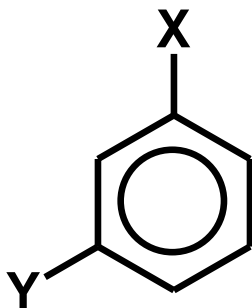
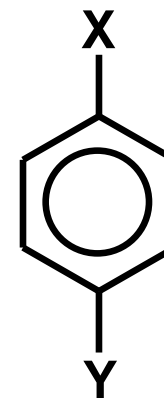


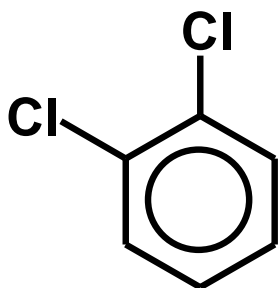
**1,2 lub orto**



**1,3 lub meta**



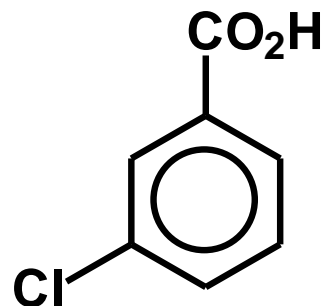
**1,4 lub para**



nazwa zwyczajowa: *orto*-dichlorobenzen

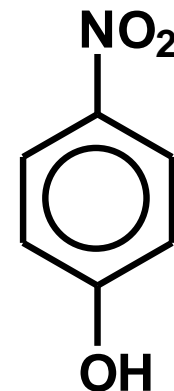
**nazwa IUPAC:**

**1,2-dichlorobenzen**



kwas *meta*-chloro-  
benzoesowy

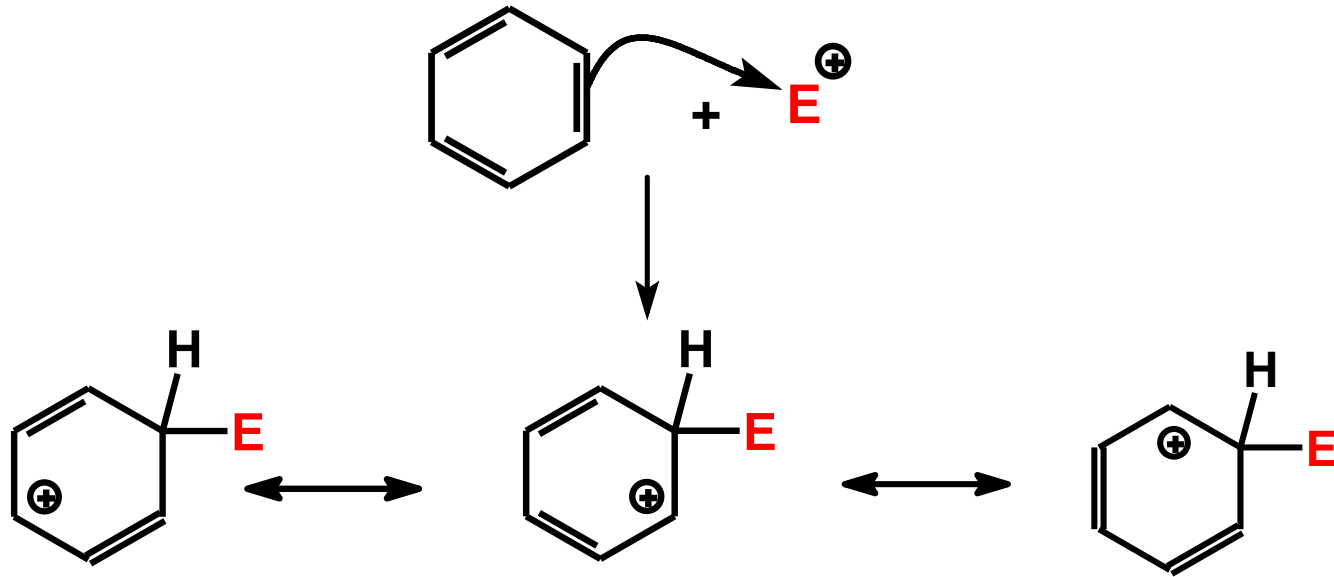
**kwas 3-chloro-  
benzoesowy**



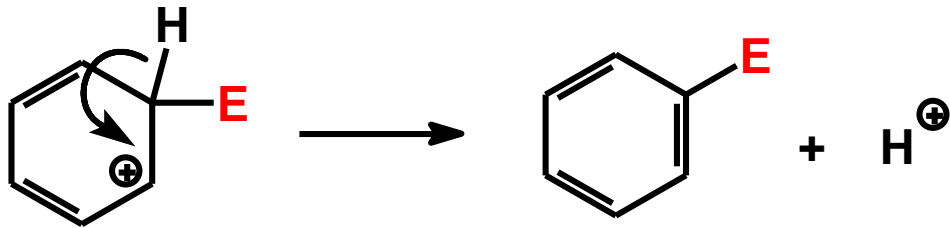
*para*-nitrofenol

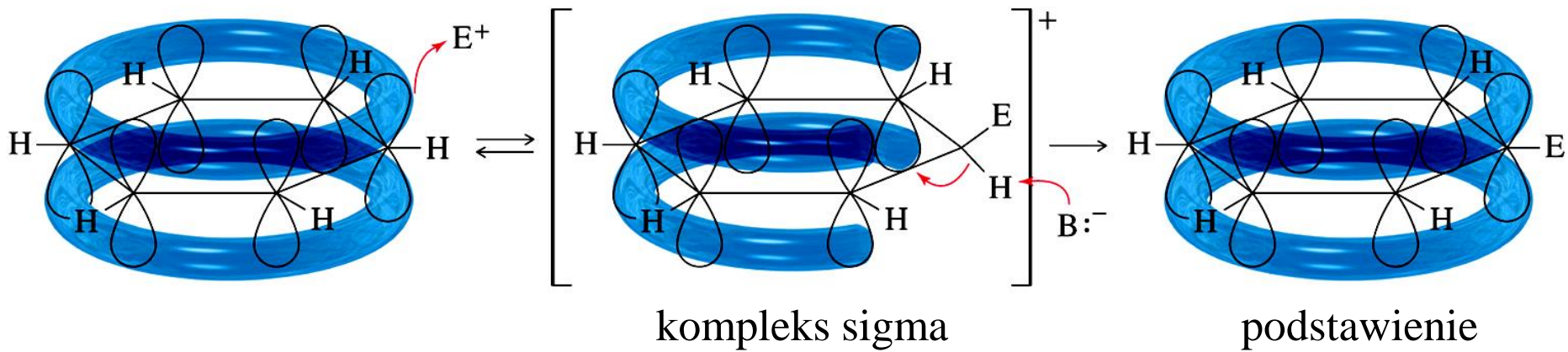
**4-nitrofenol**

# Reakcje substytucji elektrofilowej

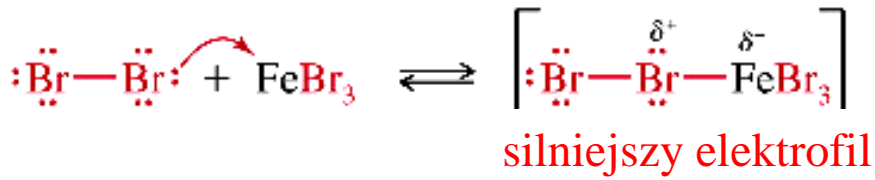


**mezomeryczny kompleks sigma**

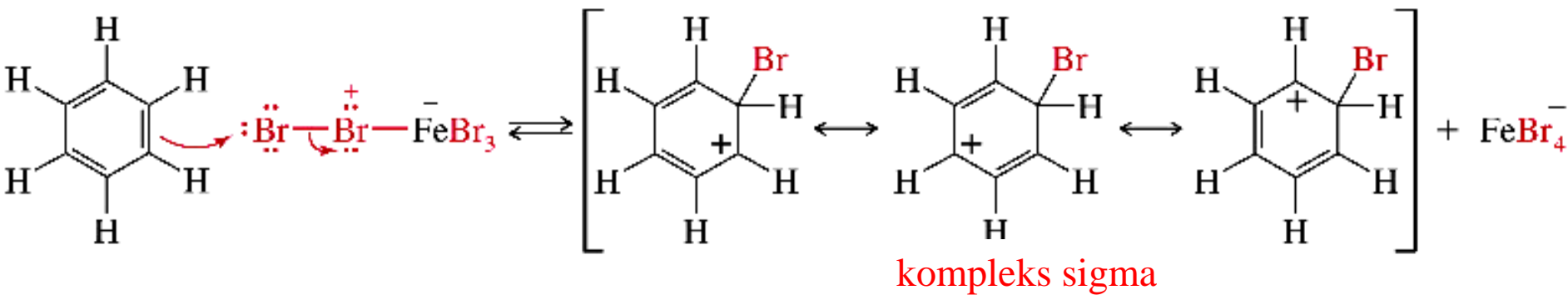




