

AQA Chemistry A-level

Topic 3.10 - Aromatic Chemistry

Flashcards

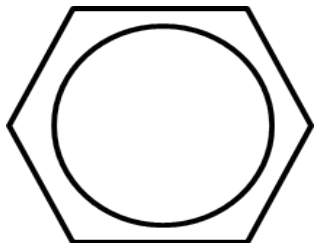
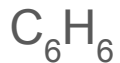
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What is benzene's formula and structure?



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What is another name for arenes? Why did this come about?



What is another name for arenes? Why did this come about?

Aromatic compounds, as first found in sweet-smelling dyes



What is the most common type of reaction of benzene?



What is the most common type of reaction of benzene?

Substitution (of a H for a different functional group)



What is the shape of benzene?



What is the shape of benzene?

Flat, regular hexagon. Bond angle = 120°



What is the bond length
between adjacent C atoms?



What is the bond length between adjacent C atoms?

Intermediate between C-C and C=C



What happens to the 4th electron in the p orbital of each C atom in benzene?



What happens to the 4th electron in the p orbital of each C atom in benzene?

It delocalises to form rings of electron density above and below the hexagon, forming rings of delocalised electron density above/below the hexagon.



What is the effect on
benzene's stability of the
rings of electron density?



What is the effect on benzene's stability of the rings of electron density?

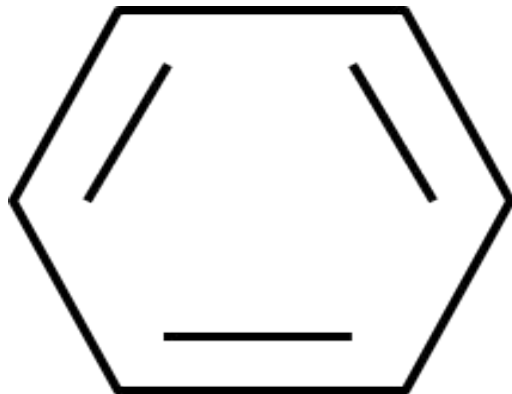
Makes benzene very stable, even though it is unsaturated (aromatic stability)



Draw the skeletal structure
of cyclohexa-1,3,5-triene



Draw the skeletal structure of cyclohexa-1,3,5-triene



What is the thermochemical evidence that benzene is more stable than cyclohexa-1,3,5-triene?



What is the thermochemical evidence that benzene is more stable than cyclohexa-1,3,5-triene?

Hydrogenation of cyclohexene = -120kJmol^{-1} →

cyclohexa-1,3,5-triene = -360kJmol^{-1}

Benzene hydrogenation = -208kJmol^{-1} so

benzene is 152kJmol^{-1} more stable



Why else is
cyclohexa-1,3,5-triene not a
suitable model for benzene?



Why else is cyclohexa-1,3,5-triene not a suitable model for benzene?

Would not be symmetrical (C=C shorter than C-C), but benzene is

Would easily undergo addition reactions across the double bonds - benzene does not

Would form two isomers on the addition of Br₂ or similar - benzene does not



What is the appearance of
benzene at 298K?



What is the appearance of benzene at 298K?

Colourless liquid



Why does benzene have a relatively high melting point?



Why does benzene have a relatively high melting point?

Close packing of flat hexagonal molecules when solid



Is benzene soluble in water? Why?



Is benzene soluble in water? Why?

No- non polar



Dangers of benzene? (why it is not used in schools)



Dangers of benzene? (why it is not used in schools)

It is a carcinogen



How do you name
compounds containing a
benzene ring?



How do you name compounds containing a benzene ring?

-benzene, or phenyl- ; can designate position on ring using numbers if there is more than one substituent



Why is benzene attacked by electrophiles?



Why is benzene attacked by electrophiles?

High electron density above/below ring due to delocalised electrons



What is delocalisation energy and what is the effect of this on benzene's reactions?



What is delocalisation energy and what is the effect of this on benzene's reactions?

The large amount of energy that is needed to break the aromatic ring apart. Results in the aromatic ring almost always staying intact



What is seen when benzene is combusted? Why?



What is seen when benzene is combusted? Why?

Smoky flames due to soot from unburnt carbon.

