Aromatics III

Electrophilic Substitution Rxns

Ref 15: 1 – 9 (both ed[ns])

Prob 15: 1, 3, 5, 7 (both ed[ns])

Adv Rdg 15: 10 – 14 (both ed[ns])

General

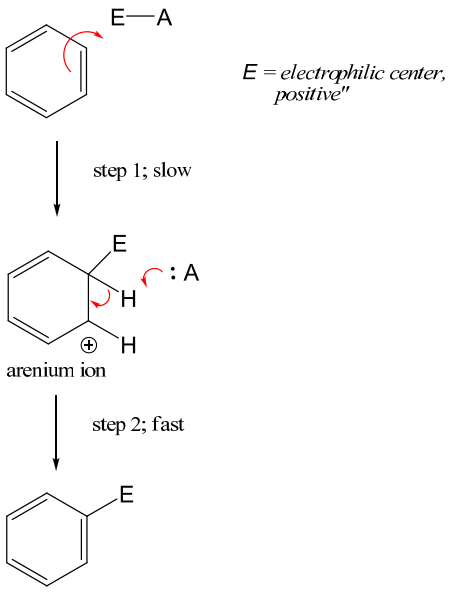
- π e⁻'s dominant
- but less reactive than in alkenes

  (*b/c of aromtic stabilization*)
- **strong** electrophiles needed
- end result:

  substitution

  (*not addition*)

General Mechanism



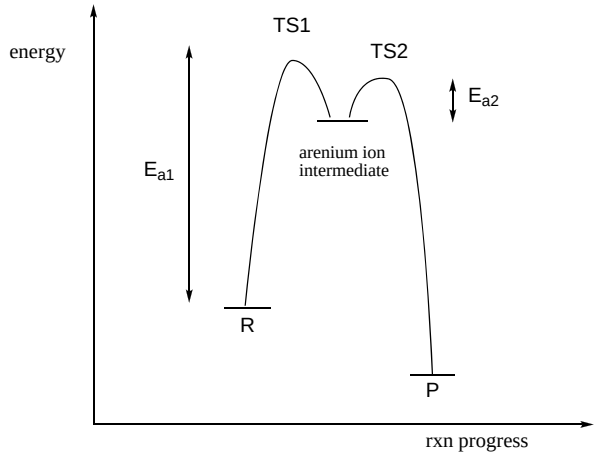
N.B. *H replaced by E*

step 1: similar to alkene rxn

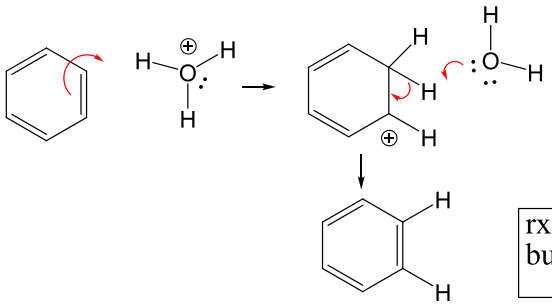
step 2: restoration of aromaticity

Reaction Profile

simple 2-step energy diagram; (like S_N1, ...)

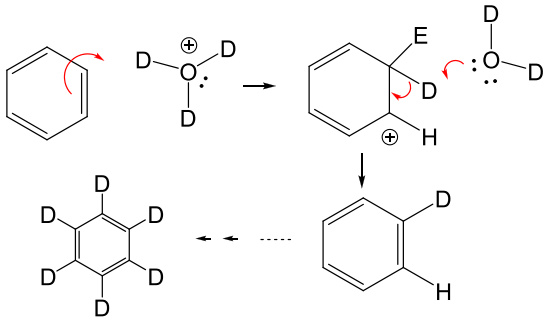


Ex. :Rxn w/ Strong Acid, C_6H_6 + HCl(aq)



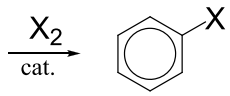
rxn !!
but P = R

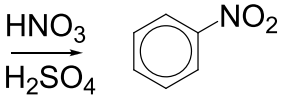
Proof: use HCl/D_2O

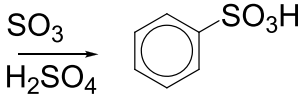


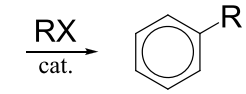
has no H signal in NMR !!

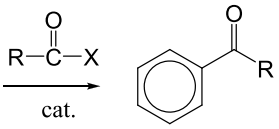
5 Important Rxns

1.) Halogenation 

2.) Nitration 

3.) Sulfonation 

4.) Alkylation 

5.) Acylation 

1.), 4.), 5.) know detailed mech.

