Question-1

What is the hybridization of carbon atoms in $HC \equiv C\text{-}CH = CH_2$?

Solution:

$HC \equiv \overset{1}{C}\text{-}\overset{2}{CH} = CH_2$ Carbon 1 is sp and 2 is sp^2 hybridised carbon atoms.

Hint: For hybridization, π bond is not taken into account. Carbon 2 is connected to three sigma bonds. Hence its hybridisation is sp^2 which gives three bonds.

C^1 is connected to two sigma bonds. Hence its hybridisation is sp.

Question-2

What is the change in the hybridisation of carbon atom, in the following dehydration reaction ?

$$CH_3CONH_2 \xrightarrow{P_2O_5} CH_3CN$$

Solution:

$$\underset{sp^2}{CH_3-\overset{\overset{O}{\|}}{C}-NH_2} \xrightarrow{P_2O_5} \underset{sp}{CH_3C \equiv N} + H_2O$$

Carbon in CH_3CONH_2 is connected with three sigma bonds. Hence, its hybridization is sp^2. But in $CH_3C \equiv N$ carbon atom is connected with two sigma bonds.

Question-3

Which of the following is not a 'Lewis acid' $AlCl_3$, $BeCl_2$, BF_3 & $SnCl_4$?

Solution:

$SnCl_4$ contains octet arrangement (8 electrons) around Sn atom. Hence Sn has no tendency to accept pair of electrons. Therefore $SnCl_4$ is not a Lewis acids.

$AlCl_3$, BF_3 have six electrons around Al and B. In $BeCl_2$, Be has only four electrons. $AlCl_3$, BF_3 and $BeCl_2$ can act as Lewis acid.

Question-4

Which of the following is not an electrophile? OH^-, SO_3 ,NO_2^+, Cl^+.

Solution:

OH^- is not an electrophile. SO_3,NO_2^+, Cl^+ are electrophiles, which attack electron rich carbanions. OH^- is a nucleophile which can attack positively charged carbon atom(carbo cation)

Question-5

Which of the following is not a nucleophile? OH^-, NH_3, BF_3 & HSO_3^-

Solution:

BF_3 , is an electron deficient, molecule. Hence it cannot act as an nucleophile.

Question-6

$C_4H_{10}O$ show metamerism, functional isomerism and position isomerism. Explain.

Solution:

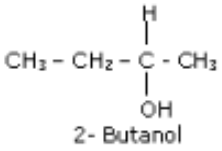
Functional isomerism

$C_4H_{10}O$ $C_2H_5OC_2H_5$ Diethyl ether

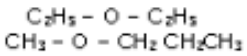
$CH_3CH_2CH_2CH_2OH$

Position isomerism :

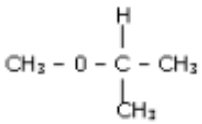
Position OH group in alcohol may be different; $CH_3CH_2CH_2\ CH_2OH$ (I) Butanol



2- Butanol



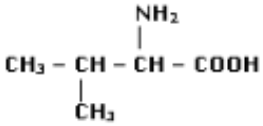
Metamerism:



isopropyl methyl ether.

Question-7

Write IUPAC names for the following compounds.

1) 

2) $CH_3 - CH = CH - C \equiv CH$

3) $CH_2 = CH - CH_2 - C \equiv CH$

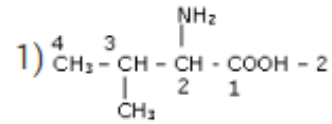
4) $CH_2 = CH - CH = CH_2$

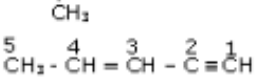
5) $CH_2 - CN$

$|$

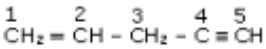
$CH_2 - CN$

Solution:

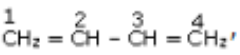
1)  2- amino – 3- methylbutanoic acid

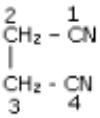
2)  pent – 3 – en – 1 – yne

End carbon atom with double or triple bond, will be given lowest number.

3)  pent – 1 –en – 4yne

If double bonds and triple bonds are in equal position, carbon atoms with double bond will be given the lowest number.

4)  , 4 butadiene.

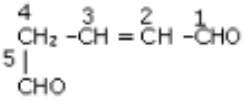
5)  1,4 – Butanedinitrile

Question-8

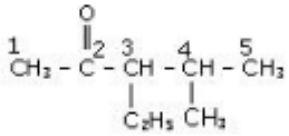
c) 2 – methoxy – 2 – butene.

Solution:

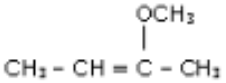
a) pent - 2 - ene - 1,5 - dial



b) 3 - Ethyl - 4 methyl - 2 - pentanone



c) 2 - Methoxy - 2 -butene

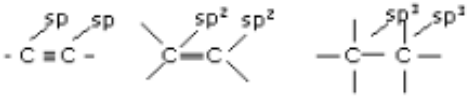


Question-9

Why C ≡ C bond has shorter bond length than C = C and C-C bond?

