ii) Stability of carbon free radical $\propto +I$ groups.

(iii) Stability of carbanion $\propto -M, -I$ groups.

Note: Resonance effect or delocalisation of electrons increases the stability of over all system.

For example carbocation, carbon free radical, carbanion & Alkenes.

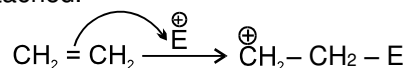
(e) **Dipole moment:** Since hyperconjugation causes the development of charge, it also affects the dipole moment of the molecule.



**(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.**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 on the 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 $\text{C}\equiv\text{N} + >\text{C}=\text{O} \longrightarrow \text{NC} \rightarrow \text{C}=\ddot{\text{O}}.$

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 Huckel $4n+2$ 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"/>		



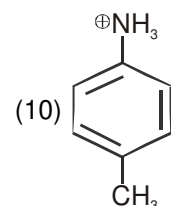
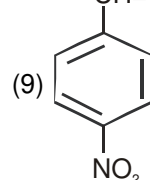
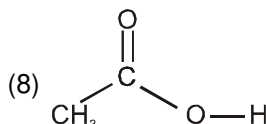
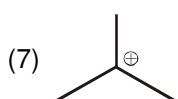
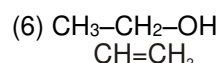
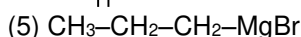
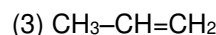
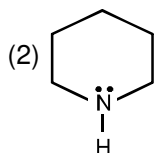
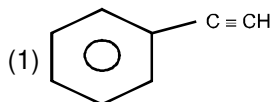
Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

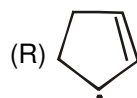
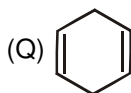
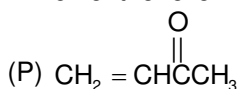
Section (A) : Inductive effect

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

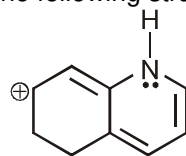


Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

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

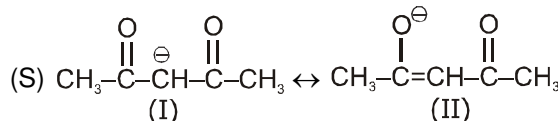
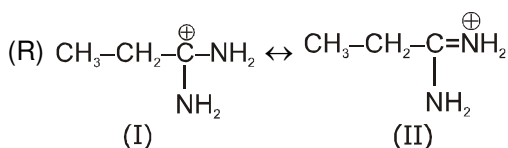
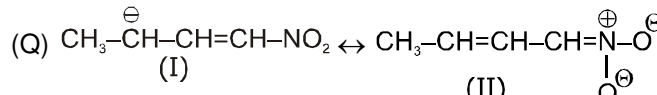
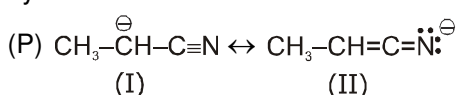


B-2. Number of π electrons in resonance in the following structure is.



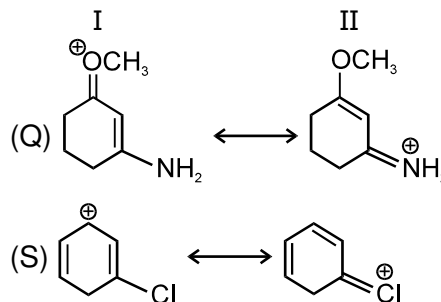
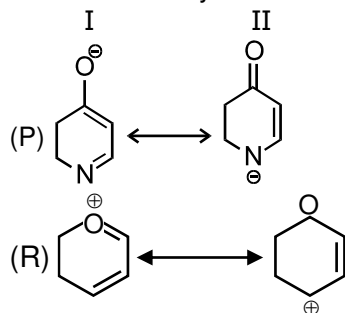
Section (C) : Stability of Resonating Structures and different species

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



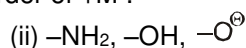
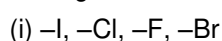


C-2. Write the stability order of following resonating structures :

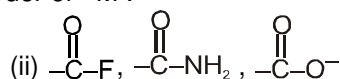
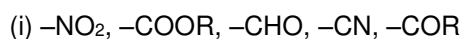


Section (D) : Mesomeric Effect

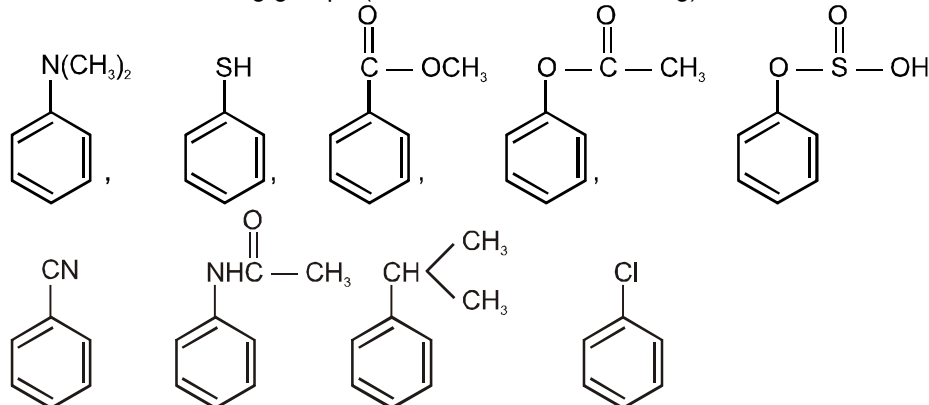
D-1. Arrange the following groups in the increasing order of +M :



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 ?



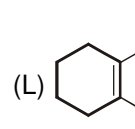
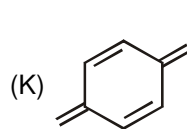
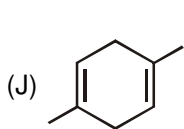
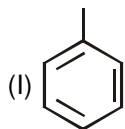
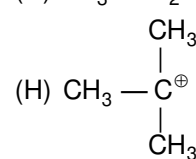
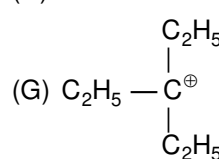
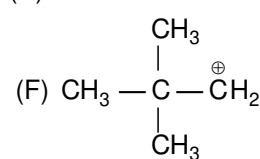
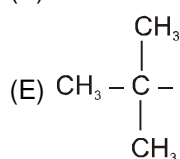
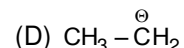
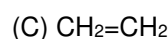
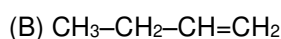
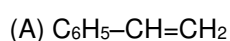
Section (E) : Steric Inhibition of Resonance (SIR Effect)

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

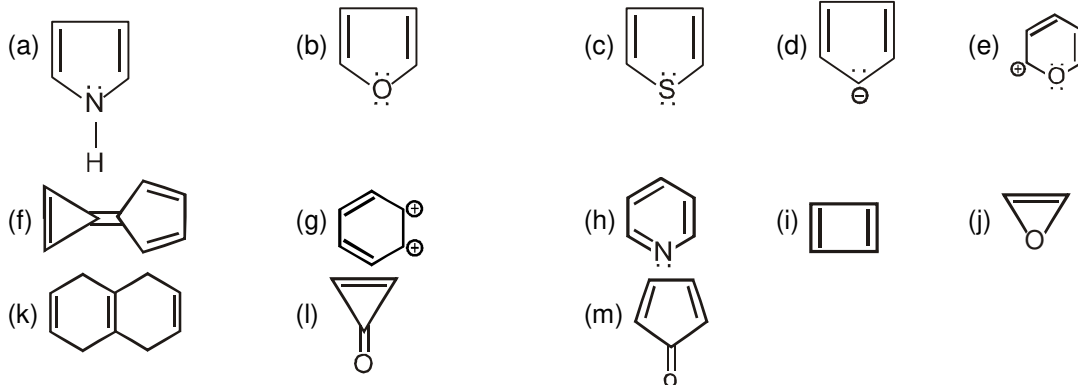




Section (G) : Concept of Aromaticity

G-1. What is aromaticity ?

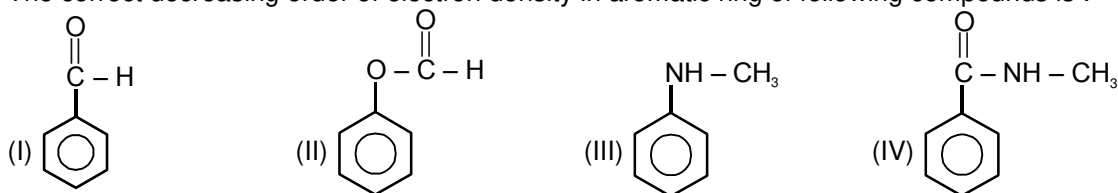
G-2. Classify the following as aromatic, antiaromatic and nonaromatic compounds.



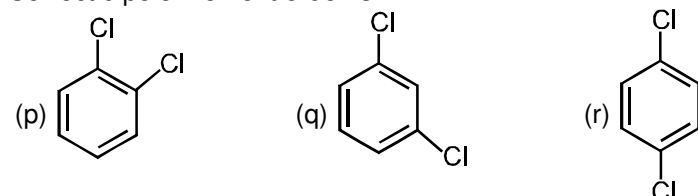
G-3. Why cyclooctatetraene is nonplanar.

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) $-\text{Br}$ (B) $-\text{COOH}$ (C) $-\text{OR}$ (D) $-\text{COO}^-$

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) $\text{iii} > \text{ii} > \text{i} > \text{iv}$ (B) $\text{ii} > \text{iii} > \text{iv} > \text{i}$ (C) $\text{iii} > \text{ii} > \text{iv} > \text{i}$ (D) $\text{ii} > \text{i} > \text{iv} > \text{iii}$



A-6. Which of the following is the strongest $-I$ group :

- (A) $-\overset{+}{N}(CH_3)_3$ (B) $-\overset{+}{NH}_3$ (C) $-\overset{+}{S}(CH_3)_2$ (D) $-F$

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.

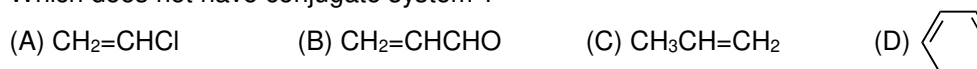
B-5. Which of the following species can not show resonance?



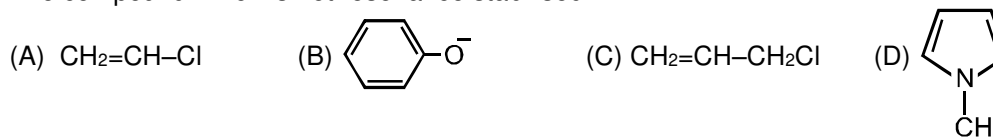
B-6. Resonance is not possible in :



B-7. Which does not have conjugate system ?



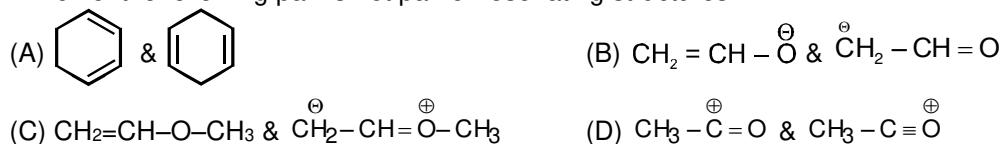
B-8. The compound which is not resonance stabilised



B-9. Which of the following is not acceptable as resonating structure :

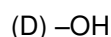
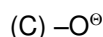
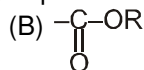
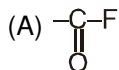


B-10. Which of the following pair is not pair of resonating structures?

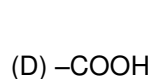
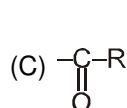
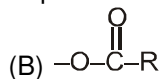




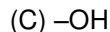
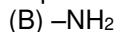
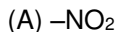
D-3. Which of the following group show +M and -I effect ?



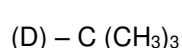
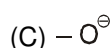
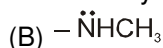
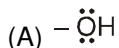
D-4. Which of the following group show +M > -I effect?



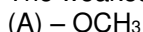
D-5. Which of the following group show -M and -I effect ?