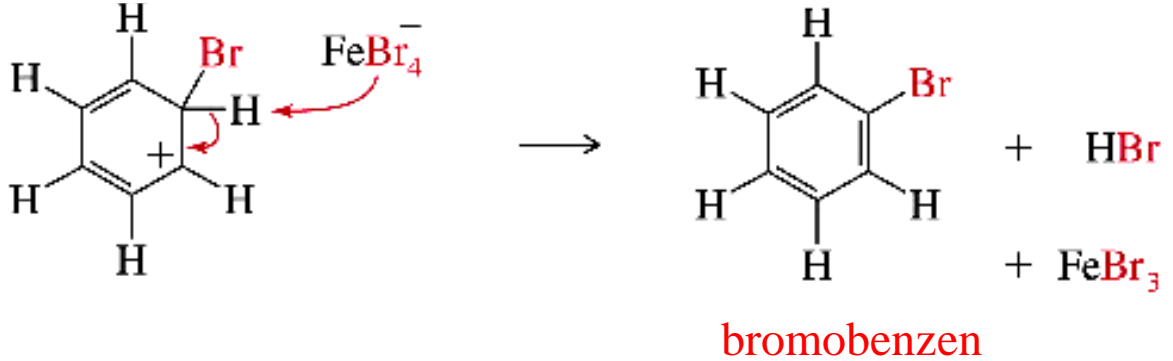
Etap 1. utworzenie silnego elektrofila

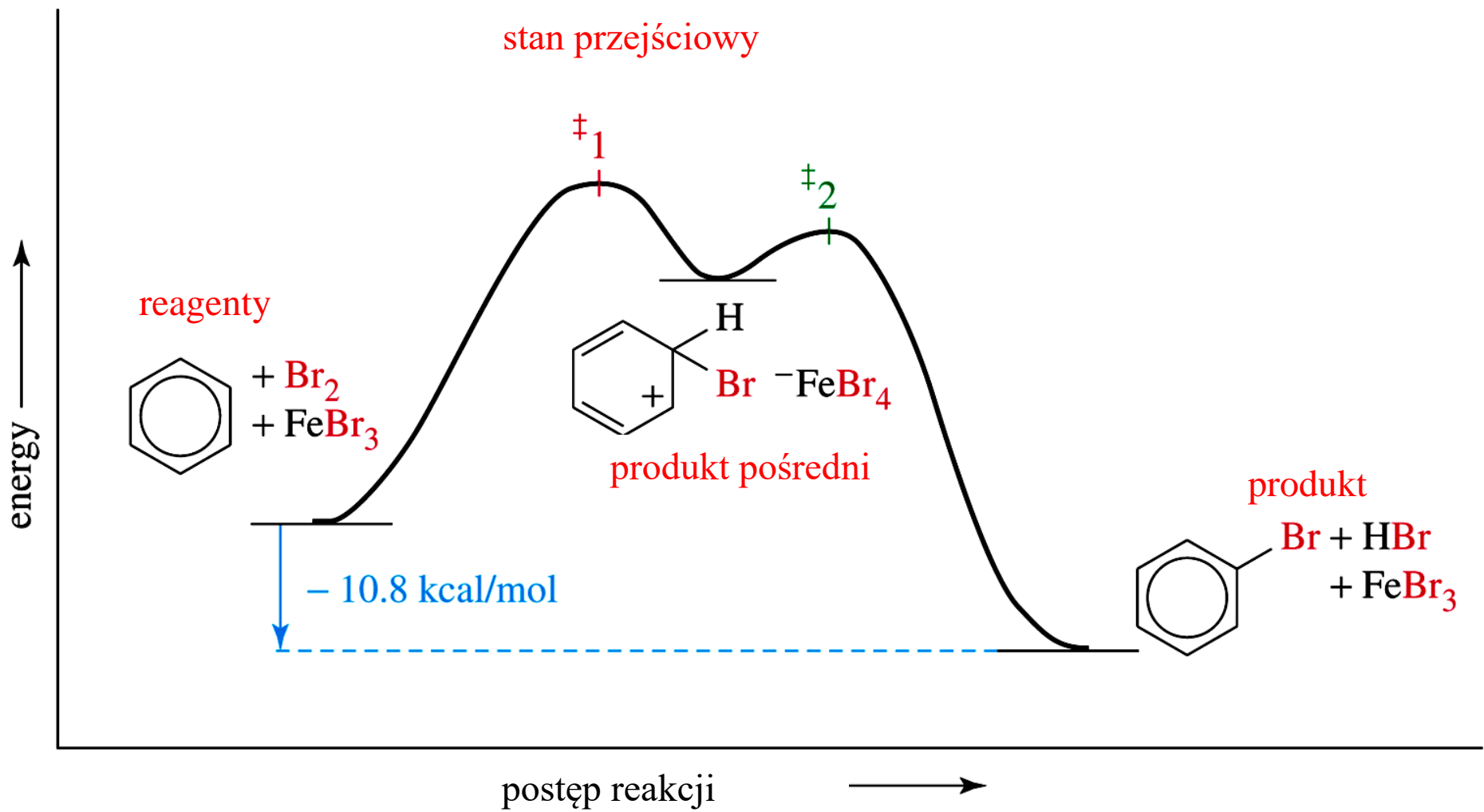


Etap 2. atak elektrofily i utworzenie kompleksu sigma

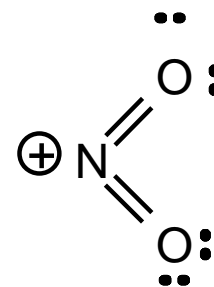
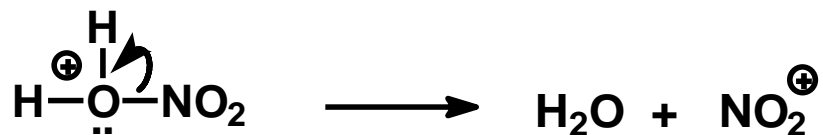
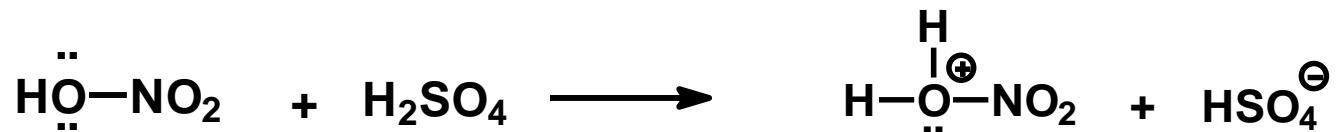


Etap 3. oderwanie protonu i utworzenie produktu podstawienia

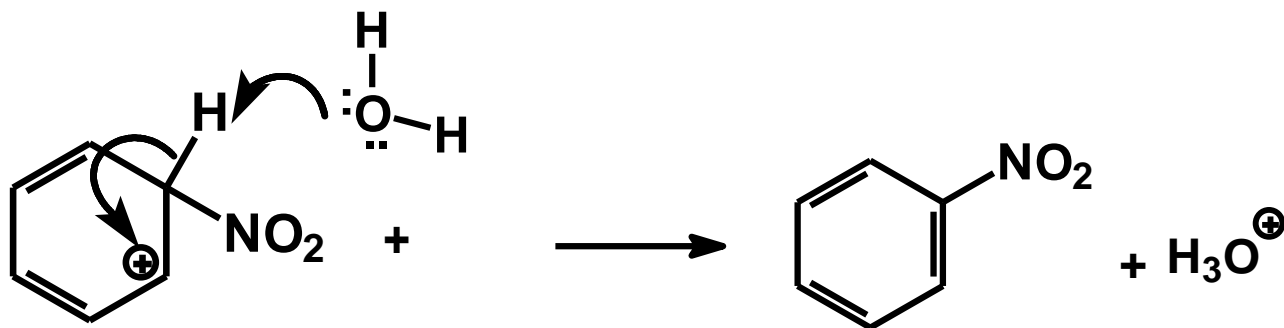
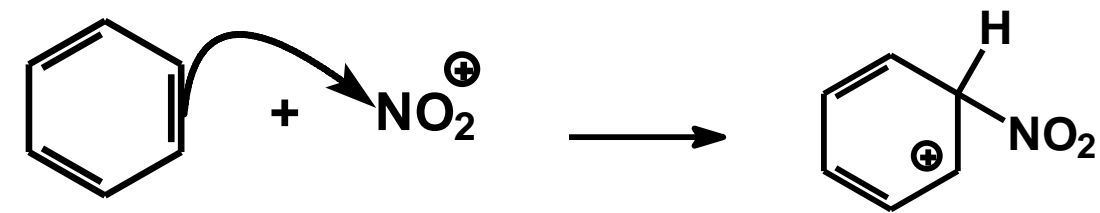




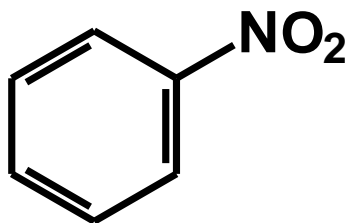
# Nitrowanie



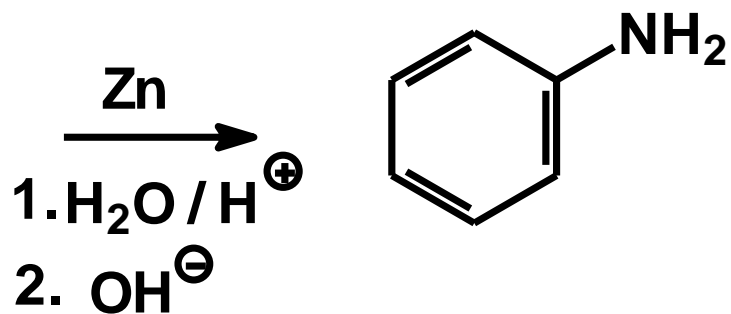
**kation nitroniowy**



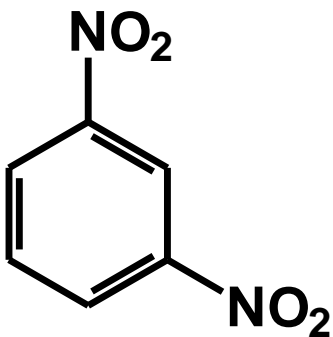
**nitrobenzen**



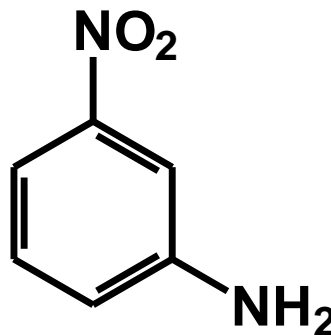
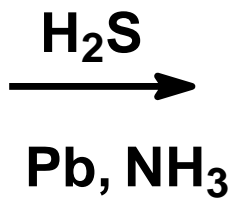
**nitrobenzen**



