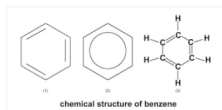


AROMATIC Hydrocarbons.

1. What is meant by the term aromatic?

Ans: The term “aromatic” was derived from the Greek word ”aroma’ meaning “fragrance”.

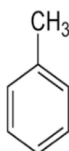
- These compound have low hydrogen to carbon ratio in their molecular formula and have a characteristic odour. However, it was soon realized that many aromatic compounds are odourless whereas many others are fragrant though they are not aromatic.
- Further, when aromatic compounds of higher molecular mass were subjected to various methods of degradation, they often produced benzene or derivatives of benzene.
- All aromatic compounds have a six carbon unit in their molecules like benzene, toluene, naphthalene, biphenyl etc.
- Benzene is the simplest and the parent member of this class of compound. Few examples of aromatic compounds are given below:



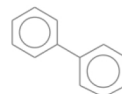
Benzene



Naphthalene



Toluene



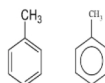
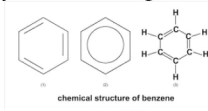
Biphenyl

2. What are aromatic hydrocarbons? Give examples:

FBD-2007,2009,SGD-2010, BWP-2015

Ans: **Define:-** “The aromatic compound that contains a benzene ring as a part of its structure”. Benzene is a cyclic hydrocarbon with formula C_6H_6 . It has a regular planar hexagonal structure.

Example: Benzene

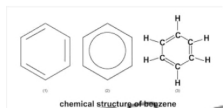


3. What are monocyclic aromatic compounds? Give examples.

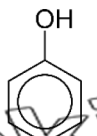
FBD -2008 ,SWL-2014

Ans: **Define:-** “The aromatic compounds which have only one benzene ring in their molecule are called monocyclic aromatic compounds.”

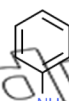
Example: Benzene, Toluene, Phenol, Aniline, Benzoic acid.



Benzene



Toluene



Phenol

4. What is polycyclic aromatic compounds? Give example.

LHR -2009, GRW-2012,SWL, FBD-2014, DGK -2015,BWP-2014,LHR,FBD-2014,DGK,RWP-2017, LHR,BWP-2018,GRW, SGD DGK -2016, SGD-2018

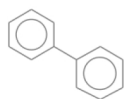
Ans: **Define:-** "Aromatic compounds containing two or more benzene rings in their molecules are called polycyclic aromatic compounds."

Polycyclic aromatic compounds may be divided further into two classes.

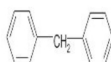
(i) **Isolated ring aromatic compounds:**

The polycyclic compound containing isolated benzene rings in them are called isolated polycyclic aromatic compounds. e.g.

Biphenyl, Diphenylmethane



Biphenyl



Diphenyl methane

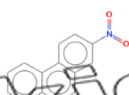
(ii) **Fused ring polycyclic compounds:**

LHR-2011,RWP-2015

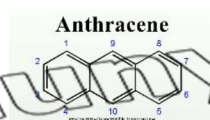
The compounds in which the benzene rings are fused together at ortho positions so that the adjacent rings have a common carbon to carbon bond are called of fused ring aromatic compounds. e.g. Naphthalene, Phenanthrene and anthracene.



Naphtalene



Phenanthrene



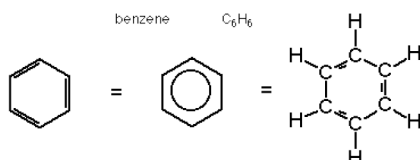
Anthracene

5. Why benzen is given a cyclic structure?

GRW -2009, LHR -2013

Ans: **Benzene has cyclic structure as:**

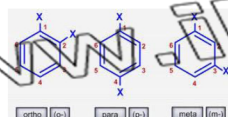
The most commonly encountered aromatic compound is benzene. The usual structural representation for benzene is a six carbon ring (represented by a hexagon) which includes three double bonds. Each of the carbons represented by a corner is also bonded to one other atom. In benzene itself, these atoms are hydrogens.



(i) Benzene give only one mono-substituted product.



(ii) Benzene give only three di-substituted products.

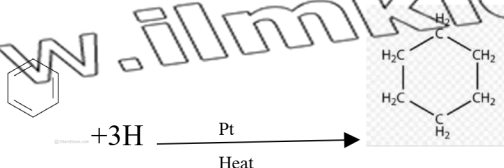


Continue.....p/3.....

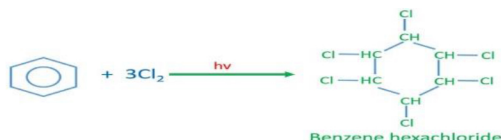
:- 3 :-

These points confirm the regular hexagonal structure for benzene in which all the carbon atoms are occupying identical positions in the molecule. Therefore, Benzene form only one toluene, one phenol and one nitrobenzene.

- (iii) Benzene adds three hydrogen molecules in the presence of a catalyst. It indicate that it has three double bond in it.



- (iv) Benzene adds three molecules of chlorine in the presence of sunlight.



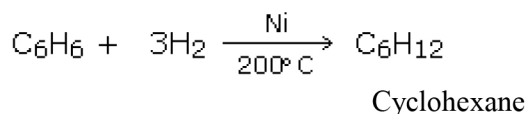
6. Give two addition reactions of Benzene. OR
 Benzene has three pi-bonds. Prove it by two chemical reactions. OR
 Give two reactions to confirm the presence of three double bonds in benzene. OR
 Write two questions in which benzene is as unsaturated compound.

SWL-2016, SGD, SWL-2017, SGD-2018

Ans: Benzene gives some addition reactions. Some typical reactions are:

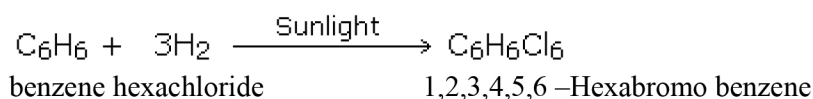
Addition of hydrogen

Benzene on reduction with hydrogen under pressure in the presence of finely divided nickel at 200°C, gives an addition product hexahydrobenzene (cyclohexane).



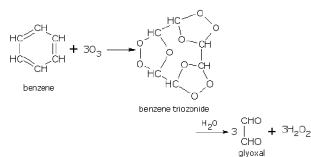
Addition of chlorine

Chlorine adds on to benzene at its boiling point, in the presence of bright sunlight, to give hexa chloride.



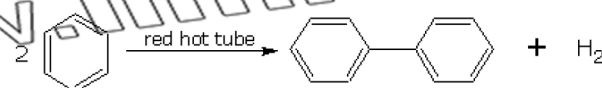
Addition of ozone

Benzene reacts slowly with ozone to form triozoneide. Triozoneide on hydrolysis with water gives glyoxal.



Pyrolysis

Benzene when passed through a red hot iron tube gives diphenyl.



Continue.....p/4.....

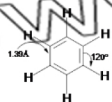
7. What information do we get from X-ray analysis of benzene?
Describe X-Ray studies of benzene structure.

OR

RWP -2007, 2017, MTN-2007, 2009, LHR-2008, 2013

Ans: **X-Ray studies of Benzene structure:**

- The X-ray studies of benzene have confirmed the hexagonal structure for it.
- These studies have also revealed that all the carbon and hydrogen atoms are in the same plane. All the angles are of 120° .
- All C – C and C – H bond lengths are $1.397 \text{ \AA}$ and $1.09 \text{ \AA}$, respectively.



8. Justification for stability of Benzene.

RWP -2007, DGK-2008

Ans: We can compare the observed and theoretical values of heats of hydrogenation. In order to illustrate it consider the heat of hydrogenation of ethane.

This amount of heat which is evolved is the exothermicity of reaction. This is the difference of enthalpy of reactants and products. Since heat is being evolved due to the hydrogenation of ethane, so it is also called heat of hydrogenation of ethane.

This $-119.5 \text{ kJ mol}^{-1}$ is both experimental and theoretical value.

