

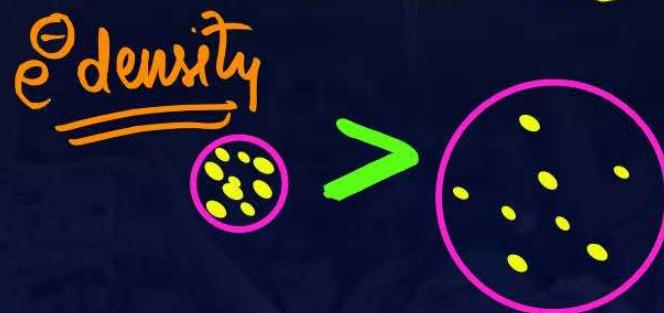


General Introduction



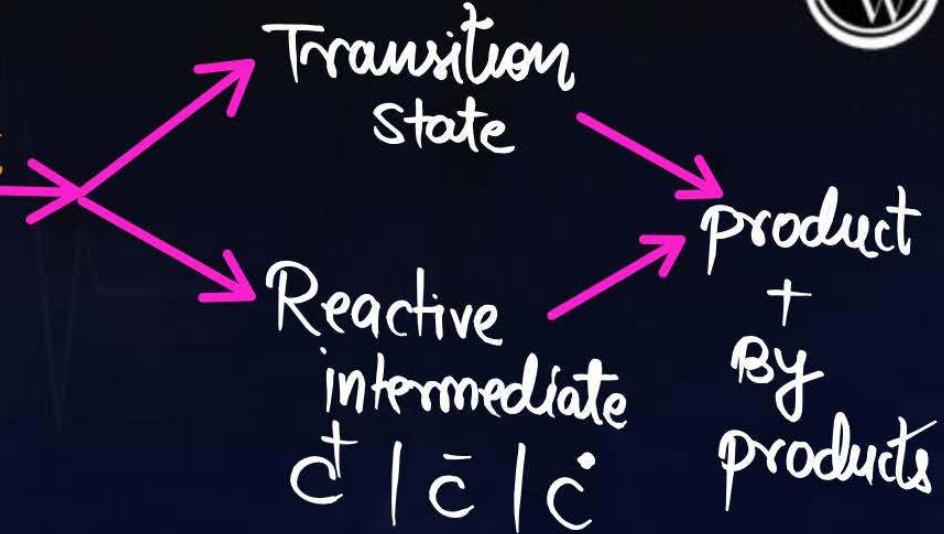
SARA KHEL ELECTRON DENSITY KA HAI

charge density \propto charge
size



Basics of any Organic Reaction

Reactant + Reagent $\xrightarrow{\text{solvent}}$



Organic Chemistry ka PANJA

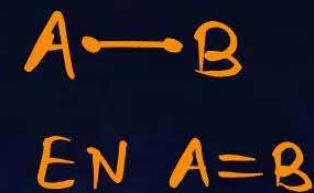
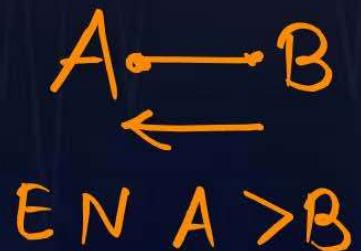


→ Reactant
→ Reagent
→ Solvent
→ T.S or reactive inter
product
+ Byproduct

Electronegativity & Electron Density



Electronegativity: The tendency to attract electron pair towards itself in a covalently bonded bond.



Electron Density:



Electronic displacement Effect

Permanent Effect

(Hamesha lagta hai)

- * 1. Inductive Effect
- * 2. Mesomeric Effect
- * 3. Hyperconjugation

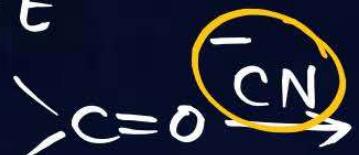
Temporary Effect

Jab reagent dalo ge tabhi lagega.

Electromeric Effect

$$1) E > I$$

$$2) + E \quad - E$$



C.Q. 1 (JEE Mains 4th April 2024, Morning Shift)

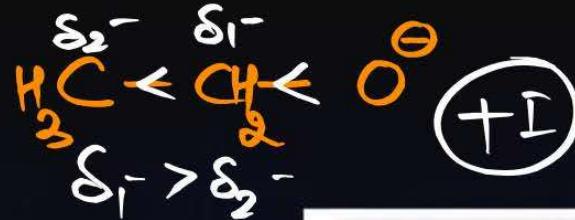


Which among the following is incorrect statement?

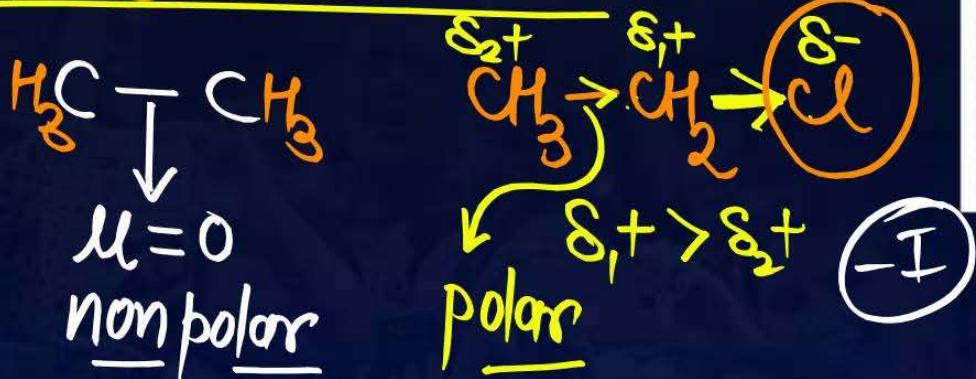
- A** Electromeric effect dominates over inductive effect.
- B** The electromeric effect is temporary effect.
- C** The organic compound shows electromeric effect in the presence of the reagent only.
- D** Hydrogen ion (H^+) shows negative electromeric effect.



Inductive Effect



1. Operate to sigma bond.
2. Partial charge development.
3. Distance dependent effect.
4. Can be neglected after 3rd carbon atom.



4th carbon from functional group



In terms of inductive effect I have no inductive effect

Inductive effect

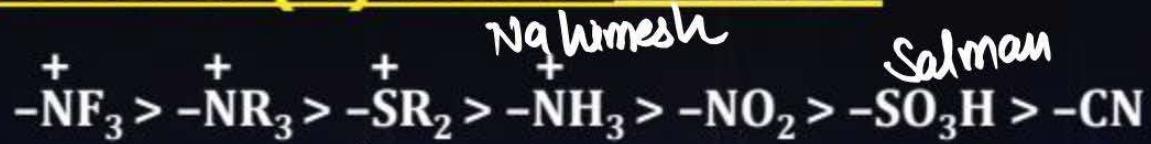
Permanent hoon sir

Power of (+I) Inductive Effect

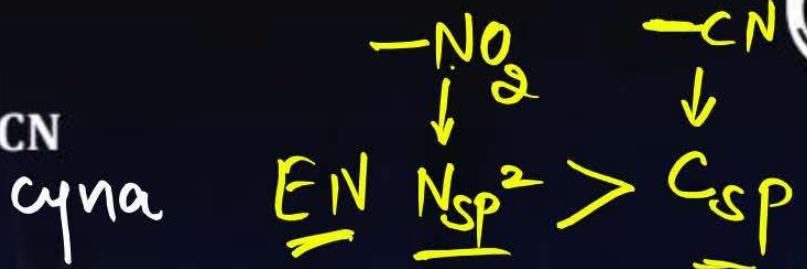
- ✓ 1. $\text{-CH}_2 > \text{-NH} > \text{-O} > \text{-COO}$ $\text{Me}^{\text{C}-} > \text{MeCH-} > \text{MeCH}_2-$
- ✓ 2. $\text{-T} > \text{-D} > \text{-H}$ zero induc.
- ✗ 3. $\text{-CH}_3 < \text{-SiH}_3 < \text{-GeH}_3$



Power of (-I) Inductive Effect



Na forsham Na shahrukh Na ompravi



Collector our alcohol ki
 > -CHO > -COOH > -F > -Cl > -Br > -I > -OR > -OH mummy
 ali ki car father beta Inspector
 Main

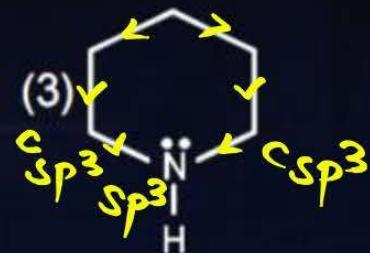
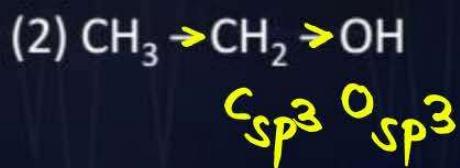
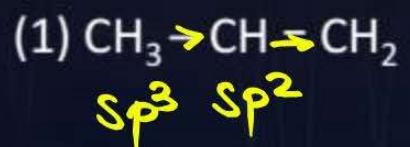
alkyne Nahihai Benz eue Hai
 > -C≡CH > -NH₂ > -Benzene > Ene > H
 -NR₂



QUESTION



Draw direction of the effect.



C.Q. 2 (NEET 2017)



Which of the following is correct with respect to -I effect of the substituents?

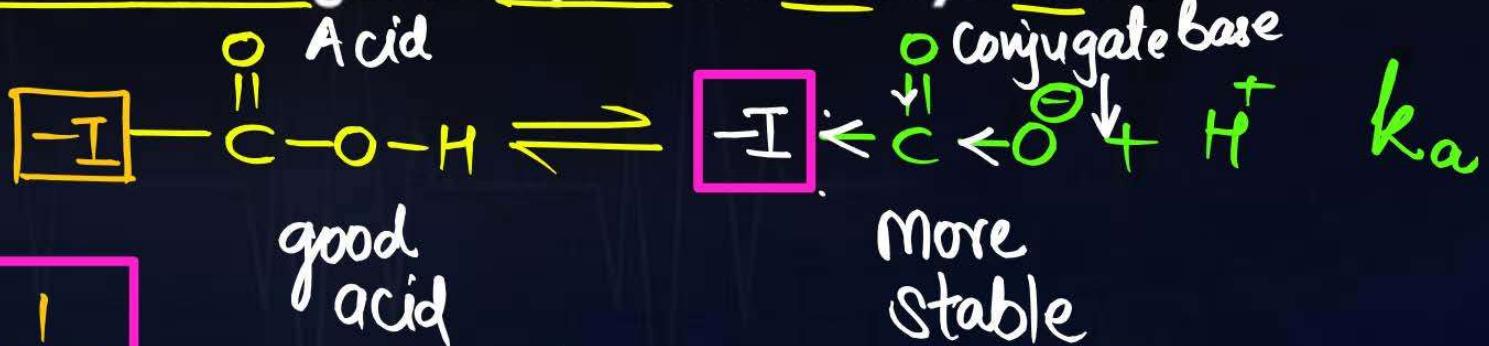
(R = alkyl)

- A $-\text{NH}_2 < -\text{OR} > -\text{F}$
- B $-\text{NR}_2 < -\text{OR} < -\text{F}$
 ~~$(-\text{NH}_2)$~~
- C $-\text{NR}_2 > -\text{OR} > -\text{F}$
- D $-\text{NH}_2 > -\text{OR} > -\text{F}$



Applications

Distance $\leftarrow D > N > P \rightarrow$ Power
 Number

1. To compare acidic strength of Aliphatic carboxylic acids.

$$A \cdot S \propto -I \propto \frac{1}{+I}$$

$$A \cdot S \propto K_a \propto [H^+] \propto \frac{1}{pK_a} \propto \frac{1}{pH}$$

$$k_a = \frac{[\text{conjugate base}][\text{H}^+]}{[\text{Acid}]}$$

The correct sequence of acidic strength of the following aliphatic acids in their decreasing order is:



$\left[\text{As} \propto \frac{1}{+\infty} \right]$

- A ~~$\text{HCOOH} > \text{CH}_3\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$~~
- B $\text{HCOOH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{CH}_3\text{COOH}$
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{CH}_3\text{COOH} > \text{HCOOH}$
- D $\text{CH}_3\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} > \text{HCOOH}$

C. Q. 4 [JEE Main 2019 Online]

The correct decreasing order for acid strength is:

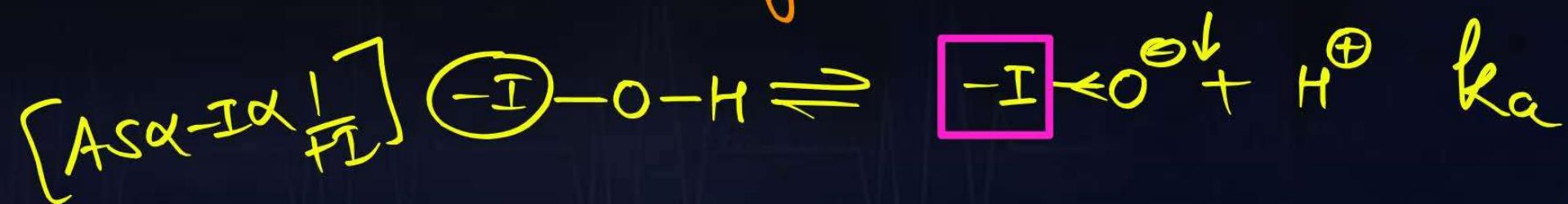
- A $\text{CNCH}_2\text{COOH} > \text{O}_2\text{NCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
- B $\text{FCH}_2\text{COOH} > \text{NCCH}_2\text{COOH} > \text{NO}_2\text{CH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
- C $\text{NO}_2\text{CH}_2\text{COOH} > \text{NCCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
- D $\text{NO}_2\text{CH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CNCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$



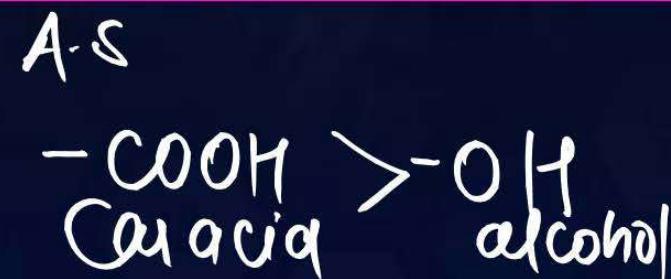
NO_2 1

2. To compare acidic strength of Alcohols

Same as carboxylic acid



$$A \cdot S \propto k_a \propto \frac{1}{pK_a} \propto [\text{H}^+] \propto \frac{1}{pH}$$



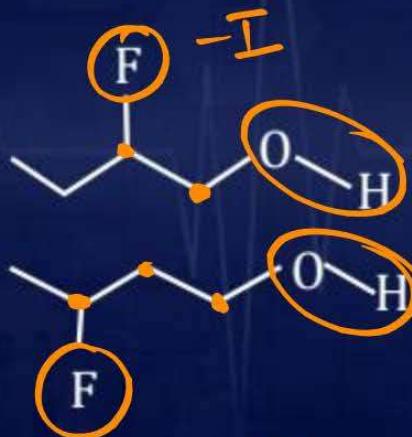
C.Q. 5

[$\text{O} > \text{N} > \text{P}$]

A.S

In which of the following compounds the hydroxylic proton is most acidic?

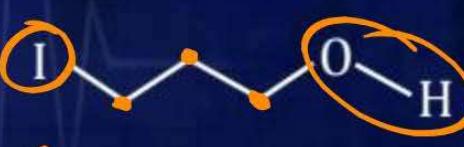
A



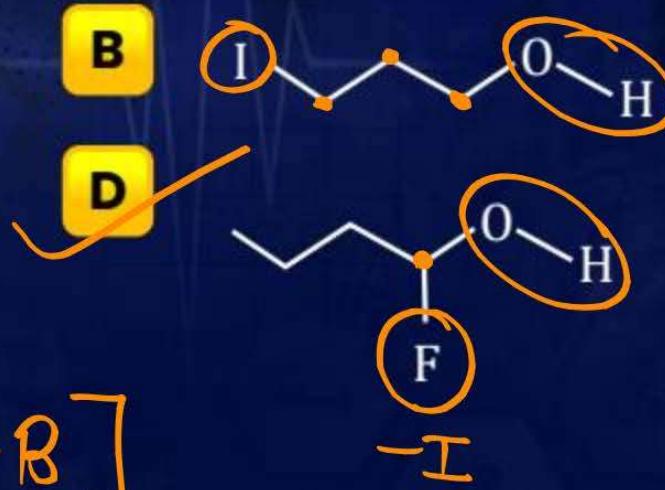
C



B

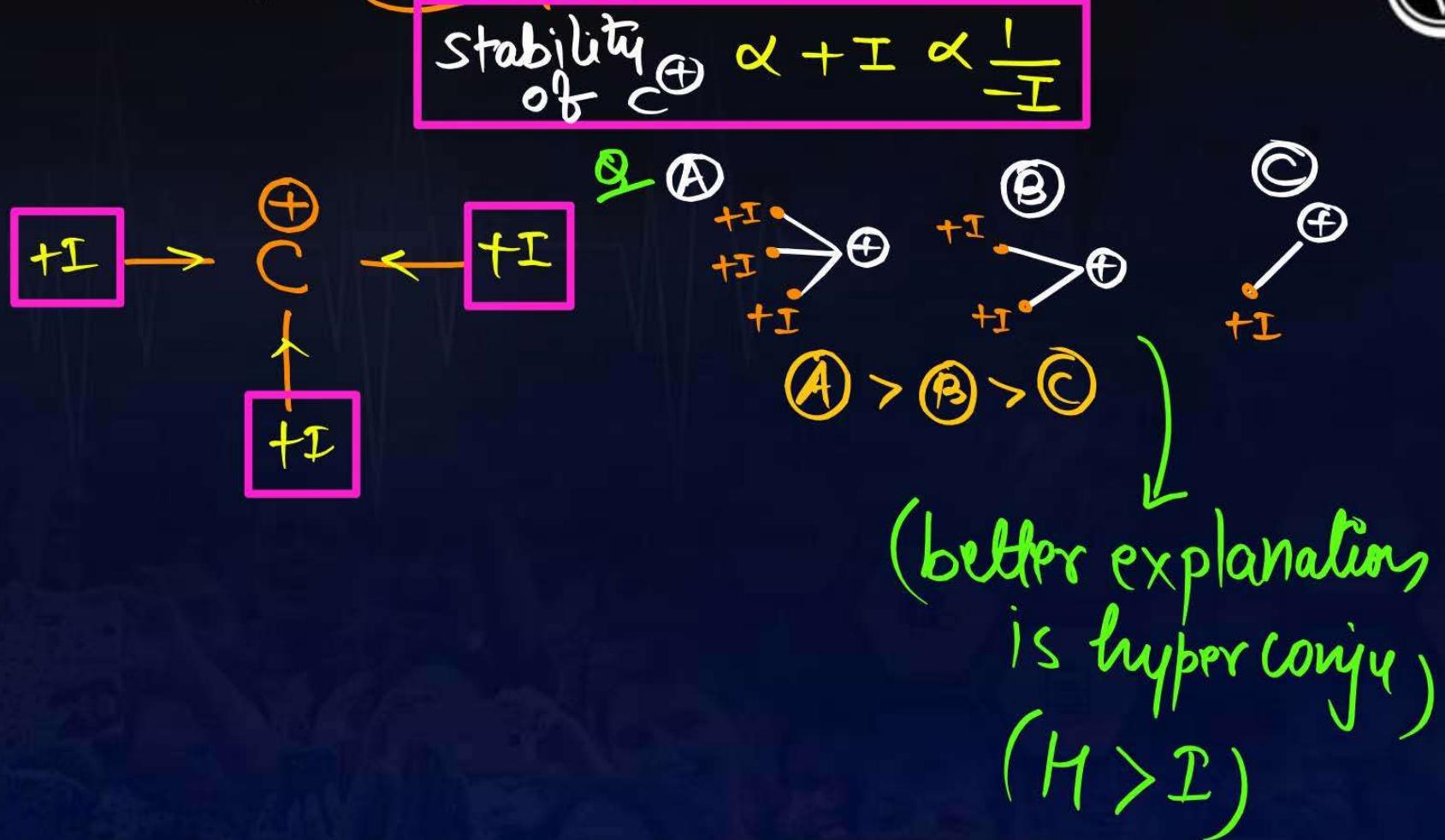


D



[$\text{D} > \text{A} > \text{C} > \text{B}$]

3. To compare stability of carbocations

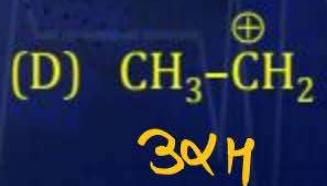
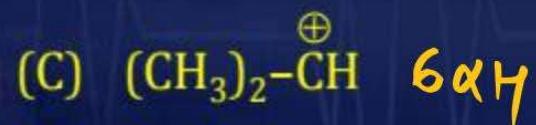


C.Q. 6 (NEET 2013)

[After hyper]



Arrange the following in increasing order of stability



A E < D < C < B < A

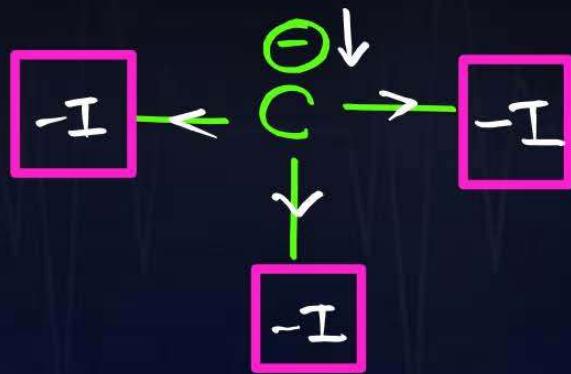
C D < E < C < A < B

B E < D < C < A < B

D A < E < D < C < B

4. To compare stability of carbanions

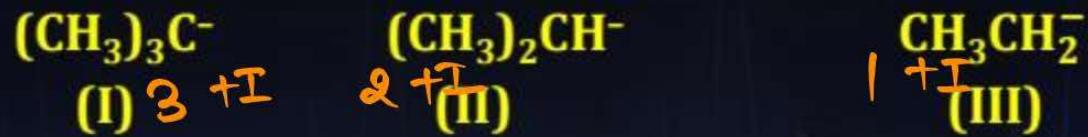
Stability of $C^\Theta \propto -I \propto \frac{1}{+I}$



C.Q. 7

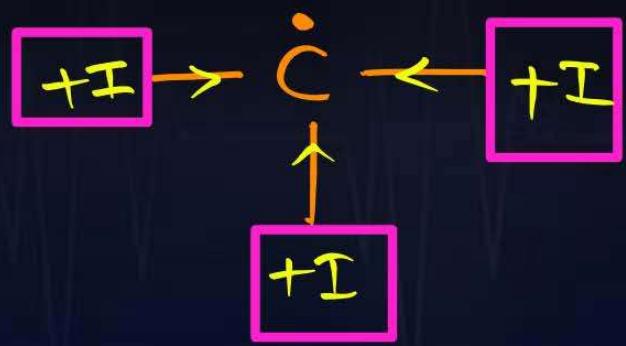


The order of decreasing stability of the anions is:

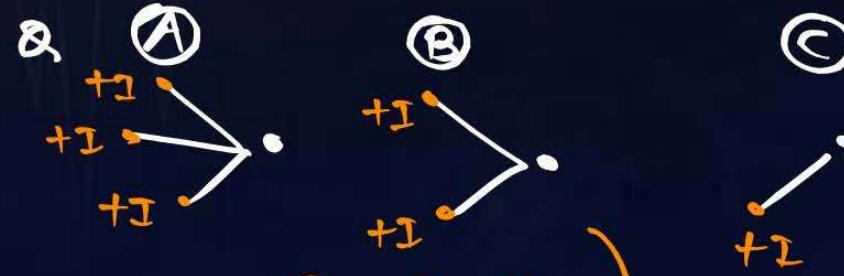


- A I > II > III
- B ~~III > II > I~~
- C II > I > III
- D I > II > III

5. To compare stability of free radicals (Same as C^+)



stability of $\dot{\text{C}} \propto +\text{I}$ $\frac{1}{-\text{I}}$

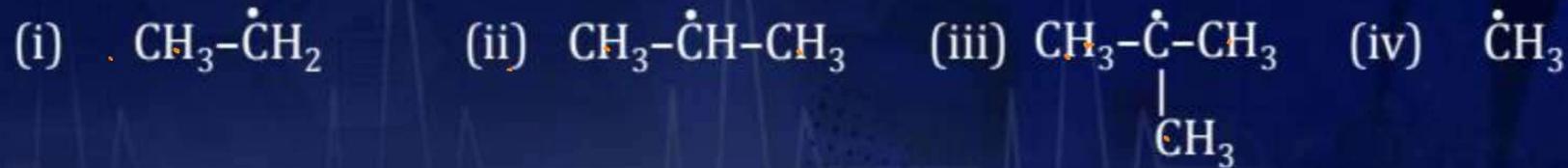


better explain
is hyper ($H > I$)

C.Q. 8



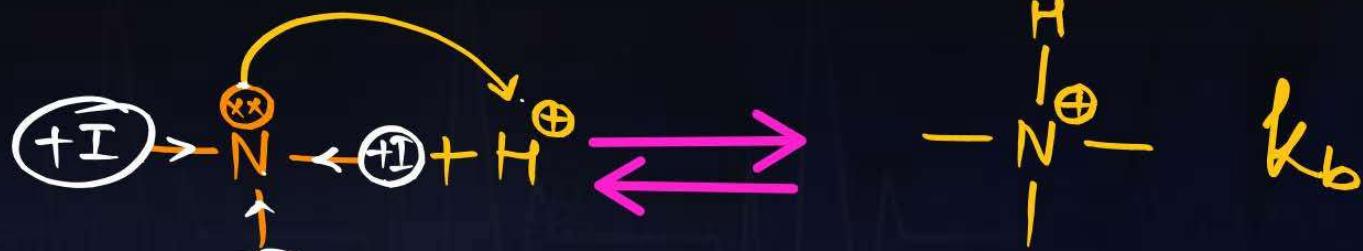
The stability of given free radicals in decreasing order is:



- A iii > iv > i > ii
C iii > ii > iv > i

- B i > ii > iii > iv
D iii > ii > i > iv

6. To compare Basic Strength of Amines



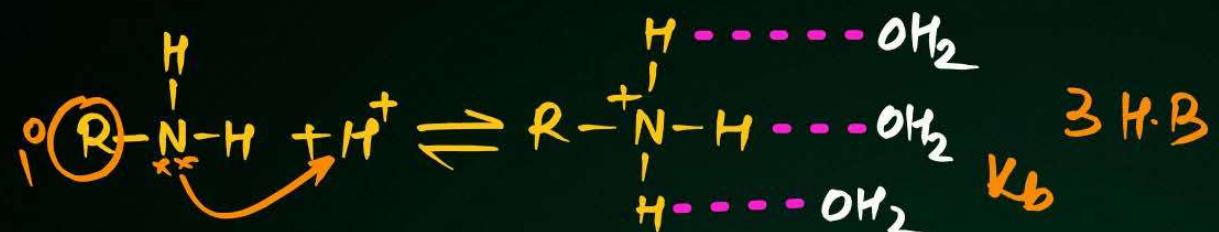
$$\left[BS\alpha + I\alpha \frac{1}{-I} \right]$$

$$BS\alpha K_b \propto [OH] \propto \frac{1}{PK_b} \propto \frac{1}{POH}$$

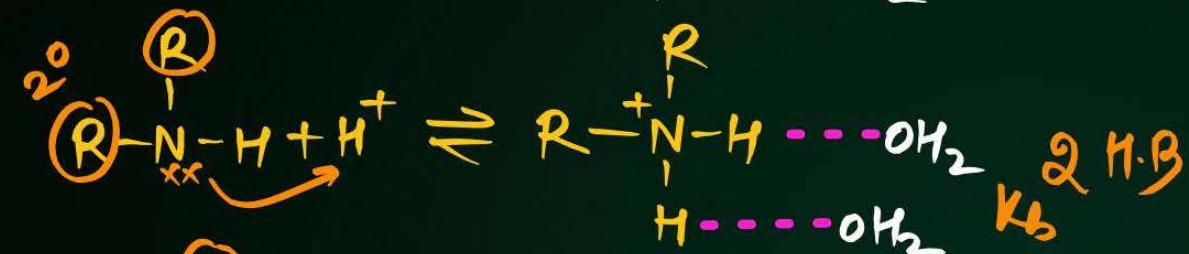
① In gas phase (only I effect)

$$\left[BS\alpha + I\alpha \frac{1}{-I} \right]$$

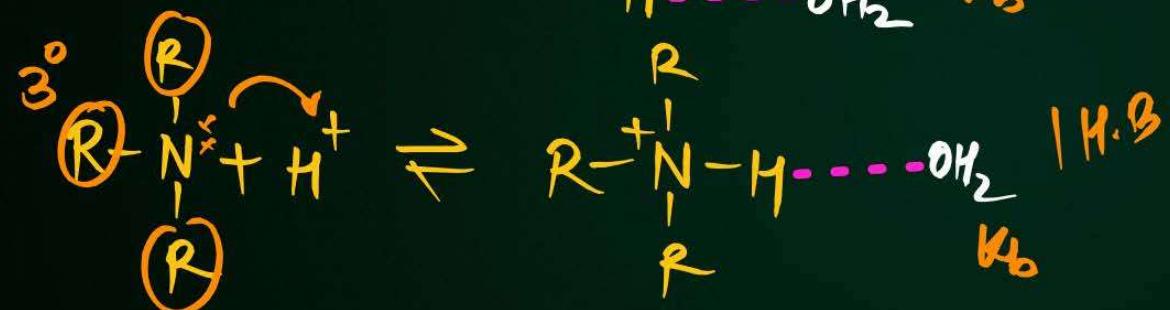
② In aq. medium I effect & Solvation



accn to H.B.
 $1^\circ > 2^\circ > 3^\circ$



accn to +I
 $3^\circ > 2^\circ > 1^\circ$



final answer

B.S $2^\circ > 1^\circ > 3^\circ \quad R = \text{Me}$

B.S $2^\circ > 3^\circ > 1^\circ \quad R = \text{Et}$

C.Q. 9

(D > N > P)



Which is most basic among the following?