**anilina**

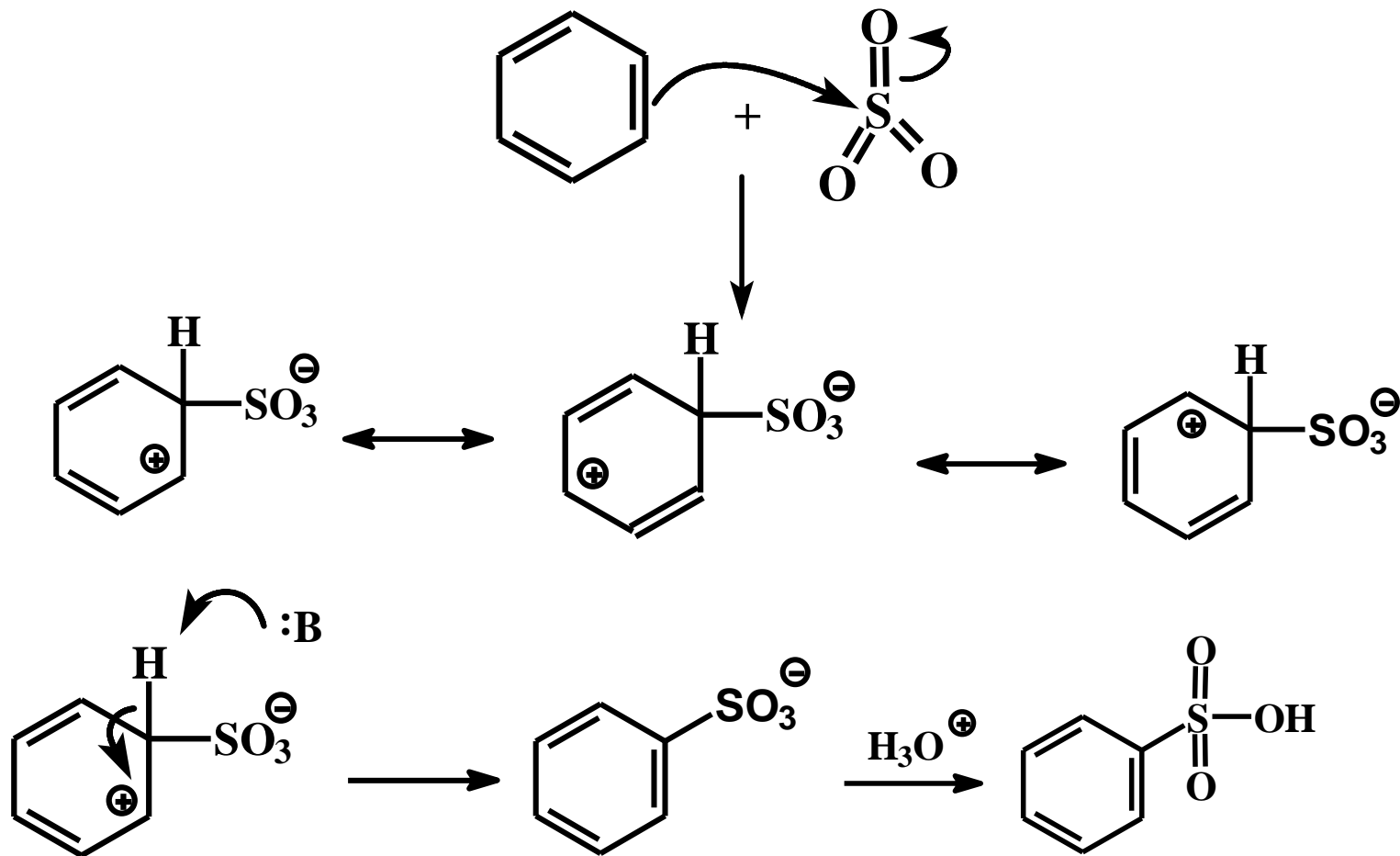


**1,3-dinitrobenzen**

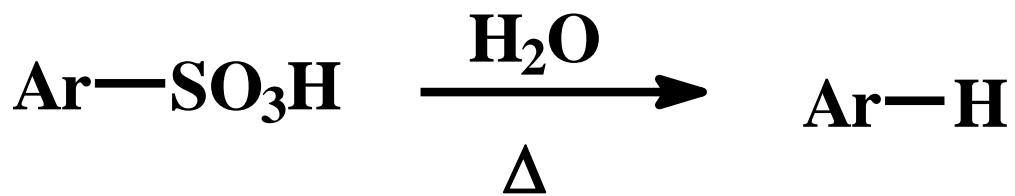
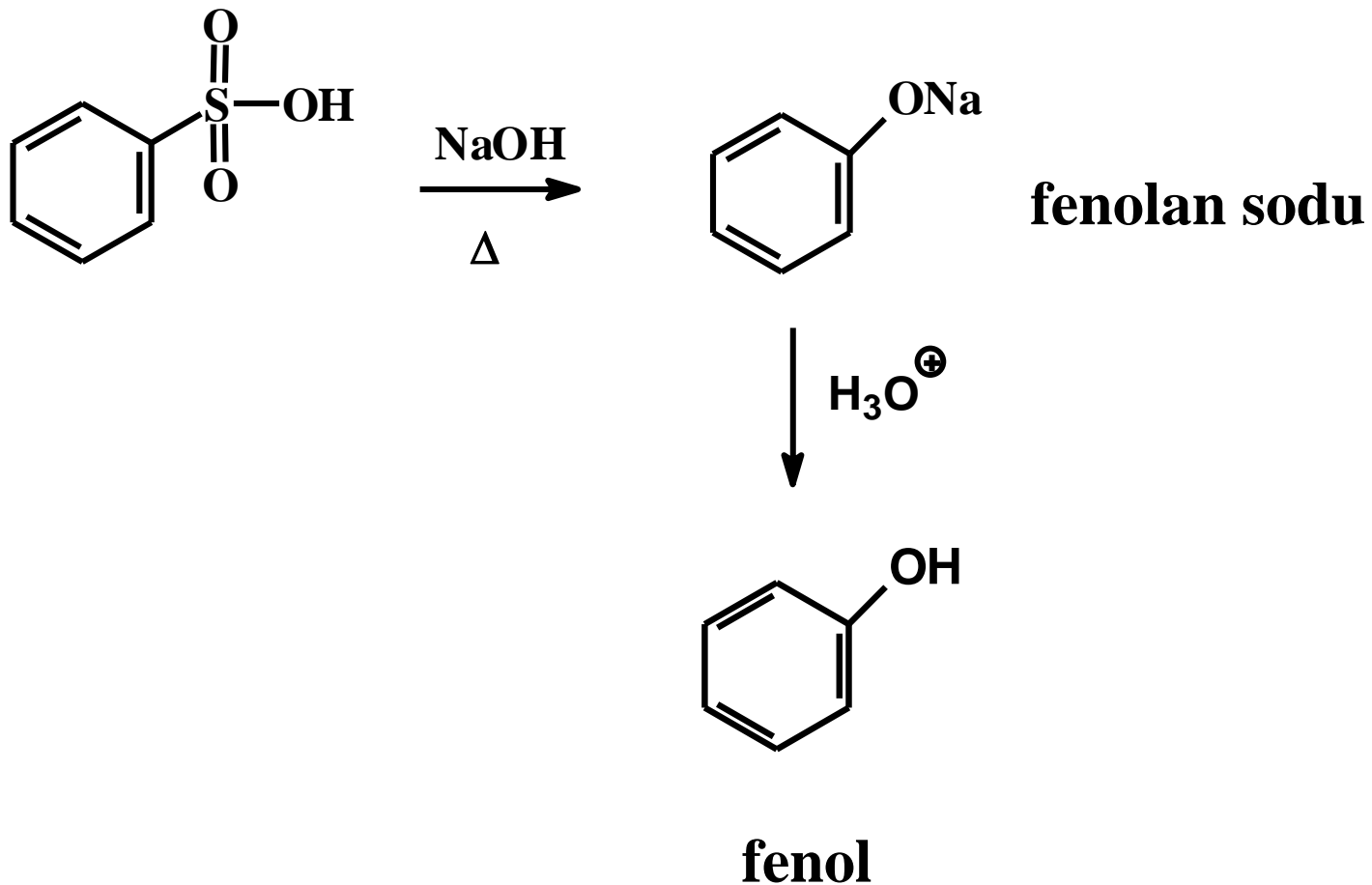


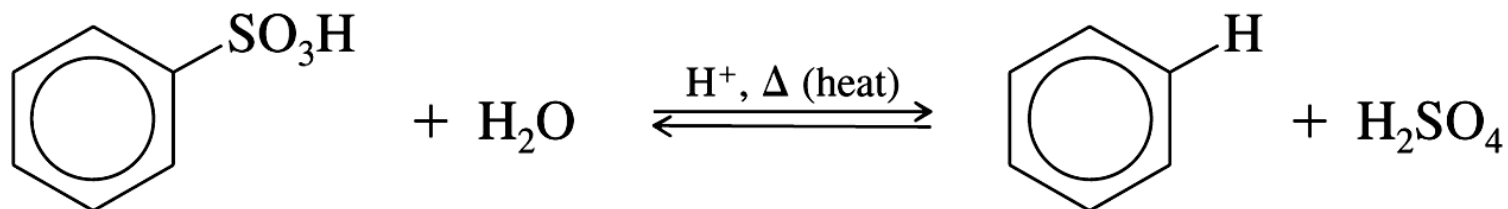
**3-nitroanilina**

# Sulfonowanie



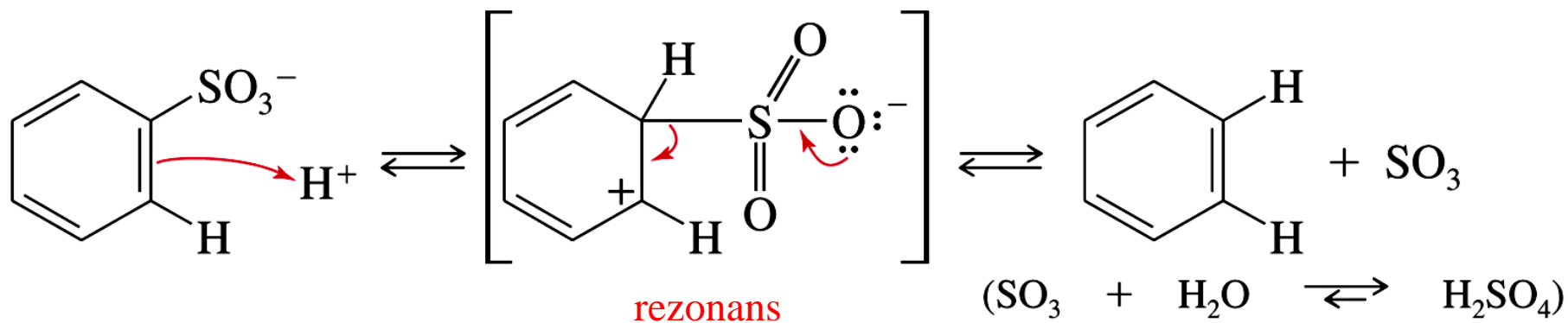
**kwask benzenosulfonowy**





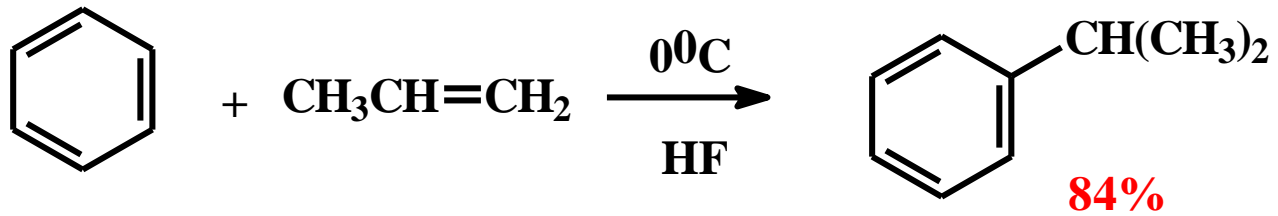
kwasy benzenosulfonowe

benzen

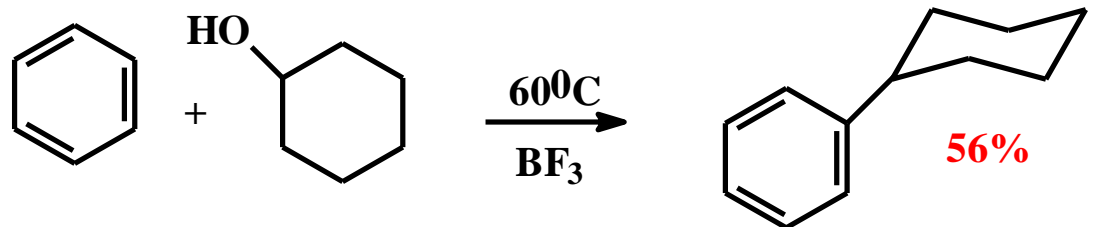
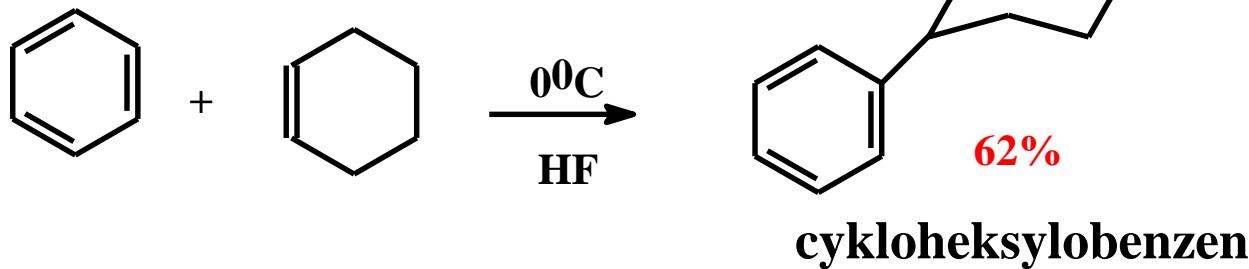