This means that cyclohexene is unstable than cyclohexane by $-119.5 \text{ kJ mol}^{-1}$.

In other words, $-119.5 \text{ kJ mol}^{-1}$ is of an isolated carbon-carbon double bond and C – C single bond. The heat of hydrogenation of a, 3-cyclohexadiene is $-231.5 \text{ kJ mol}^{-1}$.

9. What objections were raised on the Kekule's structure of benzene?

DGK-2015

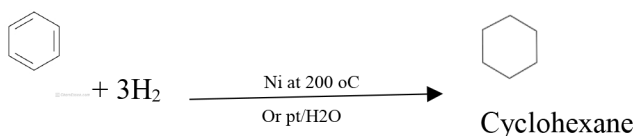
Ans: Kekule's formula with three double bonds demands a high degree of unsaturation from benzene while usually it exhibits a saturated character. This benzene yields substitution products readily and forms addition products reluctantly. Benzene is also a very stable compound, all these properties of benzene can easily be explained using its modern theories about its structure.

10. Give two reactions which show that Benzene is an unsaturated hydrocarbon?

Ans: (i) **Reduction:**

Benzene is reduced to cyclohexane on heating at high temperature with hydrogen in the presence of Pt in an acidic solvent (Acetic acid) or Ni at 200 atm as a catalyst.

This reaction shows that benzene is an unsaturated compound.



(ii) **Halogenation:**

Benzene reacts with chlorine or bromine in the presence of sunlight to give addition products, hexachlorobenzene or hexabromobenzene respectively. Fluorination is too vigorous while iodination is too slow.



Continue.....p/5.....

11. How will you prove that benzene has cyclic structure?

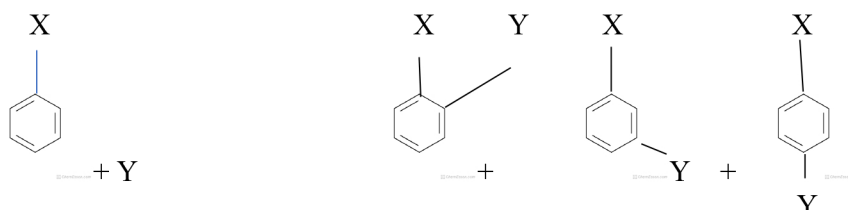
LHR- 2017

Ans: **Benzene has cyclic structure as:**

i) Benzene gives only one mono-substituted product.



And gives three di-substituted products.



Furthermore X-ray studies prove the cyclic hexagonal structure of benzene where all angles are of

120°. All C – C and C – H bond lengths are 1.397 Å and 1.09 Å respectively

12. Define resonance and write down resonance structure of benzene.

OR

Describe the structure of Benzene on the basis of Resonance.

OR

Write down the Resonance structures of Benzene.

OR

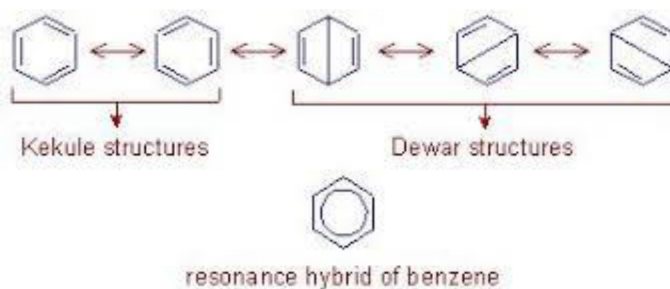
What is resonance? Draw two resonance structure of benzene?

OR

Write down four Resonance structures of Benzene.

Ans: **Define:-** LHR-2013,2014,2015, SWL-2014, GRW-2015,SGD,MTN-2016,RWP,2016,MTN,SGD-2017, GRW-2018 "The possibility of different pairing schemes of valence electrons of atoms in a molecule is called resonance." and the different structures thus arranged are called "Resonance structures".

The resonance is represented by a double headed arrow e.g the following different pairing schemes of the fourth valence (p-electrons) of carbon atoms are possible in benzene.



Continue....p/6....

13. How is benzene prepared from (i) n-hexane (ii) Cyclohexane

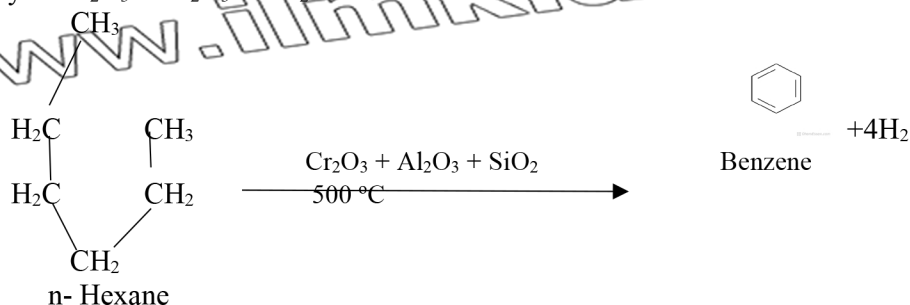
LHR -2008, MTN -2014,DGK,SWL-2018

Ans: **From Alkanes:**

(i) **n-hexane**



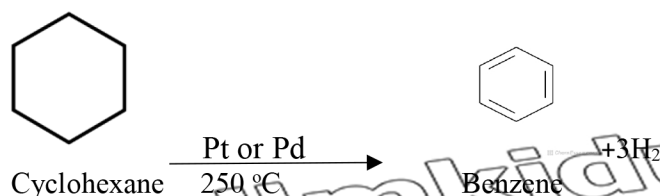
Benzene and toluene can also be prepared by passing the vaporous of n-hexane or n-heptane over a mixture of catalysts $\text{Cr}_2\text{O}_3 + \text{Al}_2\text{O}_3 + \text{SiO}_2$ at 500°C .



Dehydration of cyclohexane:

(ii) **Cyclohexane**

Benzene can be prepared by the dehydrogenation of cyclohexane, when heated at 250°C in the presence of catalyst platinum or platinum.

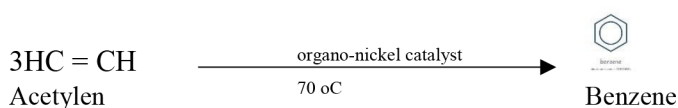


14. Benzene can be prepared commercially from acetylene. Give reaction with conditions?

LHR-2008, 2015, SWL -2015, FBD-2015

Ans: **From acetylene:**

Benzene is formed by passing acetylene under pressure over an organo-nickel catalyst at 70°C .



15. Give two reasons to rule out straight chain structure of benzene?

GRW-2012

Ans: Two the possible straight chain formulas suggested for benzene are:



- (i) A compound having above structures are oxidized by alkaline KMnO_4 solution. But benzene is stable to KMnO_4 solution.
- (ii) Assuming straight chain structure of benzene, each carbon carries one H- atom, it should be capable of forming three mono substitution product. But benzene yields only one mono substituent product.
- (iii) Alkanes have molecular formula $\text{C}_n\text{H}_{2n+2}$, alkene has C_nH_{2n} and alkyne has $\text{C}_n\text{H}_{2n-2}$. But benzene has molecular formula does not belong to open chain hydrocarbon and therefore possibility of a straight chain structure is ruled out.

Continue.....p/7.....

16. What is aromatization?

LHR - 2015

Ans: **Aromatization:**

Aromatization is a chemical reaction in which an aromatic system is formed from a single nonaromatic precursor. Typically aromatization is achieved by dehydrogenation of existing cyclic compounds, illustrated by the conversion of cyclohexane into benzene. Aromatization includes the formation of heterocyclic systems.