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

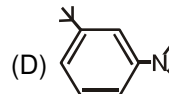
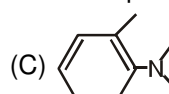
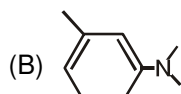
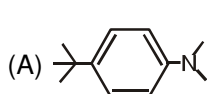


D-7. The weakest +M group of the given species is :



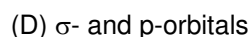
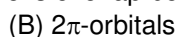
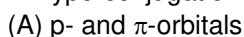
Section (E) : Steric Inhibition of Resonance (SIR Effect)

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

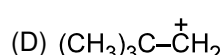
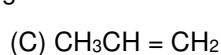
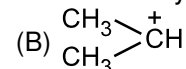
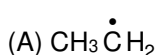


Section (F) : Hyperconjugation

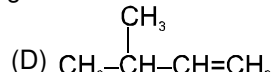
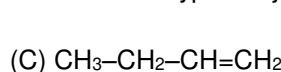
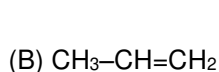
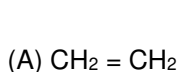
F-1. In hyperconjugation there is overlap between :



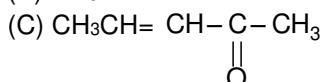
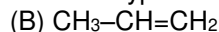
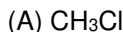
F-2. Which of the following cannot exhibit hyperconjugation -



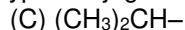
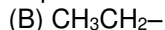
F-3. Which of the following alkenes will show maximum number of hyperconjugation forms ?



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

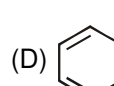
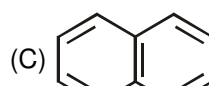
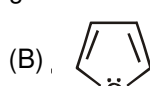
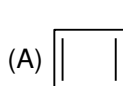


F-5. Which of the following group has the maximum hyperconjugation effect when attached to benzene ring ?

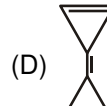
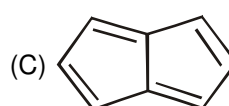
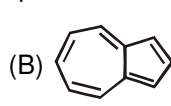
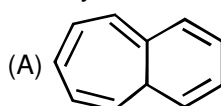


Section (G) : Concept of Aromaticity

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



G-2. Identify the aromatic compound ?

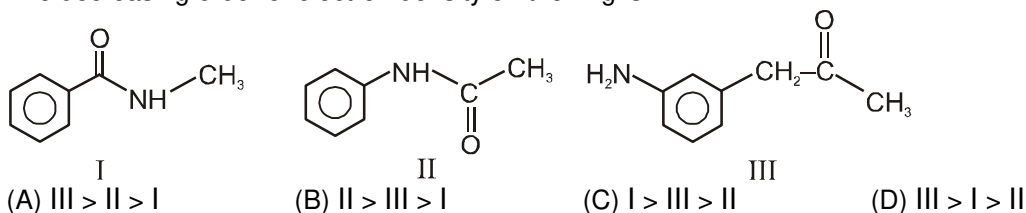




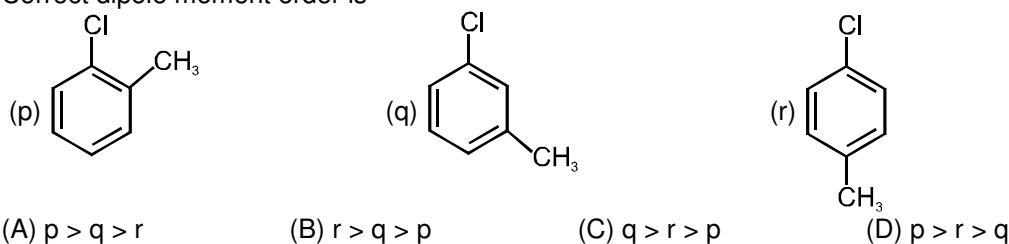
- G-3.** Aromatic compounds burn with sooty flame because :
 (A) They have a ring structure of carbon atoms.
 (B) They have a relatively high percentage of hydrogen.
 (C) They resist reaction with oxygen of air.
 (D) They have a relatively high percentage of carbon.

Section (H) : Applications of electronic effect

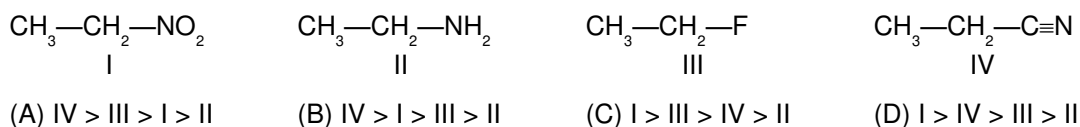
- H-1.** The decreasing order of electron density on the ring is :



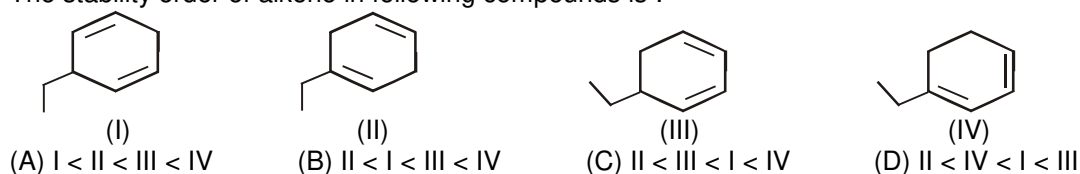
- H-2.** Correct dipole moment order is



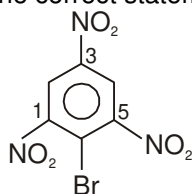
- H-3.** Arrange following compounds in decreasing order of their dipole moment.



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

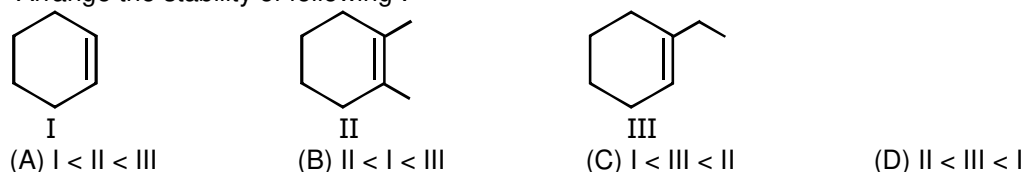


- H-5.** Select the correct statement about this compound.



- (A) All three C-N bond length are same.
 (B) C₁-N and C₃-N bonds length are same but shorter than C₅-N bond length.
 (C) C₁-N and C₅-N bonds length are same but longer than C₃-N bond length.
 (D) C₁-N and C₃-N bonds length are different but both are longer than C₅-N bond length.

- H-6.** Arrange the stability of following :





PART - III : MATCH THE COLUMN

1. Match the following :

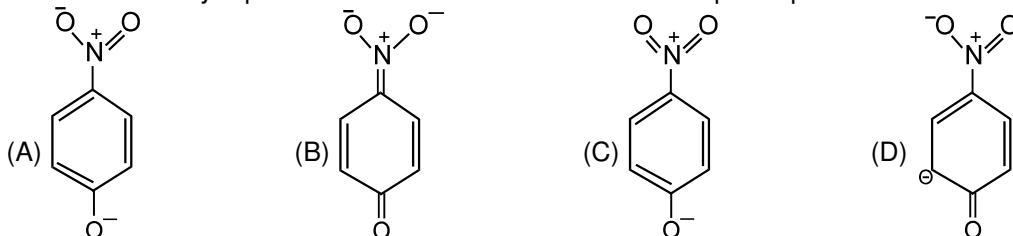
	Coulmn-I (Compounds)		Coulmn-II (Characteristics)
(A)		(p)	Mesomeric effect / resonance
(B)	Ph-CH=CH-CH ₃	(q)	Inductive effect.
(C)		(r)	Hyperconjugative effect
(D)		(s)	Nonpolar
		(t)	Polar

Exercise-2

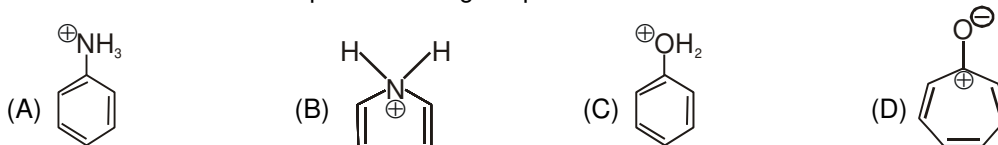
Marked questions are recommended for Revision.

PART - I : ONLY ONE OPTION CORRECT TYPE

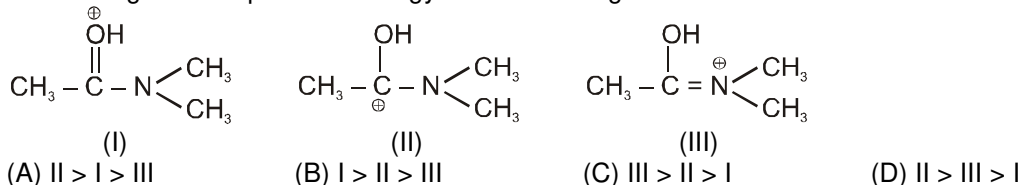
1. The most unlikely representation of resonance structures of p-nitrophenoxide ion is:



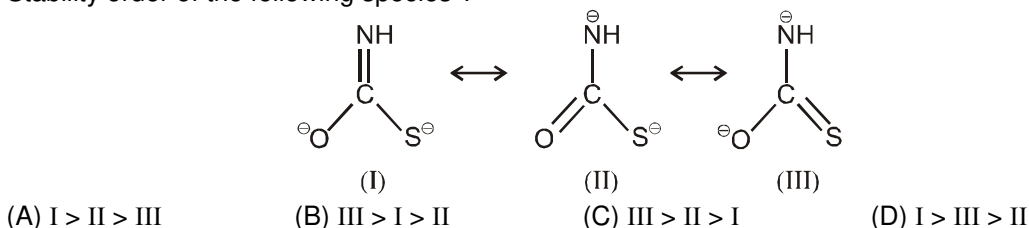
2. In which delocalisation of positive charge is possible ?



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



4. Stability order of the following species ?





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

- (A) $\text{CH}_2^{\ominus}-\text{CH}=\text{O} \longleftrightarrow \text{CH}_2=\text{CH}-\text{O}^{\ominus}$ (B) $\text{CH}_2^{\oplus}-\text{O}-\text{CH}_3 \longleftrightarrow \text{CH}_2=\text{O}^{\oplus}-\text{CH}_3$
 (C) $\text{CH}_2=\text{CH}-\text{NH}_2 \longleftrightarrow \text{CH}_2^{\ominus}-\text{CH}=\text{NH}_2^{\oplus}$ (D) $\text{O}^{\oplus}-\text{CH}=\text{CH}_2 \longleftrightarrow \text{O}=\text{CH}-\text{CH}_2^{\oplus}$

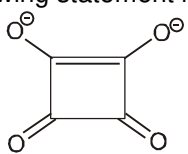
6. Which of the following is **incorrect** for stability of structures.

- (A) $\text{CH}_3-\overset{\text{O}^{\ominus}}{\underset{|}{\text{CH}}}-\text{CH}=\text{CH}_2 > \text{CH}_3-\overset{\text{O}^{\ominus}}{\underset{|}{\text{C}}}=\text{CH}-\text{CH}_3$ (B) $\text{Cyclohexyl-O}^{\ominus} < \text{CH}_3-\overset{\text{O}}{\underset{\text{O}^{\ominus}}{\parallel}}{\text{C}}-\text{O}^{\ominus}$
 (C) $\text{CH}_2=\text{CH}-\overset{\oplus}{\text{CH}}_2 > \text{CH}_3-\text{CH}_2-\overset{\oplus}{\text{CH}}_2$ (D) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}-\dot{\text{C}}\text{H}_2 > \dot{\text{C}}\text{H}_2-\text{CH}_2-\text{CH}=\text{CH}_2$


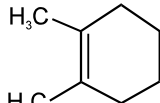


7. Least contributing resonating structure of nitroethene is :

- (A) $\text{CH}_2=\text{CH}-\overset{\text{O}^{\ominus}}{\underset{\text{O}^{\oplus}}{\parallel}}{\text{N}} \quad$ (B) $\overset{\oplus}{\text{CH}}_2-\text{CH}=\overset{\text{O}^{\oplus}}{\underset{\text{O}^{\ominus}}{\parallel}}{\text{N}} \quad$ (C) $\text{CH}_2^{\ominus}-\overset{\oplus}{\text{CH}}-\overset{\text{O}^{\oplus}}{\underset{\text{O}^{\ominus}}{\parallel}}{\text{N}} \quad$ (D) $\overset{\oplus}{\text{CH}}_2-\text{CH}=\overset{\text{O}^{\oplus}}{\underset{\text{O}^{\ominus}}{\parallel}}{\text{N}}$

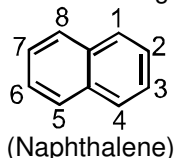
8. Which of the following statement is correct ?