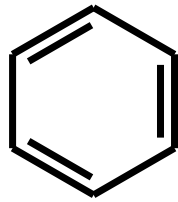
# Reakcje Friedla - Craftsa

## Reakcje alkilowania



izopropylobenzen

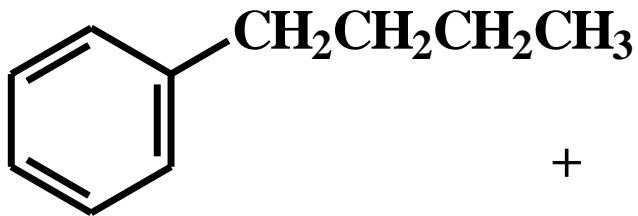




**1-chlorobutan**

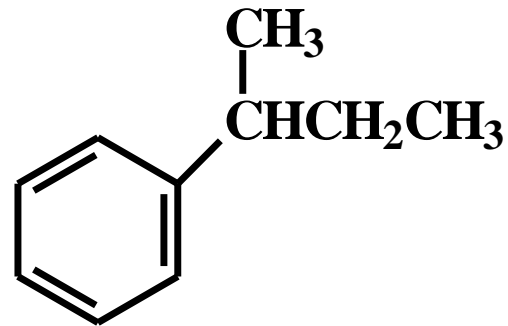


$\text{AlCl}_3$



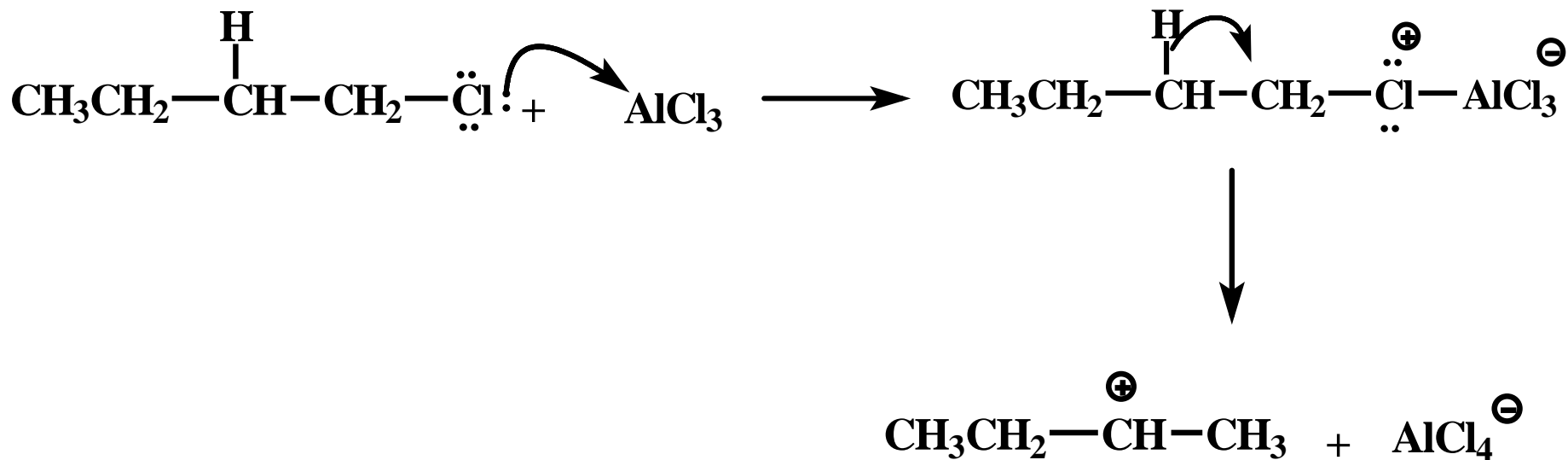
**27%**

***n*-butylobenzen**



**52%**

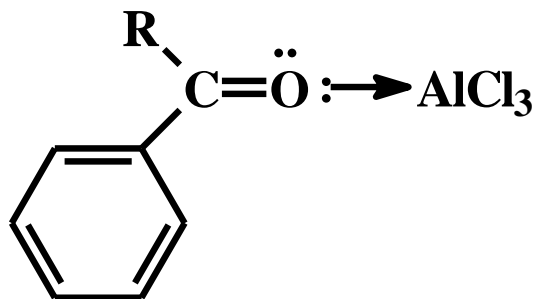
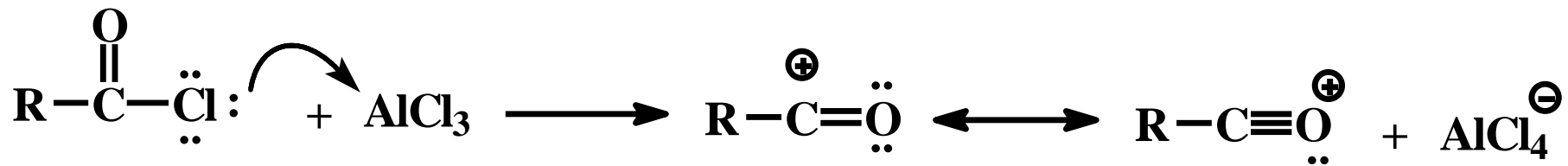
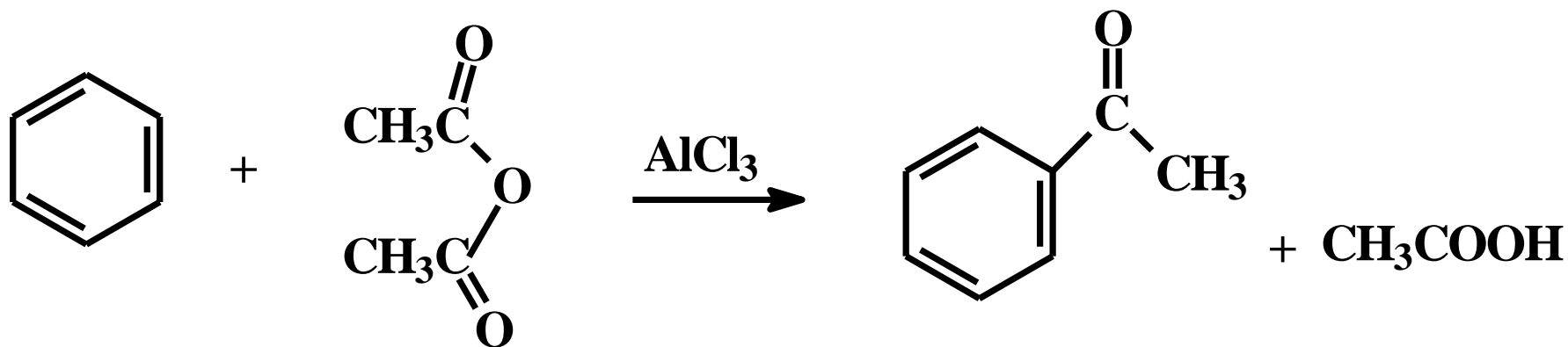
***sec*-butylobenzen**



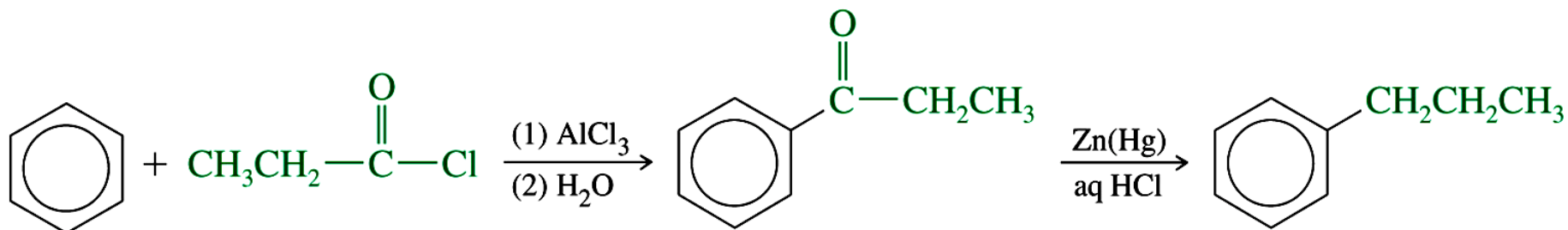
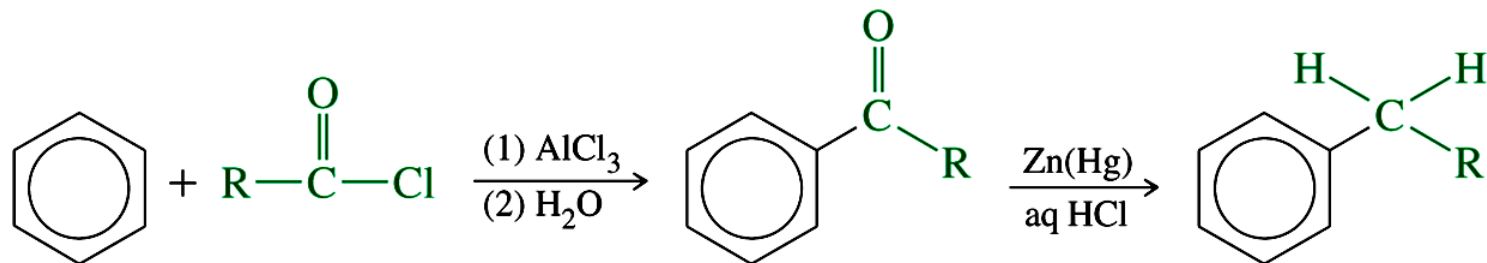
**Uwaga !**

