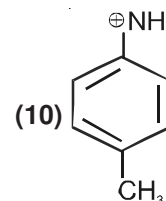
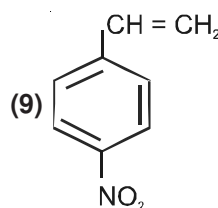
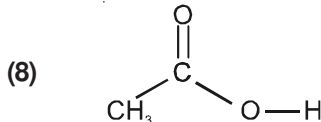
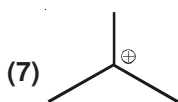
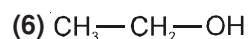
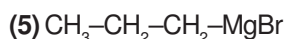
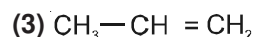
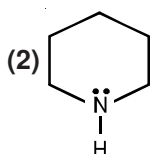
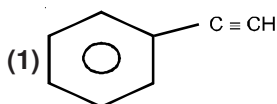


Exercise # 1 First Step towards Concept Building

PART-I : SUBJECTIVE QUESTION

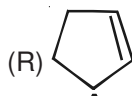
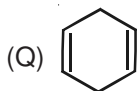
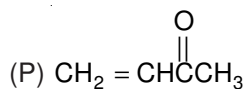
Section (A) : Inductive effect

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

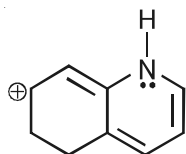


Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

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

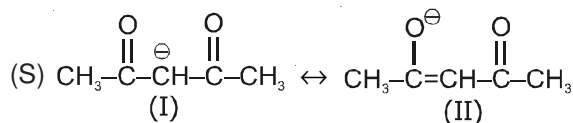
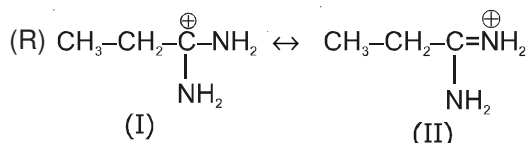
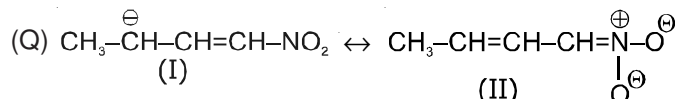
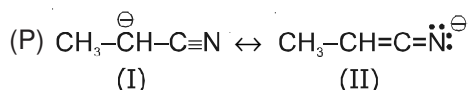


B-2. Number of π electrons in resonance in the following structure is.

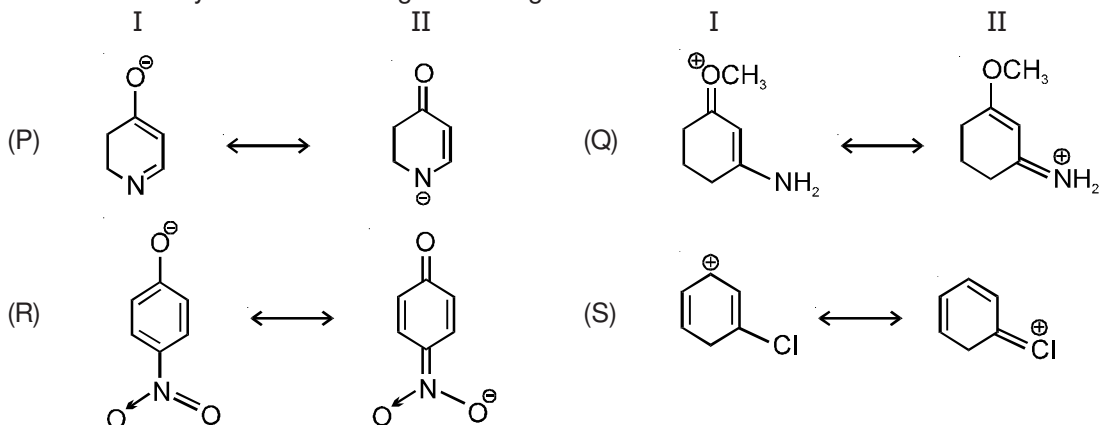


Section (C) : Stability of Resonating Structures and different species

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

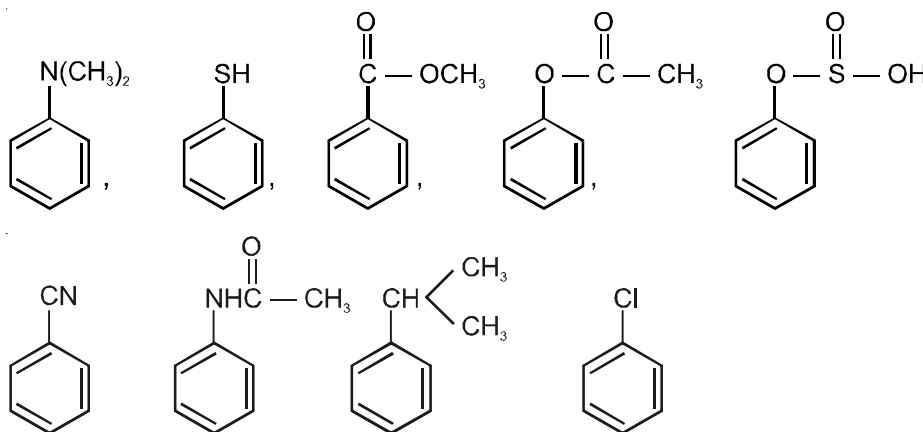
D-1. Arrange the following groups in the increasing order of +M :



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?



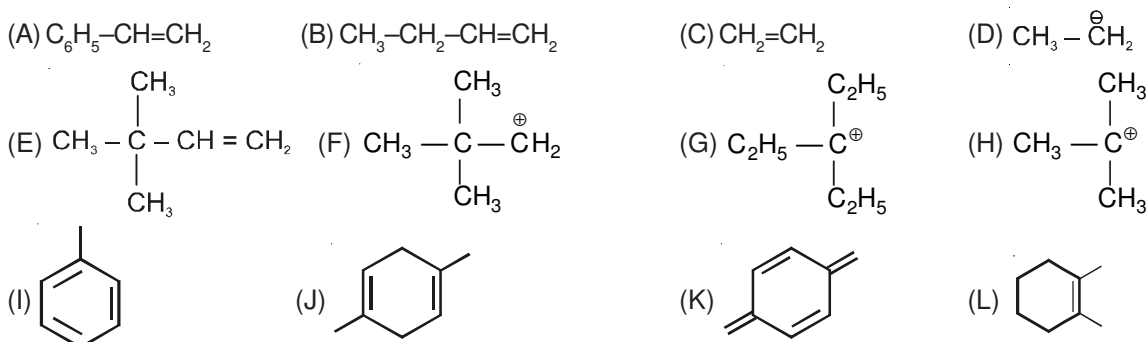
Section (E) : Steric Inhibition of Resonance (SIR Effect)

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.

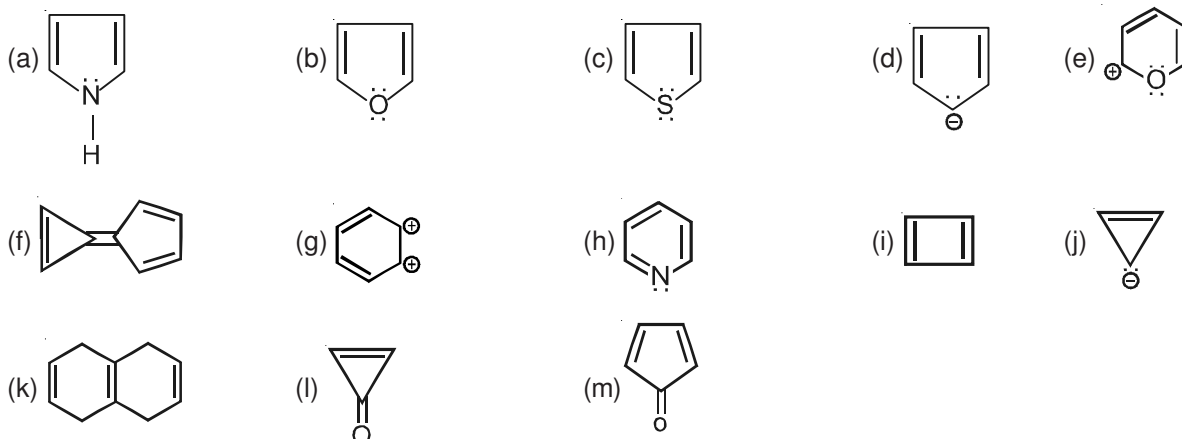
F-2. In which molecules or ions hyperconjugation effect is observed and write the number of hyperconjugable hydrogen atoms.



Section (G) : Concept of Aromaticity

G-1. What is aromaticity ?

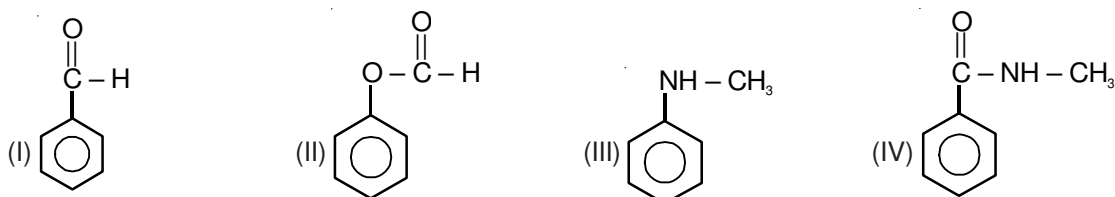
G-2. Classify the following as aromatic, antiaromatic and nonaromatic compounds.