- (A) In the dianion , all the C-C bonds are of same length but C-O bonds are of different length
 (B) In the dianion, all C-C bonds are of same length and also all C-O bonds are of same lengths
 (C) In the dianion, all C-C bond lengths are not of same length
 (D) None of the above

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

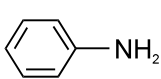
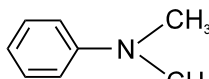
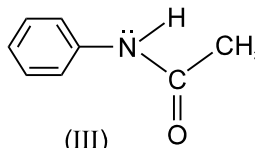
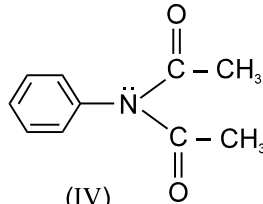
-  I  II  III  IV
 (A) II > I > IV > III (B) III > I > II > IV (C) IV > II > I > III (D) IV > I > II > III

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



- (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

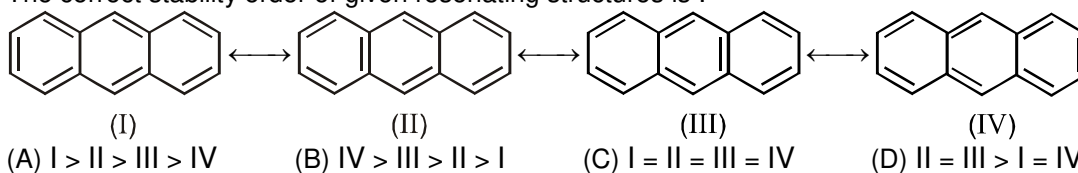
11. The correct order of +M effect of 'N' containing functional group on benzene ring, amongst the given compounds is

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

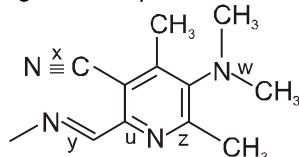


12. In which case the σ -bond pair and π -bond pair of electrons both are attracted in the same direction, (towards same atom.) :
 (A) $\text{H}_2\text{C}=\text{CH}-\text{Cl}$ (B) $\text{CH}_3-\text{CH}_2-\text{NH}_2$ (C) $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{O}$ (D) $\text{H}_2\text{C}=\text{CH}-\text{OCH}_3$

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

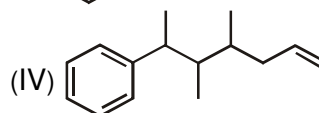
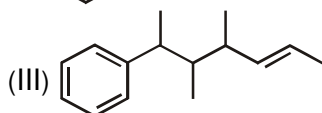
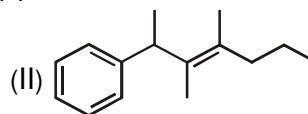
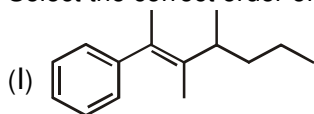


14. The longest C-N bond length in the given compound is :



- (A) x (B) y (C) z (D) w

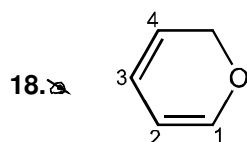
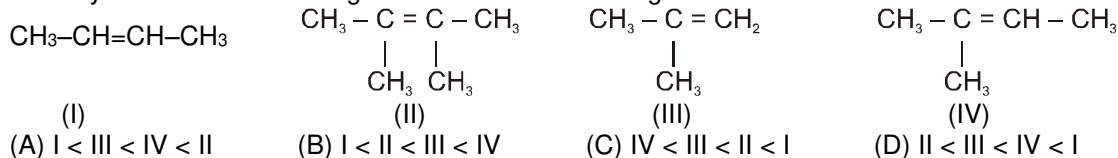
15. Select the correct order of heat of hydrogenation ?



- (A) $\text{I} > \text{II} > \text{III} > \text{IV}$ (B) $\text{IV} > \text{III} > \text{II} > \text{I}$ (C) $\text{II} > \text{III} > \text{IV} > \text{I}$ (D) $\text{II} > \text{III} > \text{I} > \text{IV}$

16. $\text{H}_3\text{C}-\overset{\oplus}{\text{C}}\text{H}-\text{CH}=\text{CH}_2$ does not involve :
 (A) σ -p overlap (B) σ - π^* overlap (C) $p\pi$ - $p\pi$ overlap (D) $p\pi$ - $d\pi$ overlap

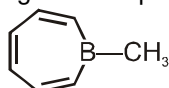
17. Stability of π -bond in following alkenes in the increasing order is :



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

- (A) C_1 and C_3 (B) C_2 and C_4 (C) C_2 and C_3 (D) C_1 and C_4

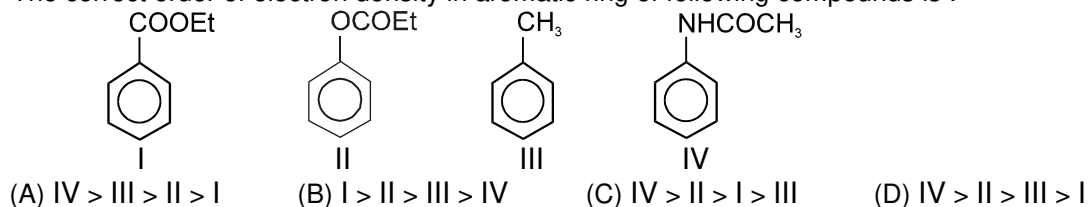
19. If the given compound is planar. Select the correct statement.



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

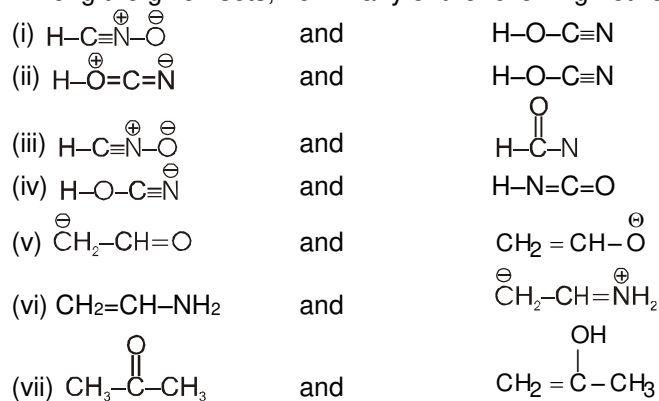


20. The correct order of electron density in aromatic ring of following compounds is :

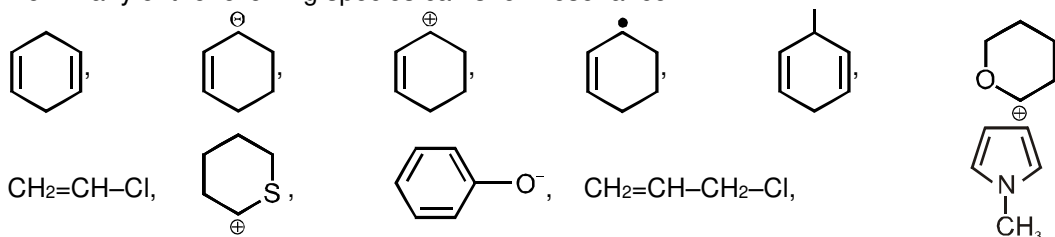


PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

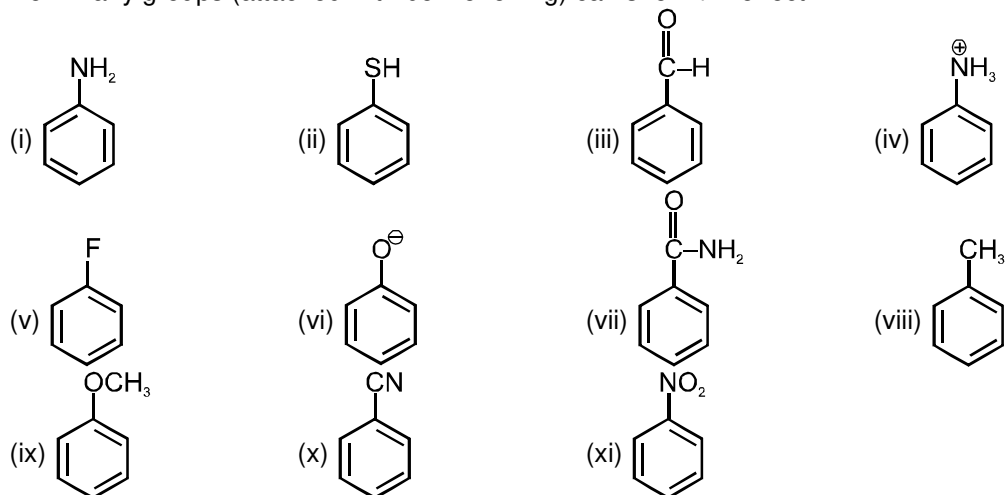
1. Among the given sets, how many of the following not represents the resonating structure :



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

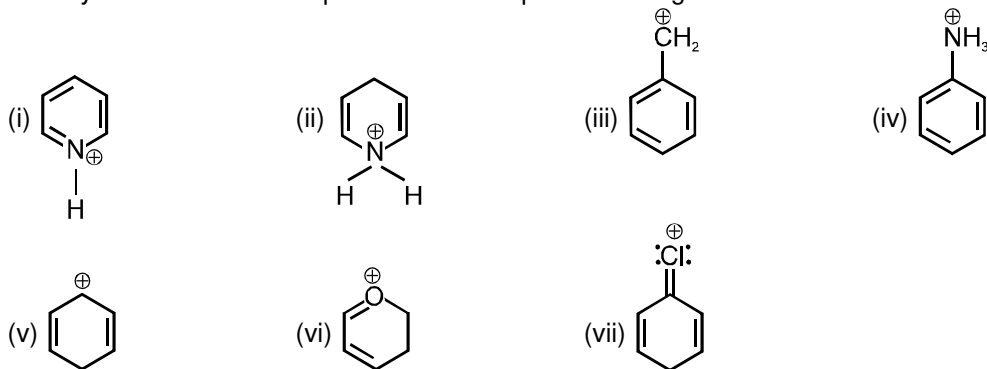


3. How many groups (attached with benzene ring) can show +M effect ?

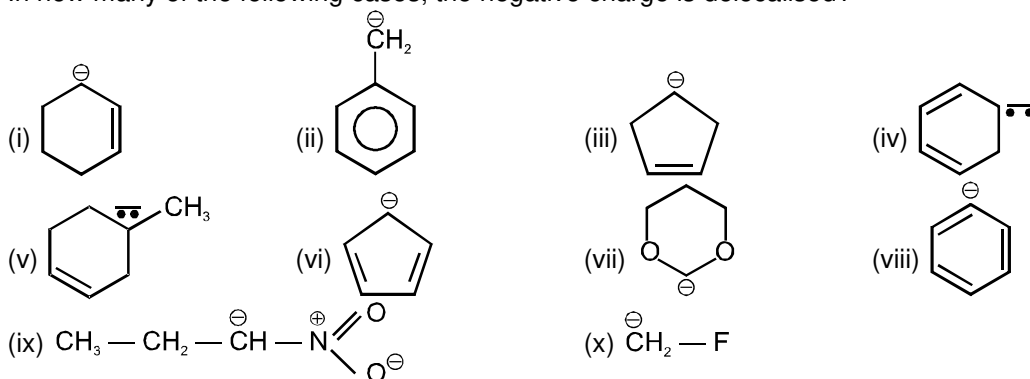




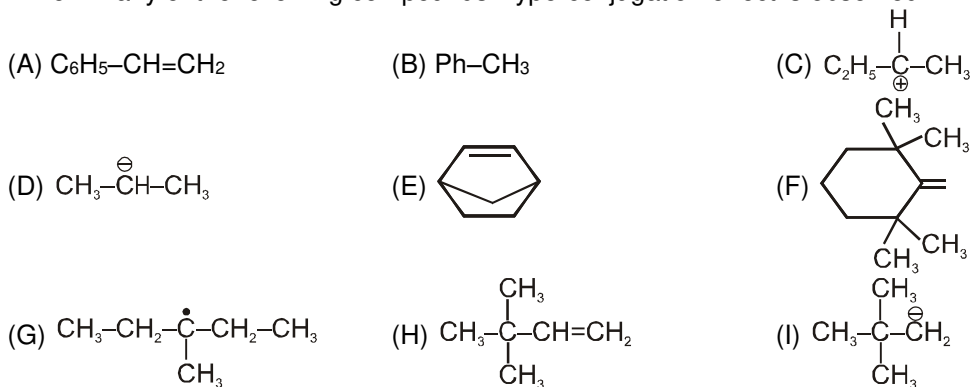
4. Identify the number of compounds in which positive charge will be delocalised ?



