

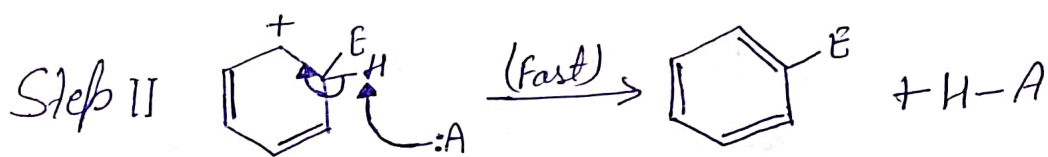
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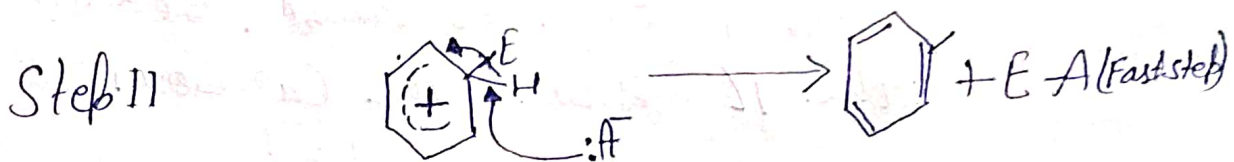
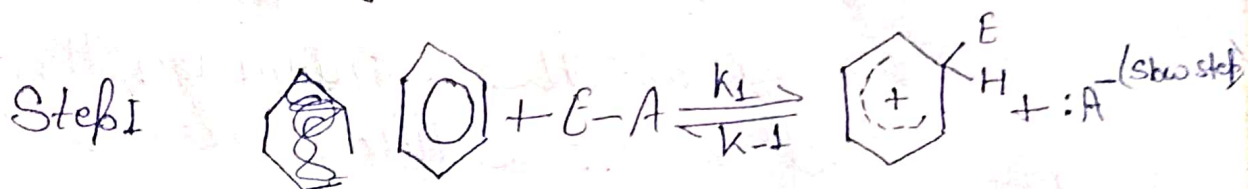
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In step 2 a proton is removed from the carbon of the arenium ion that bears the electrophile. The two electrons that bonded this proton to carbon becomes a part of the π system. The carbon atom that bears the electrophile becomes sp^2 hybridized again and a benzene derivative with six fully delocalized π electrons is formed. We can represent step 2 with any one of the resonance structures for the arenium ion.



(The proton is removed by any of the bases present, for example, by the anion derived from the electrophile). Kekulé structure are more appropriate for writing mechanism such as electrophilic aromatic substitution because they

Permit the use of resonance theory, it can be described however, using the modern formula for benzene in the following way.



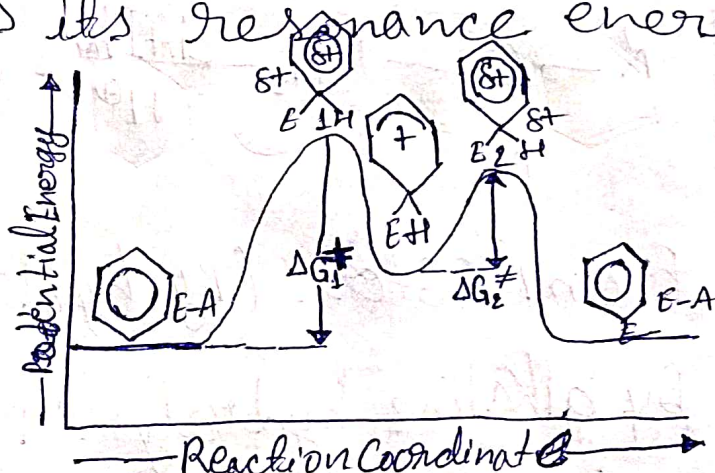
where k_1 and k_{-1} is the rate constant of the forward and backward reactions in ~~step I~~, k_2 is the rate constant of the step-II.

There is firm experimental evidence that the arenium ion is a true intermediate in electrophilic substitution reactions.

It is not a transition state. This means that in a free energy diagram (figure shown below) the arenium ion lies in an energy valley between two transition states.

The free energy of activation, $\Delta G_{\ddagger}^{\ddagger}$, for the reaction leading from benzene

and the electrophile, E^+ , to the arenium ion ~~to~~ has been shown to be much greater than the free energy of activation, $\Delta G_{(2)}^\ddagger$, leading from the arenium ion to the final product. This is consistent with what we would expect. The reaction leading from benzene and an electrophile to the arenium ion is high endothermic, because the benzene ring loses its resonance energy. The reaction leading from the arenium ion to the substituted benzene, by contrast, is highly exothermic because in it the benzene ring regains its resonance energy.



of the above two steps, step 1 the formation of the arenium ion - is usually the rate determining step in electrophilic aromatic substitution. Step 2, the removal of proton, occurs rapidly, occurs relative to step 1 and has no effect on the overall rate of reaction.