17. How benzene is prepared from (i) Phenol

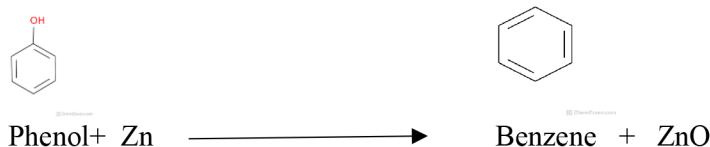
(ii) Sodium benzoate

GRW - 2008

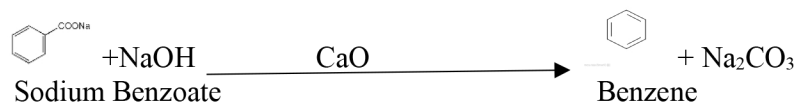
Ans: **Laboratory Preparations:**

Benzene can be prepared in the laboratory by any one of the following methods.

i. **By distilling phenol with Zinc dust:**



ii. **By heating sodium salt of benzoic acid with soda lime**

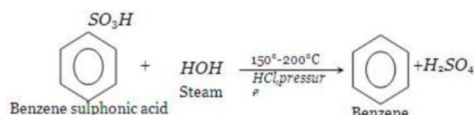


18. How benzene is prepared from benzene sulphonic acid?

RWP-2008

Ans: **Hydrolysis of benzenesulphonic acid:**

Benzene can be prepared by the hydrolysis of benzene sulphonic acid with super-heated steam or by boiling with dilute HCl.



19. How Toulene is prepared from n-neptune and benzene from n-hexane?

How will you distinguish chemically between toluene and benzene.

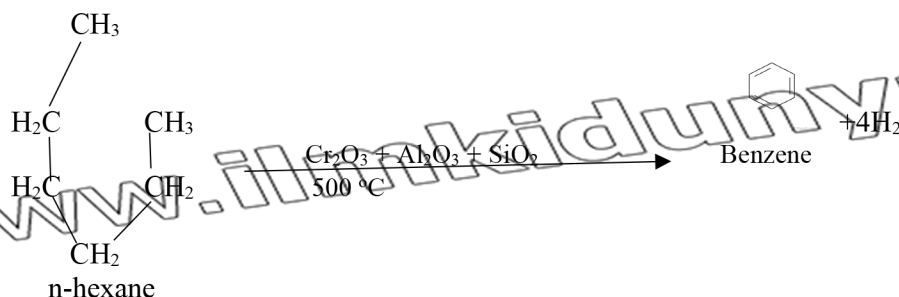
LHR-2012, DGK-2014, MTN-2015, 2018, DGK, SWL-2018

Ans: i) n-hexane $\longrightarrow$ Benzene

Benzene is an aromatic compound prepared from hexane.

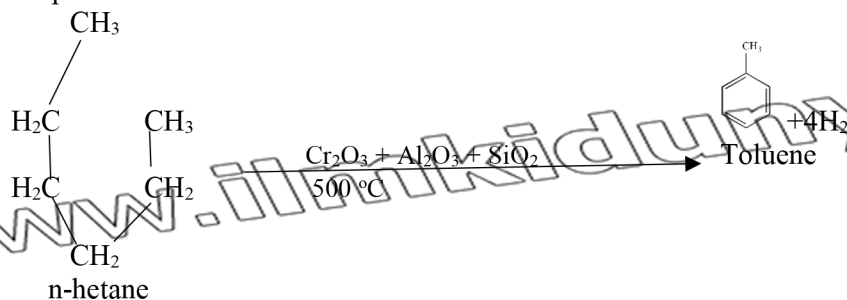
From Alkanes:

Benzene and toluene can also be prepared by passing the vapours of n-hexane or n-heptane over a mixture of catalysts Cr₂O₃ + Al₂O₃ + SiO₂ at 500 °C.



Continue.....p/8.....

D GK-SWL-2018



20. What is the general pattern of reactivity of benzene towards electrophiles? Give the general mechanism of the electrophilic aromatic substitution reactions.

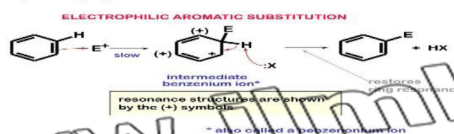
SGD-2008, FBD-2010, LHR-2010, 2012, 2017

Ans: **General Mechanism for electrophilic Substitution Reaction of Benzene:**

The general pattern of the chemical reactivity of benzene towards electrophile can be shown as follows. π -electrons of benzene ring are donated to the strong electrophile (E^+) and benzenonium ions are formed. Benzenonium ions are unstable.

MECHANISMS

All of the reactions follow the same pattern of mechanism. The reagents combine to form a strong electrophile E^+ , and its partner ($:X$), which react as follows:



The addition product is not favorable because in its formation, the characteristic stability of benzene is lost. The only possible product is the substitution product in which the stability of benzene is retained.

21. Write the mechanism of halogenation of benzene.

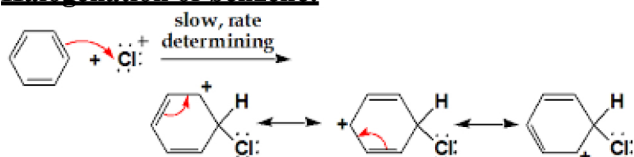
SGD-2010, GRW-2014,2015,SWL-2018

Ans: **Halogenation:**

Define:- "If hydrogen atom of benzene ring is substituted by halogen atom, it is called halogenation."

Benzene reacts with halogen in the presence of a catalyst like FeBr_3 , AlCl_3 , etc. Chlorination and bromination are normal reactions but fluorination is too vigorous to control. Iodination give poor yield.

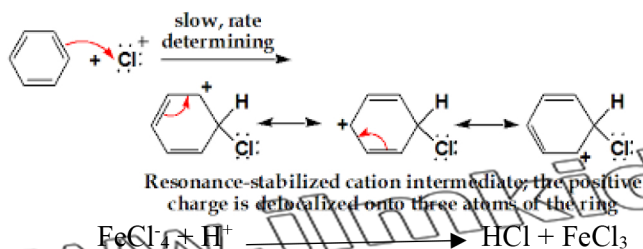
Halogenation of benzene:



Resonance-stabilized cation intermediate; the positive charge is delocalized onto three atoms of the ring

Mechanism:

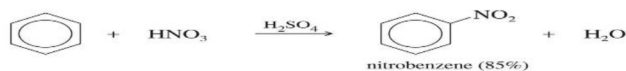




22. How does benzene reacts with conc. HNO_3 in the presence of conc. H_2SO_4 . MTN -2008,SGD-2009

Ans: The nitration of benzene takes place when it is heated with a mixture of conc. HNO_3 and conc. H_2SO_4 (1:1) at 50°C . Sulphuric acid reacts with nitric acid and generate nitronium ions (NO_2^+)

Nitration of Benzene



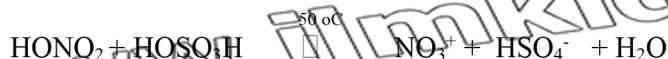
- Sulfuric acid acts as a catalyst, allowing the reaction to be faster and at lower temperatures.
- HNO_3 and H_2SO_4 react together to form the electrophile of the reaction: nitronium ion (NO_2^+).

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23. Give the mechanism of nitration of benzene.

LHR -2016, MTN-2008 ,SGD- 2009,RWP-2014, AJK,LHR-2016, MTN-2017, RWP- 2018

Ans: A strong electrophile nitronium ion (NO_2^+) is produced by the reaction of HNO_3 and H_2SO_4 .

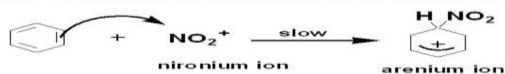


MECHANISM: NITRATION OF BENZENE

Step 1: Formation of the nitronium ion, NO_2^+



Step 2: Formation of an arenium ion as a result of electrophilic addition



Step 3: Loss of a proton gives the products

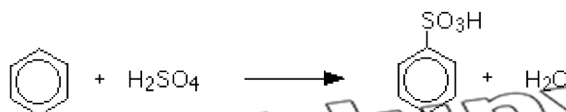


24. What happens when benzene is heated with conc. H_2SO_4 at 80°C . MTN – 2014 ,2017

Ans: When benzene is heated with conc. H_2SO_4 at 80°C , benzene sulphonic acid is produced.