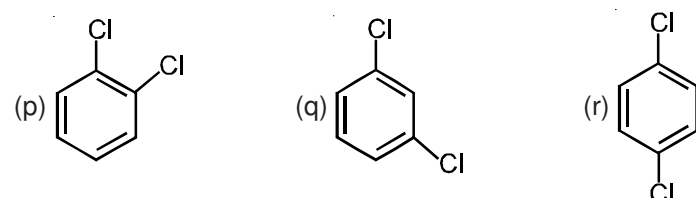
G-3. Why cyclooctatetraene is nonplanar.

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 : OBJECTIVE QUESTION

Section (A) : Inductive effect

A-1. Inductive effect involves :

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

A-2. Select correct statement about I effect?


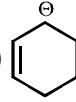
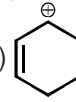
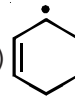
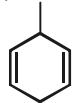



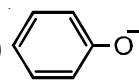
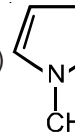
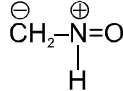
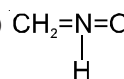
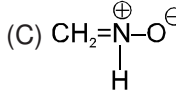
- (A) I effect transfers electrons from one carbon atom to another.
 (B) I effect is the polarisation of σ bond electrons.
 (C) I effect creates net charge in the molecule.
 (D) I effect is distance independent.

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

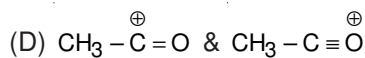
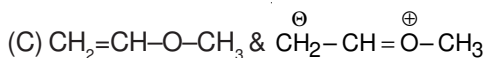
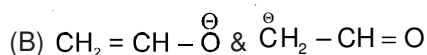
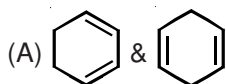
- (A) -Br (B) -COOH (C) -OR (D) -COO⁻

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

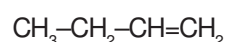
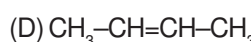
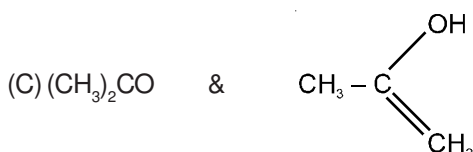
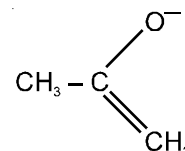
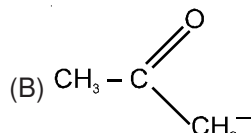
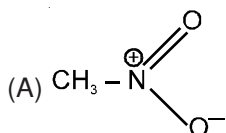
Section (B) : Resonance Concepts, Conditions, Resonating Structures & Conjugation

- B-1.** Resonance is delocalisation of :
 (A) π electrons (B) σ electrons (C) $\sigma-\pi$ electrons (D) None
- B-2.** Resonance involves :
 (A) Delocalization of π -electrons along a conjugated system.
 (B) Delocalization of lone pair along a conjugated system.
 (C) Delocalization of negative charge along a conjugated system.
 (D) All are correct.
- B-3.** During delocalization, which statement is incorrect :
 (A) Net charge remains same (B) Number of paired electrons remain same
 (C) Number of unpaired electrons remain same (D) Energy of resonating structures always remains same
- B-4.** Resonance structure of the molecule does not have
 (A) higher energy than their hybrid structure. (B) identical arrangement of atoms.
 (C) the same number of paired electrons. (D) always equal contribution to the resonance hybrid.
- B-5.** Which of the following species can not show resonance?
 (A)  (B)  (C)  (D) 
- B-6.** Resonance is not possible in :
 (A)  (B)  (C) $\text{CH}_2=\text{CH}-\text{Cl}$ (D) 
- B-7.** Which does not have conjugate system ?
 (A) $\text{CH}_2=\text{CHCl}$ (B) $\text{CH}_2=\text{CHCHO}$ (C) $\text{CH}_3\text{CH}=\text{CH}_2$ (D) 
- B-8.** The compound which is not resonance stabilised
 (A) $\text{CH}_2=\text{CH}-\text{Cl}$ (B)  (C) $\text{CH}_2=\text{CH}-\text{CH}_2\text{Cl}$ (D) 
- B-9.** Which of the following is not acceptable as resonating structure :
 (A)  (B)  (C)  (D) None of these

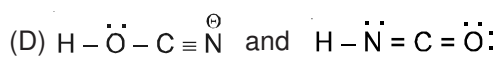
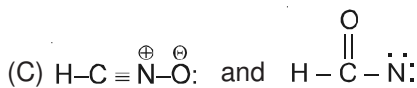
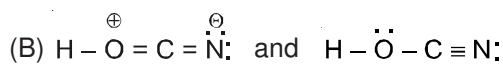
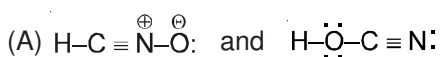
B-10. Which of the following pair is not pair of resonating structures?



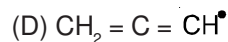
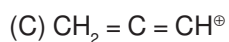
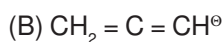
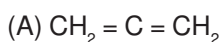
B-11. Which of the following structures are resonance structures ?



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

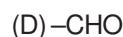
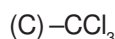
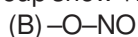
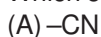


B-13. In which of the following resonance is not possible?

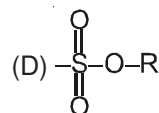
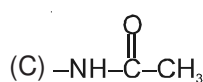
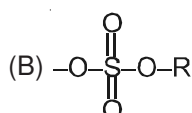
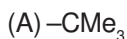


Section (C) : Mesomeric Effect

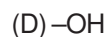
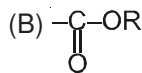
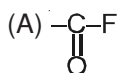
C-1. Which of the following group show +M effect?



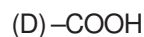
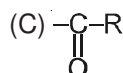
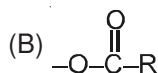
C-2. Which of the following group show -M effect?



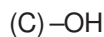
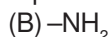
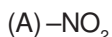
C-3. Which of the following group show +M and -I effect ?



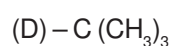
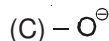
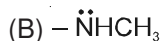
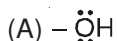
C-4. Which of the following group show +M > -I effect ?



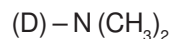
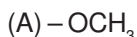
C-5. Which of the following group show -M and -I effect ?



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

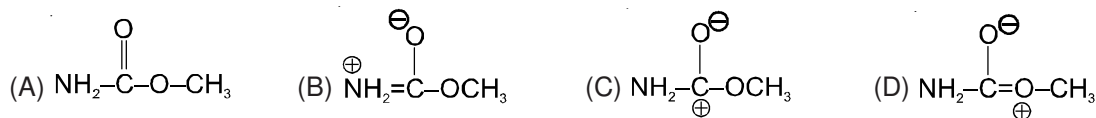


C-7. The weakest +M group of the given species is :

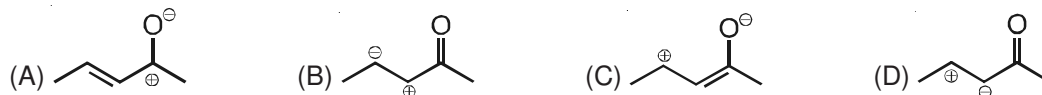


Section (D) : Stability of Resonating Structures and different species

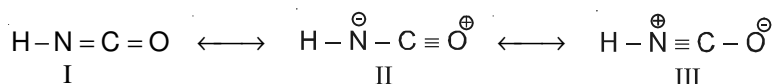
D-1. Which one of the following is least stable resonating structure ?



D-2. Which of the following resonating structure is the least contributing structure ?



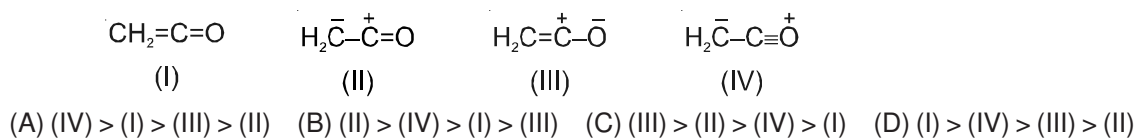
D-3. HNCO (isocyanic acid) has following resonating structures :



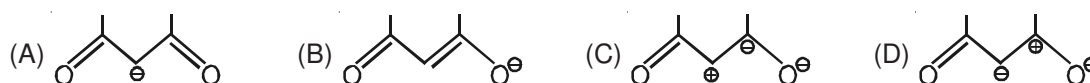
The order of stability is :

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

D-4. The correct stability order of the following resonating structures is :



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

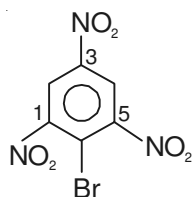


Section (E) : Steric Inhibition of Resonance (SIR Effect)

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



E-2. 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.

