Answer all the questions below as fully as you can then check your answers

1. What is the molecular formula of benzene?

A. C_6H_6 B. C_6H_{12} C. C_5H_5 D. C_7H_8

2. Which of the following correctly describes the bonding in benzene?

A. Alternate single and double bonds

B. A ring of sigma bonds and delocalized pi electrons

C. Only single bonds

D. Only double bonds

3. What type of reaction does benzene typically undergo?

A. Electrophilic addition B. Nucleophilic substitution

C. Electrophilic substitution D. Free-radical substitution

4. What catalyst is used in the bromination of benzene?

A. $FeCl_3$ B. $AlCl_3$ C. $FeBr_3$ D. H_2SO_4

5. What is the enthalpy change of hydrogenation for benzene?

A. $-120\ kJ\ mol^{-1}$ B. $-208\ kJ\ mol^{-1}$

C. $-360\ kJ\ mol^{-1}$ D. $-150\ kJ\ mol^{-1}$

6. Explain why benzene does not undergo electrophilic addition reactions like alkenes.

7. Draw Kekulé's structure for benzene. Highlight its limitations.

8. Describe what is meant by resonance in the context of benzene. Use diagrams where appropriate.

9. The enthalpy of hydrogenation for cyclohexene is $-120\ kJ\ mol^{-1}$. Based on Kekulé's structure, what would you expect for benzene? Why is the actual value different?

10. Explain why only one isomer is formed in the reaction of benzene with bromine to form monobromobenzene.

Answers

1. What is the molecular formula of benzene?

A. C_6H_6 B. C_6H_{12} C. C_5H_5 D. C_7H_8

Answer: C6H6

2. Which of the following correctly describes the bonding in benzene?

A. Alternate single and double bonds

B. A ring of sigma bonds and delocalized pi electrons

C. Only single bonds

D. Only double bonds

Answer: B. A ring of sigma bonds and delocalised pi electrons

3. What type of reaction does benzene typically undergo?

A. Electrophilic addition B. Nucleophilic substitution

C. Electrophilic substitution D. Free-radical substitution

Answer: C. Electrophilic substitution

4. What catalyst is used in the bromination of benzene?

A. $FeCl_3$ B. $AlCl_3$ C. $FeBr_3$ D. H_2SO_4

Answer: C. $FeBr_3$

5. What is the enthalpy change of hydrogenation for benzene?

A. $-120\ kJ\ mol^{-1}$ B. $-208\ kJ\ mol^{-1}$

C. $-360\ kJ\ mol^{-1}$ D. $-150\ kJ\ mol^{-1}$

Answer: B. $-208\ kJ\ mol^{-1}$

6. Explain why benzene does not undergo electrophilic addition reactions like alkenes.

Answer:

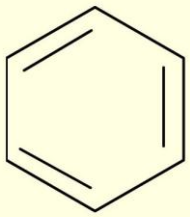
Benzene has a delocalised pi-electron cloud above and below the ring.

This delocalization provides extra stability to the molecule.

Electrophilic addition would disrupt the delocalised system and reduce stability, making it unfavourable.

7. Draw Kekulé's structure for benzene. Highlight its limitations.

Answer:

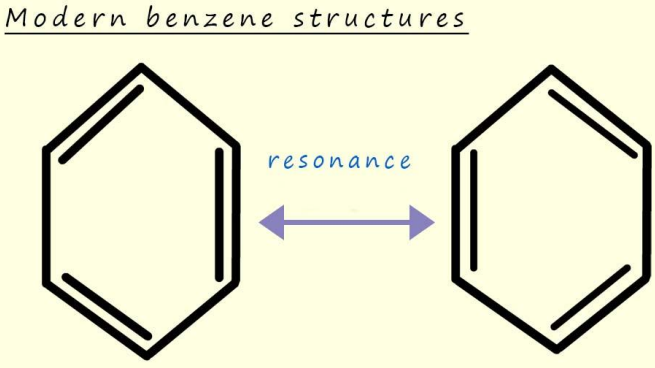


It does not explain benzene's equal bond lengths (measured as intermediate between single and double bonds).

It cannot account for benzene's low enthalpy of hydrogenation compared to the expected value for alternating double bonds.

8. Describe what is meant by resonance in the context of benzene. Use diagrams where appropriate.

Answer: Resonance refers to the delocalization of pi electrons across all six carbon atoms in benzene. The two Kekulé structures are resonance forms, but the actual structure is a hybrid with equal bond lengths.



9. The enthalpy of hydrogenation for cyclohexene is -120 kJ mol^{-1}. Based on Kekulé's structure, what would you expect for benzene? Why is the actual value different?

Answer:

Based on Kekulé's structure (three double bonds), the enthalpy of hydrogenation for benzene would be 3x-120=-360 kJ mol^{-1}

The actual value is -208 kJ mol^{-1} showing benzene is 152 kJ mol^{-1} more stable than expected.

This is due to the delocalisation of pi electrons, which provides extra stability (resonance stabilisation).

10. Explain why only one isomer is formed in the reaction of benzene with bromine to form monobromobenzene.

Answer:

All hydrogen atoms in benzene are equivalent due to the symmetry of the delocalized pi system.
Substitution at any carbon gives the same product.