OR



Continue.....p/10.....

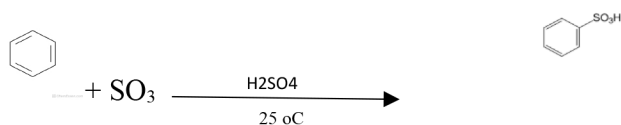
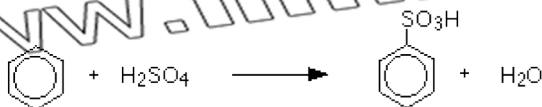
25. Give mechanism of Sulphonation of benzene.

GRW, RWP-2008

Ans: **Sulphonation:**

Define:- "The introduction of sulphonic acid group ($-SO_3H$) in benzene ring is called sulphonation."

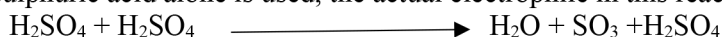
When benzene is heated with fuming H_2SO_4 or conc. H_2SO_4 it yields benzene sulphonic acid. Mixture of conc. H_2SO_4 and SO_3 is called fuming sulphuric acid.



LHR - 2015

Mechanism:

When sulphuric acid alone is used, the actual electrophile in this reaction is SO_3 .



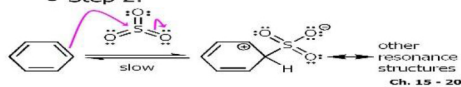
5. Sulfonation of Benzene

✧ Mechanism

• Step 1:



• Step 2:



26. What is Friedel craft alkylation? Give mechanism of reaction? OR
How benzene does reacts with CH_3Cl in the presence of AlCl_3 ?

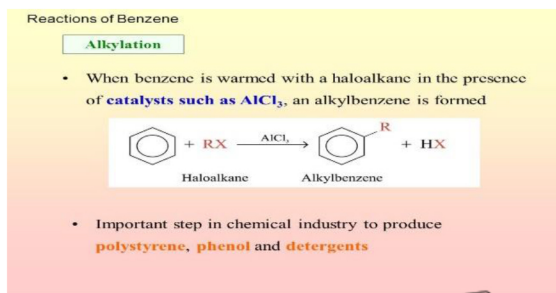
LHR - 2007, LHR-2014, AJK-2016

Ans: **Friedel Craft Alkylation:**

Define: "The introduction of an alkyl group in the benzene ring in the presence of an alkyl halide and a catalyst AlCl_3 is called Friedel Crafts alkylation or Alkylation."

Alkylation: "The introduction of an alkyl group ($-R$) in the Benzene ring in the presence of an alkyl halide and AlCl_3 is called Friedel Craft's alkylation. e.g.

For example:



Continue.....p/11.....



:- II :-



+ HCl

+ CH₃Cl

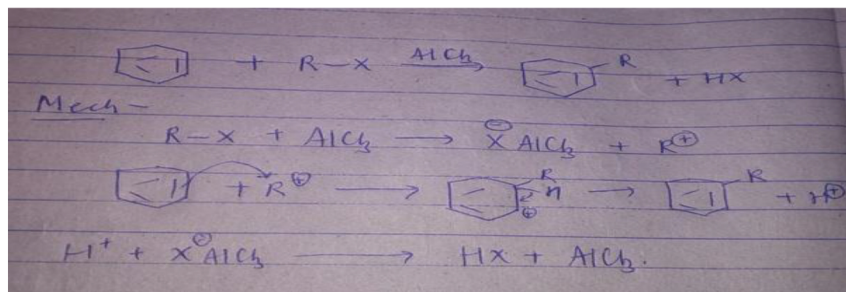
AlCl₃

→ Toluene

Acylation:

"The introduction of Acyl group ($\text{R}-\overset{\text{O}}{\parallel}{\text{C}}$) in the benzene ring in the presence of an acyl halide and catalyst AlCl₃ is called Friedel Craft's Acylation. e.g.

Mechanism:



27. Give the mechanism of acylation of benzene.

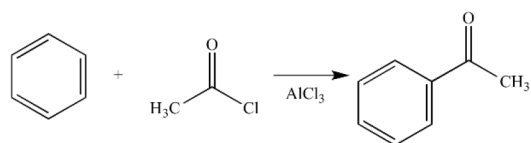
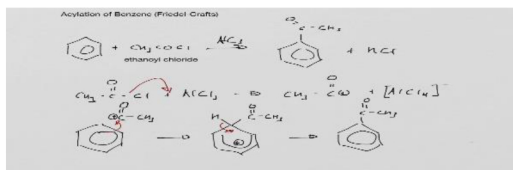
LHR-2014, SGD-2014, AJK-2016

Ans: **Friedel Craft Acylation:**

Define:-

The introduction of an acyl group $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}$ in the benzene ring, in the presence of acyl halide and a catalyst AlCl₃ is called Friedel Crafts Acylation or Acylation

Example:



Benzene

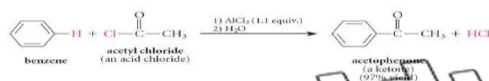
Acetyl Chloride

Acetophenone (Methyl Phenyl Ketone)

+ HCl

Continue.....p/12.....

Friedel-Crafts Acylation of Benzene



- The acyl group is typically derived from an acid chloride



16.4 Electrophilic Aromatic Substitution Reactions of Benzene

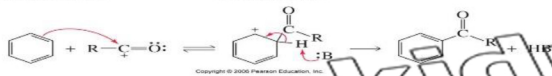
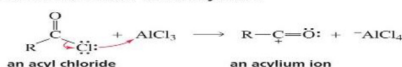
Mechanism:

AlCl₃ mechanism
AlCl₃ is electron deficient molecule. It accept chloride ion (Cl⁻) from acid halide and forms AlCl₄⁻ and a strong electrophile acyl ion.



Friedel-Crafts Acylation of Benzene

mechanism for Friedel–Crafts acylation



Friedel–Crafts Acylation

Friedel–Crafts acylation



Example



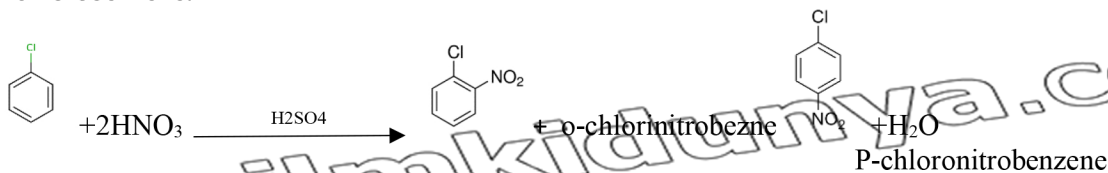
- Acyl chloride is used in place of alkyl chloride.
- The product is a phenyl ketone that is less reactive than benzene.

28. How p-chlorinrobenzene is prepared from benzene in two steps?

SGD – 2015

Ans: **Nitration of chlorobenzene:**

On the other hand, a mixture of o-chloronitrobenzene and p-chloronitrobenzene is obtained from the nitration of chlorobenzene.



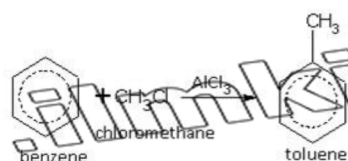
Continue....p/13....