Section (F) : Hyperconjugation

F-1. In hyperconjugation there is overlap between :

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

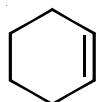
F-2. Which of the following cannot exhibit hyperconjugation -

- (A) $\text{CH}_3\dot{\text{C}}\text{H}_2$ (B) $\begin{matrix} \text{CH}_3 \\ \diagup \\ \text{C}^+ \\ \diagdown \\ \text{CH}_3 \end{matrix}$ (C) $\text{CH}_3\text{CH}=\text{CH}_2$ (D) $(\text{CH}_3)_3\text{C}-\overset{+}{\text{C}}\text{H}_2$

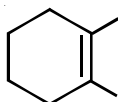
F-3. Which of the following alkenes will show maximum number of hyperconjugation forms ?

- (A) $\text{CH}_2=\text{CH}_2$ (B) $\text{CH}_3-\text{CH}=\text{CH}_2$ (C) $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2$ (D) $\begin{matrix} \text{CH}_3 \\ | \\ \text{CH}_3-\text{CH}-\text{CH}=\text{CH}_2 \end{matrix}$

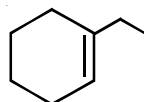
F-4. Arrange the stability of following



I



II



III

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

F-5. Which one of the following has inductive, mesomeric and hyperconjugation effect ?

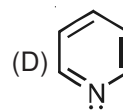
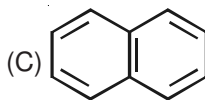
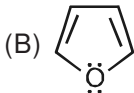
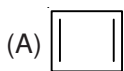
- (A) CH_3Cl (B) $\text{CH}_3-\text{CH}=\text{CH}_2$
 (C) $\text{CH}_3\text{CH}=\text{CH}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ (D) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

F-6. Which of the following group has the maximum hyperconjugation effect when attached to benzene ring ?

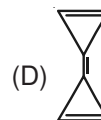
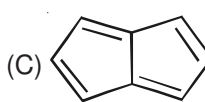
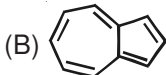
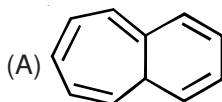
- (A) CH_3- (B) CH_3CH_2- (C) $(\text{CH}_3)_2\text{CH}-$ (D) $(\text{CH}_3)_3\text{C}-$

Section (G) : Concept of Aromaticity

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



G-2. Identify the aromatic compound ?

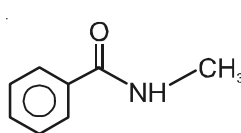


G-3. Aromatic compounds burn with sooty flame because :

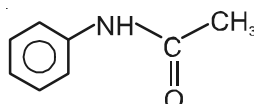
- (A) They have a ring structure of carbon atoms.
 (B) They have a relatively high percentage of hydrogen.
 (C) They resist reaction with oxygen of air.
 (D) They have a relatively high percentage of carbon.

Section (H) : Applications of electronic effect

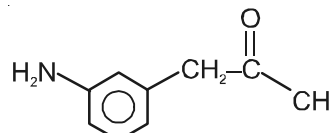
H-1. The decreasing order of electron density on the ring is :



I



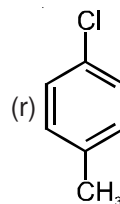
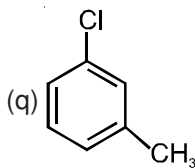
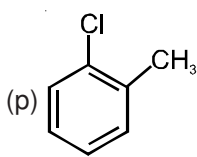
II



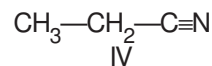
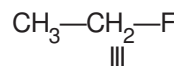
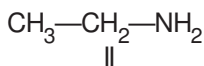
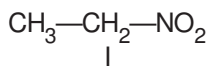
III

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

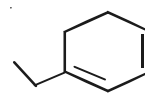
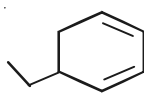
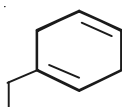
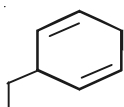
H-2. Correct dipole moment order is

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

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

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

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

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

PART-III : MATCH THE FOLLOWING

1.

Match the following

- Column-I
(Compounds)**
- (A)
- (B) Ph—CH=CH—CH_3
- (C)
- (D)

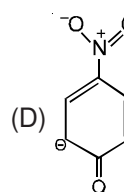
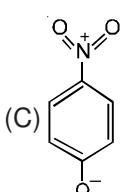
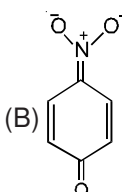
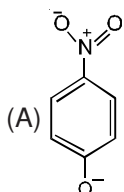
- Column-II
(Characteristics)**
- (p) Mesomeric effect / resonance
- (q) Inductive effect.
- (r) Hyperconjugative effect
- (s) Nonpolar
- (t) Polar

Exercise # 2

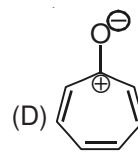
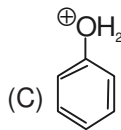
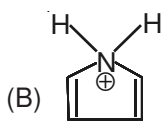
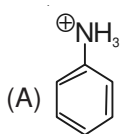
READY FOR CHALLENGES

PART-I : OBJECTIVE QUESTION

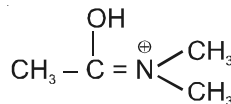
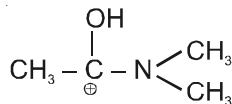
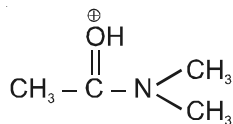
1. The most unlikely representation of resonance structures of p-nitrophenoxide ion is :



2. In which delocalisation of positive charge is possible ?



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



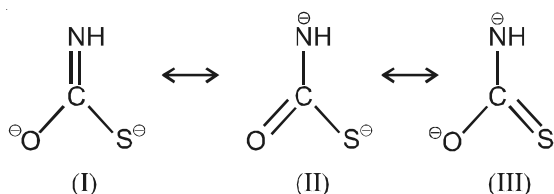
(I)
(A) II > I > III

(II)
(B) I > II > III

(III)
(C) III > II > I

(D) II > III > I

4. Stability order of the following species ?



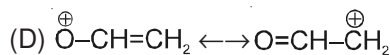
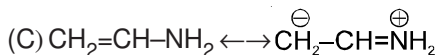
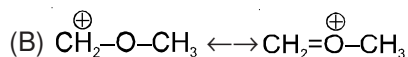
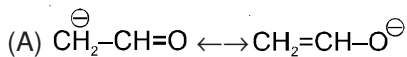
(A) I > II > III

(B) III > I > II

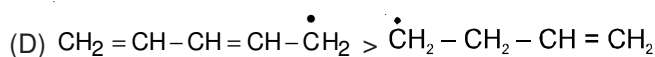
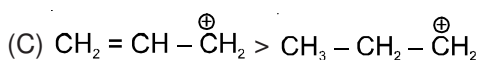
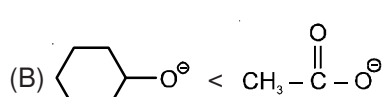
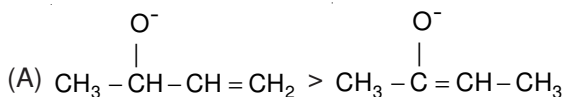
(C) III > II > I

(D) I > III > II

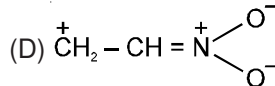
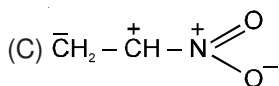
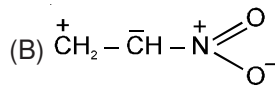
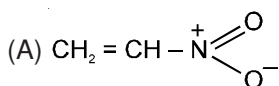
5. In which of the following first resonating structure is more stable than the second ?



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



7. Least contributing resonating structure of nitroethene is :



8. Which of the following statement is correct ?

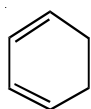
(A) In the dianion , all the C-C bonds are of same length but C-O bonds are of different length

(B) In the dianion, all C-C bonds are of same length and also all C-O bonds are of same lengths

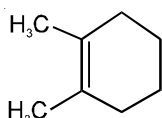
(C) In the dianion, all C-C bond lengths are not of same length

(D) None of the above

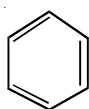
9. The decreasing order of bond length of C=C bond in the following compounds is:



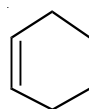
I



II



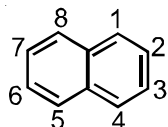
III



IV

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

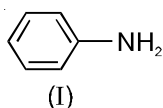
10. Which of the following is correct about the following compound



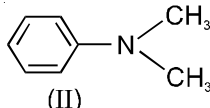
(Naphthalene)

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

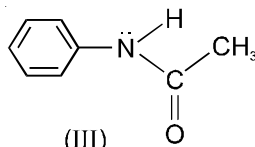
11. The correct order of +M effect of 'N' containing functional group on benzene ring, amongst the given compounds is



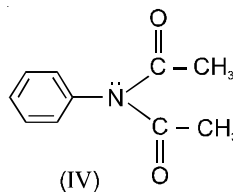
(I)



(II)



(III)



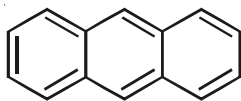
(IV)

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

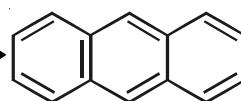
12. In which case the σ -bond pair and π bond pair of electrons both are attracted in the same direction, (towards same atom.) :

