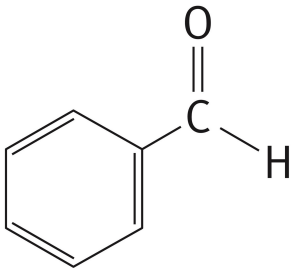


تسعة فاطمة لانه طري المربا، اعطت الهمافسان  
Chapter 4: Aromatic Compounds

وهي من التوابل الحارة الحارة الحارة الحارة  
الحارة الحارة



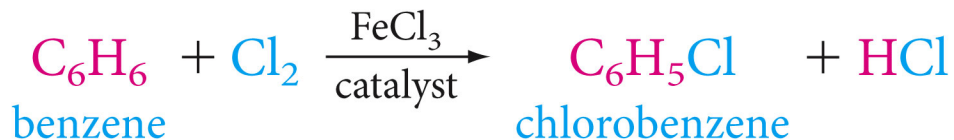
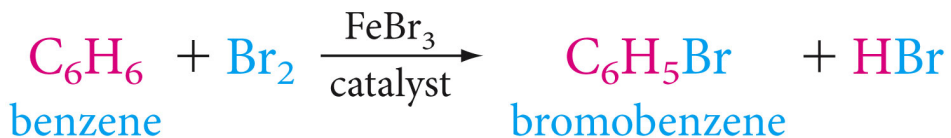
benzaldehyde

Bitter almonds are the source of the aromatic compound benzaldehyde



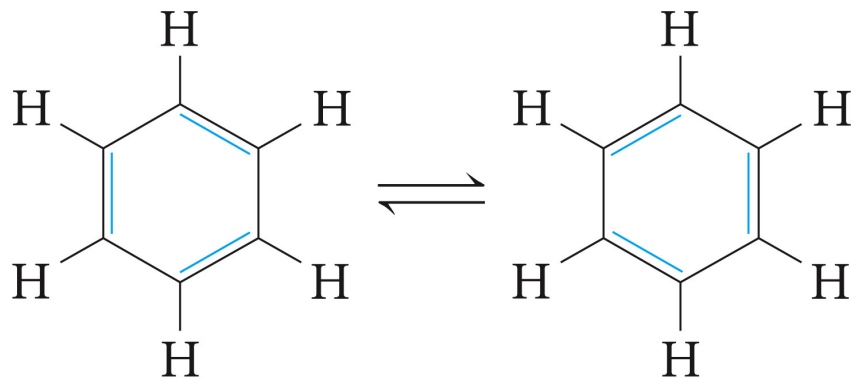
# Some Facts About Benzene

Reacts mainly by substitution

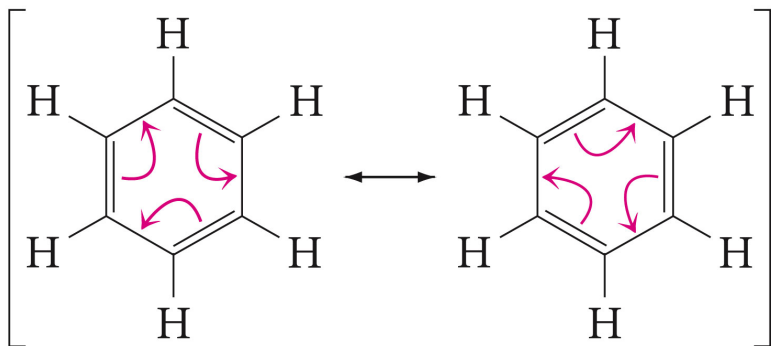




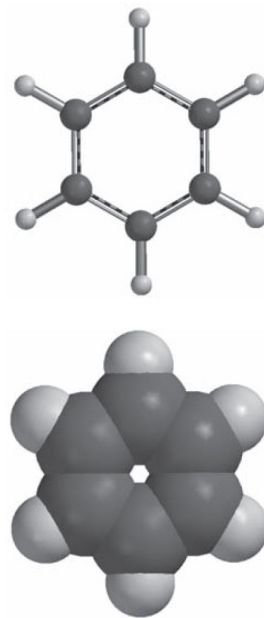
Friedrich August Kekulé



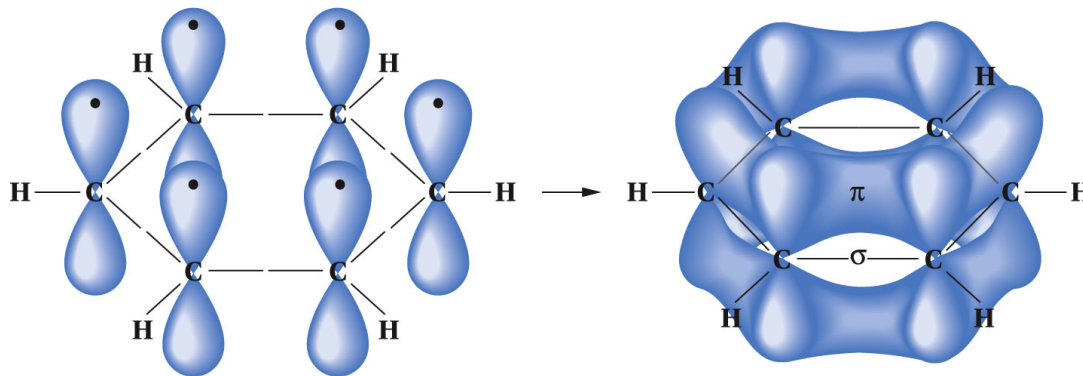
the Kekulé structures for benzene



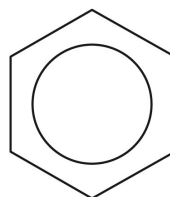
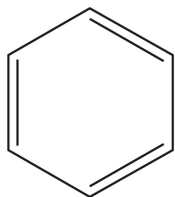
Benzene is a resonance hybrid of these two contributing structures.



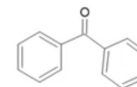
# The Orbital Model for Benzene



## Symbols for Benzene



Key  
C  
H  
N  
O  
F  
Na  
S  
P  
S  
Cl  
Br



Benzophenone



benzenesulfonic acid

*Handwritten signature*

Kekulé *derivative* delocalized pi cloud

اذا كان في مجموعة واحدة مع حلقة البنزين ليصبح mono substituted benzene  
 اذا كانت مجموعتين او ثلاثة في حلقة البنزين فيكون di substituted benzene او tri substituted benzene

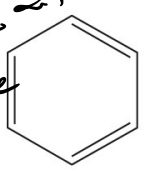
# Nomenclature of Aromatic Compounds

mono substituted benzene derivative  
 حلقة بنزين عليها مجموعة واحدة

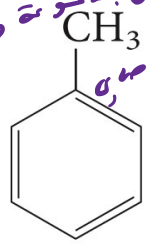
## Monosubstituted benzenes with common names

بما حالة انه  
 تركب في المجموعة  
 في الكماله الخاصه  
 اصبه فيكون اسمها  
 Common name  
 المعروفه  
 مثل البنزين  
 صان الالكه  
 ولازم خطهم

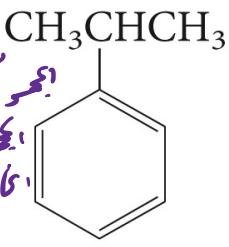
بعضها ترتبط بمجموعة اخرى  
 رتبه صاف  
 المجموعه فيها  
 المجموعات  
 الاكبر



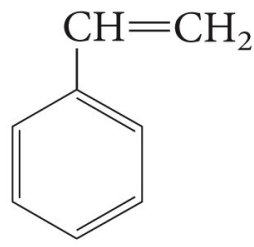
benzene



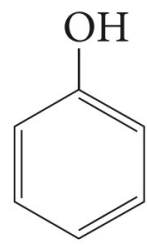
toluene



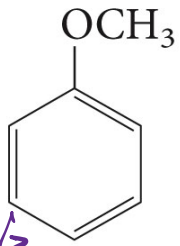
cumene



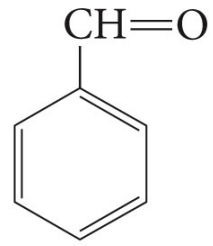
styrene



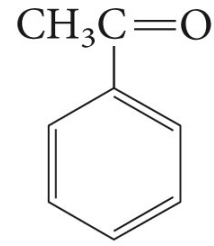
phenol



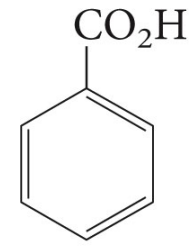
anisole



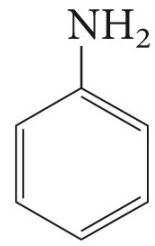
benzaldehyde



acetophenone



benzoic acid



aniline

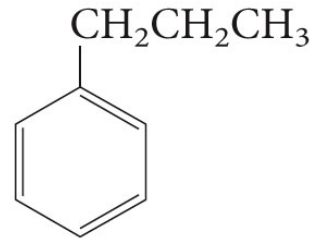
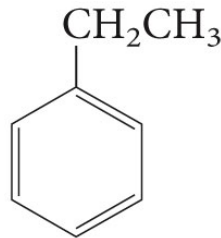
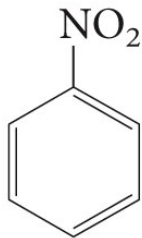
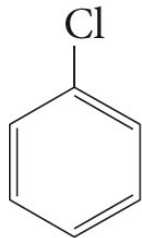
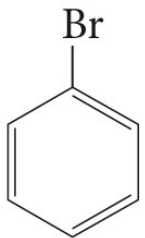
بما كان  
 زياده فيبنون

هؤلاء المركبات معروفه بالاسم المعروف في الكماله

سج الاوليا

هناك 5 بنزين غير شائعة

# Monosubstituted benzenes that do not have common names



bromobenzene

chlorobenzene

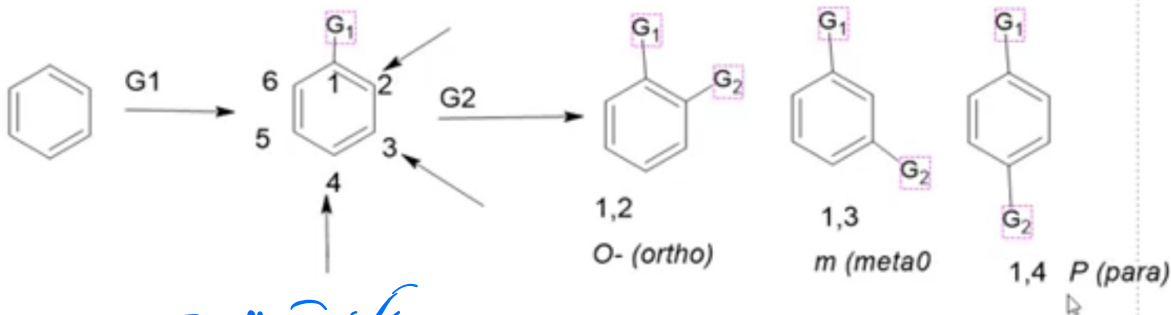
nitrobenzene

ethylbenzene

n-propylbenzene

بعض البنزين غير شائعة  
بعض البنزين غير شائعة

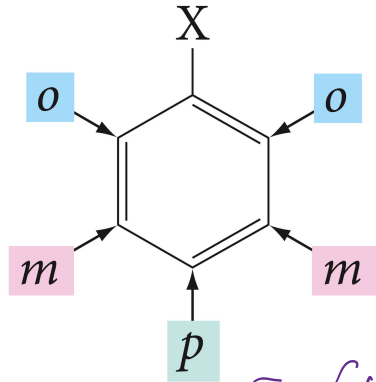
root name



بعض البنزين غير شائعة

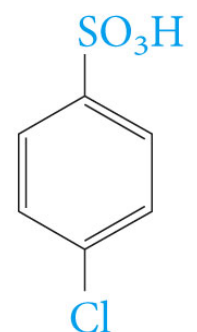
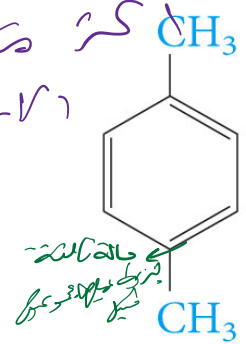
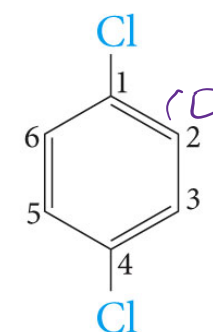
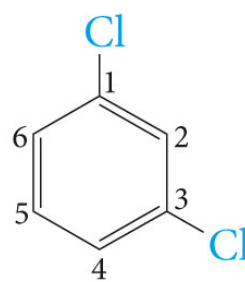
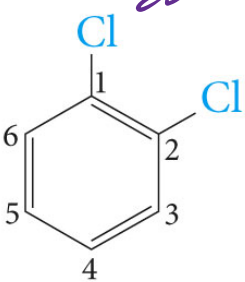
three isomers

When two substituents are present, we use prefixes *ortho-*, *meta-*, and *para-*, usually abbreviated as *o-*, *m-*, and *p-*, respectively.