29. Convert benzene into : (i) Toluene

(ii) Acetophenone

GRW-2011

Ans: (i) **Toluene**

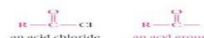


(ii) **Acetophenone**

Friedel-Crafts Acylation of Benzene



- The acyl group is typically derived from an acid chloride



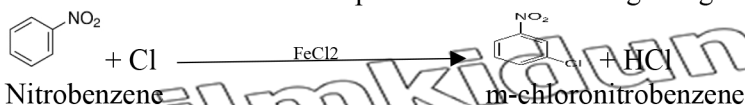
16.4 Electrophilic Aromatic Substitution Reactions of Benzene

30. Convert benzene into (i) m-Chloronitrobenzene (ii) o-chloronitrobenzene

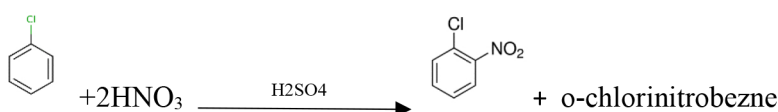
GRW-2013.SGD-2015.BWP-2015.LHR-2006.2013

Ans: (i) **m-Chloronitrobenzene:**

m-Chloronitrobenzene is the main product of the following halogenation reaction.



(ii) **o-chloronitrobenzene:**

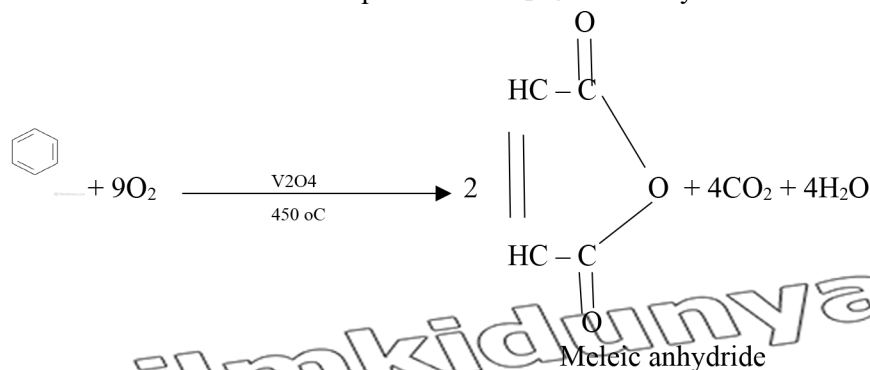


31. Convert benzene to maleic anhydride and cyclohexane.

LHR-2012.SWL-2014

Ans: **Catalytic oxidation:**

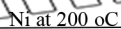
Benzene is not oxidized by KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$ at room temperature. The ring is destroyed when benzene is strongly heated at 450°C with air in the presence of V_2O_5 as a catalyst.



Continue.....p/14.....

Addition of hydrogen (Reduction):

Benzene is reduced to cyclohexane on heating at high temperature with hydrogen in the presence of Pt in an acidic solvent (Acetic acid) or Ni at 200 °C as a catalyst.

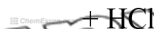
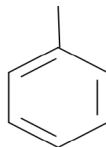
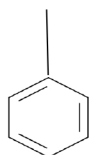
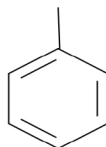
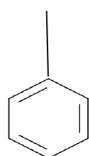
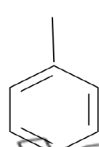
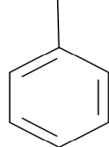


32. Write the chemical reactions of benzene with Cl_2 in the presence of sunlight.

BWP- 2014 ,MTN-2016

Ans: **Halogenation:**

Benzene reacts with chlorine or bromine in the presence of sunlight to give addition products, hexachloro benzene or hexabromo benzene respectively. Fluorination is too vigorous while iodination is slow.

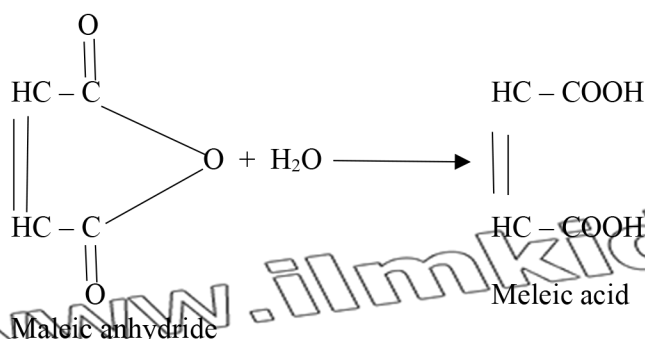
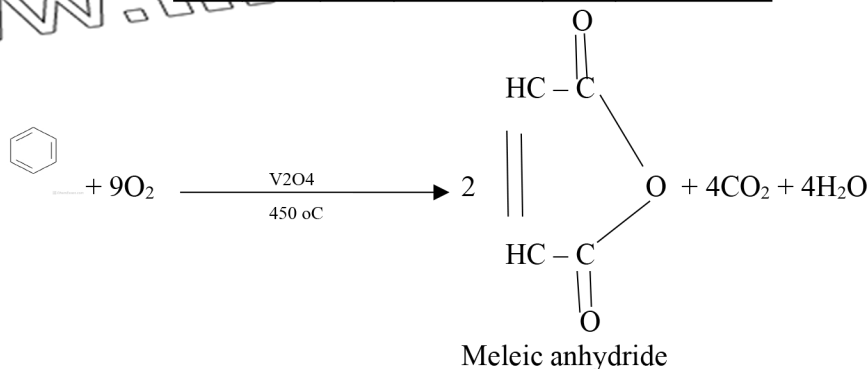


Continue....p/15....

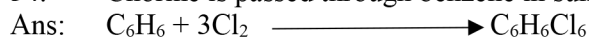
33. Write the reaction of benzene with O_2 in the presence of catalyst V_2O_5 . OR
 How will convert benzene into melecic acid? OR
 Give catalytic oxidation of benzene. OR
 What happens when a mixture of benzene vapors and air are passed over heated vanadium pentaoxide. OR
 Explain the term oxidation with one example using benzene.

SGD-2008, 2014, BWP-2008, GRW-2008, RWP-2010, MTN, LHR, DGK-2016, DGK, LHR, FBD, SWL-2017, FBD, MTN -2018

Ans:



34. Chlorine is passed through benzene in sunlight?



35. Benzene is burnt in free supply of air.

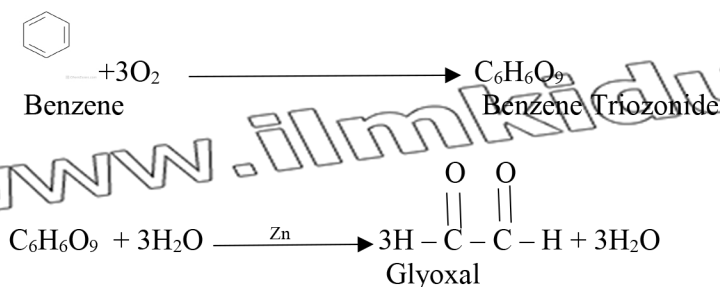


36. How does benzene react with O_3 followed by hydrolysis?

LHR -2016, SGD-2008, 2010, GRW -2008, LHR -2008

Ans: **Ozonolysis:**

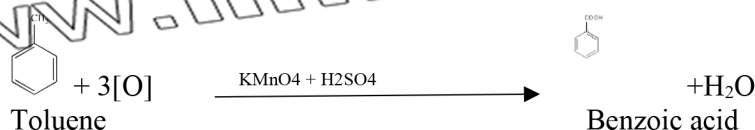
Benzene reacts with ozone and give glyoxal through benzene triozone.



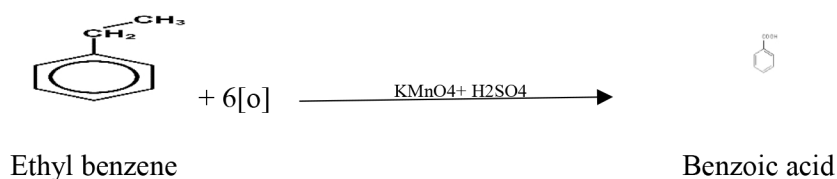
37. How toluene is converted to benzoic acid.

BWP-2015

Ans; Alkyl benzene are readily oxidized by acidified KMnO_4 or $\text{K}_2\text{Cr}_2\text{O}_7$. IN these reactions, the alkyl groups are oxidized keeping the benzene ring intact.



