Benzene Chemistry Questions with Solutions

Q-1: Benzene is aromatic because it follows

a) Huckel's rule
b) Aromaticity conditions
c) 4n pi electron rule
d) None of the above

Answer: a) Huckel's rule

Explanation: According to the Huckel rule, compound should possess,

(i) Planarity
(ii) π electrons complete delocalisation in the ring
(iii) (4n + 2) π electrons presence in the ring where n is an integer (n = 0, 1, 2, . . .).

In the case of benzene, there are 6 pi electrons.

Hence, 4n+2 =6
This results in, n=1 (a positive value)

Because benzene follows Huckel's rule, it is aromatic.

Q-2: Is benzene soluble in ethanol?

Answer: No

Explanation: According to the "like dissolves like" solubility principle, polar solutes can be dissolved in polar solvents and nonpolar solutes can be dissolved in non-polar solvents.

Because benzene is nonpolar and ethanol is polar, it is not soluble in ethanol.

Q-3: NO_2^+ is formed as an electrophile during the nitration of benzene. Its shape is

a) Bent
b) Linear
c) Angular
d) Can't predict

Answer: b) Linear

Explanation: The steric number of a particular atom can be used to determine the shape of a molecule.

We can write, SN = (number of electron lone pairs on the central atom) + (number of sigma bonds formed by the atom)

The structure of NO_2^+ molecule is:

It can be concluded from the structure that,

- Number of electron pairs on nitrogen =0
- Number of sigma bonds formed by nitrogen = 2

SN of nitrogen atom = 0+2=2

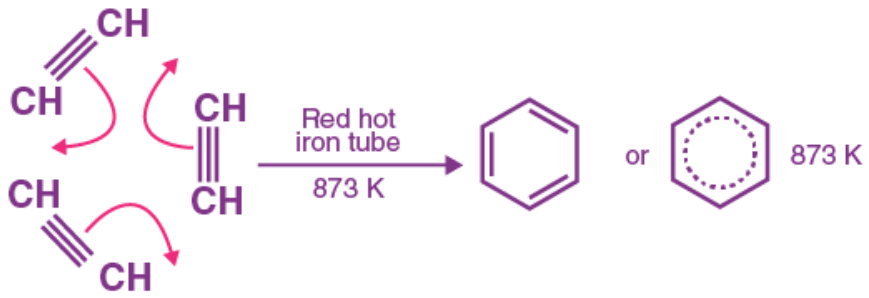
According to VSEPR theory, a steric number equal to 2 corresponds to hybridisation “sp” and the molecular geometry of the molecule as linear.

Q-4: Polymerisation of ethyne produces benzene provided the temperature is

a) 573 K
b) 873 K
c) 673 K
d) Room temperature

Answer: b) 873 K

Explanation: Cyclic polymerization occurs when ethyne passes through a red hot iron tube at 873K. Three molecules polymerise to form benzene. The reaction is shown below:



Q-5: Benzene burns with a

a) Non sooty flame
b) Sooty flame
c) Blue flame
d) Non-Luminous flame

Answer: b) Sooty flame

Explanation: Incomplete combustion of hydrocarbons due to insufficient air supply results in a sooty luminous flame (yellow). Such flames are usually shown by unsaturated or aromatic hydrocarbons. Example: Benzene

If there is sufficient air supply, a non-sooty non-luminous flame (blue) is observed as hydrocarbons are completely burned. Alkanes (saturated hydrocarbons) show such kinds of flames.

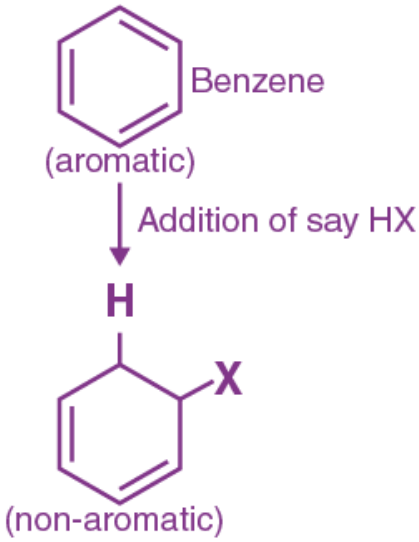
Q-6: Addition reaction is not shown by benzene because

a) It is planar
b) It has cyclic structure
c) Double bonds are very strong
d) Stabilisation due to resonance needs to be reserved

Answer: d) Stabilisation due to resonance needs to be reserved

Explanation: Because of the delocalisation of pi electrons, benzene is stable. If the benzene is subjected to an addition reaction, its aromaticity will be lost due to the formation of sp^3 carbon at which delocalisation stops. As a result, it does not exhibit an addition reaction in order to avoid the loss of aromatic character.

The following reaction can help you understand in a better way:



We can clearly see that the aromatic system(highly stable) is getting converted into a non-aromatic system (less stable).

