

QUESTION BANK

RESONANCE

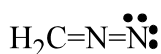
StudySteps.in

RESONANCE

Q.1 Consider structural formulas A, B and C:



(A)



(B)



(C)

- Are A, B and C constitutional isomers, or are they resonance forms?
- Which structures have a negatively charged carbon?
- Which structures have a positively charged carbon?
- Which structures have a positively charged nitrogen?
- Which structures have a negatively charged nitrogen?
- What is the net charge on each structure?
- Which is a more stable structure, A or B? Why?
- Which is a more stable structure, B or C? Why?

Q.2 In each of the following pairs, determine whether the two represent resonance forms of a single species or depict different substances. If two structures are not resonance forms, explain why.



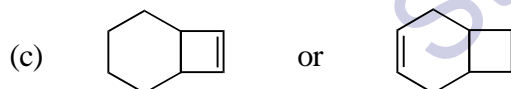
Q.3 Match each alkene with the appropriate heat of combustion:

Heats of combustion (kJ/mol) : 5293 ; 4658; 4650; 4638; 4632

- | | |
|-------------------------------|--------------------------------|
| (a) 1-Heptene | (b) 2,4-Dimethyl-1-pentene |
| (c) 2,4-Dimethyl-2-pentene | (d) (Z)-4,4-Dimethyl-2-pentene |
| (e) 2,4,4-Trimethyl-2-pentene | |

Q.4 Choose the more stable alkene in each of the following pairs. Explain your reasoning.

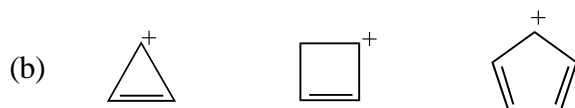
- 1-Methylcyclohexene or 3-methylcyclohexene
- Isopropenylcyclopentane or allylcyclopentane



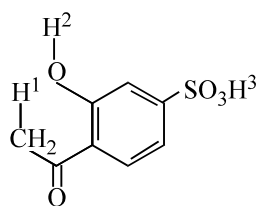
- (Z)-Cyclononene or (E)-cyclononene
- (Z)-Cyclooctadecene or (E)-cyclooctadecene

Q.5 Rank the following sets of intermediates in increasing order of their stability giving appropriate reasons for your choice.

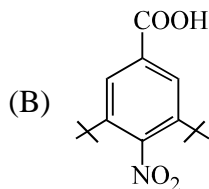
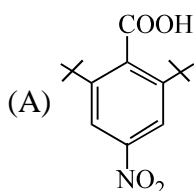
- (a) C_6H_5^+ , $p\text{-NO}_2(\text{C}_6\text{H}_4)^+$, $p\text{-CH}_3(\text{C}_6\text{H}_4)^+$, $p\text{-Cl-C}_6\text{H}_4^+$



Q.6 For the following compounds, arrange the labelled proton in increasing order of their ease of deprotonation.



Q.7 Which is stronger acid, A or B and why?



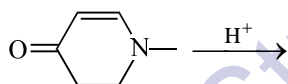
Q.8 Discuss the following observations:

- C-Cl bond in vinyl chloride is stronger than in chloroethane.
- Carbon-carbon bond length in ethene is shorter than in $\text{CH}_2=\text{CHOCH}_3$
- CH_3SH is stronger acid than CH_3OH
- $\text{CH}_3\text{CH}_2\text{NH}_2$ is stronger base than $\text{CH}_2=\text{CHNH}_2$.

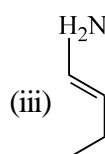
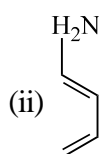
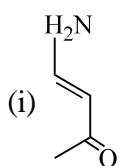
Q.9 Discuss the basic strength of two nitrogens in benzimidazole.



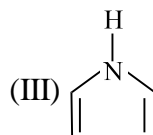
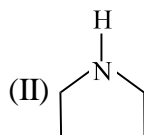
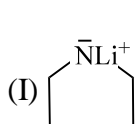
Q.10 In the following structure, which is better site of protonation and why-oxygen or nitrogen?