Solution:

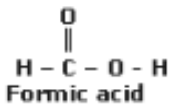
More penetrating character 2 orbital towards its nuclear.



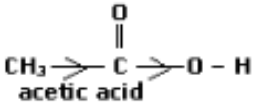
In sp hybrid orbitals ratio of s & p character = 1 : 1
In sp^2 hybrid orbitals ratio of s & p character 1 : 2
In sp^3 hybrid orbitals ratio of s & p character 1 : 3
s-orbital is a localised orbital and the size of the orbital is very small. Hence bond due to s-orbital will be the shorter one. p-orbital is more diffused and hence bond due to p-orbital will be longer than that due to s-orbital. More the s-character more shorter will be the bond length. Triple bond has more s-character. Hence it will have shortest bond length.

Question-10

Formic acid is a stronger acid than acetic acid. Explain.

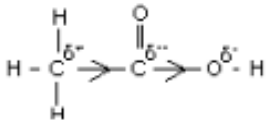


Formic acid



acetic acid

Solution:



CH_3 group in acetic acid is a group with +I effect. It is an electron donating group in which a pair of electrons in C – C bond between CH_3 and COOH groups are pushed towards carbon of –COOH group. Similarly pair of electrons of C – O bond of –CO group and –OH are pushed towards oxygen of OH group.
Since oxygen carries δ^- release of hydrogen as H^+ becomes difficult. Hence, acetic acid is a weaker acid than formic acid.

Question-11

How is a mixture of benzoic acid and benzophenone separated?

Solution:

Benzoic acid is soluble in hot water and benzophenone is not soluble in hot water. The mixture is separated by dissolving it in hot water and filtering the hot solution. Benzoic acid crystallizes on cooling the filterate while benzophenone remains as an insoluble residue.

Question-12

By what method is glycerol formed during saponification of oil separated?

Solution:

Glycerol has higher boiling point 563 K with some decomposition. Hence it is separated from spont lye in soap industry by distillation under reduced pressure. Under reduced pressure (12 mm) glycerol distills over at a lower temperature (453K).

Question-13

What is meant by theoretical plate?

Solution:

A fractionating coloumn provides many surfaces for heat exchanges between the ascending vapours and the descending, condensed liquid. These surfaces may consist of fixed plates or glass beads. Each successive condensation and vaporization is called a theoretical plate. Fractionating columns with hundreds of plates are present in commercial fractionating coloumn.

Question-14

How is a mixture of aniline and water, essential oil or turpentine oil from plants, separated? Give the reason:

Solution:

Aniline, essential oil, and turpentine oil are steam volatile and are immiscible with water. When steam is passed through the mixture and distilled, a mixture of steam and the volatile organic compounds is condensed and collected. Using separating funnel, Aniline, or essential oil or turpentine oil is separated from water.

In steam distillation the mixture boils when the sum of vapour pressures due to the Aniline and that due to water becomes equal to the atmospheric pressure. Hence aniline will boil at a low temperature than its boiling point. Since the other liquid is water, mixture will boil at to but below 373 K as aniline gives some vapour pressure.

Question-15

What is meant Rf value? What is the use of it?

Solution:

$$Rf : \frac{\text{Distance moved by the substance from base line}}{\text{Distance moved by the solvent from base line}}$$

It is the qualitative index for substances. From Rf value it is possible to identify the substances.

Question-16

Why is paper chromatography a partition chromatography?

Solution:

In paper chromatography compounds of a mixture are partitioned between stationary phase and mobile phases. Water trapped in the chromatography is the stationary phase and solvents acts as mobile phases. Substances are partitioned according to its solubility between water and the solvents.

Question-17

Define the term 'elution' as applied to column chromatography.

Solution:

The process by which adsorbed substances are desorbed from the stationary phase, by allowing an appropriate solvent or a mixture of solvents to flow down the column slowly. Depending upon the degree to which the compound is adsorbed, partial or complete separation takes place.

Question-18

Which are called stationary phase and mobile phase in chromatography?

Solution:

The solid or liquid on which the mixture to be separated applied called stationary phase. In column chromatory, silica gel, alumina, activated charcoal act as stationary phase. Water trapped in the chromatography paper and silica gel or alumina in thin layer chromatography are other examples. A pure solvent, a mixture of solvents, or a gas which moves slowly over the stationary phase is called mobile phase.

Question-19

List any four modern techniques for structural elucidation.

Solution:

Infrared (IR), ultra violet – visible, (uv-vis) nuclear magnetic resonance(NMR) spectroscopy, and mass spectrometry, XRD(X-ray diffraction technique) are the important modern techniques used for structural elucidation.

Question-20

How steam distillation differs from fractional distillation?

Solution:

Fractional distillation is applicable to separate liquids with closer boiling points. (Ex. Petroleum fractionation). Steam distillation is used to separate substances which are volatile in steam and insoluble in water. These substances may also have higher boiling points (>373 K at 760 mm) and decomposes at or below its boiling point (Ex: turpentine oil / essential oil / aniline).