NCERT SOLUTIONS
CLASS-XI CHEMISTRY
CHAPTER-12
ORGANIC CHEMISTRY

Question 12.1:

Mention the hybridisation states of each carbon atom in the following compounds

$CH_2=C=O$, $CH_3CH=CH_2$, $(CH_3)_2CO$, $CH_2=CHCN$, C_6H_6

Answer 12.1:

(i) $\overset{1}{C}H_2=\overset{2}{C}=O$

C–1 is sp^2 hybridised.

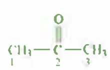
C–2 is sp hybridised.

(ii) $\overset{1}{C}H_3-\overset{2}{C}H=\overset{3}{C}H_2$

C–1 is sp^3 hybridised.

C–2 is sp^2 hybridised.

C–3 is sp^2 hybridised.

(iii) 

C–1 and C–3 are sp^3 hybridised.

C–2 is sp^2 hybridised.

(iv) $\overset{1}{C}H_2=\overset{2}{C}H-\overset{3}{C}\equiv N$

C–1 is sp^2 hybridised.

C–2 is sp^2 hybridised.

C–3 is sp hybridised.

(v) C_6H_6

All the 6 carbon atoms in benzene are sp^2 hybridised.

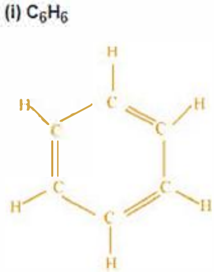
Question 12.2:

Indicate the σ and π bonds in the following molecules:

C_6H_6, C_6H_{12}, CH_2Cl_2, $CH_2=C=CH_2$, CH_3NO_2, $HCONHCH_3$

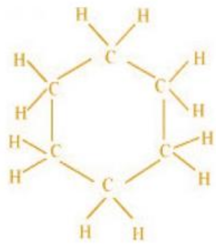
Answer 12.2:

(i) C_6H_6



There are six C – C sigma (σ_{C-C}) bonds, six C–H sigma (σ_{C-H}) bonds, and three C=C pi (π_{C-C}) resonating bonds in the given compound.

(ii) C_6H_{12}



There are six C – C sigma (σ_{C-C}) bonds and twelve C–H sigma (σ_{C-H}) bonds in the given compound.

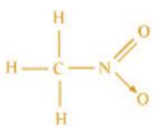
(iii) CH_2Cl_2

There are two C – Cl sigma (σ_{C-Cl}) bonds and two C–H sigma (σ_{C-H}) bonds in the given compound.

(iv) $CH_2 = C = CH_2$

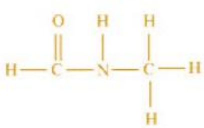
There are two C–C sigma (σ_{C-C}) bonds, four C–H sigma (σ_{C-H}) bonds, and two C=C pi(π_{C-C}) bonds in the given compound.

(v) CH_3NO_2



There are three C–H sigma (σ_{C-H}) bonds, one C–N sigma (σ_{C-N}) bond, one N–O sigma(σ_{N-O}) bond, and one N=O pi (π_{N-O}) bond in the given compound.

(vi) $HCONHCH_3$



There are four C–H sigma (σ_{C-H}) bonds, two C–N sigma (σ_{C-N}) bond, one N–H sigma(σ_{N-O}) bond, and one C=O pi (π_{N-O}) bond in the given compound.

Question 12.3:

What are the bond line formulas for the following compounds?

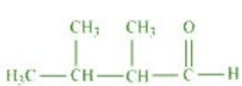
(a)2, 3–dimethyl butanal

(b) Heptan–4–one

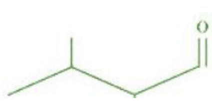
(c) Isopropyl alcohol

Answer 12.3:

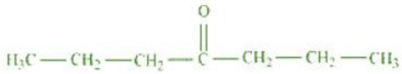
(a)2, 3–dimethyl butanal



$\Rightarrow$

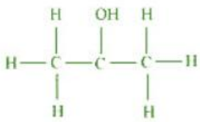


(b) Heptan–4–one



⇒

(c) Isopropyl alcohol



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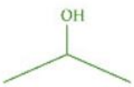


Question 12.4:

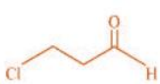
Give the IUPAC names of the following compounds:

(a) 

(b) 

(c) 

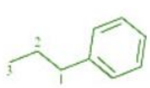
(d) 

(e) 

(f) Cl_2CHCH_2OH

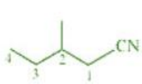
Answer 12.4:

(a)



3–phenyl propane

(b)

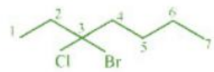


2–methyl–1–cyanobutane

(c)

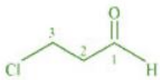
2, 5–dimethyl heptane

(d)



3–bromo–3–chloroheptane

(e)



3–chloropropanal

(f) Cl_2CHCH_2OH

1, 1–dichloro–2–ethanol

Question 12.5:

Which of the following names of the respective compounds are the correct IUPAC-prescribed ones?