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

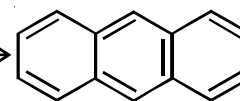
13. The correct stability order of given resonating structures is :



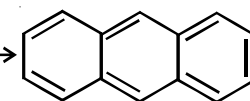
(I)



(II)



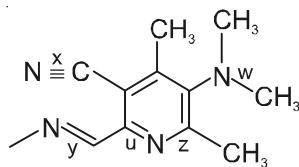
(III)



(IV)

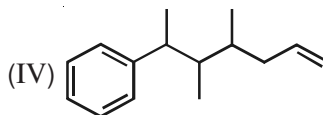
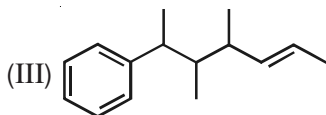
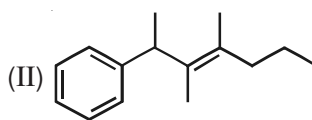
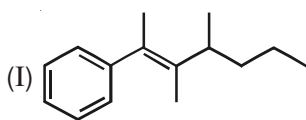
- (A) I > II > III > IV (B) IV > III > II > I (C) I = II = III = IV (D) II = III > I = IV

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



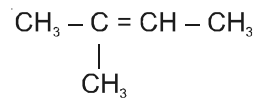
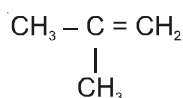
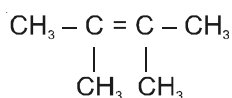
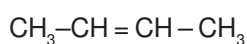
- (A) x (B) y (C) z (D) w

15. Select the correct order of heat of hydrogenation ?



- (A) I > II > III > IV (B) IV > III > II > I (C) II > III > IV > I (D) II > III > I > IV
16. $\text{H}_3\text{C}-\overset{\oplus}{\text{C}}\text{H}-\text{CH}=\text{CH}_2$ 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 :



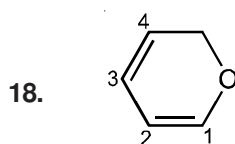
(I)

(II)

(III)

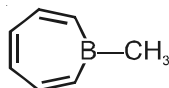
(IV)

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

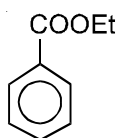


In this molecules, π -electron density is more on :

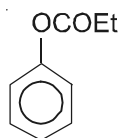
- (A) C_1 and C_3 (B) C_2 and C_4 (C) C_2 and C_3 (D) C_1 and C_4
19. If the given compound is planar. Select the correct statement.



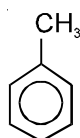
- (A) The boron is sp^2 hybridized and the p-orbital contains an unshared pair of electron
 (B) The boron is sp^2 hybridized and a hybrid orbital contains an unshared pair of electron.
 (C) The boron in sp^2 hybridized and hybrid orbital is vacant
 (D) The boron is sp^2 hybridized and the p-orbital is vacant
20. The correct order of electron density in aromatic ring of following compounds is :



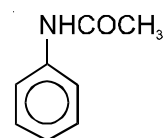
I



II



III



IV

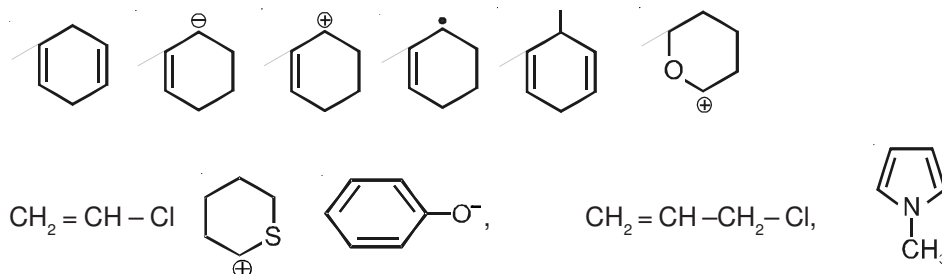
- (A) IV > III > II > I (B) I > II > III > IV (C) IV > II > I > III (D) IV > II > III > I

PART-II : SINGLE AND DOUBLE VALUE INTEGER TYPE

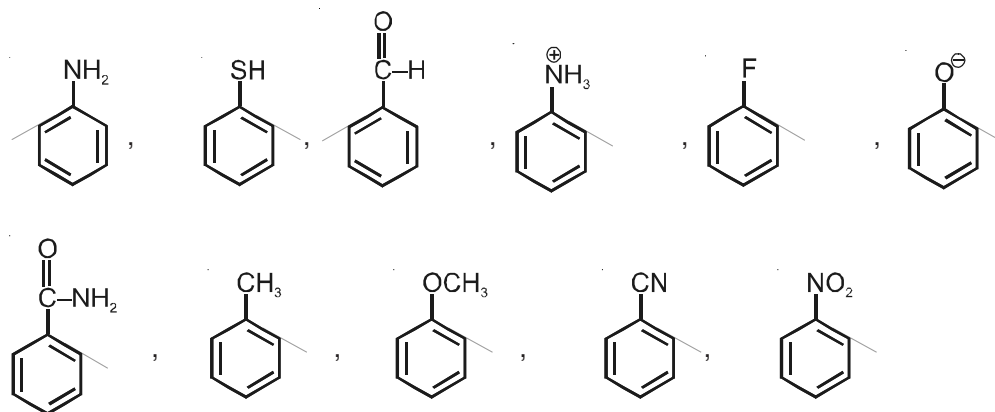
1. Among the given sets, how many of the following not represents the resonating structure :

- (i) $\text{H}-\text{C}\equiv\overset{\oplus}{\text{N}}-\overset{\ominus}{\text{O}}$ and $\text{H}-\text{O}-\text{C}\equiv\text{N}$
- (ii) $\text{H}-\overset{\oplus}{\text{O}}=\text{C}=\overset{\ominus}{\text{N}}$ and $\text{H}-\text{O}-\text{C}\equiv\text{N}$
- (iii) $\text{H}-\text{C}\equiv\overset{\oplus}{\text{N}}-\overset{\ominus}{\text{O}}$ and $\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{N}$
- (iv) $\text{H}-\text{O}-\text{C}\equiv\overset{\ominus}{\text{N}}$ and $\text{H}-\text{N}=\text{C}=\text{O}$
- (v) $\overset{\ominus}{\text{C}}\text{H}_2-\text{CH}=\text{O}$ and $\text{CH}_2=\overset{\oplus}{\text{C}}\text{H}-\text{O}$
- (vi) $\text{CH}_2=\text{CH}-\text{NH}_2$ and $\overset{\ominus}{\text{C}}\text{H}_2-\text{CH}=\overset{\oplus}{\text{N}}\text{H}_2$
- (vii) $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ and $\text{CH}_2=\overset{\text{OH}}{\text{C}}=\text{CH}_3$

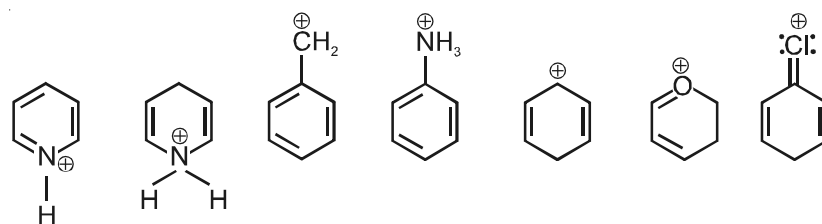
2. How many of the following species can show resonance.



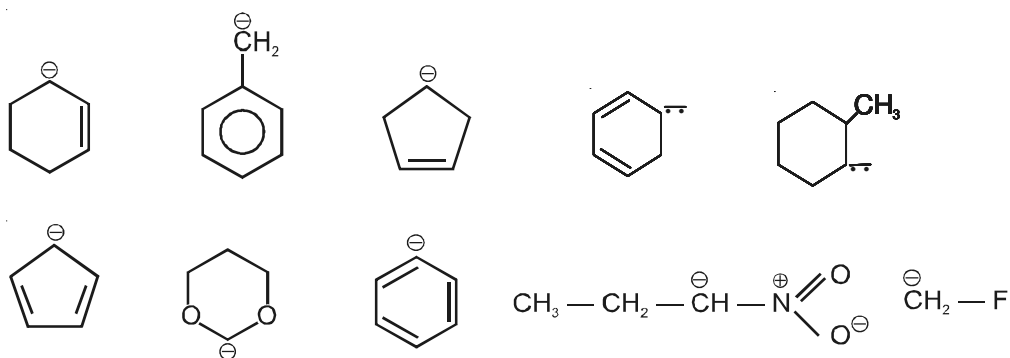
3. How many groups (attached with benzene ring) can show +M effect ?