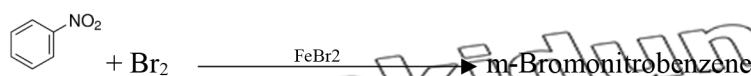
Whatever the length of an alkyl group may be, it gives only one carboxyl group. Moreover, the colour of KMnO_4 is discharged. Therefore, this reaction is used as a test for alkyl benzene.



38. What is major product of bromination of nitrobenzene?

LHR - 2011

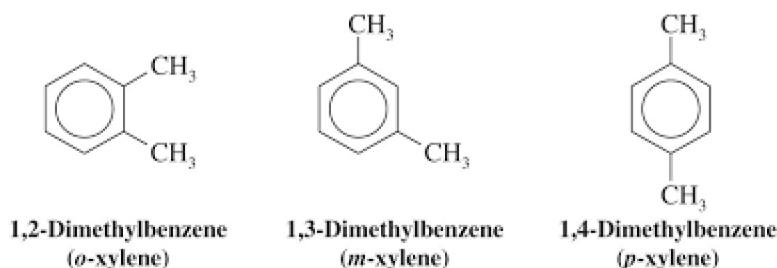
Ans: **Nitro Group is meta direct to:**



39. Write name and draw structures of three possible isomers of exylene.

SGD -2014

Ans:

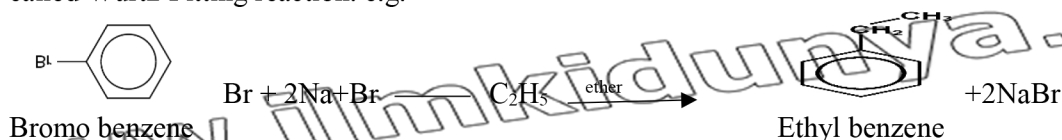


40. What is Wurtz-fitting reaction? Give an example.

LHR-2014, AJK.RWP, MTN-2015, MTN-2016, LHR-2018

Ans: The Wurtz reaction for the synthesis of alkanes was extended by Fitting in 1864 to the synthesis of alkyl aromatic hydrocarbons.

When a mixture of alkyl halide and an aryl halide is treated with sodium metal in dry ether, the sodium preferentially attack the alkyl halide to form alkylated aromatic compound. Thus mixed Wurtz reaction is called Wurtz-Fitting reaction. e.g.



Continue.....p/17.....

41. Why benzene is less reactive than alkenes?

OR

OR

Justify that ethane is more reactive than benzene.

SGD-2007,2010, DGK-2008,2009, BWP-2009,RWP, FBD-2016, SGD-2017, DGK-2018

Ans: Benzene is stable compound due to delocalization of pi electron cloud. The hybridized 2pz orbital partially overlap to form a continuous sheath of electron cloud enveloping above and below the six carbon sigma bonds of the ring. As the 2pz orbital is overlap by delocalized electron cloud.

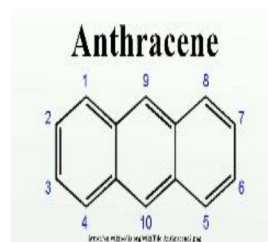
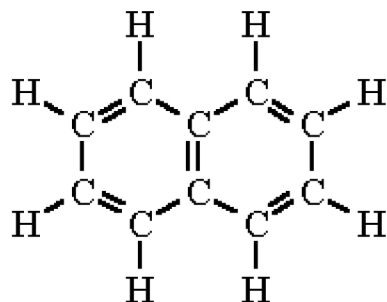
42. Write down the structural formula of.

SGD – 2009

(i) Naphthalene

(ii) Anthracene

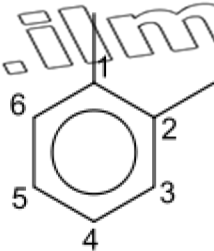
Ans: (i) Naphthalene



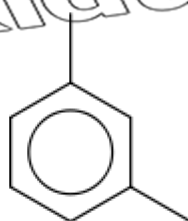
43. Write IUPAC name of x-xylene and p-xylene.

BWP-2008,SGD-2009

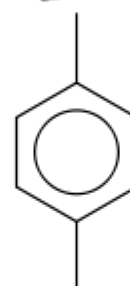
Ans:



1,2-dimethylbenzene
(ortho-xylene)



1,3-dimethylbenzene
(meta-xylene)

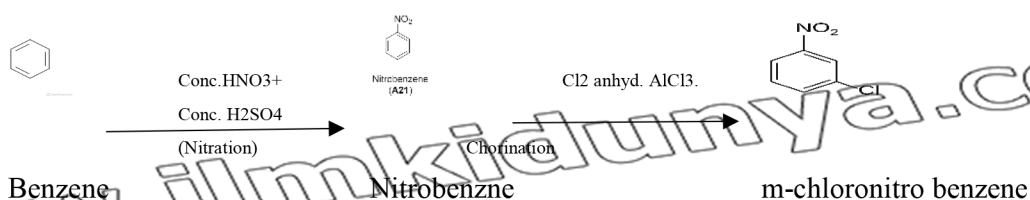


1,4-dimethylbenzene
(para-xylene)

44. Prepare m-chloronitro benzene from benzene in two steps.

SGD,BWP-2015, DGK-2018

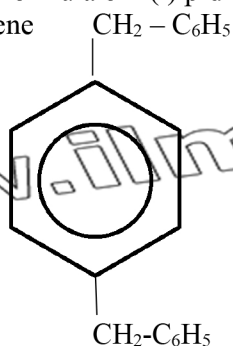
Ans: Benzene can be converted into m-chloronitrobenzene through the following 2- steps.



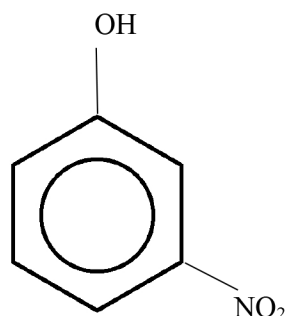
Continue.....p/18.....

45. Draw structural formula of (i) p-dibenzylbenzene (ii) m-nitrophenol
 Ans: p-dibenzylbenzene

FBD – 2008



m-nitrophenol

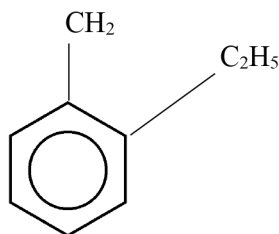
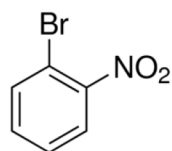


46. Draw the structural formula of :

- (i) o-bromintrobenzene (ii) o-ethyl toluene (iii) m-chlorobenzene acid (iv) p-hydroxybenzoic acid
 (v) p-Nitroaniline (vi) 2,4,6 Trinitrotoluene (vii) m-nitrophenol
 (viii) 2-Amino-5-bromo-3-nitrobenzene sulphonic acid (ix) Diphenyl methane (x) Biphenyl

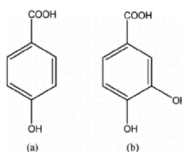
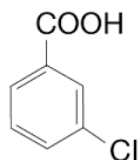
Ans: (i) o-bromintrobenzene **RWP-2008**

(ii) o-ethyl toluene **RWP-2008**



(iii) m-chlorobenzene acid.