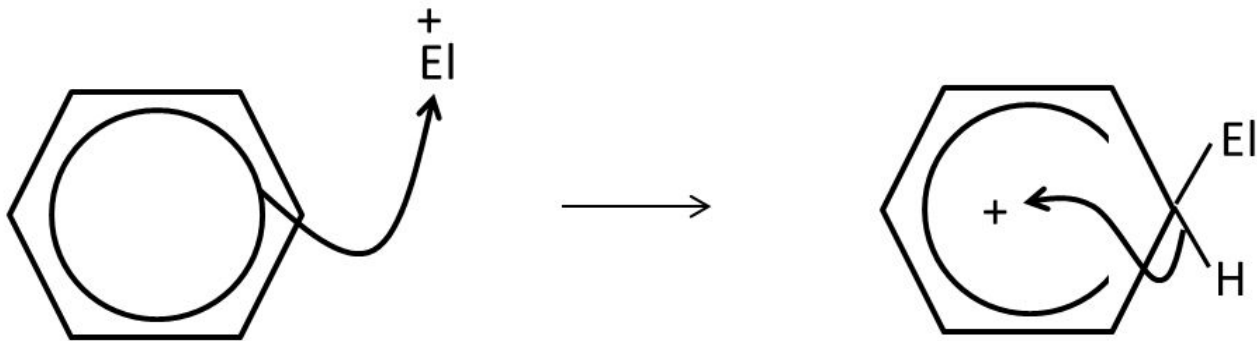
This is because of the high Carbon:Hydrogen ratio.



Draw a general electrophilic substitution mechanism of benzene, using EI^+ to represent an electrophile.



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Which ion (name and formula) is used to nitrate benzene?



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NO_2^+ (+ charge is on the nitrogen). Nitronium ion or nitryl cation

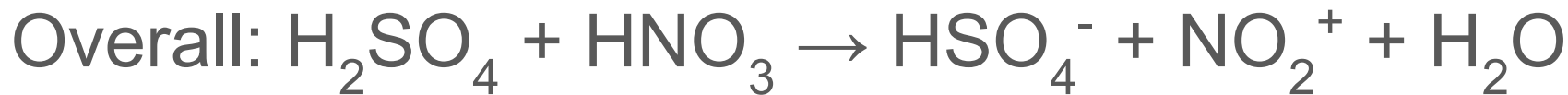


How is this NO_2^+ ion
generated? (conditions and
equations)



How is this NO_2^+ ion generated? (conditions and equations)

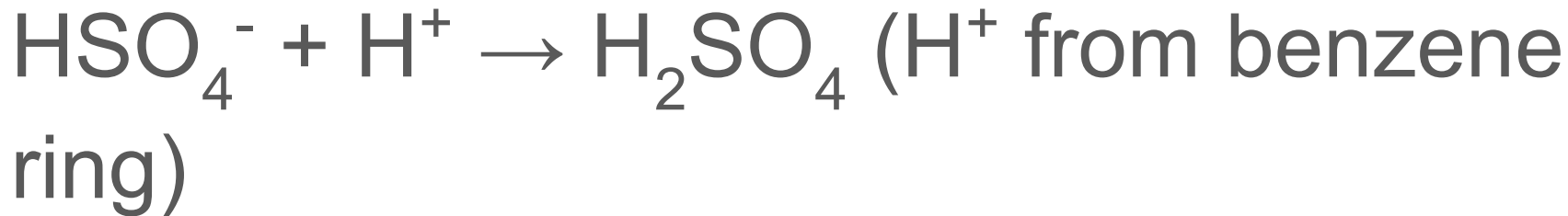
Concentrated H_2SO_4 and concentrated HNO_3 .



How is the H_2SO_4 catalyst regenerated in the nitration of benzene?



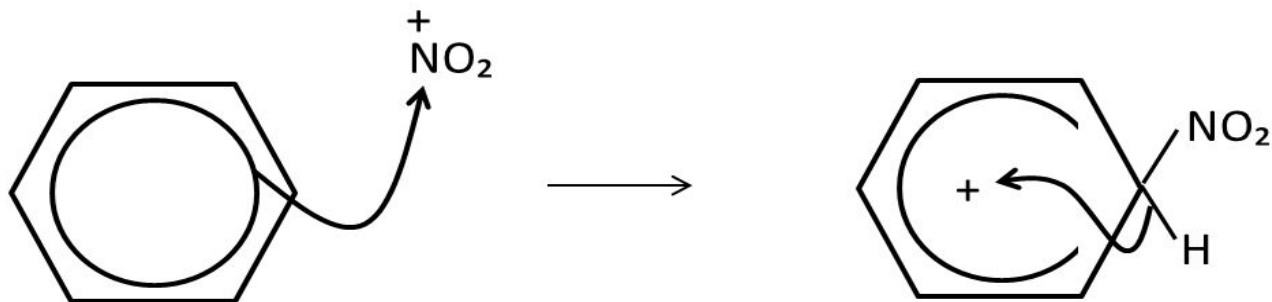
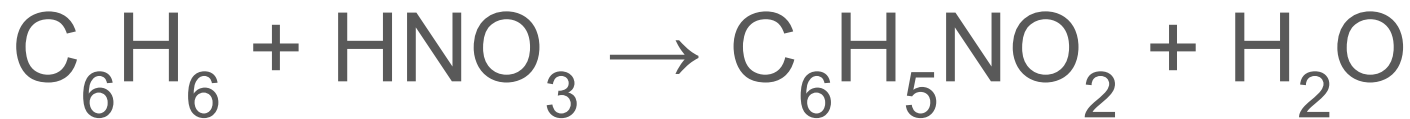
How is the H_2SO_4 catalyst regenerated in the nitration of benzene?