ایکھو عیسے حشر  
مہ اناک کھائی صند

الاحرف تان لکھو  
کتر مہ



*ortho*-dichloro-  
benzene

*meta*-dichloro-  
benzene

*para*-dichloro-  
benzene

*para*-xylene<sup>\*\*</sup>  
Common name

*para*-chlorobenzenesulfonic  
acid

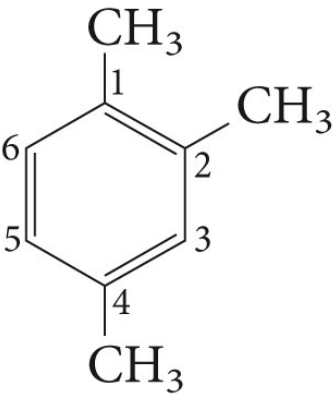
۱- بڈ کر اکم، کچھو عیسے ربر ائی لکھریسے  
الاعجدی ادا کا نو، مختلف



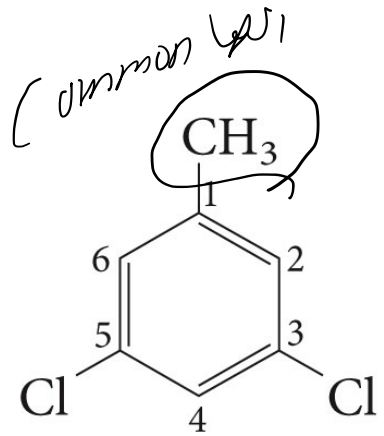


التركيبات المتعددة المستبدات

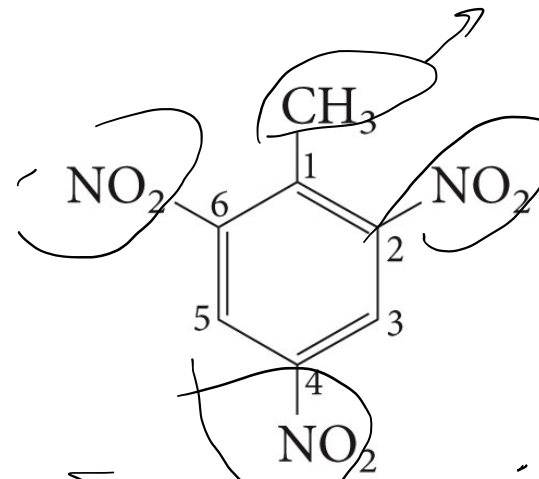
For more than two substituents, their positions are designated by numbering the ring.



1,2,4-trimethylbenzene

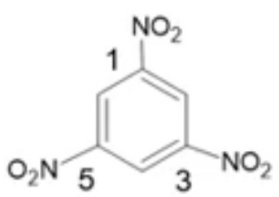


3,5-dichlorotoluene

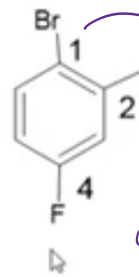


2,4,6-trinitrotoluene (TNT)

poly substituted compound



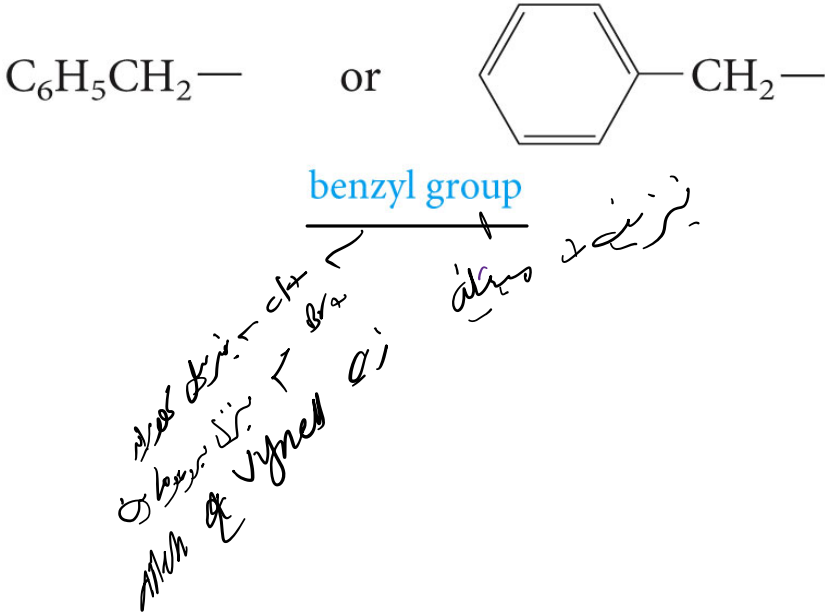
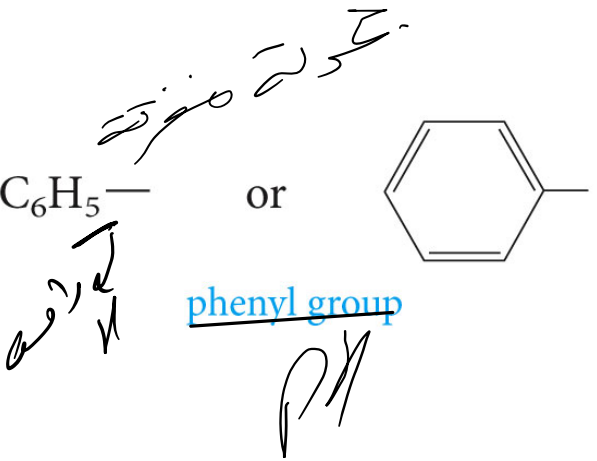
1,3,5-trinitrobenzene



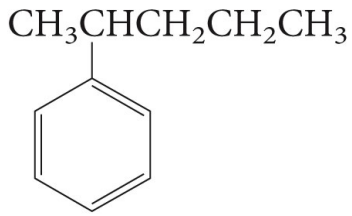
1-bromo-2-chloro-4-fluorobenzene

ph

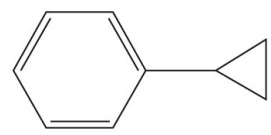
Aromatic hydrocarbons, as a class called Arenes (Ar) the aryl groups are therefore aromatic substituents.



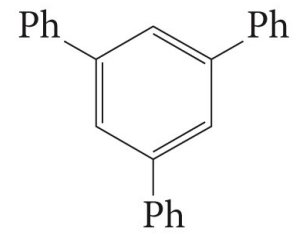
The symbol Ph is sometimes used as an abbreviation for phenyl group



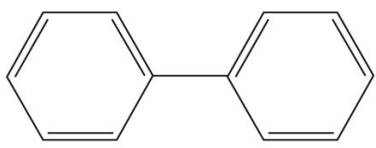
بنزينه مرتبه 2  
2-phenylpentane  
(or 2-pentylbenzene)



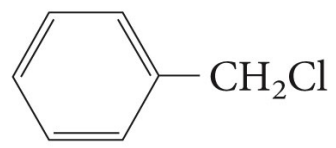
phenylcyclopropane  
(or cyclopropylbenzene)



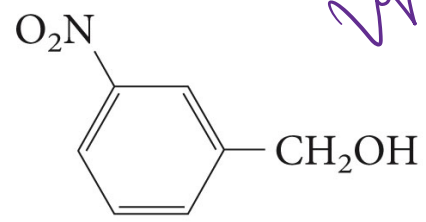
1,3,5-triphenylbenzene



biphenyl



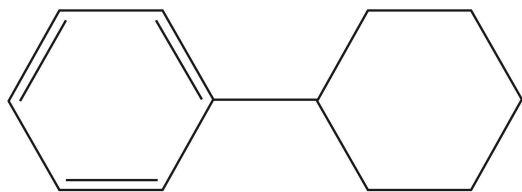
benzyl chloride



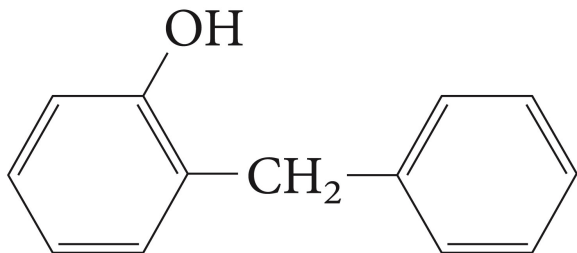
m-nitrobenzyl alcohol

بنزينه مرتبه 3  
بنزينه مرتبه 2  
بنزينه مرتبه 1

Name the following structures



cyclohexylbenzene  
phenyl cyclohexane



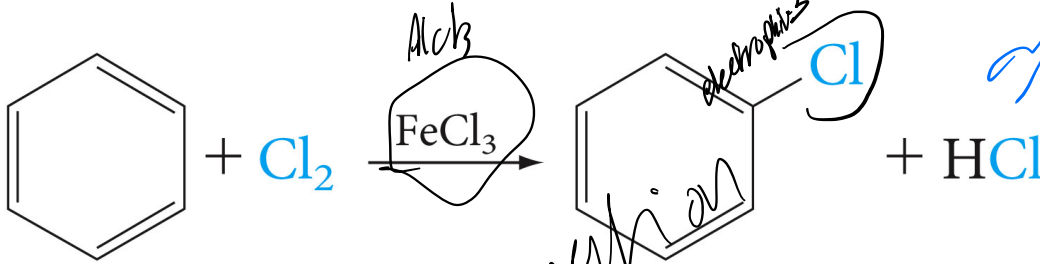
1-phenylethanol

احد عتقنا بلو  
نسبة الارتفاع

الاستبدال الكهربي

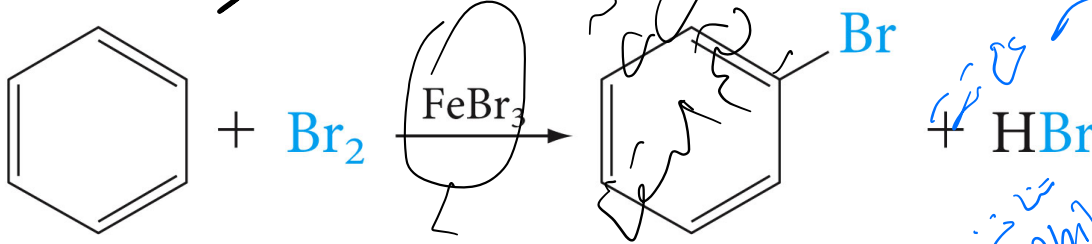
# Electrophilic Aromatic Substitution

البزينة لها كثافة الكهربية عالية



طبعاً الكهربية nucleophile  
هنا ال nucleophile

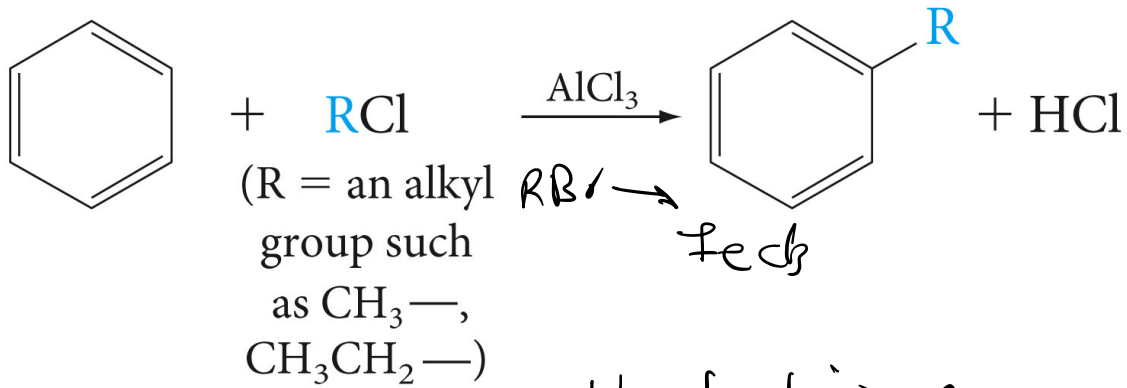
2. Halogenation



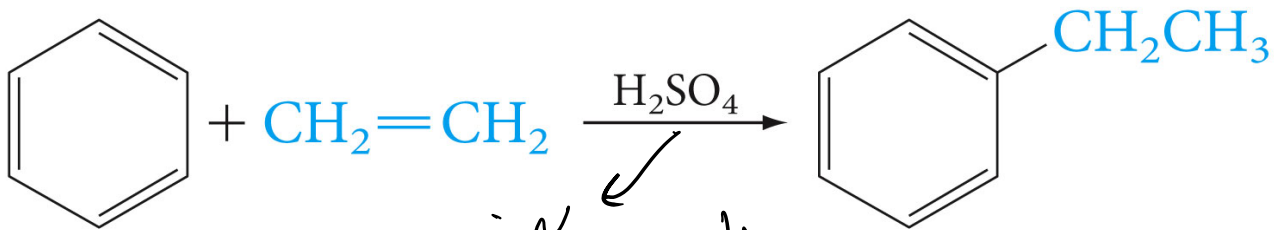
Electrophile  
نظراً لارتفاع الكثافة الكهربية

