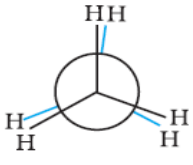
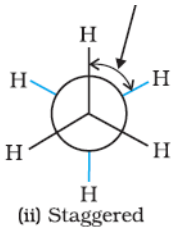
PREVIOUS HSE QUESTIONS AND ANSWERS OF THE CHAPTER "HYDROCARBONS"

1. Draw the Newman projections for the eclipsed and staggered conformations of ethane. (2)

Ans:



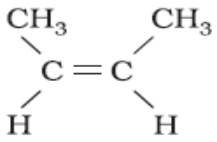
(i) Eclipsed



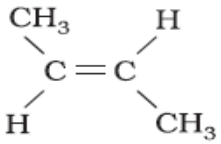
(ii) Staggered

2. Draw the geometrical isomers of but-2-ene. (2)

Ans:



cis-But-2-ene



trans-But-2-ene

3. Explain the following :

(i) Wurtz reaction

(ii) Kharash effect (2 x 2 = 4)

Ans: (i) Alkyl halides react with metallic sodium in dry ether to form alkanes. This reaction is known as Wurtz reaction.

$$CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} CH_3-CH_3 + 2NaBr$$

Bromomethane Ethane

(ii) In presence of organic peroxide, addition of HBr to unsymmetrical alkenes takes place against Markovnikov rule. This is known as ***peroxide or Kharash effect.***

e.g. $CH_3\text{-}CH = CH_2 + HBr \xrightarrow{\text{Org. peroxide}} CH_3\text{-}CH_2\text{-}CH_2Br$

Propene *1-bromopropane*

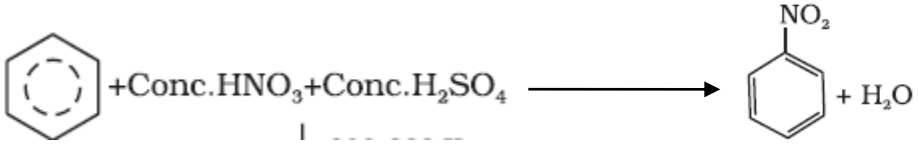
4. (i) Which gas is formed when water is added to Calcium carbide (CaC_2) ? (1)

(ii) What are electrophilic substitution reactions ? Explain any one electrophilic substitution reaction of benzene with necessary chemical equations. (3) [December 2021]

Ans: (i) Ethyne or acetylene (C_2H_2)

(ii) These are reactions in which a weak electrophile is replaced by a strong electrophile. The important electrophilic substitution reactions are Nitration, Sulphonation, Halogenation and Friedel-Crafts alkylation and acylation.

E.g.: ***Nitration****: When benzene is heated with a mixture of conc.* HNO_3 *and conc.* H_2SO_4*, we get nitrobenzene.*



5. Write A and B in the following reactions :

(a) $3CH \equiv CH \xrightarrow[\text{iron tube,873 k}]{\text{Red hot}} A$

(b) $2CH_3Cl + 2Na \xrightarrow{\text{dry ether}} B$ (2)

Ans: (a) A is benzene (C_6H_6)

(b) B is ethane (CH_3-CH_3)

6. Write the geometrical isomers of But-2-ene. (2)

Ans: Refer the answer of Question number 2.

7. CH_3-CH = CH_2 + HBr ⟶ A + B

(Propene)

(a) Identify A and B. (1)

(b) Which is the major product in the above reaction ? (1)

(c) Name and state the rule which decides the major product in the above reaction. (2)

Ans: (a) A is CH_3-CHBr-CH_3 (2-Bromopropane) and B is CH_3-CH_2-CH_2Br(1-Bromopropane).

(b) The major product is CH_3-CHBr-CH_3 .

(c) It is selected according to Markownikoff's rule. The rule states that when an unsymmetrical reagent is added to an unsymmetrical alkene, the negative part of the reagent gets attached to the carbon containing lesser number of hydrogen atoms.

8. (i) Draw Newman's projection formula for the conformers of ethane molecule. (2)

(ii) Which conformer of ethane is more stable ? Give reason. (2) [September 2021]

Ans: Refer the answer of Question number 1.