D > A > B > C



Resonance

Arrow Ghumana Seekh Jaoge

Old definition

1. When a single Lewis structure cannot explain all the properties of a molecule
Then we need more than one such structures.
2. These structures are called Resonating structures (or canonical form).
R.S.
3. R. S. are hypothetical.
4. Resonance hybrid is the real structure.



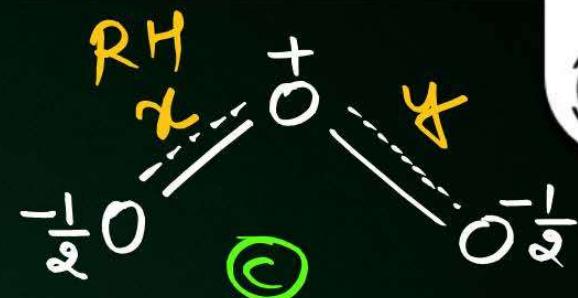
Bond order or Bond length





Ⓐ & Ⓑ are Resonating struc (R.S)
or
(Canonical forms)

Ⓒ Resonance hybrid

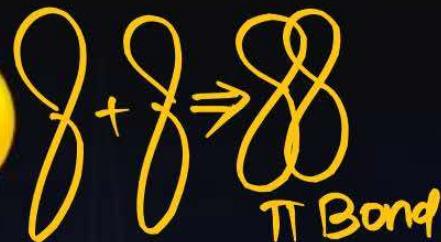


Bond length
 $x = y$





Resonance



Definition: Delocalization of n electrons in conjugated system.

PPP concept ÷ Parallel position of 'p' orbitals

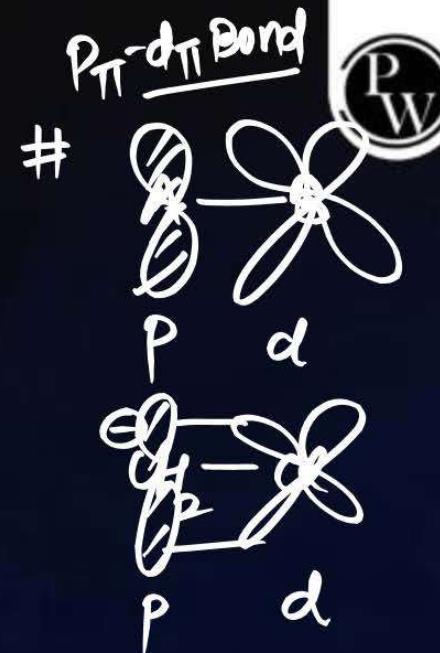
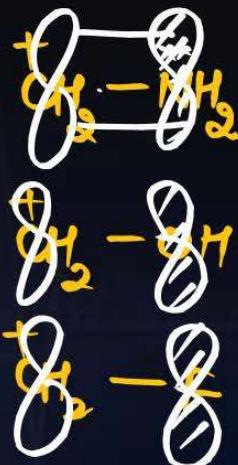
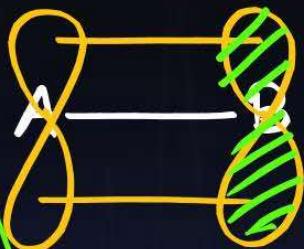
2 p ✓
3 p ✓
4 p ✓

π Bond

Types of Conjugation

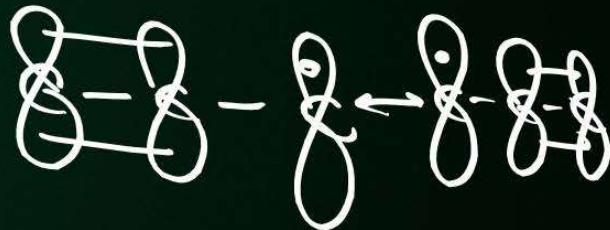
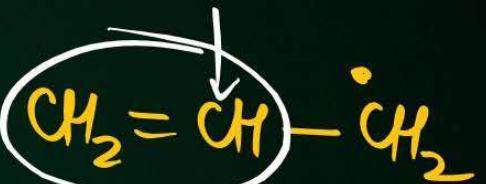
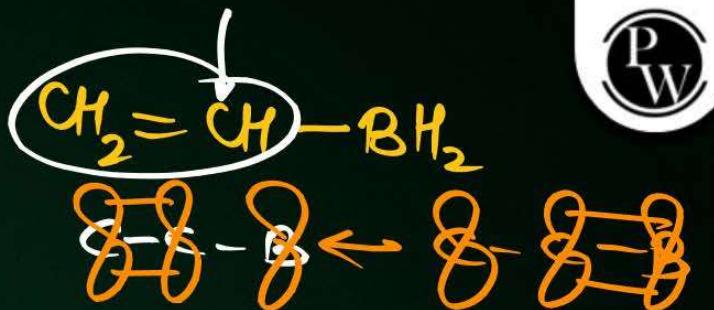
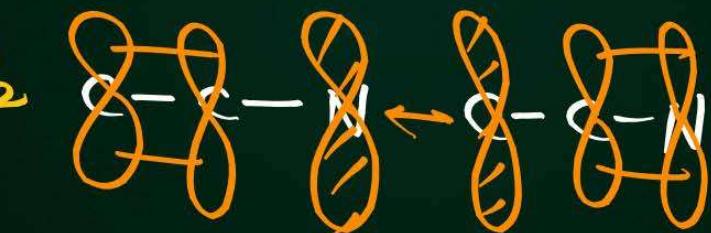
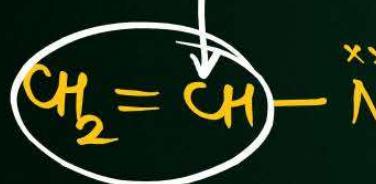
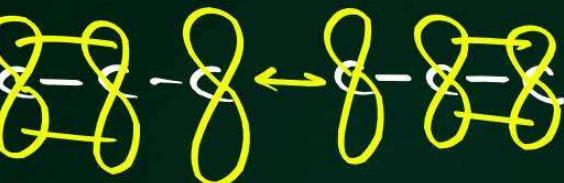
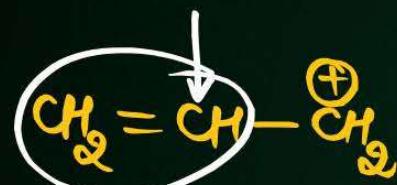
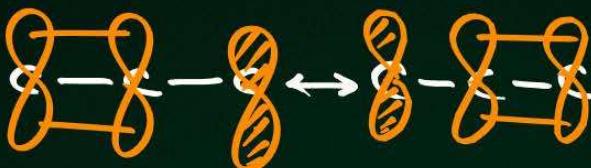
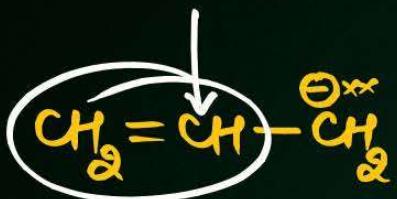
O & P

Back bonding

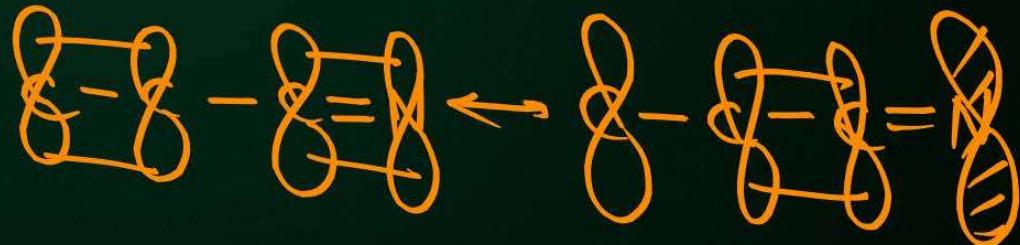
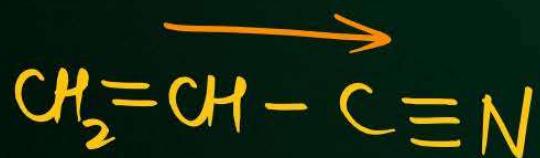
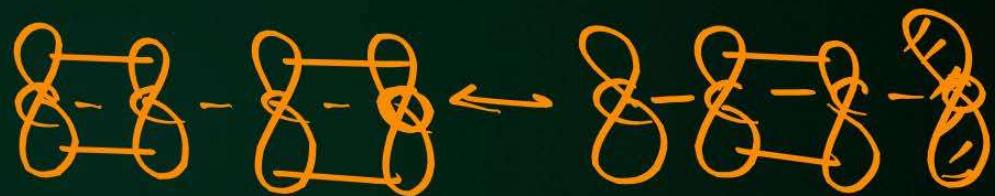
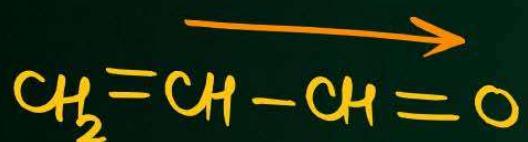


At No 13-19
Vacant ; ;
'd' ; ;
Usually
(P, S, Cl, Br, I)

② 3P



③ \rightleftharpoons



Condition for Resonance

1. Molecule should be planner.
2. Conjugated system.



πe^{\ominus} move ✓
 σe^{\ominus} move ✗
atom move ✗

C.Q. 10

Which of the following compounds have not delocalized electrons?

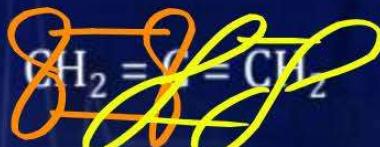
A



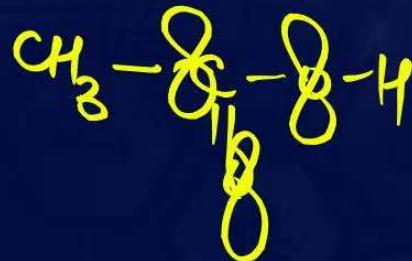
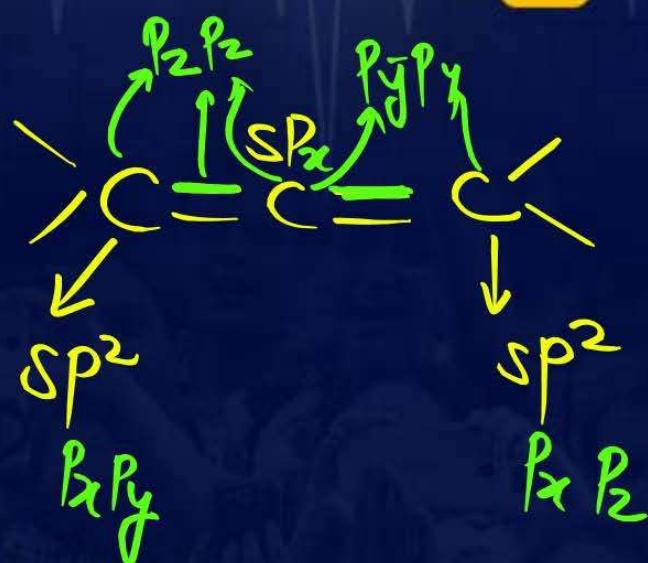
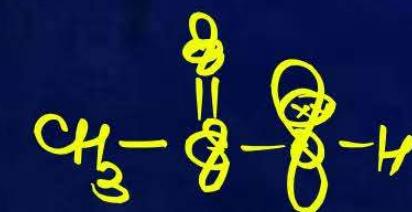
C



B



D

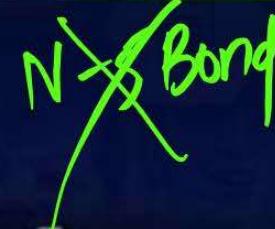


PW

OP Points

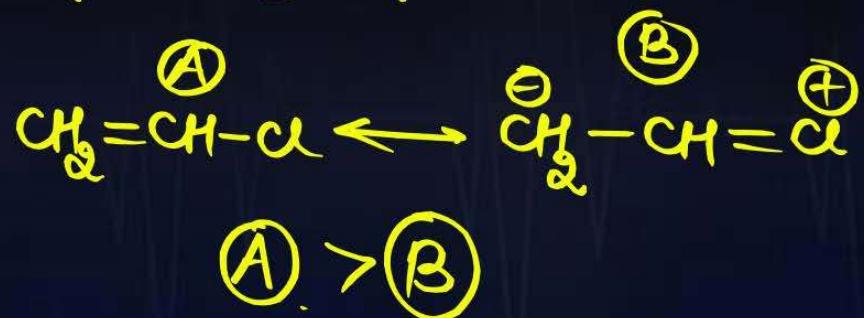
1. Hypothetical concept ✓
2. Intramolecular process ✓
3. RS are imaginary concept ✓
4. RH is real ✓
5. Atom cannot move in resonance. ✓
6. Total number of paired unpaired electrons remain same. ✓
7. Total number of electrons remain same. ✓
8. Any structure violating the fundamental rule is not accepted as RS.

Lewis rule



Compare Stability in Pankaj sir's style

1. Neutral R.S > Charged R.S



2. Stability of R.S \propto no. of π bonds



Compare Stability in Pankaj sir's style

3. Stability of R.S & Stability of Charge

L to R $\text{F} \cdot \text{N}$

-ve charge stability increases

$\bar{\text{C}} < \bar{\text{N}} < \bar{\text{O}} < \text{F}^-$

Priority [-ve > +ve]

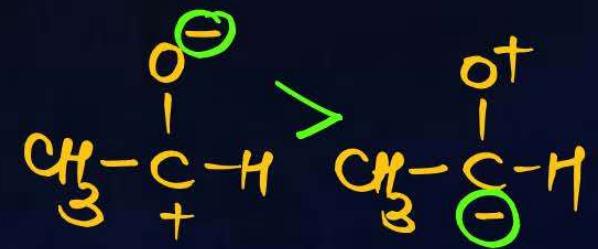
$\xrightarrow[-\text{ve}]{\text{inc}}$

Size

Top to B

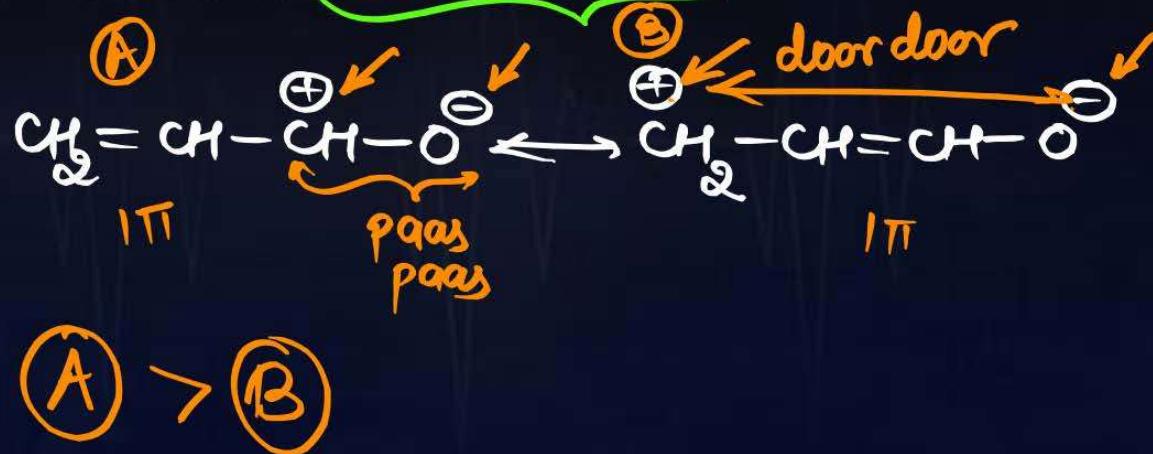
-ve charge stability increases

$\text{F}^- < \bar{\text{Cl}} < \text{Br}^- < \text{I}^-$



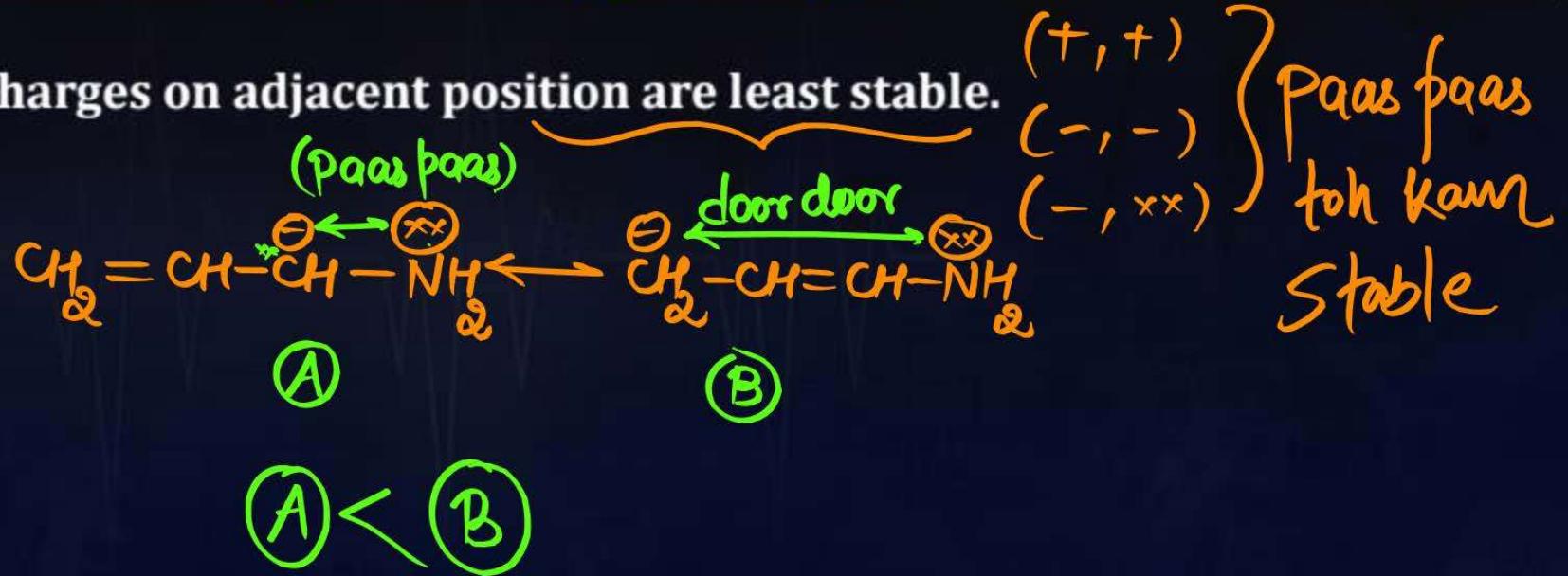
Compare Stability in Pankaj sir's style

4. Charge separating R.S are less stable. + 2 - door door toh kam stable.



Compare Stability in Pankaj sir's style

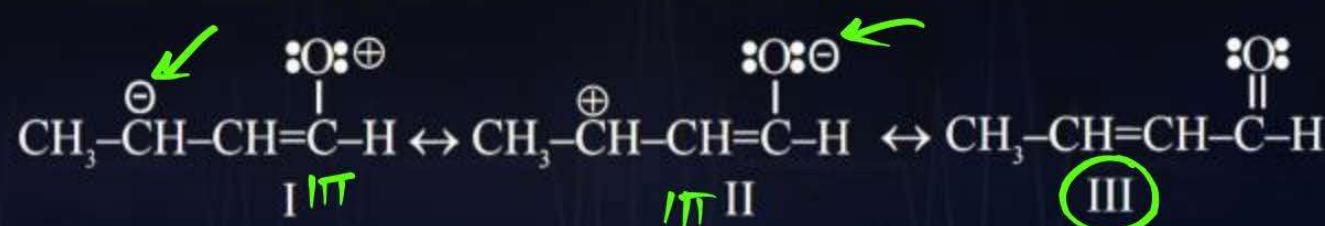
5. Like charges on adjacent position are least stable.



