BP 202T - PHARMACEUTICAL ORGANIC CHEMISTRY - I

UNIT: 2 ALKANES, ALKENE & CONJUGATED DIENES

CLASS: 1

TOPIC: SP^3 HYBRIDIZATION OF ALKANES, SP^2 HYBRIDIZATION OF ALKENES & STABILITIES OF ALKENES

SP^3 HYBRIDIZATION

Hybridization, in Chemistry, is defined as the concept of mixing two atomic orbitals to give rise to a new type of hybridized orbitals. This intermixing usually results in the formation of hybrid orbitals having entirely different energy, shapes, etc. The atomic orbitals of the same energy level mainly take part in hybridization. However, both fully-filled and half-filled orbitals can also take part in this process, provided they have equal energy.

During the process of hybridization, the atomic orbitals of comparable energies are mixed together and mostly involves the merging of two 's' orbitals or two 'p' orbitals or the mixing of an 's' orbital with a 'p' orbital, as well as 's' orbital with a 'd' orbital. The new orbitals, thus formed, are known as **hybrid orbitals.** More significantly, hybrid orbitals are quite useful in explaining atomic bonding properties and molecular geometry.

Sp^3 Hybridization

When one 's' orbital and 3 'p' orbitals belonging to the same shell of an atom mix together to form four new equivalent orbitals, the type of hybridization is called a **tetrahedral hybridization or sp^3**. The new orbitals formed are called **sp^3 hybrid orbitals.**

- These are directed towards the four corners of a regular tetrahedron and make an angle of 109°28' with one another.
- The angle between the sp3 hybrid orbitals is 109.28^0
- Each sp^3 hybrid orbital has 25% s character and 75% p character.
- Examples of sp^3 hybridization are ethane (C_2H_6) and methane

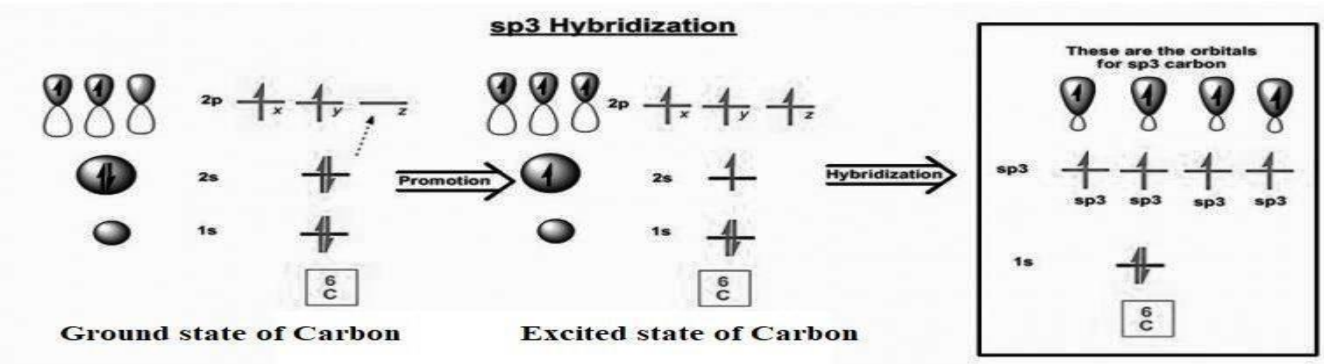
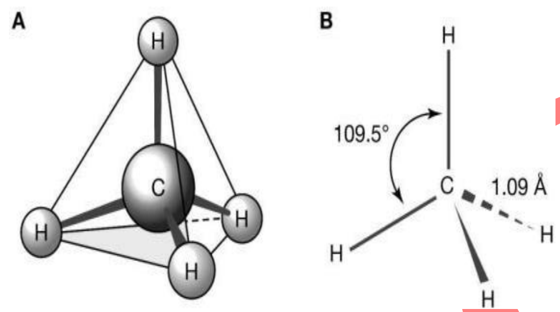