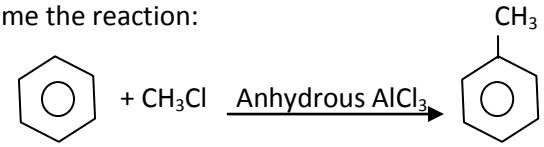
(ii) Staggered conformation of ethane is more stable than eclipsed conformation. It is due to less torsional strain in Staggered form.

9. The cold dilute aqueous solution of potassium permangante ($KMnO_4$) is generally known as ---------- (1)

Ans: Baeyer's reagent

10. (a) Explain Wurtz reaction. (1)

(b) Name the reaction:



(1)

Ans: (a) Alkyl halides react with metallic sodium in dry ether to form alkanes. This reaction is known as Wurtz reaction.

(b) Friedel Craft's alkylation reaction

11. (a) CH_3-CH=CH_2 + HBr ⟶ A + B

(i) Identify A and B

(ii) Which is the major product and why? (2)

(b) State Huckel rule of aromaticity. (1) [December 2020]

Ans: (a) (i) A is CH_3-CHBr-CH_3 (2-Bromopropane) and B is CH_3-CH_2-CH_2Br (1-Bromopropane).

(ii) The major product is CH_3-CHBr-CH_3 . It is selected according to Markownikoff's rule. The rule states that when an unsymmetrical reagent is added to an unsymmetrical alkene, the negative part of the reagent gets attached to the carbon containing lesser number of hydrogen atoms.

(b) Huckel's rule states that cyclic, planar, conjugated systems containing (4n+2) π electrons are aromatic.

12. The class of organic compound differ by a > CH_2 group between adjacent members are called _____. (1)

Ans: homologues

13. Draw the Newman projections for staggered and eclipsed conformations of ethane. (2)

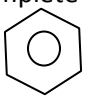
Ans: Refer the answer of Question number 1.

14. (a) What is Lindlar's catalyst ? (½)

(b) Identify A, B and C.

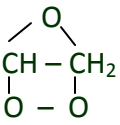
$CH_3 - CH = CH_2 + O_3 \longrightarrow A \xrightarrow{Zn/H_2O} B + C.$ (1½)

(c) Complete the reaction.

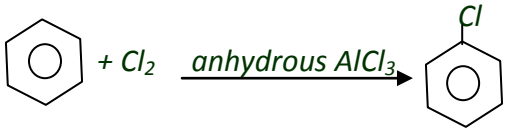


$+ Cl_2 \xrightarrow{\text{anhydrous } AlCl_3}$ ---------- (1) [March 2020]

Ans: (a) Lindlar's catalyst is Partially deactivated palladised charcoal.

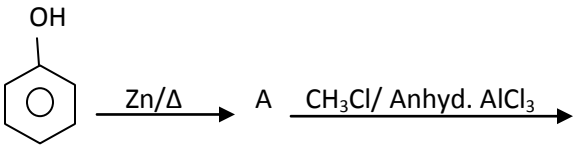
(b) A is  *(Propeneozonide) ; B is CH_3-CHO (Ethanal) and C is HCHO (Methanal)*

(c)



$+ Cl_2$ $\xrightarrow{\text{anhydrous } AlCl_3}$

15. Identify A and B in the following reaction :



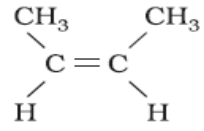
$\xrightarrow{Zn/\Delta}$ A $\xrightarrow{CH_3Cl/\text{ Anhyd. } AlCl_3}$ B (2)

Ans: A – Benzene (C_6H_6) and B – Toluene (C_6H_5-CH_3)

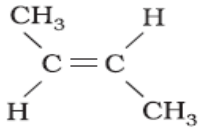
16. An alkene on ozonolysis gives two molecules of ethanal. Identify the alkene. Draw its geometrical isomeric forms. (2)

Ans: But-2-ene (CH_3-CH=CH-CH_3)

Its geometrical isomers are:



cis-But-2-ene



trans-But-2-ene

17. Briefly describe the following with suitable chemical equations :

(a) Wurtz reaction (b) Kharash effect (3) [July 2019]

Ans: (a) Wurtz reaction: Alkyl halides react with metallic sodium in dry ether to form alkanes. This reaction is known as Wurtz reaction.