تجارب  
nucleophile



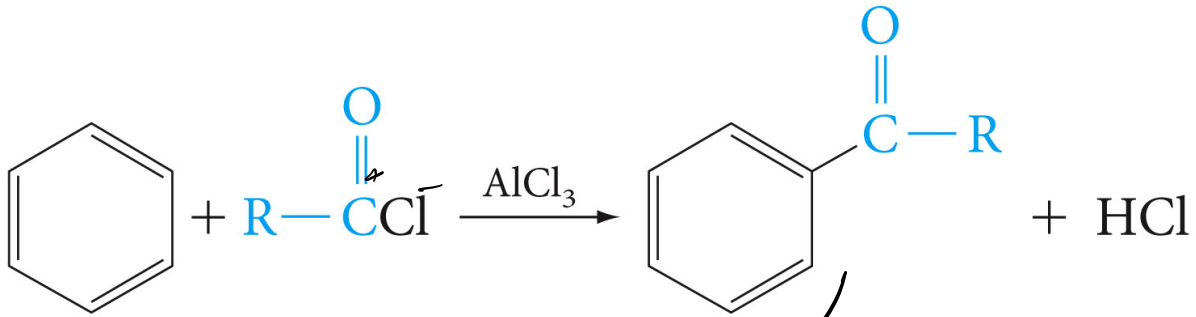


فر التحلالت



لا يتفاعل مع حمض الكبريتيك  
 لا يتفاعل مع حمض الكبريتيك  
 $\text{CH}_3\text{CH}_2^+$   
 $\text{CH}_2^+\text{CH}_3$



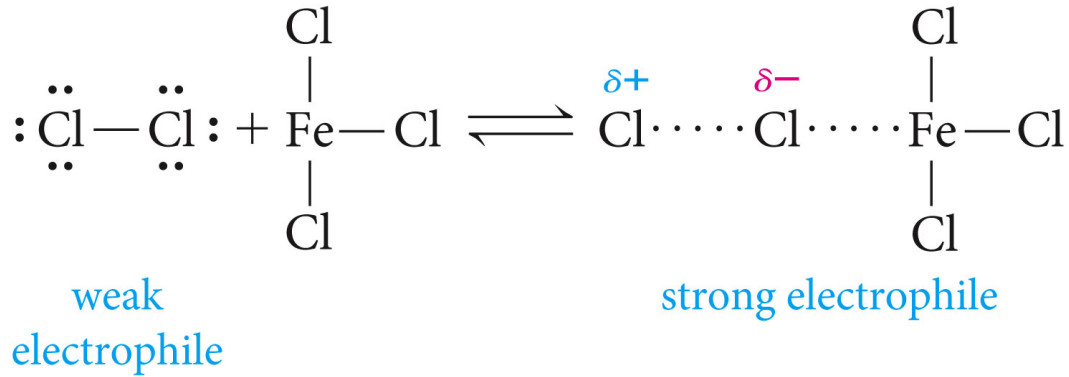


5 acylation

کیتون  
ظہیر کیتون اور اے ڈی  
عبارتہ کیا ہے

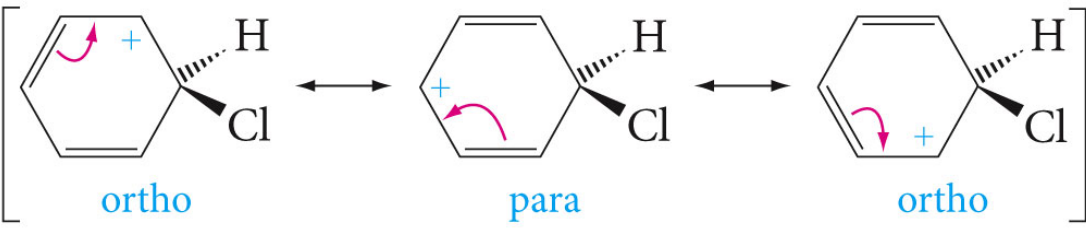
در الكيمياء العضوية، تفاعل الاستبدال الكهروضوئي (electrophilic substitution)

# The Mechanisms of Electrophilic Substitutions

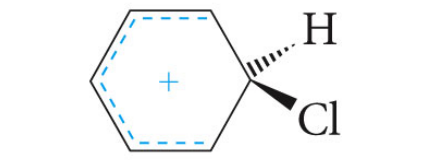








resonance forms of a benzenonium ion

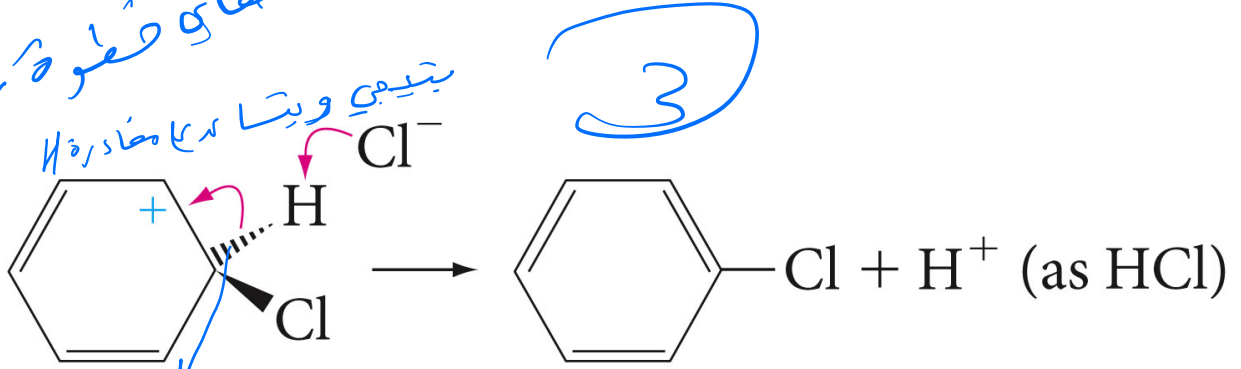


composite representation of the benzenonium ion resonance hybrid

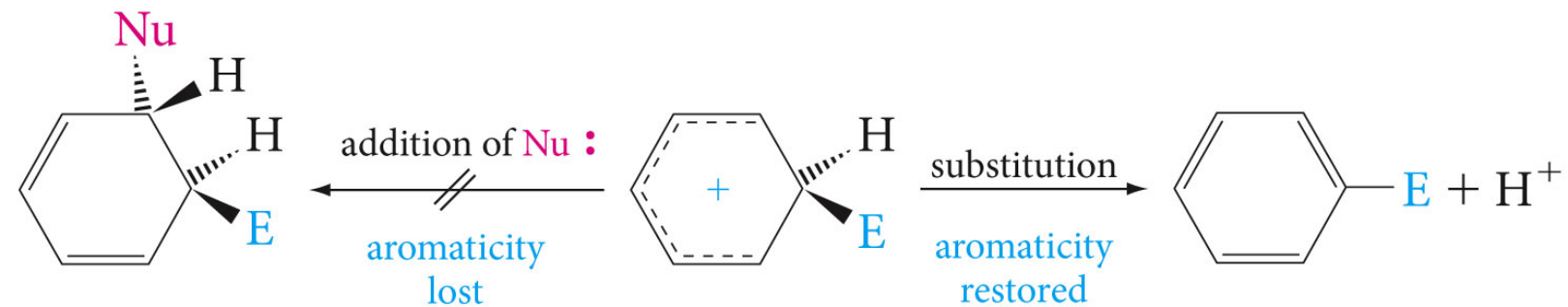
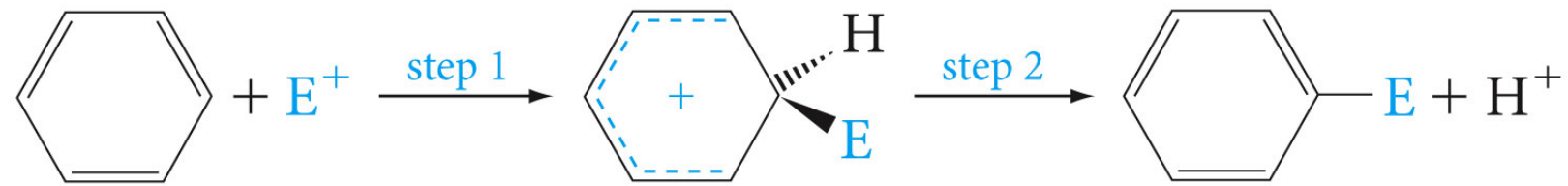
صاري قطرة بديلة

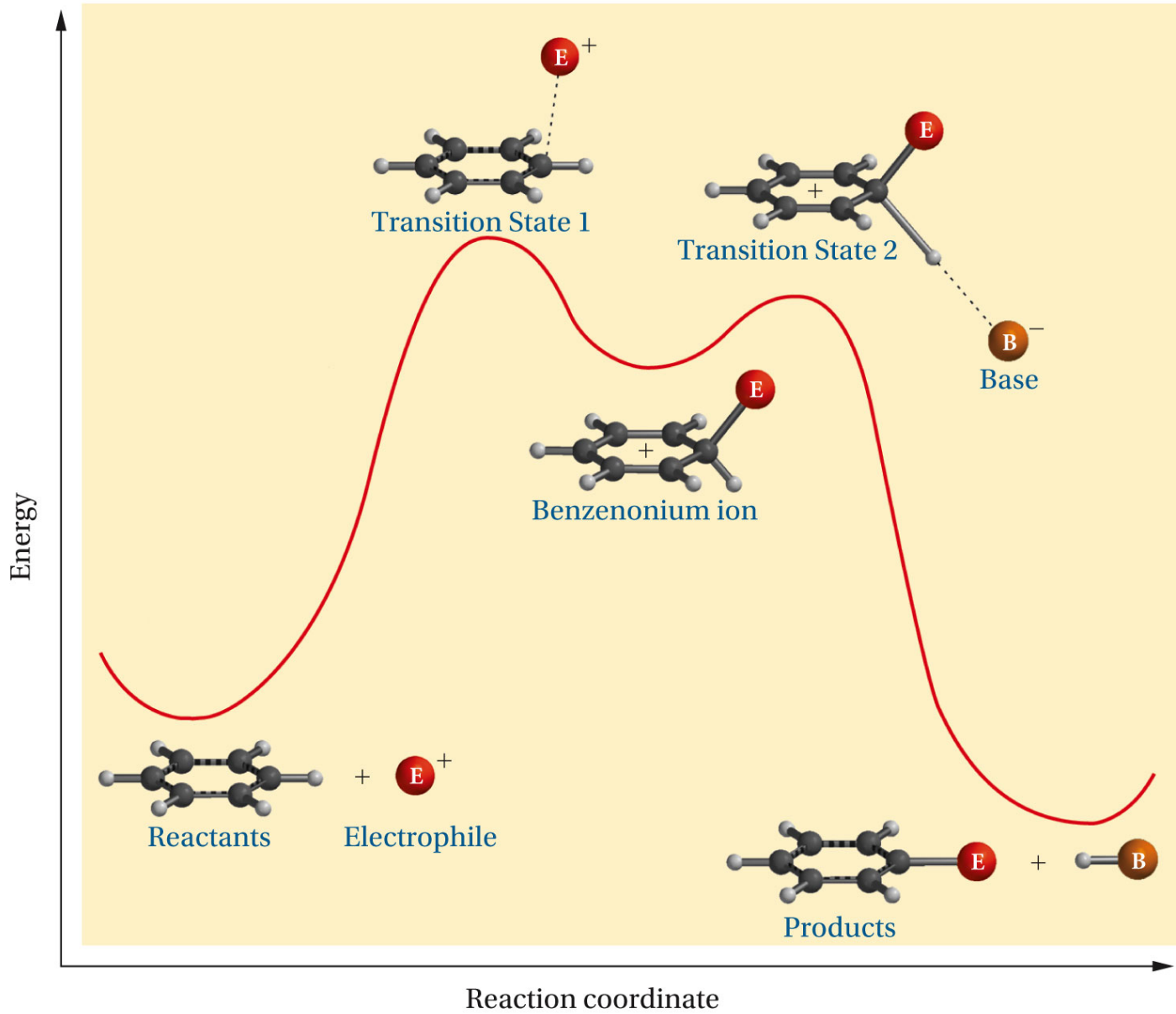
صاري قطرة بديلة  
 بتبني ويتا دريا مقاديرة

