Chapter 12. Hydrocarbons

Question-1

What is the difference between conformational isomers and geometrical isomers?

Solution:

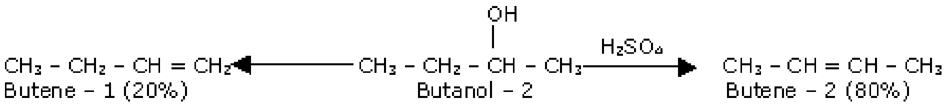
Conformational isomers are different spatial arrangements of atom or groups of a molecule that arises from free rotation about a single bond. Since conformations cannot be isolated, they are not isomers. (Eclipsed, staggered and skew).

Geometrical isomers are the different spatial arrangements of atoms or groups of a molecule that arises due to the restriction of rotation about a double bond. They are separable Ex. cis & trans isomers).

Question-2

Which is the main product when butanol – 2 is dehydrated and why?

Solution:



$$\underset{\text{Butene - 1 (20\%)}}{CH_3-CH_2-CH=CH_2} \longleftarrow \underset{\text{Butanol - 2}}{CH_3-CH_2-\overset{\overset{OH}{|}}{CH}-CH_3} \xrightarrow{H_2SO_4} \underset{\text{Butene - 2 (80\%)}}{CH_3-CH=CH-CH_3}$$

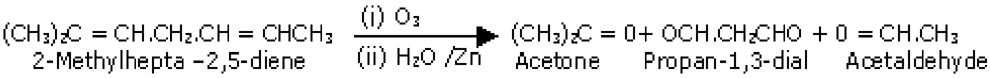
Dehydration is governed by Saytzeff's rule. According to which hydrogen is preferentially eliminated from carbon atom with few number of hydrogen atom, i.e. the poor becomes poorer. Thus 2-butane is the main product. [Greater the number of alkyl groups attached to the doubly bonded carbon atoms, the more stable is the alkene].

Question-3

A hydrocarbon (X) takes up two molecules of hydrogen and converted into a saturated hydrocarbon. On ozonolysis, X gives a mixture of three carbonyl compounds namely acetaldehyde, acetone and propan – 1,3-dial. Assign structure to compound X.

Solution:

Since the compound X takes up two molecules of hydrogen, it must be having either a triple bond or two double bonds. The formation of three products, on ozonolysis, indicates that the compound is having unsaturation at two places, hence it must be a diene. The nature of ozonolysis products leads to following structure to the compound (X).



$$(CH_3)_2C = CH.CH_2.CH = CHCH_3 \xrightarrow[\text{(ii) } H_2O\ /Zn]{\text{(i) } O_3} (CH_3)_2C = 0 + OCH.CH_2CHO + 0 = CH.CH_3$$

2-Methylhepta –2,5-diene   Acetone   Propan-1,3-dial   Acetaldehyde

Question-4

How will you distinguish between

1) Butene – 1 and Butene – 2

2) Butyne and butene – 1

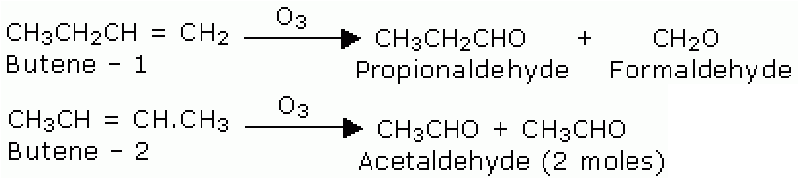
3) Ethene and benzene

4) Benzene and Cyclohexene

Solution:

1) Butene - 1 and Butene - 2

Butene - 1 and butene-2 can be distinguished either by ozonolysis or by oxidation with acidic $KMnO_4$ solution with which they give different carbonyl compounds.



$$\underset{\text{Butene - 1}}{CH_3CH_2CH = CH_2} \xrightarrow{O_3} \underset{\text{Propionaldehyde}}{CH_3CH_2CHO} + \underset{\text{Formaldehyde}}{CH_2O}$$

$$\underset{\text{Butene - 2}}{CH_3CH = CH.CH_3} \xrightarrow{O_3} \underset{\text{Acetaldehyde (2 moles)}}{CH_3CHO + CH_3CHO}$$