(a) 2,2-Dimethylpentane or 2-Dimethylpentane

(b) 2,4,7-Trimethyloctane or 2,5,7-Trimethyloctane

(c) 2-Chloro-4-methylpentane or 4-Chloro-2-methylpentane

(d) But-3-yn-1-ol or But-4-ol-1-yne

Answer 12.5:

(a)The prefix *di* shows that there are two methyl groups in the chain. Thus the correct IUPAC name would be 2,2-Dimethylpentane.

(b)The locant number should start from the minimum. Here, 2,4,7 is lower than 2,5,7. Thus, the correct IUPAC name would be 2,4,7-Trimethyloctane.

(c)If the substituents in the chain are in equivalent positions, then the lower number is given to the substituent group in an alphabetical order.Thus, the correct IUPAC name would be 2-Chloro-4-methylpentane.

(d)Out of the two functional groups present in the given compound, the alcoholic group is the principal functional group. Thus, the parent chain will have an –ol suffix. Since, the alkyne group is in C–3, the IUPAC name would be But–3–yn–1–ol.

Question 12.6:

What are the formulas for the first five members of each of the homologous series beginning with the below-given compounds?

(a) H–COOH

(b) CH_3COCH_3

(c) $H–CH=CH_2$

Answer 12.6:

The first five members of each homologous series beginning with the given compounds are

(a)

H–COOH :Methanoic acid

CH_3–COOH :Ethanoic acid

CH_3–CH_2–COOH :Propanoic acid

CH_3–CH_2–CH_2–COOH :Butanoic acid

CH_3–CH_2–CH_2–CH_2–COOH :Pentanoic acid

(b)

CH_3COCH_3 :Propanone

$CH_3COCH_2CH_3$: Butanone

$CH_3COCH_2CH_2CH_3$: Pentan-2-one

$CH_3COCH_2CH_2CH_2CH_3$: Hexan-2-one

$CH_3COCH_2CH_2CH_2CH_2CH_3$: Heptan-2-one

(c)

H–CH=CH_2 :Ethene

CH_3–CH=CH_2 : Propene

CH_3–CH_2–CH=CH_2 : 1-Butene

CH_3–CH_2–CH_2–CH=CH_2 : 1-Pentene

CH_3–CH_2–CH_2–CH_2–CH=CH_2 : 1-Hexene

Question 12.7:

Write thebond line and condensed structural formulas and also find out the functional group for the following compounds.

(a)2,2,4-Trimethylpentane

(b)2-Hydroxy-1,2,3-propanetricarboxylic acid

(c) Hexanedial

Answer 12.7:

(a) 2, 2, 4–trimethylpentane

Condensed formula

$(CH_3)_2CHCH_2C\ (CH_3)_3$

Bond line formula : 

(b) 2–hydroxy–1, 2, 3–propanetricarboxylic acid

Condensed Formula

$(COOH)CH_2C(OH)\ (COOH)CH_2(COOH)$

Bond line formula: 

Functional groups:

Carboxylic acid(-COOH) and Alcoholic (-OH) groups

(c) Hexanedial

Condensed Formula

$(CHO)(CH_2)_4(CHO)$

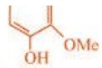
Bond line formula: 

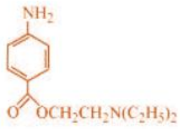
Functional groups:

Aldehyde(-CHO)

Question 12.8:

What are the functional groups present in the below given compounds?

(a) 

(b) 

(c) 

Answer 12.8:

(a) Hydroxyl (–OH),Aldehyde (–CHO), Methoxy (–OMe),

C=C double bond $\left(-\overset{|}{C}=\overset{|}{C}-\right)$

(b)Ketone (C = O),Amino (–NH2),Diethylamine (N(C2H5)2)

(c) Nitro (–NO2),

C=C double bond $\left(-C=C-\right)$

Question 12.9:

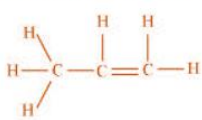
Which of the two given compounds: $O_2NCH_2CH_2O^-$ or $CH_3CH_2O^-$would you expect to be more stable and why?