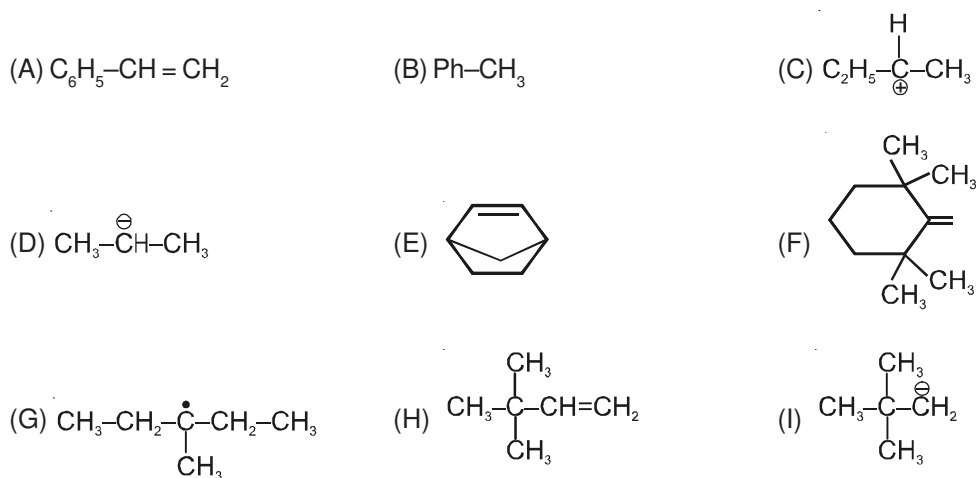
4. Identify the number of compounds in which positive charge will be delocalised ?



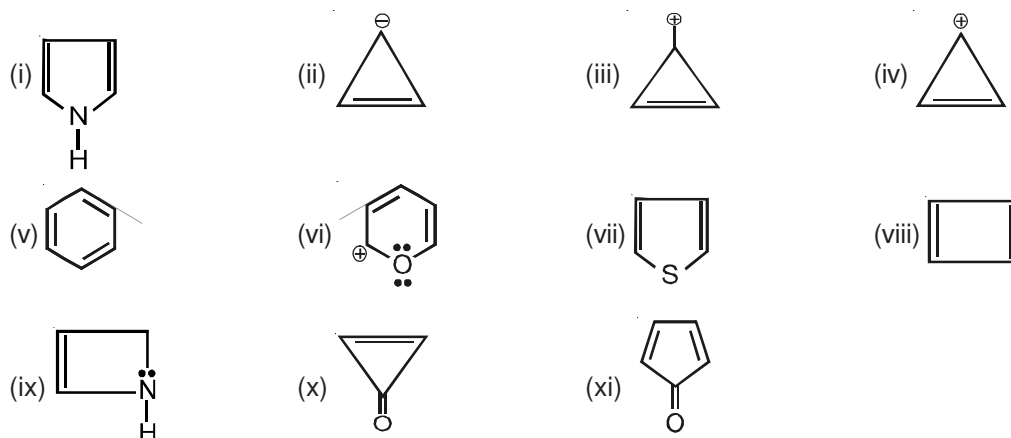
5. In how many of the following cases, the negative charge is delocalised?



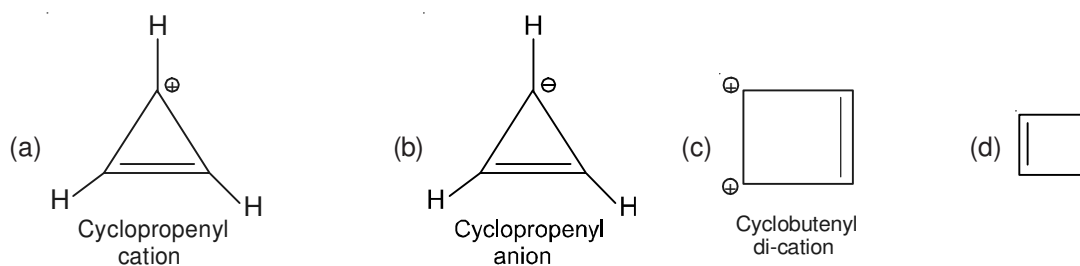
6. In how many of the following compounds Hyperconjugation effect is observed -

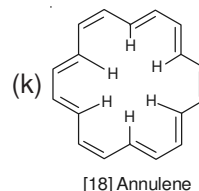
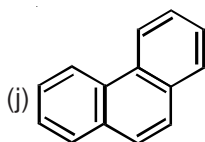
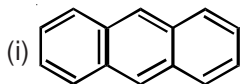
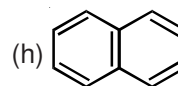
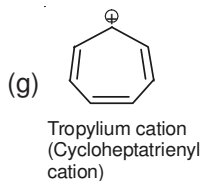
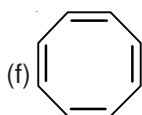
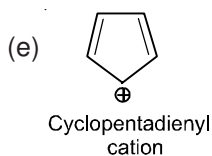


7. How many of the following compounds is/are aromatic ?

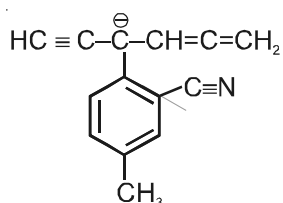


8. Total number of molecules which are antiaromatic ?

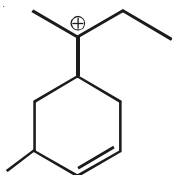




9. Find the number of carbon atoms including the given structure which can have negative change in resonating structures. (The structure with charge repeating are not accepted)



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



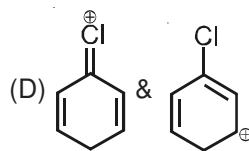
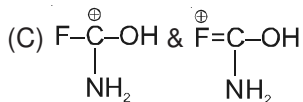
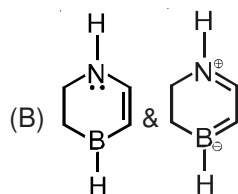
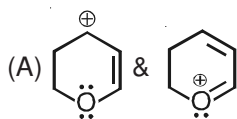
11. Find the total number of positions where positive charge can be delocalized by true resonance



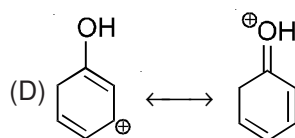
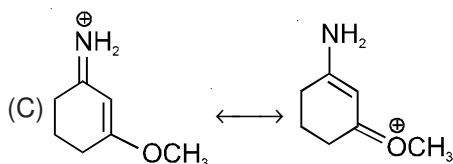
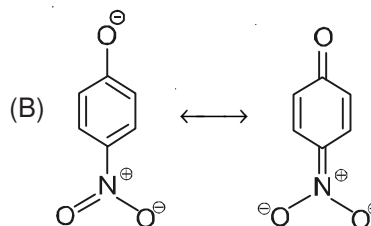
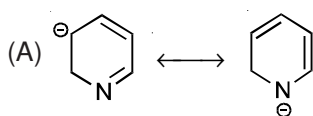
PART-III : MULTIPLE CHOICE QUESTION

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

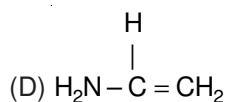
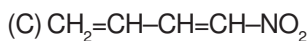
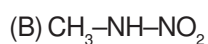
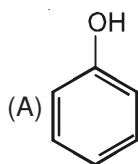
3. In which of the following pairs of compounds, will second structure have more contribution to resonance hybrid than first ?



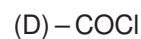
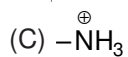
4. In which of the following pairs of resonating structures first resonating structure is more stable than second?



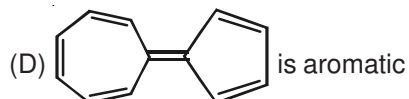
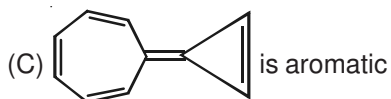
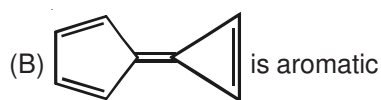
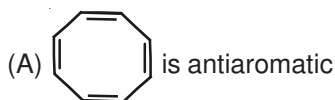
5. In which of the following compounds delocalisation of electrons and shifting of electron in the same direction?



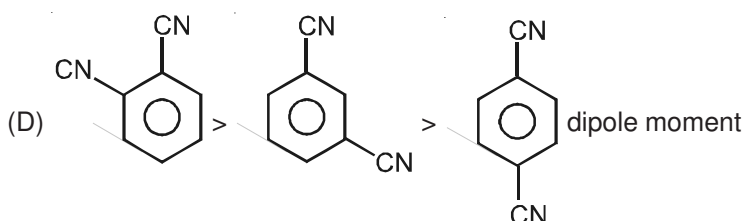
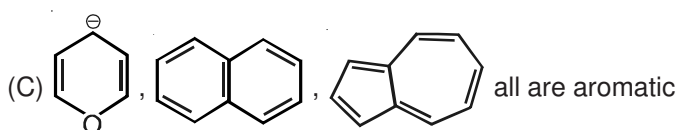
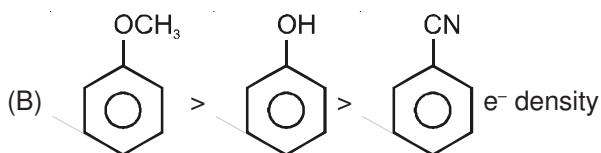
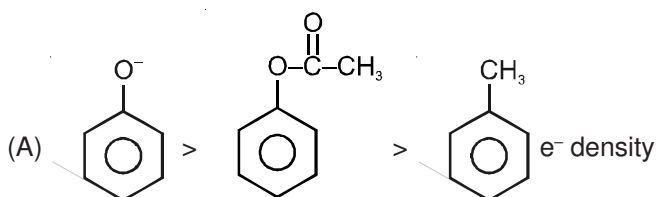
6. Which of the following groups cannot participate in resonance with benzene :



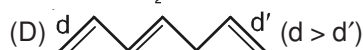
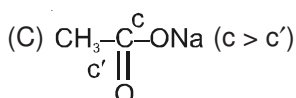
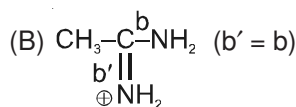
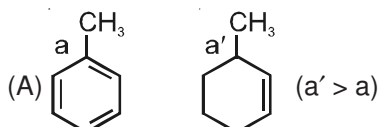
7. Which of the following is/are correct :



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



9. The correct orders for bond length are :



PART-IV : COMPREHENSION

Read the following passage carefully and answer the questions.