C.Q. 11 (JEE Mains 9th April 2024, Evening Shift)



The correct stability order of the following resonance structures of $\text{CH}_3\text{-CH}=\text{CH-CHO}$ is:



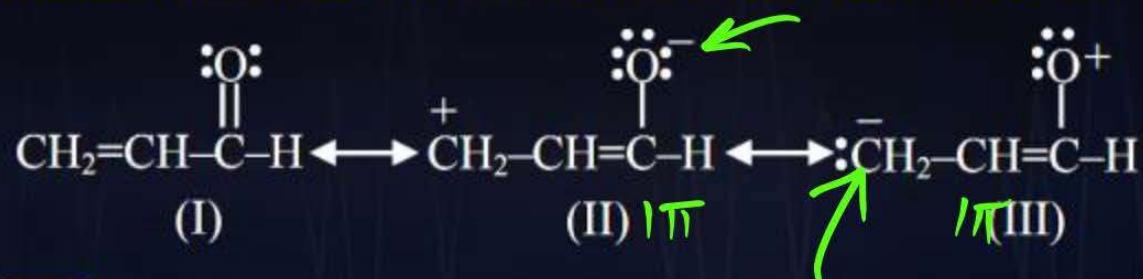
A $\cancel{II > III > I}$

B $\cancel{III > II > I}$

C $\cancel{I > II > III}$

D $\cancel{II > I > III}$

Relative stability of the contributing structures is:

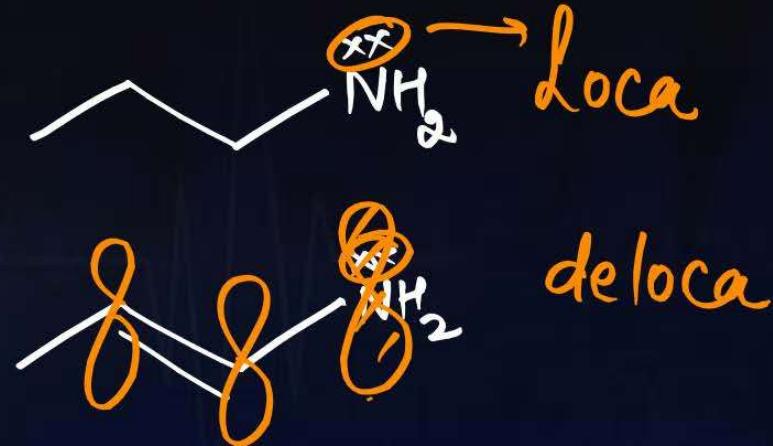


- A** (I) > (III) > (II)
- B** (I) > (II) > (III)
- C** ~~(II) > (I) > (III)~~
- D** ~~(III) > (II) > (I)~~

Localized & Delocalized lone pairs

L.P. does
not parti
in reso

L.P. parti
in reso

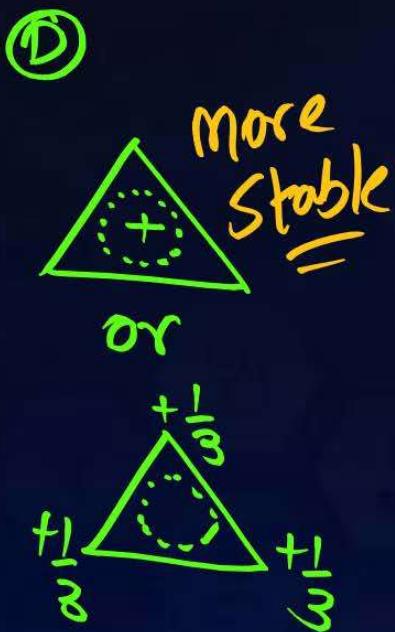
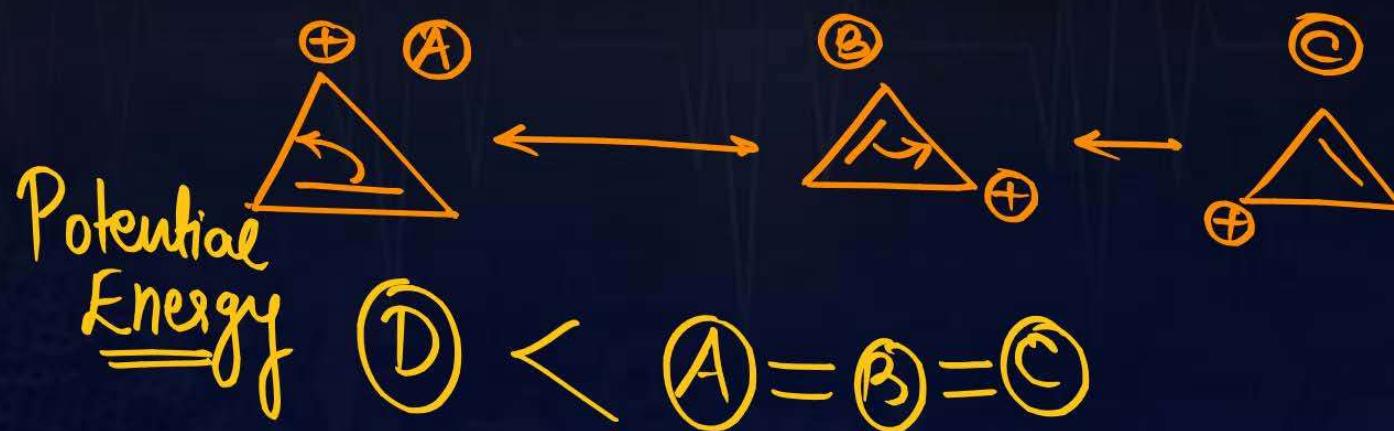


Equivalent Resonance

[Same Saqal Ke]



1. When P.E of all R.S are equal then R.S are called equivalent R.S.
2. Contribution of all R.S are same.



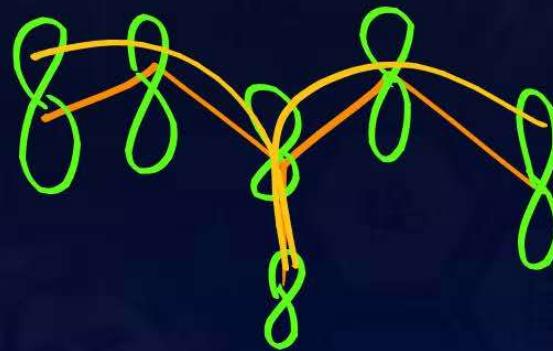
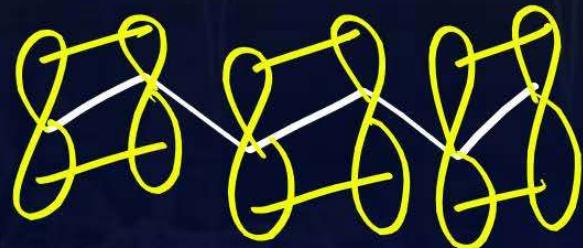
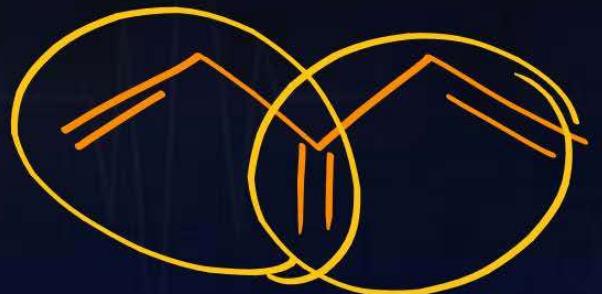
Extended & Cross Conjugation

Stability Ext > Cross

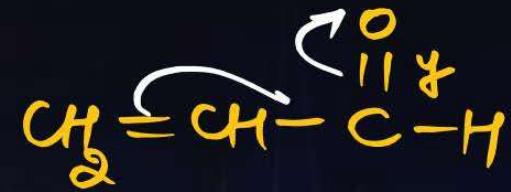
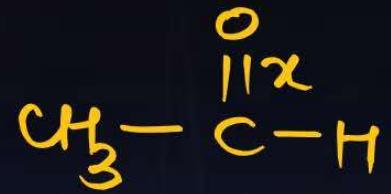
ϵ_K he saans
main



Do alag -2



Bond length



BL $x < y$

BL $\equiv < = < \cdots < -$

~~Fries Rule~~

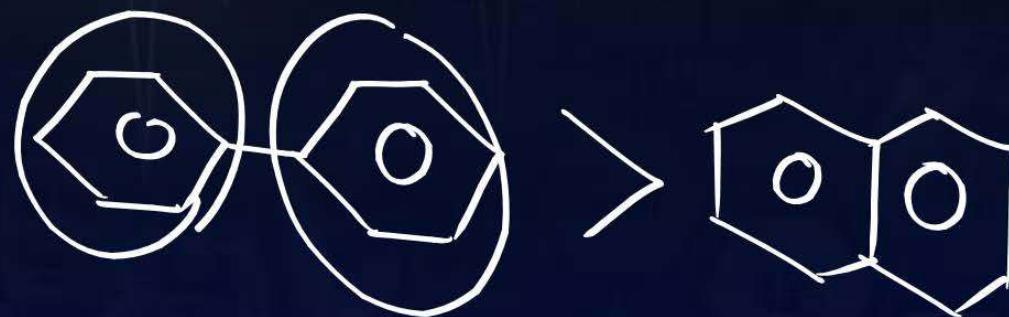


For Resonating structure of Benzenoid compound

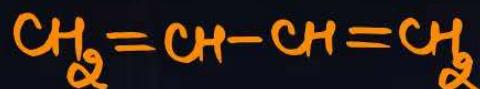
1. Stability \propto no. of benzenoid ring.



2. Two separating benzenoid rings are more stable than two fused benzenoid rings.



Resonance v/s Mesomeric Effect



Reso



Meso



Effect

tab lagta hai

Jab koi group

no

All resonance effect are mesomeric effect. (T/F)

All mesomeric effect are resonance effect. (T/F)



Mesomeric Effect

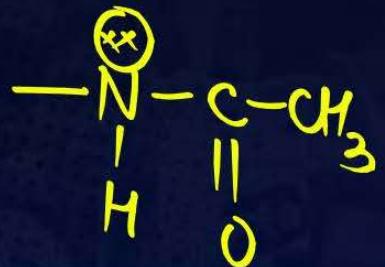
PW

Definition	+M Effect	-M Effect
<ol style="list-style-type: none"><u>Permanent effect.</u><u>Operate to π bond.</u><u>Distance Independent effect.</u><u>Actual Charge Develop.</u>	<p>+M Effect</p> <p>If an <u>atom or group</u> <u>donate P orbital e⁻s</u> to <u>conjugated system</u> (like <u>double bond</u> or <u>Benzene Ring</u> usually).</p> <p>$\text{CH}_2=\text{CH}-\text{NH} \leftrightarrow \text{CH}_2-\text{CH}=\text{NH}_2$</p> <p>A pink arrow points from the nitrogen atom in the first structure to the double bond in the second structure, indicating electron movement.</p>	<p>-M Effect</p> <p>If an <u>atom or group withdraw P orbital e⁻s</u> to <u>conjugated system</u> (like <u>double bond</u> or <u>Benzene Ring</u> usually).</p> <p>$\text{CH}_2=\text{CH}-\text{CH}=\ddot{\text{O}}$</p> <p>$\text{CH}_2-\text{CH}=\text{CH}-\text{O}^{\ominus}$</p>

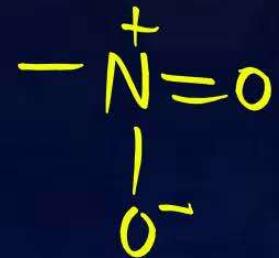
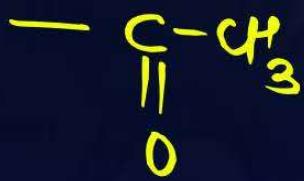
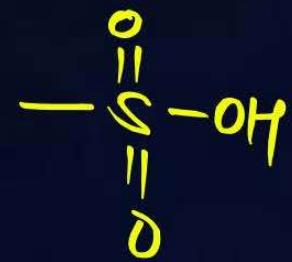
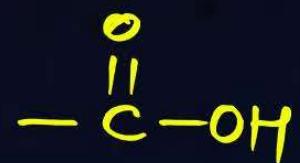
Identification of +M and -M groups



1st atom ke
paar L.P.
toh +M



1st atom ke baas π Bond



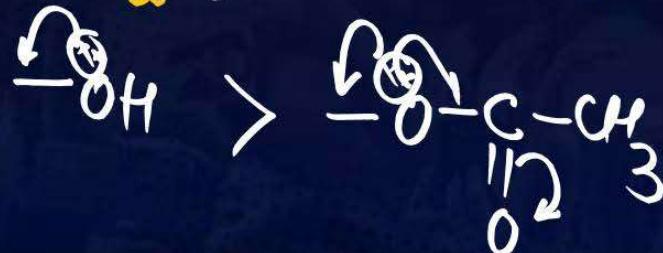
Comparison Power of +M Group

1. +M power \propto extent of overlapping

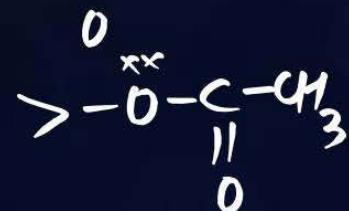
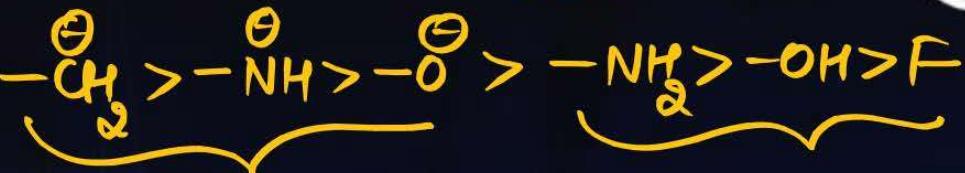
1) Charge \uparrow +M power \subseteq 2 atom A

2) Size diff \downarrow overlap \uparrow +M power \uparrow
of
C & A

2. +M due to L.P $>$ +M due to internal conjugation

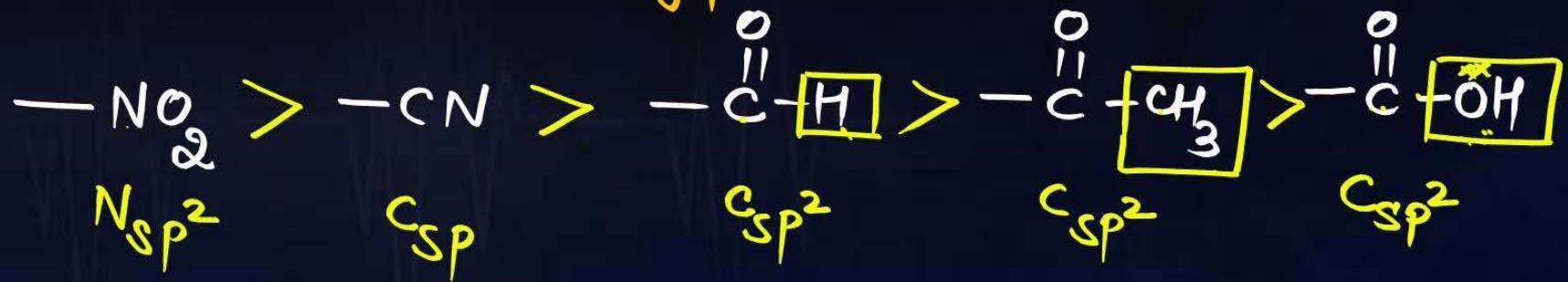


2nd period [C > N > O > F]



Comparison Power of -M Group

-M power $\propto e^\Theta$ withdrawing power of 1st atom

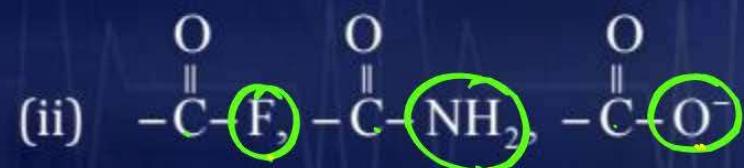
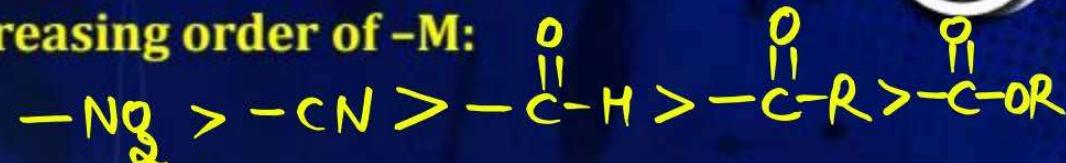


Side atom ki donations ↑
1st atom ki -M power ↓

C.Q. 13



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

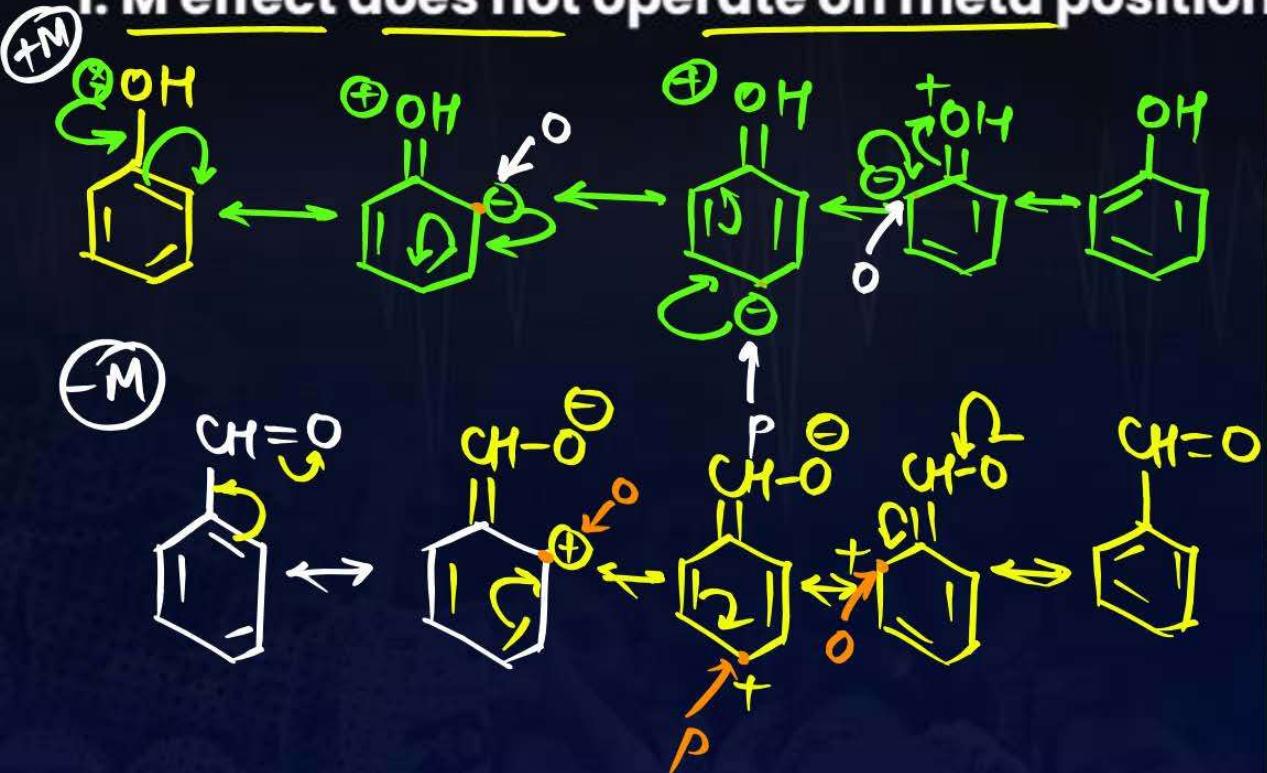


donation of side atoms [$\overset{\text{O}^+}{\text{O}} > \text{NH}_2 > \text{F}$]

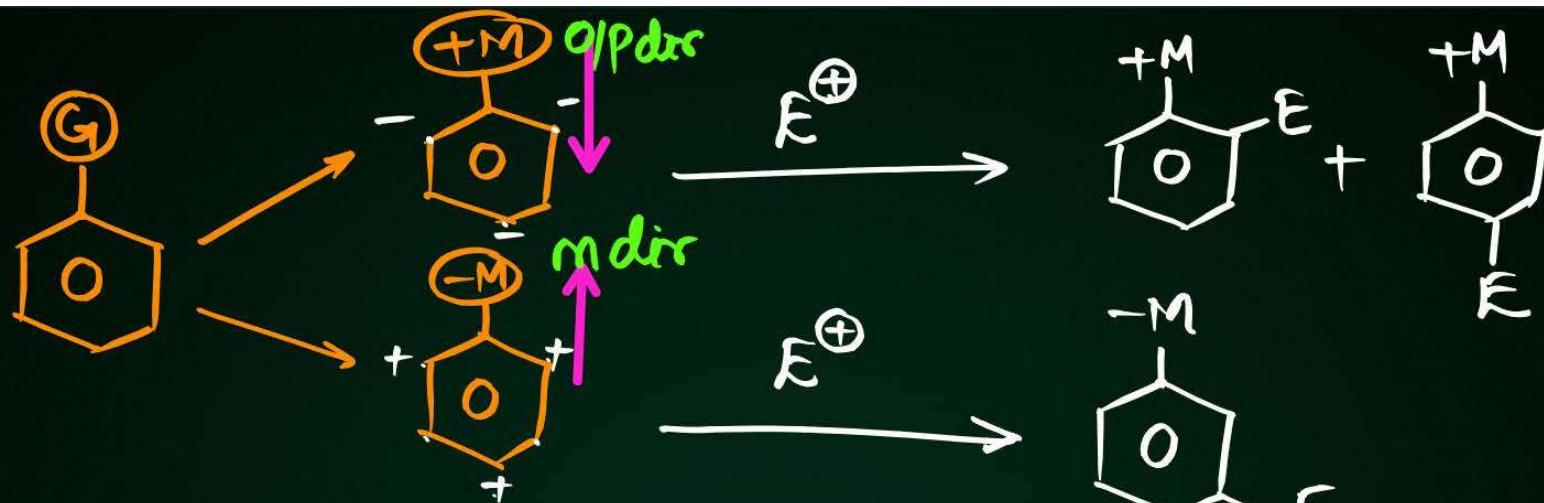
withdrawing
power of 1st atom

OP Points

1. M effect does not operate on meta position.



1

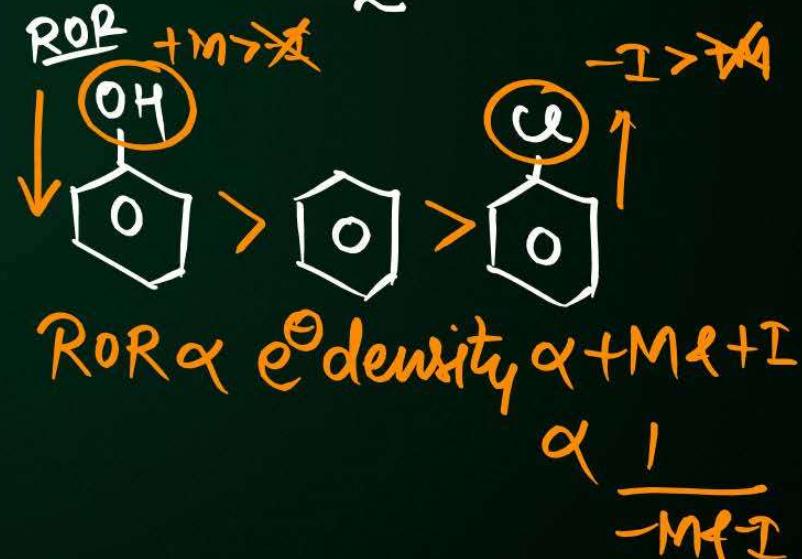


2 ROR

check dominating effect

$$\boxed{M > I}$$

but 1) in N, O $+M > -I$
 2) in X $-I > +M$



The set of meta directing functional group from the following sets is:

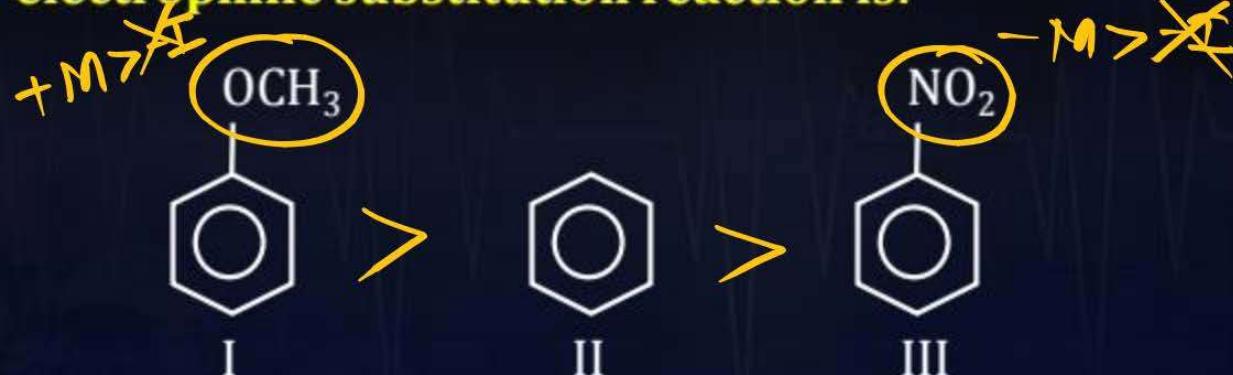
- A $\begin{matrix} -M & +M & +M & +M \\ -CN, -\ddot{N}H_2, -\ddot{N}HR, -\ddot{O}CH_3 \end{matrix}$
- B $\begin{matrix} -M & +M & -M & -M \\ -NO_2, -NH_2, -COOH, -COOR \end{matrix}$
- C $\begin{matrix} -M & -M & -M & -M \\ -NO_2, -CHO, -SO_3H, -COR \end{matrix}$
- D $\begin{matrix} -M & -M & +M & -M \\ -CN, -CHO, -NHCOCH_3, -COOR \end{matrix}$

Kaha Sa dirr hai
Ye M effect se bata chalega.

C.Q. 15 (AIIMS 2012)

PW

Among the following compounds (I-III), the correct order of reactivity towards electrophilic substitution reaction is:



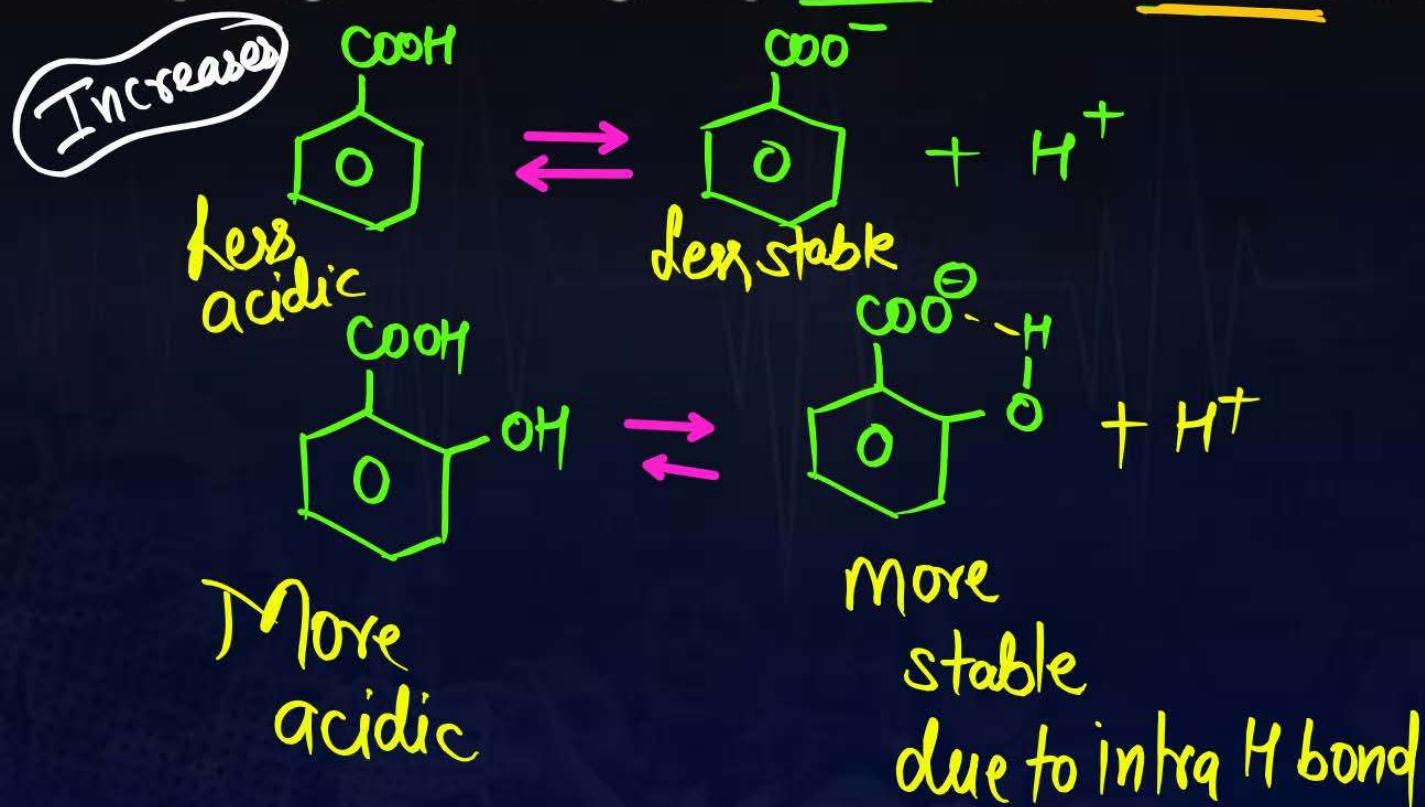
Dominating effect

- A II > III > I
- B III < I < II
- C I > II > III
- D I = II > III

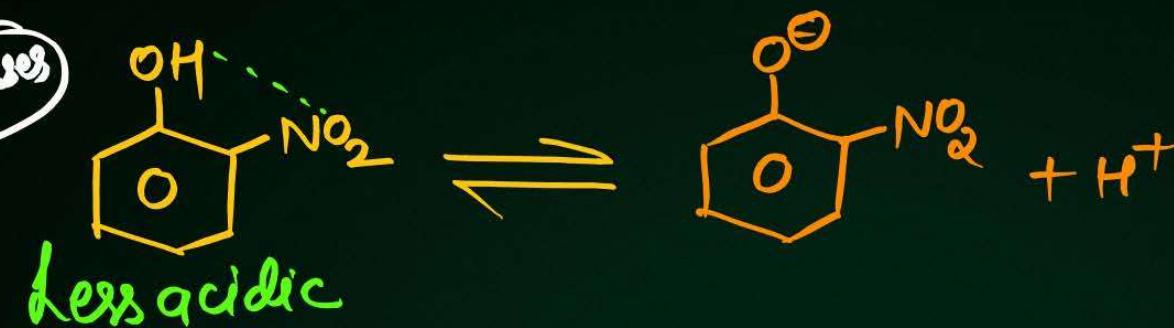
C.Q. 16

- Which of the following decreases electron density in benzene ring through $-M$ effect?
- A $-\text{CN}$ $\quad -\text{C}\equiv\text{N}$
 - B $-\text{CH}_3$
 - C NH_3^+
 - D All of these
- Handwritten notes:*
 st^{t} atom
ke paas
 π Bond