3 خطوات



دالك كزديا الربطة  
 تكون رابطة مشابهة  
 بالقدرة

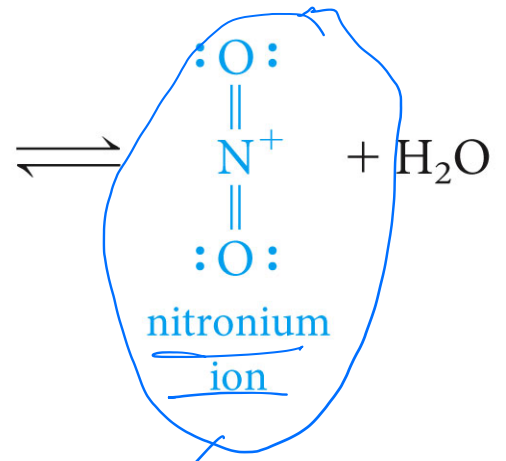
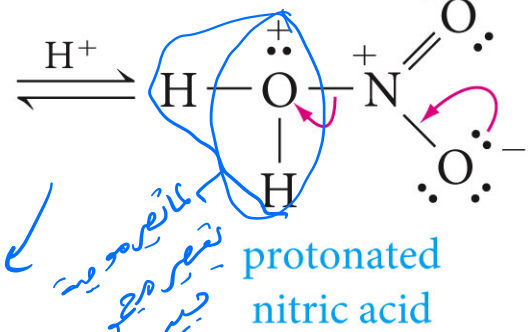
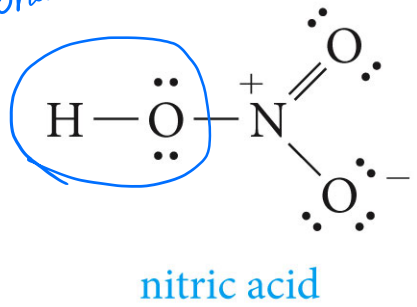




# Nitration →

مقدرة البرزين مع acid

ليسر الكيمياء protonation

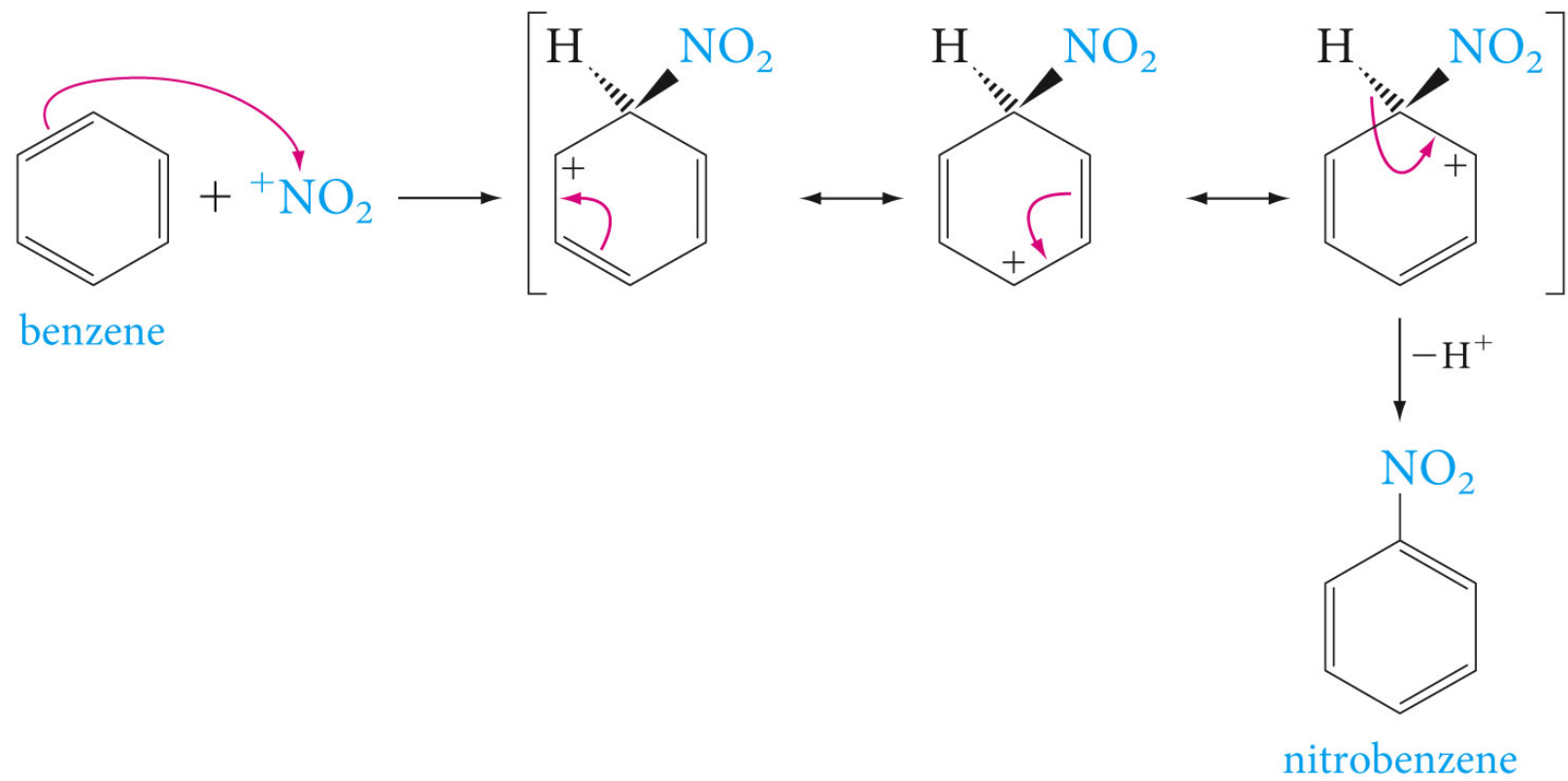


حالت HNO3  
مقابل الماء

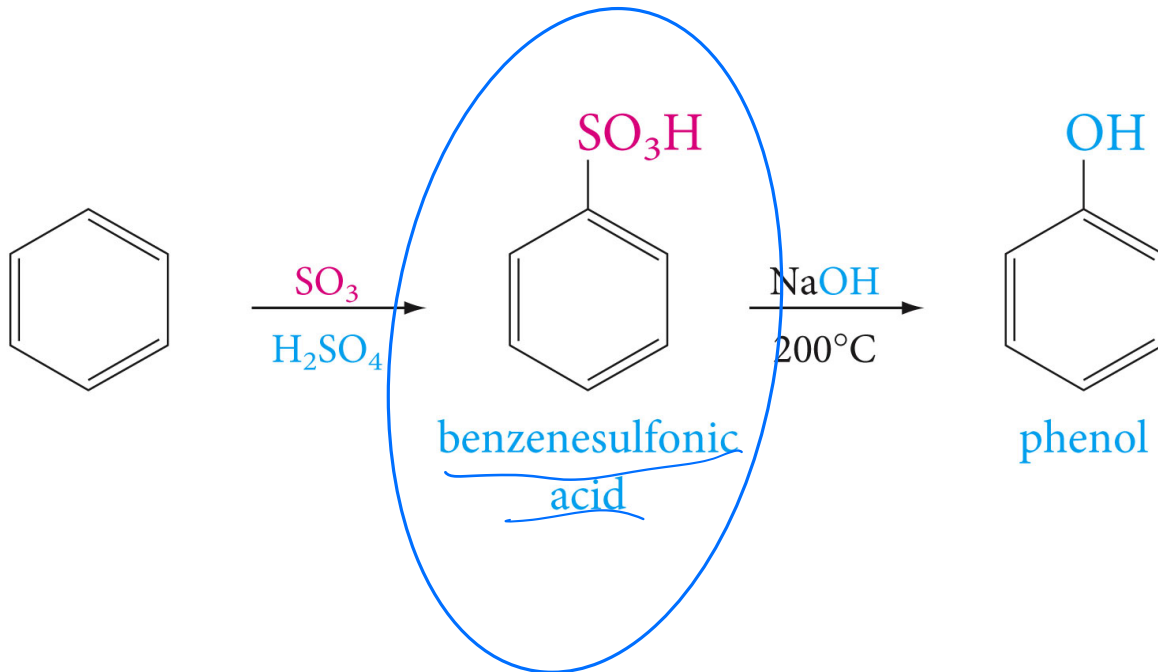
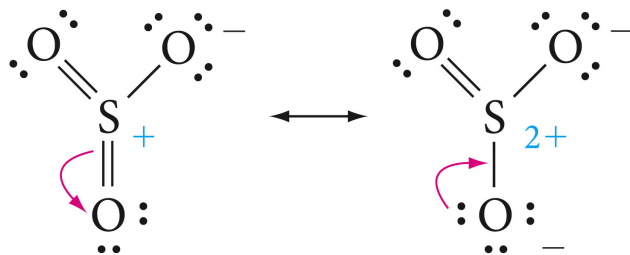
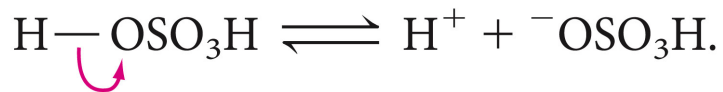
علاقة قوية  
تغير في  
بنيته  
بجانب العلاقة بين  
انها تنكسر

electrophile  
المطلوب



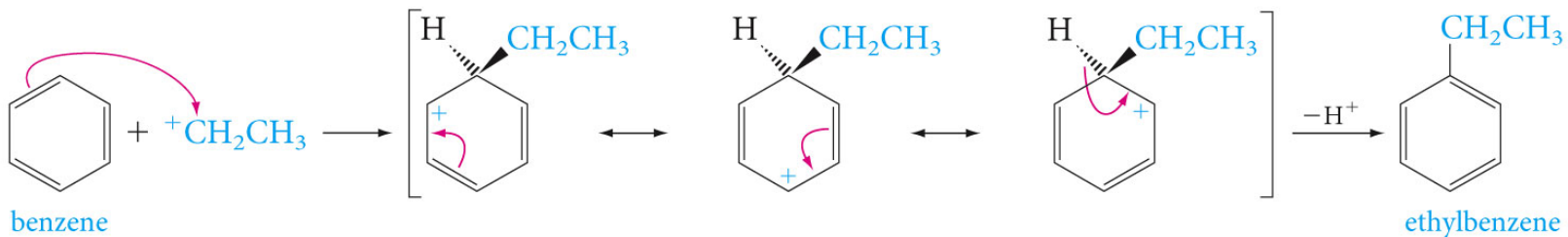
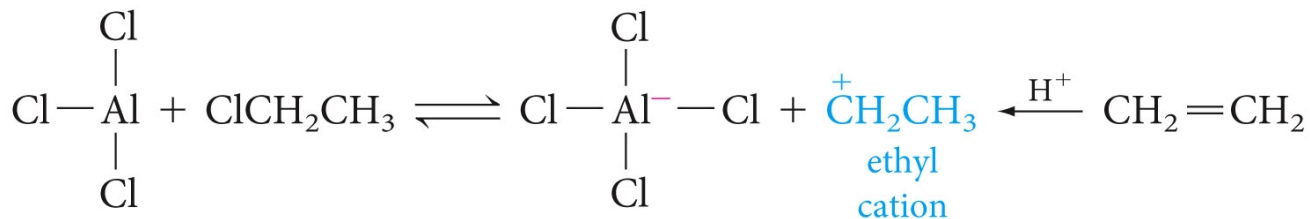


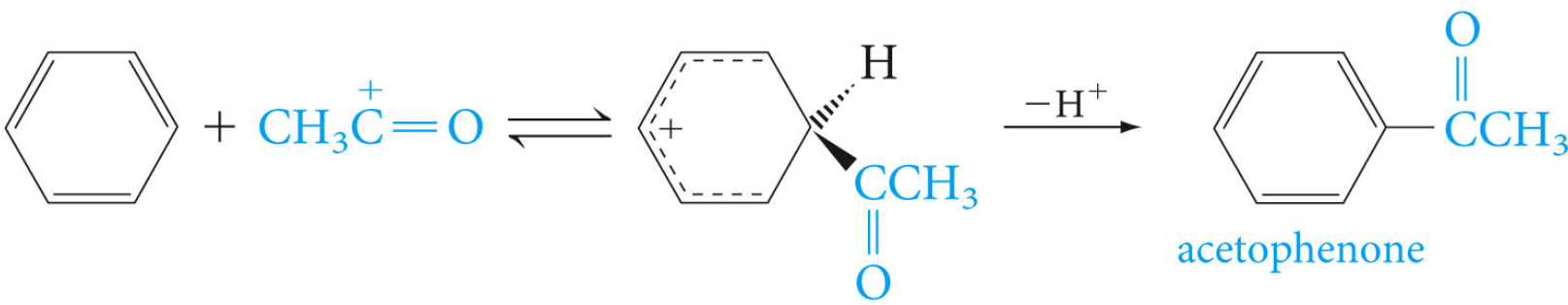
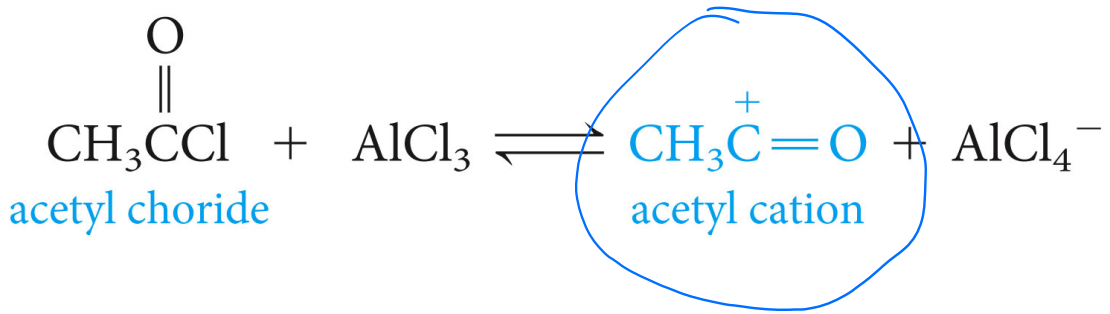
# sulfonation