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

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

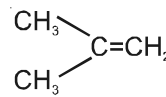
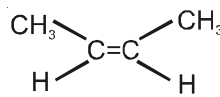
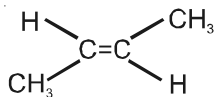
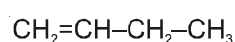
(A) $p > q > r > s$

(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)

(A) $I > II > III > IV$

(B) $II > III > IV > I$

(C) $IV > II > III > I$

(D) $IV > III > II > I$

Exercise # 3

HITTING THE TARGET

PART-I : JEE PROBLEMS (PREVIOUS YEARS)

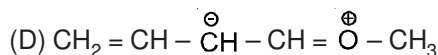
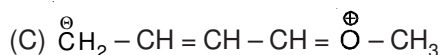
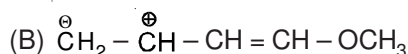
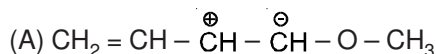
* Marked Questions may have more than one correct option.

1. Write resonating structure of the compound $\text{H}_3\text{C}-\text{CH}=\text{CH}-\text{CH}_2$. [JEE-03(S), 2/60]

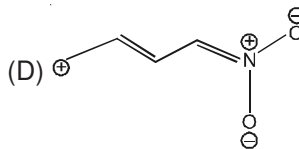
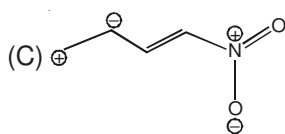
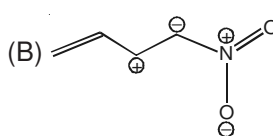
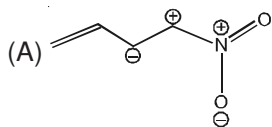


2. Explain why 7-bromo-1, 3, 5-cycloheptatriene exist as an ion while 5-Bromo-1, 3-cyclopentadiene does not form any ion even in the presence of Ag^+ . Explain why? [JEE 2004, 4/60]

3. Which will be the least stable resonating structure : [JEE-05(S), 3/84]

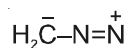
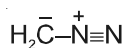
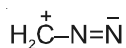
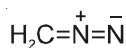


4. Among the following, the least stable resonating structure is : [JEE-07, 3/162]



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]



(I)

(II)

(III)

(IV)

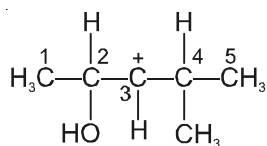
(A) (I) > (II) > (IV) > (III)

(B) (I) > (III) > (II) > (IV)

(C) (II) > (I) > (III) > (IV)

(D) (III) > (I) > (IV) > (II)

7. In the following carbocation; H/ CH_3 that is most likely to migrate to the positively charged carbon is



[JEE-09, 3/160]

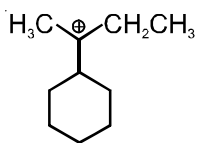
(A) CH_3 at C-4

(B) H at C-4

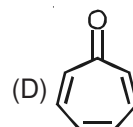
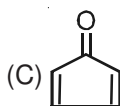
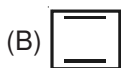
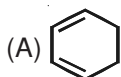
(C) CH_3 at C-2

(D) H at C-2

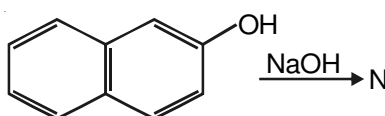
8. The total number of contributing structures showing hyperconjugation (involving C–H bonds) for the following carbocation is [JEE-11, 4/180]



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



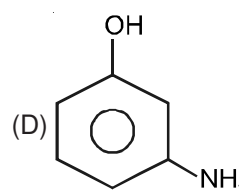
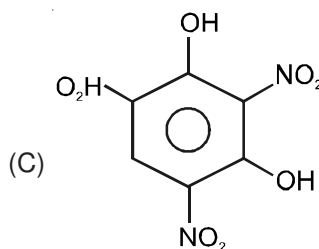
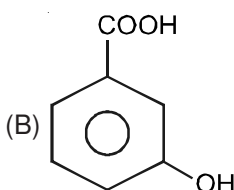
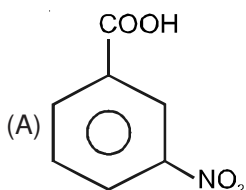
10. Find the number of resonance structures for N. [IIT-2013]



PART-II : AIEEE PROBLEMS (PREVIOUS YEARS)

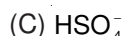
1. Picric acid is

[JEE MAIN-2002]

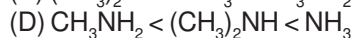
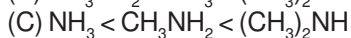
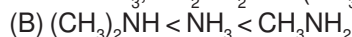


2. Which of the following species acts both as bronsted acid and base ?

[JEE MAIN-2002]

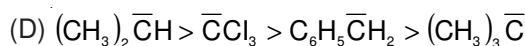
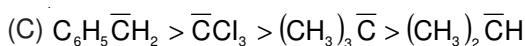
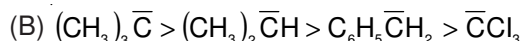
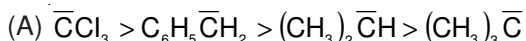


3. The correct order of increasing basic nature for the bases NH_3 , CH_2NH_2 and $(\text{CH}_3)_2\text{NH}$ is



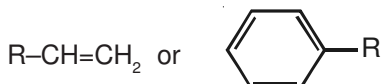
4. Arrange the carbanions, $(\text{CH}_3)_3\text{C}^-$, CCl_3^- , $(\text{CH}_3)_2\text{CH}^-$, $\text{C}_6\text{H}_5\text{CH}_2^-$, in order of their decreasing stability

[JEE MAIN-2002]



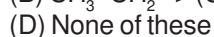
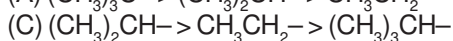
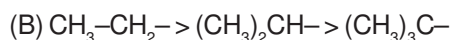
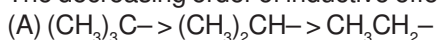
5. In the following benzyl/allyl system

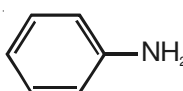
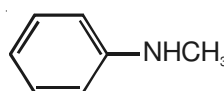
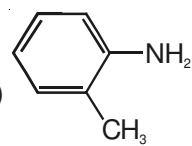
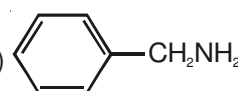
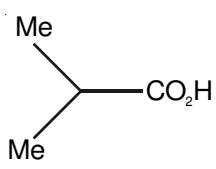
[JEE MAIN-2002]



(R is alkyl group)

The decreasing order of inductive effect is



6. Consider the acidity of the carboxylic acids; [JEE MAIN-2003]
 (i) Ph-COOH (ii) o-NO₂C₆H₄COOH (iii) p-NO₂C₆H₄COOH (iv) m-NO₂C₆H₄COOH
 Which of the following is the correct order of acidity ?
 (A) i > ii > iii > iv (B) ii > iv > iii > i (C) ii > iv > i > iii (D) ii > iii > iv > i
7. In the anion HCOO⁻, the two carbon-oxygen bonds are found to be of equal length. What is the reason for it? [JEE MAIN-2003]
 (A) Electronic orbits of carbon atoms are hybridised
 (B) The C=O bond is weaker than the C-O bond
 (C) The anion HCOO⁻ has two resonating structures
 (D) The anion is obtained by removal of a proton from the acid molecule
8. Which one of the following does not have sp² hybridised carbon ? [JEE MAIN-2004]
 (A) Acetamide (B) Acetic acid (C) Acetonitrile (D) Acetone
9. Which of the following is the strongest base ? [JEE MAIN-2004]
- (A)  (B)  (C)  (D) 
10. Among the following acids which has the lowest pK_a value ? [JEE MAIN-2005]
 (A) CH₃CH₂COOH (B) (CH₃)₂CHCOOH (C) HCOOH (D) CH₃COOH
11. Amongst the following, the most basic compound is : [JEE MAIN-2005]
 (A) p-nitroaniline (B) Acetanilide (C) Aniline (D) Benzylamine
12. What is the conjugate base of OH⁻ ? [JEE MAIN-2005]
 (A) H₂O (B) O₂ (C) O₂⁻ (D) O⁻
13. Among the following acids which has the lowest pK_a value ? [JEE MAIN-2005]
 (A) HCOOH (B) CH₃COOH (C) CH₃CH₂COOH (D) (CH₃)₂CH-COOH
14. Due to the presence of an unpaired electron, free radicals are [JEE MAIN-2005]
 (A) Chemically inactive (B) Chemically ractive
 (C) Cations (D) Anions
15. The increasing order of stability of the following free radicals is [JEE MAIN-2006]
 (A) (C₆H₅)₃Ċ < (C₆H₅)₂ĊH < (CH₃)₃Ċ < (CH₃)₂ĊH
 (B) (C₆H₅)₃ĊH < (C₆H₅)₂Ċ < (CH₃)₃Ċ < (CH₃)₂ĊH
 (C) (CH₃)₂ĊH < (CH₃)₃Ċ < (C₆H₅)₃Ċ < (C₆H₅)₂ĊH
 (D) (CH₃)₂ĊH < (CH₃)₃Ċ < (C₆H₅)₂ĊH < (C₆H₅)₃Ċ
16. The correct order of increasing acid strength of the compounds is [JEE MAIN-2006]
- (a) CH₃CO₂H (b) MeOCH₂CO₂H (c) CF₃CO₂H (d) 
- (A) d < a < c < b (B) d < a < b < c (C) a < d < c < b (D) b < d < a < c