2. Hydrogen bonding may increase or decrease acidic strength.



Decreases



less acidic

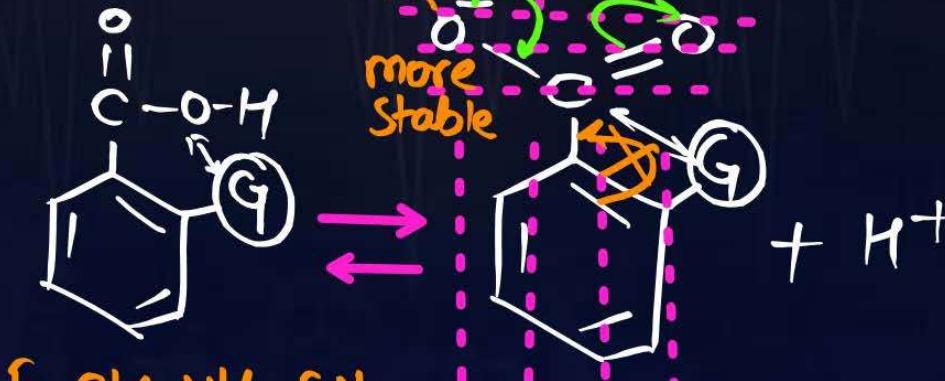
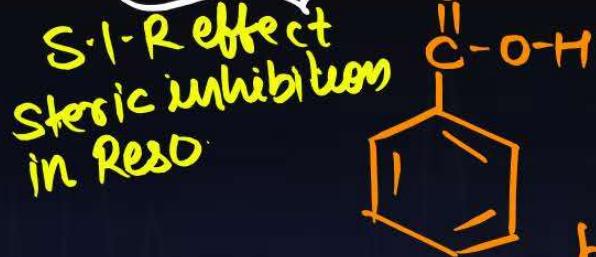


more

acidic

$\text{P} > \text{O} > \text{M}$

3. Ortho effect \div A.s of α -substituted aro carb acid increases.



$G + H, D, T, F, OH, NH_2, CN$
Non bulky etc

G -tum bewafa ho

4. Usually, M > I

$$+M > -I \quad N \neq 0$$

$$-I > +M \quad \times$$

C.Q. 17 (JEE Mains 2025, 24 January Shift-2)

Identify correct statement/s:

- (A) $-\text{OCH}_3$ and $-\text{NHCOCH}_3$ are activating group.
- (B) $-\text{CN}$ and $-\text{OH}$ are meta directing group.
- (C) $-\text{CN}$ and $-\text{SO}_3\text{H}$ are meta directing group.
- (D) Activating groups act as ortho and para directing groups.
- (E) Halides are activating groups. \times $(-\text{I} > \text{M})$

$+\text{M}, +\text{I}$

$-\text{M}, -\text{I}$

e^\ominus density \uparrow Acti

e^\oplus density \downarrow deacti

Choose the correct answer from the options given below:

- A** (A), (C) and (D) only ✓
- B** (A) and (C) only
- C** (A) only
- D** (A), (B) and (E) only

Applications of Mesomeric effect

1. To compare Acidic Strength of Carboxylic acids

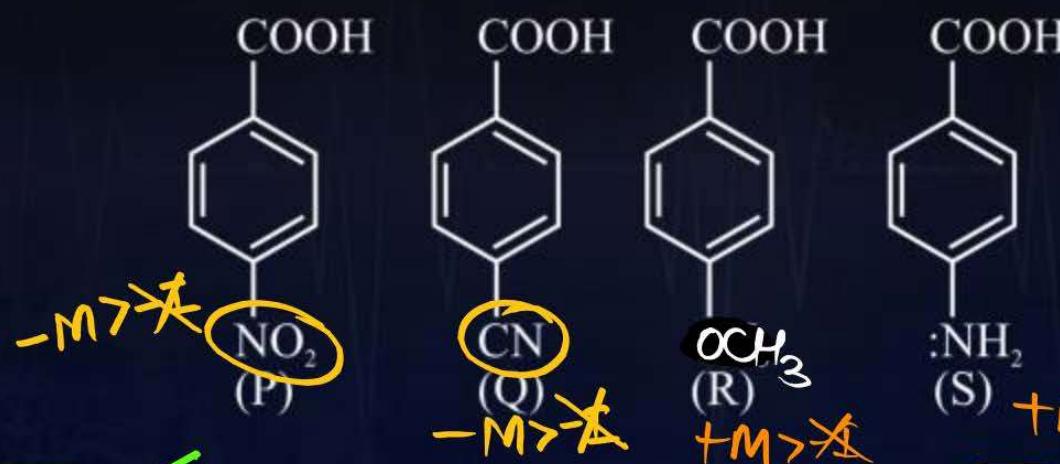
$$\text{A.S} \propto -M\alpha - I \propto \frac{1}{+M} \propto \frac{1}{+I}$$

C.Q. 18

(Dominating effect)

PW

The decreasing order of acidity of following benzoic acid derivatives is:



-M power $\text{NO}_2 > \text{CN}$
[P > Q > R > S]
+M power $\text{OCH}_3 < \text{NH}_2$

- A P > Q > R > S
C S > R > Q > P

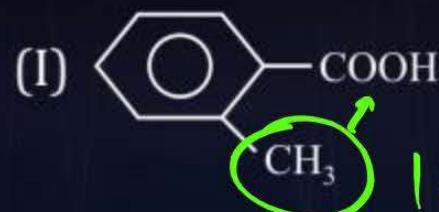
- B Q > P > S > R
D R > S > P > Q

C.Q. 19

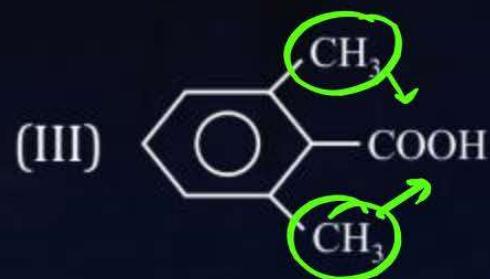
ortho effect AS ↑

P
W

The three acids are given below. The order of their acidic nature is:



| ortho



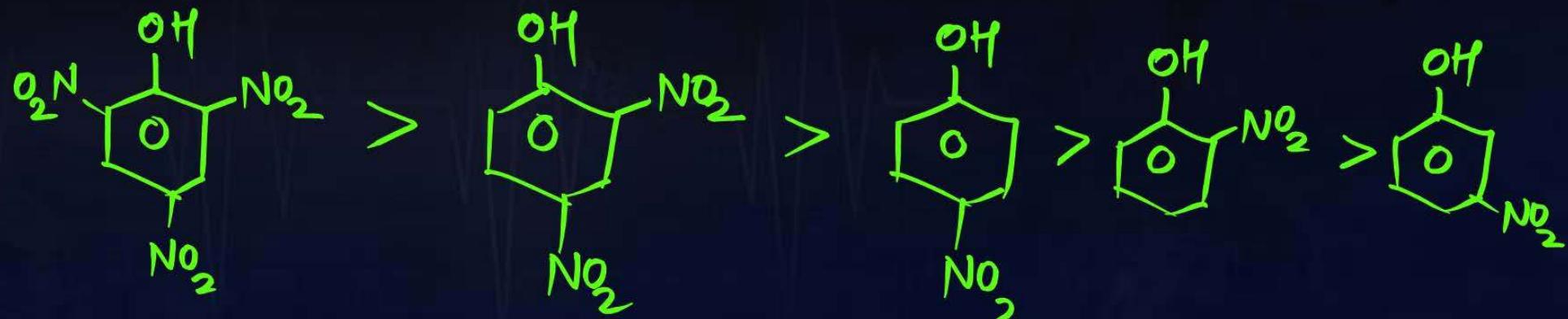
& ortho

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

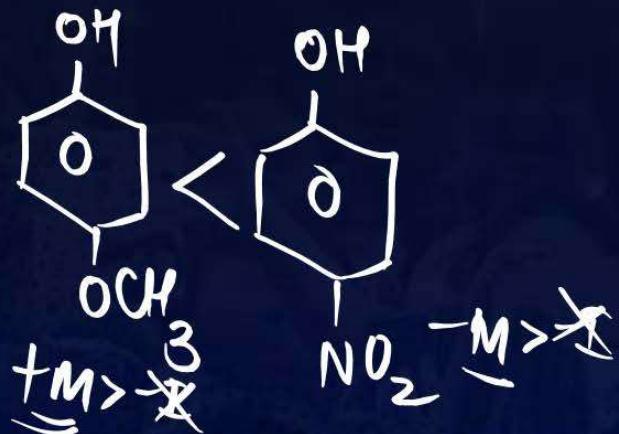
Applications of Mesomeric effect

2. To compare Acidic Strength of Phenols

$$A_S \propto -M, -I \propto \frac{1}{+M, +I}$$



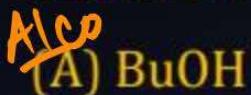
$P > O > M$



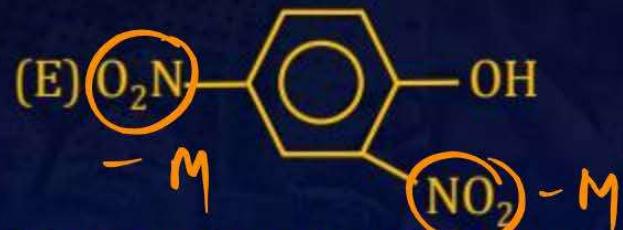
C.Q. 20 (JEE Mains 27th January 2024, Morning Shift)



The ascending order of acidity of -OH group in the following compounds is:



$$[A < C < D < B < E]$$



Choose the correct answer from the options given below:

- A (A) < (D) < (C) < (B) < (E)
- B (C) < (A) < (D) < (B) < (E)
- C (C) < (D) < (B) < (A) < (E)
- D (A) < (C) < (D) < (B) < (E)

Match List I with List II.

List-I (Compound)		List-II (pK _a value)	
A. Ethanol	II	I.	10.0
B. Phenol	I	II.	15.9
C. m-Nitrophenol	IV	III.	7.1
D. p-Nitrophenol	III	IV.	8.3

Choose the correct answer from the options given below:

- A** A-I, B-II, C-III, D-IV
- B** A-IV, B-I, C-II, D-III
- C** A-III, B-IV, C-I, D-II
- D** A-II, B-I, C-IV, D-III

Statement-I: The acidic strength of monosubstituted nitrophenol is higher than Phenol because of electron withdrawing **nitro** group.

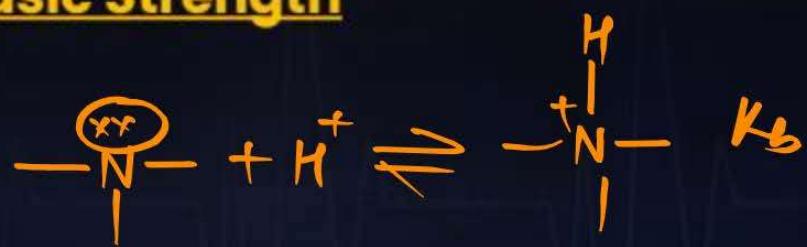
Statement-II: ~~o-nitrophenol, m-nitrophenol, p-nitrophenol will have same acidic strength as they one nitro group attached to the phenolic ring.~~

P>o>m

- A** Both Statement I and Statement II are incorrect.
- B** Both Statement I and Statement II are correct.
- C** Statement I is correct and Statement II is incorrect.
- D** Statement I is incorrect and Statement II is correct.

Applications of Mesomeric effect

3. To compare Basic Strength

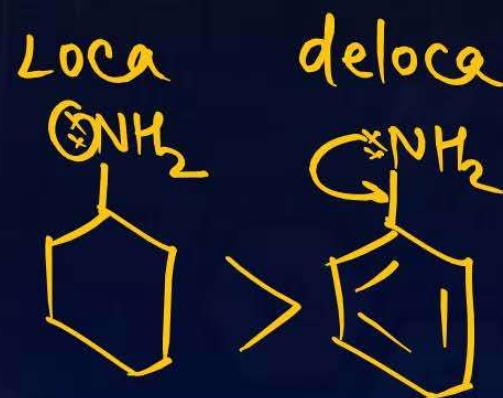


OP Points

1. Availability of Lone pair on Nitrogen, more will be Basicity.

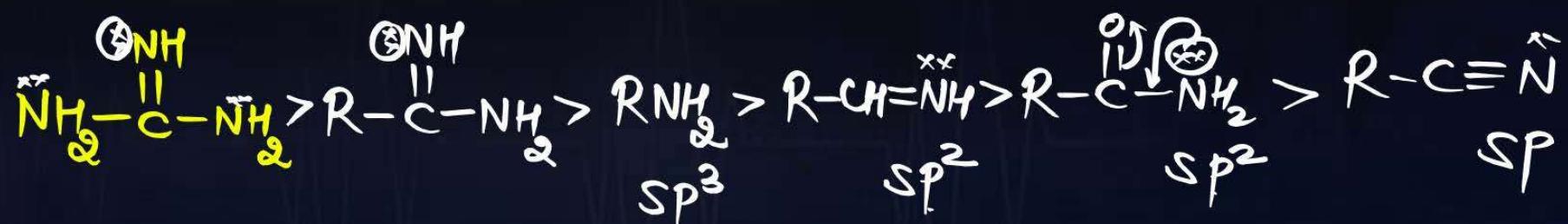
$$\text{B.S} \propto +M, +I \propto \frac{1}{-M \& -I}$$

2. Localized L.P > Delocalized L.P



3. Organic Nitrogenous Bases

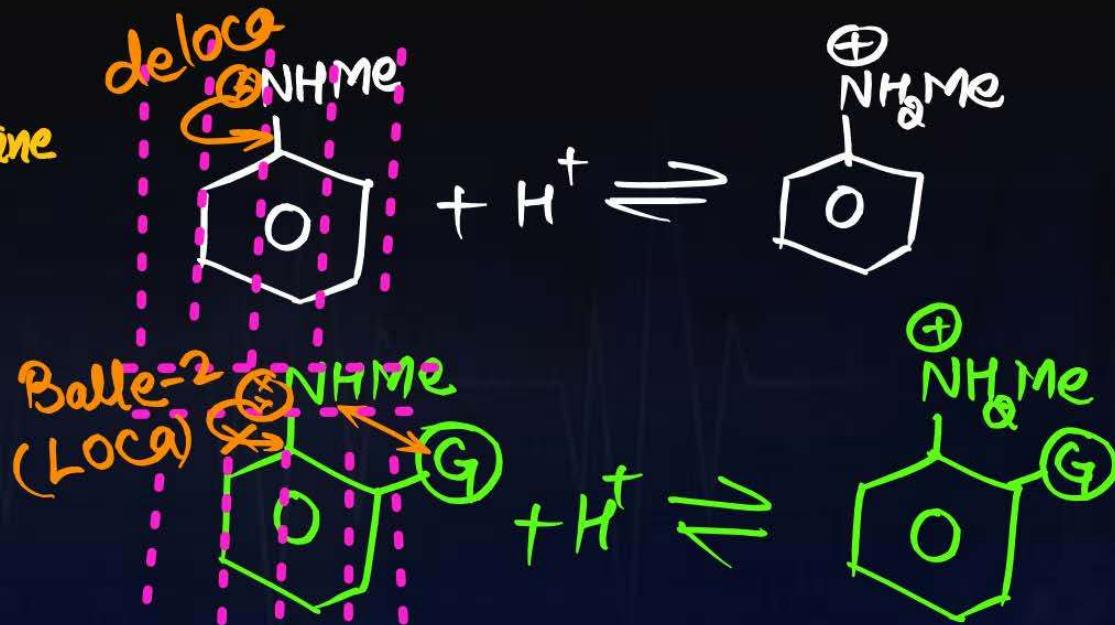
Guanidine > Amidine > Amines > Imines > Amides > Cyanides



4. SIR effect

2° & 3° aro amine
BS ($3^\circ > 2^\circ$)

B.S increases
due to o-sub
aro amines



5. SIP effect

steric inhibition in protonation

$\text{^{\circ} aro amine}$

B.S decreases

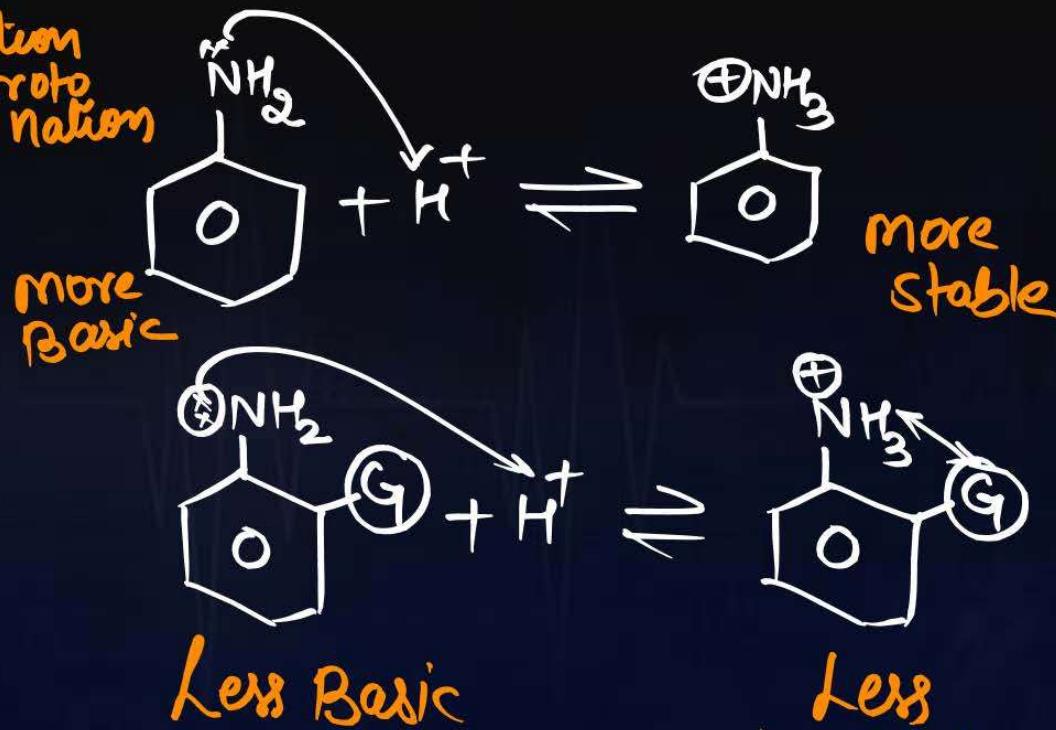
in O-sub $\text{^{\circ} aro amine}$

NHR
 NR_2

Bulky

$\boxed{\text{NH}_2}$ nonbulky

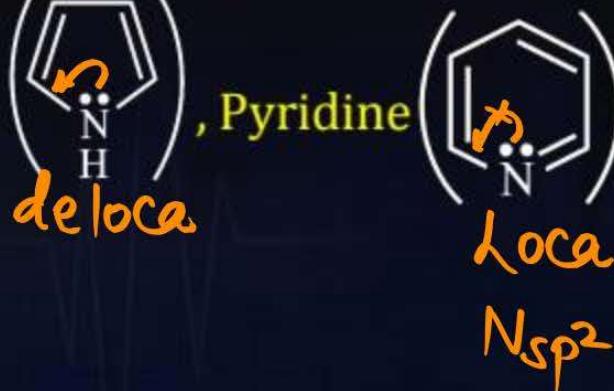
NH_3^+ Bulky



C.Q. 23 (JEE Mains 9th April 2024, Morning Shift)



Correct order of basic strength of Pyrrole



A Piperidine > Pyridine > Pyrrole

C Pyridine > Piperidine > Pyrrole

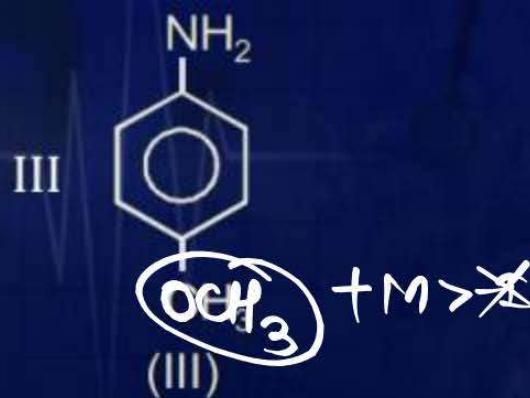
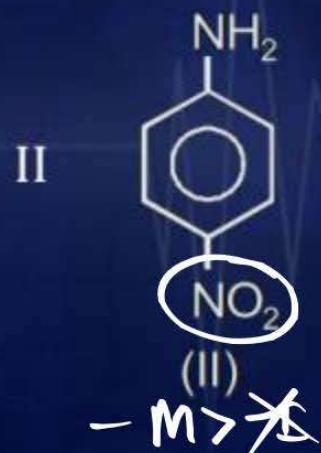
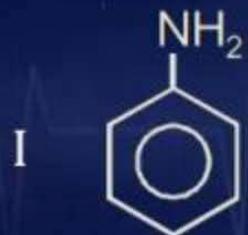
B Pyrrole > Pyridine > Piperidine

D Pyrrole > Piperidine > Pyridine

C.Q. 24 (NEET 2017)



The correct increasing order of basic strength for the following compounds is:



- A $\text{III} > \text{I} > \text{II}$
- C $\text{II} > \text{I} > \text{III}$

- B $\text{III} > \text{II} > \text{I}$
- D $\text{II} > \text{III} > \text{I}$



Hyperconjugation



Definition: It involves delocalization of σ electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p orbital.

alkene/Benzene



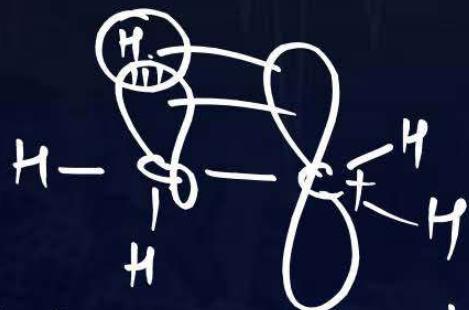
1. Hyperconjugation is a permanent effect.
2. Also Known as No Bond Resonance or Baker-Nathan Effect.

Case 01: In Carbocations

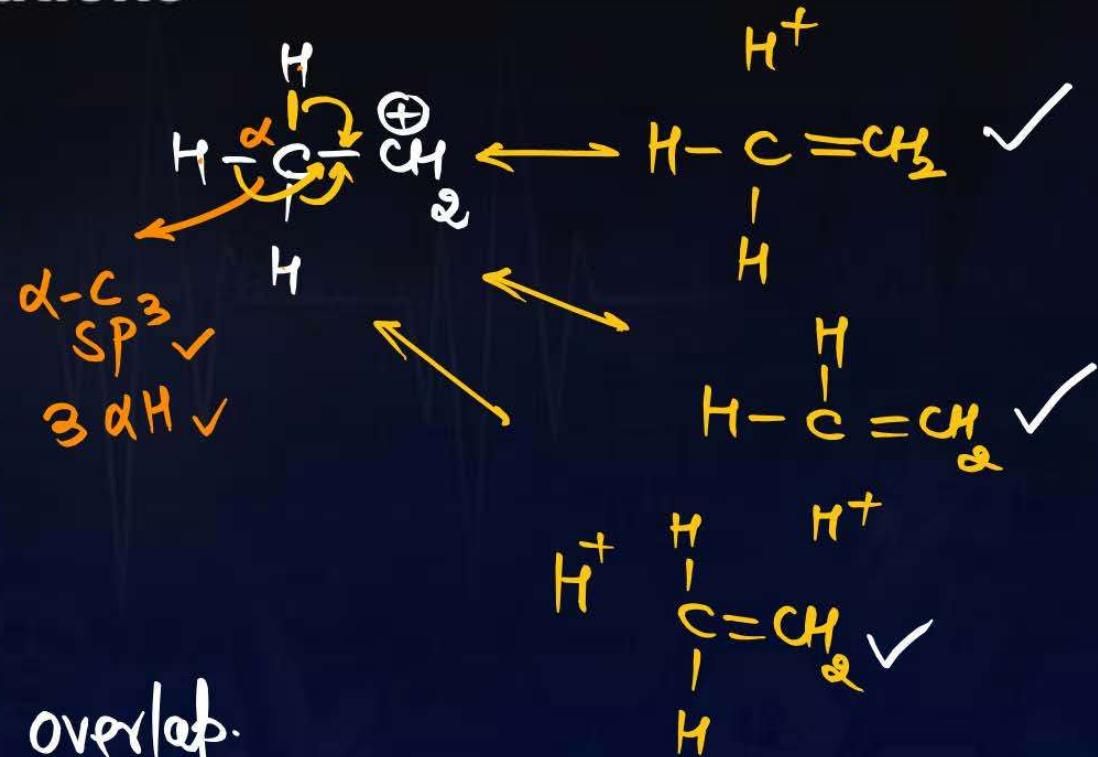
Condⁿ ÷ 1) α -C SP^3

2) at least 1 α -H

α -C
 SP^3 ✓
3 α H ✓



σ SP^3-S & vacant 'P' overlap.
 α -C

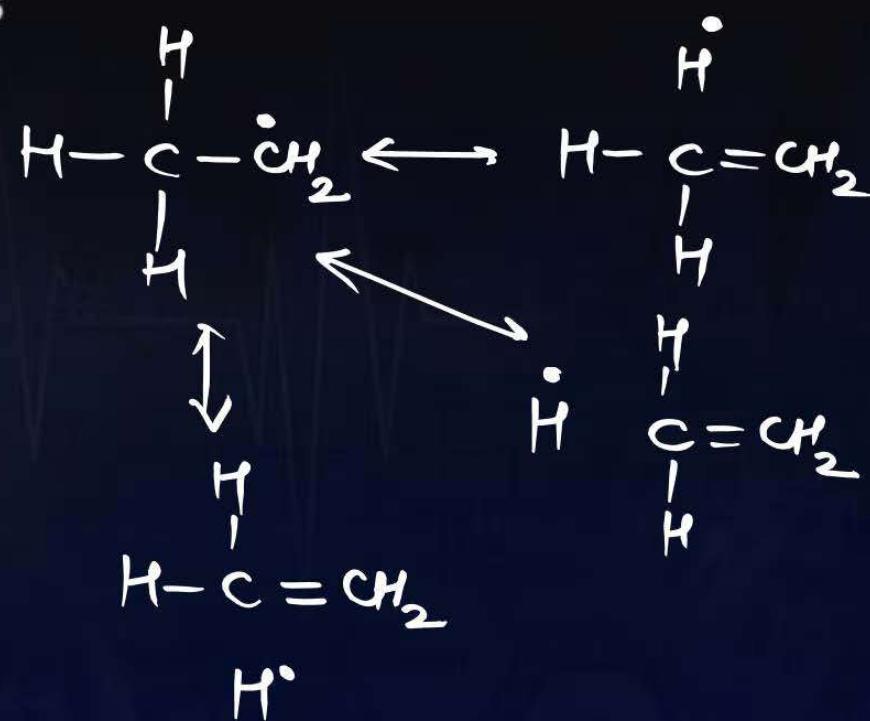


Case 02: In Free radicals

Condⁿ ÷ $\alpha\text{-C } sp^3$
 $\alpha\text{-H at least 1}$

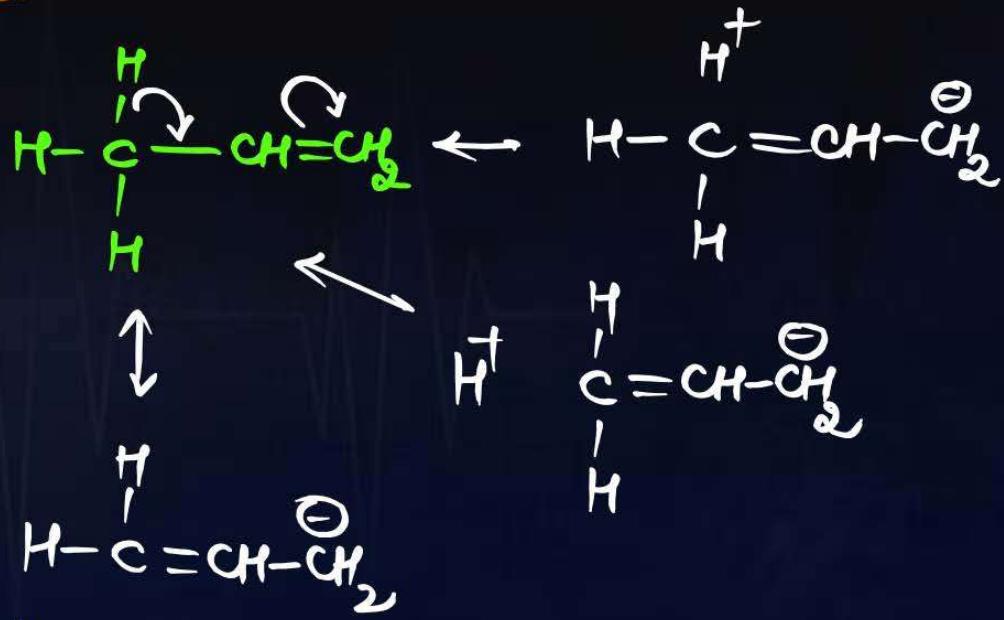
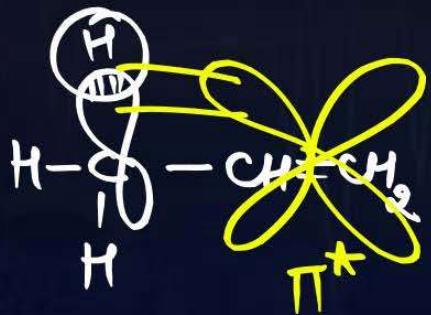


sp^3-s & Half filled 'P'