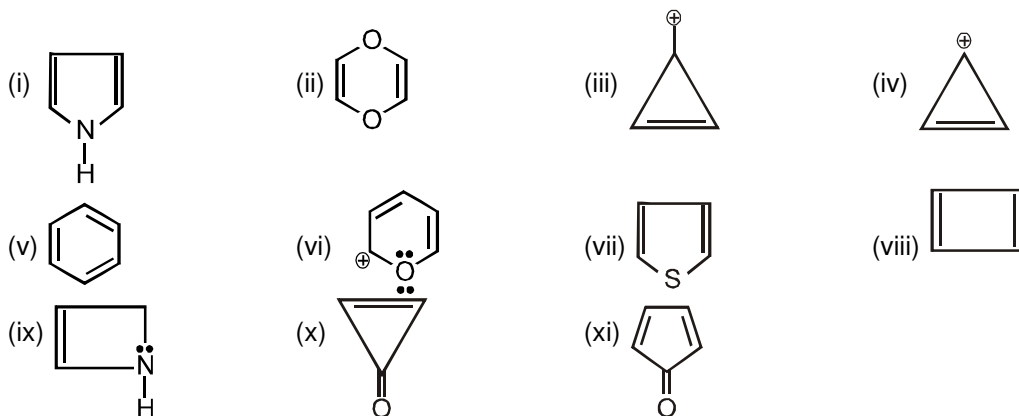
5. In how many of the following cases, the negative charge is delocalised?



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

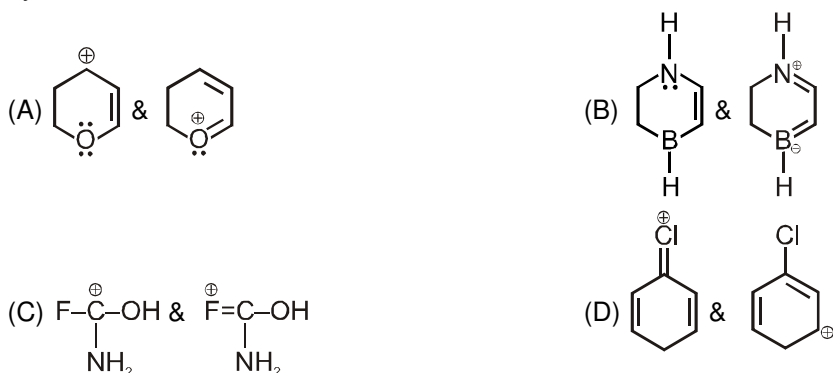


7. How many of the following compounds is/are aromatic ?

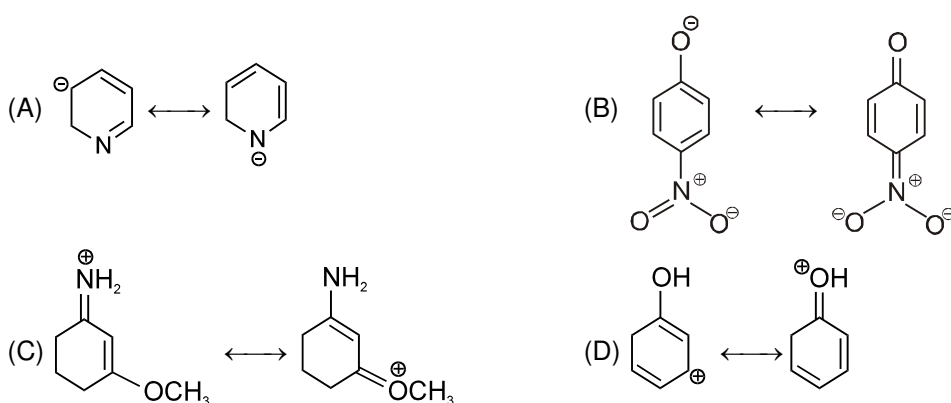




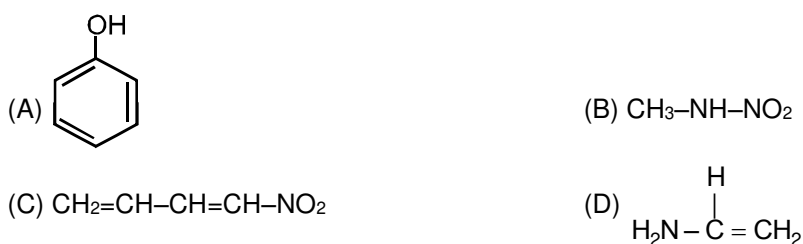
3. In which of the following pairs of compounds, will second structure have more contribution to resonance hybrid than first ?



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



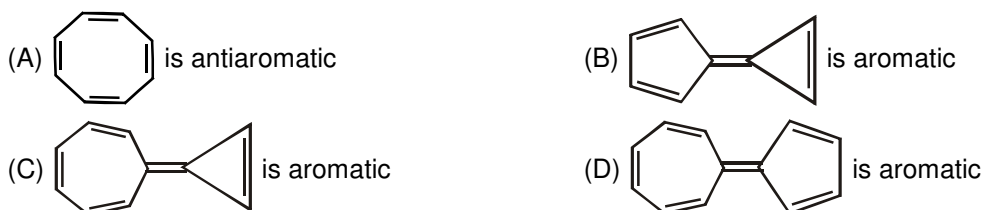
5. In which of the following compounds delocalisation of electrons and shifting of electron in the same direction ?



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

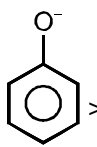
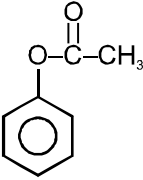
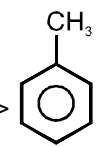
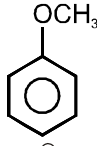
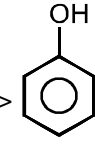
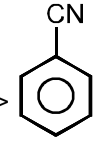
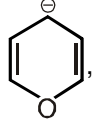
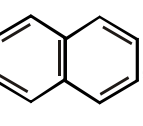
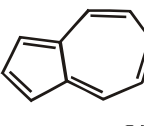
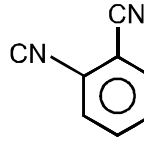
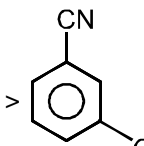
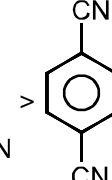


7. Which of the following is/are correct :

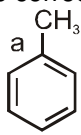
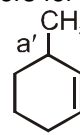
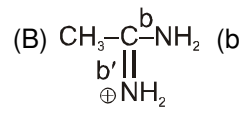
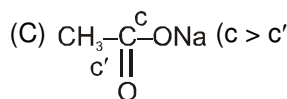
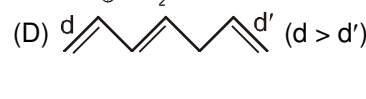




8. Which of the following is/are correct statement :

- (A)  >  >  e^- density
- (B)  >  >  e^- density
- (C) , ,  all are aromatic
- (D)  >  >  Dipole moment

9. The correct orders for bond length are :

- (A)   ($a' > a$)
- (B)  ($b' = b$)
- (C)  ($c > c'$)
- (D)  ($d > d'$)

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension

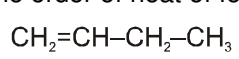
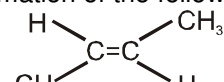
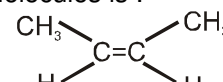
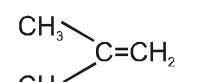
Hydrogenation of unsaturated hydrocarbons is an exothermic reaction. Due to hyperconjugation and resonance the stability of unsaturated hydrocarbons increases and the increase in stability is more due to resonance. Compound with same number of π -bonds and more stability has lower heat of hydrogenation.

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.

1. The correct heat of hydrogenation order is :

- (p) 1,3-Pentadiene (q) 1,3-Butadiene
(r) 2,3-Dimethyl-1,3-butadiene (s) Propadiene
(A) $p > q > r > s$ (B) $s > q > p > r$ (C) $q > s > p > r$ (D) $s > p > q > r$

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

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



Comprehension # 2

Answer Q.3, Q.4 and Q.5 by appropriately matching the information given in the three columns of the following table.

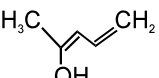
	Column-I	Column-II	Column-III
(P)		(i) lone pair is present in hybrid orbital	(I) delocalised lone pair
(Q)		(ii) Charge is present in hybrid orbital	(II) localised lone pair
(R)		(iii) lone pair is present in p-orbital	(III) localised charge
(S)		(iv) charge is present in p-orbital	(IV) delocalised charge

3. The only correct combination for pyridine is –
 (A) (Q) (i), (II) (B) (P) (i) (II) (C) (R) (iv) (III) (D) (Q) (ii) (II)
4. The only correct combination for benzyl cation is–
 (A) (P) (ii), (II) (B) (R) (iv) (IV) (C) (S) (iv) (IV) (D) Q (i) (II)
5. The only correct combination for pyrrole is
 (A) (P) (ii), (II) (B) (R) (iv) (IV) (C) (S) (iv) (IV) (D) Q (iii) (I)

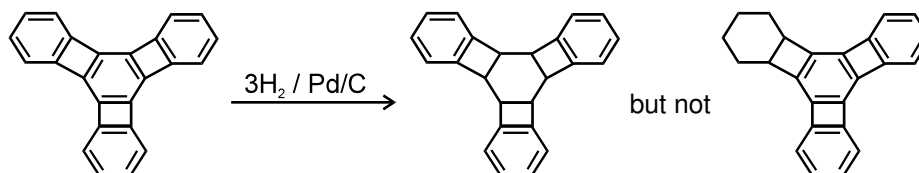
Exercise-3

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

* Marked Questions may have more than one correct option.