Answer 12.9:

Since NO_2 belongs to the electron-withdrawing group, it shows –I effect. NO_2 tries to decrease the negative charge on the compound by withdrawing the electrons toward it. This stabilizes the compound whereas ethyl group belongs to the electron-releasing group and shows +I effect. This results in an increase in the negative charge on the compound thus destabilizing the compound. Hence, I would expect $O_2NCH_2CH_2O^-$to be more stable than $CH_3CH_2O^-$.

Question 12.10:

Why do you think alkyl groups act as electron donors when they get attached to a π system?

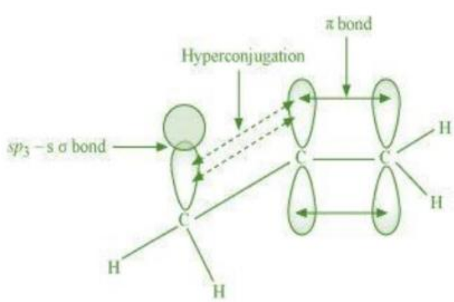


Answer 12.10:

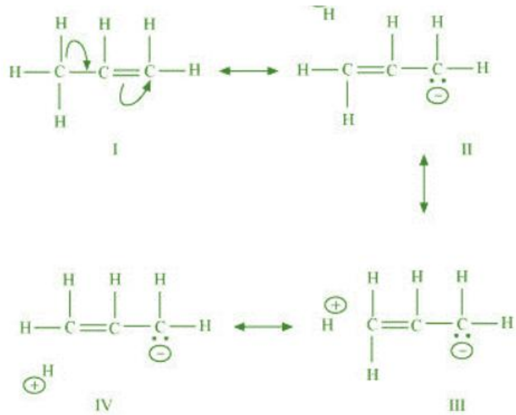
Due to hyperconjugation, an alkyl group behaves as an electron-donor group when attached to a π system.For example, look at propene.

The sigma electrons of the C-H bond get delocalized due to hyperconjugation. The alkyl is attached directly to an unsaturated system. The delocalization happens due to the partial overlap of a sp^3-s sigma bond orbital with an empty p orbital of the n bond of an adjacent carbon atom.

This process can be shown as:



The overlap as shown above results in delocalization making the compounds more stable.



Question 12.11:

Sketch the resonance structures of the below given compounds along with a curved arrow notation to show the electron shift.

(a) C_6H_5OH

(b) $C_6H_5NO_2$

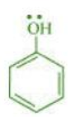
(c) $CH_3CH = CH – CHO$

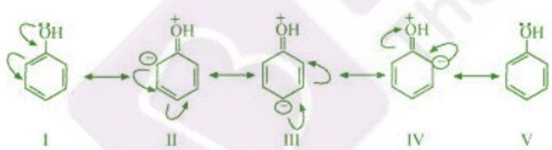
(d) C_6H_5CHO

(e) $C_6H_5\text{-}CH_2$

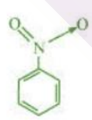
(f)$CH_3CH\text{=}CHCH_2$

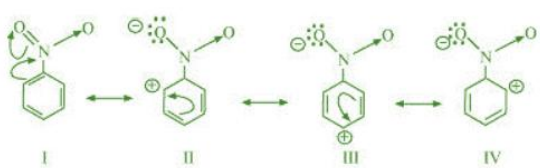
Answer 12.11:

(a) The structure of C_6H_5OH is: 



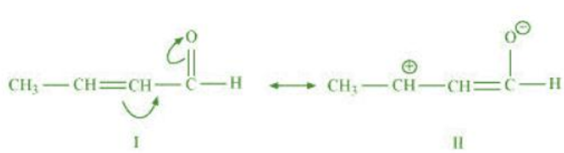
Resonating structures:

(b) The structure of $C_6H_5NO_2$ is: 

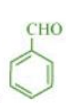


Resonating structures:

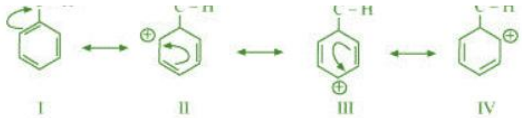
(c) $CH_3CH = CH – CHO$



Resonating structures:

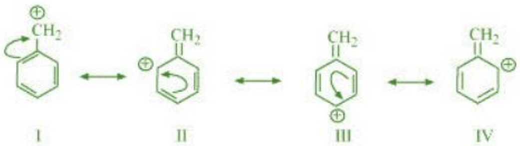
(d) The structure of C_6H_5CHO is: 

Resonating structures:



(e) C_6H_5-CH_2

Resonating structures:



(f) CH_3CH=$CHCH_2$

Resonating structures:

Question 12.12:

Define Nucleophiles and Electrophiles with the help of examples.