Case 03: In Alkenes | Benzene

Condⁿ: α -C sp^3
 α H at least 1



σ_{sp^3-s} & vacant π^* orbital H^+

α -C

Total no. of Hyperconjugating Structures

No. of α -H

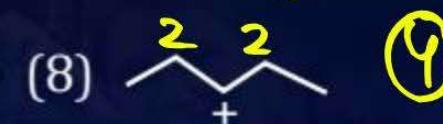
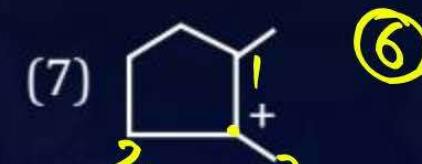
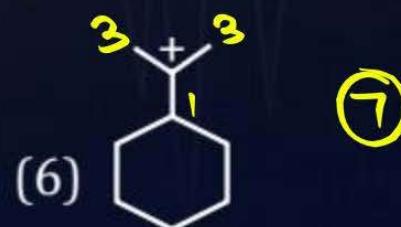
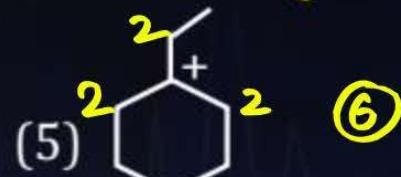
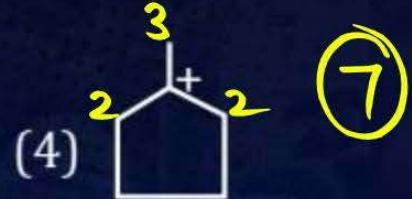
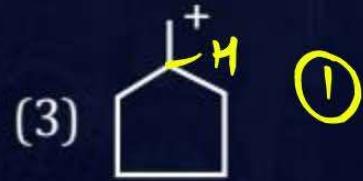
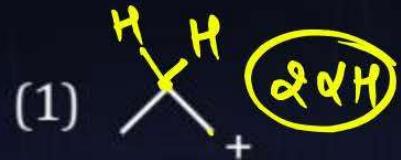
OP Points

1. ~~CO₂ CN~~ cannot show hyper due to high energy of π^* orbital.
2. Hyper conjugative structures (Involving C-H bond breaking) = No. of α -H
3. Hyper conjugative structure = No. of α -H + 1

QUESTION



Find total number of hyper conjugative structure (Involving C-H bond breaking).



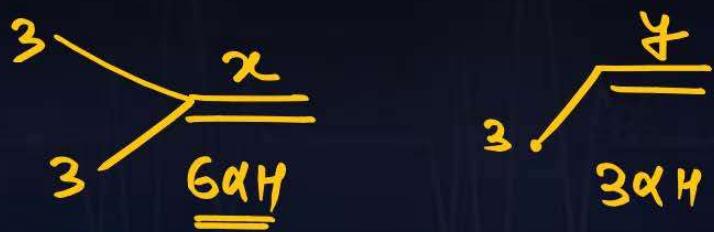
Application of Hyperconjugation

1. To compare stability of Carbocations, Free radicals and Alkenes.

Stability \propto No. of α -H

Application of Hyperconjugation

2. Bond length

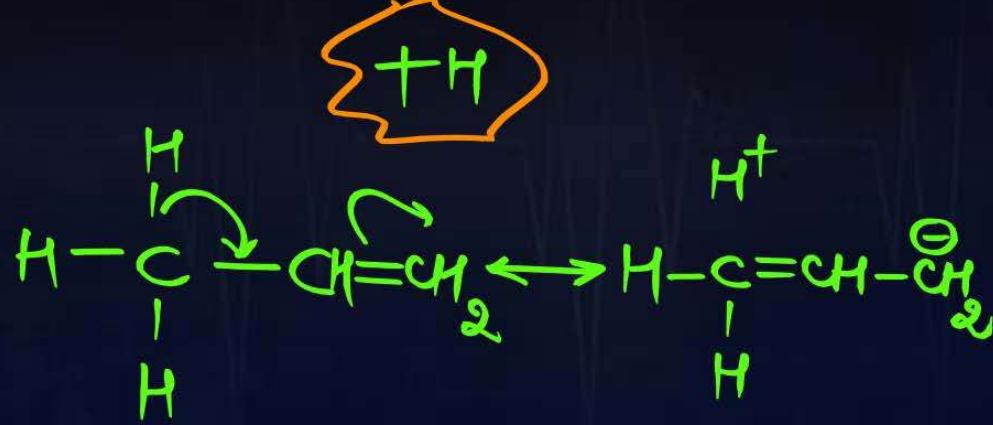


[C=C bond length \propto No of α -H]

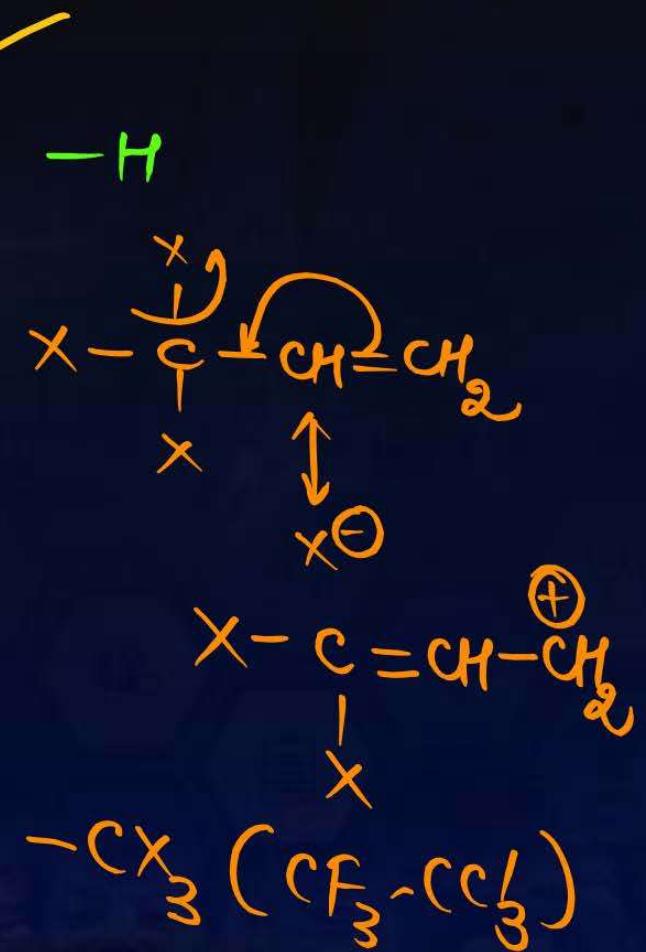
B.L [x > y]

Reverse Hyperconjugation

Delocalization of π electrons to vacant orbital



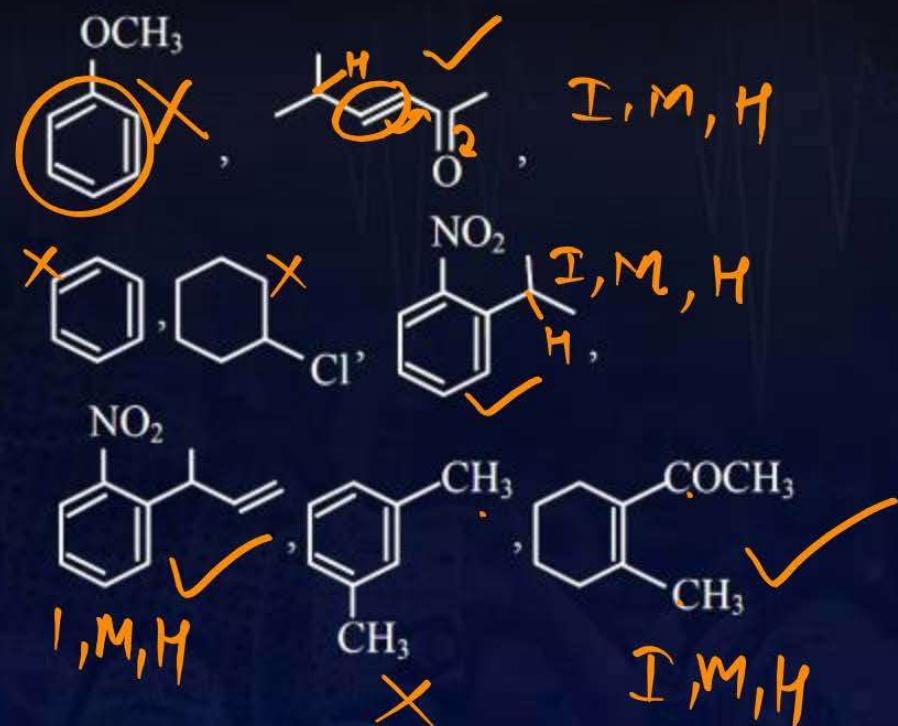
Alkyl group (R)



C.Q. 25 (JEE Mains 9th April 2024, Morning Shift)



How many compounds among the following compounds show inductive, mesomeric as well as hyperconjugation effects?



Ans 4

C.Q. 26 [JEE Mains 27 July 2021]



Given below are two statements:

Statement-I: Hyperconjugation is permanent effect.

Statement-II: Hyperconjugation in ethyl cation ($\text{CH}_3 - \overset{+}{\text{CH}}_2$) involves the overlapping of C_{sp^2} bond with empty $2p$ orbital of other carbon.

Choose the correct option.

- A Statement-I is false but Statement -II is true.
- B Statement-I is true but Statement-II is false.
- C Both Statement-I and Statement-II are false.
- D Both Statement-I and Statement-II are true.

C.Q. 27



PW

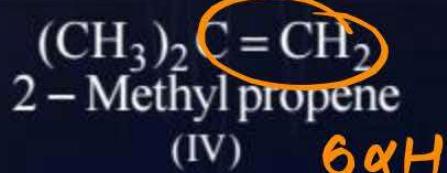
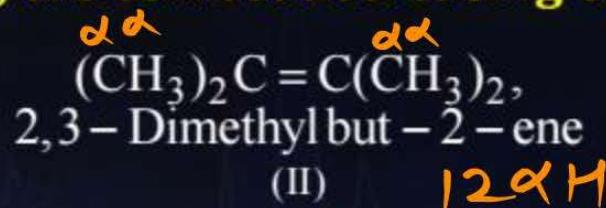
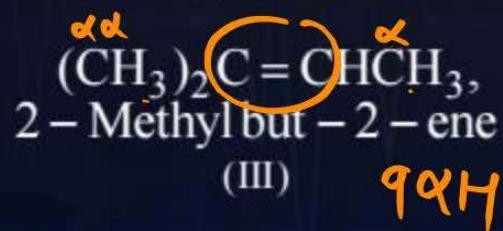
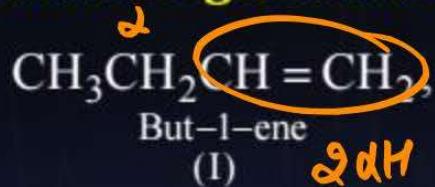
Assertion: 2, 3-Dimethylbut-2-ene is more stable than but-2-ene.

Reason: Six hyperconjugation structures can be written for 2, 3-dimethylbut-2-ene while but-2-ene has twelve.

- A Both Assertion and Reason are correct and Reason is the correct explanation for Assertion.
- B Both Assertion and Reason are correct but Reason is not the correct explanation for Assertion.
- C Assertion is correct but Reason is incorrect.
- D Both Assertion and Reason are incorrect.

C.Q. 28

Considering the following alkenes, the correct decreasing order of stability is:

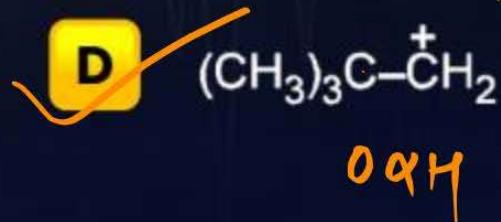
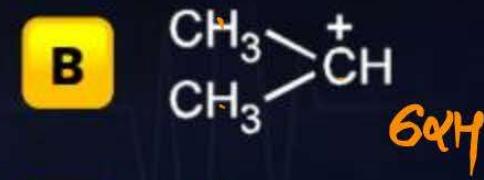
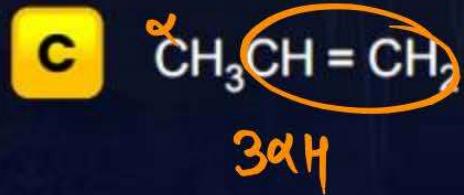


- A I > II > III > IV
- B II > III > IV > I
- C IV > III > II > I
- D III > IV > I > II

C.Q. 29



Which of the following cannot exhibit hyperconjugation?





Aromaticity

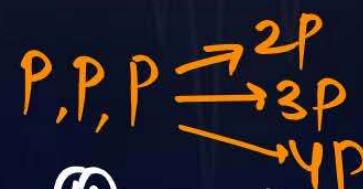
PW

1, 2, 3 main koi bhi ek fail
Nonaro

1. Cyclic ankho se dekh kar

2. Planar each atom $\rightarrow \text{SP}^2$

3. Conjugation



4. Huckel's Rule

$$(4n+2)\pi e^-$$

$$n = 0, 1, 2, 3$$

$$2\pi e^- \quad 6\pi e^- \quad 10\pi e^- \quad 14\pi e^-$$

Aro

④ Sizzi's rule

$$4n\pi e^-$$

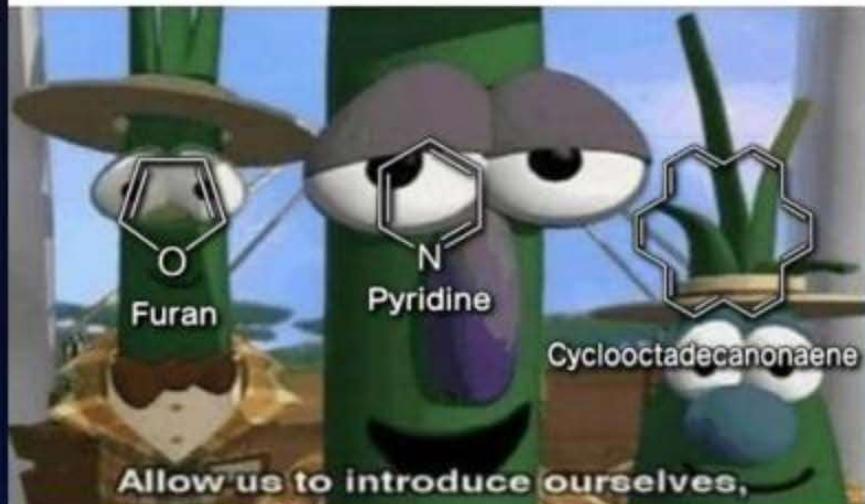
$$n = 1, 2, 3, \dots$$

$$4 \quad 8 \quad 12$$

Anti Aro

Me: "All aromatic compounds have a benzene ring!"

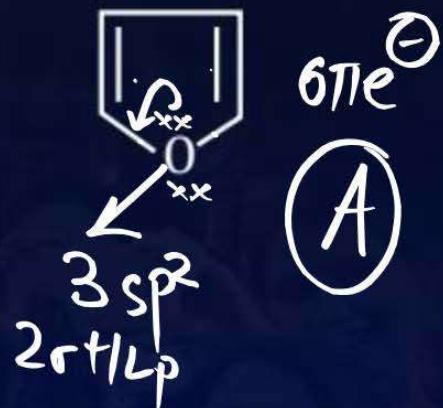
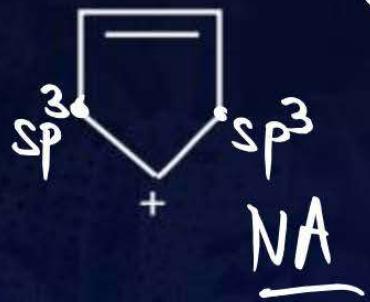
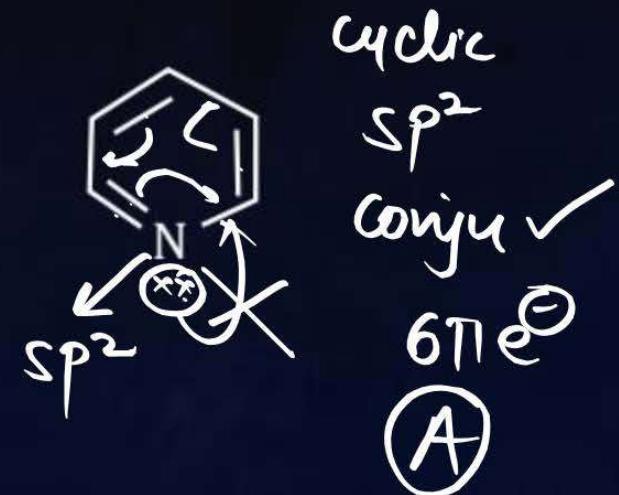
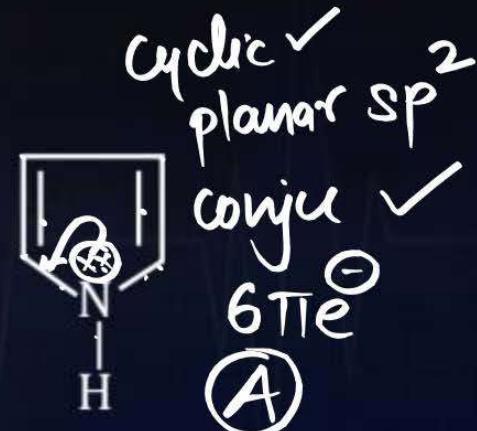
Organic Chemistry:



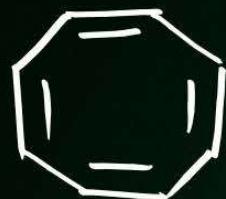
QUESTION

PW

Comment on Aromaticity.



[8]-Annulene



Non aro due to tub like struc

Non planar



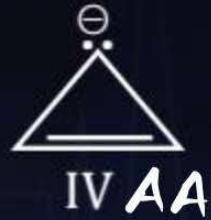
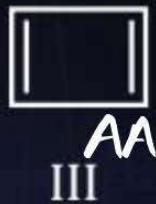
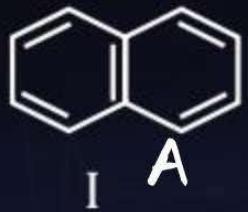
[10]-Annulene Non aro due to non planarity



C.Q. 30 (NEET 2023)

PW

Consider the following compounds/species:



The number of compounds/species which obey Huckel's rule is.....

A 5

C 6

B 4

D 2

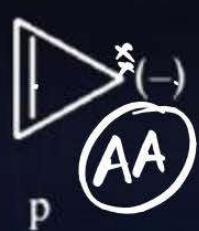
Ar⁰

Application of Aromaticity

1. Stability of Intermediates

~~A > NA > AA~~

The correct stability order of the following species/molecules is:

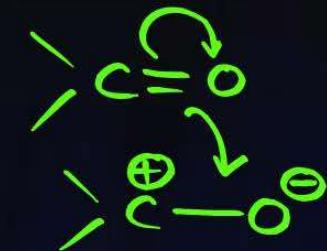
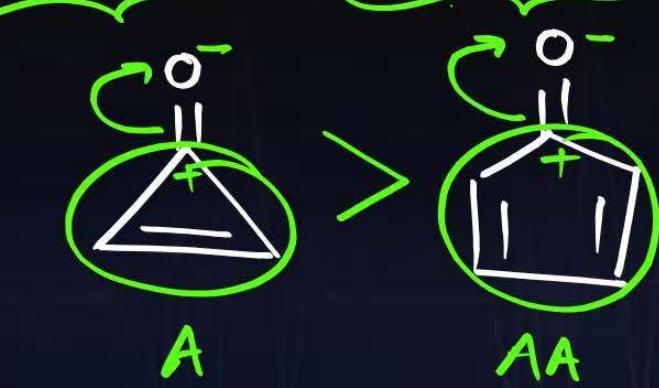


- A q > p > r
C r > q > p

- B p > q > r
D q > r > p

D q > r > p

2. Dipole moment, Bond Length and Rate of Protonation



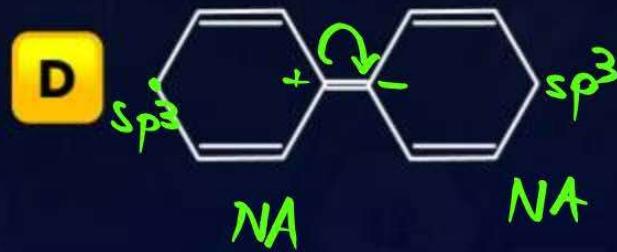
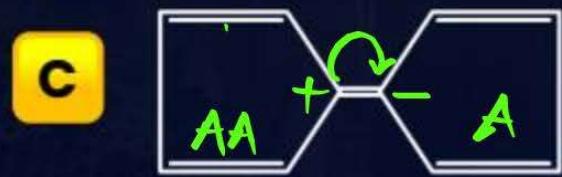
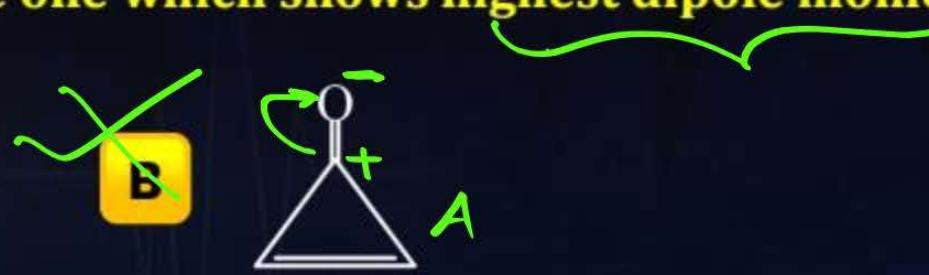
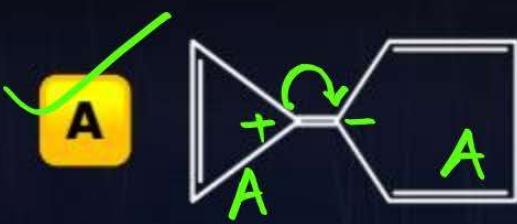
DM ↑ BL ↑

Rate of proto ↑

C.Q. 32 [JEE Mains 13 April 2023]



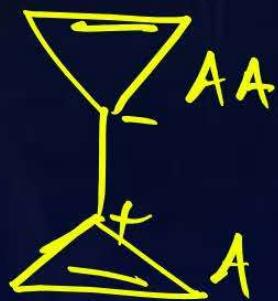
Among the following compounds, the one which shows highest dipole moment is:



3. Rotational Energy Barrier

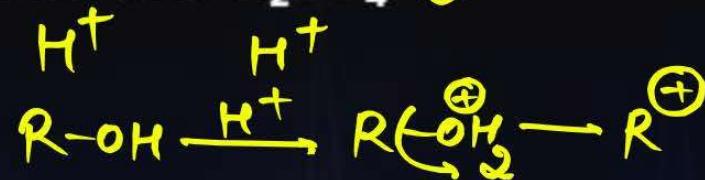


A hand-drawn circle containing the mathematical inequality symbol " $<$ ".