Draw a mechanism and
write an overall equation for
the nitration of benzene



Draw a mechanism and write an overall equation for the nitration of benzene



What are the uses of nitrated arenes?



What are the uses of nitrated arenes?

Production of explosives e.g. TNT

(1-methyl-2,4,6-trinitrobenzene) - releases lots of heat and gas on explosion.

To make aromatic amines that are used for industrial dyes



How do substituents with a positive inductive effect (e.g. alkyl groups) affect further substitution?



How do substituents with a positive inductive effect (e.g. alkyl groups) affect further substitution?

They release electrons into the delocalised electron ring, increasing the electron density and making further substitution reactions more likely/quick.

Direct substituents to the 2,4,6 positions



How do substituents with a negative inductive effect (e.g. NH_2) affect further substitution?



How do substituents with a negative inductive effect (e.g. NH_2) affect further substitution?

Remove electrons from the delocalised electron ring, decreasing the electron density and making further substitution reactions less likely/quick.

Direct substituents to 3,5 positions



What type of catalyst is used for a Friedel-Crafts reaction?



What type of catalyst is used for a Friedel-Crafts reaction?

A halogen carrier (e.g. AlCl_3)



Write an equation to form an electrophile that could be used to acylate benzene, starting with AlCl_3 and RCOCl



Write an equation to form an electrophile that could be used to acylate benzene, starting with AlCl_3 and RCOCl



RCO^+ can attack benzene



What is happening when
 AlCl_4^- is formed in terms of
electrons?



What is happening when AlCl_4^- is formed in terms of electrons?

Chlorine atom's lone pair of electrons is forming a coordinate bond to Al



How is the AlCl_3 catalyst reformed?



How is the AlCl_3 catalyst reformed?



How could you use a
Friedel-Crafts mechanism to
add a methyl group to a
benzene ring?



How could you use a Friedel-Crafts mechanism to add a methyl group to a benzene ring?

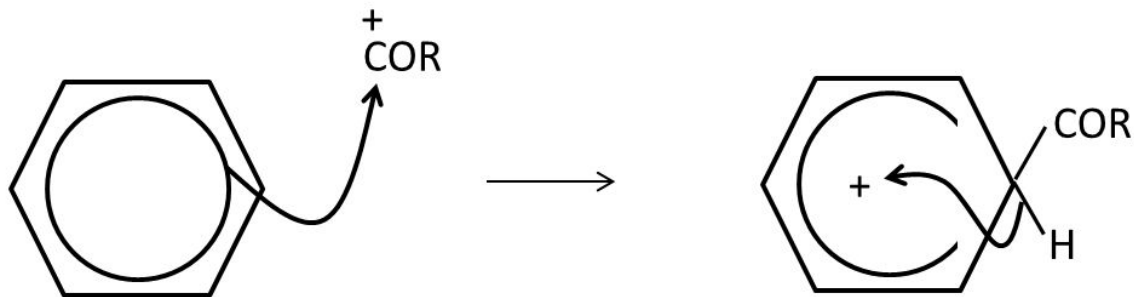
Use a halogenoalkane and AlCl_3 to create an electrophile that can attack benzene



Draw the mechanism for the
acylation of benzene from
 RCO^+ .



Draw the mechanism for the acylation of benzene from RCO^+ .



If you are considering cyclic compounds, what might happen if two double bonds are next to each other?



If you are considering cyclic compounds, what might happen if two double bonds are next to each other?

C=C bonds are in close proximity, so electrons in pi cloud/p orbitals can partially delocalise and move between the two C=C double bonds



What effect would electrons in p orbitals moving between the two C=C double bonds have on the stability of the molecule and its enthalpy of hydrogenation?



What effect would electrons in p orbitals moving between the two C=C double bonds have on the stability of the molecule and its enthalpy of hydrogenation?

Makes the molecule more stable; makes enthalpy of hydrogenation more positive