$$\underset{\text{Bromomethane}}{CH_3Br} + 2Na + \underset{}{BrCH_3} \xrightarrow{\text{dry ether}} \underset{\text{Ethane}}{CH_3-CH_3} + 2NaBr$$

(b) Kharash Effect: In presence of organic peroxide, addition of HBr to unsymmetrical alkenes takes place against Markovnikov rule. This is known as ***peroxide or Kharash effect.***

e.g. CH_3-CH= CH_2 + HBr $\xrightarrow{Org.\ peroxide}$ CH_3-CH_2-CH_2Br

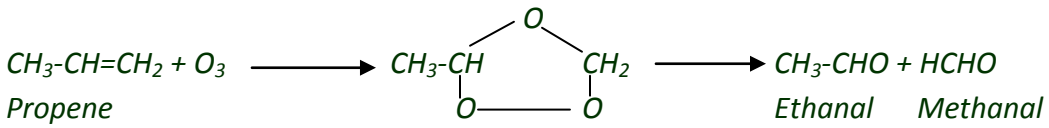
Propene *1-bromopropane*

18. Draw the Newman Projections of the eclipsed and staggered conformations of ethane molecule. (2)

Ans: Refer the answer of Question number 1

19. Give the chemical equations for the steps involved in the ozonolysis of propene. (2)

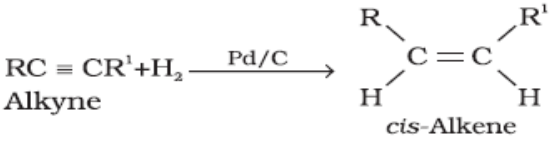
Ans:



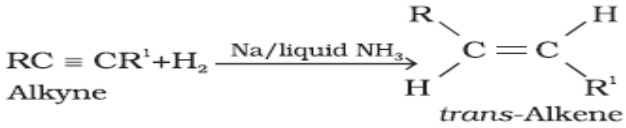
20. Alkynes can be converted selectively into cis-alkenes and trans-alkenes. Explain with suitable examples. (3)

[March 2019]

Ans: Alkynes on partial reduction with dihydrogen in the presence of palladised charcoal partially deactivated with sulphur compounds or quinoline give cis-alkenes.

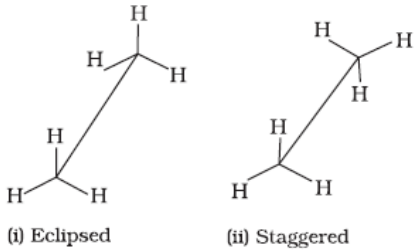


If we use sodium in liquid ammonia as the reducing agent, we get trans alkene.



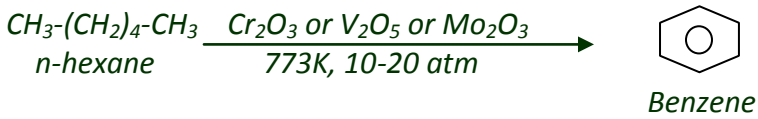
21. Draw the 'sawhorse' projections of the eclipsed and staggered conformations of ethane. (2)

Ans:



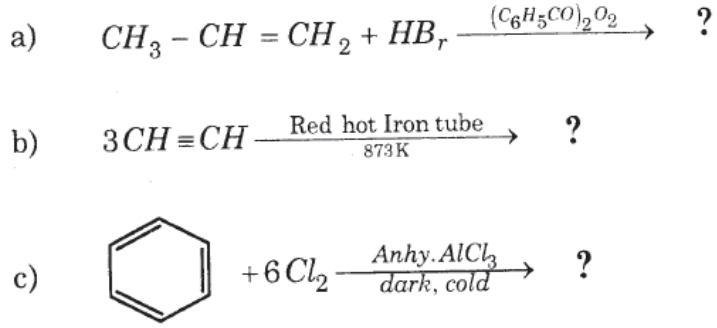
22. Give the chemical equation for the conversion of hexane to benzene. Write the name of the process. (2)

Ans:



The process is known as Aromatisation.