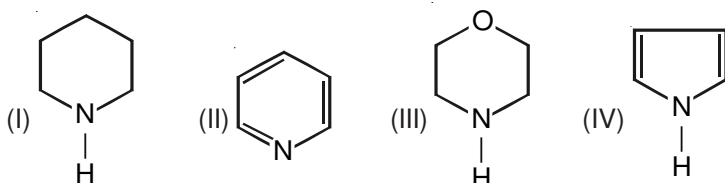
17. Which one of the following is the strongest bases in aqueous solution ? [JEE MAIN-2007]
 (A) Trimethyl amine (B) Aniline (C) Dimethylamine (D) Methylamine
18. The correct order of increasing basicity of the given conjugate base ($R=CH_3$) is [JEE MAIN-2010]
 (A) $RCOO^- < HC \equiv \bar{C} < \bar{N}H_2 < R^-$ (B) $RCOO^- < HC \equiv \bar{C} < R^- < \bar{N}H_2$
 (C) $R^- < HC \equiv \bar{C} < RCOO^- < \bar{N}H_2$ (D) $RCOO^- < \bar{N}H_2 < HC \equiv \bar{C} < R^-$
19. The strongest acid amongst the following compounds is [JEE MAIN-2011]
 (A) $CH_3CH_2CH(Cl)CO_2H$ (B) $ClCH_2CH_2CH_2COOH$
 (C) CH_3COOH (D) $HCOOH$

20. The correct order of acidic strength of the following compounds is [JEE MAIN-2011]
 (a) Phenol (b) p-Bresol (c) m-Mitrophenol (d) p-Nitrophenol
 (A) $c > b > a > d$ (B) $d > c > a > b$ (C) $b > d > a > c$ (D) $a > b > d > c$

21. The non-aromatic compound among the following is [JEE MAIN-2011]



22. In the following compounds :

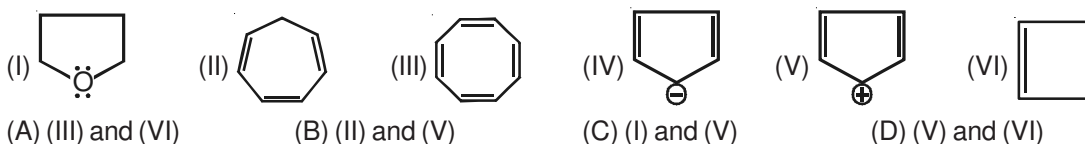


the order of basicity is as follows:

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

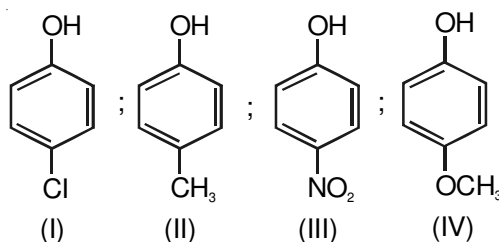
23. The most basic compound among the following is [JEE MAIN-2012]
 (A) Acetanilide (B) Benzylamine (C) p-Nitroaniline (D) Aniline

24. Which of the following compounds are antiaromatic? [JEE MAIN-2012(online)]



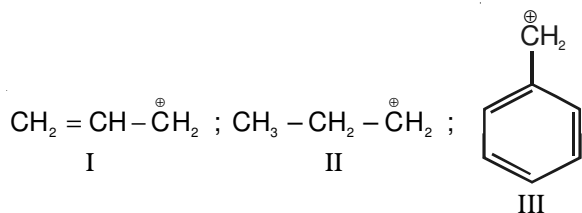
25. The order of basicity of amines in gaseous state is [JEE MAIN-2013]
 (A) $3^\circ > 2^\circ > NH_3 > 1^\circ$ (B) $1^\circ > 2^\circ > 3^\circ > NH_3$ (C) $NH_3 > 1^\circ > 2^\circ > 3^\circ$ (D) $3^\circ > 2^\circ > 1^\circ > NH_3$

26. Arrange the following compounds in order of decreasing acidity [JEE MAIN-2013]




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


27. The order of stability of the following carbocations: [JEE MAIN-2013]

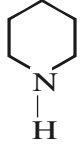


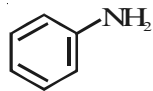

- (A) III > II > I (B) II > III > I (C) I > II > III (D) III > I > II
28. The conjugate base of hydrazoic acid is [JEE MAIN-2014]
 (A) HN_3^- (B) N_3^- (C) N_2^- (D) N_3^-
29. Which one of the following compounds will not be soluble in sodium bicarbonate ? [JEE MAIN-2014]
 (A) Benzene sulphonic acid (B) Benzoic acid
 (C) o-Nitrophenol (D) 2, 4, 6-Trinitrophenol
30. Considering the basic strength of amines in aqueous solution, which one the smallest pK_b value ? [JEE MAIN-2014]
 (A) $(\text{CH}_3)_3\text{N}$ (B) $\text{C}_6\text{H}_5\text{NH}_2$ (C) $(\text{CH}_3)_2\text{NH}$ (D) CH_3NH_2
31. Among the following oxoacids, the correct decreasing order of acid strength is [JEE MAIN-2014]
 (A) $\text{HClO}_4 > \text{HClO}_3 > \text{HClO}_2 > \text{HOCl}$ (B) $\text{HClO}_2 > \text{HClO}_4 > \text{HClO}_3 > \text{HOCl}$
 (C) $\text{HOCl} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$ (D) $\text{HClO}_2 > \text{HOCl} > \text{HClO}_2 > \text{HClO}_3$


PART-III : NEET PROBLEMS (PREVIOUS YEARS)


1. The hybridisation of carbons in 1,3-Butadiene is :- [RPMT-2010]
 (1) sp^2 (2) sp , sp^3 (3) sp^2 , sp^3 (4) sp , sp^2 , sp^3
2. Which of the following is the strongest base :- [RPMT-2010]
 (1) $\text{C}_6\text{H}_5\text{NH}_2$ (2) $m\text{-NO}_2\text{C}_6\text{H}_4\text{NH}_2$ (3) $p\text{-NO}_2\text{C}_6\text{H}_4\text{NH}_2$ (4) $\text{C}_6\text{H}_5\text{-CH}_2\text{-NH}_2$
3. The strongest base among the following is :- [AIIMS-2004]
- (1) 

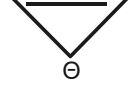
(2) 

(3) 

(4) 
4. Among the following the dissociation constant is highest for [AIIMS-2004]
 (1) $\text{C}_6\text{H}_5\text{OH}$ (2) $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$ (3) $\text{CH}_3\text{C}\equiv\text{CH}$ (4) $\text{CH}_3\text{NH}_3^+ \text{Cl}^-$
5. Among the following the aromatic compound is [AIIMS-2004]
- (1) 

(2) 

(3) 

(4) 
6. Which of the following compounds has the highest boiling point – [AIIMS-2006]
 (1) $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$ (2) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$ (3) $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}$ (4) $(\text{CH}_3)_3\text{CCl}$

7. Which amongst the following is the most stable carbocation :- [AIPMT-2005]



8. Which one of the following compounds is most acidic :- [AIPMT-2005]



9. Pyridine is less basic than triethylamine because [AIIMS-2005]

- (1) Pyridine has aromatic character (2) Nitrogen in pyridine is sp^2 hybridized
 (3) Pyridine is a cyclic system (4) In pyridine, lone pair of nitrogen is delocalized

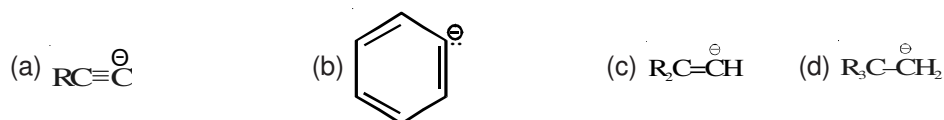
10. Which of the following is more basic than aniline [AIPMT-2006]

- (1) Diphenyl amine (2) Triphenyl amine
 (3) p-nitro aniline (4) Benzyl amine

11. Which of the following presents the correct order of the acidity in the given compounds : [AIPMT-2007]

- (1) $\text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
 (2) $\text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
 (3) $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
 (4) $\text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH}$