**Reakcji alkilowania Friedla - Craftsa towarzyszy  
przegrupowanie karbokationu;  
tam gdzie to jest możliwe.**

# Reakcje acylowania



# Redukcja Clemmensena

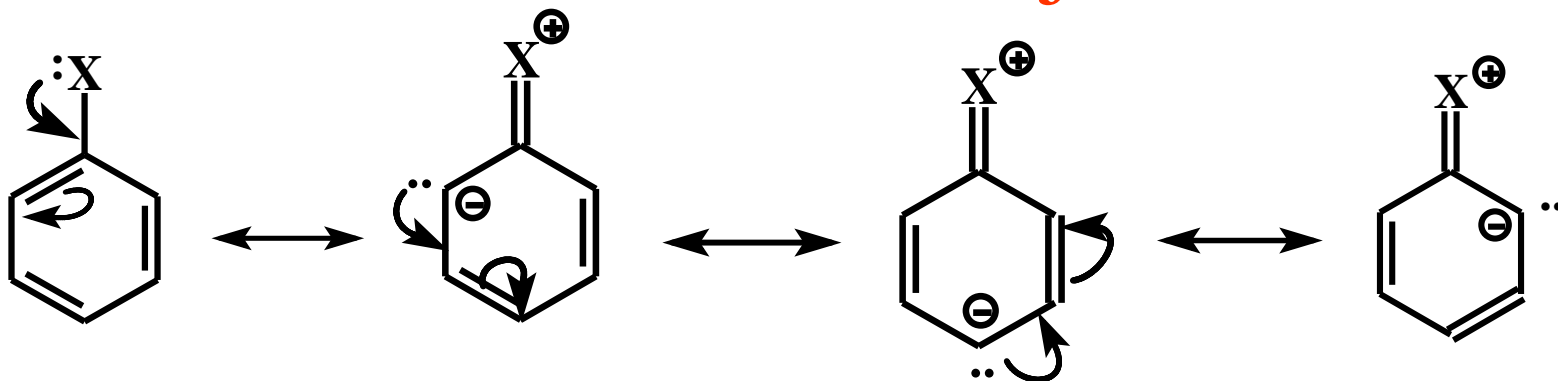


chlorek kwasu  
propionowego

keton fenylo-  
etylowy

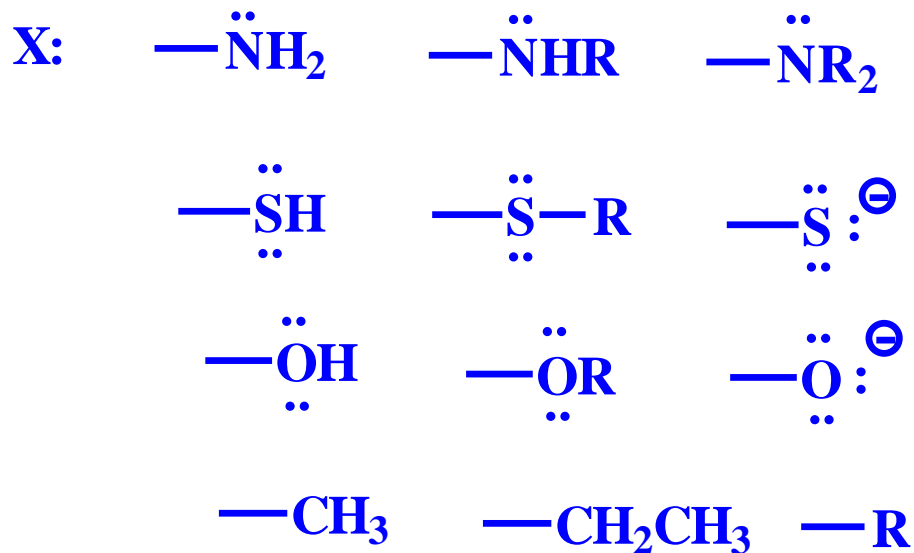
*n*-propylobenzen

# Wpływ podstawnika na reakcję substytucji elektrofilowej

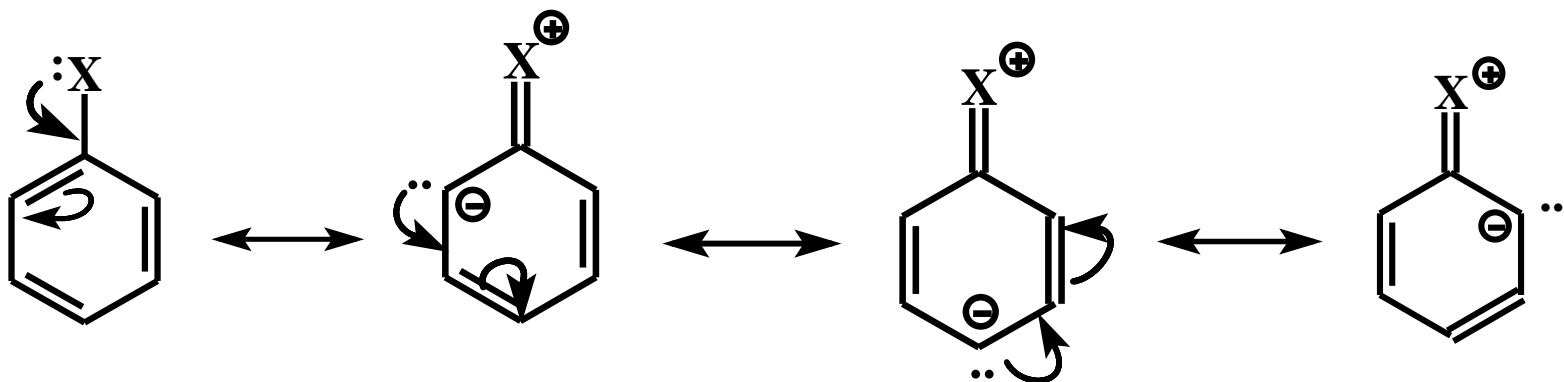


**Efekt +M**

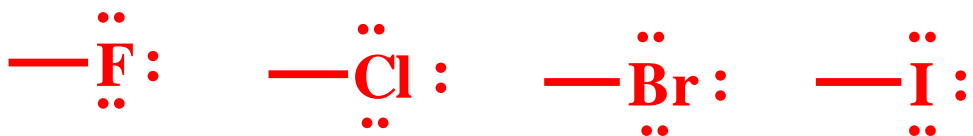
**Podstawniki elektronodonorowe**



**Podstawniki aktywujące  
układ aromatyczny na  
reakcje  $\text{S}_{\text{E}}$**

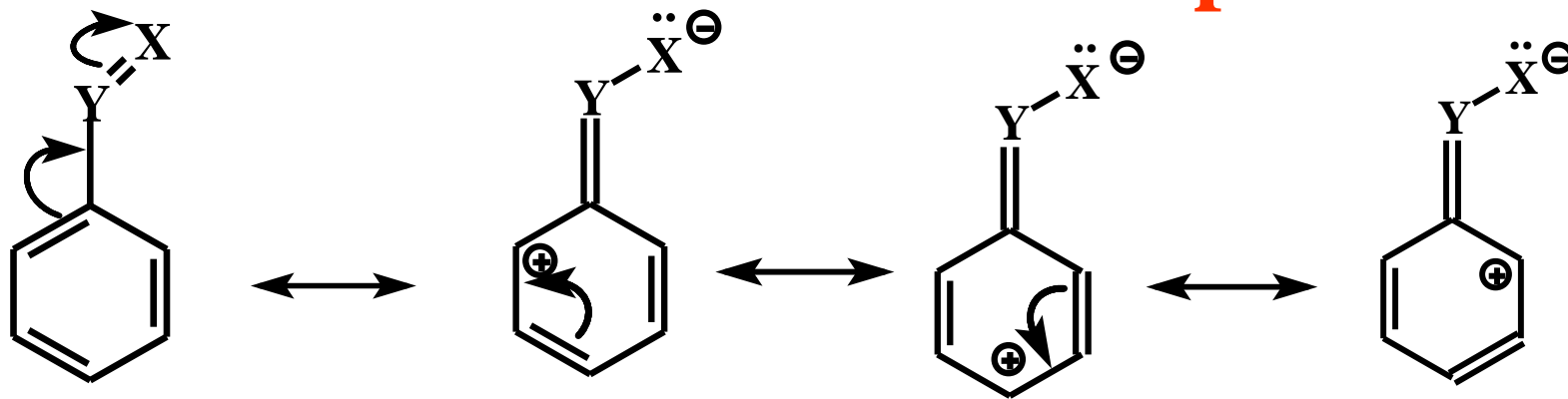


Podstawniki o efekcie +M i -I

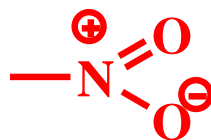
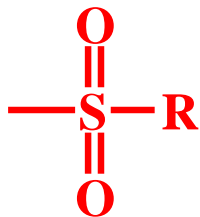
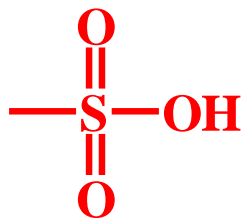
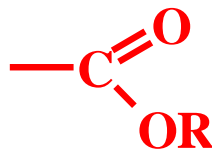
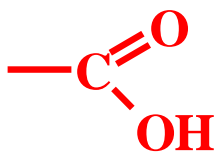
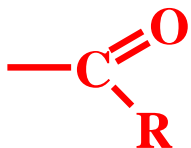
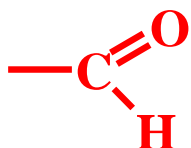


