CHAPTER

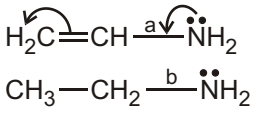
18

Bond Energy and Bond Length

APPLICATION OF RESONANCE

(i) Bond length : The compound in which resonance occurs, its double bond is slightly longer while its single bond is slightly shorter. Due to delocalization, the bond will acquire the character of partial double bond.

Ex.



If we compare bond length of C — N bond of above compounds, the bond length order is b > a.

Reason : Due to delocalization, the **a** bond will acquire the partial double bond character, thus bond length decreases.

Double Bond Character (DBC) $\frac{1}{\text{bond length}}$

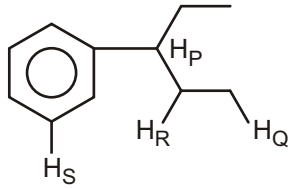
Single Bond Character (SBC) bond length

(ii) Bond dissociation energy : More stable free radical and less is the energy required to form a free radical

Bond dissociation energy $\frac{1}{\text{stability of free radical}}$

Solved Example

- Compare order of bond dissociation energy of given hydrogens in given following compound :



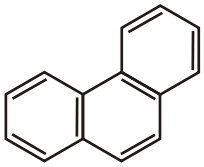
Sol. Bond dissociation energy $\propto \frac{1}{\text{stabality of free radical}}$

Order of stability of free radical P > R > Q > S

So bond dissociation energy S > Q > R > P

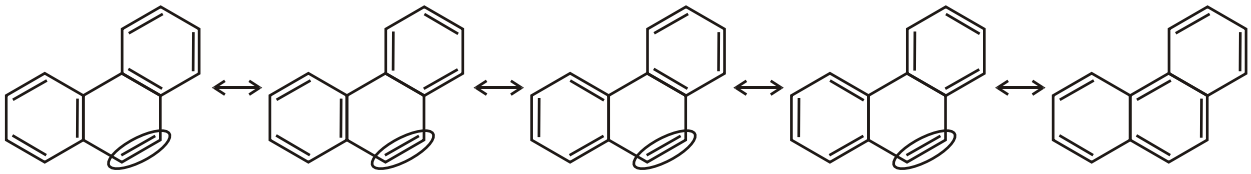
Solved Example

- Phenanthrene has five resonance structures, one of which is shown. Draw the other four and Look at the five resonance structures for phenanthrene and predict which of its carbon-carbon bonds is shortest.



Phenanthrene

Sol.

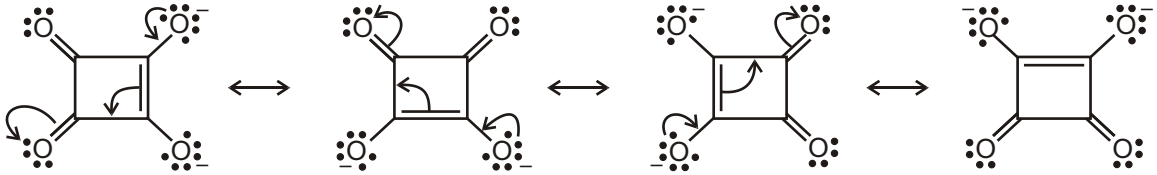


The circled bond is represented as a double bond in four of the five resonance forms of phenanthrene. This bond has more double-bond character and thus is shorter than the other carbon-carbon bonds of phenanthrene.

Solved Example

- Draw four Resonating Structures of dianion of squaric acid.

Sol. The dianion is a hybrid of the following resonance structures :

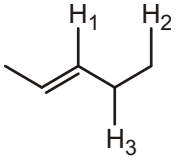


❑ **NOTE :** It is more stable than acetate ion.

EXERCISE

Single Choice Questions

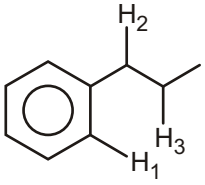
1. Compare the bond strength of the indicated bonds in the given compound :



(A) 1 > 2 > 3 (B) 3 > 1 > 2

(C) 2 > 1 > 3 (D) 2 > 3 > 1

2. Compare the bond strength of the indicated bonds in the given compound :



(A) 1 > 3 > 2 (B) 3 > 1 > 2

(C) 2 > 1 > 3 (D) 2 > 3 > 1

3. Compare the bond strength of the indicated bonds in the given compound :

(A) 1 > 2 (B) 1 = 2

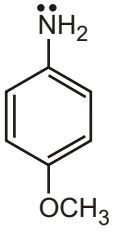
(C) 2 > 1 (D) can not be predicted

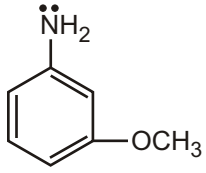
4. Which of the following sequences regarding ease of abstraction of hydrogen atom is correct?