Q-7: Match the column I with column II

Column I	Column II
1) Benzene + Cl_2 + $AlCl_3$ →	a) Toluene
2) Benzene + CH_3Cl + $AlCl_3$ →	b) Benzoic acid
3) Benzene + CH_3COCl + $AlCl_3$ →	c) Chlorobenzene
4) Toluene + $KMnO_4$/NaOH →	d) Methyl phenyl ketone e) Benzene Hexa chloride

Answer:

Column I	Column II
1) Benzene + Cl_2 + $AlCl_3$ →	Chloro benzene
2) Benzene + CH_3Cl + $AlCl_3$ →	Toluene
3) Benzene + CH_3COCl + $AlCl_3$ →	Methyl phenyl ketone

4) Toluene + $KMnO_4/NaOH \rightarrow$	Benzoic acid

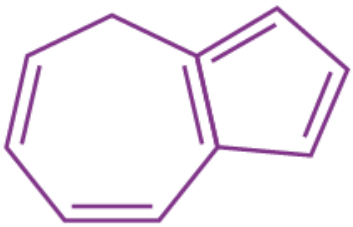
Q-8: In which of the following systems, benzene ring is not present?

a) Naphthalene
b) Phenanthrene
c) Anthracene
d) Azulene

Answer: d) Azulene

Explanation: A system that consists of a benzene ring is said to be a benzenoid system and a system without a benzene ring is said to be a non benzenoid system.

The structure of azulene is shown below:



Azulene

We can clearly see that there is no benzene ring present in it. Therefore a non-benzenoid system.

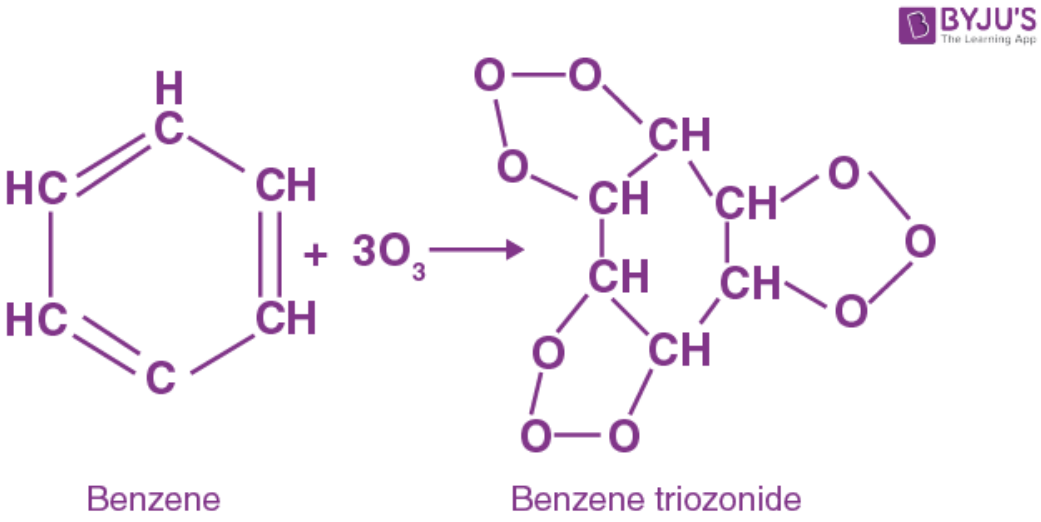
Q-9: Which of the following structures demonstrates that benzene has three double bonds?

a) Molozonide
b) Diozonide
c) Trioxane
d) Triozonide

Answer: d) Triozonide

Explanation: Triozonide is formed when benzene undergoes ozonolysis. Ozonolysis is an organic chemical reaction in which ozone is used to cleave the unsaturated bonds of alkenes.

Because benzene contains three double bonds, it forms a triozonide.



Q-10: Give the chemical equation for the combustion of benzene.

Answer: When heated in air, benzene emits a sooty flame and produces CO_2 and H_2O. This type of reaction is known as a combustion reaction, and it is depicted below:

$C_6H_6 + 15/2O_2 \rightarrow 6CO_2 + 3H_2O$

Q-11: State three important uses of benzene.

Answer: Benzene has a wide range of applications:

1. Benzene is a common solvent in many industrial, commercial, and research applications. Manufacturers use benzene-containing products as solvents at various stages of production, and it is used in the production of chemical and plastic products. Resins, synthetic products such as nylon, Styrofoam are a few examples

2. Many people and manufacturers use benzene as a fuel because of its high octane number and natural availability. It has been used as a gasoline additive to help fuel burn more efficiently.

3. Most products used in the printing industry contain benzene. There are products that contain this chemical and are specifically used for cleaning printing equipment, making it last longer and function better.

Q-12: What observations did Kekule consider when assigning the structure to benzene?