1. Write resonating structure of the compound . [JEE-03(S), 2/60]

2. Explain the following observations [JEE-05, 2/84]

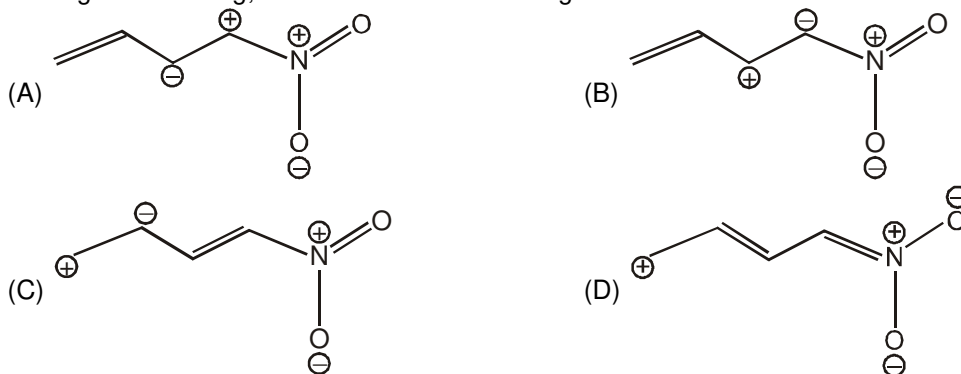


3. Which will be the least stable resonating structure : [JEE-05(S), 3/84]
- (A) $\text{CH}_2=\text{CH}-\overset{+}{\text{C}}\text{H}-\overset{-}{\text{C}}\text{H}-\text{O}-\text{CH}_3$ (B) $\overset{-}{\text{C}}\text{H}-\overset{+}{\text{C}}\text{H}-\text{CH}=\text{CH}-\text{OCH}_3$
 (C) $\overset{-}{\text{C}}\text{H}-\text{CH}=\text{CH}-\text{CH}=\overset{+}{\text{O}}-\text{CH}_3$ (D) $\text{CH}_2=\text{CH}-\overset{-}{\text{C}}\text{H}-\text{CH}=\overset{+}{\text{O}}-\text{CH}_3$



4. Among the following, the least stable resonating structure is :

[JEE-07, 3/162]



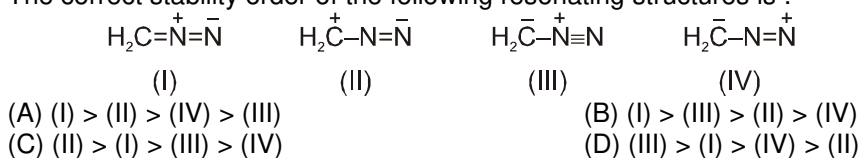
5. Hyperconjugation involves overlap of the following orbitals :

[JEE-08, 3/163]

(A) $\sigma-\sigma$ (B) $\sigma-p$ (C) $p-p$ (D) $\pi-\pi$

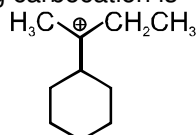
6. The correct stability order of the following resonating structures is :

[JEE-09, 3/160]



7. The total number of contributing structures showing hyperconjugation (involving C-H bonds) for the following carbocation is

[JEE-11, 4/180]



- 8.* Which of the following molecules, in pure form, is (are) **unstable** at room temperature? [JEE-12, 4/136]



9. The hyperconjugative stabilities of tert-butyl cation and 2-butene, respectively, are due to

[JEE(Advanced)-2013, 4/120]

(A) $\sigma \rightarrow p$ (empty) and $\sigma \rightarrow \pi^*$ electron delocalisations.

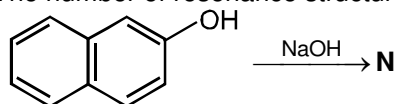
(B) $\sigma \rightarrow \sigma^*$ and $\sigma \rightarrow \pi$ electron delocalisations.

(C) $\sigma \rightarrow p$ (filled) and $\sigma \rightarrow \pi$ electron delocalisations.

(D) p (filled) $\rightarrow \sigma^*$ and $\sigma \rightarrow \pi^*$ electron delocalisations.

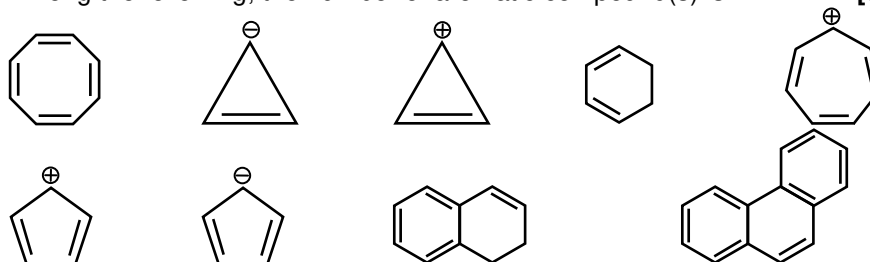
10. The number of resonance structures for **N** is

[JEE(Advanced)-2015, 4/168]



11. Among the following, the number of aromatic compound(s) is

[JEE(Advanced)-2017, 3/122]


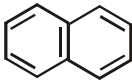


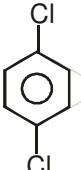
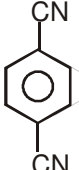
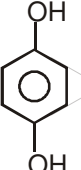
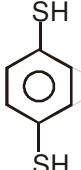
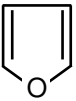
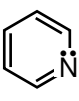
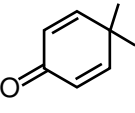
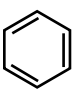




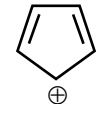
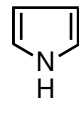
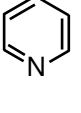
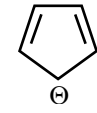

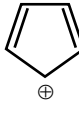
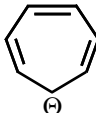
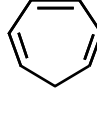
PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

- In the following benzyl/allyl system

$$R-CH=CH_2 \quad \text{and} \quad \text{C}_6\text{H}_5-R \quad (R \text{ is alkyl group})$$
 Then decreasing order of inductive effect is : [AIEEE-2002, 3/225]
 (1) $(CH_3)_3C- > (CH_3)_2CH- > CH_3CH_2-$ (2) $CH_3CH_2- > (CH_3)_2CH- > (CH_3)_3C-$
 (3) $(CH_3)_2CH- > CH_3CH_2- > (CH_3)_3C-$ (4) $(CH_3)_3C- > CH_3CH_2- > (CH_3)_2CH-$
- In the anion $HCOO^-$ the two carbon-oxygen bonds are found to be of equal length. What is the reason for it? [AIEEE 2003, 3/225]
 (1) electronic orbitals of carbon atom are hybridised
 (2) the $C=O$ bond is weaker than the $C-O$ bond
 (3) the anion $HCOO^-$ has two resonating structures
 (4) the anion is obtained by removal of a proton from the acid molecule.
- The non aromatic compound among the following is : [JEE-Main 2011, 4/120]
 (1)  (2)  (3)  (4) 
- For which of the following molecule significant $\mu \neq 0$? [JEE(Main)-2014, 4/120]
 (a)  (b)  (c)  (d) 
 (1) Only (a) (2) (a) and (b) (3) Only (c) (4) (c) and (d)
- Which of the following molecules is least resonance stabilized ? [JEE(Main)-2017, 4/120]
 (1)  (2)  (3)  (4) 

JEE(MAIN) ONLINE PROBLEMS

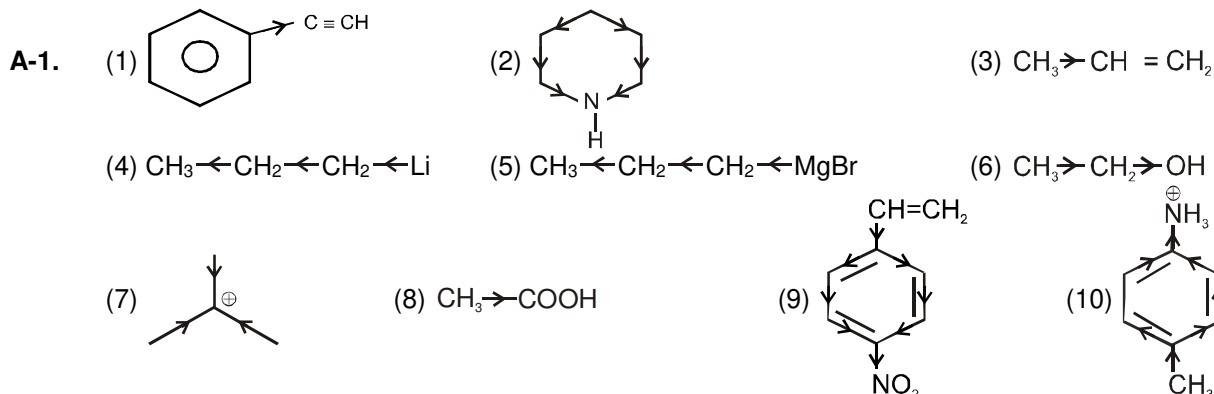
- Which of the following compounds is not aromatic? [JEE(Main) 2019 Online (09-01-19), 4/120]
 (1)  (2)  (3)  (4) 
- Which compound(s) out of the following is/are not aromatic? [JEE(Main) 2019 Online (11-01-19), 4/120]
 (A)  (B)  (C)  (D) 
 (1) (B) (2) (B), (C) and (D)
 (3) (C) & (D) (4) (A) & (C)



Answers

EXERCISE - 1

PART - I

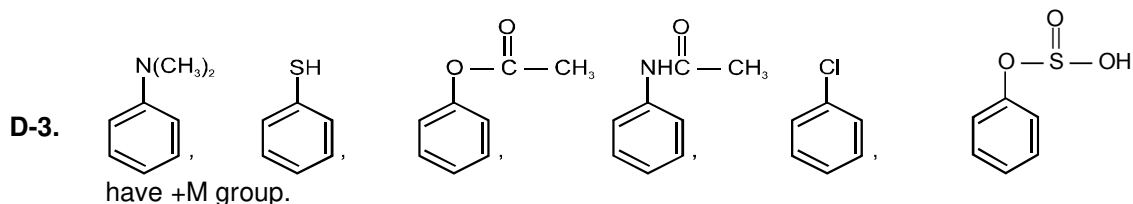


B-1. (P), (R), (S)

B-2. 8

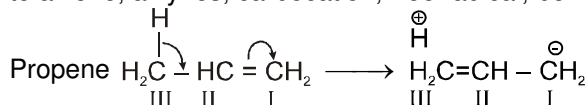
C-1. (P) I – minor
(R) I – minorII – major
II – major(Q) I – minor
(S) I – minorII – major
II – major

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

D-1. (i) +m : $-\text{I} < -\text{Br} < -\text{Cl} < -\text{F}$ (ii) +m : $-\text{OH} < -\text{NH}_2 < -\text{O}^\oplus$ D-2. (i) –m : $-\text{COOR} < -\text{COR} < \text{CHO} < \text{CN} < \text{NO}_2$ (ii) –m : $-\text{C}(=\text{O})\text{O}^- < -\text{C}(=\text{O})\text{NH}_2 < -\text{C}(=\text{O})\text{F}$ 

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.

F-2. (A) 0 (B) 2 (C) 0 (D) No hyperconjugation
(E) 0 (F) 0 (G) 6 (H) 9
(I) 3 (J) 10 (K) 0 (L) 10


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**PART - I**

- | | | | | |
|----------------|----------------|----------------|----------------|----------------|
| 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) |

PART - II

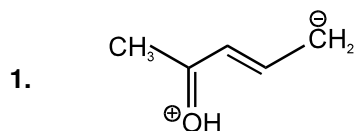
- | | | |
|---|--|--------------------------------|
| 1. 4 (i, iii, iv, vii) | 2. 8 (ii, iii, iv, vi, vii, viii, ix, xi) | 3. 5 (i, ii, v, vi, ix) |
| 4. 5 (i, iii, v, vi, vii) | 5. 5 (i, ii, iv, vi, ix) | 6. 3 (B, C & G). |
| 7. 6 (i, iv, v, vi, vii, x) | | |
| 8. 3
Aromatic – a, c, g, h, i, j, k. ; Antiaromatic – b, d, e ; Nonaromatic – f | | |
| 9. 6 | 10. 9 | 11. 2 |

**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) | 3. (B) | 4. (C) | 5. (D) |
|--------|--------|--------|--------|--------|

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 | 11. 5 | |

PART - II**JEE(MAIN) OFFLINE PROBLEMS**

- | | | | | |
|--------|--------|--------|--------|------|
| 1. (1) | 2. (3) | 3. (4) | 4. (4) | 5. 3 |
|--------|--------|--------|--------|------|

JEE(MAIN) ONLINE PROBLEMS

- | | |
|--------|--------|
| 1. (1) | 2. (2) |
|--------|--------|



Additional Problems for Self Practice (APSP)

Marked questions are recommended for Revision.

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Time : 1 Hr.

Max. Marks : 120

Important Instructions

- The test is of **1 hour** duration.
- The Test Booklet consists of **30** questions. The maximum marks are **120**.
- Each question is allotted **4 (four)** marks for correct response.
- Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question.
 $\frac{1}{4}$ (**one fourth**) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
- There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

- Stability of π -bond in following alkenes in the increasing order is :
 $\text{CH}_3\text{--CH=CH--CH}_3$ $\text{CH}_3\text{--C=C--CH}_3$ $\text{CH}_3\text{--C=CH}_2$ $\text{CH}_3\text{--C=CH--CH}_3$

CH_3
|
(I)

$\begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ | \quad | \end{array}$
(II)

CH_3
|
(III)

CH_3
|
(IV)

(1) I < III < IV < II

(2) I < II < III < IV

(3) IV < III < II < I

(4) II < III < IV < I
- Select the correct statement regarding the following compounds :

(I)

(II)

(1) II has a greater dipole moment than I
(3) I is more soluble in polar solvent than II

(2) Covalent character of II is less than I
(4) None of these
- Which of the following resonating structure of 1-Methoxy-1,3-butadiene is least stable ?