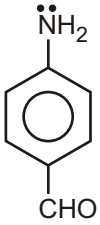
(A) 3° > 2° > 1° (B) 3° < 2° < 1°

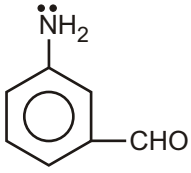
(C) 3° < 2° > 1° (D) 3° > 2° < 1°

5. Which C — N bond having more bond strength.

(A) 

(B) 

(C) 

(D) 

6. Which one of the following statement is not correct?

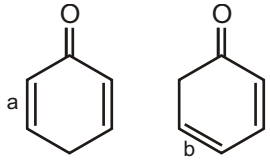
(A) Amines are stronger bases than water.

(B) Basic strength of amines decreases in the following order : $R_3N > R_2NH > RNH_2$ (In gaseous state).

(C) Carbon-nitrogen bond length in aniline is shorter than that of C — N bond length in hydrogen cyanide.

(D) Aromatic compound has (4*n* 2) electrons in the loop.

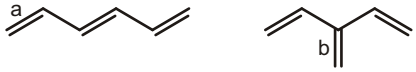
7. Compare the bond lengths of the indicated bonds in the given compound :



(A) a > b (B) a < b

(C) a = b (D) Cannot be predicted

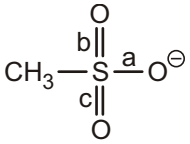
8. Compare the bond lengths of the indicated bonds in the given compound :



(A) a > b (B) a < b

(C) a = b (D) Cannot be predicted

9. Compare the bond lengths of the indicated bonds in the given compound :



(A) a < b = c

(B) a > b = c

(C) a = b = c

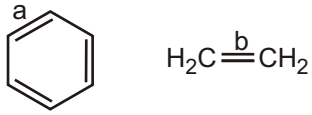
(D) cannot be compared

10. Compare the bond lengths of the indicated bonds in the given compound :

(A) a > b (B) a < b

(C) a = b (D) Cannot be predicted

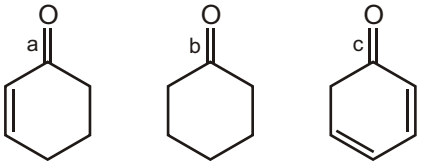
11. Compare the bond lengths of the indicated bonds in the given compound :



(A) a > b (B) a < b

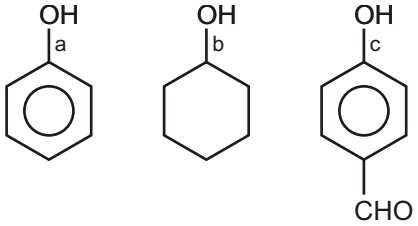
(C) a = b (D) Cannot be predicted

12. Compare the bond lengths of the indicated bonds in the given compound :



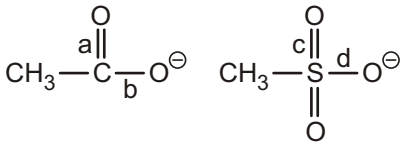
(A) a > c > b (B) c > a > b (C) b > c > a (D) b > a > c

13. Compare the bond lengths of the indicated bonds in the given compound :



(A) a > c > b (B) c > a > b (C) b > c > a (D) b > a > c

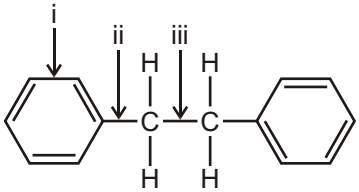
14. Compare the bond order of the indicated bonds in the given compound :



(A) a = b = c = d (B) a = b > c = d

(C) a = b < c = d (D) cannot be compared

15. Arrange the following bonds in order of increasing C — C bond strength.



(A) i < ii < iii (B) i < iii < ii (C) ii < iii < i (D) iii < ii < i

(E) iii < i < ii

Answers

Single Choice Questions

1. (A)	**2.** (A)	**3.** (C)	**4.** (A)	**5.** (C)	**6.** (C)	**7.** (B)	**8.** (A)
9. (C)	**10.** (B)	**11.** (A)	**12.** (B)	**13.** (D)	**14.** (B)	**15.** (D)	

1. Stablity of free radical 2 > 3 > 1,
so bond strength 1 > 3 > 2

2. Stablity of free radical 2 > 3 > 1,
so bond strength 1 > 3 > 2

3. Stablity of free radical 1 > 2
so bond strength 2 > 1

4. Stablity of free radical 3º > 1º > 1º

5. M of $-OCH_3$ is not operate at meta position

6. Bond length = single bond > partial double bond > double bond > triple bond

7. Bond b have more resonance then bond a so its bond length is more.

8. Bond a have extended conjugation but bond b have cross conjugation.

9. Due to equivalent RS all bonds are same.

10. Bond b have more double bond character due to $-M-CH \quad O \quad CH \quad CH_2$.

11. Bond length = single bond > partial double bond > double bond > triple bond

12. Bond c have more resonance so it have more single bond character thus bond length is longest.

13. Bond c have more resonance so it have more double bond character thus bond length is shortest.

❑❑❑