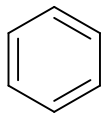
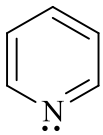
Marks 6

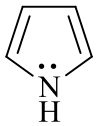
- Benzene, pyridine and pyrrole are all aromatic.



benzene



pyridine



pyrrole

cyclopentadiene
pK_a = 15

cyclopentene
pK_a = 45

What three criteria must be met for a compound to be aromatic?

- **Cyclic and planar,**
- **Each atom in the ring must have be sp^2 hybridised so that it has a *p*-orbital perpendicular to the ring and**
- **The π system must have $4n+2$ electrons where *n* is any integer.**

Apply your previous answer to explain the following.

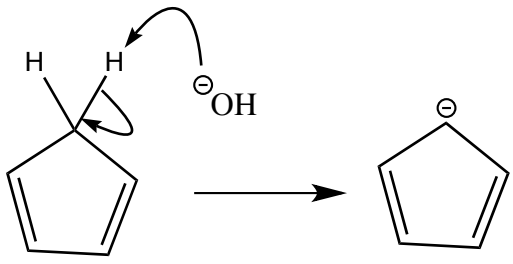
Pyridine is basic but pyrrole is not.

The N in pyridine contributes 1 e^- to π system which adds to the 5 e^- from the carbon atoms to give an aromatic electron count of 6. The lone pair on N is in an sp^2 hybrid, pointing out from the molecule and lying in the plane. It is not involved in the π system and is free to attach a proton. It is basic.

The N atom in pyrrole uses its 'lone pair' in the π system to add to the 4 e^- from the carbon atoms to give an aromatic electron count of 6. The 'lone pair' is in a *p*-orbital and is part of the π bonding. It is not available to attach a proton. It is not basic.

The pK_a of cyclopentadiene is much lower than that of cyclopentene.

Cyclopentadiene, C_5H_6 is not aromatic; there is a CH_2 group in the ring and it is not planar. Lose of a proton to give $C_5H_5^-$ however leads to a lone pair on one carbon atom. Adopting a planar geometry gives 6 π electrons and an aromatic molecul

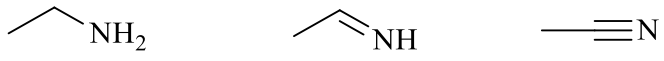


The analogous reaction for cyclopentene does not lead to an aromatic system as there are still CH_2 groups in the ring and it is not planar.

The additional aromatic stabilisation of the conjugate base of cyclopentadiene increases its acidity and lowers its pK_a.

- Consider the amine **D**, imine **E** and nitrile **F** shown below. Draw any lone pairs of electrons that are required to complete the structures.

Marks **3**



D **E** **F**

What is the hybridisation at *N* in compound **D**?	***sp*^{3}**
What is the hybridisation at *N* in compound **E**?	***sp*^{2}**
What is the hybridisation at *N* in compound **F**?	***sp***

Which of these compounds is the most basic? Why?

D is most basic. The s*p*^{3} hybridised N has more *p* orbital character (75%) compared to s*p*^{2} (67%) or s*p* (50%). D therefore has a more diffuse lone pair that is more available for protonation.

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.