Q.11 Compare the C-N bond-length in the following species:

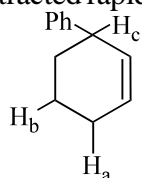


Q.12 Rank the following in increasing order of basic strength, explaining reason for your choice:



Q.13 Answer the following:

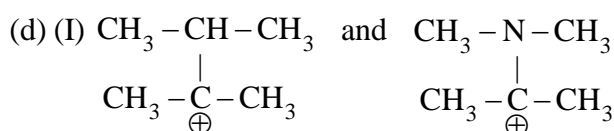
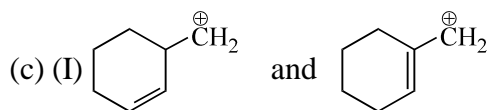
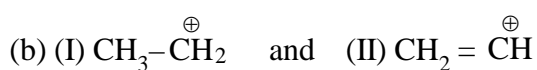
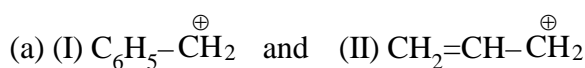
- (i) Which of the indicated H is abstracted rapidly by bromine radical and why?



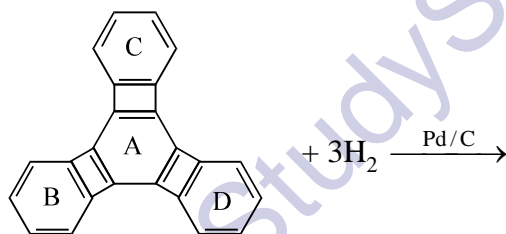
- (ii) One of the indicated proton H_a or H_b , is approximately 10^{30} times more acidic than other, which is more acidic and why?



Q.14 In each of the following pairs of ions which ion is more stable:



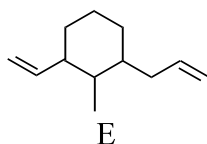
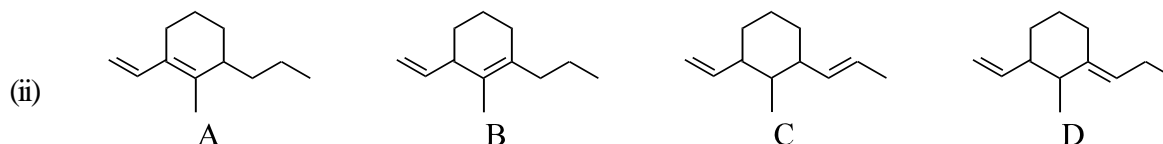
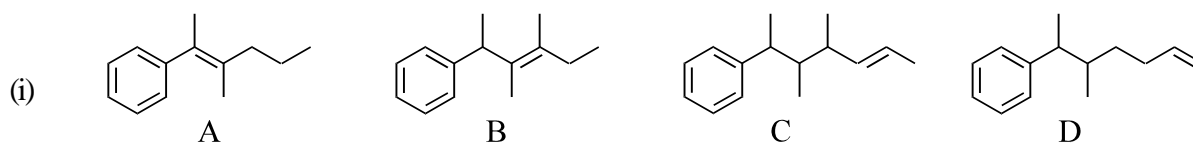
Q.15 Consider the given reaction:

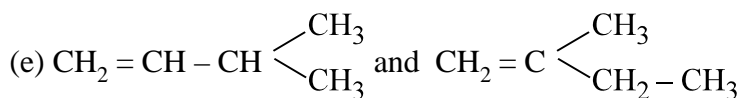
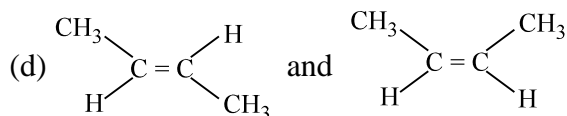
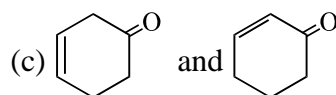
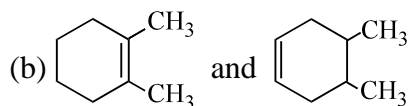


In the above reaction which one of the given ring will undergo reduction?

Q.16 Compare heat of hydrogenation (Decreasing order)

- (a) heat of hydrogenation





Q.17 Which of the following statements is (are) true about resonance.