(1) $\text{CH}_2\text{=CH=CH=CH=O}^+\text{--CH}_3$
(3) $\text{CH}_2\text{=CH=CH=CH=O}^+\text{--CH}_3$

(2) $\text{CH}_2\text{=CH=CH=CH=O}^+\text{--CH}_3$
(4) $\text{CH}_2\text{=CH=CH=CH=O}^+\text{--CH}_3$
- Select the correct option related to stability of following structures.

(1)

(2)

(3)

(4)
- The minimum magnitude of heat of hydrogenation per mole of molecule is -

(1)

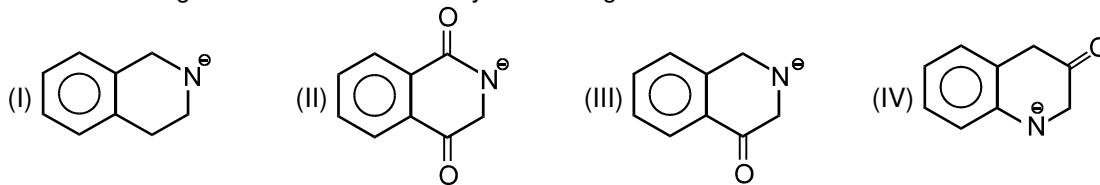
(2)

(3)

(4)



6. The decreasing order of electron density on the ring is :



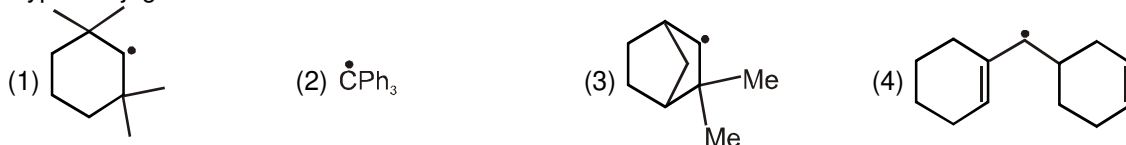
(1) (II) > (III) > (IV) > (I)

(3) (IV) > (I) > (III) > (II)

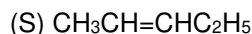
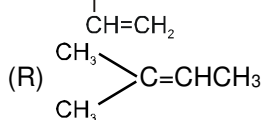
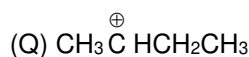
(2) (IV) > (I) > (II) > (III)

(4) (I) > (III) > (IV) > (II)

7. Hyperconjugation observed in



8. The number of hyperconjugable hydrogen atoms of following species are respectively :



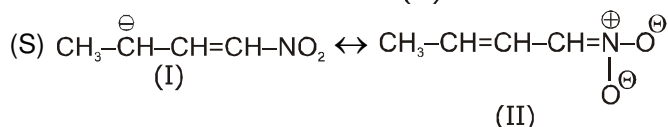
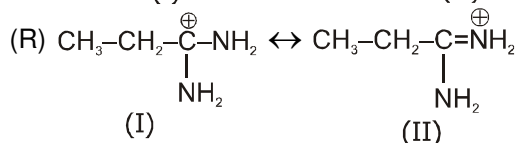
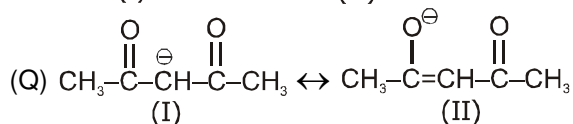
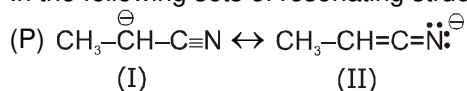
(1) 3, 5, 9, 8

(2) 3, 5, 9, 5

(3) 5, 5, 3, 5

(4) 5, 2, 6, 5

9. In the following sets of resonating structure, label the major contributors towards resonance hybrid.



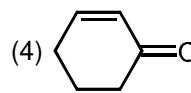
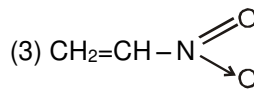
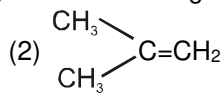
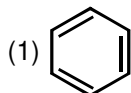
(1) II, II, I, II

(2) II, II, II, I

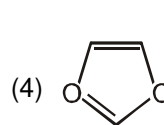
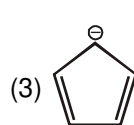
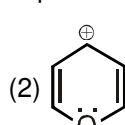
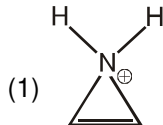
(3) II, II, II, II

(4) I, I, II, I

10. In which of the following C = C bond length is minimum :

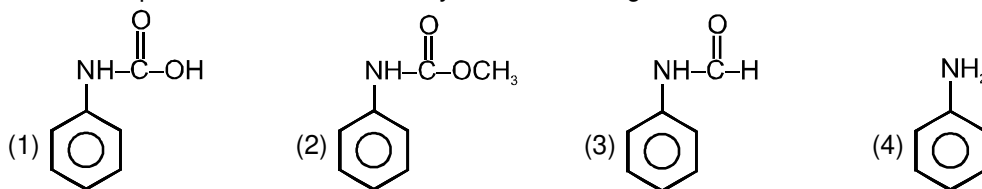


11. Which of the following compound is non aromatic :

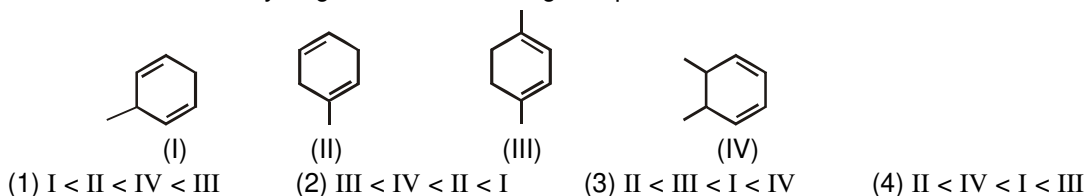




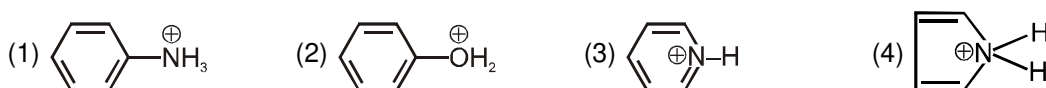
12. Which compound has least e^- density in benzene ring



13. The order of heat of hydrogenation in following compound is :



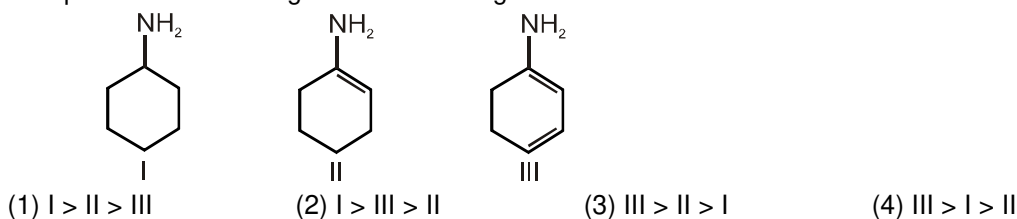
14. Resonance stabilized cation is :



15. In HCOO^- , the two carbon-oxygen bonds are found to be of equal length. What is the reason for this ?

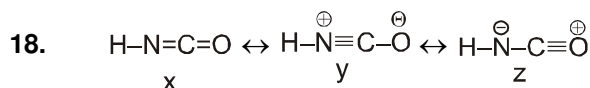
- (1) The anion is obtained by the removal of a proton from the acid molecule.
 (2) Electronic orbitals of carbon atoms are hybridised.
 (3) The $\text{C}=\text{O}$ bond is weaker than $\text{C}-\text{O}$ bond.
 (4) The anion HCOO^- has two equally stable resonating structures.

16. Compare C-N bond length in the following :



17. Which of the following is false for order of -I effect :

- (1) $-\text{F} > -\text{Cl} > -\text{Br} > -\text{I}$ (2) $-\text{C}\equiv\text{CH} > -\text{CH}=\text{CH}_2 > -\text{CH}_2-\text{CH}_3$
 (3) $-\text{C}\equiv\text{CN} > -\text{C}(=\text{O})-\text{OH}$ (4) $-\text{Ph} > -\text{C}\equiv\text{CH}$



which resonating structure is least stable

- (1) x (2) y (3) z (4) All are equivalent

19. The aromatic compound would be :

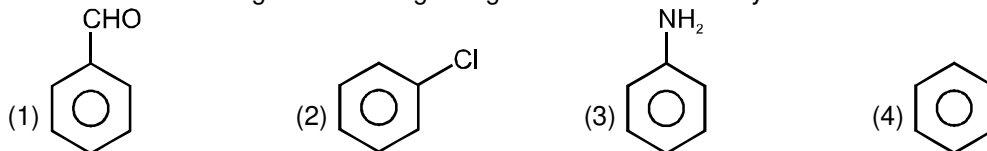


20. Number of delocalized e^- pairs in squaric acid and dianion of squaric acid are respectively.

- (1) 5 & 5 (2) 5 & 7 (3) 3 & 5 (4) 7 & 7



21. Which of the following benzene ring has greater electron density than Toulene



22. Which of the following has the maximum number of resonating structures ?

- (1) Benzene (2) Naphthalene
(3) Anthracene (4) Phenanthrene

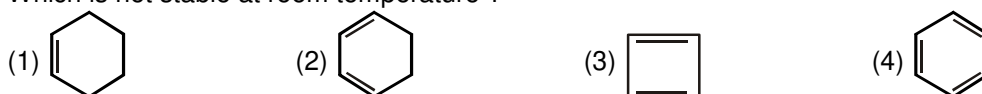
23. Among the following aromatic compound is



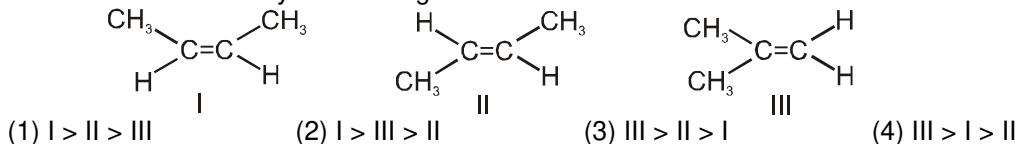
24. $\text{CH}_2=\text{C}(\text{O}^-)-\text{CH}_3$ and $\text{CH}_2=\text{C}(\text{O}^-)-\text{CH}_3$ are :

- (1) Resonating structures (2) Tautomers
(3) Geometrical isomers (4) Optical isomers

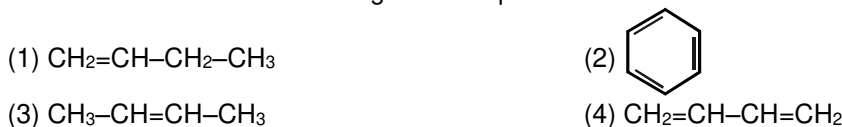
25. Which is not stable at room temperature ?