23. Predict the Products :

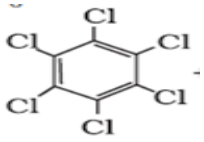


(3) [August 2018]

Ans: a) 1-Bromopropane (CH_3-CH_2-CH_2Br)

b) Benzene (C_6H_6)

c) Hexachlorobenzene (C_6Cl_6) Or,



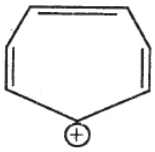
24. What is Wurtz reaction? Give an example. (2)

Ans: Alkyl halides react with metallic sodium in dry ether to form alkanes. This reaction is known as Wurtz reaction.

$$CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} CH_3-CH_3 + 2NaBr$$

Bromomethane Ethane

25. Cycloheptatrienyl cation is given below :



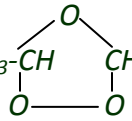
Is this ion aromatic or not? Justify the answer. (2)

Ans: This compound is aromatic since it contains 6 delocalised π electrons according to Huckel's rule.

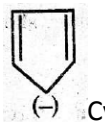
26. Identify X, Y and Z in the following sequence of reactions :

$$CH_3-CH_2-CH_2Br \xrightarrow{\text{Alcoholic KOH}} X \xrightarrow{O_3} Y \xrightarrow{Zn/H_2O} Z + HCHO$$ (3) [March 2018]

Ans: X is CH_3-CH=CH_2, Y is CH_3-CH CH_2 and Z –isCH_3-CHO



27. a)



Cyclopentadienyl anion is aromatic. Why? (1)

b) Explain the following reactions: i) Substitution ii) Addition (2)

c) Ethyne is acidic in nature. Explain. (2) [July 2017]

Ans: a) This compound is aromatic since it contains 6 delocalised π electrons according to Huckel's rule.

b) ***i) Substitution Reaction:*** *It is the replacement of an atom or group of atom by another atom or atom group. E.g.: Halogenation* $CH_4 + Cl_2 \xrightarrow{h\upsilon} CH_3Cl + HCl$

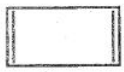
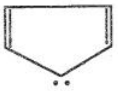
ii) Addition Reaction: *It is the process of addition of simple molecules like H_2, X_2, HX etc. to an unsaturated system.*

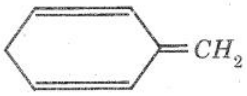
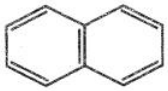
$CH_2 = CH_2 + HBr \rightarrow CH_3$-$CH_2Br$

c) In Ethyne, the H atoms are attached to sp hybridized carbon atoms. Due to the greater s-character and electronegativity of sp hybridized C, it attracts the electron pairs of C – H bonds strongly. So the hydrogen atom is readily removed as H^+ and hence ethyne is acidic.

28. Benzene and benzeniod compounds show aromatic character.

a) Select the aromatic compounds from the following:

i)  ii) 

iii)  iv) 

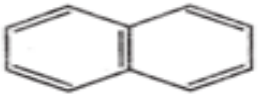
b) Suggest a method to convert ethyne to benzene. (2)

c) Give the products formed when benzene reacts with the following:

i) $CH_3Cl/AlCl_3$ ii) Cl_2/hv [March 2017]

Ans: a)

ii) 

iv) 

b) $3\ C_2H_2 \xrightarrow{\text{Red hot iron tube \& 873K}} C_6H_6$

c) i) Toluene

ii) Chlorobenzene

29. a) i) Complete the following reactions:

1) $CH_3CH_2COOK \xrightarrow{electrolysis}$ .....

2)  $+CH_3Cl \xrightarrow{AlCl_3}$ .....

ii) Write the names of the above reactions? (2)

b) Baeyer's reagent is used to find whether the compound is unsaturated or not. What is Baeyer's reagent? (1)

c) What is the product formed when ethylene is treated with Baeyer's reagent? (2) [September 2016]

Ans: a) i)

1) $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3$

2) $C_6H_5\text{-}CH_3$

ii) 1) Kolbe's Electrolysis 2) Friedel Craft's reaction

b) Cold dilute aqueous $KMnO_4$

c) Ethylene glycol

$$CH_2=CH_2+H_2O+O \xrightarrow[273\ K]{\text{dil. } KMnO_4} \underset{\text{Ethane-1, 2-diol (Glycol)}}{\overset{\begin{matrix}CH_2-CH_2\\ |\quad\ |\\ OH\quad OH\end{matrix}}{}}$$

30. a) 1-Alkynes are weakly acidic in nature. Give any two reactions to show the acidic character of ethyne. (2)

b) From the following, select the one in which Markownikoff's rule is best applicable.