- Resonance is an intramolecular process.
- Resonance involves delocalization of both σ and π electrons.
- Resonance involves delocalization of π electrons only.
- Resonance decreases potential energy of a molecule.
- Resonance has no effect on the potential energy of a molecule.
- Resonance is the only way to increase molecular stability.
- Resonance is not the only way to increase molecular stability.
- Any resonating molecule is always more stable than any nonresonating molecule.
- The canonical structure explains all features of a molecule.
- The resonance hybrid explains all features of a molecule.
- Resonating structures are real and resonance hybrid is imaginary.
- Resonance hybrid is real and resonating structures are imaginary.
- Resonance hybrid is always more stable than all canonical structures.

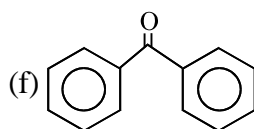
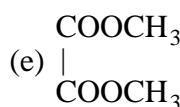
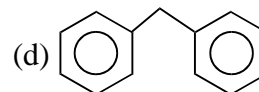
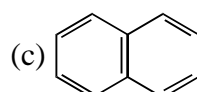
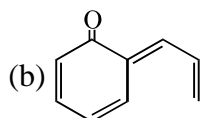
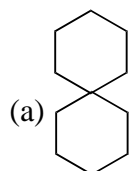
Q.18 Resonance energy will be more if

- canonical structures are equivalent than if canonical structures are non-equivalent.
- molecule is aromatic than if molecule is not aromatic.

Q.19 A canonical structure will be more stable if

- it has more number of π bonds than if it has less number of π bonds.
- the octets of all atoms are complete than if octets of all atoms are not complete.
- it involves cyclic delocalization of $(4n + 2) \pi$ - electrons than if it involves acyclic delocalization of $(4n + 2) \pi$ - electrons.
- it involves cyclic delocalization $(4n) \pi$ - electrons than if it involves acyclic delocalization of $(4n) \pi$ - electrons.
- +ve charge is on more electronegative atom than if +ve charge is on less electronegative atoms.
- ve charge is on more electronegative atom than if -ve

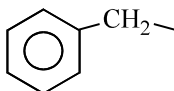
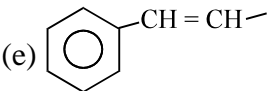
Q.20 In which of the following molecules resonance takes place through out the entire system.



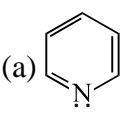
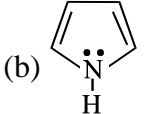
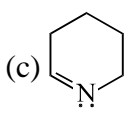
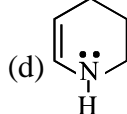
Q.21 Which of the following groups cannot participate in resonance with other suitable group :

- (a) $-\text{COOH}$ (b) $-\text{COO}^-$ (c) $-\text{COCl}$ (d) $-\text{NH}_3^+$
 (e) $-\text{CH}_2^+$ (f) $-\dot{\text{C}}\text{H}_2$ (g) $\text{CH}_2 = \text{N}^+ - \text{CH}_3$

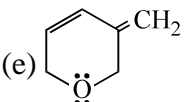
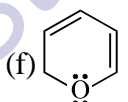
Q.22 Which of the following group can participate in resonance with other suitable group :

- (a) $\text{CH}_2 = \text{O}^+$ (b) $-\text{CH}_2 - \text{C}^-\text{H}_2$ (c) $-\text{CH}_2 - \text{CH}_2^+$ (d) 
 (e)  (f) $-\text{BH}_2$ (g) $-\text{P}^+\text{Ph}_3$

Q.23 In which of the following lone-pair indicated is involved in resonance :

- (a)  (b)  (c)  (d) 
 (e) $\text{CH}_2 = \text{CH} - \text{CH}_2^+$ (f) $\text{CH}_2 = \text{CH} - \text{CH} = \ddot{\text{N}}\text{H}$

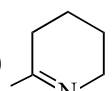
Q.24 In which of the following lone-pair indicated is not involved in resonance :

- (a) $\text{CH}_2 = \text{CH} - \ddot{\text{N}}\text{H} - \text{CH}_3$ (b) $\text{CH}_2 = \text{CH} - \text{CH} = \ddot{\text{O}}$
 (c) $\text{CH}_2 = \text{CH} - \ddot{\text{O}} - \text{CH} = \text{CH}_2$ (d) $\text{CH}_2 = \text{CH} - \text{C} \equiv \text{N}:$
 (e)  (f) 