Answer 12.12:

A nucleophile is a reagent that has an electron pair and is willing to donate it. It is also known as a nucleus-loving reagent. Ex: NC^-, OH^-, R_3C^- (carbanions) etc.

An electrophile is a reagent which is in need of an electron pair and is also known as an electron-loving pair. Ex: Carbonyl groups, $CH_3CH_2^+$(Carbocations), Neutral molecules(due to the presence of a lone pair).

Question 12.13:

Classify the following reagents as Electrophiles or Nucleophiles.

(a) $CH_3COOH + HO^- \rightarrow CH_3COO^- + H_2O$

(b) CH_3COCH_3+ $C^-N \rightarrow (CH_3)_2C(CN) + (OH)^-$

(c) $C_6H_5 + CH_3C^+O \rightarrow C_6H_5COCH_3$

Answer 12.13:

A nucleophile is a reagent that has an electron pair and is willing to donate it. It is also known as a nucleus-loving reagent.

An electrophile is a reagent which is in need of an electron pair and is also known as an electron-loving pair.

(a) $CH_3COOH + HO^- \rightarrow CH_3COO^- + H_2O$

It is a nucleophile since HO- is electron rich in nature.

(b) CH_3COCH_3+ $C^-N \rightarrow (CH_3)_2C(CN) + (OH)^-$

It is a nucleophile since C^-N is electron rich in nature.

(c) $C_6H_5 + CH_3C^+O \rightarrow C_6H_5COCH_3$

It is an electrophile since CH_3C^+O is electron-deficient in nature.

Question 12.14:

Find out the type of reaction happening in each of the following equations:

(a) $CH_3CH_2Br + HS^- \rightarrow CH_3CH_2SH + Br^-$

(b) $(CH_3)_2$ C=CH_2 + HCl→$(CH_3)_2$ClC⁻CH_3

(c) CH_3CH_2Br + HO^-→CH_2=CH_2 + H_2O + Br^-

(d) $(CH_3)_3$C–CH_2 OH + HBr→$(CH_3)_2$ CBrCH_2CH_3 + H_2O

Answer 12.14:

(a) Substitution reaction since bromine group gets substituted by –SH group.

(b) Addition reaction since two reactant molecules combines to form a single product.

(c) Elimination reaction since reaction hydrogen and bromine are removed to form ethene.

(d) Substitution reaction since rearrangement of atoms takes place.

Question 12.15:

Are the below given sets of compounds related to each other? If so, are they geometrical or structural isomers or resonance contributors?

(a) 

(b) 

(c) 

Answer 12.15:

(a) The given compounds are a pair of structural isomers since they have the same molecular formula but have different structures. These compounds differ in the position of the ketone group. For the first structure, it is in C-3 whereas, for the 2^{nd} one, it is in C-2.

(b) The given compounds are a pair of geometrical isomers since they have the same molecular formula, sequence of covalent bonds and the same constitution but differ in the relative positioning of the atoms in space. These compounds differ in the positioning of the Deutrium and Hydrogen.

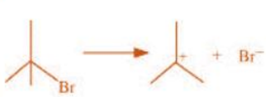
(c) The given compounds are a pair of contributing structures or canonical structures. They do not represent any real molecule and are purely hypothetical. They are also called as resonance isomers.

Question 12.16:

For each of the below given bond cleavages, show the electron flow by using curved arrows and classify them as heterolysisor homolysis. Classify the intermediate produced as carbocation or free radical or carbanion.

(a) 

(b) 

(c) 

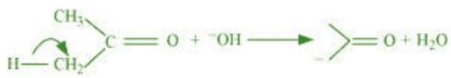
(d) 

Answer 12.16:

(a) The bond cleavage can be shown as:

It comes under homolytic cleavage since one of the shared pair in a covalent bond goes with the bonded atom. A free radical is formed as the reaction intermediate.