26. Correct order of stability of following alkenes is



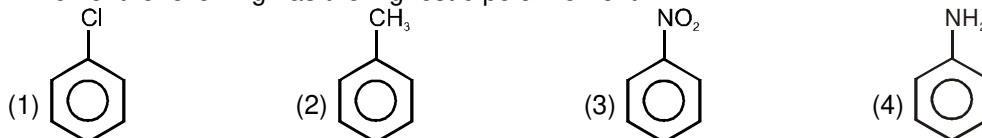
27. All the carbon-carbon bond lengths are equal in



28. The kind of delocalization involving sigma bond orbitals is called

- (1) Inductive effect (2) Hyperconjugation effect
(3) Electromeric effect (4) Mesomeric effect

29. Which of the following has the highest dipole moment.



30. $\text{CH}_3-\text{C}(\text{H})(\text{CH}_3)-\text{CH}_2-\text{H}$ in C_1-H , C_2-H and C_3-H the homolytic bond dissociation energy order is :

[Hint : Dissociation energy $\propto \frac{1}{\text{stability of free radical}}$]

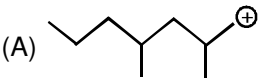
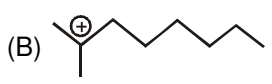
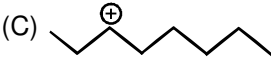
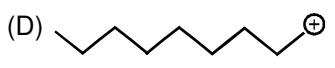
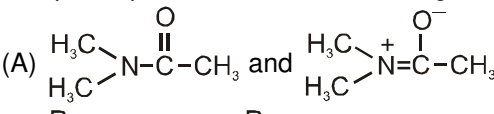
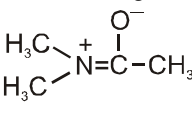
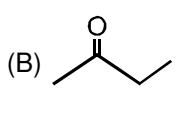
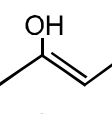
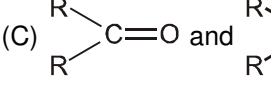
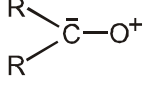
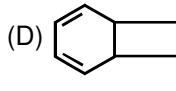
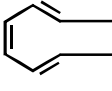
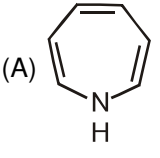
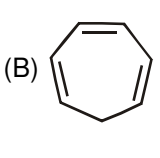
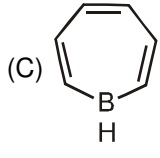
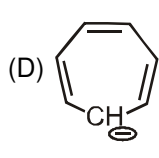
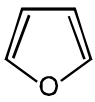
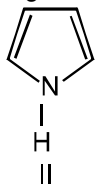
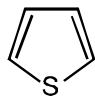
- (1) $\text{C}_2-\text{H} > \text{C}_3-\text{H} > \text{C}_1-\text{H}$ (2) $\text{C}_2-\text{H} > \text{C}_3-\text{H} > \text{C}_1-\text{H}$
(3) $\text{C}_2-\text{H} > \text{C}_3-\text{H} > \text{C}_1-\text{H}$ (4) $\text{C}_3-\text{H} > \text{C}_2-\text{H} > \text{C}_1-\text{H}$



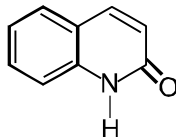
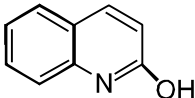


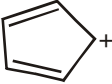

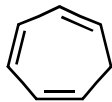
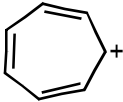
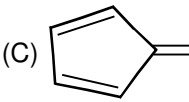
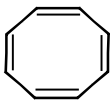


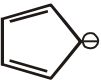

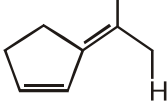
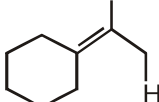
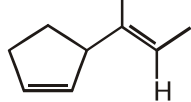
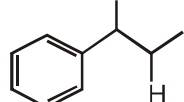
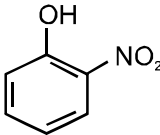
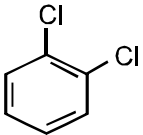
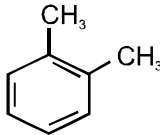
Practice Test-1 (IIT-JEE (Main Pattern))
OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

PART-II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

- Which of the following is true about the cycloheptatrienyl free radical ? [NSEC-2000]
 (A) It is an isolatable stable free radical (B) It is an aromatic free radical
 (C) It has $4n + 2\pi$ electrons (D) None of these
- Select the most stable carbonium ion from amongst the following [NSEC-2001]
 (A)  (B) 
 (C)  (D) 
- The pair representation valid resonating structures is [NSEC-2003]
 (A)  and 
 (B)  and 
 (C)  and 
 (D)  and 
- The aromatic compound would be [NSEC-2004]
 (A)  (B) 
 (C)  (D) 
- Inductive effect is a polarisation of a [NSEC-2004]
 (A) sigma bond (B) π -bond
 (C) co-ordinate bond (D) conjugated system.
- Match the resonance energies 67, 88 and 121 kJ mol⁻¹ for the following compounds. [NSEC-2005]
  
 I II III
 (A) I - 67, II - 121, III - 88 (B) I - 121, II - 67, III - 88
 (C) I - 67, II - 88, III - 121 (D) I - 121, II - 88, III - 67



7. The pair of resonating structures among the following is [NSEC-2005]
- (A) $R_2CH-N=O$ $R_2C=N-OH$ (B) $R_2CH-N^+=O^-$ $R_2CH-N^+=O^-$
- (C)   (D) $R_2CH-N^+=O^-$ $R_2C=NN^+=O^-$
8. Identify the aromatic compound from the following. [NSEC-2005]
- (A)  (B)  (C)  (D) 
9. Which of the following species is aromatic? [NSEC-2006]
- (A)  (B)  (C)  (D) 
10. The number of π electrons required for a planar cyclic conjugated system to exhibit aromatic behaviour is $(4n + 2)$. Here n is [NSEC-2006]
- (A) number of C atoms in the system (B) number of π bonds
(C) a non-negative integer (D) number of bonds in the system.
11. Following is an example of [NSEC-2006]
- $CH_2=CH-\overset{\overset{O}{\parallel}}{C}-H \leftrightarrow CH_2=CH-\overset{\overset{O^-}{\parallel}}{C^+}-H \leftrightarrow \overset{\ominus}{C}H_2=CH-\overset{\overset{O^-}{\parallel}}{C}-H$
- (A) hyperconjugation (B) tautomerism
(C) resonance (D) inductive effect.
12. The relative stabilities of the following carbocations is : [NSEC-2007]
- $H_2CO-CH=CH-\overset{+}{C}H_2$ $H_2C=\overset{+}{C}(OMe)-CH_2$ $CH_3OCH_2-\overset{+}{C}H_2$ $CH_3O\overset{+}{C}H_2$
- (A) I > II > III > IV (B) I > IV > II > III (C) II > III > IV > I (D) III > I > II > IV
13. Identify the odd species out (Which of the species among the following is different from others ?) [NSEC-2007]
- (A)  (B)  (C)  (D) 
14. Which of the following represents the true order of bond dissociation energy of the indicated C-H bond of the following molecules ? [NSEC-2007]
- (I)  (II)  (III)  (IV) 
- (A) I < II < IV < III (B) III < IV < II < I (C) IV < II < I < III (D) III < IV < II < I
15. The correct order of dipole moment for the following molecules is [NSEC-2011]
- (I)  (II)  (III) 
- (A) I = II = III (B) I < II < III (C) I > II > III (D) II < III < I



16. The order of decreasing stability is : [NSEC-2011]
- (I) (II) (III) (IV)
- (A) IV > I > II > III (B) I > IV > III > II (C) I > II > IV > III (D) IV > II > I > III
17. The most Carbocations, carbanions, free radicals and radical cation are reactive carbon intermediates. Their hybrid orbitals respectively are [NSEC-2012]
- (A) sp^2 , sp^2 , sp^3 , sp (B) sp^2 , sp^2 , sp , sp^3
 (C) sp^2 , sp^3 , sp^2 , sp (D) sp^3 , sp^2 , sp , sp^2
18. The electronegativities of acetylene, ethylene and ethane are in the order : [NSEC-2012]
- (A) ethylene > acetylene > ethane (B) acetylene > ethylene > ethane
 (C) ethane > acetylene > ethylene (D) acetylene > ethane > ethylene
19. Which of the following structure is aromatic ? [NSEC-2013]
- (I) (II) (III) (IV)
- (A) Structures I and II (B) Structure I only (C) Structures II only (D) Structure III only
20. Which of the following is most stable ? [NSEC-2013]
- (A) 2,3-Dimethyl-2-butene (B) 2-Butene
 (C) 2-Methyl-1,2-butene (D) 1-Butene
21. How many hyperconjugative structures are possible in the following carbocation? [NSEC-2013]
-
- (A) 1 (B) 3 (C) 5 (D) 6
22. Which of the following is not a resonating structure for the phenoxide ion ? [NSEC-2013]
- (I) (II) (III) (IV)
- (A) I (B) II (C) III (D) IV
23. Among the following compound that is not aromatic [NSEC-2014]
- (A) (B) (C) (D)
24. The correct order of dipole moment for the following molecules is [NSEC-2014]
- (I) (II) (III) (IV)
- (A) IV > I > III > II (B) I > IV > III > II (C) III > I > II > IV (D) II > III > IV > I



PART - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr.

Max. Marks : 54

Important Instructions

A. General :

- The test is of 1 hour duration.
- The Test Booklet consists of 18 questions. The maximum marks are 54.

B. Question Paper Format

- Each part consists of five sections.
- Section 1 contains 8 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
- Section 2 contains 6 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
- Section 3 contains 3 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
- Section 4 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

C. Marking Scheme

- For each question in Section 1 and 4 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (– 1) mark will be awarded.
- For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
- For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

SECTION-1 : (Only One option correct Type)

This section contains 8 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

- Which of the following is correctly ordered :
 (A) $-\text{OH} > -\text{NH}_2$ (+M effect) (B) $-\text{SO}_3\text{H} > -\text{NO}_2$ (–M effect)
 (C) $-\text{F} > -\text{CN}$ (–I effect) (D) $-\text{CN} > -\text{F}$ (–I effect)
- Which of the following compound(s) is/are an aromatic compounds ?

(i)

(ii)

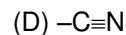
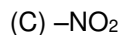
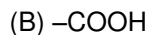
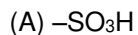
(iii)

(iv)

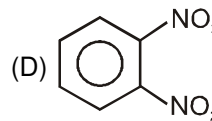
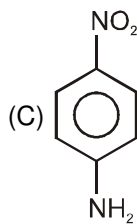
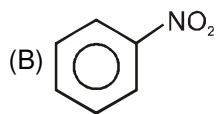
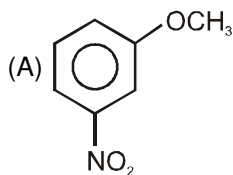
(A) I, II and III
(B) III and IV
(C) IV only
(D) I, III and IV
- Which of the following resonating structure of 1-methoxy-1,3-butadiene is most stable :
 (A) $\overset{\oplus}{\text{CH}}_2 - \text{CH} = \text{CH} - \text{CH} = \overset{\oplus}{\text{O}} - \text{CH}_3$ (B) $\text{CH}_2 = \text{CH} - \overset{\oplus}{\text{CH}} - \text{CH} = \overset{\oplus}{\text{O}} - \text{CH}_3$
 (C) $\text{CH}_2 = \text{CH} - \overset{\oplus}{\text{CH}} - \overset{\oplus}{\text{CH}} - \text{O} - \text{CH}_3$ (D) $\text{CH}_2 = \text{CH} - \overset{\oplus}{\text{CH}} - \overset{\oplus}{\text{CH}} - \text{O} - \text{CH}_3$
- Which of the following has shortest C–Cl bond ?
 (A) $\text{CH}_3\text{--Cl}$ (B) $\text{CH}_2=\text{CH--Cl}$ (C) (D) $\text{CH}_2=\text{CH--CH=CH--Cl}$



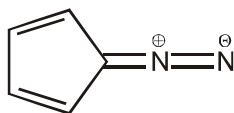
5. Which of the following is strongest-m group



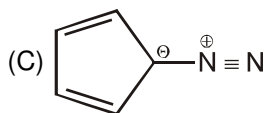
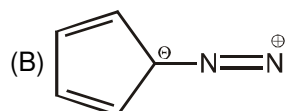
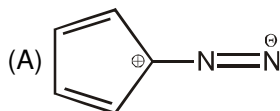
6. In which of the following molecules π -electron density in ring is minimum :



7.