Q.25 Identify electron – donating groups in resonance among the following :

- (a) $-\text{CONH}_2$ (b) $-\text{NO}_2$ (c) $-\text{OCOCH}_3$ (d) $-\text{COOCH}_3$
 (e) $-\text{CHO}$ (f) $-\text{NHCOCCH}_3$

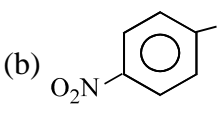
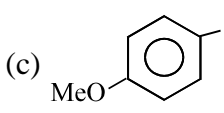
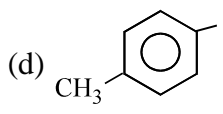
Q.26 Identify electron – withdrawing groups in resonance among the following :

- (a) $-\text{COOH}$ (b) $-\text{CONHCH}_3$ (c) $-\text{COCl}$ (d) $-\text{CN}$
 (e) $-\text{O} - \text{CH} = \text{CH}_2$ (f) 

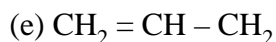
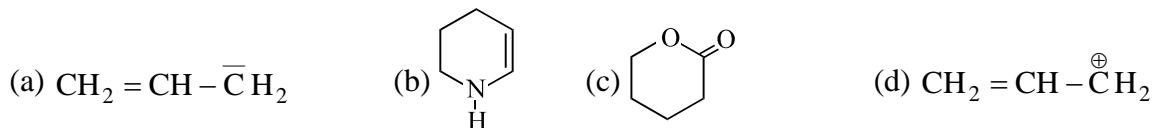
Q.27 Which of the following groups can either donate or withdraw a pair of electrons in resonance depending upon situation :

- (a) $-\text{NO}_2$ (b) $-\text{NO}$ (c) $-\text{CH} = \text{CH}$ (d) $-\text{CHO}$
 (e) $-\text{NH}_2$ (f) $-\text{N} = \text{NH}$

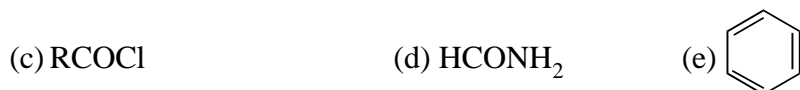
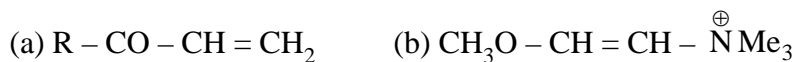
Q.28 Which of the following groups can only withdraw a pair of electrons in resonance depending upon situation :

- (a) $-\text{Ph}$ (b)  (c)  (d) 
 (e) $-\text{N}^+\text{Me}_3$ (f) $-\text{CONH}_2$

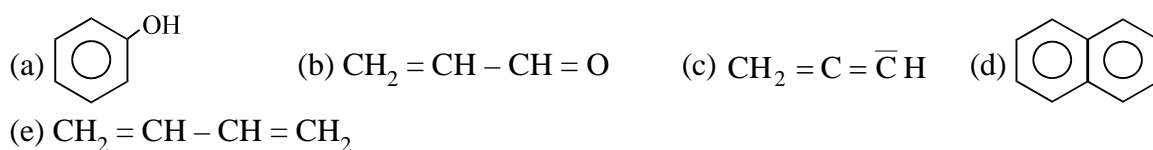
Q.29 Write the resonance hybrid of each of the following :



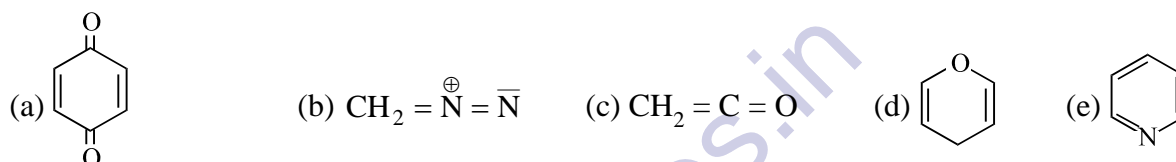
Q.30 Write the canonical structures of each of the following :