**Fluorowce  
 dezaktywują  
 układ aromatyczny  
 na reakcję  $S_E$**

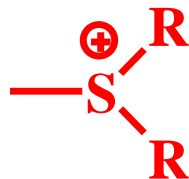
# Podstawniki elektronoakceptorowe



## Podstawniki o efekcie -M

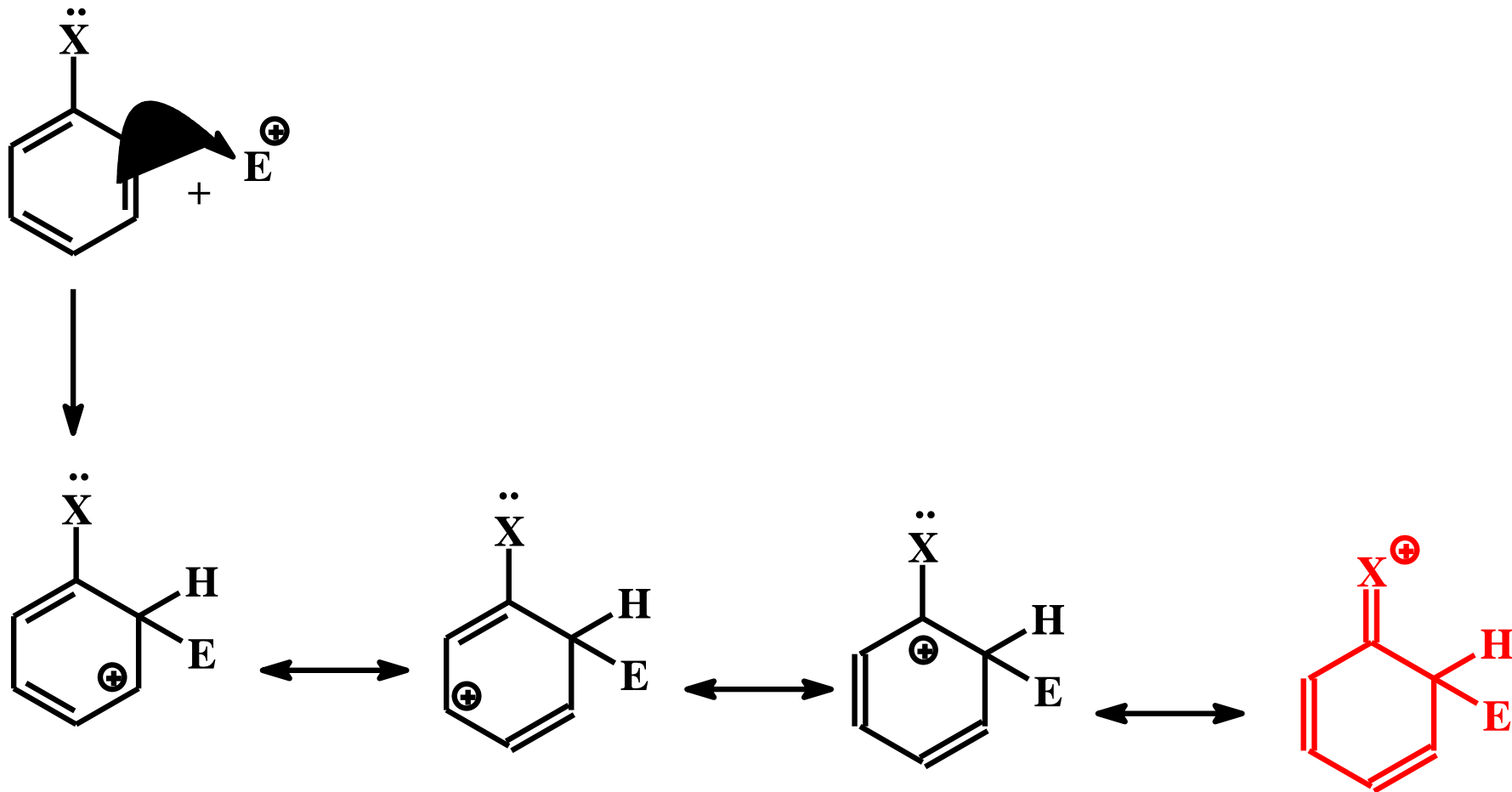


## Podstawniki o efekcie -I

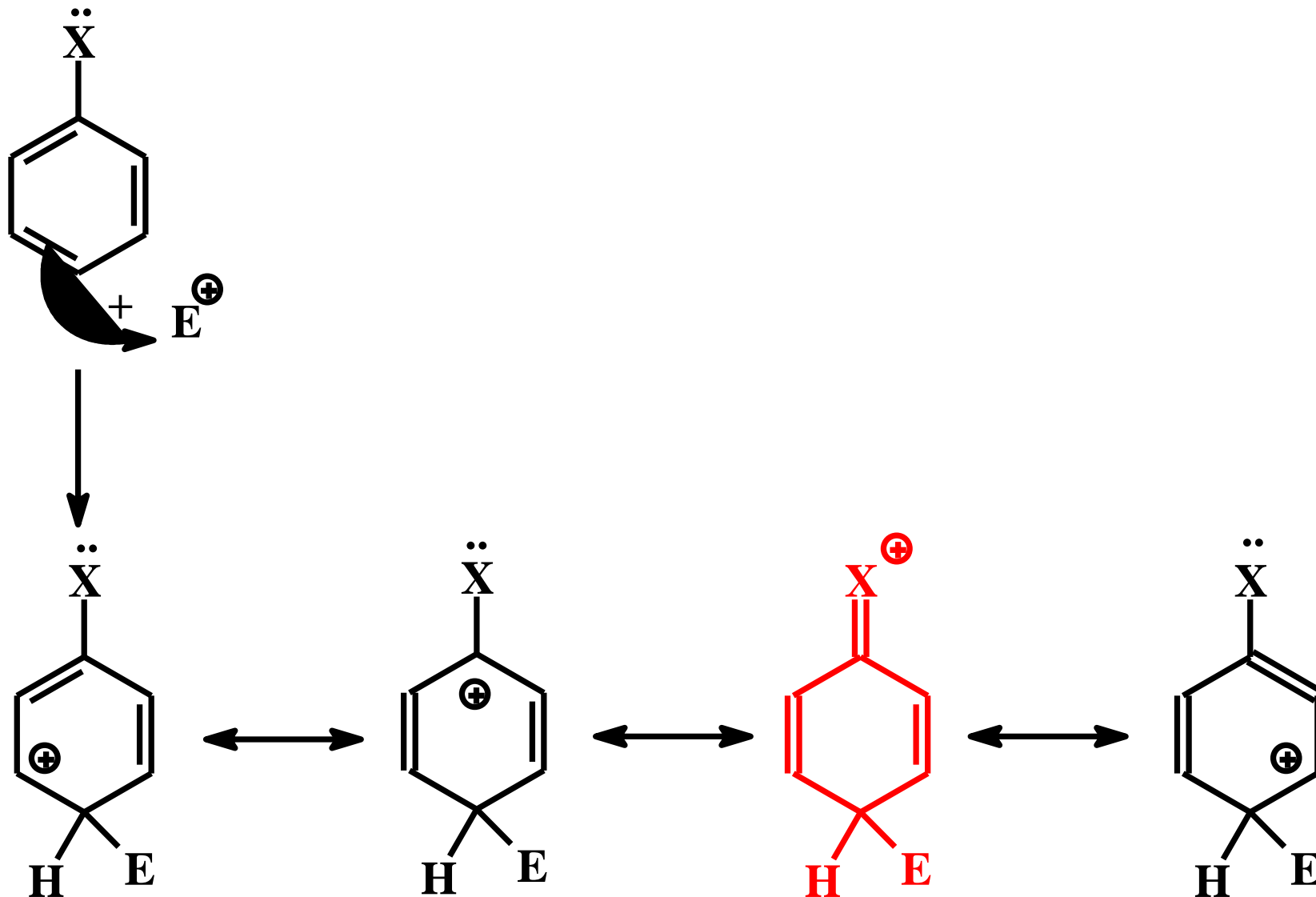


Podstawniki  
dezaktywujące  
układ aromatyczny  
na reakcję  $S_E$

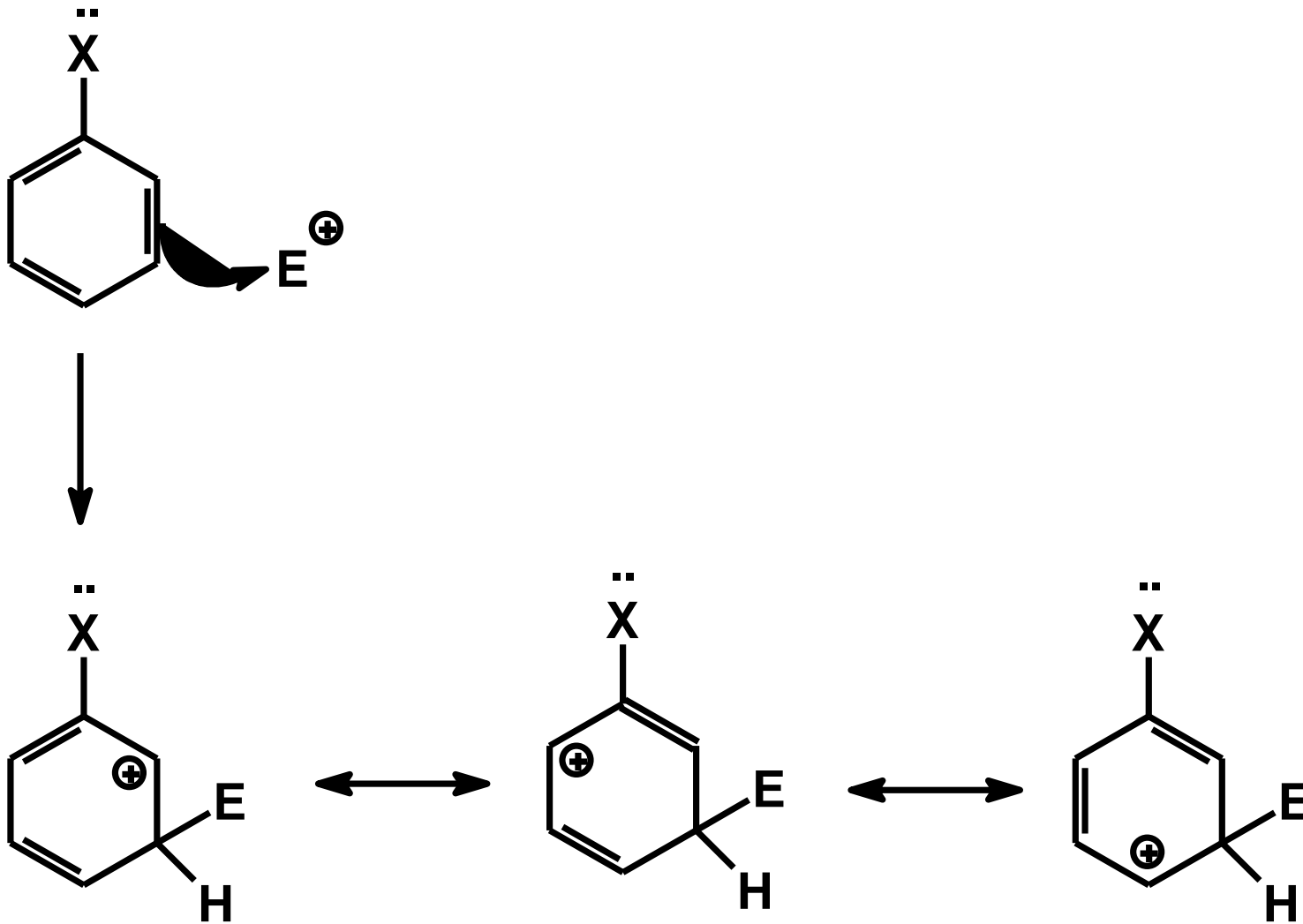
# Atak w pozycji orto



# Atak w pozycji para

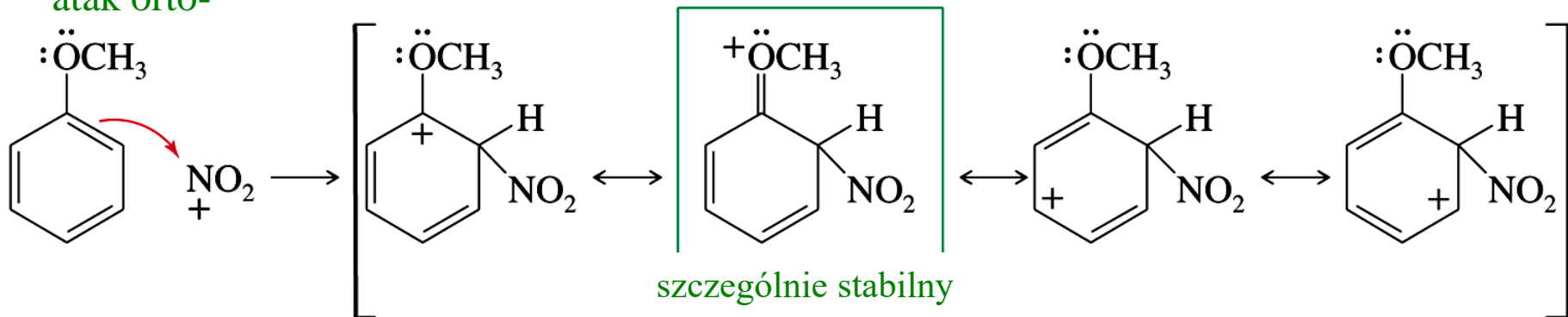