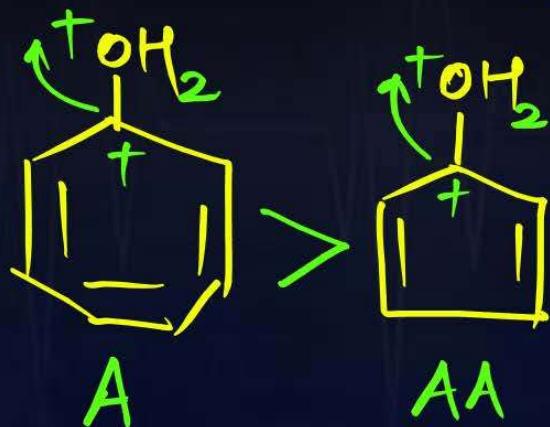


4. Reactivity with HX and H_2SO_4 ✓

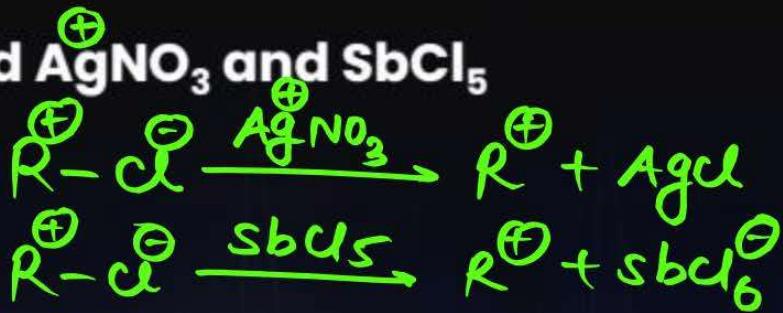
PW



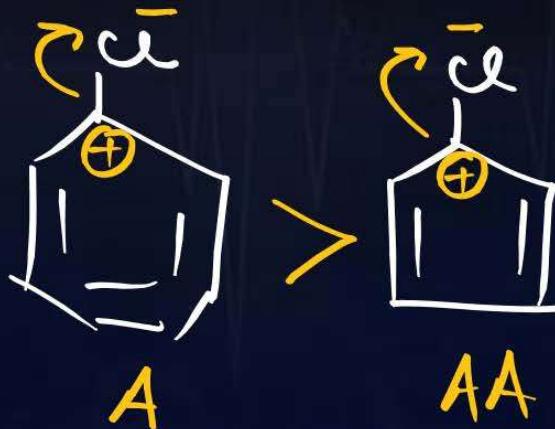
Stability of $\text{R}^\oplus \uparrow$ $\text{ROR} \uparrow$



5. Reactivity toward AgNO_3 and SbCl_5



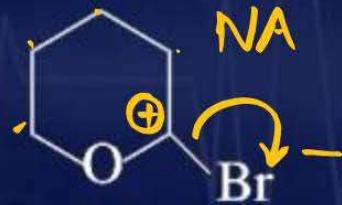
R^{\oplus} stab↑ ROR↑



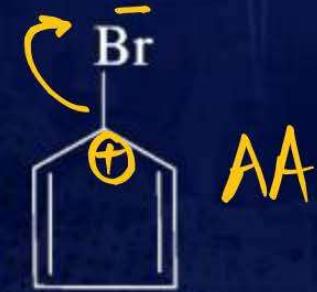
C.Q. 33

Among the following which is more reactive toward AgNO_3 ?

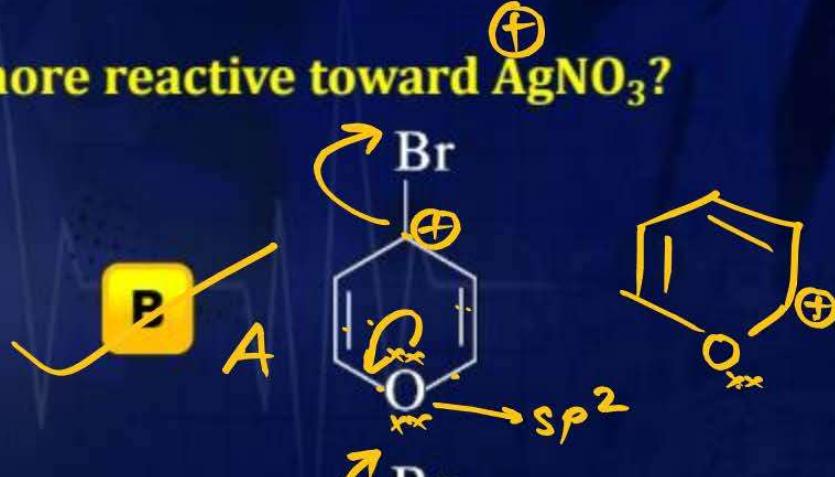
A



C



B

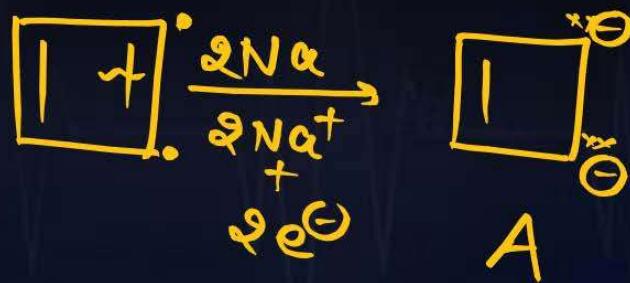


D

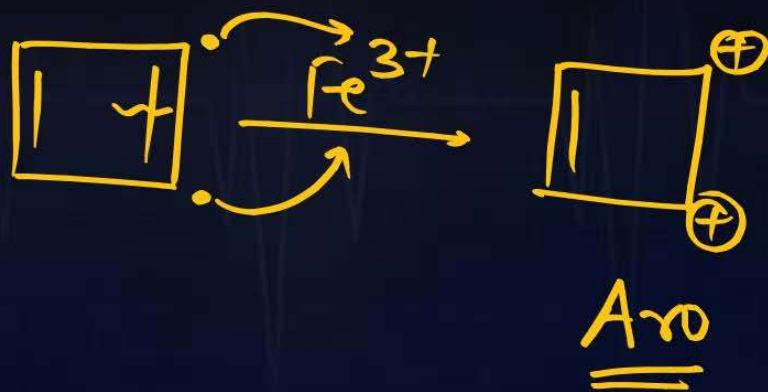


NA

6. Reaction with Na, K & Al



7. Reaction with Fe^{3+}





Stability of Intermediates



BB > Aro > M > H > I
(α P)
(Conjy)

Stability of Carbocations

Definition: Formed by Heterolytic bond breaking.



6 e⁻
1 vacant 'p' orbital
dia
MM = 0

C.Q. 34 (JEE Mains 2025, 22 January Shift-2)



The most stable carbocation from the following is:

$C > B > D > A$

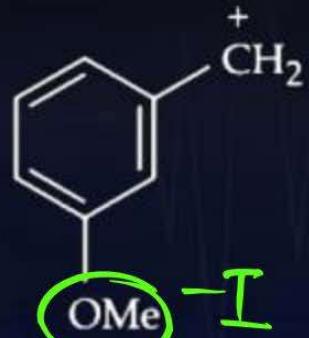
Stability of δ^+

$\alpha + M, + H, + I$

$\alpha \frac{1}{-M, -H, -I}$

$[M > H > I]$

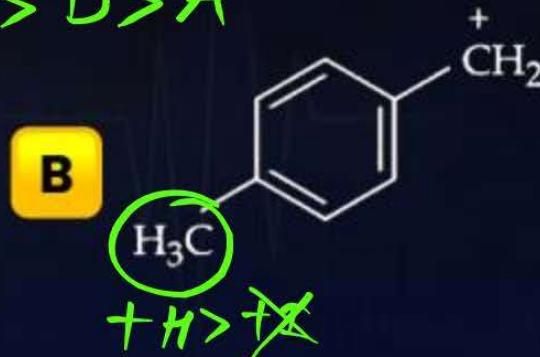
A



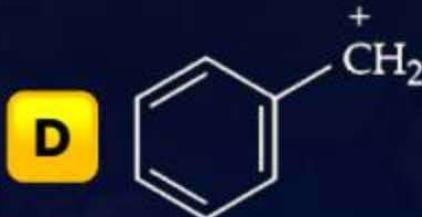
C



B



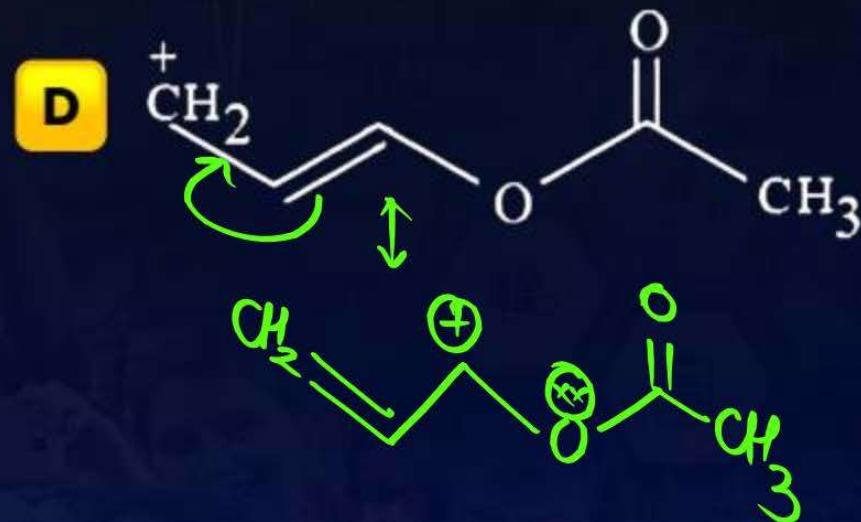
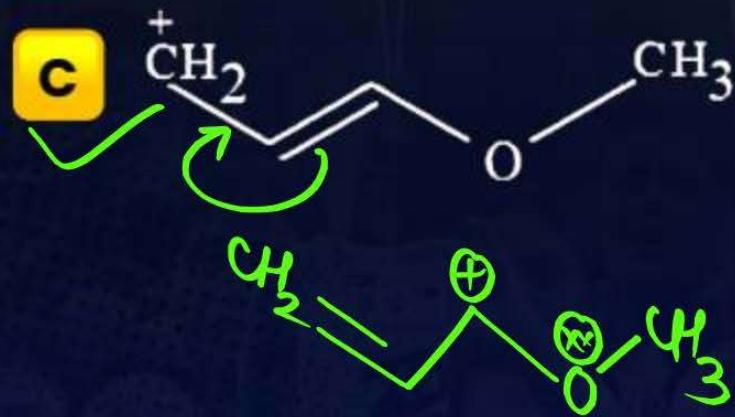
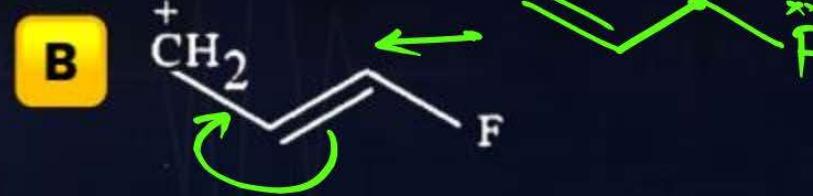
D



C.Q. 35 (JEE Mains 2025, 24 January Shift-1)



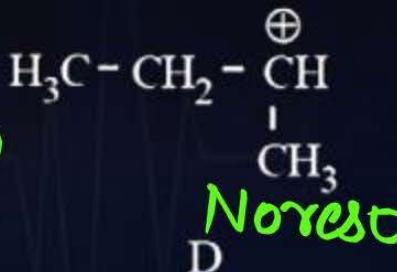
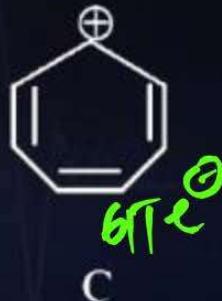
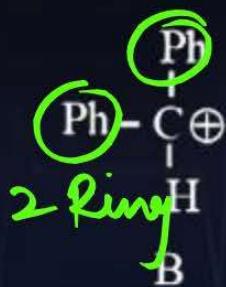
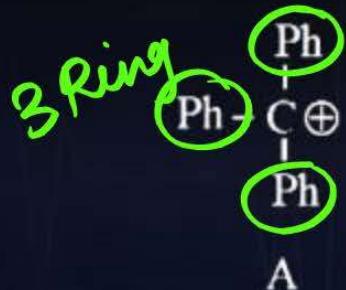
Which one of the carbocations from the following is most stable?



C.Q. 36 (JEE Mains 2025, 28 January Shift-1)

PW

The correct order of stability of following carbocations is:



BB X
ArQ ✓
M ✓

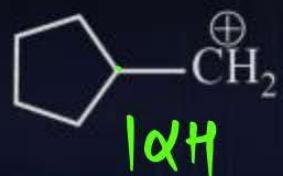
- A** C > A > B > D
- B** A > B > C > D
- C** C > B > A > D
- D** B > C > A > D

C.Q. 37 (NEET 2024)

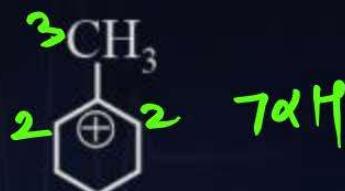
PW

The most stable carbocation among the following is:

A



B



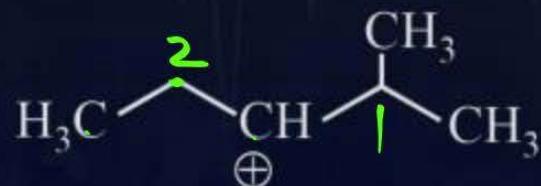
BB X

Am X

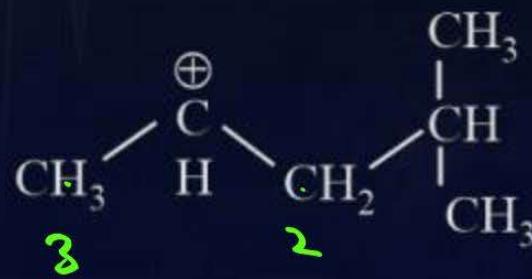
M X

H

C



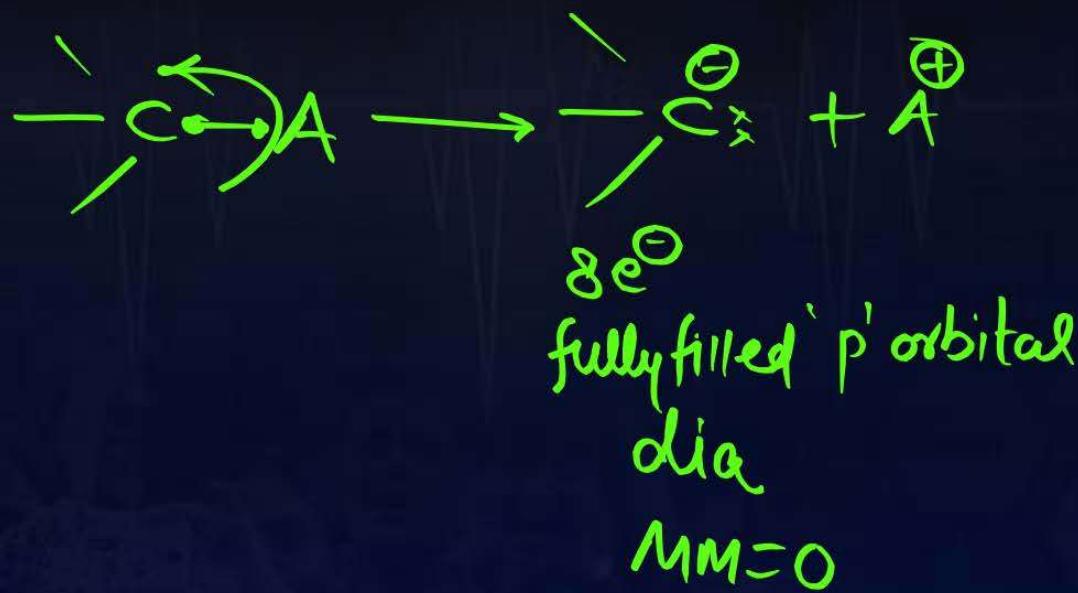
D



$B > D > C > A$

Stability of Carbanion

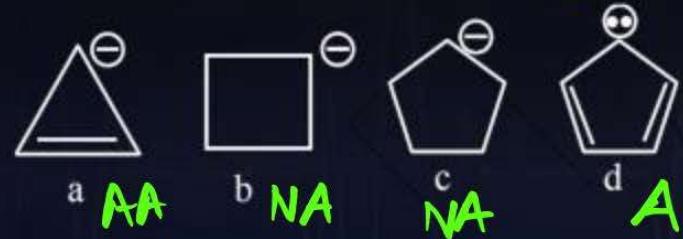
Definition: Formed by Heterolytic bond breaking.



C.Q. 38 (JEE Mains 4th April 2024, Evening Shift)

PW

Correct order of stability of carbanion is:



A $c > b > d > a$

$d >$ $c > b$

B $a > b > c > d$

C $d > a > c > b$

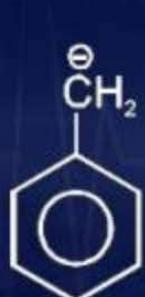
D $d > c > b > a$

Stability of ring
6 > 5 > 4 > 3

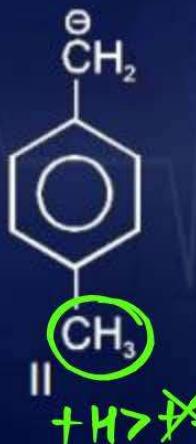
C.Q. 39

Stability of $\text{C}^\ominus \propto -M, -H, +I \propto \frac{1}{+M, +H, +I}$

Arrange the following carbanions in decreasing order of stability:



I



II
 $+H > \cancel{X}$



III
 $-M > \cancel{X}$



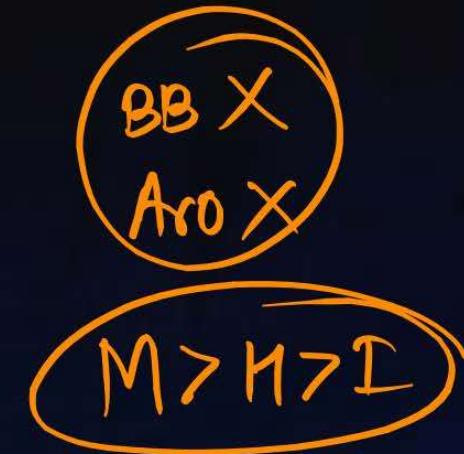
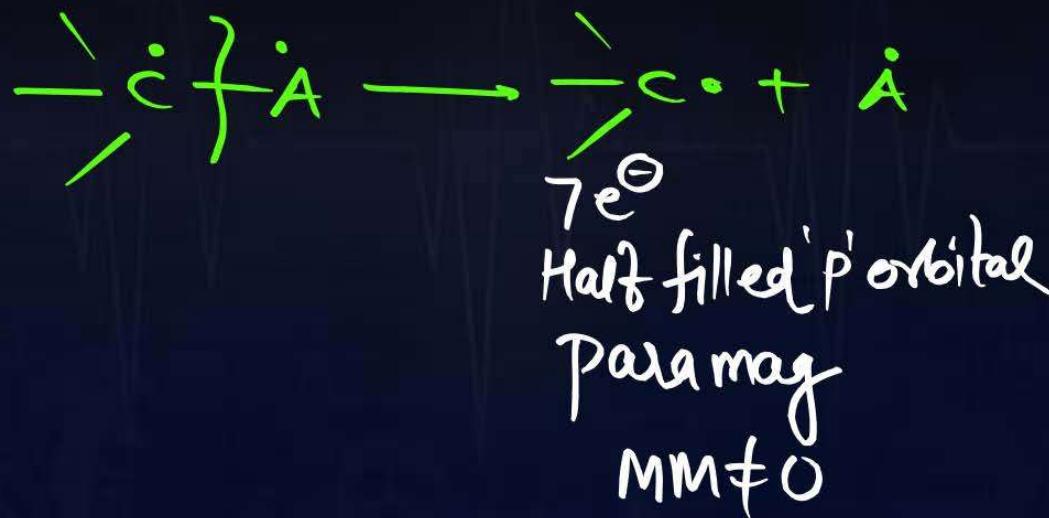
IV
 $+M > \cancel{X}$

- A $\cancel{X} \text{ III} > \text{II} > \text{IV} > \text{I}$
- C $\cancel{X} > \text{III} > \text{II} > \text{IV}$

- B $\cancel{X} \text{ III} > \text{II} > \text{I} > \text{IV}$
- D $\cancel{X} \text{ III} > \text{I} > \text{II} > \text{IV}$

Stability of Free Radical

Definition: Formed by Homolytic bond breaking.



The increasing order of stability of the following free radicals is:

- A** $(C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C} < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$
- B** $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C}$ 3 ring
 6dH 9dH
- C** $(CH_3)_3\dot{C} < (CH_3)_2\dot{C}H < (C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C}$
- D** $(C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

C.Q. 41



Which of the following statements is wrong?

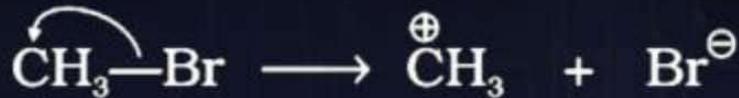
- A A tertiary free radical is more stable than a secondary free radical.
- B A secondary free radical is more stable than a primary free radical.
- C A tertiary carbocation is more stable than a secondary carbocation.
- D A primary carbocation is more stable than a secondary carbocation.

C.Q. 42 (NCERT Exercise)

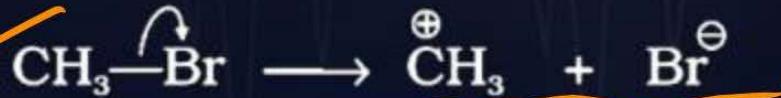


Covalent bond can undergo fission in two different ways. The correct representation involving a heterolytic fission of $\text{CH}_3\text{-Br}$ is:

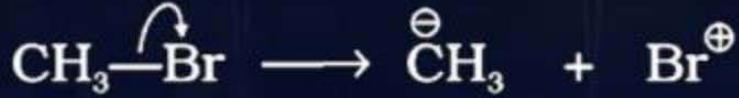
A



B



C



D



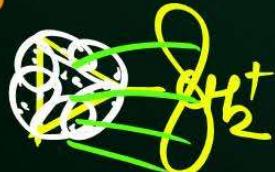
Op point

γ -S \uparrow EN \uparrow



3Me + I

④ Dancing reso



⑤ BE of C-H bond

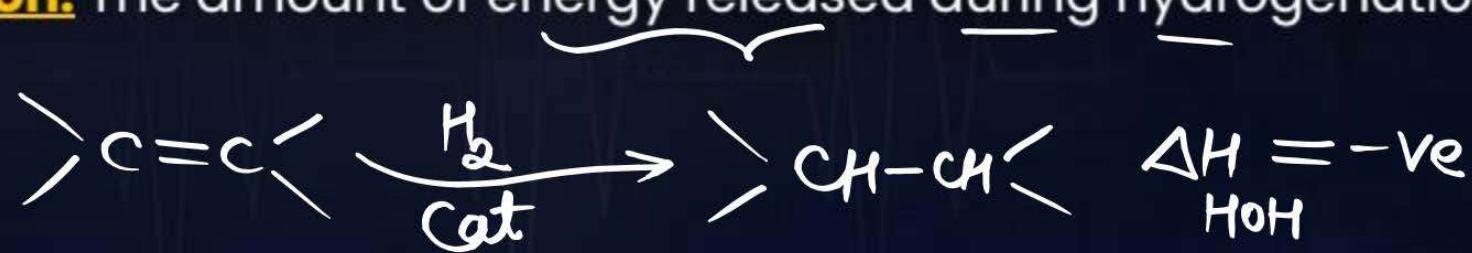
$\propto \frac{1}{\text{stability of C}}$





Heat of Hydrogenation

Definition: The amount of energy released during hydrogenation reaction.



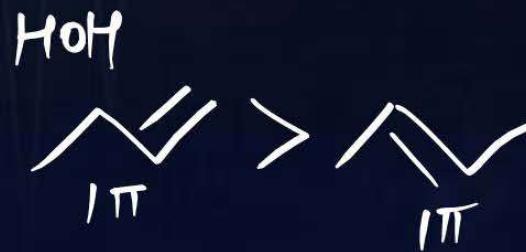
Compare Heat of Hydrogenation

① $\text{HOH} \propto \text{No. of } \pi \text{ bond}$



② If No. of π bonds are same

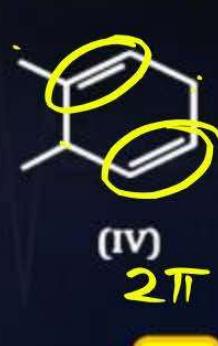
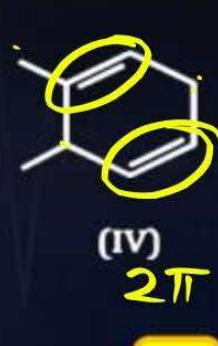
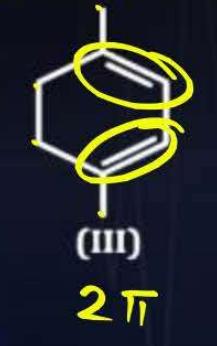
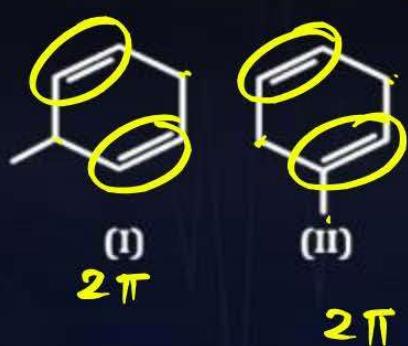
$\text{HOH} \propto \frac{1}{\text{Stability}}$



C.Q. 43

PW

The order of heat of hydrogenation in following compound is:



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

C.Q. 44

PW

Assertion: Heat of hydrogenation of $\text{CH}_2 = \text{CH}_2$ is greater than $\text{CH}_3\text{CH} = \text{CH}_2$. $\text{H}\pi$

Reason: $-\text{CH}_3$ give additional effect to double bond. $+\text{H}$

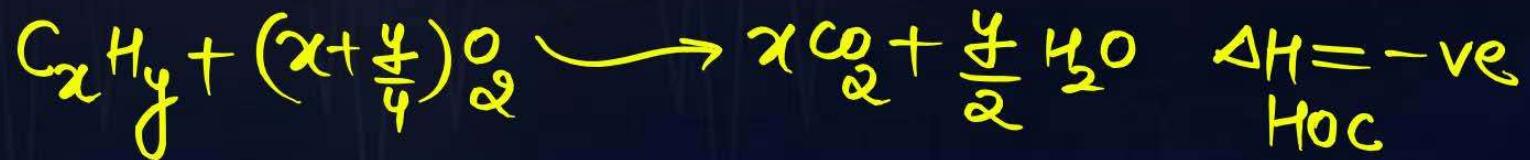
- A Both Assertion and Reason are correct and Reason is the correct explanation for Assertion.
- B Both Assertion and Reason are correct but Reason is not the correct explanation for Assertion.
- C Assertion is correct but Reason is incorrect.
- D Both Assertion and Reason are incorrect.



Heat of Combustion



Definition: The amount of energy released during combustion reaction.