Figure: 1 Bond angle and bond length of methane



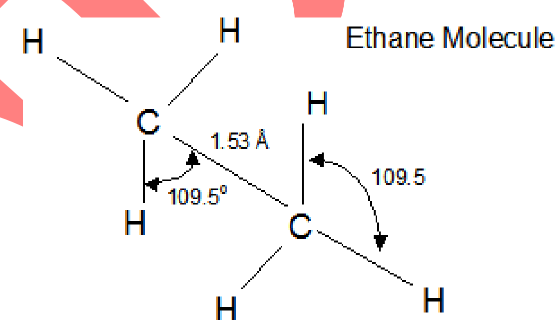
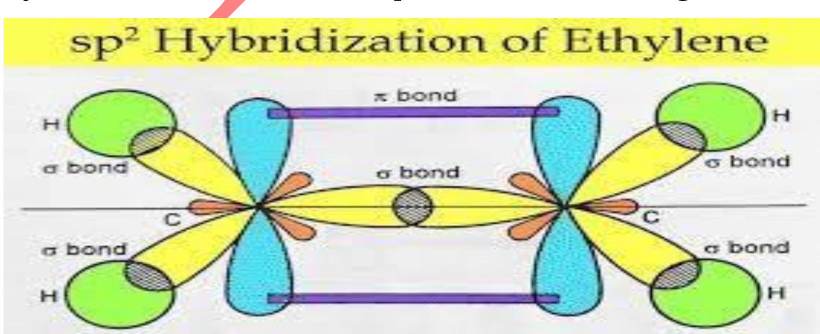


Figure 2: Bond angle and bond length of ethane

SP^2 HYBRIDIZATION

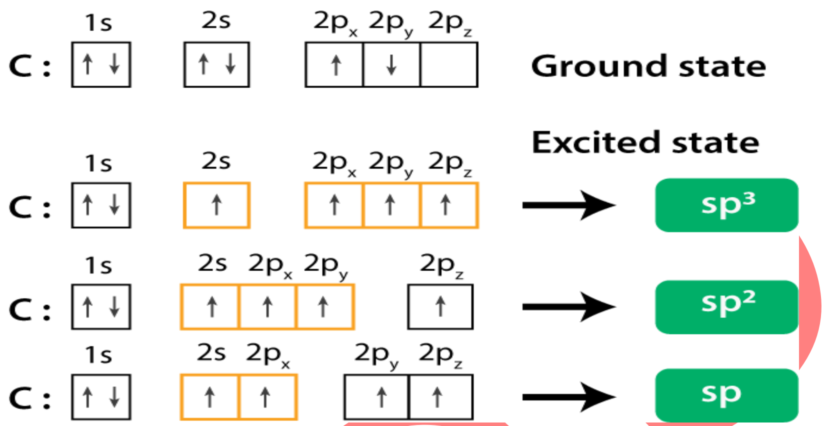
sp^2 hybridization is observed when one s and two p orbitals of the same shell of an atom mix to form 3equivalent orbitals. The new orbitals formed are called sp^2 hybrid orbitals.

- SP^2 hybridization is also called trigonal hybridization.
- It involves the mixing of one ‘s’ orbital and two ‘p’ orbitals of equal energy to give a new hybridorbital known as sp^2.
- A mixture of s and p orbital formed in trigonal symmetry and is maintained at 120^0.
- All three hybrid orbitals remain in one plane and make an angle of 120° with one another.



Each ofthe hybrid orbitals formed has a 33.33%. ‘s’ character and 66.66% ‘p’ character.

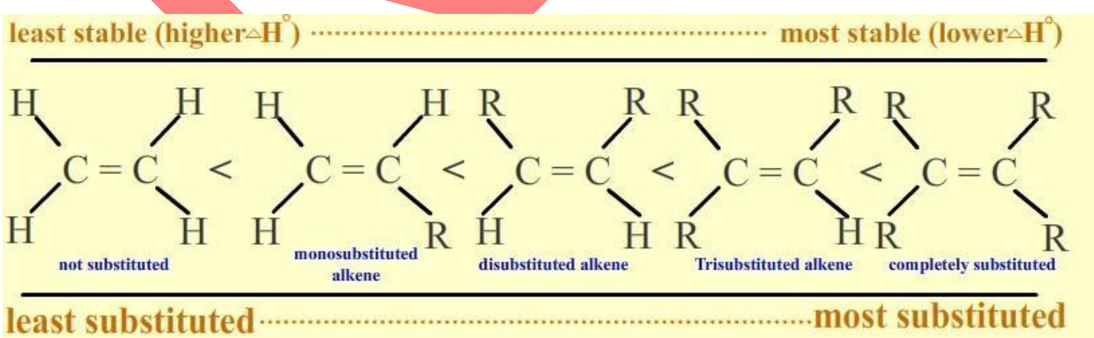
- The molecules in which the central atom is linked to 3 atoms and is sp2 hybridized have a triangularplanar shape.