Answer: Benzene was discovered to be a stable molecule that forms a triozonide, indicating the presence of three double bonds. Benzene was also discovered to produce only one monosubstituted derivative, indicating that all six carbon and six hydrogen atoms in benzene are identical. On the basis of this observation, August Kekulé proposed the cyclic arrangement of six carbon atoms with alternate single and double bonds and one hydrogen atom attached to each carbon atom in 1865.

Q-13: The carbon-carbon double bond distance in benzene is intermediate between that of C-C single and double bond distance due to

a) Presence of pi electrons
b) Resonance
c) Its Aromatic nature
d) P-orbitals

Answer: b) Resonance

Q-14: When phenol is treated with _____, it produces benzene.

Answer: Phenol is reduced to benzene by passing its vapours over heated zinc dust.

Q-15: Which structure is isoelectronic and structurally equivalent to benzene? What is the common name for it?

Answer: Borazole, or borazine, is a polar inorganic compound with the chemical formula $B_3H_6N_3$. The three NH units and three BH units alternate in this cyclic compound. With benzene, the compound is isoelectronic and isostructural. As a result, borazine is also known as "inorganic benzene."

Practise Questions on Benzene

Q-1: Which compound is formed when benzene reacts with three chlorine molecules under ultraviolet light?

a) Hexachlorocyclohexane
b) Gammaxane
c) Hexa chloro benzene
d) 1,3,5-trichloro benzene

Answer: b) Gammaxane

Explanation: Under ultra-violet light, three chlorine molecules add to benzene to produce benzene hexachloride, $C_6H_6Cl_6$ which is also called gammaxane.

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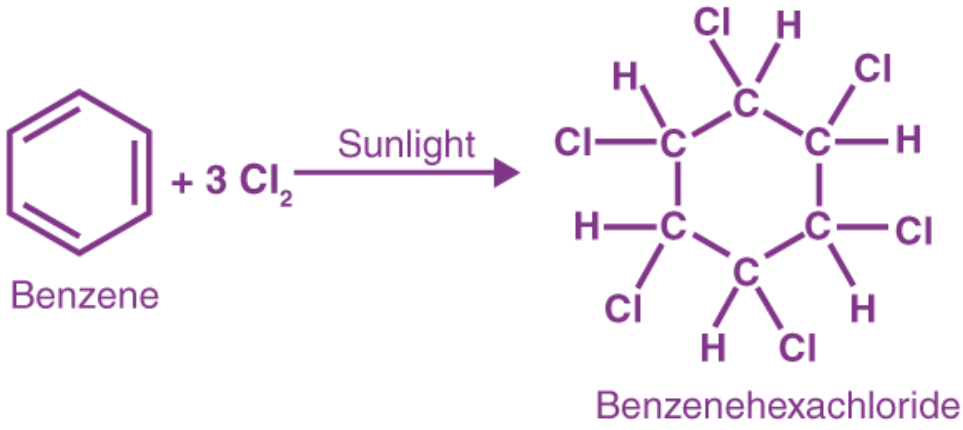

Q-2: Which of the following name reactions uses benzene as a starting material?

a) Etard reaction
b) Gattermann koch reaction
c) Gattermann reaction
d) Sandmeyer reaction

Answer: b) Gattermann koch reaction

Explanation: In the presence of anhydrous aluminium chloride or cuprous chloride, benzene is treated with carbon monoxide and hydrogen chloride. The product is benzaldehyde. This is known as the Gattermann Koch reaction.

The reaction is shown below:

$$C_6H_6 \xrightarrow[AnhyAlCl_3/CuCl]{CO+HCl} C_6H_5CHO$$

Q-3: The overlapping of orbitals is of type _____ in benzene.

a) sp-sp
b) sp^2-sp^2
c) p-p
d) sp^3-sp^2

Answer: c) p-p and **b)** sp^2-sp^2

Explanation: The orbital overlapping provides a clearer picture of benzene's structure. In benzene, all six carbon atoms are sp^2 hybridised.Each carbon atom's two sp^2 hybrid orbitals overlap with the sp^2 hybrid orbitals of adjacent carbon atoms to form six C—C sigma bonds in the hexagonal plane.Each carbon atom is now left with one unhybridized p orbital. The unhybridized p orbital of carbon atoms are close enough to form a π bond by lateral overlap.The p orbital of each carbon atom overlaps with the p orbitals of adjacent carbon atoms to form π bonds.

Q-4: How does benzene and PAHs cause toxicity?

Answer: Benzene and polynuclear hydrocarbons (PAHs) containing more than two benzene rings fused together are toxic and are said to be carcinogenic (cause cancer).
These polynuclear hydrocarbons are formed during the incomplete combustion of organic materials such as tobacco, coal, and petroleum.
They enter the human body and undergo various biochemical reactions before damaging DNA and causing cancer.

Q-5: How can you prepare haloarene from benzene?

Answer: Benzene reacts with halogens in the presence of a Lewis acid like anhydrous $FeCl_3$, $FeBr_3$ or $AlCl_3$ to yield haloarenes.