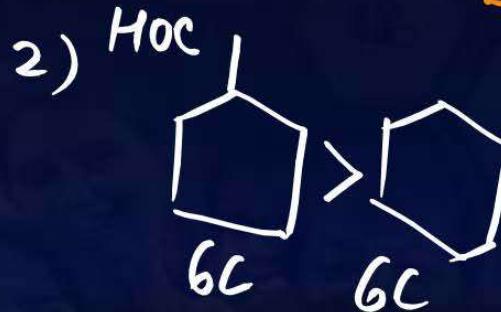
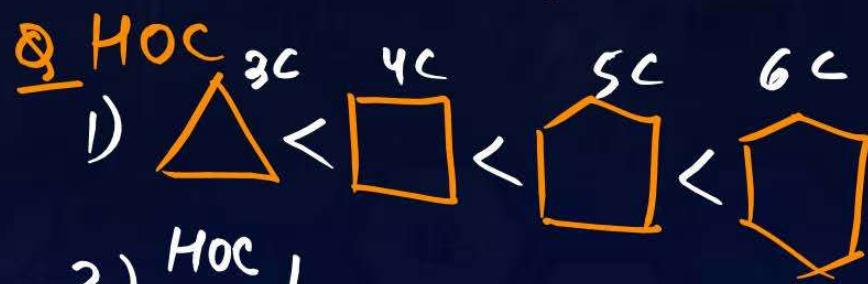
Compare Heat of Combustion



① $\text{HOC} \propto \text{No. of 'C' atoms}$

② If No. of 'C' atoms same

$\text{HOC} \propto \frac{1}{\text{Stability}}$



C.Q. 45

PW



Cyclopropane

(i)



Cyclobutane

(ii)



Cyclopentane

(iii)

The correct order of heats of combustion of above compounds is:

A (i) > (ii) > (iii)

B (ii) > (i) > (iii)

C (iii) > (ii) > (i)

D (iii) > (i) > (ii)





Resonance Energy



① > ②
R-S

③
R-H

Definition: The potential energy difference between resonance hybrid and most stable resonating structure.

1. R.E is always negative.
2. R.E can be calculated by HOH data.

Thermochem

$$RE = E_3 - E_1$$

Energy of R-H Energy of Most stable

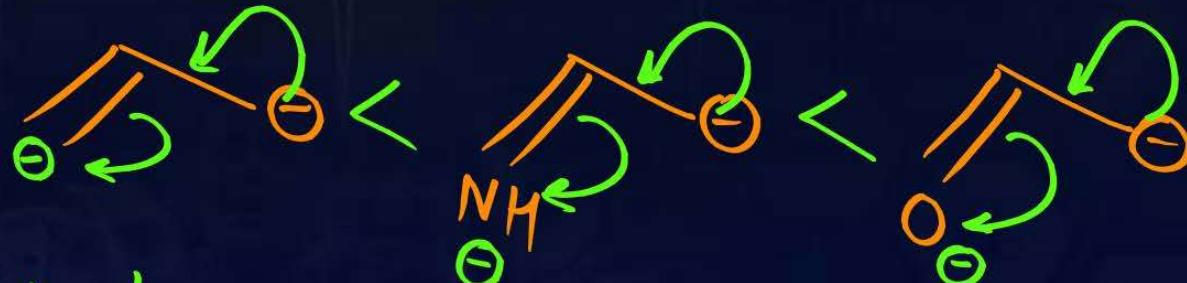
Compare Resonance Energy

[R.E \propto Extent of Resonance]

1)



2)



3) Ext > cross

C.Q. 46 (NCERT Exemplar)



Assertion (A): Energy of resonance hybrid is equal to the average of energies of all canonical forms.

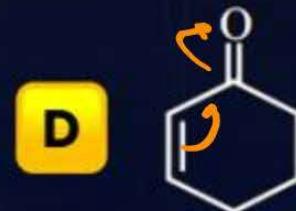
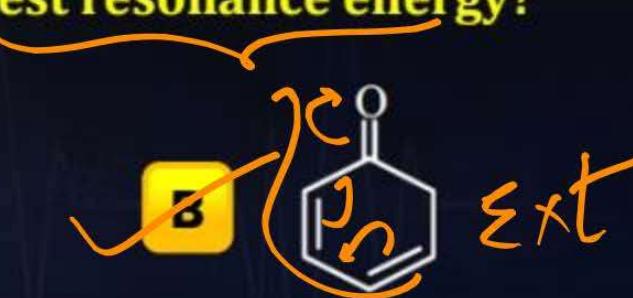
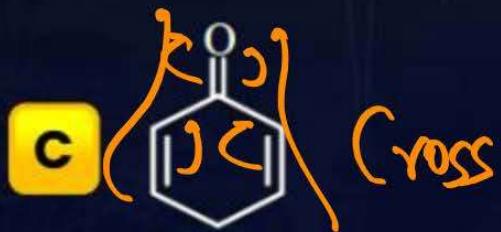
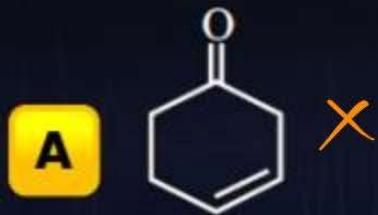
Reason (R): Resonance hybrid cannot be presented by a single structure.

- A** Both A and R are correct and R is the correct explanation of A.
- B** Both A and R are correct but R is not the correct explanation of A.
- C** Both A and R are not correct.
- D** A is not correct but R is correct.

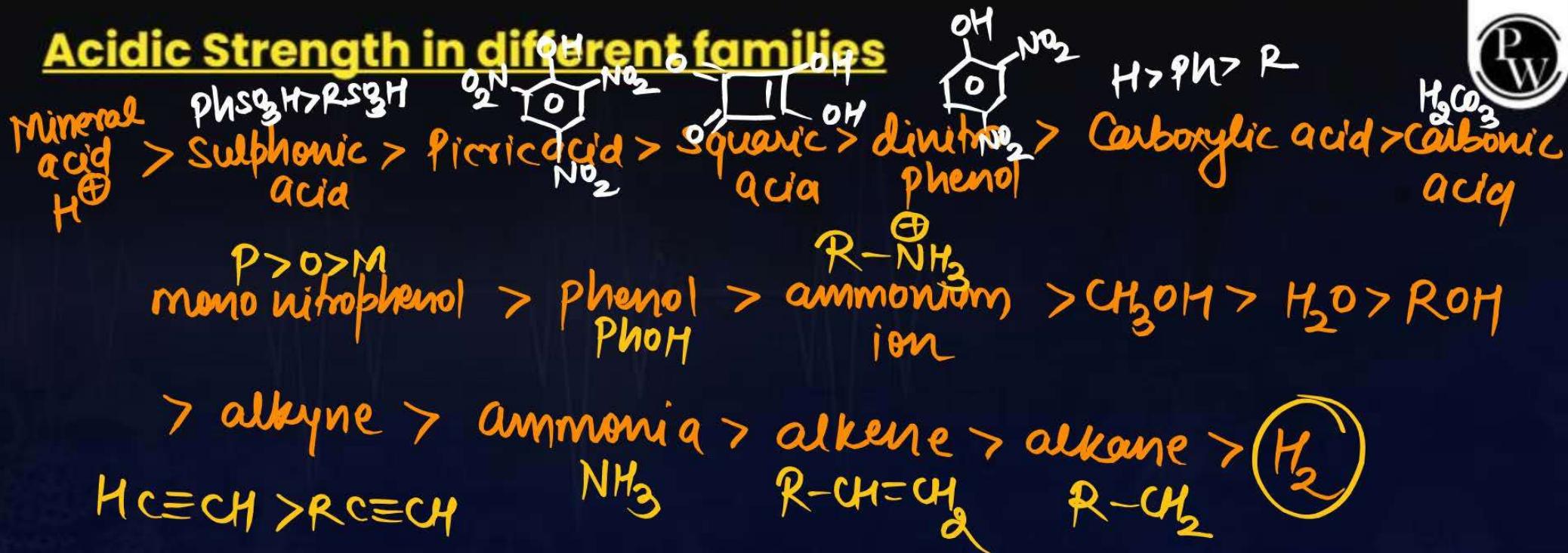
C.Q. 47

PW

Which of the following has highest resonance energy?



Acidic Strength in different families



C.Q. 48 (NEET 2017)



Which one is the correct order of acidity?

- A $\text{CH} \equiv \text{CH} > \underline{\text{CH}_3 - \text{C} \equiv \text{CH}} > \text{CH}_2 = \text{CH}_2 > \text{CH}_3 - \text{CH}_3$ ✓ $\begin{matrix} \nearrow \text{s} \uparrow & \nearrow \text{EN} \uparrow \\ \underline{\text{C}} \Theta \uparrow \end{matrix}$
- B $\text{CH} \equiv \text{CH} > \text{CH}_2 = \text{CH}_2 > \text{CH}_3 - \text{C} \equiv \text{CH} > \text{CH}_3 - \text{CH}_3$
- C $\text{CH}_3 - \text{CH}_3 > \text{CH}_2 = \text{CH}_2 > \text{CH}_3 - \text{C} \equiv \text{CH} > \text{CH} \equiv \text{CH}$
- D $\text{CH}_2 = \text{CH}_2 > \text{CH}_3 - \text{C} \equiv \text{CH} > \text{CH}_3 - \text{CH}_3 > \text{CH} \equiv \text{CH}$

C.Q. 49 (AIPMT 2003)



Which of the following orders of acidic strength is correct?

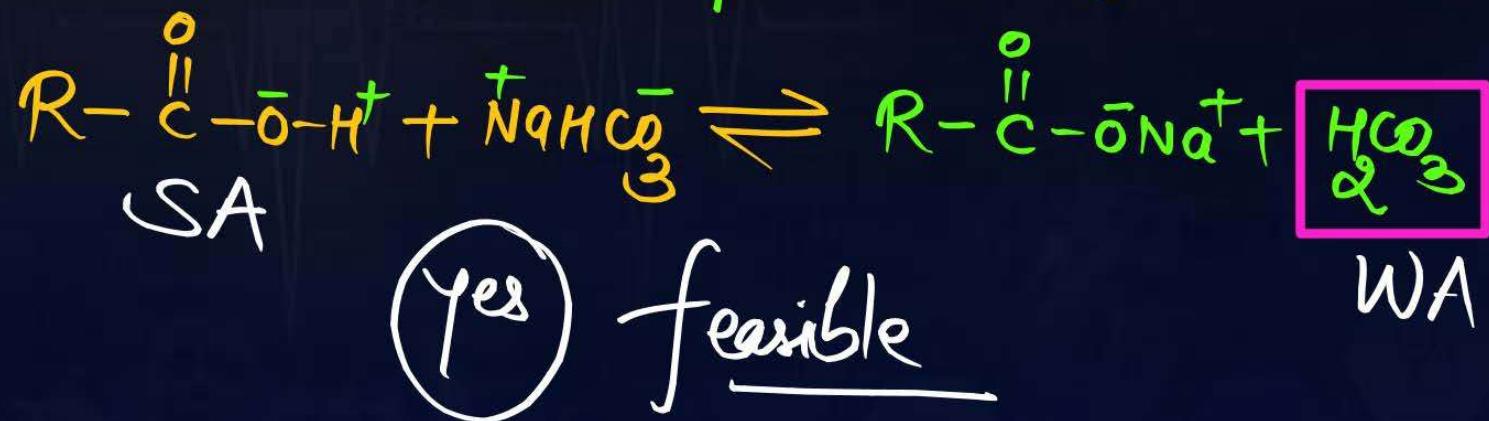
- A RCOOH > ROH > HOH > HC ≡ CH
- B RCOO⁻H⁺ > HOH⁻ > ROH⁻ > HC ≡ CH⁺
~~RCOO~~
- C RCOOH > HOH > HC ≡ CH > ROH
- D RCOOH > HC ≡ CH > HOH > ROH

Application of Acidic Strength in different families

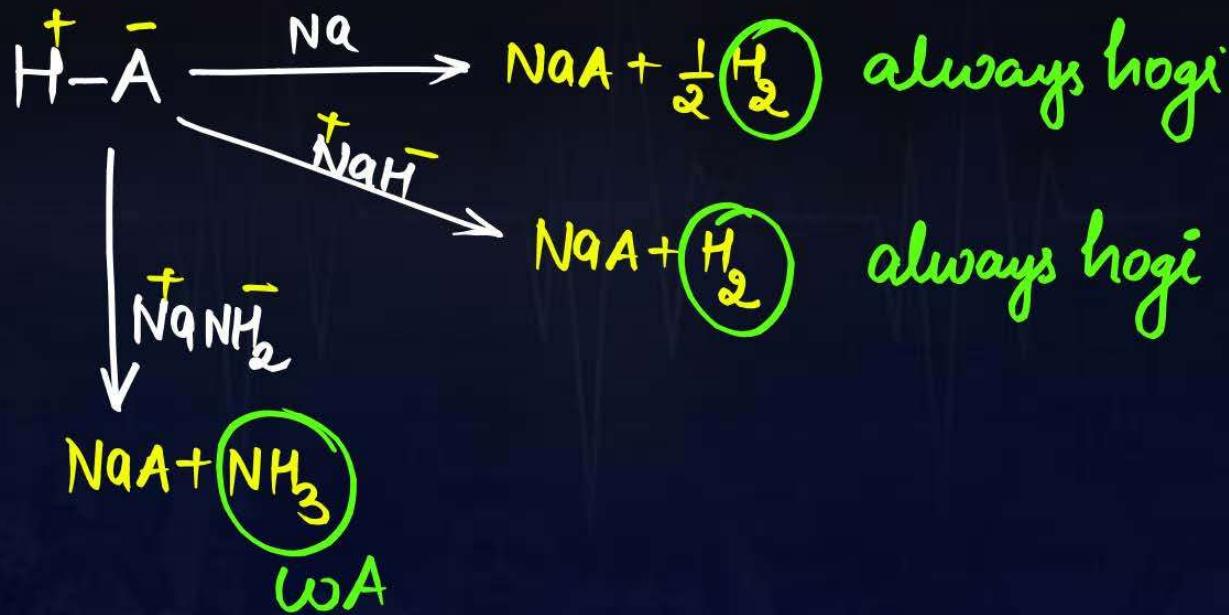


How to check the feasibility of Reaction on microseconds in Pankaj sir's style

The Rxn will proceed in the production of weaker acid

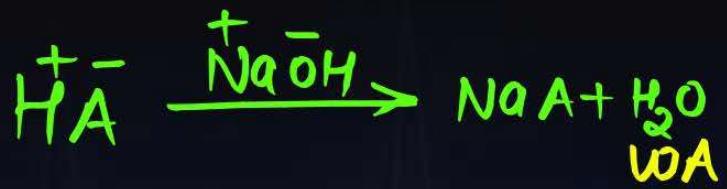


1. Na, NaH & NaNH₂ Test



As of HA > NH₃

2. NaOH Test

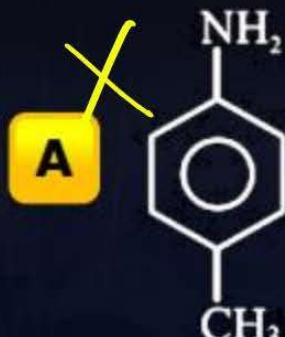


~~A.s of H.A > A.s of H₂O~~

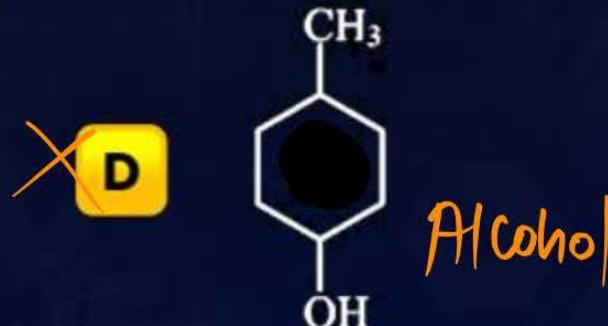
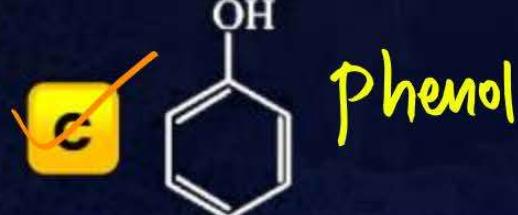
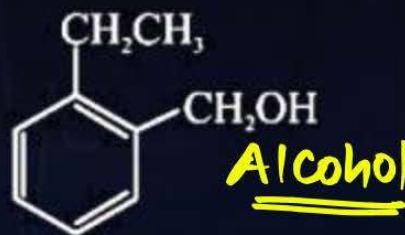
C.Q. 50

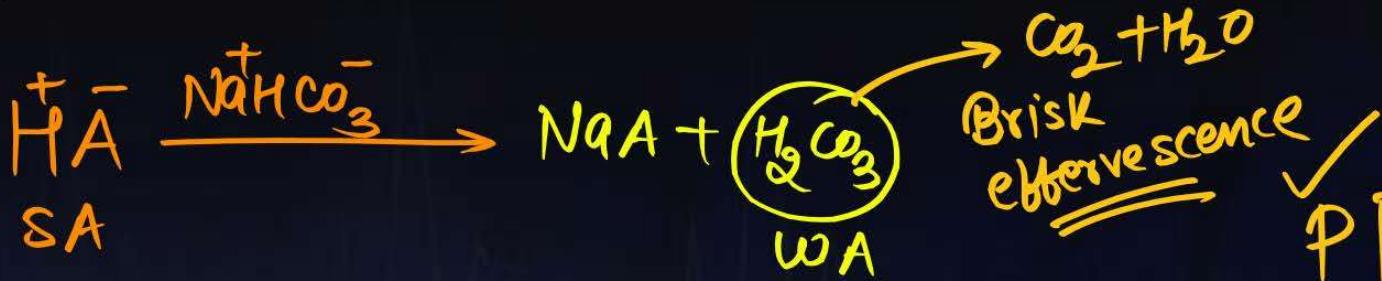
PW

Which of the following are soluble in aq. NaOH solution?



$\text{A.s of HA} > \text{A.s of H}_2\text{O}$

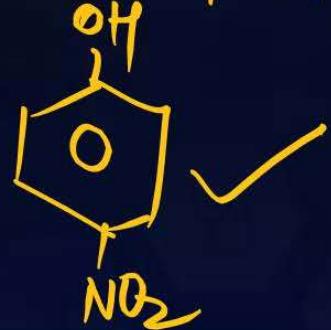


3. NaHCO_3 Test

~~P TOM~~

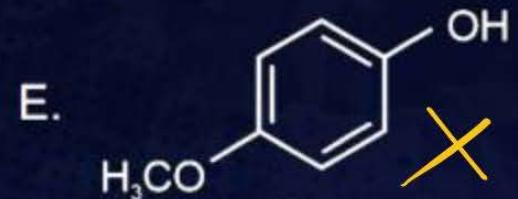
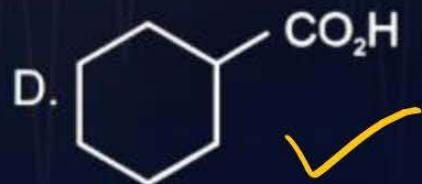
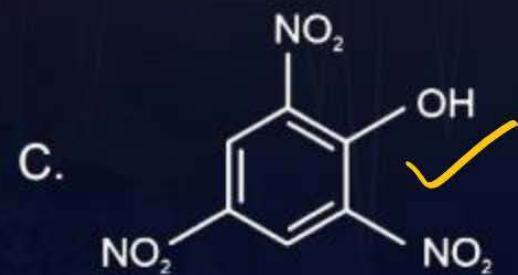
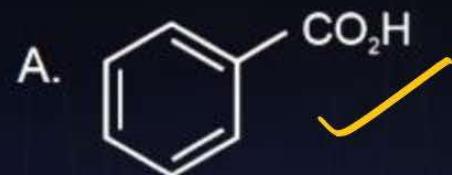
~~AS of HA > AS of HCO_3^-~~

Paranitrophenol



C.Q. 51 (JEE Mains 2025, 28 January Shift-1)

The compounds that produce CO_2 with aqueous NaHCO_3 solution are:



Choose the *correct* answer from the options given below:

- A** A, B and E Only
- B** A and C Only
- C** A, C and D Only
- D** A and B Only

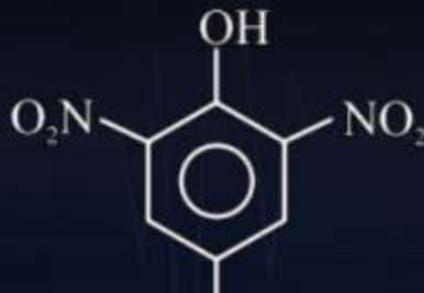
C.Q. 52

PW

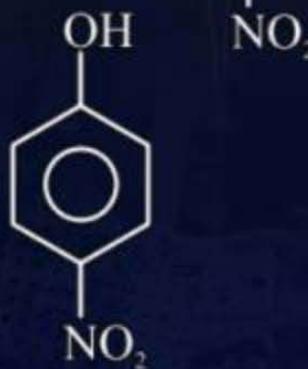


Compound which is soluble in NaOH & NaHCO₃ both?
Insoluble

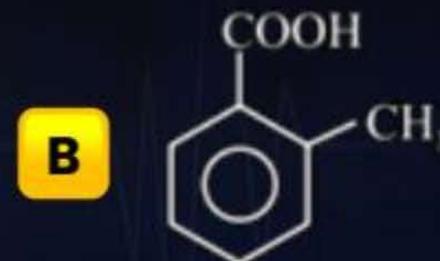
A



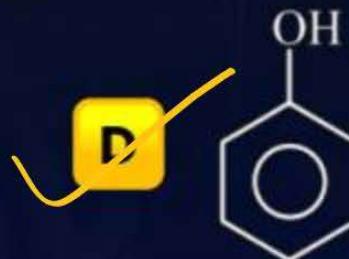
C



B



D

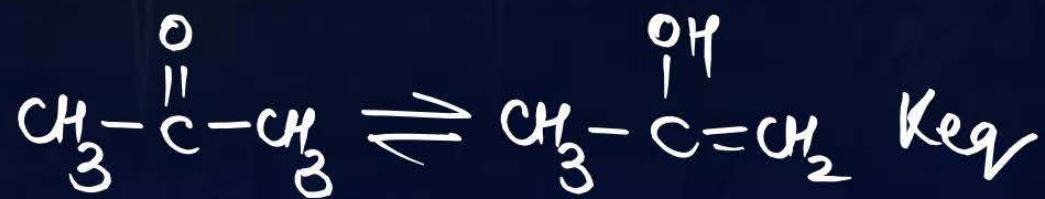
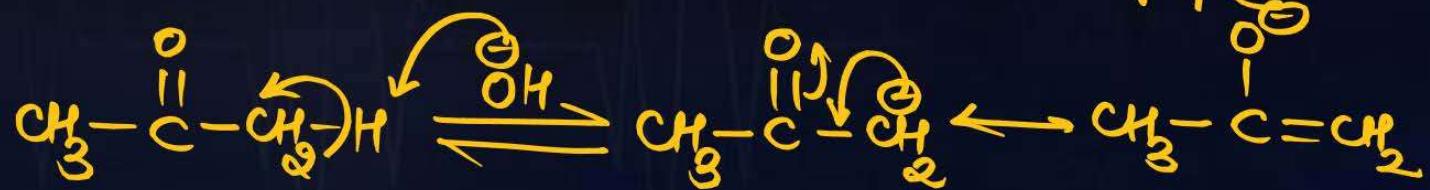




Tautomerism



Keto enol



$$K_{eq} = \frac{[\text{enol}]}{[\text{keto}]} = \text{enol content}$$



Enol Content



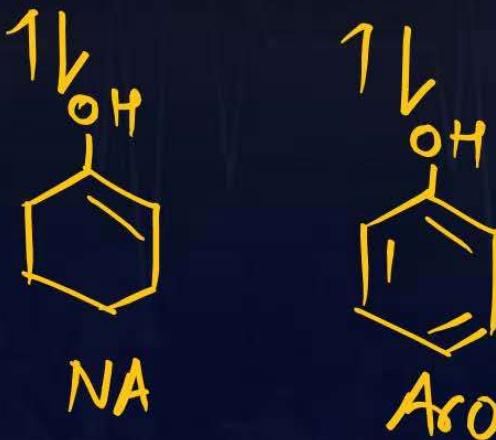
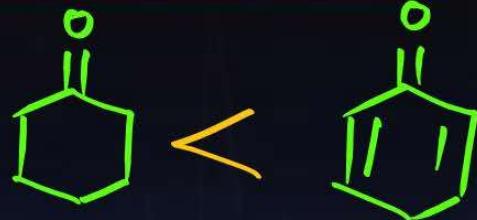
① In Mono Keto Keto > enol



Enol content \propto Aro
 \propto Hydrogen bonding
 \propto reso

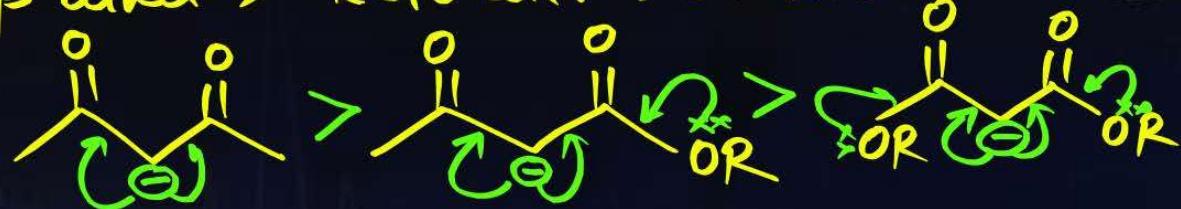
Enol Content Order

①



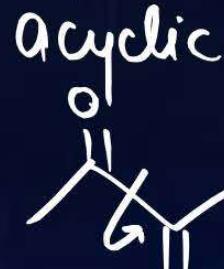
②

β -diket > keto ester > diester

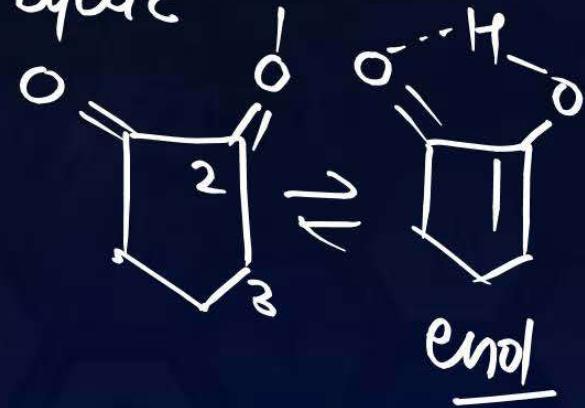


③

α -diketone \rightarrow cyclic



Anti
=V (Keto)

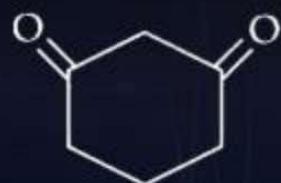


C.Q. 53 (JEE Mains 27th January 2024, Morning Shift)

