This page gives you the facts and a simple, uncluttered mechanism for the electrophilic addition reactions between bromine (and the other halogens) and alkenes like ethene and cyclohexene.

The electrophilic addition of bromine to ethene

Alkenes react in the cold with pure liquid bromine, or with a solution of bromine in an organic solvent like tetrachloromethane. The double bond breaks, and a bromine atom becomes attached to each carbon. The bromine loses its original red-brown color to give a colorless liquid. In the case of the reaction with ethene, 1,2-dibromoethane is formed.

\[
\text{CH}_2=\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_2-\text{CH}_2 \quad \text{Br} \quad \text{Br}
\]

This decoloration of bromine is often used as a test for a carbon-carbon double bond. If an aqueous solution of bromine is used ("bromine water"), you get a mixture of products. The other halogens, apart from fluorine, behave similarly. (Fluorine reacts explosively with all hydrocarbons - including alkenes - to give carbon and hydrogen fluoride.) If you are interested in the reaction with, say, chlorine, all you have to do is to replace Br by Cl.

Mechanism

The reaction is an example of **electrophilic addition**. The bromine is a very "polarizable" molecule and the approaching pi bond in the ethene induces a dipole in the bromine molecule. If you draw this mechanism in an exam, write the words "induced dipole" next to the bromine molecule - to show that you understand what's going on.

\[
\text{CH}_2=\text{CH}_2 \quad \text{Br}^{\delta+} \quad \text{Br}^{\delta-} \rightarrow \text{CH}_2-\text{CH}_2 \quad \text{Br} \quad \text{Br}
\]

*Figure: A simplified version of the mechanism*

In the first stage of the reaction, one of the bromine atoms becomes attached to both carbon atoms, with the positive charge being found on the bromine atom. A bromonium ion is formed.

\[
\text{CH}_2=\text{CH}_2 \quad \text{Br}^{\delta+} \rightarrow \text{CH}_2-\text{CH}_2 \quad \text{Br}^{\delta-}
\]

*Figure: Step 1 in mechanism of addition of Bromine to ethene*

The bromonium ion is then attacked from the back by a bromide ion formed in a nearby reaction.
Electrophilic addition of bromine to cyclohexene

Cyclohexene reacts with bromine in the same way and under the same conditions as any other alkene. 1,2-dibromocyclohexane is formed.

Mechanism

The reaction is an example of electrophilic addition. Again, the bromine is polarized by the approaching \( \pi \) bond in the cyclohexene. Do not forget to write the words "induced dipole" next to the bromine molecule.

The bromonium ion is then attacked from the back by a bromide ion formed in a nearby reaction.
Figure: Step 2 in mechanism of addition of Bromine to cyclohexane

Contributors

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