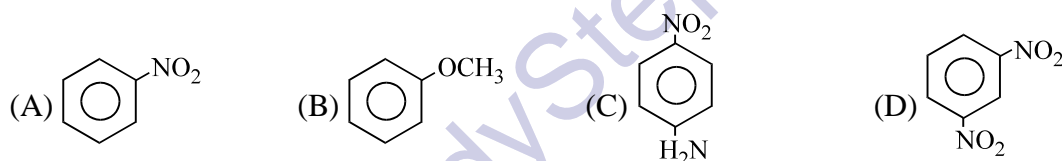
Q.31 Write the resonance hybrid of each of the following :



Q.32 Write the canonical structures of each of the following :



Q.33 In which of the following molecules π -electron density in ring is minimum :



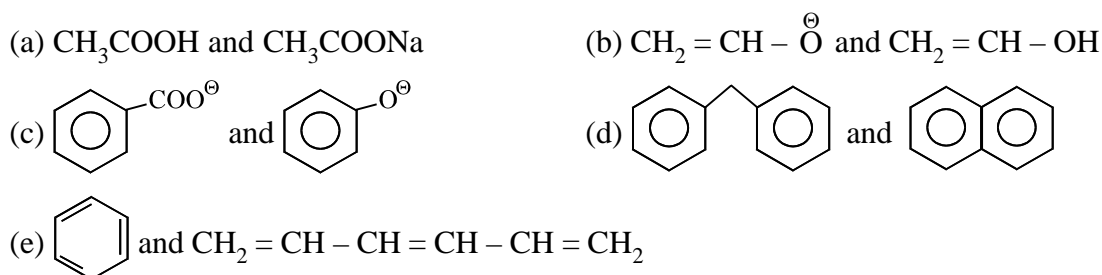
Q.34 In which of the following molecules π -electron density in ring is maximum :



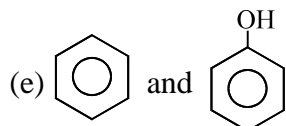
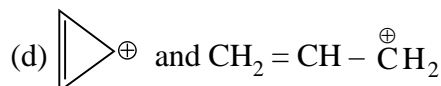
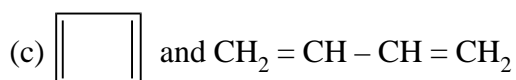
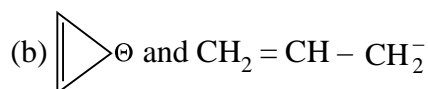
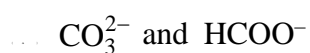
Q.35 $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH} - \text{CH}_3$ is more stable than $\text{CH}_3 - \text{CH} = \text{C} = \text{CH} - \text{CH}_3$ because

- (A) there is resonance in I but not in II (B) there is tautomerism in I but not in II
 (C) there is hyperconjugation in I but not in II (D) II has more canonical structures than I.

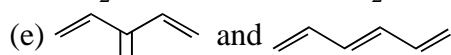
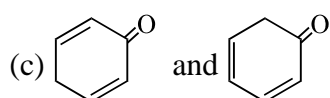
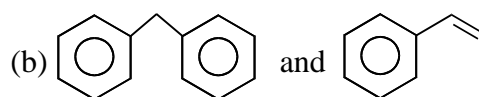
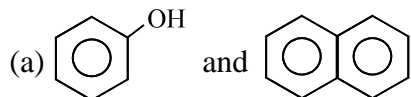
Q.36 Which of the following pairs has higher resonance energy :



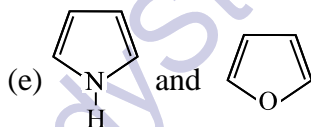
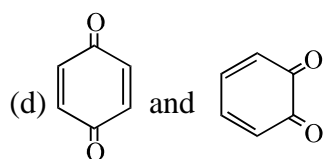
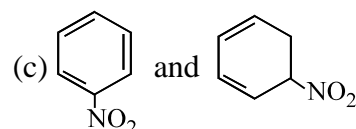
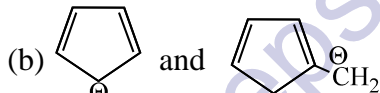
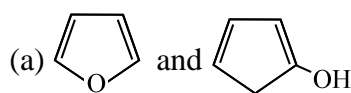
Q.37 Which of the following pairs has less resonance energy :