2) Butyne and Butene - 1

Since butyne-1 ($CH_3.CH_2C \equiv CH$) has an acetylenic hydrogen atom, it will give white precipitate with ammonical silver nitrate, and red precipitate with ammonical cuprous chloride. On the other hand, butene-1($CH_3CH_2.CH = CH_2$) does not respond these tests.

$$2CH_3.CH_2.C \equiv CH + Cu_2Cl_2 + 2NH_4OH \longrightarrow 2CH_3CH_2C \equiv CCu\downarrow + 2NH_4Cl + 2H_2O$$

3) Ethene and benzene

Since the double bonds of benzene are not localized, benzene does not give the usual properties of unsaturation and hence it does not decolourise bromine water and Baeyer's reagent. On the other hand, ethane being an unsaturated compound, gives positive response to bromine water test and Baeyer's test.

4) Benzene and cyclohexene

Since the double bonds of benzene are not localized, benzene does not give the usual properties of unsaturation and hence it does not decolourise bromine water and Baeyer's reagent. On the other hand, cyclohexene, being an unsaturated compound, gives positive response to bromine water test and Baeyer's test.

Question-5

Acetylene is acidic in nature; but it does not react NaOH or KOH; Give reason.

Solution:

Acetylene is a very weak acid ($pK_a = 25$) and hence only an extremely strong base like amide ion (NH_2^-) can successfully remove a proton.

Question-6

n-pentane has higher boiling point than neopentane….. why?

Solution:

n-pentane has higher b. p. (36.2^0C) than neopentane(9.5^0C). It is due to vander Waals forces. n-Pentane has a rod-like shape, while neopentane is sphere-like. Rods can touch along their entire length, while the spheres touch only at a point. The more the contact between molecules, the greater the vander waals forces and hence higher the b.pt.)

Question-7

Give reason Toluene reacts with bromine in the presence of light to give benzyl bromide while in presence of $FeBr_3$ it gives p-bromotoluene.

Solution:

In presence of light, toluene undergoes free radical substitution leading to substitution in the side chain forming benzyl bromide, while in presence of $FeCl_3$ toluene undergoes electrophilic substitution leading to substitution in the nucleus forming p-bromotoluene.

Question-8

The $-OCH_3$ group strongly activates the o,p-positions but weakly deactivates the m-position, while $-CH_3$ activates all positions, but mainly the o- and p-.

Solution:

The $-OCH_3$ group is electron-donating and activating due to electromeric and mesomeric effects. It activates the o-, p-positions. The group is also electron withdrawing due to – I effect which prevails in the m-position which is thus deactivated.

The $-CH_3$ group is electron-donating due to +I effect and hyperconjucation. Hyperconjucation is effective only in the o,p-positions which therefore are more activated than the m-positions.

Question-9

Complete the following:

$$Q = [A] \xrightarrow{\text{alc. KOH}} [B] \xrightarrow{Br_2} CH_3CHBr.CH_2Br \xrightarrow{KNH_2} [C] \xrightarrow{Na / n - C_3H_7Br}$$

Solution:

(i) CH_3 - $CHBr.CH_2Br$ is formed from B addition [B] i.e. should be $CH_3.CH=CH_2$

(ii) A should be an alkyl halide which gives alkene with alc. KOH. CH_3CHBr - CH_3 or $CH_3CH_2CH_2Br$

(iii) Alkyne will be formed for a dibromide with KNH_2: c) should be $CH_3.CH \equiv CH$

(iv) Compound C reacts with Na to form a sodium derivative. This derivative reacts with n-C_3H_7Br to form a substituted product as follows.

$$CH_3.CH \equiv CH + Na / n - C_3H_7Br \longrightarrow CH_3CH \equiv C.C_3H_7 .$$

Question-10

How is the reactivity of cycle alkanes related with the bond angle of them?

Solution:

Cyclopropane, cyclobutane, cyclopentane and cyclohexane have bond angles 60^0 , 90^0, 108^0 and 120^0 respectively. Greater the deviation of bond angle from $109^0 28'$, greater will be the strain in molecules and more will be the reactivity.

$d = \frac{100°20' - \alpha}{2}$ were α = bond angle . d = deviation

Order of reactivity is cyclopropane > cyclobutane > Cyclopentane