# Alkylation and Acylation (Friedel-Crafts reaction)

تتطلب تفاعل فريدل-كرايفتس الازم  
سائبه Al/Fe...  
يوجد عامل

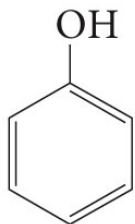




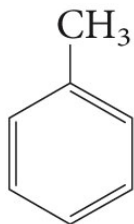
کلیم نف ایک سے بہا العری  
 یا تطوہ اادی (electrophilic)

# Ring-Activating and ring-Deactivating Substituents

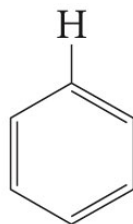
حلقة البنزين  
 ما هي مشكلة رينج  
 به صا ترتبط لا تحا الاماكن  
 السته نضاب  
 يعا السته  
 one product



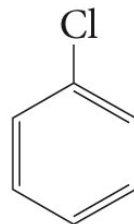
1000



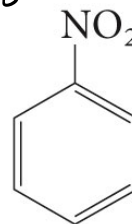
24.5



1.0



0.033



0.0000001

nitration rate  
(relative)

decreasing rate

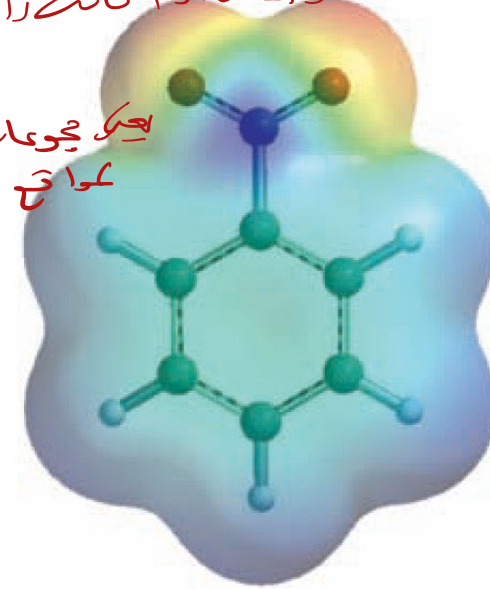
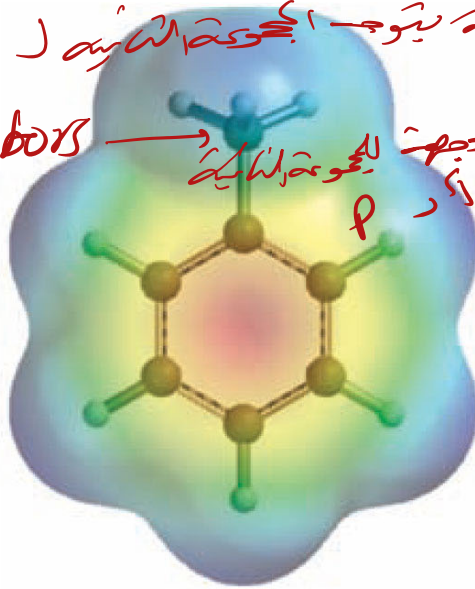
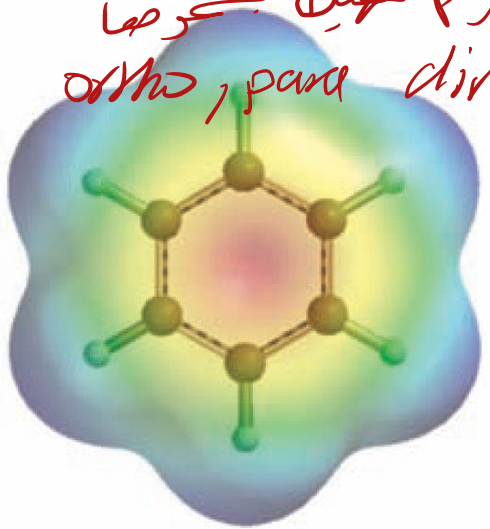
اما عديا فحسا هيكن يتكون 2 ، هوكا يترتب  
 رانه اد ائيشه محد اظم  
 صا زالكلام بعند 3 ، الحور عا لاري  
 لانهما هما الي لا توصي الحور عا لاري  
 وكان ترتبط لانهما  
 لسهل بكرة  
 الحور عا لاري

يه اذا بيدي اذ نط-حور عا لاري  
 الكماكن الحور عا لاري المتبديه  
 نضاب السته  
 يعي هوكا يتكون  
 صا زالكلام نظريا  
 isomers

طبيعاً بعدة اتجاهات، لذلك لم يكن ترتيب  $O$  و  $P$  و  $m$  صيغة الجزيء لادى  
 منتهى تفهمه، تحسين ركنيسين، معك تكون داخلة للكربون  
 يعطى تفرغ  $m$  باتجاه حلقة البنزين ويزيد الكفاءة الالكترونية لحلقة البنزين  
 لكي صاى المالة اذا كانت رافعة يتوجه الجحوة الشبيه ل  $O$  و  $P$  لتصبح كمرصا

ortho, para directors

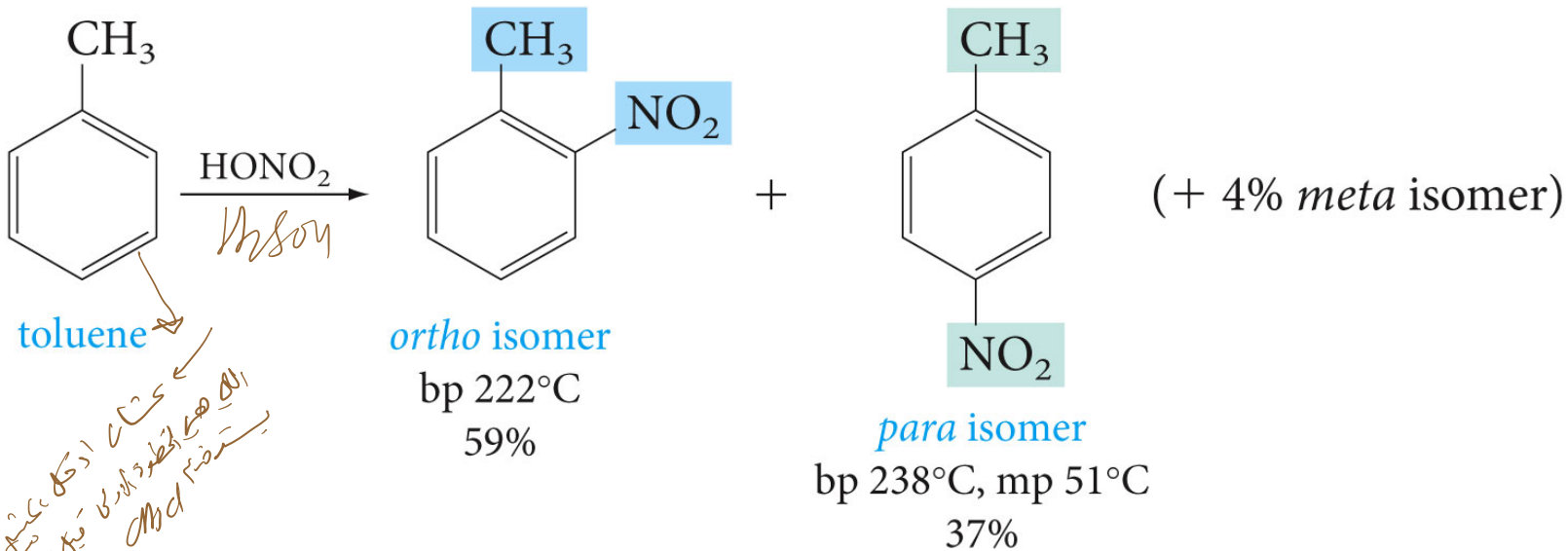
بشكل مجموعته من حيث الجحوة الشبيه ل  $P$   
 كواحد من اذكار



طبيعاً كيميائياً  
 اعرف توفى الجحوة  
 عا سبه قبول  
 موضع

النوع الاخرى المتكون الجحوة ساصية لادى يعطى تحسينه  
 مطقة البنزين باتجاهها وبالتالي يتقلد الكفاءة الالكترونية لحلقة  
 البنزين لكي صاى المالة يتوجه  $m$   
 وبعوضا  $m$ -directors

# Ortho, Para-Directing and Meta-Directing Groups

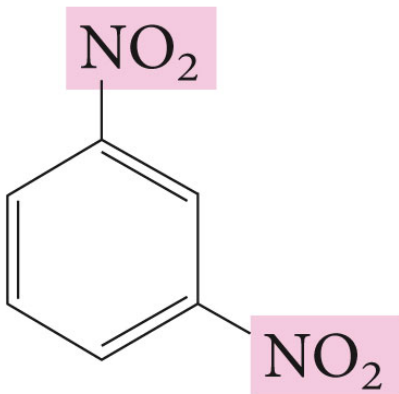
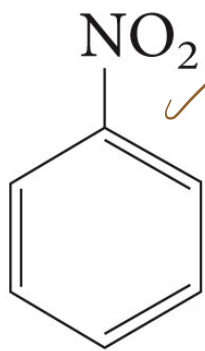


Handwritten notes in Arabic script:   
البنزين هو الحلقة التي يتكون منها المركبات العطرية   
وهي تتكون من 6 ذرات كربون مرتبطة في حلقة واحدة   
مع وجود 6 إلكترونات  $\pi$  في الحلقة   
وهي تسمى الحلقة العطرية   
AlCl3

Handwritten note: 2 isomers

Handwritten note: 15

*NO<sub>2</sub> are  
HNO<sub>3</sub>*



(+ 7% *ortho* isomer)