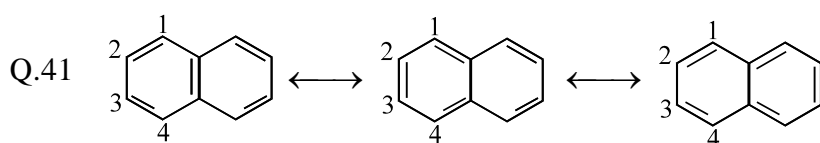
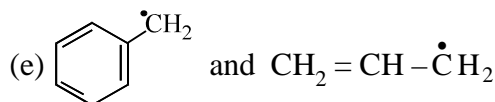
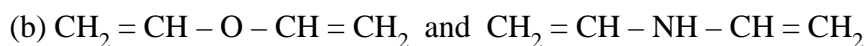
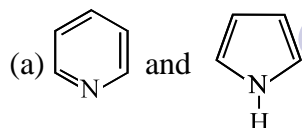
Q.38 Which of the following pairs has higher resonance energy :



Q.39 Which of the following pairs has less resonance energy :




Q.40 Which of the following pairs has higher resonance energy :



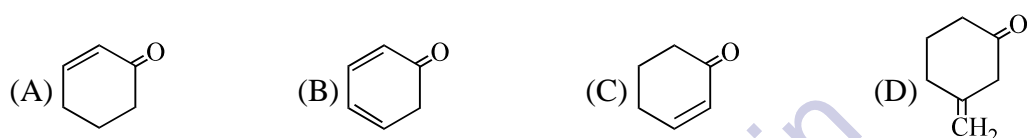
These are three canonical structures of naphthalene. Examine them and find correct statement among the following :

- (A) All C – C bonds are of same length (B) C1 – C2 bond is shorter than C2 – C3 bond.
 (C) C1 – C2 bond is longer than C2 – C3 bond (D) none.

Q.46 In which of the following pairs, indicated bond having less bond dissociation energy :

- (a)  and $\text{CH}_2=\text{CH}_2$ (arrow on C=C bond)
- (b) $\text{CH}_3-\text{C}\equiv\text{CH}$ (arrow on C-C bond) and $\text{HC}\equiv\text{CH}$ (arrow on C-C bond)
- (c) $\text{CH}_2=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$ (arrow on C-C single bond) and $\text{CH}_2=\text{CH}-\text{C}(\text{CH}_3)=\text{CH}_2$ (arrow on C=C double bond)
- (d) $\text{H}_2\text{N}-\text{C}(=\text{O})-\text{NH}_2$ (arrow on C=O bond) and $\text{CH}_3-\text{C}(=\text{O})-\text{NH}_2$ (arrow on C=O bond)
- (e) $\text{Cl}-\text{C}(=\text{O})-\text{Cl}$ (arrow on C=O bond) and $\text{CH}_3-\text{C}(=\text{O})-\text{Cl}$ (arrow on C=O bond)
- (f) $\text{H}_2\text{N}-\text{C}(=\text{O})-\text{NH}_2$ (arrow on C=O bond) and $\text{H}-\text{C}(=\text{O})-\text{NH}_2$ (arrow on C=O bond)

Q.47 Which of the following has longest C – O bond :



Q.48    $\text{CH}_2=\text{NH}$

I

II

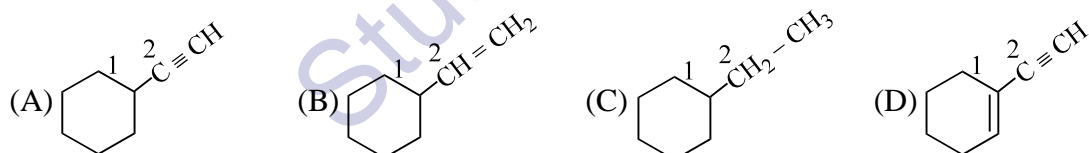
III

IV

Among these compounds, the correct order of C – N bond lengths is :