i) $C_2H_4 + HCl$ ii) $C_3H_6 + Br_2$ iii) $C_3H_6 + HBr$ iv) $C_3H_8 + Cl_2$ (1)

c) Hydrocarbons exhibit isomerism.

i) Name the type of isomerism exhibited by 2-Butene.

ii) Draw the structure of the isomers of 2-butene and select the one which is more polar. (2) [March 2016]

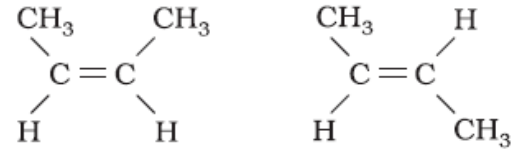
Ans: a) $CH{\equiv}CH + Na \rightarrow CH{\equiv}C^-Na^+ + ½\ H_2$

CH_3-$C{\equiv}CH + Na \rightarrow CH_3$-$C{\equiv}C^-Na^+ + ½\ H_2$

b) iii) $C_3H_6 + HBr$

c) i) Geometrical isomerism

ii)



cis-But-2-ene *trans*-But-2-ene

Cis-But-2-ene is more polar than the trans form.

31. Controlled oxidation of alkanes in the presence of suitabie catalysts give a variety of products.

a) Complete the following reaction :

$CH_4 + O_2 \xrightarrow{Mo_2O_3/heat}$ ..... + H_2O (1)

b) Free rotation about a carbon-carbon single bond is permitted in an alkane molecule.
What are conformers? Draw the structure of the eclipsed and staggered conformers of ethane in Sawhorse and Newman projections and explain their relative stability. (4) [October 2015]

Ans: a) HCHO

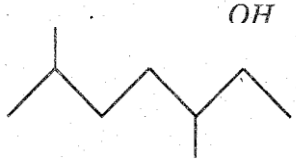
b) The different spatial arrangements of atoms arising due to free rotation around a C-C single bond are called conformations.

For projection formulas refer Question no. 1 and 21.

Staggered conformation is stabler than eclipsed form due to minimum repulsive forces between the electron clouds of C-H bonds.

32. Write the IUPAC names of the following compounds:

a) $CH_2{=}CH-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

b) 

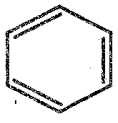
Ans: a) Pent-4-en-2-ol

b) 2,5-Dimethylheptane

33. a) Complete the following chemical equations:

i) $CH_3CH_2Br + 2Na + BrCH_2CH_3 \xrightarrow{dry\ ether}$ ..... (1)

ii) $CH_3CH_2I \xrightarrow[\Delta]{alc.\ KOH}$ ..... (1)

iii)  $+ CH_3Cl \xrightarrow{anhydrous\ AlCl_3}$ ..... $+ HCl$ (1)

b) Explain the geometrical isomerism taking 2-Butene as an example. (2) [March 2015]

Ans: a)

i) CH_3-CH_2-CH_2-CH_3

ii) CH_2=CH_2

iii) C_6H_5-CH_3 *(Toluene)*

b) Refer the answer of the question number 2.

34. a) Draw the cis and trans isomers of the following compound:

C_2H_5-$C(CH_3)$ = $C(CH_3)$-C_2H_5. (2)

b) Complete the following reactions. (1)

i. $3CH \equiv CH \xrightarrow{\text{Red hot iron tube at 873 K}}$ ……

ii. $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2$ + …….

c) Draw the sawhorse projections for eclipsed and staggered forms of an ethane molecule. (2)

Ans: a)

Cis-isomer *Trans-isomer*

b) i) C_6H_6 *(Benzene)*

ii) C_2H_2 *(Ethyne or acetylene)*

c) Refer the answer of the question number 21.

35. a) How is alkane prepared by Kolbe's electrolytic method? (2)

b) Select the activating groups from the following: (1)

i) $-NH_2$ ii) $-SO_3H$ iii) $-CH_3$ iv) –COOH

c) What is ozonolysis? Write the names of the products obtained when propene undergoes ozonolysis? (2)

[August 2014]

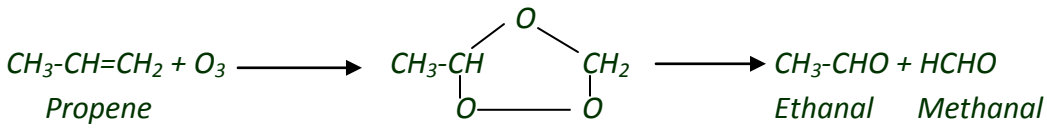
Ans: a) In Kolbe's electrolytic method, an aqueous solution of sodium or potassium salt of a carboxylic acid is electrolysed to get an alkane.