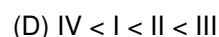
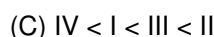
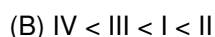
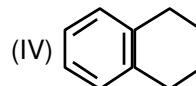
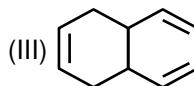
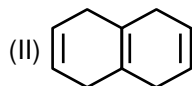
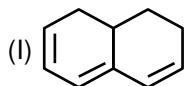


The most stable canonical structure of this molecule is :



(D) All are equally stable

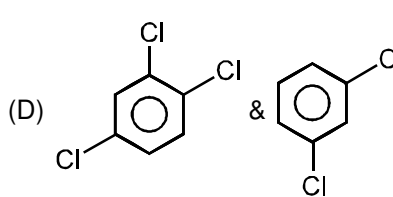
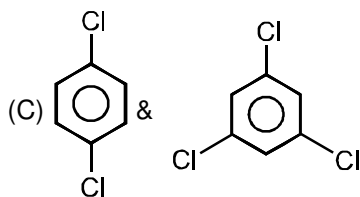
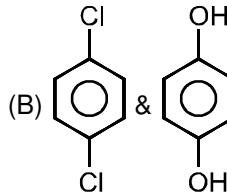
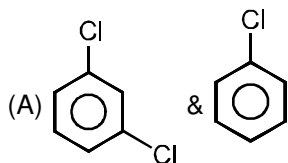
8. Give the correct order of magnitude of heat of hydrogenation of the following :



Section-2 : (One or More than one options correct Type)

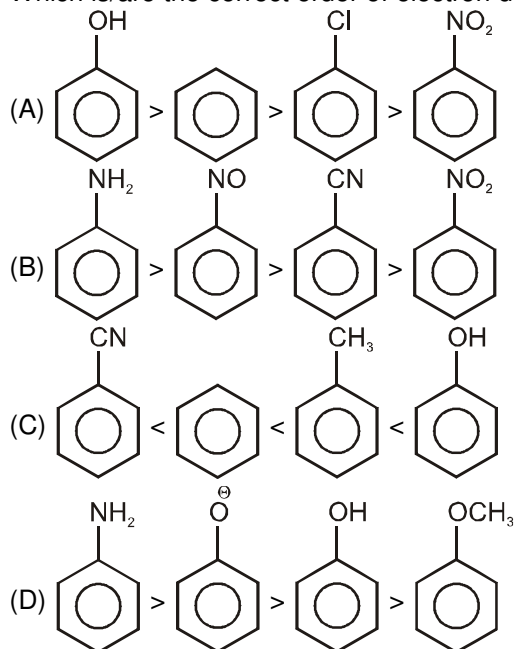
This section contains 6 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

9. Which of the following pairs have same dipole moment

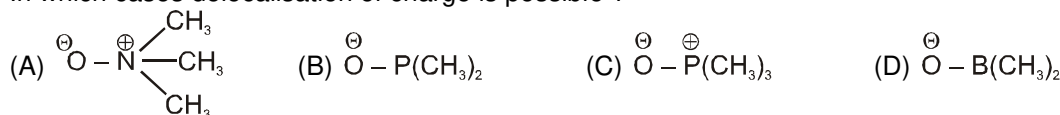




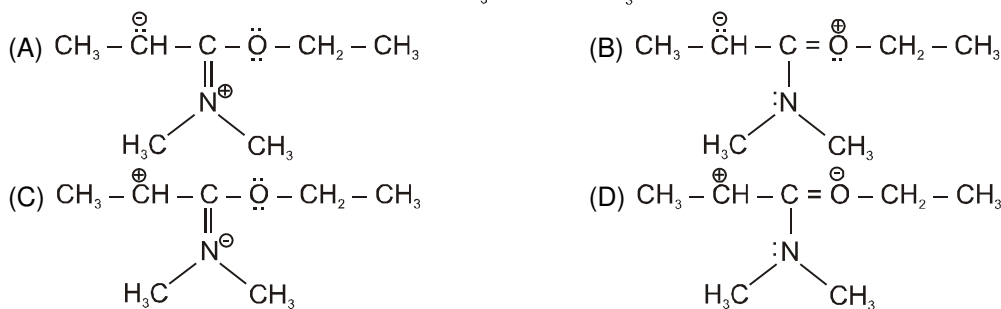
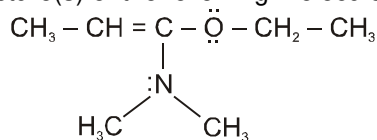
10. Which is/are the correct order of electron density in aromatic ring ?



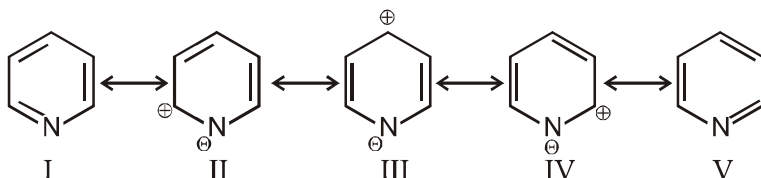
11. In which cases delocalisation of charge is possible ?



12. The acceptable resonating structure(s) of the following molecule is/are :



13.



Among these canonical structures of pyridine, the correct order of stability is/are :

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

14. Which of the following statement is/are correct ?

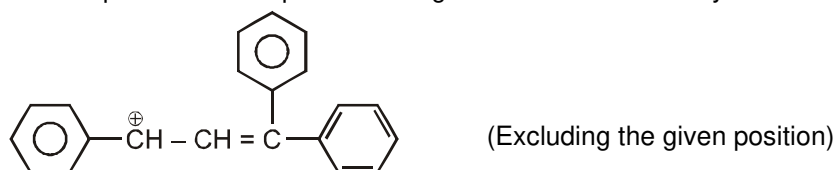
- (A) Contributing structures contributes to the resonance hybrid is directly proportional of their energies.
 (B) Equivalent contributing structures make the resonance important.
 (C) Contributing structures represent hypothetical molecules having no real existence.
 (D) Contributing structures are less stable than the resonance hybrid.



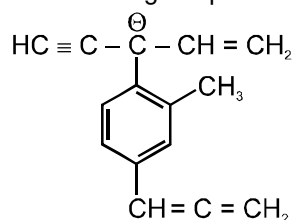
Section-3 : (One Integer Value Correct Type.)

This section contains 3 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

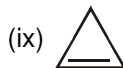
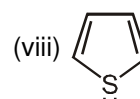
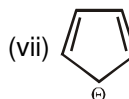
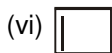
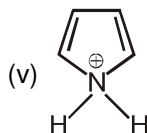
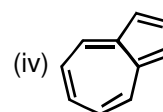
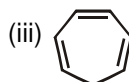
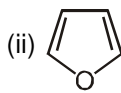
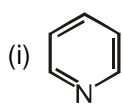
15. Find total number of the position where positive charge can be delocalized by true resonance.



16. Find the number of carbon atoms including the given structure which can have negative charge in resonating structures. (The structures with charge separation are not acceptable)



17. How many species out of the following are aromatic ?



SECTION-4 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

18. Match the column :

	Column – I		Column – II
(P)		(1)	Aliphatic Hydrocarbon
(Q)		(2)	Anti aromatic
(R)		(3)	Aromatic
(S)		(4)	Alicyclic Compound

Code :

	P	Q	R	S		P	Q	R	S
(A)	3	1	4	2	(B)	1	2	4	3
(C)	2	1	3	4	(D)	3	2	1	4



Practice Test-2 ((IIT-JEE (ADVANCED Pattern))
OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18		
Ans.										



APSP Answers

PART – I

1. (1)	2. (3)	3. (4)	4. (3)	5. (4)
6. (3)	7. (4)	8. (2)	9. (3)	10. (2)
11. (1)	12. (3)	13. (2)	14. (3)	15. (4)
16. (1)	17. (4)	18. (3)	19. (3)	20. (1)
21. (3)	22. (4)	23. (3)	24. (1)	25. (3)
26. (3)	27. (2)	28. (2)	29. (3)	30. (4)

PART – II

1. (D)	2. (B)	3. (A)	4. (C)	5. (A)
6. (C)	7. (B)	8. (A)	9. (B)	10. (C)
11. (C)	12. (B)	13. (B)	14. (A)	15. (C)
16. (A)	17. (C)	18. (B)	19. (B)	20. (A)
21. (D)	22. (D)	24. (D)	24. (B)	

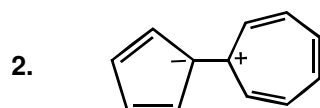
PART - III

1. (D)	2. (D)	3. (B)	4. (C)	5. (C)
6. (D)	7. (C)	8. (C)	9. (ACD)	10. (ABC)
11. (BCD)	12. (AB)	13. (BD)	14. (BCD)	15. 10
16. 7	17. 5 (i, ii, iv, vii, viii)	18. (A)		

APSP Answers

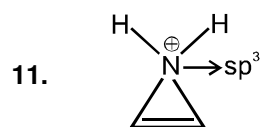
PART – I

1. Stability \propto Number of hyperconjugative H-atoms.



both rings are aromatic so, it will be polar in nature.

3. In (4) negative charge and lone pair on adjacent position.

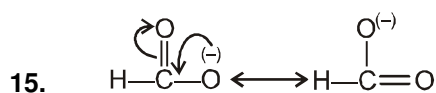
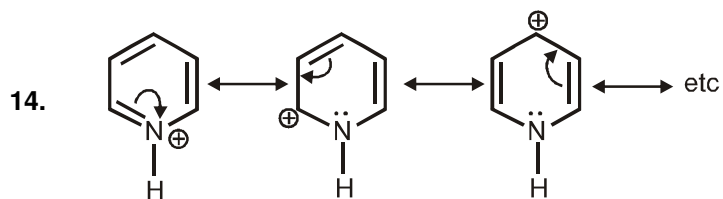


sp^3 , N-atom, nonpolar molecule so, it will be non-aromatic.

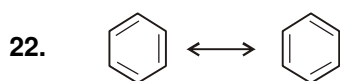


13. Heat of hydrogenation $\propto \frac{1}{\text{stability of alkene}}$.

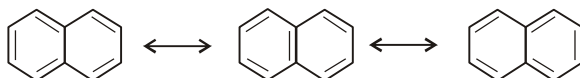
(III & IV have both resonance and hyperconjugation where as I and II have only hyperconjugation.)



In HCOO^- , the two carbon oxygen bonds are of equal length because the anion HCOO^- has two equally stable resonating structures.



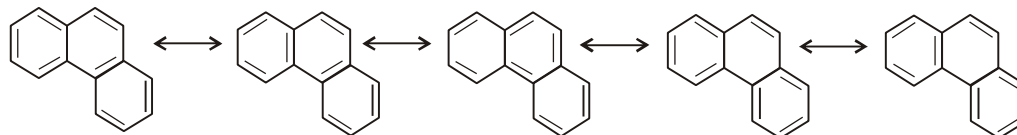
Benzene has two



Naphthalene has three

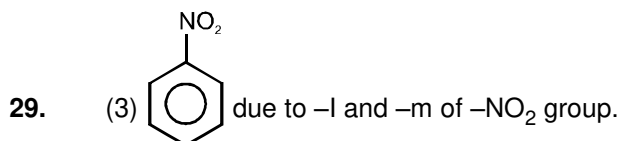


Anthracene has four

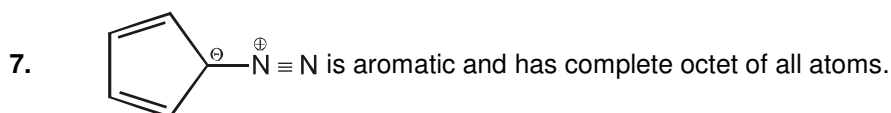


Phenanthrene has five resonating structures

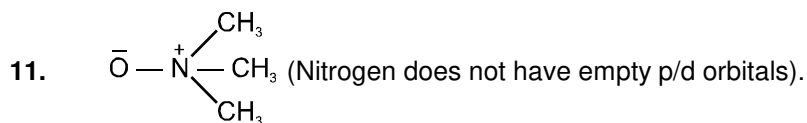
25. Anti aromatic compounds are unstable at room temperature.



PART - III



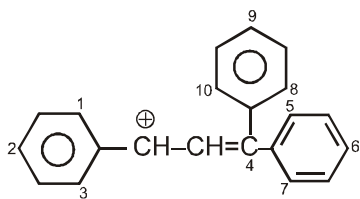
10. On the basis of electronic effect.



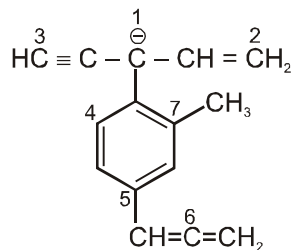
12. A & B are proper resonating structures while C & D violate octet rule.



15.



16.



The negative charge is delocalised on the marked carbon atoms (1 - 7).

17.

Aromatic species are :