2.), 3.) know reagents & products

1.) Halogenation

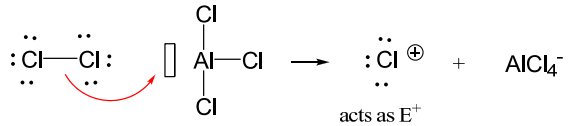
(w/ Cl_2, Br_2, I_2)

catalyst needed:

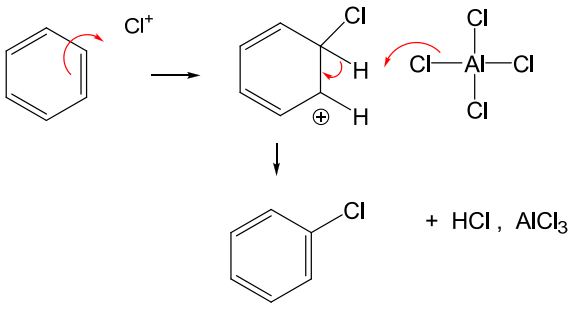
"Friedel- Crafts" = Lewis acid

common cat.: $AlCl_3$, $FeCl_3$ (*have e^- gap*)

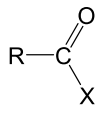
Ex. Chlorination of benzene



acts as E^+



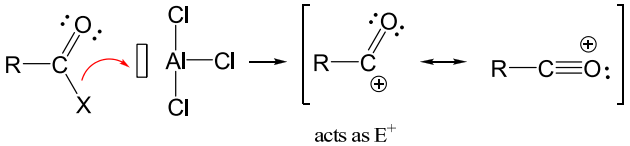
5.) Acylation



& Lewis acid

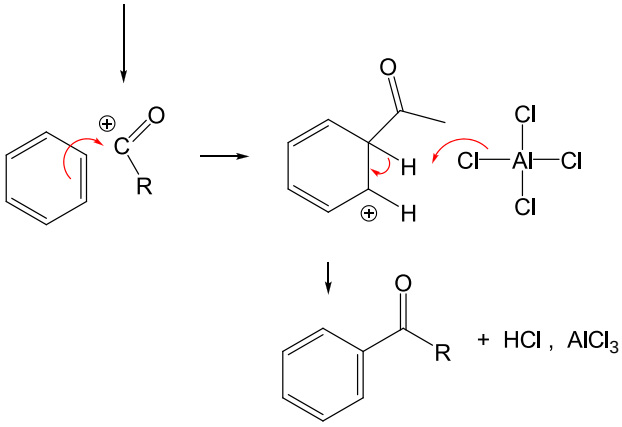
acid chloride = "acyl chloride"

Formation of "E^+":



acts as E^+

Example:

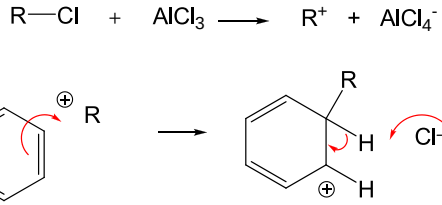


Aromatic Ketone !!

4.) Alkylation

alkyl halide & Lewis acid

Details:



Alkyl Benzene !!

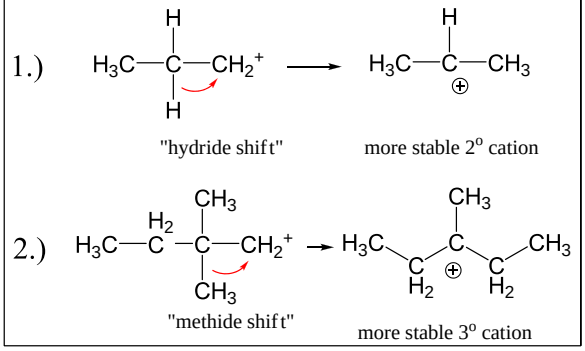
Complication w/ Alkylations

1.) rearrangement of R^+ cation

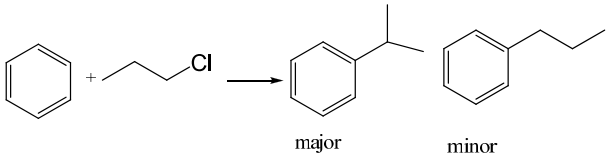
can occur if more stable cation

can be formed by hydride or alkide shift

Aside on carbocation rearrangement



Ex.:



2.) multi - substitution

initial product may be more reactive

than original substrate

Ex.