

# Halogenation

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

1. What is an electrophile?
2. What is usually used to test a substance for unsaturation? Give the result of this test.
3. What type of reaction do:
  - i. alkenes usually undergo?
  - ii. aromatic rings usually undergo?
  - iii. Explain the difference you would see if a sample of bromine was added to a test tube of benzene and a test tube containing cyclohexene.
- a. Explain why aromatic rings will not undergo electrophilic addition reactions.
- b. Name the type of catalyst used in the bromination and chlorination of aromatic rings.
- c. Explain why a Lewis acid catalyst is needed in the bromination of benzene.
- d. Write an equation to show the production of bromobenzene from benzene and bromine.
- e. Name a suitable test and the result of the test to prove that the gas given off in this reaction is an acidic gas.
- f. Benzene will not react with bromine without the presence of a catalyst yet phenol will readily react without the presence of a catalyst. Explain this observation.

## Answers

1. What is an electrophile?

Electrophiles are electron deficient species, they can accept an electron pair from electron rich species

2. What is usually used to test a substance for unsaturation? Give the result of this test.

Orange bromine water or bromine in a solvent is added to the substance to be tested, if the substance in question is unsaturated then the orange/brown colour of the bromine will decolourise to form a colourless solution.

3. What type of reaction do:

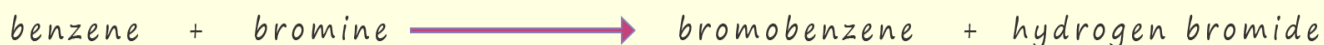
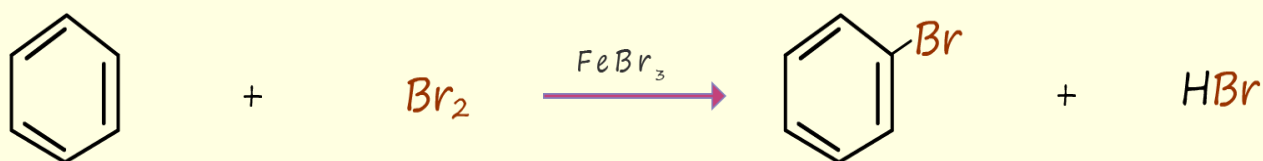
i. alkenes usually undergo? –electrophilic addition

ii. aromatic rings usually undergo?– electrophilic substitution.

iii. Explain the difference you would see if a sample of bromine was added to a test tube of benzene and a test tube containing cyclohexene.



- a. Explain why aromatic rings will not undergo electrophilic addition reactions. If an aromatic ring were to undergo electrophilic addition the delocalisation energy, created due to the delocalisation of the 6  $\pi$ -electrons in the ring would be lost. This basically means that the additional energy created by the delocalisation would have to be provided to the reaction, this would mean that the reaction would be highly endothermic.
- b. Name the type of catalyst used in the bromination and chlorination of aromatic rings.  
A Lewis acid or halogen carrier or simply a metal (III) halide such as iron (III) bromide or aluminium chloride.
- c. Explain why a Lewis acid catalyst is needed in the bromination of benzene. Benzene is a stable molecule due to the delocalisation energy provided by the delocalisation of the  $\pi$  electrons, this means that an excellent electrophile is needed before an aromatic ring will attack it. The cation created by the addition of a good electrophile will be partially offset by the cation being resonance stabilised. The Lewis acid catalyst will ensure that the electrophile has a full positive charge, that is it is an excellent electrophile.
- d. Write an equation to show the production of bromobenzene from benzene and bromine.



- e. Name a suitable test and the result of the test to prove that the gas given off in this reaction is an acidic gas. Moist pH paper or moist blue litmus paper will turn red.

f. Benzene will not react with bromine without the presence of a catalyst yet phenol will readily react without the presence of a catalyst. Explain this observation.

Phenol contains an activated aromatic ring, the hydroxyl group will "push" electron density into the aromatic ring, making it a better nucleophile.