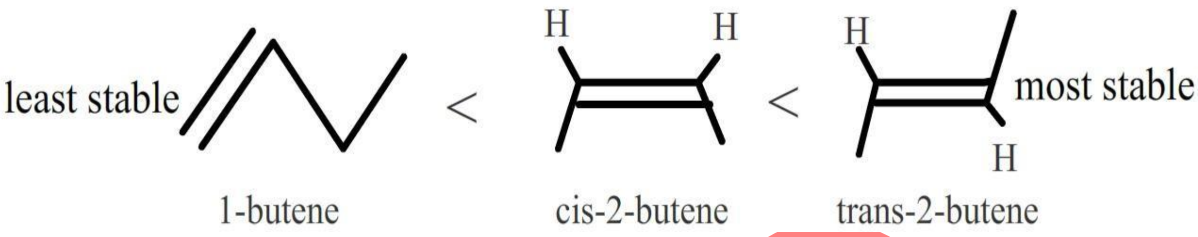
STABILITY OF ALKENES

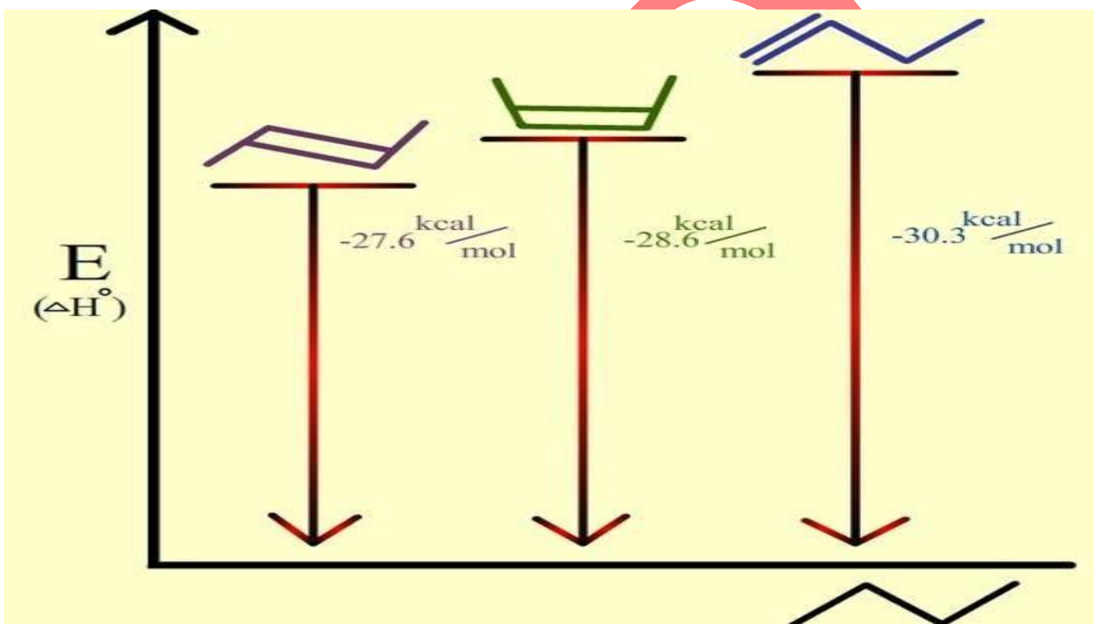
The stability of alkene can be determined by measuring the amount of energy associated with the hydrogenation of the molecule. Since the double bond is breaking in this reaction, the energy released in hydrogenation is proportional to the energy in the double bond of the molecule. This is a useful tool because heats of hydrogenation can be measured very accurately. The is usually around -30 kcal/mol for alkenes.

Stability is simply a measure of energy. Lower energy molecules are more stable than higher energy molecules. More substituted alkenes are more stable than less substituted ones due to hyperconjugation. They have a lower heat of hydrogenation. The following illustrates stability of alkenes with various substituents:



In disubstituted alkenes, trans isomers are more stable than cis isomers due to steric hindrance. Also, internal alkenes are more stable than terminal ones. See the following isomers of butene:





2 MARKS QUESTIONS

1. Define SP^2 hybridisation with suitable examples?
2. Define SP^3 hybridisation with suitable examples?

5MARKS QUESTION

1. Explain in detail about the stability of alkanes?
2. Write in brief about SP^2 & SP^3 hybridisation with examples?