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

Q.49 C1 – C2 bond is shortest in



Q.50 Among the following molecules, the correct order of C – C bond length is

- (A) $\text{C}_2\text{H}_6 > \text{C}_2\text{H}_4 > \text{C}_6\text{H}_6 > \text{C}_2\text{H}_2$ (B) $\text{C}_2\text{H}_6 > \text{C}_6\text{H}_6 > \text{C}_2\text{H}_4 > \text{C}_2\text{H}_2$ (C_6H_6 is benzene)
 (C) $\text{C}_2\text{H}_4 > \text{C}_2\text{H}_6 > \text{C}_2\text{H}_2 > \text{C}_6\text{H}_6$ (D) $\text{C}_2\text{H}_6 > \text{C}_2\text{H}_4 > \text{C}_2\text{H}_2 > \text{C}_6\text{H}_6$

Q.51 $\text{CH}_3\text{O}-\text{CH}=\text{CH}-\text{NO}_2$

$\text{CH}_2=\text{CH}-\text{NO}_2$

$\text{CH}_2=\text{CH}-\text{Cl}$

$\text{CH}_2=\text{CH}_2$

I

II

III

IV

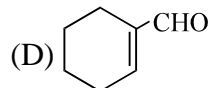
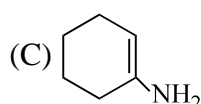
Which of the following is the correct order of C – C bond lengths among these compounds :

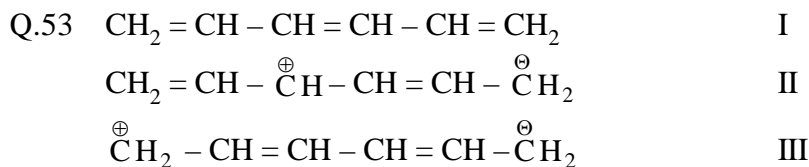
- (A) I > II > III > IV (B) IV > III > II > I (C) I > III > II > IV (D) II > III > I > IV

Q.52 In which of the following molecules resonance is equivalent :



(B) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

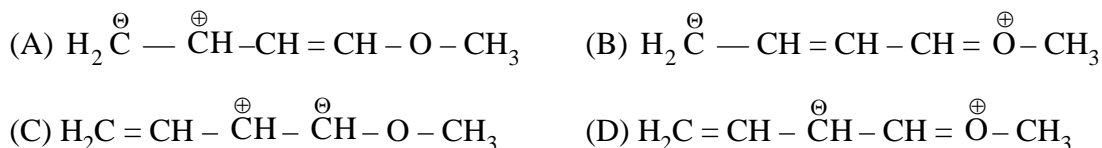




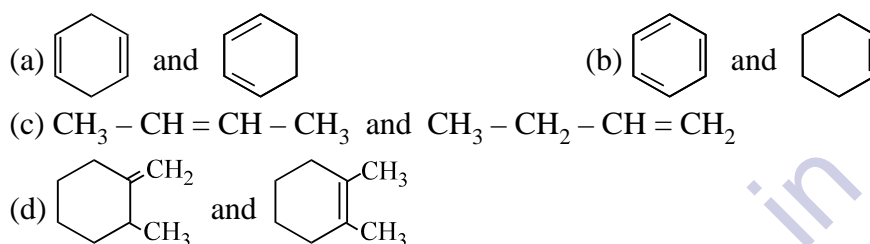
Among these three canonical structures (through more are possible) what would be their relative contribution in the hybrid :

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

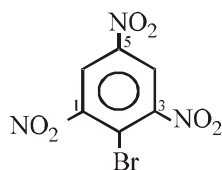
Q.54 For 1-methoxy-1, 3-butadiene, which of the following resonating structure is the least stable?



Q.55 Among the following pairs identify the one which gives higher heat of hydrogenation :



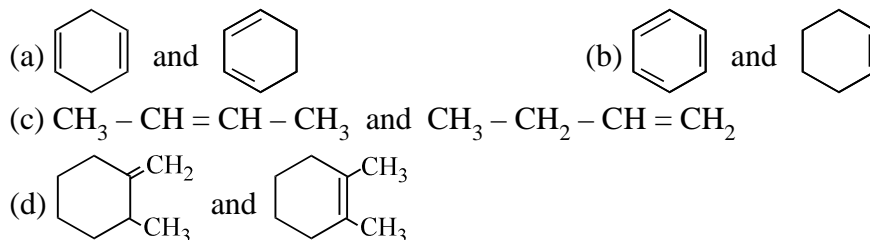
Q.56 Which of the following statements would be true about this compound :



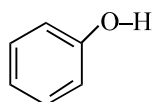
- (A) All three C – N bonds are of same length.
 (B) C1 – N and C3 – N bonds are of same length but shorter than C5 – N bond.
 (C) C1 – N and C3 – N bonds are of same length but longer than C5 – N bond.
 (D) C1 – N and C3 – N bonds are of different length but both are longer than C5 – N bond.