$2CH_3COONa + 2H_2O \xrightarrow{\text{electrolysis}} CH_3 - CH_3 + 2CO_2 + 2NaOH + H_2$

Sod. Acetate *ethane*

b) $-NH_2$ *and* $-CH_3$

c) Alkenes add ozone to form an ozonide which on hydrolysis in presence of Zn to form aldehydes or ketones. This reaction is known as ozonolysis.



36. a) Write the products of the following chemical reactions and also name them.

i) $2CH_3 - Br + 2Na \xrightarrow{\text{dry ether}}$ ……..

ii) $CH_3 - CH_2Br \xrightarrow{\text{alcoholic KOH}}$ ……..

iii) $CH_3 - COONa \xrightarrow{NaOH/CaO}$ …… (3)

b) An alkene 'A' on ozonolysis gave two molecules of formaldehyde. Write the name of 'A' and the chemical equation of ozonolysis. (2) [March 2014]

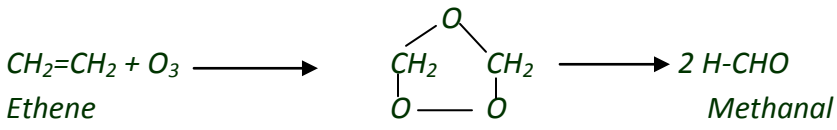
Ans: a)

i) CH_3-CH_3 *[Ethane]*

ii) CH_2=CH_2 *[Ethene or Ethylene]*

iii) CH_4 (Methane)

b) *$CH_2=CH_2$ [Ethene or Ethylene]*



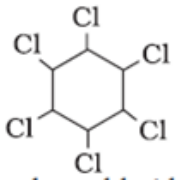
37. a)  + $3Cl_2$ $\xrightarrow{\text{uv /500K}}$ A

Name the product A. (1)

b) Draw the Newman's projections for the eclipsed and staggered conformations of n-butane. (2)

c) What is Baeyer's reagent? Write the chemical equation of its reaction with ethylene ($CH_2=CH_2$). (2) [Sept. 2013]

Ans: a) Benzene hexachloride (BHC)



b) Refer the answer of the question number 1.

c) Refer the answer of the question number 29 (b) and (c).

38. Free rotation is possible with respect to a C – C bond in the case of alkanes.

a) The repulsive interaction between the adjacent bonds in a conformation is called ……. (1)

b) Draw Newman's projections of the two conformers of ethane. Which among these is more stable? Justify. (2)

c) An alkene on ozonolysis followed by reduction of the ozonide formed with zinc and water gave a mixture of ethanal and methanal.

i) Identify the alkene. (1)

ii) Illustrate the above mentioned reaction using the chemical equation. (1) [March 2013]

Ans: a) Torsional strain

b) Refer the answer of the question number 1.

Staggered conformation is stabler than eclipsed form due to minimum repulsive forces between the electron clouds of C-H bonds.

c) i) Propene

ii) Refer the answer of the question number 19.

39. a) Name the following reactions:

i) C_6H_{14} (n-hexane) $\xrightarrow{\text{Anhydrous } AlCl_3/HCl}$ $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_2 - CH_3$ (2-Methyl pentane)

ii) C_6H_{14} $\xrightarrow[10 - 20 \text{ atm}]{V_2O_5/773K}$  (Benzene)

iii) C_6H_{14} $\xrightarrow{773K}$ C_4H_8 (butene) + C_2H_6 (ethane) (3 x 1 = 3)

b) Naphthalene is an aromatic compound. Explain its aromaticity using Huckel's rule. (2) [September 2012]

Ans: a) i) Isomerisation

ii) Aromatisation

iii) Pyrolysis

b) According to Huckel's rule, cyclic, planar, conjugated systems containing (4n+2) π electrons are aromatic. Naphthalene contains 10 π electrons and follows this rule. So it is aromatic.