# Atak w pozycji meta

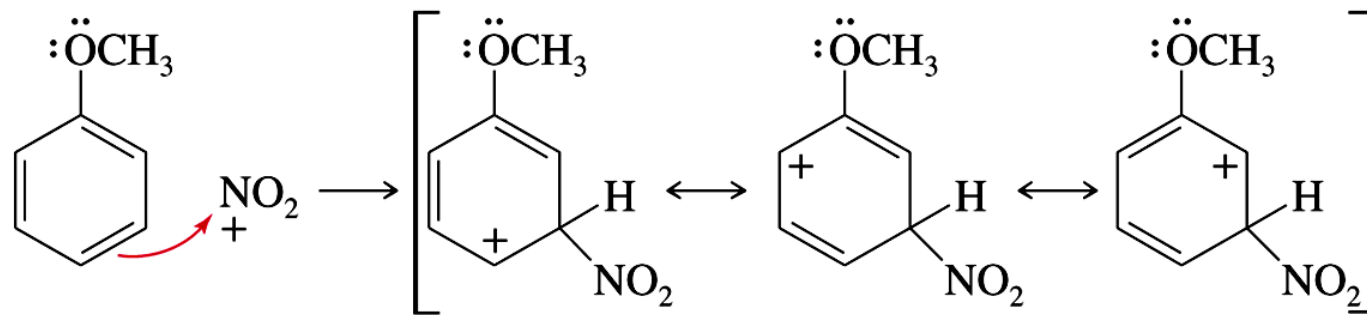


# Orientacja podstawnika w reakcji S<sub>E</sub>

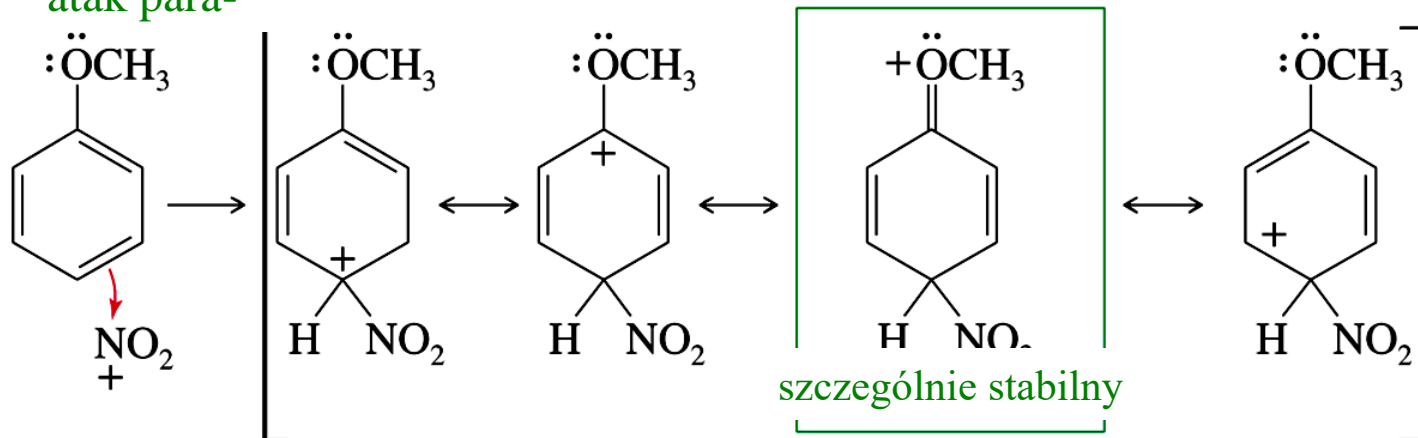
atak orto-

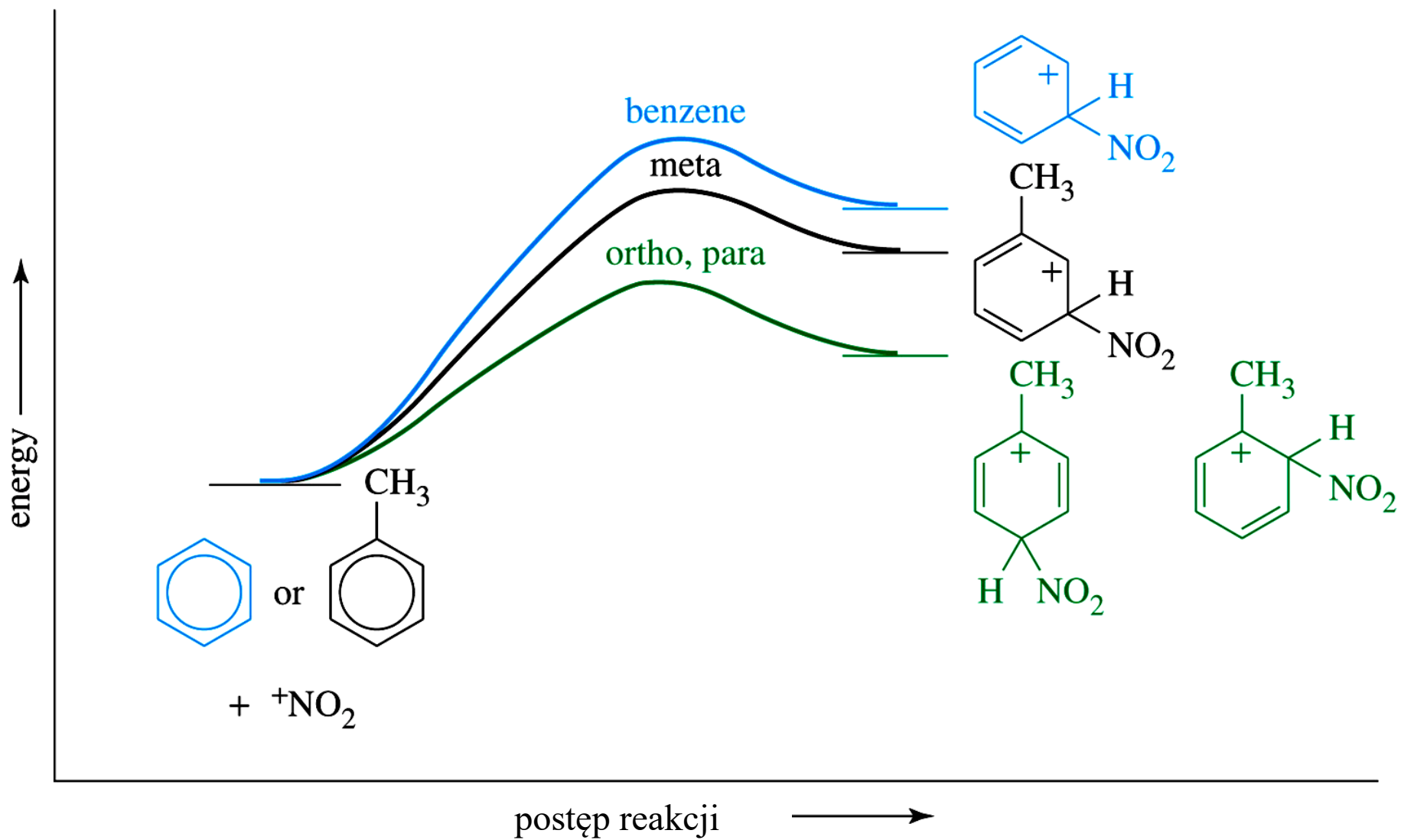


atak meta-



atak para-

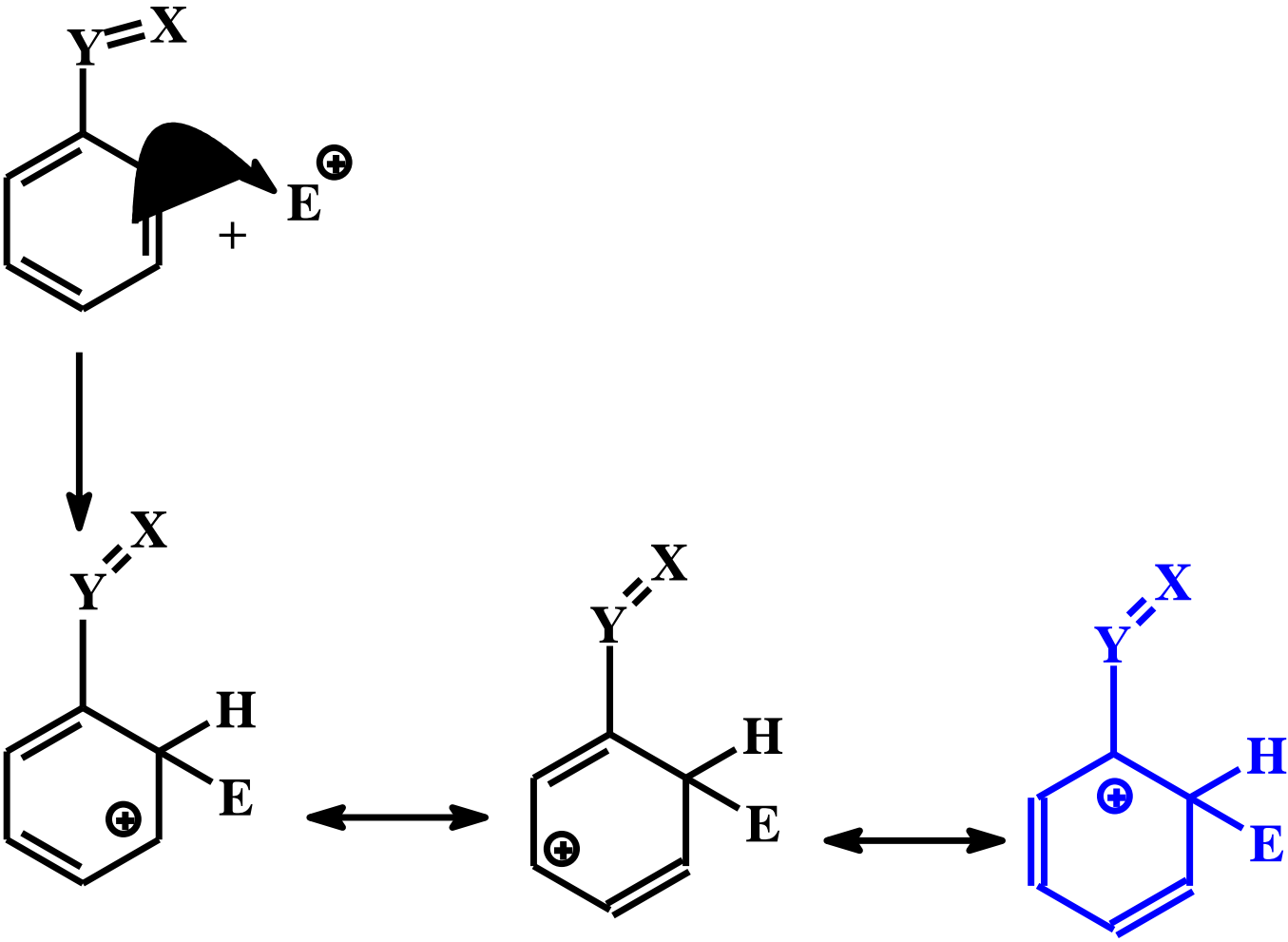




# Wniosek

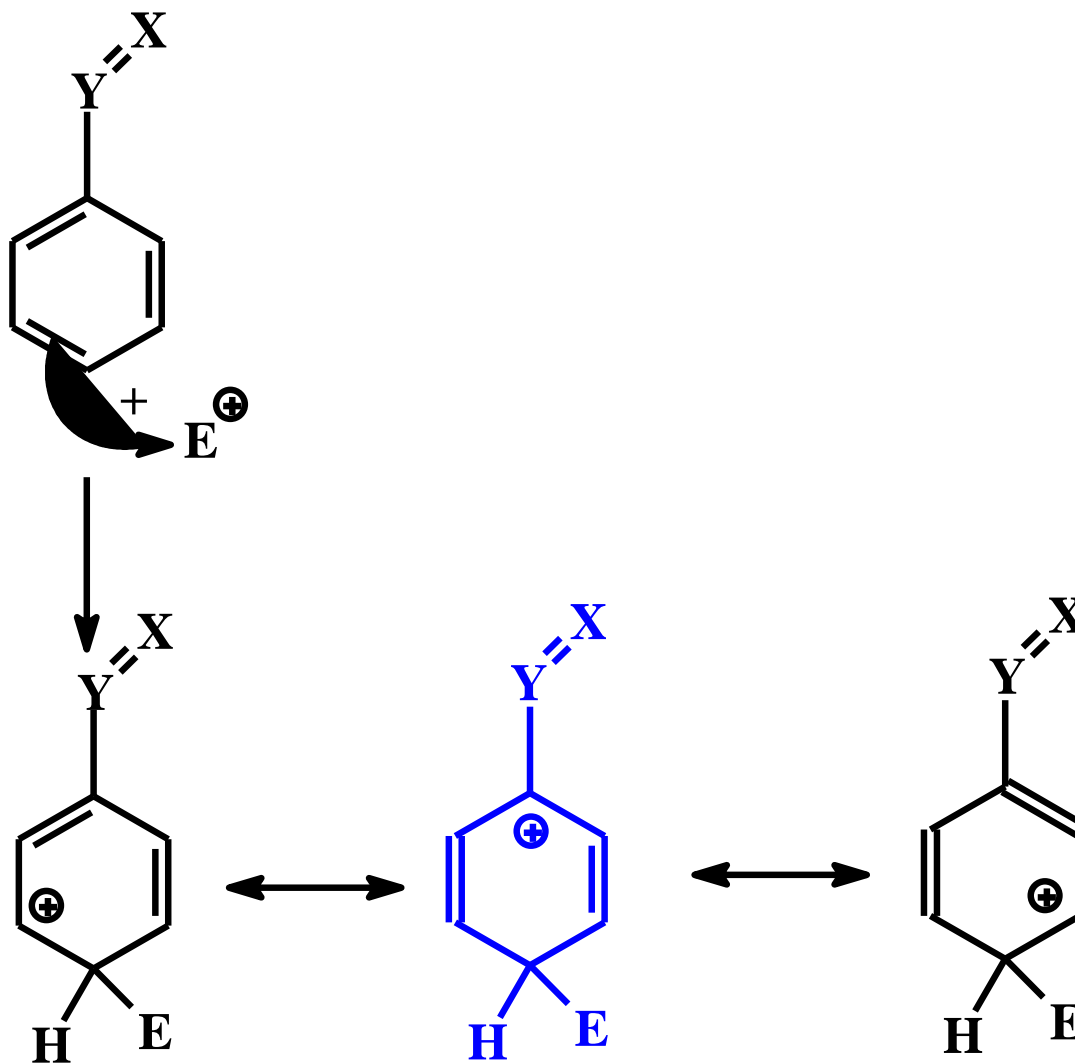
**Podstawniki elektronodonorowe w reakcji  $S_E$  kierują w pozycję orto i para**