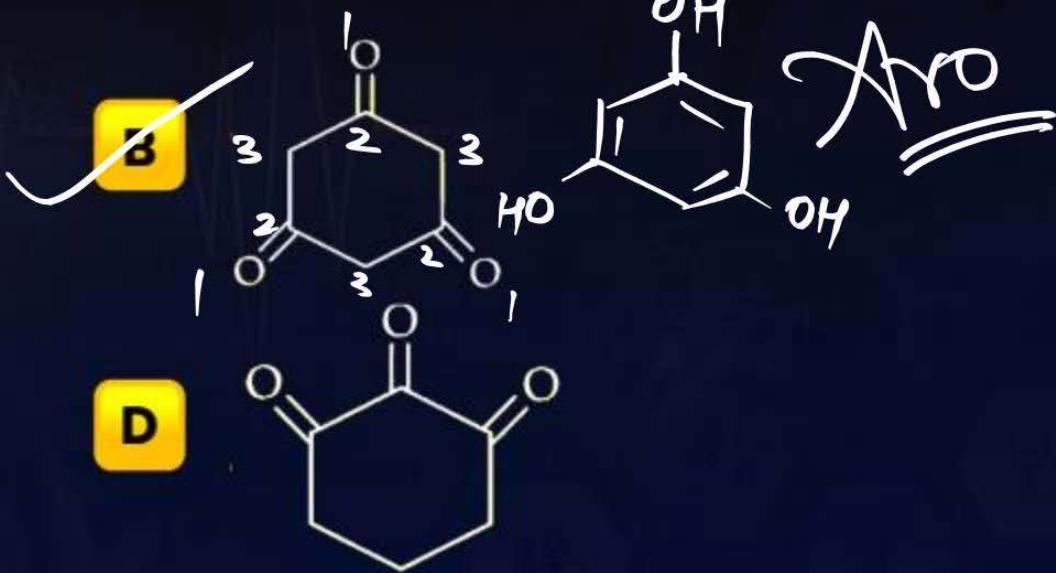
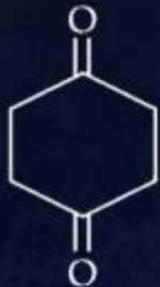
PW

Highest enol content will be shown by:

A



C

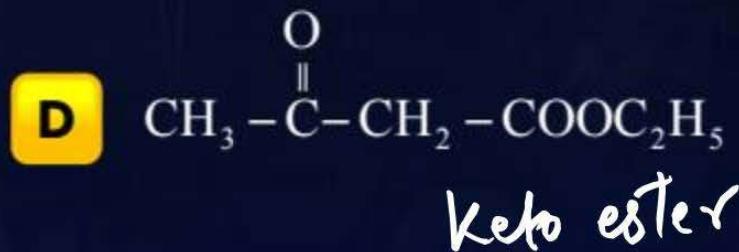
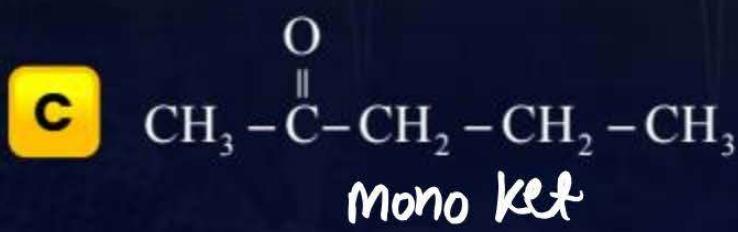
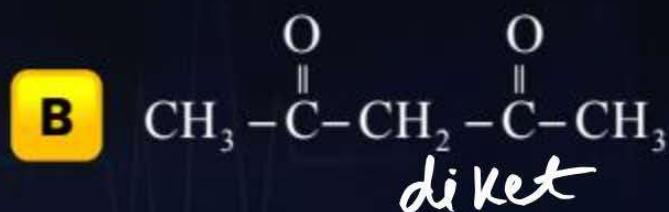
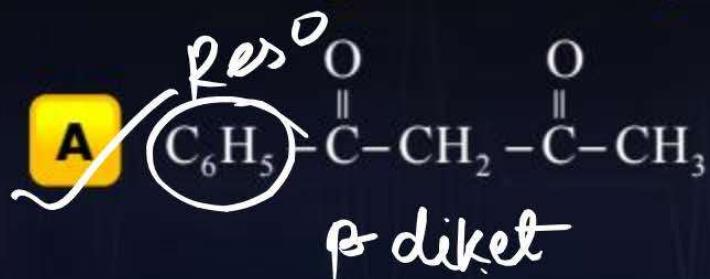


C.Q. 54

diket > mono

PW

Which among the following compound will give maximum enol content?



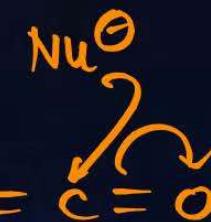
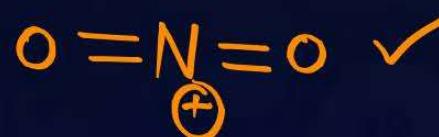


Electrophile



1. Electron loving species (Electro deficient)

2. Having or not having vacant orbital



The correct statement regarding electrophile is:

- A Electrophile can be either neutral or positively charged species and can form a bond by accepting a pair of electrons from a nucleophile.
- B Electrophile is a negatively charged species and can form a bond by accepting a pair of electrons from a nucleophile.
- C Electrophile is a negatively charged species and can form a bond by accepting a pair of electrons from another electrophile.
- D Electrophiles are generally neutral species and can form a bond by accepting a pair of electrons from a nucleophile.

C.Q. 56 (AIPMT 2010)



Which of the following species is not electrophilic in nature?





Nucleophile

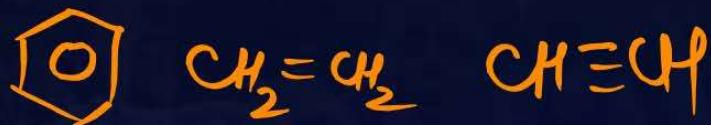


δP

πe^G

1. Electron Rich and Precise Species

2. Having or not having lone pair



Which of the following statements is not correct for a nucleophile?

- A Nucleophiles are not electron seeking.
- B Nucleophile is a Lewis acid.
- C Ammonia is a nucleophile.
- D Nucleophiles attack low electron density sites.

C.Q. 58 (NCERT Example)



Nucleophile is a species that should have

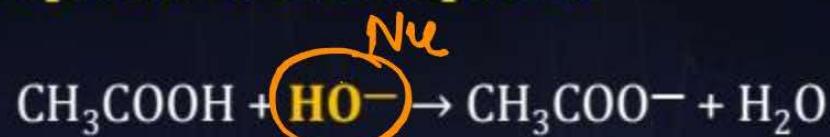
- A a pair of electrons to donate
- B positive charge
- C negative charge
- D Both (A) & (C)

C.Q. 59 (NCERT Example)



Identify the reagents shown in bold in the following equations as nucleophiles or electrophiles:

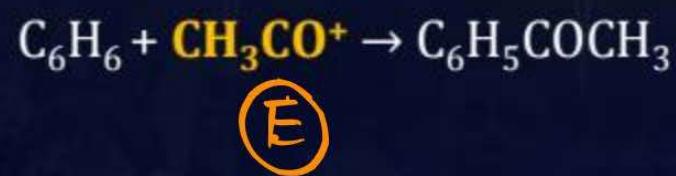
A



B



C



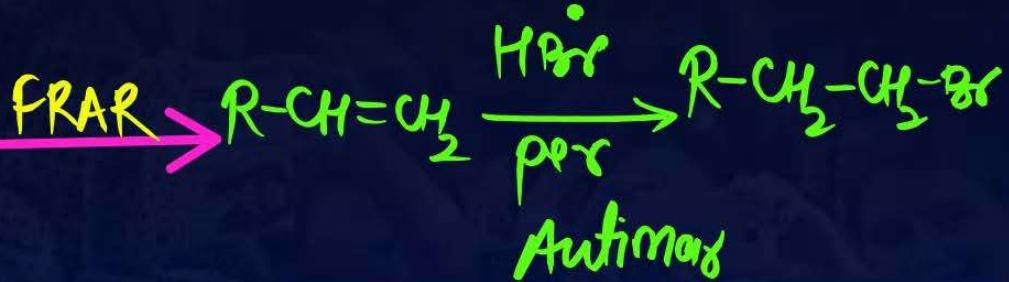
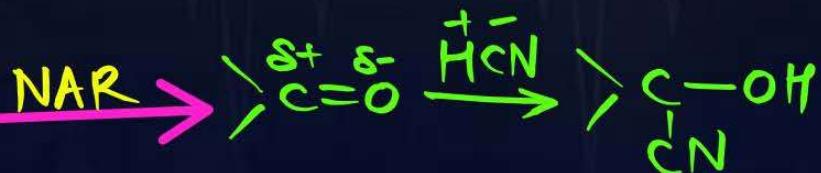
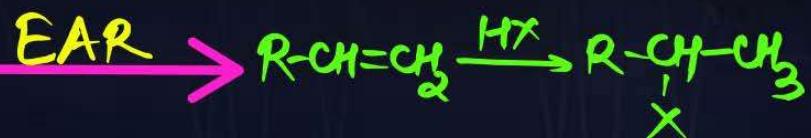
Ambident Nu
(σ donor site)

but only one can
donate at a time)



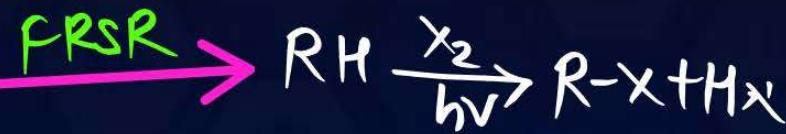
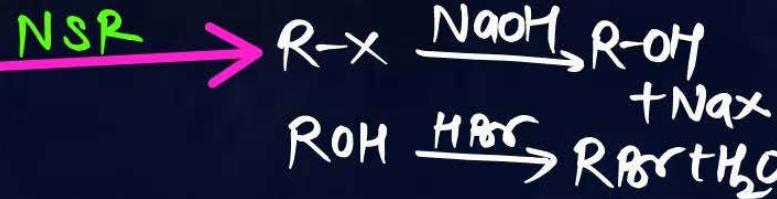
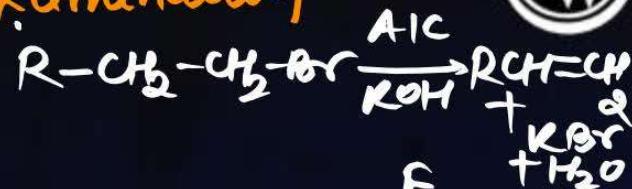
Types of Reaction

Addition Rxn



Substitution Rxn

Elimination



QUESTION



Match the following:

- (a) Substitution reaction ③
- (b) Addition reaction ⑤
- (c) Elimination reaction ⑥
- (d) Homolytic fission ②
- (e) Heterolytic fission ①
- (f) Electrophile ④
- (g) Nucleophile ⑦

- (i) $A:B \rightarrow A^+:B^-$
- (ii) $A:A \rightarrow \dot{A}:\dot{A}$
- (iii) $CH_3Cl \xrightarrow{KOH} CH_3OH$
- (iv) BF_3
- (v) $H_2C=CH_2 + HBr \rightarrow CH_3CH_2Br$
- (vi) $CH_3CH_2OH \xrightarrow{H_2SO_4} H_2C=CH_2$
- (vii) NH_3

C.Q. 60 (NCERT Exercise)

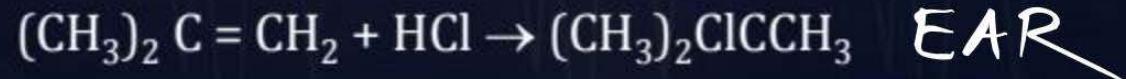


Classify the following reactions in one of the reaction type studied in this unit.

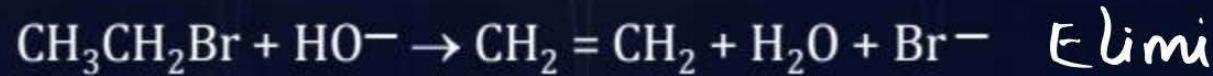
A



B



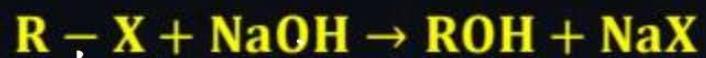
C



D



C.Q. 61



The above reaction is classified as

- A Nucleophilic substitution
- B Electrophilic substitution
- C Reduction
- D Oxidation



Practice Problems

QUESTION-1

- A** +I effect of $-\text{CH}_3$ group
- B** -I effect of $-\text{CH}_3$ group
- C** Hyperconjugation effect of $-\text{CH}_3$ group
- D** Steric inhibition of protonation by $-\text{CH}_3$ group

QUESTION-2

Arrange the following in the correct decreasing order of acidic strength.

- (I) 2, 4, 6-Trinitrophenol
- (II) 2, 4-Dinitrophenol
- (III) o-Nitrophenol
- (IV) p-Nitrophenol

A I > II > III = IV

C I > II > IV > III

B IV > III > II > I

D III > II > I > IV

QUESTION-3



Highest K_a AS \uparrow

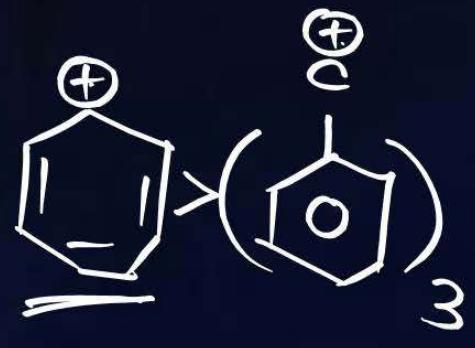
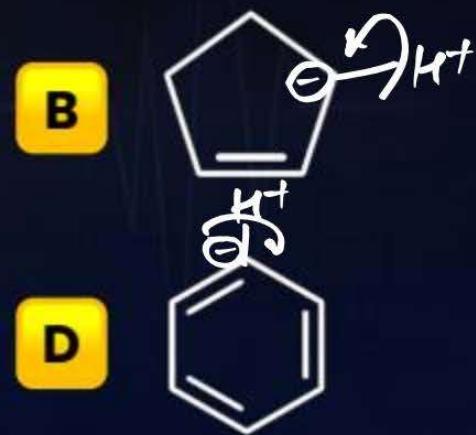
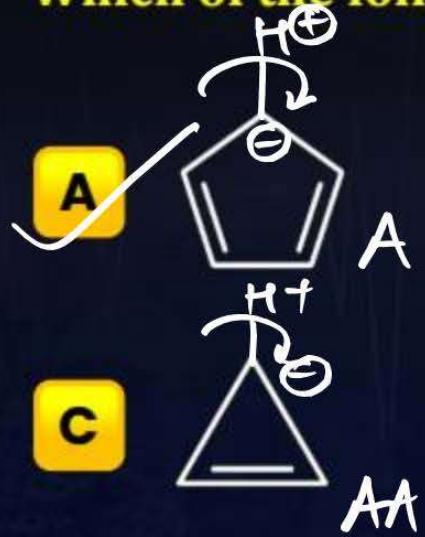
Which of following has lowest pK_a value?

- A $\text{Cl}-\text{CH}_2-\text{CO}_2\text{H}$
- C $\text{Cl}_3\text{C}-\text{CO}_2\text{H}$
- B $\text{Cl}-\text{CH}(\text{Cl})-\text{CO}_2\text{H}$
- D $\text{CH}_3-\text{CO}_2\text{H}$

$\text{D} > \text{N} > \text{P}$

QUESTION-4

Which of the following hydrocarbon is most acidic?



QUESTION-5

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: Tertiary butyl carbanion is less stable than methyl carbanion.

Reason R: +I effect of the three methyl groups in tertiary butyl carbanion tends to make it less stable than methyl carbanion.

In the light of the above statements, choose the correct answer from the options given below:

- A** A is true but R is false.
- B** A is false but R is true.
- C** Both A and R are true and R is the correct explanation of A.
- D** Both A and R are true but R is NOT the correct explanation of A.

QUESTION-6



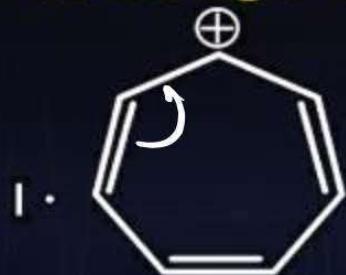
The reaction intermediate produced by homolytic cleavage of bond is called:

- A carbocations
- C free radicals

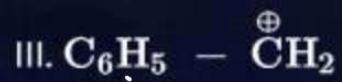
- B carbanions
- D carbenes

QUESTION-7

Decreasing order of stability of given carbocations is as:



I > III > II > IV



A III > II > IV > I

B I > III > IV > II

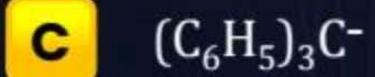
C I > III > II > IV

D III > II > I > IV

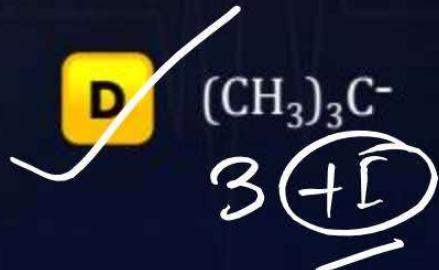
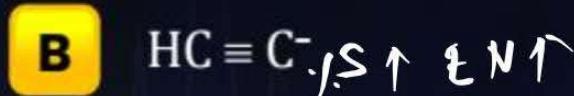


QUESTION-8

Which one of the following carbanions is least stable?



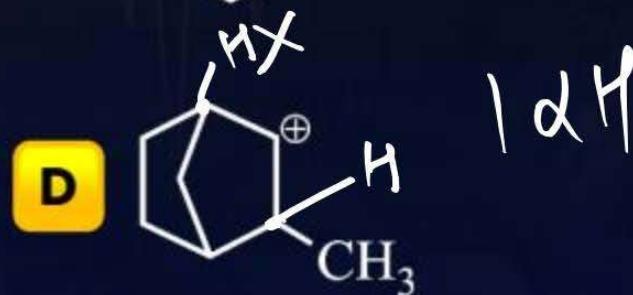
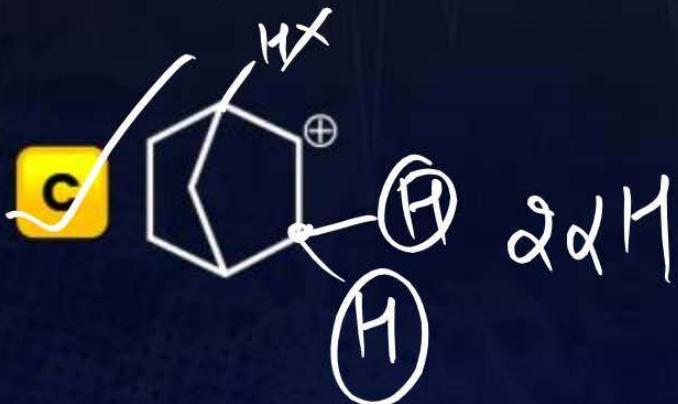
Reso



3 $\overset{+\text{I}}{\text{C}}^-$

QUESTION-9

Which of the following is maximum stable carbocation?



QUESTION-10



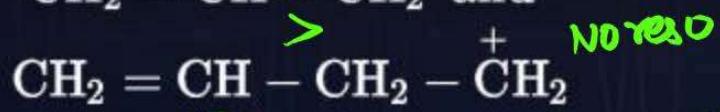
Which of the following is the most stable carbanion?



QUESTION-11



In which of the following pairs of carbocations, the first carbocation is more stable than the second?



YRH

- A** (i) , (ii) and (iii)
- C** (ii) and (iii)

- B** (i), (ii) and (iv)
- D** (iii) and (iv)



QUESTION-12

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion (A): Tertiary carbocations are generally formed more easily than primary carbocations.

Reason (R): Hyperconjugations as well as inductive effect due to additional alkyl groups stabilize tertiary carbocations.

In the light of the above statements, choose the correct answer from the options given below:

- A** A is true but R is false.
- B** A is false but R is true.
- C** Both A and R are true and R is the correct explanation of A.
- D** Both A and R are true but R is NOT the correct explanation of A.

QUESTION-13



Which of the following is not an electrophile?

A



C



B



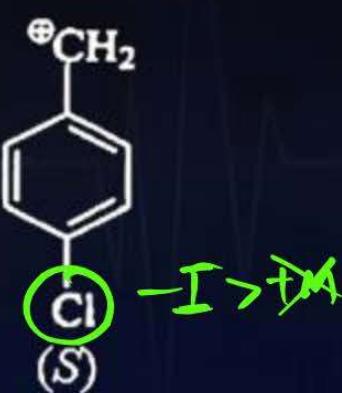
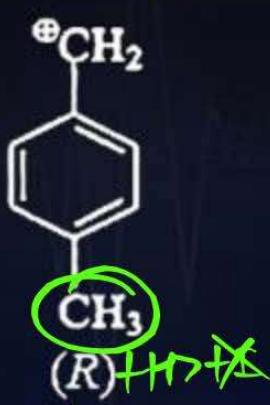
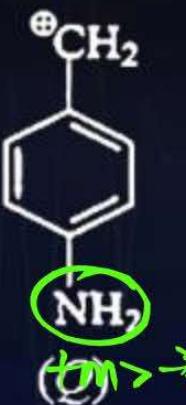
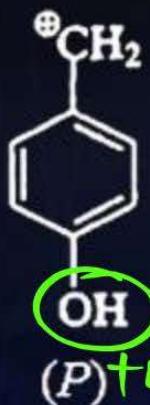
D



QUESTION-14



The decreasing order of stability of following cations is:



A ~~P > Q > R > S~~

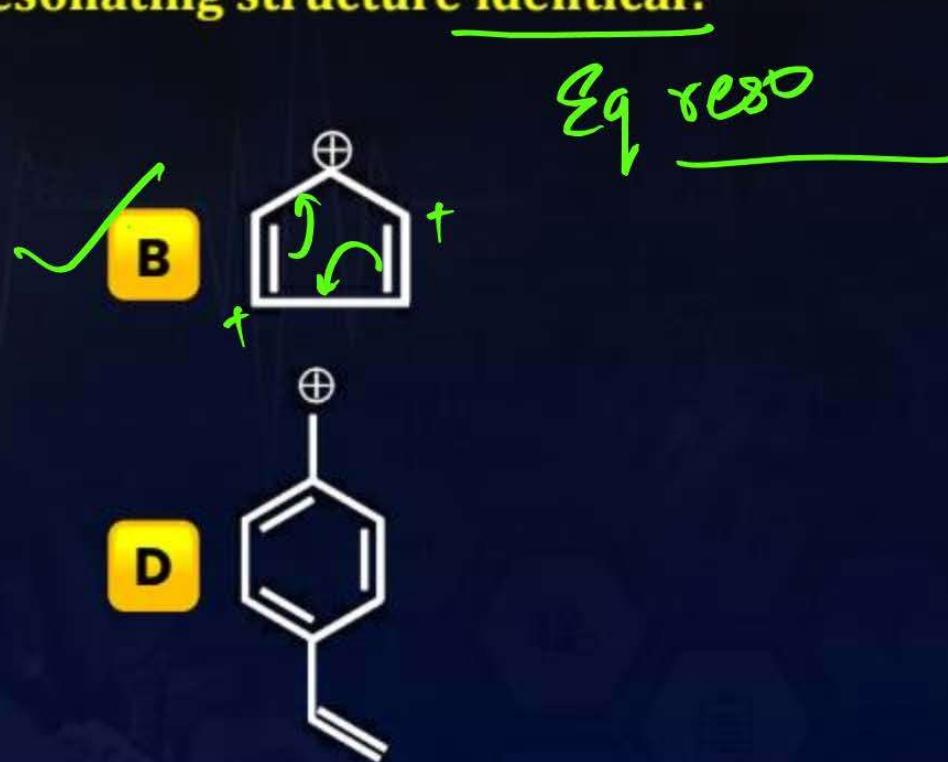
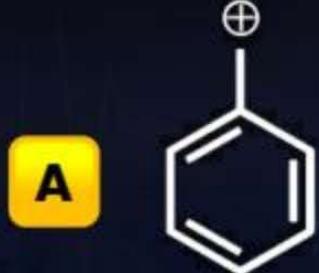
B ~~Q > S > R > P~~

C Q > P > S > R

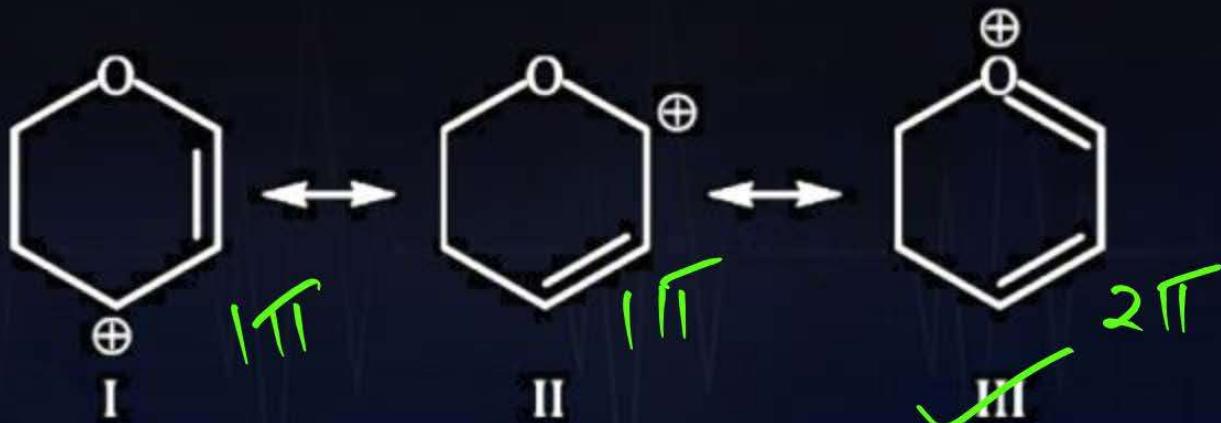
D Q > P > R > S

QUESTION-15

Which of the following have all resonating structure identical?



QUESTION-16



The most stable canonical structure among these is:

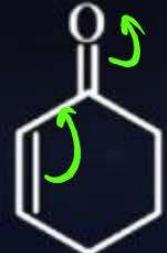
- A III
- B II
- C I
- D all are equally stable

QUESTION-17

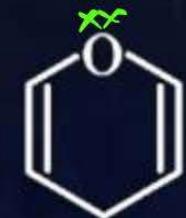


Which of the following species can show conjugation?

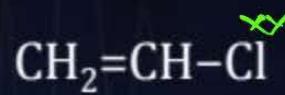
A



C



B



D All of these



QUESTION-18

Which of the following compounds will show the maximum 'enol' content?



Keto ester



QUESTION-19



How many π electrons are there in the following species?



A 2

A

4

C 6

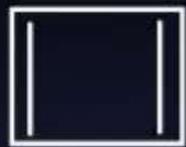
C 6

8

D 8

QUESTION-20

Among the following the aromatic compound is:

A

AA

C

A

B

AA

D

AA