40. Hydrocarbons are organic compounds containing carbon and hydrogen only.

a) Complete the following chemical reactions:

i) $2CH_3Br + 2\ Na \xrightarrow{\text{dry ether}} \ldots\ldots\ldots\ldots + 2\ NaBr$

ii) $\ldots\ldots\ldots\ldots + Zn \xrightarrow{\text{heat}} C_6H_6 + ZnO$

iii)  $+ 3Cl_2 \xrightarrow{\text{UV, 500K}} \ldots\ldots\ldots\ldots\ldots$ (3 x 1 = 3)

b) Analyze the following reaction:

$CH_3 - CH = CH_2 + H - Br \longrightarrow$ 'A' + 'B'

If 'A' is the major product and 'B' is the minor product, identify 'A' and 'B'. Also name the related rule. (2)

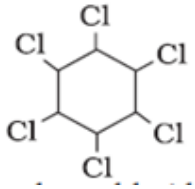
[March 2012]

Ans: a)

i) $CH_3 - CH_3$ (Ethane)

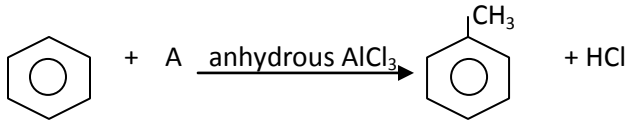
ii) C_6H_5-OH (Phenol)

iii) Benzene hexachloride or,



b) A is CH_3-CHBr-CH_3 (2-Bromopropane) and B is CH_3-CH_2-CH_2Br (1-Bromopropane). The rule behind the selection of the major product is Markownikoff's rule.

41. The higher homologue of benzene can be prepared by the following reaction.



a) Identify the reagent A. (1)

b) Which named reaction is this? (1)

c) Write the reaction mechanism of this reaction. (3) [October 2011]

Ans:

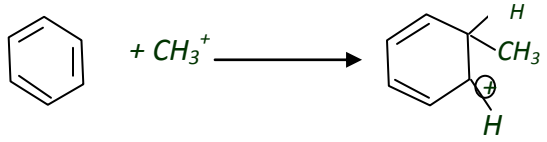
a) CH_3-Cl (Chloromethane)

b) Friedel Craft's reaction

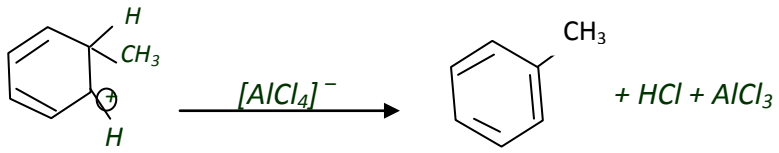
c) The mechanism involves the following steps:

i) Generation of Electrophile: CH_3-Cl + $AlCl_3$ $\longrightarrow$ $CH_3^+ + [AlCl_4]^-$

ii) Formation of carbocation:



iii) Removal of a proton:



42. a) Complete the following reactions:

i) $CH_3 - Br + Na \xrightarrow{\text{dry ether}} ?$

ii) $CaC_2 + H_2O \longrightarrow ?$

iii) $3CH \equiv CH \xrightarrow[873\ K]{\text{Red hot iron tube}} ?$ (3 x 1 = 3)

b) Illustrate Markovnikov's rule taking the example of propene. (2) [March 2011]

Ans: a)

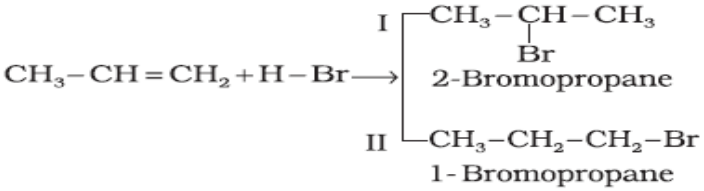
i) CH_3-CH_3 (Ethane)

ii) C_2H_2 (Ethyne or Acetylene)

iii) C_6H_6 (Benzene)

b) Markownikoff's (Markovnikov's) rule states that when an unsymmetrical reagent is added to an unsymmetrical alkene, the negative part of the addendum (adding molecule) gets attached to the carbon containing lesser number of hydrogen atoms.

E.g. When HBr is added to propene, we get 2 products – 1-bromopropane and 2-bromopropane.