12. The stability of carbanions in the following:-

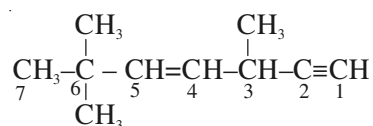


is in the order of:-

[AIPMT-2008]

- (1) (d) > (b) > (c) > (a) (2) (a) > (c) > (b) > (d) (3) (a) > (b) > (c) > (d) (4) (b) > (c) > (d) > (a)

13. The state of hybridization of C_2 , C_3 , C_5 and C_6 of the hydrocarbon,



is in the following sequence :-

[AIPMT-2009]

- (1) sp , sp^2 , sp^3 and sp^2 (2) sp , sp^3 , sp^2 and sp^3
 (3) sp^3 , sp^2 , sp^2 and sp (4) sp , sp^2 , sp^2 and sp^3

14. Which one of the following compounds has the most acidic nature ? [AIPMT-2010]



15. Given are cyclohexanol (I), acetic acid (II), 2, 4, 6-trinitrophenol (III) and phenol (IV). In these the order of decreasing acidic character will be :- [AIPMT-2010]

(1) III > IV > II > I (2) III > II > IV > I (3) II > III > I > IV (4) II > III > IV > I

16. Among the following four compounds :- [AIPMT (Main)-2010]

(a) phenol (b) methyl phenol (c) metanitrophenol (d) paranitrophenol,

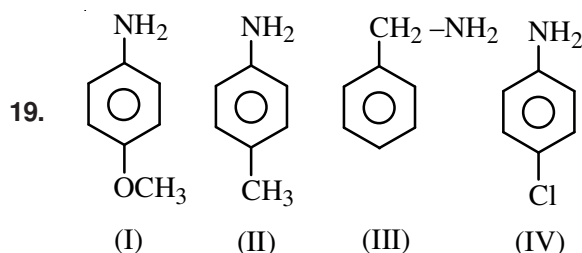
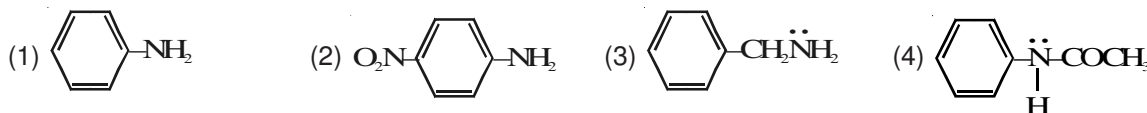
The acidity order is :

(1) c > d > a > b (2) c > d > c > b (3) b > a > c > d (4) d > c > a > b

17. Which of the following species is not electrophilic in nature :- [AIPMT (Main)-2010]

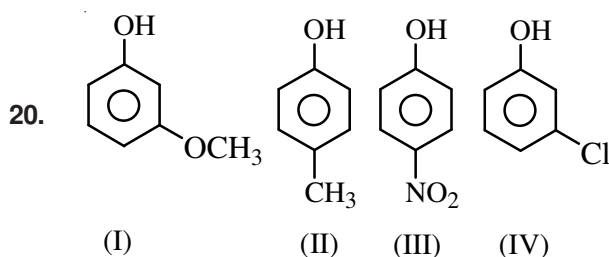
(1) BH₃ (2) H₃O⁺ (3) NO₂⁺ (4) Cl⁺

18. Which of the following compounds is most basic ? [AIPMT Mains -2011]



The correct decreasing order of pK_b is:-

(1) I > II > III > IV (2) III > IV > II > I (3) II > III > IV > I (4) IV > II > I > III [AIIMS-2011]



The correct decreasing order of pK_a is:-

(1) II > IV > I > III (2) IV > II > III > I (3) III > II > IV > I (4) IV > I > II > III [AIIMS-2011]

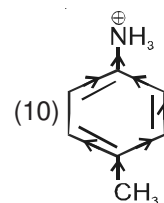
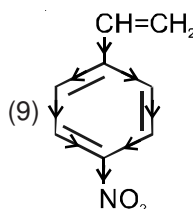
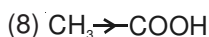
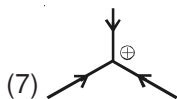
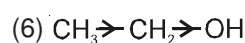
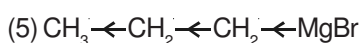
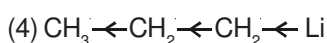
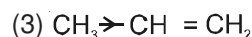
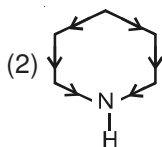
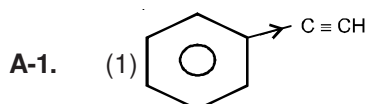
21. The correct order of decreasing acid strength of trichloroacetic acid (A), trifluoroacetic acid (B), acetic acid (C) and formic acid (D) is: [AIPMT Pre.-2012]

(1) A > B > C > D (2) A > C > B > D (3) B > A > D > C (4) B > D > C > A

ANSWER KEY

Exercise # 1 First Step towards Concept Building

PART-I : SUBJECTIVE QUESTION



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

B-2. 8

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

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

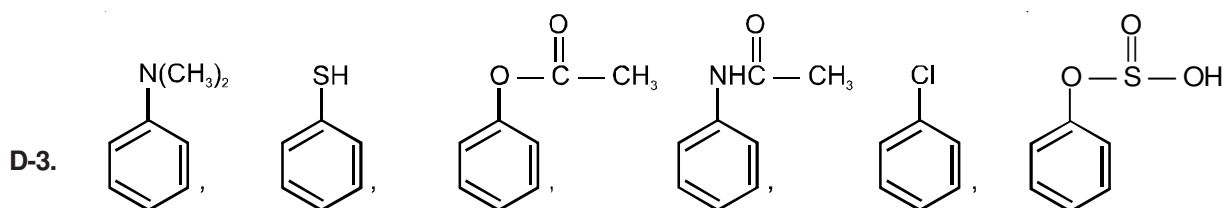
C-2. (P) I > II ; (Q) II > I ; (R) I > II ; (S) II > I

D-1. (i) +m : -I < -Br < -Cl < -F

(ii) +m : -OH < -NH₂ < -O[⊖]

D-2. (i) -m : -COOR < -COR < CHO < CN < NO₂

(ii) -m : $\text{C}(=\text{O})\text{O}^- < \text{C}(=\text{O})\text{NH}_2 < \text{C}(=\text{O})\text{F}$

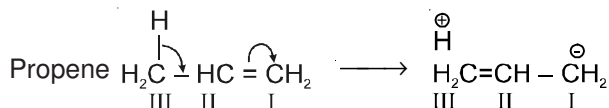


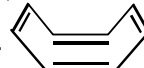
have + M group.

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

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

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



- 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 $n = 0, 1, 2, 3, 4$
- 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 : OBJECTIVE QUESTION

- | | | | | |
|-----------|-----------|-----------|-----------|----------|
| 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. (B) |
| C-2. (D) | C-3. (D) | C-4. (B) | C-5. (A) | C-6. (C) |
| C-7. (C) | D-1. (C) | D-2. (B) | D-3. (A) | D-4. (D) |
| D-5. (B) | E-1. (C) | E-2. (C) | F-1. (D) | F-2. (D) |
| F-3. (B) | F-4. (C) | F-5. (C) | F-6. (A) | G-1. (C) |
| G-2. (B) | G-3. (D) | H-1. (A) | H-2. (B) | H-3. (D) |
| H-4. (A) | | | | |

PART-III : MATCH THE COLUMN

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

Exercise # 2

READY FOR CHALLENGES

PART-I : OBJECTIVE QUESTION

- | | | | | |
|---------|---------|---------|---------|---------|
| 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 : SINGLE AND DOUBLE VALUE INTEGER TYPE

- | | | |
|---|---|-------------------------|
| 1. 5 (i, iii, iv, v, vii) | 2. 8 (ii, iii, iv, vi, vii, viii, ix, xi) | 3. 5 (i, ii, v, vi, ix) |
| 4. 5 (i, iii, v, vi, 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 : MULTIPLE CHOICE QUESTION

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

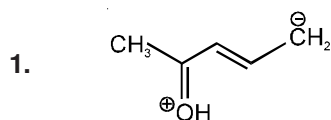
PART-IV : COMPREHENSION

1. (B) 2. (C)

Exercise # 3

HITTING THE TARGET

PART-I : JEE PROBLEMS (PREVIOUS YEARS)



2. 7-bromo-1, 3, 5-cycloheptatriene on ionisation gives tropylium ion which is aromatic & highly stable, but ionisation of 5-bromo-1, 3-cyclopentadiene gives 1, 3-cyclopentadienyl cation which is anti aromatic & unstable. (non existent)

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

PART-II : AIEEE PROBLEMS (PREVIOUS YEARS)

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

PART-III : NEET PROBLEMS (PREVIOUS YEARS)

| | | | | | | | | | | | | | | | |
|-------------|----|----|----|----|----|----|---|---|---|----|----|----|----|----|----|
| Que. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Ans. | 1 | 4 | 3 | 4 | 1 | 2 | 3 | 1 | 2 | 4 | 3 | 3 | 2 | 3 | 2 |
| Que. | 16 | 17 | 18 | 19 | 20 | 21 | | | | | | | | | |
| Ans. | 4 | 2 | 3 | 4 | 1 | 3 | | | | | | | | | |