nitrobenzene

*meta* isomer

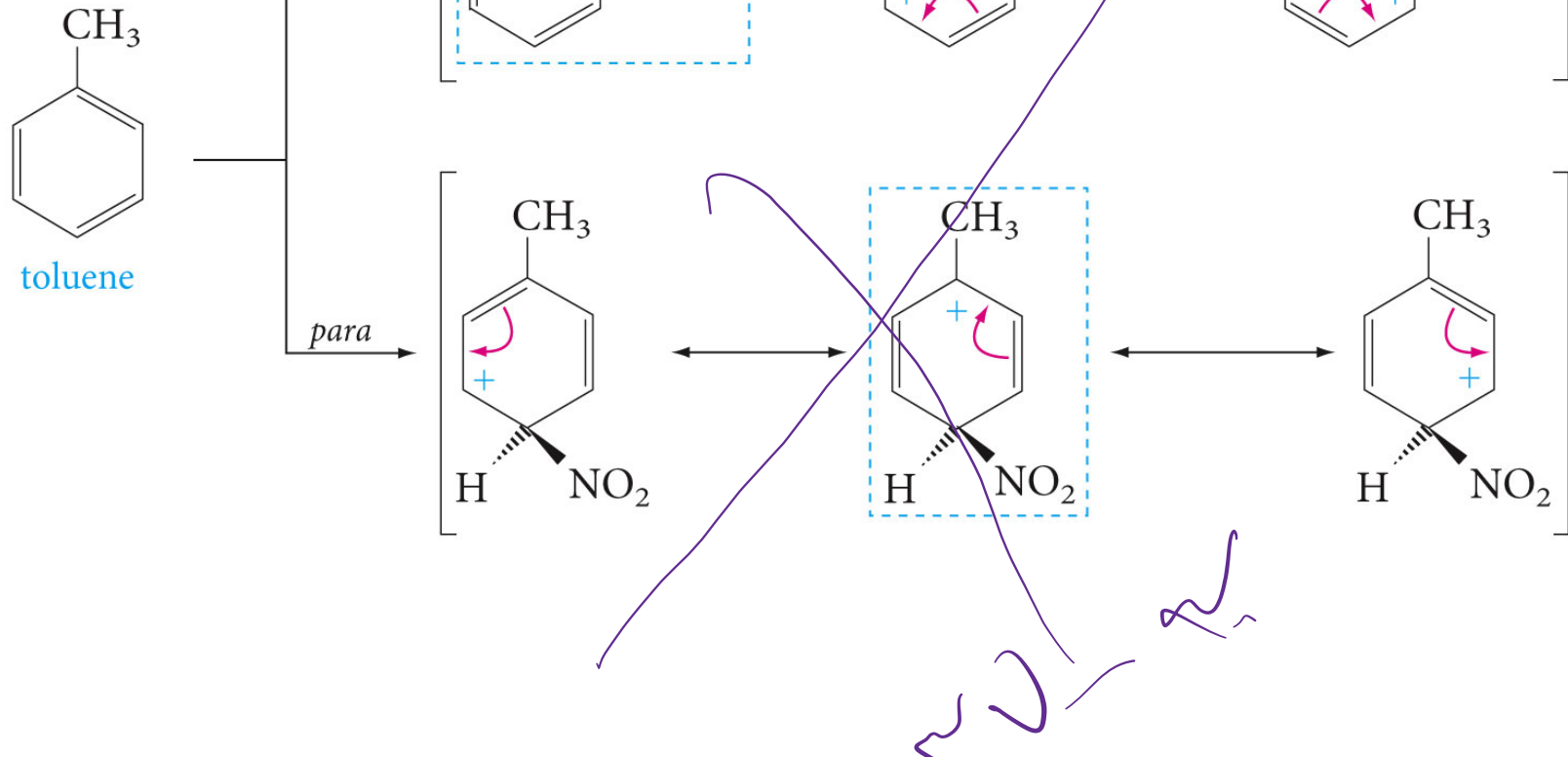
mp 89°C

93%

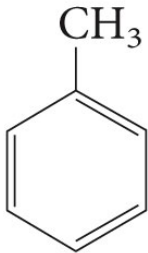


# Ortho, Para-Directing Groups

Ortho, para attack



Meta attack



toluene

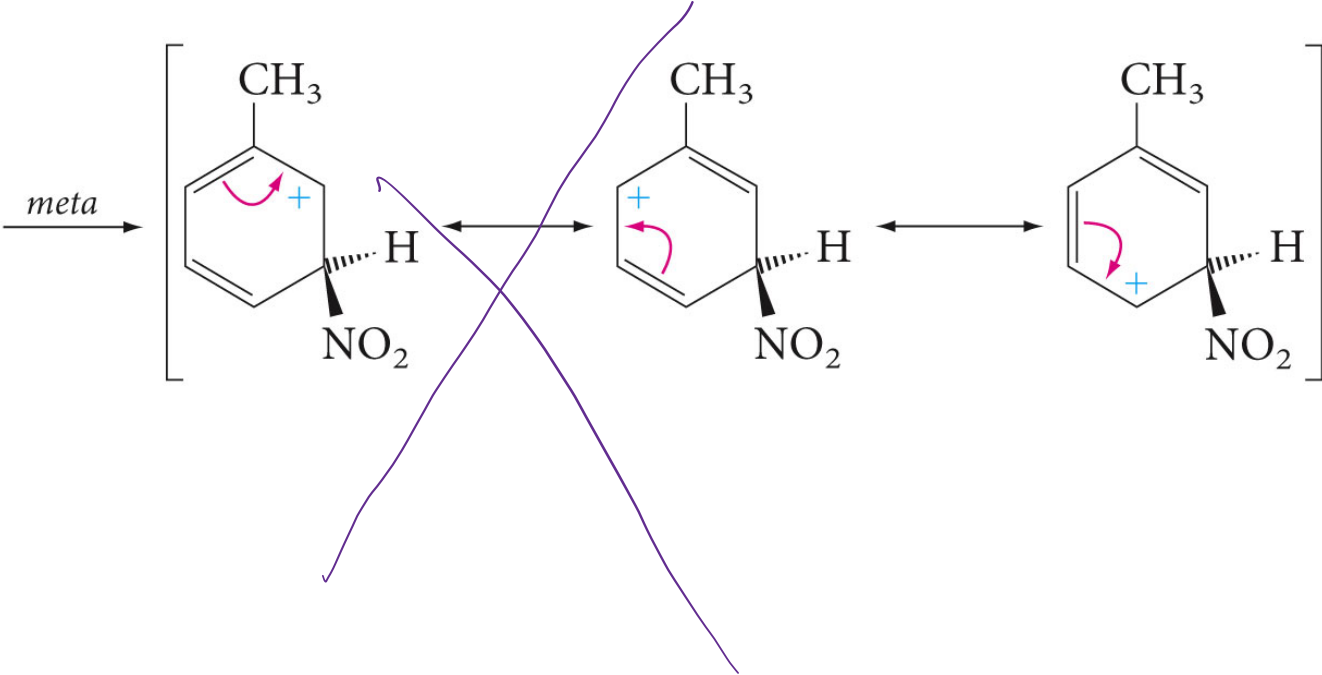
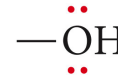
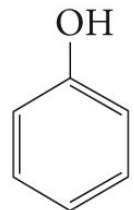


Table 4.1 ■ Directing and Activating Effects of Common Functional Groups (Groups are Listed in Decreasing Order of Activation)

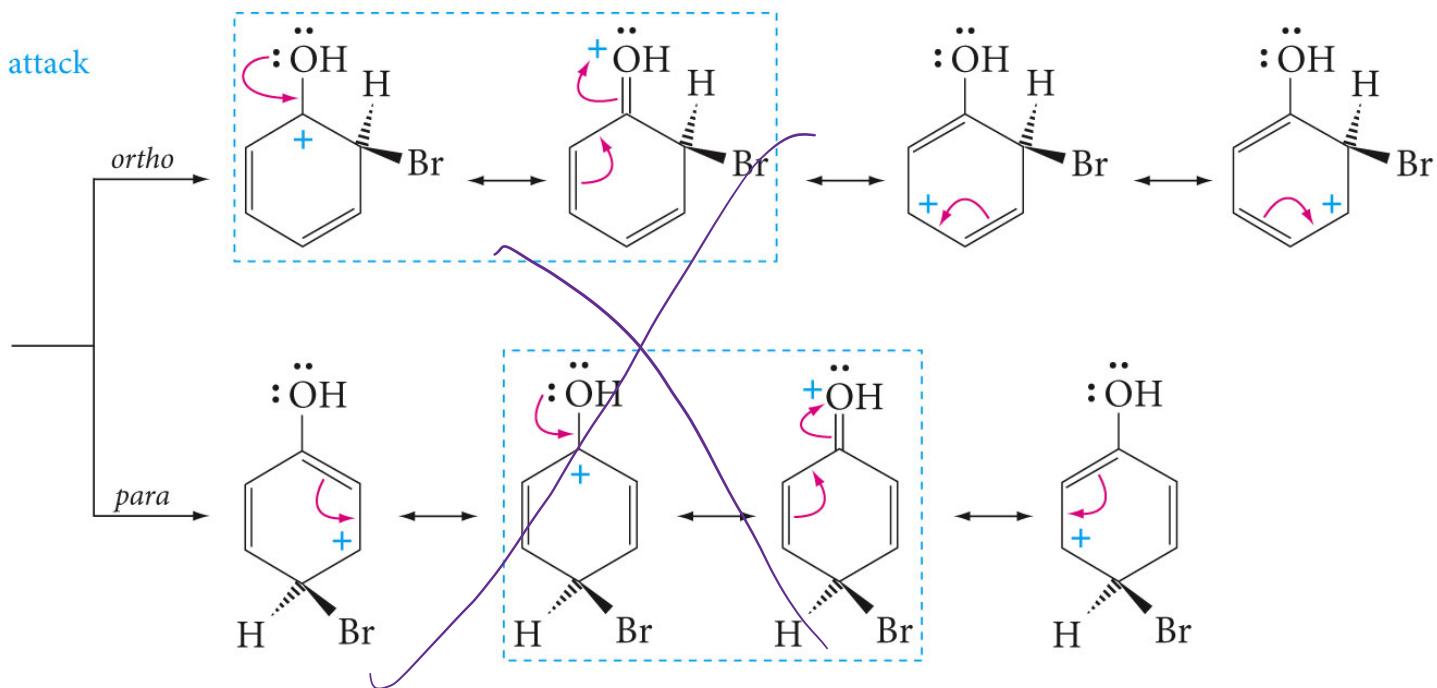
	<i>Substituent group</i>	<i>Name of group</i>	
<b>Ortho,Para-Directing</b>	$-\ddot{\text{N}}\text{H}_2, -\ddot{\text{N}}\text{HR}, -\ddot{\text{N}}\text{R}_2$	amino	<b>Activating</b>
	$-\ddot{\text{O}}\text{H}, -\ddot{\text{O}}\text{CH}_3, -\ddot{\text{O}}\text{R}$	hydroxy, alkoxy	
	$\begin{array}{c} \text{O} \\    \\ -\ddot{\text{N}}\text{HC}-\text{R} \end{array}$	acylamino	
	$-\text{CH}_3, -\text{CH}_2\text{CH}_3, -\text{R}$	alkyl	
	$-\ddot{\text{F}}:, -\ddot{\text{Cl}}:, -\ddot{\text{Br}}:, -\ddot{\text{I}}:$	halo	
<b>Meta-Directing</b>	$\begin{array}{c} \text{:O:} \\    \\ -\text{C}-\text{R} \end{array}$	acyl, carboxy	<b>Deactivating</b>
	$\begin{array}{c} \text{:O:} \\    \\ -\text{C}-\ddot{\text{O}}\text{H} \end{array}$		
	$\begin{array}{c} \text{:O:} \\    \\ -\text{C}-\ddot{\text{N}}\text{H}_2 \end{array}$	carboxamido, carboalkoxy	
	$\begin{array}{c} \text{:O:} \\    \\ -\text{C}-\ddot{\text{O}}\text{R} \end{array}$		
	$\begin{array}{c} \text{:O:} \\    \\ -\text{S}-\ddot{\text{O}}\text{H} \\ \text{:O:} \end{array}$	sulfonic acid	
$-\text{C}\equiv\text{N}:$	cyano		
	$\begin{array}{c} \text{:O:} \\    \\ -\text{N}^+ \\   \\ \ddot{\text{O}}^- \end{array}$	nitro	



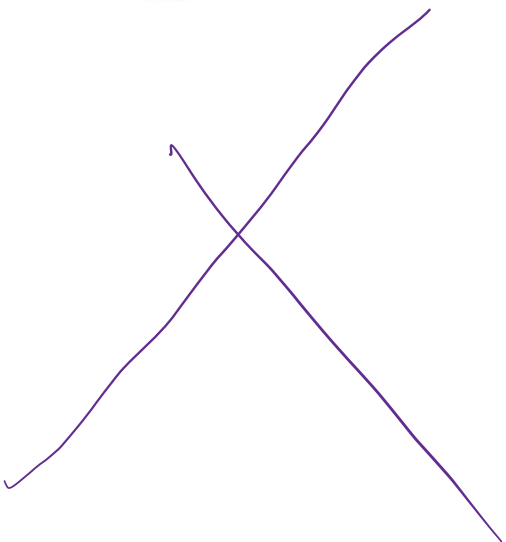
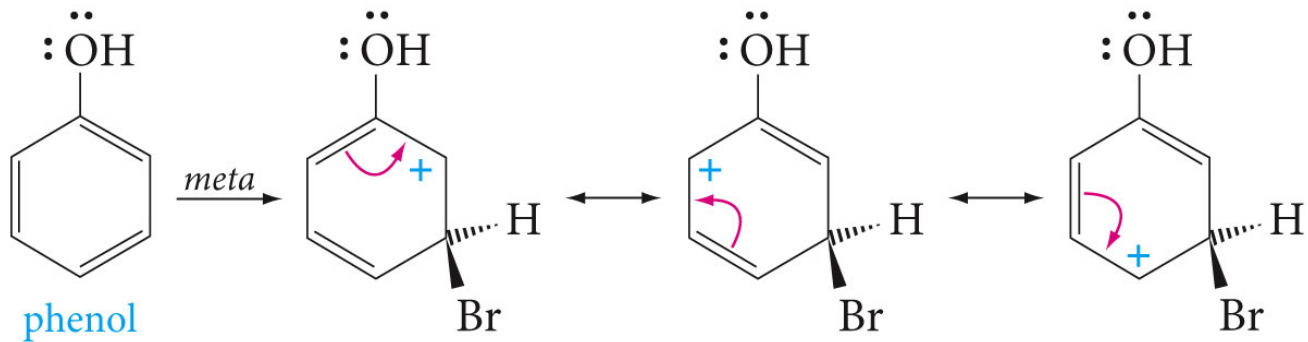
*Ortho,para attack*