(b) The bond cleavage can be shown as:



It comes under heterolytic cleavage since the shared remains with the carbon atom of propanone. A carbanion is formed as the reaction intermediate.

(c) The bond cleavage can be shown as:

It comes under heterolytic cleavage since the shared remains with the bromine ion. A carbocation is formed as the reaction intermediate.

(d) The bond cleavage can be shown as:

It comes under heterolytic cleavage since the shared remains with one of the fragments. A carbocation is formed as the reaction intermediate.

Question 12.17:

Define the terms Electromeric and Inductive effects. Which effect of electron displacement do you think can explain the below given correct orders of acidity of the carboxylic acids?

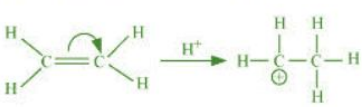
(a) $Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH$

(b) $CH_3CH_2COOH > (CH_3)_2CHCOOH > (CH_3)_3C.COOH$

Answer 12.17:

Electrometric effect

The complete transfer of the shared pair of π electrons to either of the two atoms linked by multiple bonds in the presence of an attacking agent is called the electrometric effect. It can either be – E effect or +E effect.



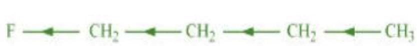
– E effect: Occurs when electrons are moved away from the attacking agent

+ E effect: Occurs when electrons are moved towards the attacking agent

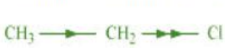
Inductive effect

Inductive effect involves the permanent displacement of sigma (σ) electrons along a saturated chain, whenever an electron withdrawing or electron donating group is present.

It can either be + I effect or – I effect. When an atom or group attracts electrons towards itself more strongly than hydrogen, it is said to possess – I effect.

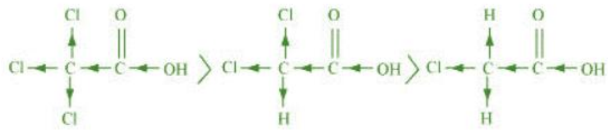


When the force with which an atom attracts electrons towards itself is greater than that of hydrogen, it is said to exhibit +I effect.



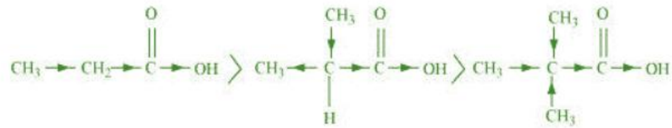
(a) $Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH$

The acidity increases with the increase in –I effect which is directly proportional to the number of chlorine atoms.



(b) CH_3CH_2COOH > $(CH_3)_2$ $CHCOOH$ > $(CH_3)_3C.COOH$

The acidity increases with the increase in +I effect which is directly proportional to the number of alkyl groups.



Question 12.18:

Explain the following techniques with the help of examples.

(a)Distillation

(b) Crystallisation

(c) Chromatography

Answer 12.18:

(a) Crystallisation

Crystallization is used to purify solid organic compounds.

Principle: The principle on which it works is the difference in the solubility of the compound and impurities in a given solvent. The impure compound is made to dissolve in the solvent at a higher temperature since it is sparingly soluble at lower temperatures. This is continued till we get an almost saturated solution. On cooling and filtering it, we get its' crystals. Ex: By crystallizing 2-4g of crude aspirin in 20mL of ethyl alcohol, we get pure aspirin. It is heated if needed and left undisturbed until it crystallizes. The crystals are then separated and dried.

(b) Distillation

This method is used to separate non-volatile liquids from volatile impurities. It is also used when the components have a considerable difference in their boiling points.

Principle: The principle on which it works is that liquids having different boiling points vaporise at different temperatures. They are then cooled and the formed liquids are separated.

Ex: A mixture of aniline (b.p = 457 K) and chloroform (b.p = 334 K) is taken in a round bottom flask having a condenser. When they are heated, Chloroform, vaporizes first due to its high volatility and made to pass through a condenser where it cools down. The aniline is left behind in the round bottom flask.

(c) Chromatography

It is widely used for the separation and purification of organic compounds.

Principle: The principle on which it works is that individual components of a mixture move at different paces through the stationary phase under the influence of mobile phase.

Ex: **Chromatography** can be used to separate a mixture of blue and red ink. This mixture is placed on chromatogram where the component which is less adsorbed by the chromatogram moves faster up the paper than the other component which is almost stationary.