# Atak w pozycji orto



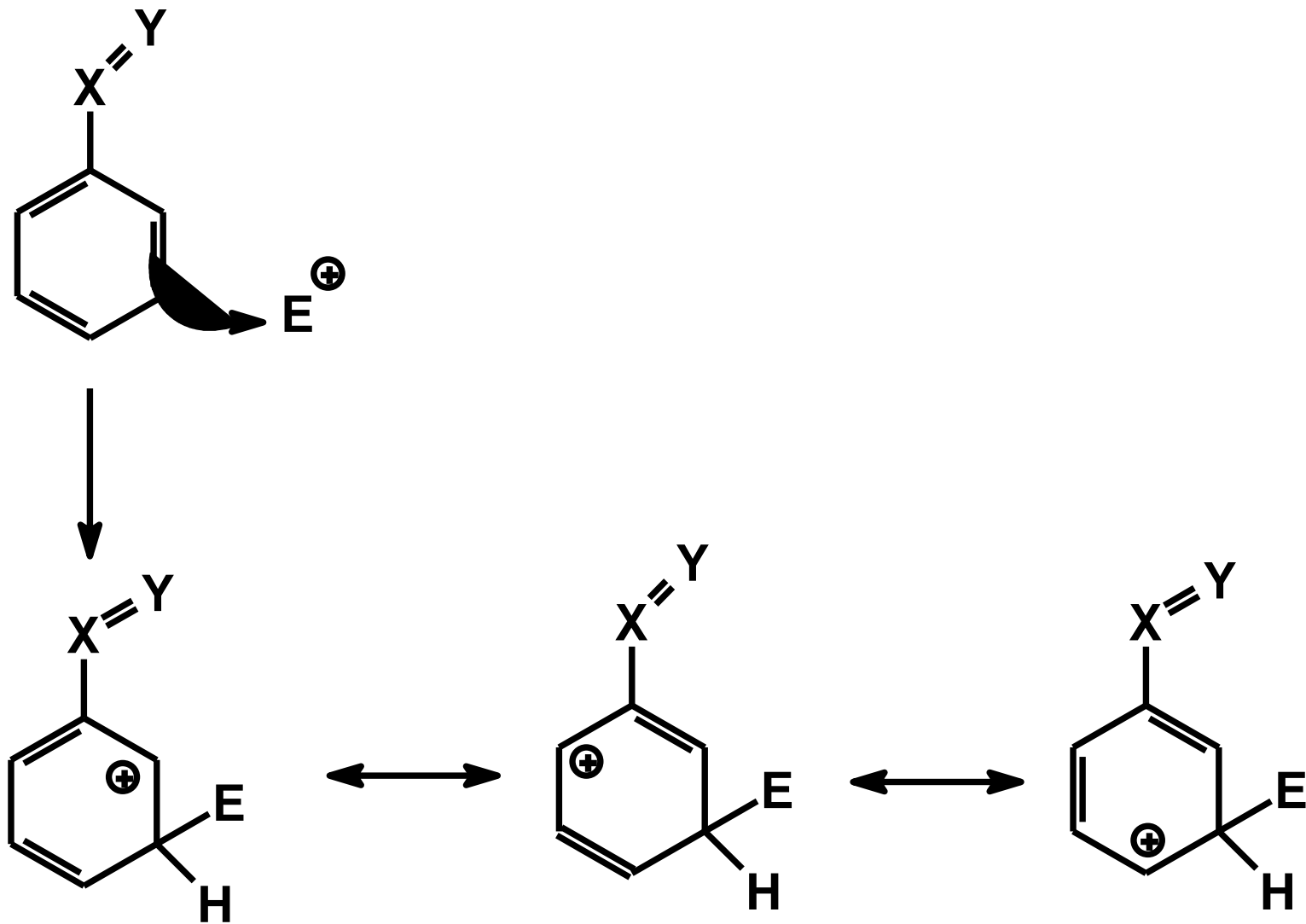
destabilizacja

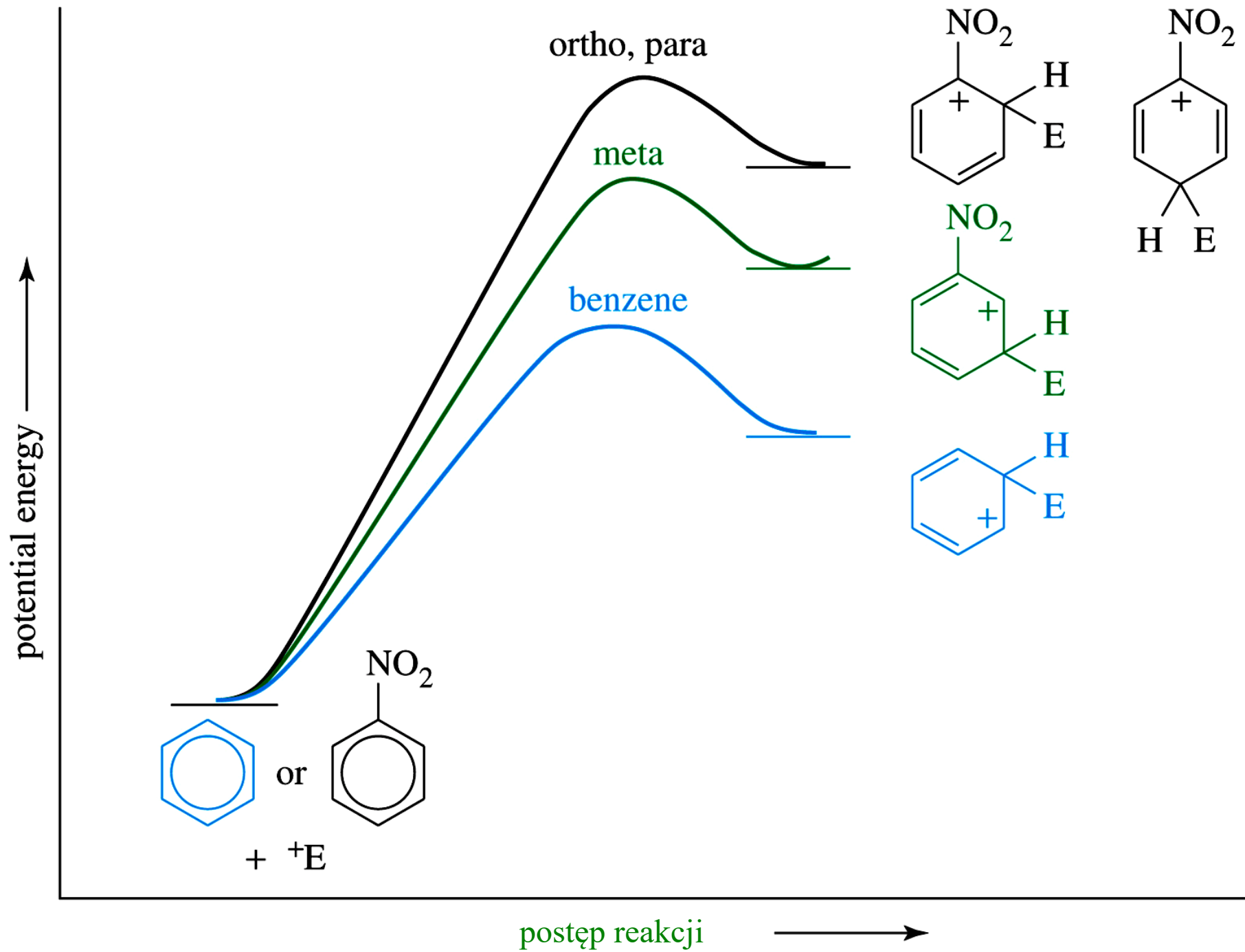
# Atak w pozycji para



destabilizacja

# Atak w pozycji meta

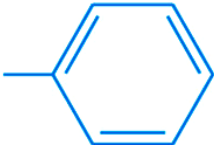




# Wniosek

Podstawniki elektronoakceptorowe dezaktywują pierścień aromatyczny na reakcję  $S_E$  i kierują w pozycje meta

# Podsumowanie

$\pi$ -donorowe	$\sigma$ -donorowe	halogenki	karbonylowe	inne
$-\ddot{\text{N}}\text{H}_2$ $-\ddot{\text{O}}\text{H}$ $-\ddot{\text{O}}\text{R}$ $-\ddot{\text{N}}\text{HCOCH}_3$	$-\text{R}$ (alkyl)  (aryl)	$-\text{F}$ $-\text{Cl}$ $-\text{Br}$ $-\text{I}$	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{R} \end{array}$ $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{OH} \end{array}$ $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{OR} \end{array}$	$-\text{SO}_3\text{H}$ $-\text{C}\equiv\text{N}$ $-\text{NO}_2$ $-\overset{+}{\text{N}}\text{R}_3$

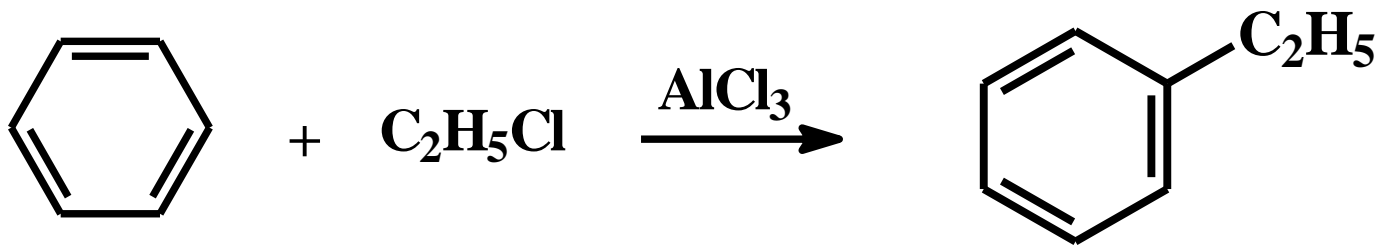
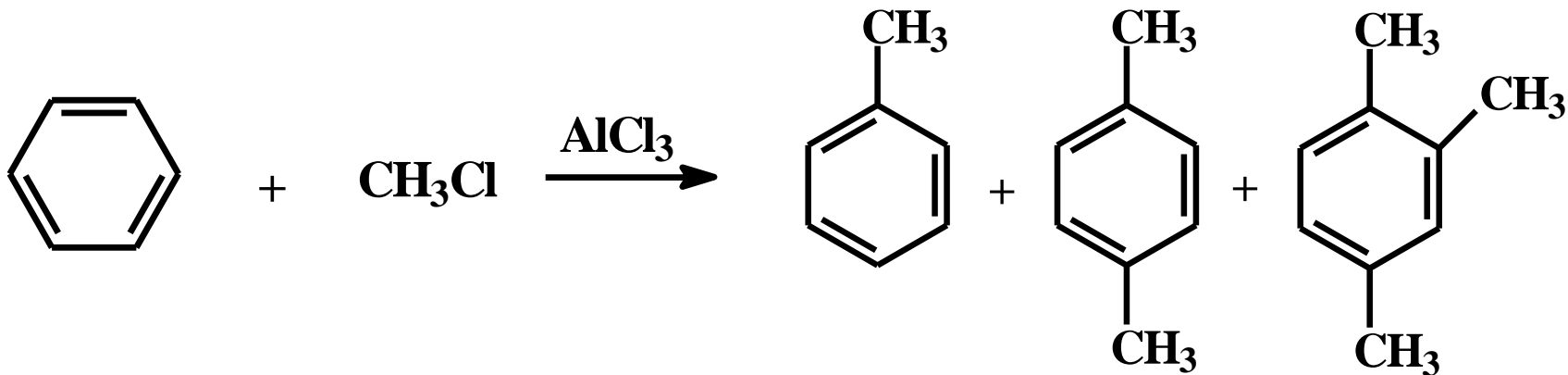
kierują w orto i para

kierują w meta

AKTYWUJĄCE

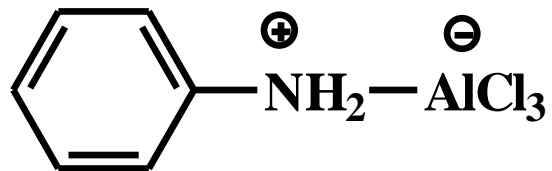
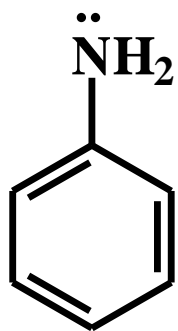
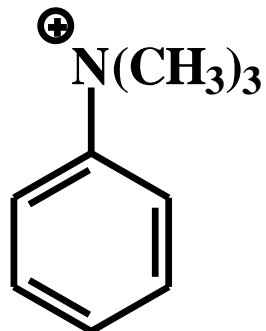
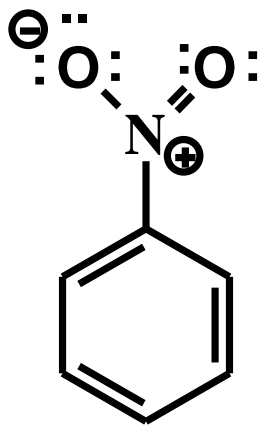
DEZAKTYWUJĄCE

# Syntetyczne ograniczenia reakcji S<sub>E</sub>

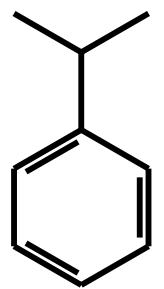
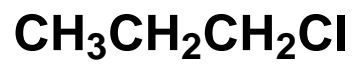
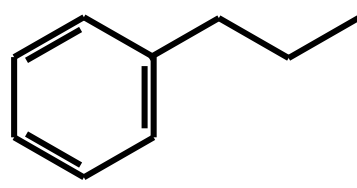
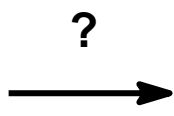
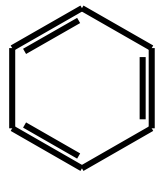


15 x nadmiar

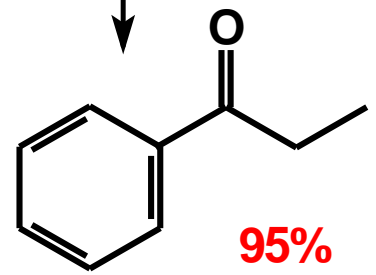
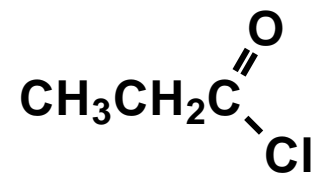
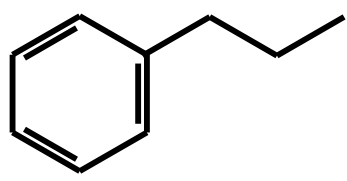
85%



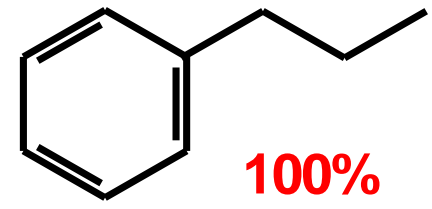
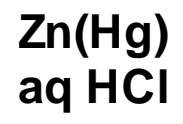
**Nie ulegają alkilowaniu metodą Friedla-Craftsa**  
**Zbyt duża dezaktywacja**



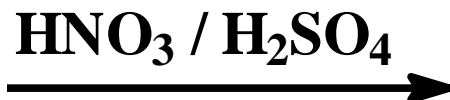
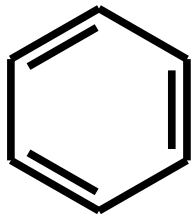
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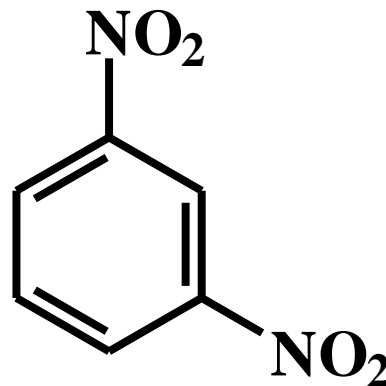
95%



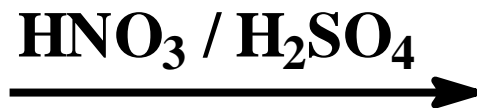
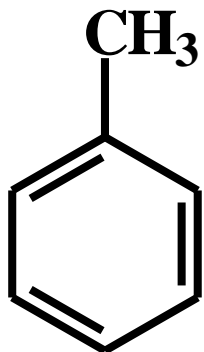
100%



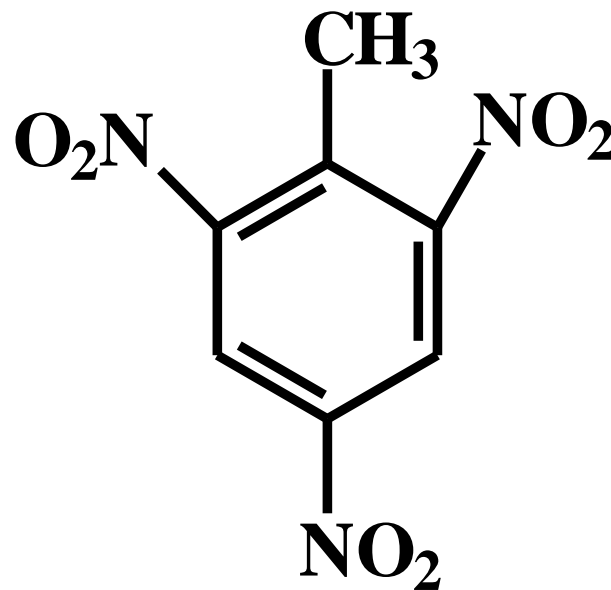
nadmiar



meta-dinitrobenzen



nadmiar



2,4,6-trinitrotoluen