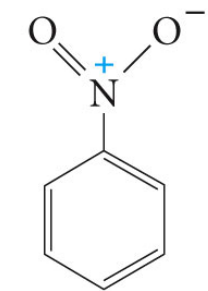
phenol



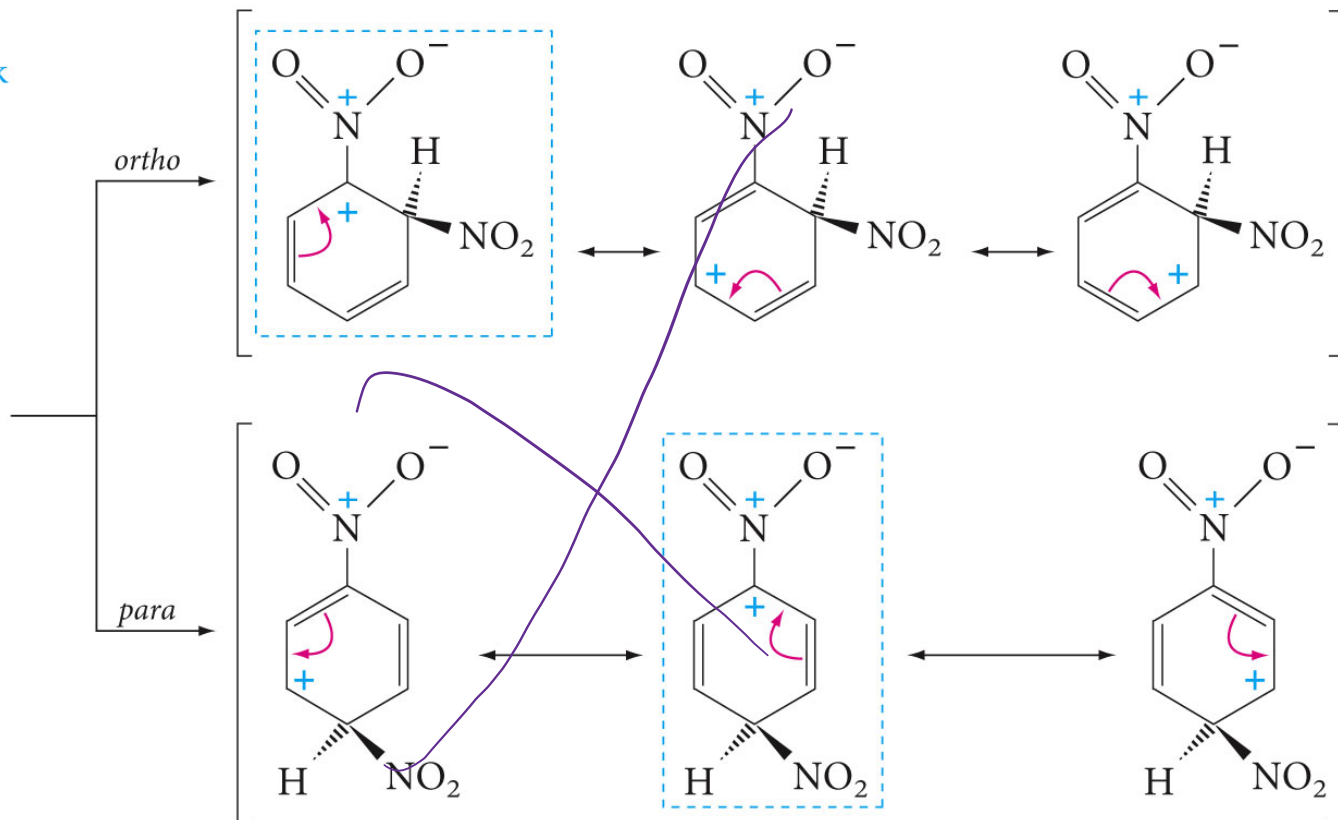
Meta attack



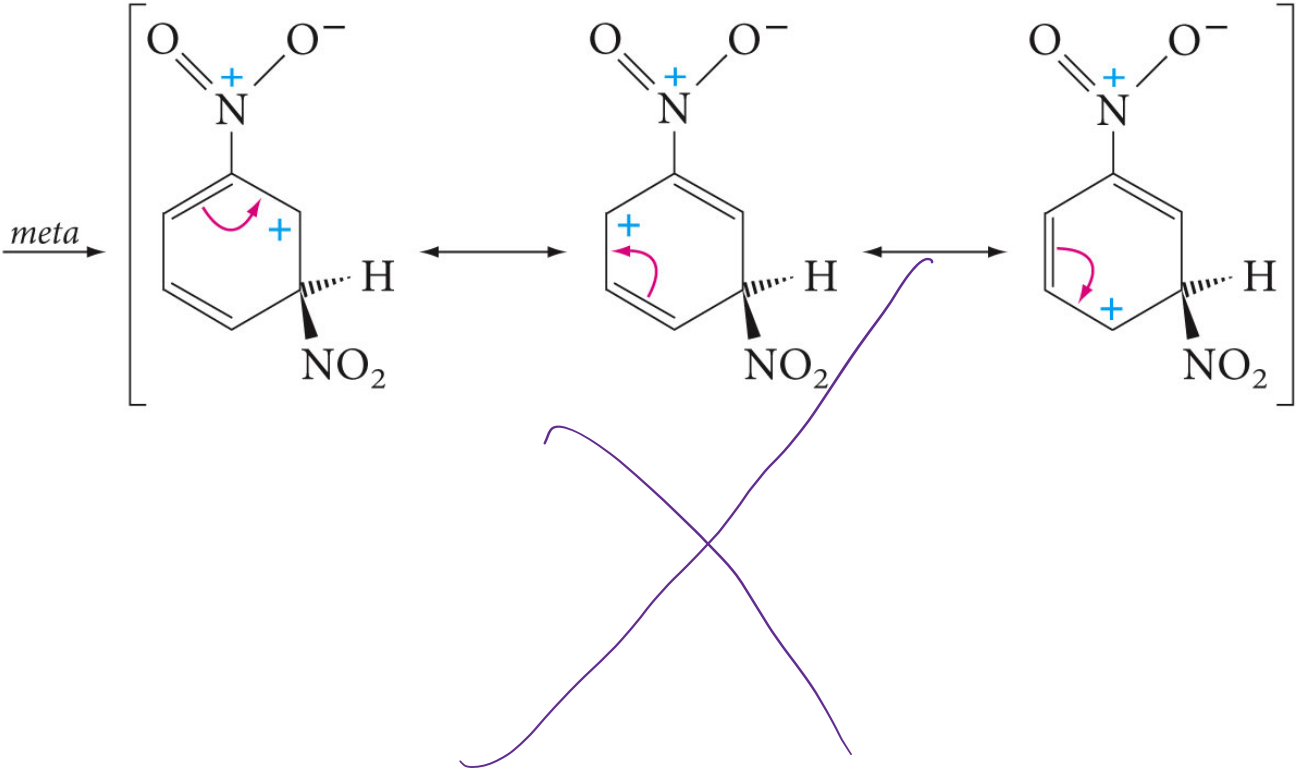
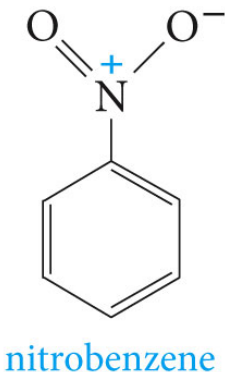
*Ortho,para attack*

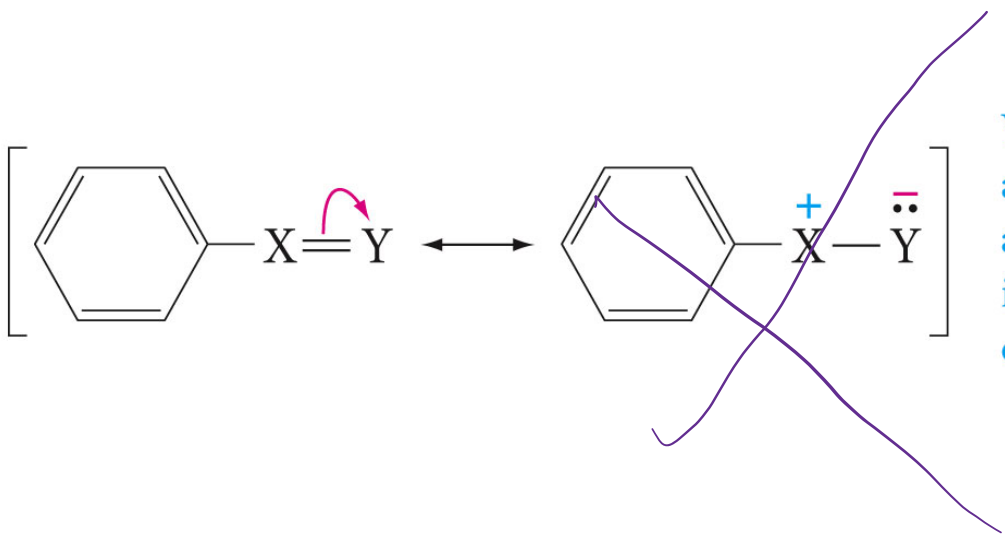


nitrobenzene



Meta attack

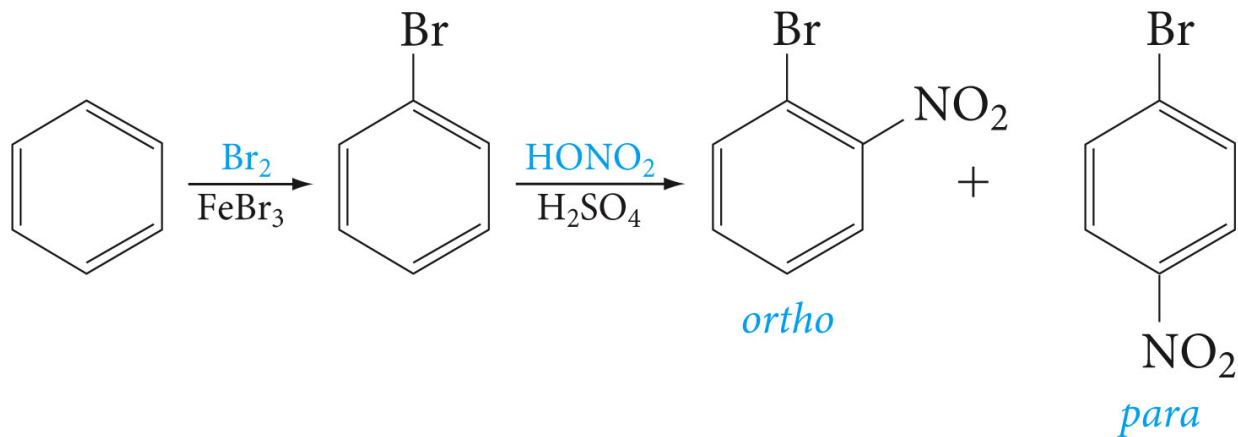


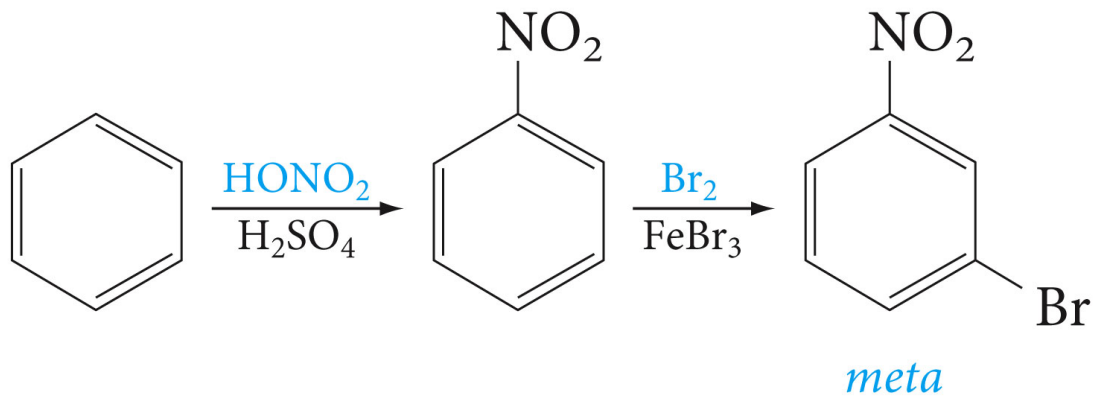


Y is an electron-withdrawing atom such as oxygen or nitrogen; atom X carries a positive charge in one of the resonance contributors.