Q.57 Write resonating structures of σ complex formed when an electrophile (E^{\oplus}) attacks on (i) α and (ii) β position of naphthalene. Also state which is more stable.

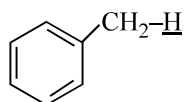
Q.58 Among the following pairs identify the one which gives higher heat of hydrogenation :



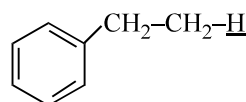
Q.59 Number the following compounds in order of increasing acidity of indicated proton giving mechanistic reasoning:



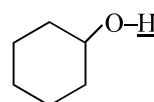
I



II



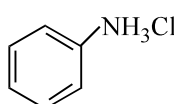
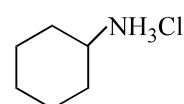
III

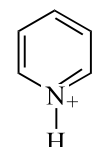
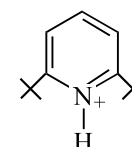


IV

Q.60 From the following pair, select the stronger acid providing clear reasoning:

(a) $\text{O}_2\text{N}-\text{CH}_2-\text{COOH}$ or $\text{CH}_3-\text{CH}_2-\text{COOH}$

(b)  or 

(c)  or 

ANSWER KEY

- Q.1 a = Resonance form, b = A, c = C, d = A & B, e = B & C, f = B, g = B, h = B
 Q.2 (a) are resonance form
 Q.3 (a) 4658, (b) 4638, (c) 4632, (d) 4656, (e) 5293
 Q.4 (a) i, (b) i, (c) ii, (d) i, (e) ii
 Q.5 (a) ii < iv < i < iii, (b) iii < ii < i
 Q.6 $1 < 2 < 3$
 Q.7 A = i
 Q.11 iii > ii > i
 Q.12 III < II < I
 Q.13 (i) H_c , (ii) H_a
 Q.14 (a) I, (b) I, (c) II, (d) II
 Q.15 A
 Q.17 (a), (c), (d), (g), (j), (l), (m)
 Q.18 (a), (b)
 Q.19 (a), (b), (c), (f)
 Q.20 (b), (c)
 Q.21 (d)
 Q.22 (a), (e), (f), (g)
 Q.23 (b), (d), (e)
 Q.24 (b), (d), (e)
 Q.25 (c), (f)
 Q.26 (a), (b), (c), (d), (f)
 Q.27 (b), (c), (f)
 Q.28 (f)
 Q.33 D
 Q.34 B
 Q.35 A
 Q.36 (a) II, (b) I, (c) I, (d) I, (e) I
 Q.37 (a) II, (b) I, (c) I, (d) II, (e) I
 Q.38 (a) II, (b) I, (c) II, (d) II, (e) II
 Q.39 (a) II, (b) II, (c) II, (d) II, (e) II
 Q.40 (a) I, (b) II, (c) II, (d) I, (e) I
 Q.41 B
 Q.42 A, C, D
 Q.43 (a) I, (b) I, (c) I, (d) I, (e) II, (f) II
 Q.44 (a) I, (b) II, (c) II, (d) II, (e) I
 Q.45 (a) II, (b) I, (c) I, (d) I, (e) II, (f) II
 Q.46 (a) I, (b) I, (c) II, (d) I, (e) I, (f) I
 Q.47 B
 Q.48 C
 Q.49 D
 Q.50 B
 Q.51 A
 Q.52 A
 Q.53 C
 Q.54 C
 Q.55 (a) I, (b) I, (c) II, (d) I
 Q.56 C
 Q.57 E^+ attack on α is more stable
 Q.58 (a) I, (b) I, (c) II, (d) I
 Q.59 III < II < IV < I
 Q.60 (a) I, (b) I, (c) II