Here 2-bromopropane is the major product.

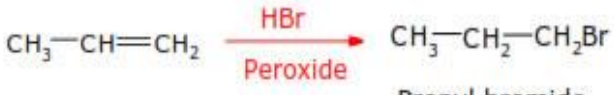
43. In a special condition, addition of HBr to unsymmetrical alkene takes place contrary to Markovnikov's rule.

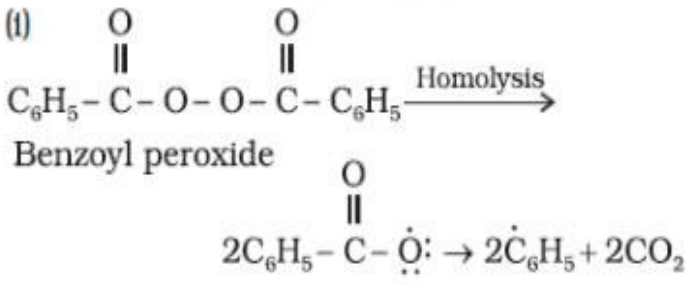
a) What is the special condition? (1)

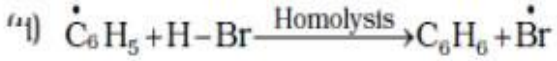
b) Give the mechanism of anti Markovnikov's addition of HBr to propene. (4) [September 2010]

Ans: a) The special condition is the presence of organic peroxide.

b) Mechanism of anti Markovnikov's addition







(iii) $CH_3—CH=CH_2 + \dot{B}r$

Homolysis

$CH_3—\dot{C}H—CH_2—Br$ (b) (more stable secondary free radical)

$CH_3—CH(Br)—\dot{C}H_2$ (a) (less stable primary free radical)

(iv) $CH_3-\dot{C}H-CH_2Br + H-Br \xrightarrow{\text{Homolysis}} CH_3-CH_2-CH_2Br + \dot{B}r$ (major product)

44. a) The spacial arrangements of atoms which can be converted into one another by rotation around a C – C single bond are called conformations.
    i) Represent Sawhorse and Newman projection formulae of staggered and eclipsed conformations of ethane. (2)
    ii) Compare the stabilities of staggered and eclipsed conformations. (1)
    b) Consider the reaction given below:
    $CH_3 – CH = CH_2 + HBr \longrightarrow CH_3 – CHBr – CH_3 + CH_3 – CH_2 – CH_2Br$
    i) Identify the major product obtained. (1)
    ii) Name the rule governing the formation of the major product. (1) [March 2010]

Ans: a)

i) Refer the answer of the question number 1 and 21.

ii) Staggered conformation is stabler than eclipsed form due to minimum repulsive forces between the electron clouds of C-H bonds.

b) i) $CH_3 – CHBr – CH_3$ (2-Bromopropane)

ii) Markovnikov's rule.

45. a) How will you prepare ethane by Kolbe's electrolytic method? (2)
    b) Expalin the Markovnikov's rule for the addition reaction using a suitable example. (3) [March 2009]

Ans: a) By the electrolysis of aqueous solution of sodium or potassium acetate.

$2CH_3COONa + 2H_2O \dashrightarrow CH_3 – CH_3 + 2CO_2 + 2NaOH + H_2$

Sod. Acetate *Ethane*

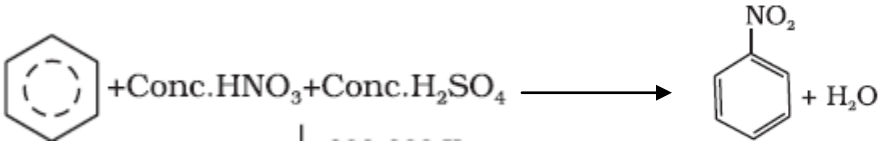
b) Refer the answer of the question number 28 (b)

46. a) Consider the reaction between benzene and nitrating mixture.

$+ HNO_3 \xrightarrow{\text{Conc. } H_2SO_4} ?$ (1)

    b) What is the reacting species in the above reaction? (1)
    c) How is the species formed in the system? (1) [[June 2008]

Ans: a)



b) *Nitronium ion (NO_2^+)*

c) *It is produced by the transfer of a proton from H_2SO_4 to HNO_3 followed by dehydration of the resulting product.*