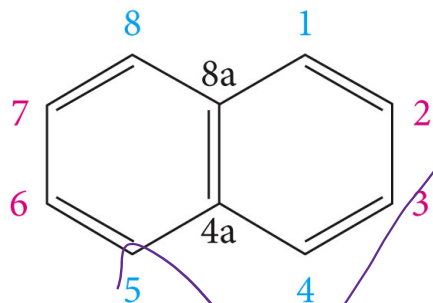


# Importance of Directing Effects in Synthesis



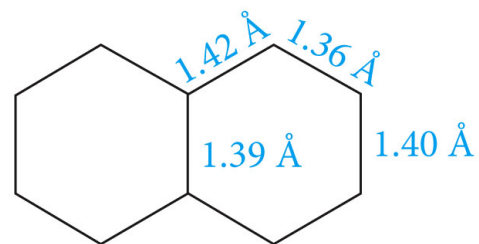


# Polycyclic Aromatic Hydrocarbons



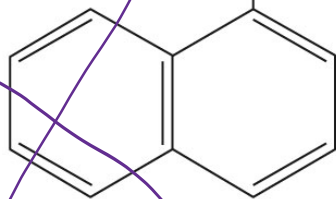
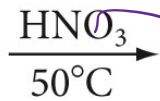
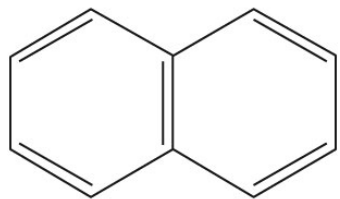
naphthalene

mp 80°C



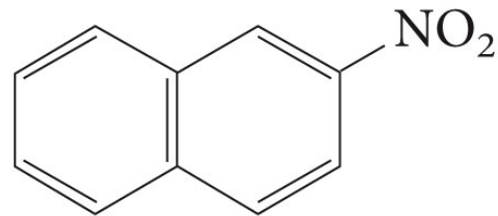
bond lengths in  
naphthalene

*Handwritten purple scribbles.*



1-nitronaphthalene

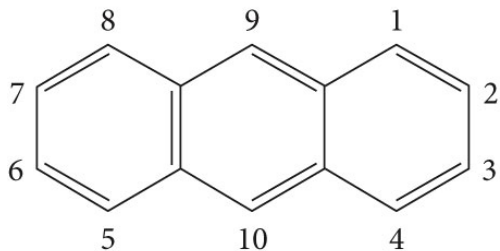
+



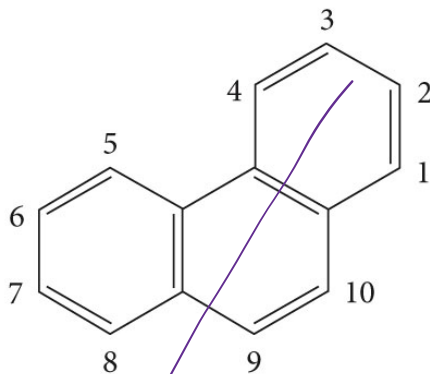
2-nitronaphthalene

(ratio 10:1)

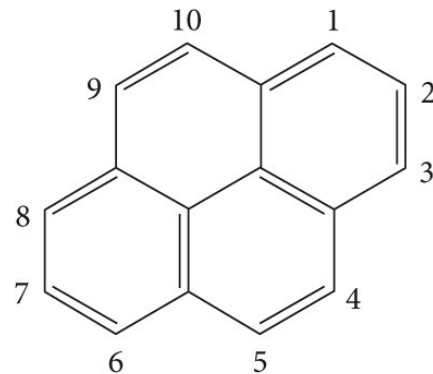
# Fused polycyclic hydrocarbons



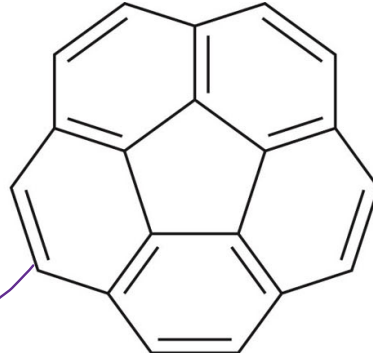
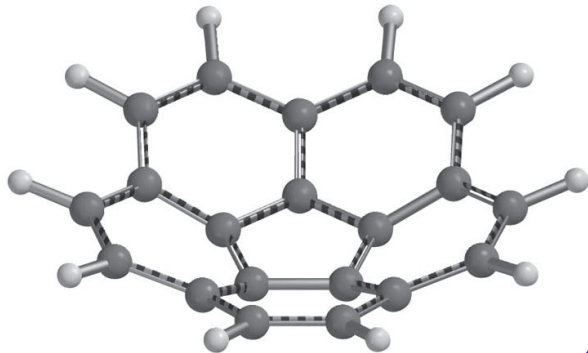
anthracene  
mp 217°C



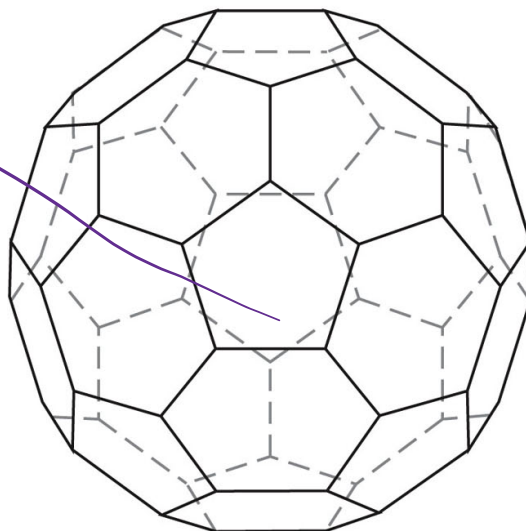
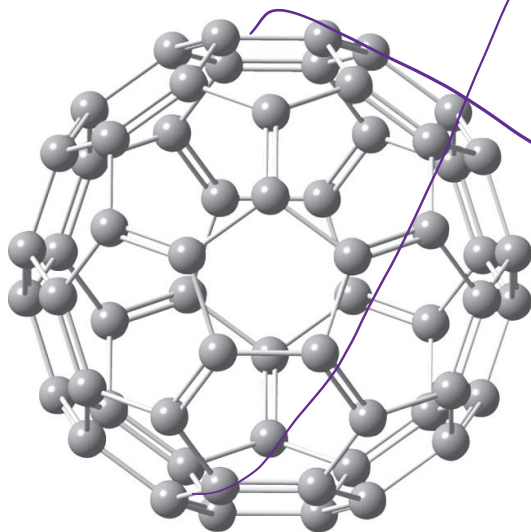
phenanthrene  
mp 98°C



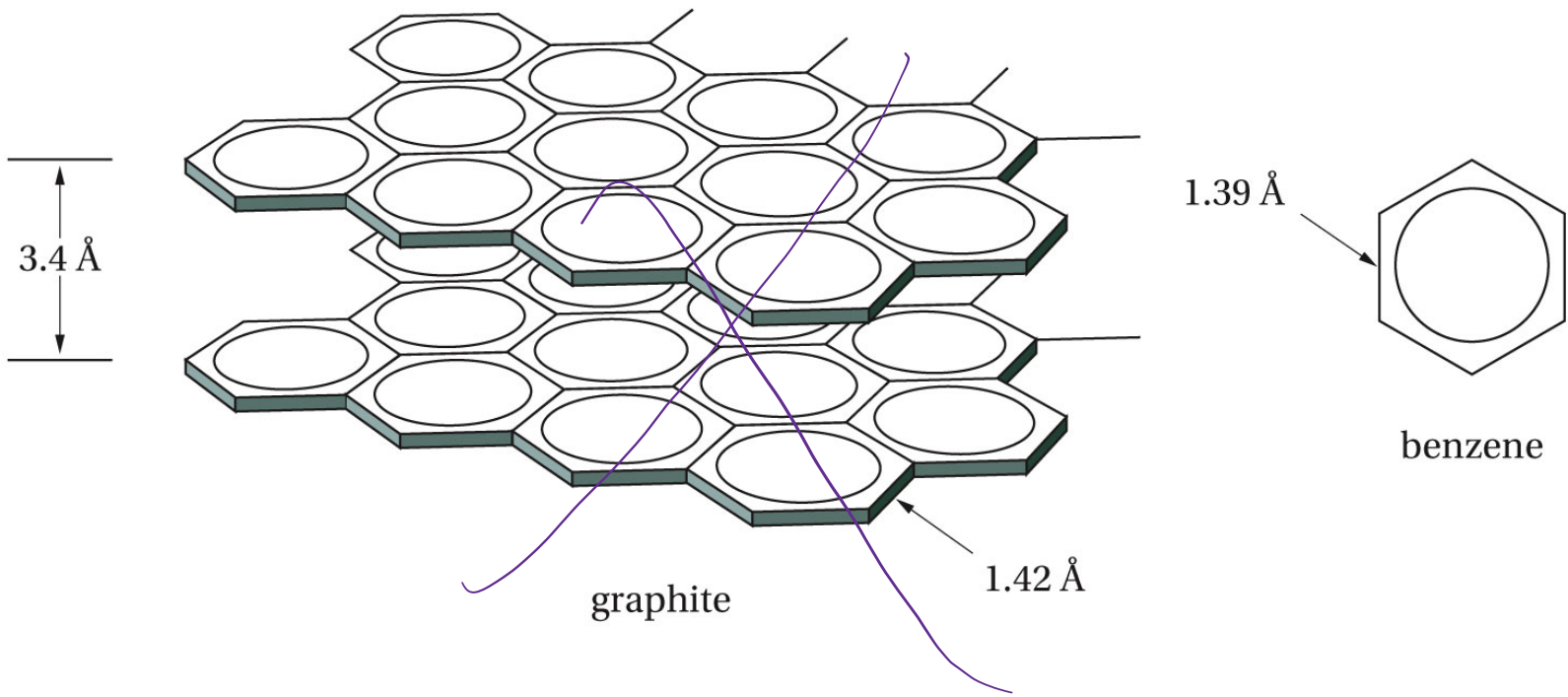
pyrene  
mp 156°C

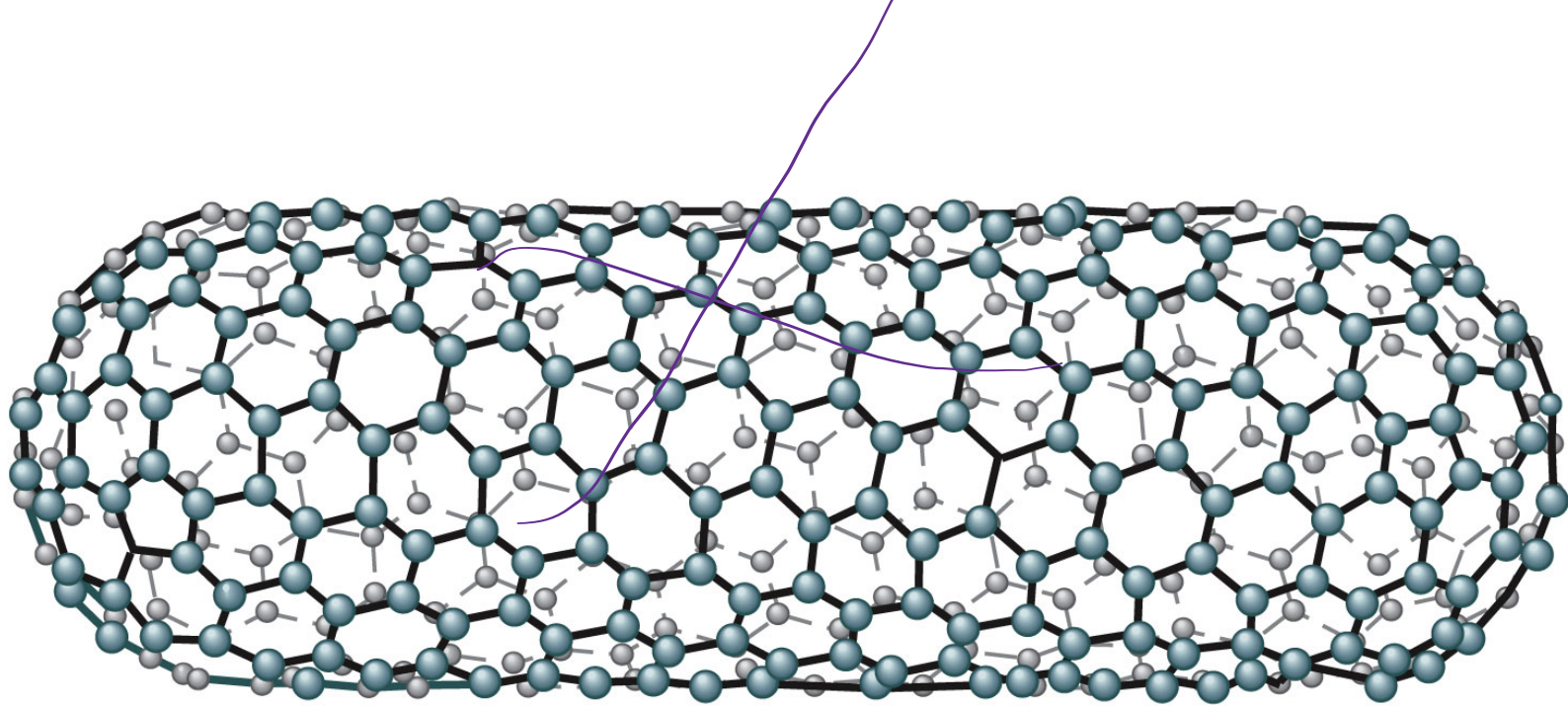


corannulene



C<sub>60</sub> (the pi bonds are not shown)





Carbon nanotube<sup>1</sup>