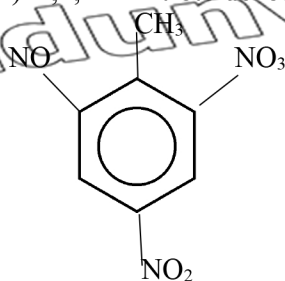
(iv) p-hydroxy benzoic acid



(v) p-Nitroaniline

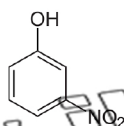


(vi) 2,4,6 Trinitrotoluene

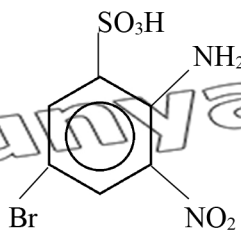


:- 19 :-

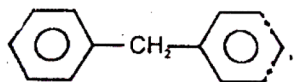
(vii) m-Nitrophenol



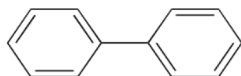
(viii) 2-Amino-5-bromo-3-nitrobenzenesulphonic acid



(ix) Diphenyl methane

**LHR – 2017**

(x) Biphenyl

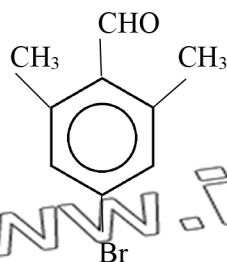


biphenyl

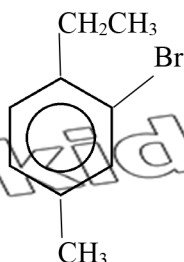
FBD-2017

47. Write IUPAC name of.

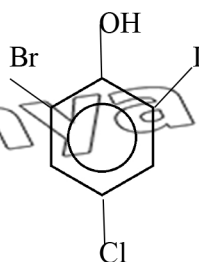
Ans:



4, Bromo-2,6-dimethyl benzaldehyde



3-Bromo-4-ethyltoluene

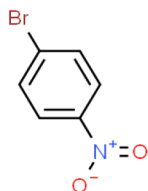


2-Bromo-4-chloro-6-iodophenol

MTN-2008

48. Write the name and four possible structural isomers of bromonitrobenzene.

Ans:

**FBD-2010.2015**

49. How alkyl benzene can be tested chemically?

Ans:

Alkyl phenyl selenones can be metallated with LDA in THF but the reaction is for the reversed-phase analysis of several alkylbenzenes on chemically bonded or monolith) coming from major manufacturers is individually tested in quality ...

MTN – 2006

50. Bring about the following conversions:

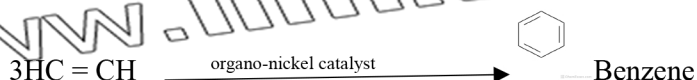
BWP – 2014

- (i) Acetylene $\longrightarrow$ Benzene (ii) Phenol $\longrightarrow$ Benzene

Ans: (i) Acetylene $\longrightarrow$ Benzene

From Acetylene:

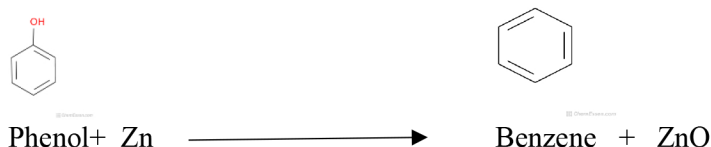
Benzene is formed by passing acetylene under pressure over an organo-nickel catalyst at 70 °C



- (ii) Phenol $\longrightarrow$ Benzene

By distilling phenol with Zinc dust:

By distilling phenol with Zinc dust:

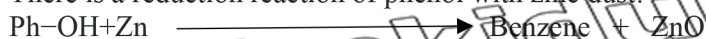


51. Give reaction of: (i) Phenol with zinc (ii) Benzene with SO_3

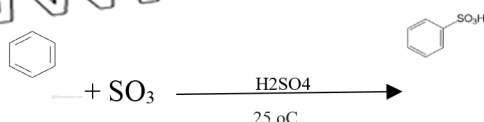
LHR – 2015

Ans: (i) **Phenol with Zinc:**

There is a reduction reaction of phenol with zinc dust.



- (ii) **Benzene with SO_3**



52. Why hydroxyl group (OH-) is ortho and para directing?

FBD – 2016

Ans: Hydroxyl group release electrons to the benzene ring, thereby facilitating the availability of electrons to the electrophiles at ortho and para positions. This result in the increases chemical reactivity of benzene ring toward electrophiles. The benzene ring can offer more than one position to the new incoming groups.

53. What are aromatic hydrocarbons? Give two examples.

Ans: The carbocyclic compounds, containing at least one benzene ring six carbon atoms with three alternate double and single bonds are called aromatic hydrocarbons. These bonds are usually shown in the form of a circle. Example: Toluene, Phenol, Benzaldehyde and Nitrobenzene.

54. What is meant by meta directing group?

MTN – 2016

Ans: **Meta directing group:**

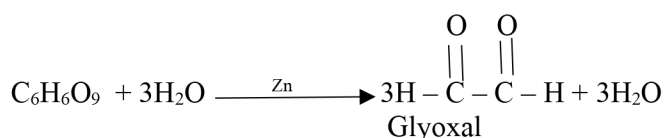
The groups which withdraw the electrons of the benzene ring towards themselves, and reduce the availability to the electrophile are called meta directing groups. The result is the decreased chemical reactivity of benzene. In their presence incoming electrophile will prefer to attack on meta position rather than ortho and para position. For example: $-\text{N}^+\text{R}_2$, $-\text{V}=\text{N}^+$, $-\text{CN}$, $-\text{CHO}$, $-\text{COOH}$ etc.

55. A mixture of benzene vapours and air are passed over heated vanadium pentaoxide.
 Explain the term oxidation with one example using benzene
 How benzene is converted into maleic acid by catalytic oxidation?
 Give catalytic oxidation of benzene.
 Reaction of benzene with ozone.
 What happens when ozone is reacted with benzene?

OR
OR
OR
OR
OR

Ans: **Ozonolysis:**

Benzene reacts with ozone and give glyoxal through benzene triozone.

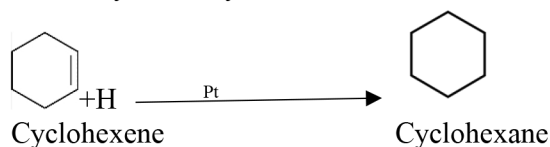


56. What is sandwich structure?

Ans: A continuous sheath of electrons is present above and below the carbon plane and structure is called **sandwich structure**.

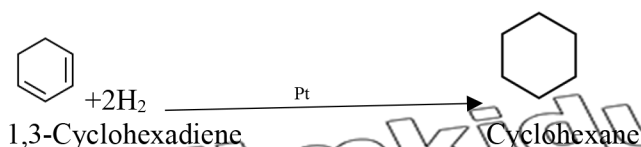
57. What of Heat of hydrogenation for cyclohexene.

Ans: Cyclohexene, a six membered ring containing one double bond, can be easily hydrogenated to give cyclohexane. When the ΔH (hydrogenation) for this reaction is measured, it is found to be -119.5 KJ/mole, very much like that of any similarly substituted alkene.



58. What Heat of hydrogenation for 1,3-cyclohexadiene.

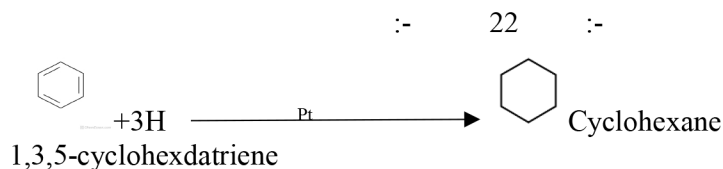
Ans: We would expect, that hydrogenation of 1,3-cyclohexadiene would liberate roughly twice as much heat, and thus have ΔH equal to about -239 KJ/mole. When this experiment is done, the result is $\Delta H = -231.5$ KJ/mole. This result is quite close to what we calculated and the difference is 7.5 KJ. It can be explained by taking into account the fact that compounds containing conjugated double bonds are usually somewhat more stable than those containing isolated double bonds.



59. What Heat of hydrogenation for 1,3,5 cyclohexatriene.

Ans: The heat of hydrogenation of 1,3,5-cyclohexatriene should be three times of the cyclohexene which is $(-119.5 \times 3 = -358.5 \text{ kJ})$. Actual value of heat of hydrogenation of benzene is only -208 kJ mol^{-1}

Continue.....p/22.....



60. Define Resonance energy.
Define Resonance Energy. Give Resonance energy of Benzene.

How do justify that 150.5 KJ/mol is the resonance energy of benzene?

Ans: **Define:-** "The difference in energy between hypothetical structure (1,3,5-cyclohexatriene) and actual structure (benzene) is called resonance energy."

It means benzene shows the phenomenon of Resonance which makes it more stable than others.

Resonance energy of Benzene:

Calculated $\Delta H = (3 \times -119.5) = -358.5 \text{ KJ/mol}$

Observed $\Delta H = -208 \text{ KJ/mol}$

Difference = 150.5 KJ/mol

So, Resonance energy of Benzene is 150.5 KJ/mol

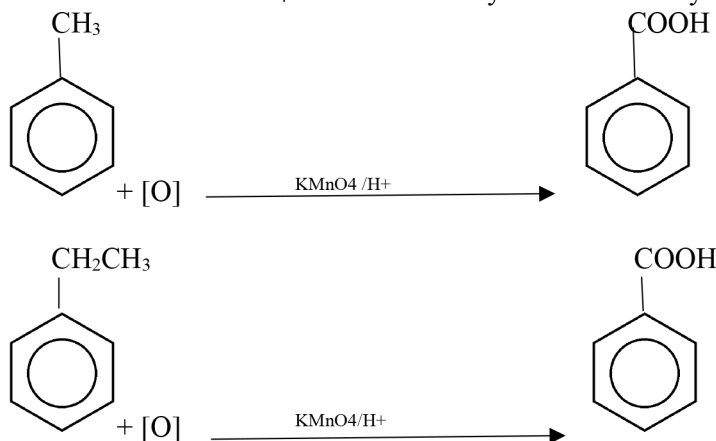
61. Define electrophilic substitution reactions.

Ans: **Define:-** "The reactions in which one electrophile is replaced by another strong electrophile are called electrophilic substitution reactions."

In benzene, the electrophile H^+ can be replaced by strong electrophiles like Cl^+ chloronium, Br^+ , Bromonium, carbonium, sulphonium, nitronium NO_2^+ etc.

62. What happens when acidified KMnO_4 is added to Methyl benzene and Ethyl benzene? **BWP -2017**

Ans: When acidified KMnO_4 is added to methyl benzene or ethyl benzene, they are oxidized to benzoic acid.

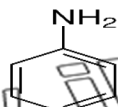


63. Write any four ortho para directing groups.

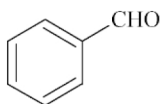
Ans: (i) $\text{N}(\text{CH}_3)_2$ (ii) $-\text{NH}_2, -\text{OH}$ (iii) $-\text{OCH}_3$ (iv) $-\text{Cl}, \text{Br}, -\text{I}$

64. Write down the formula of Aniline and Benzaldehyde.

Ans: Aniline:



Benzaldehyde:

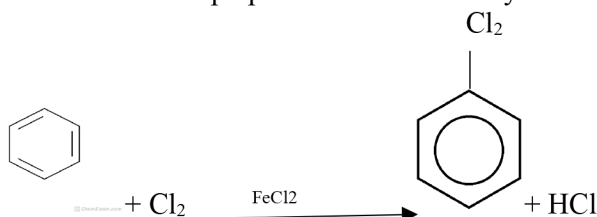


65. How para-chloronitrobenzene is prepared from benzene in two steps.

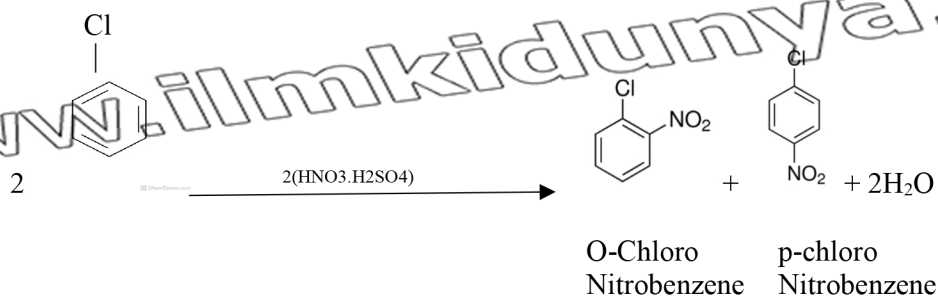
SGD – 2015

Ans: P-chloronitrobenzene can be prepared from benzene by the following 2-Steps.

Step (i)



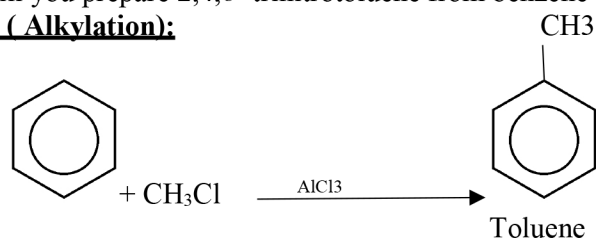
Step (ii)



66. How will you prepare 2,4,6- trinitrotoluene from benzene in two steps.

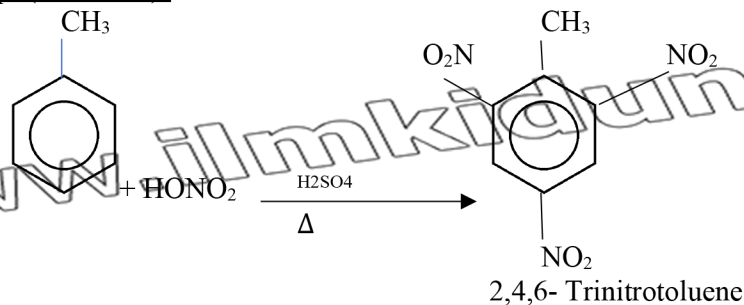
GRW – 2017

Ans: **1st step (Alkylation):**



Continue.....p/24.....

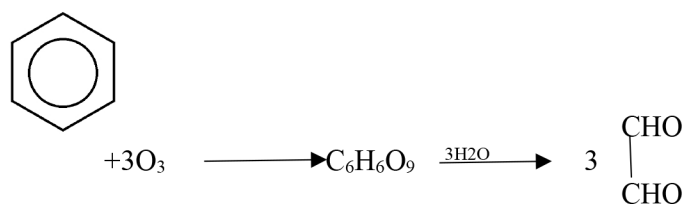
2nd Step. (Nitration):



67. What happens when benzene is oxidized with ozone?

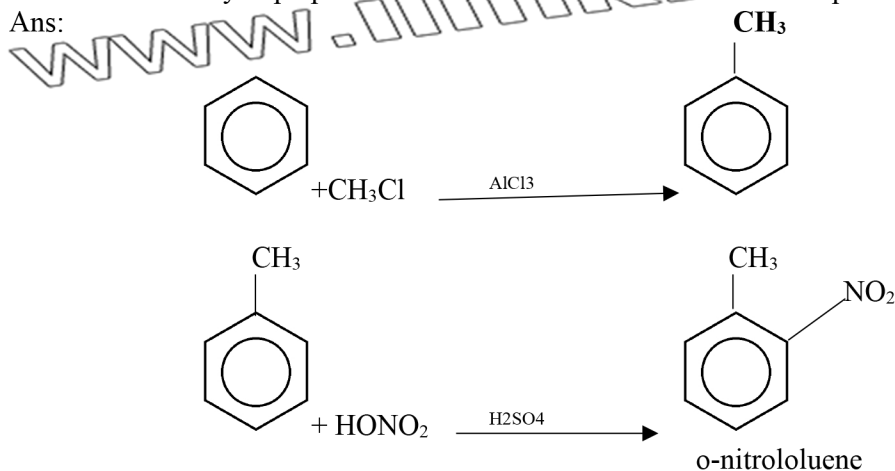
GRW - 2017

Ans: Benzene reacts with ozone and gives glyoxal through benzene triozone.



68. How will you prepare o-nitro-toluene from benzene in two step?

DGK – 2017 GRW – 2018



.....THE END.....