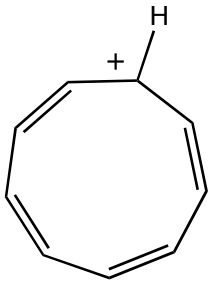
Additional Problems for practice:

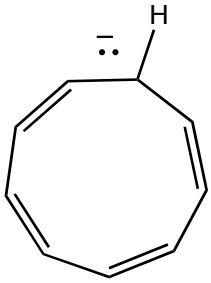
1. Which would you expect to be the most stable: the cyclononatetraenyl cation or anion? Why?

cation:unstable



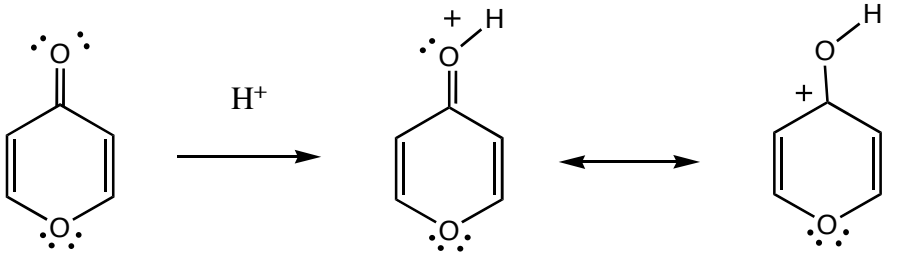
8 π electrons
4N => antiaromatic

anion:stable

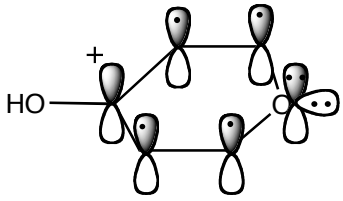


10 π electrons
4N+2 ==> aromatic

2. Upon reaction with acid, 4-pyrone is protonated on one of the oxygens to give a stable cationic product. Which oxygen is protonated and what is the structure of the protonated product? Explain the stability of the protonated product.

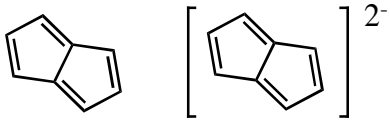


aromatic: 6π electrons



4-pyrone

3. Pentalene, shown below, has never been isolated; however, the pentalene dianion is well known and quite stable. Explain

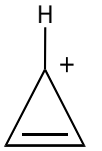


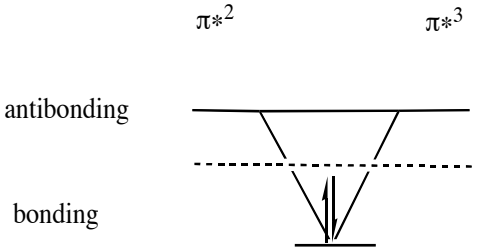
Pentalene Pentalene dianion

The pentalene dianion has 10 π electrons and is therefore aromatic; it is a stable molecule. Pentalene, on the other hand, has 8π electrons and is thus antiaromatic, so it is expected to be highly reactive and not very stable.

4. Draw an energy diagram for the three molecular orbitals of the cyclopropenyl system. How are these three molecular orbitals occupied in the cyclopropenyl anion and cation? Which of these species is predicted to be the most stable and aromatic?

Cyclopropenyl cation





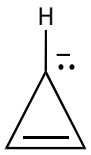
π^1

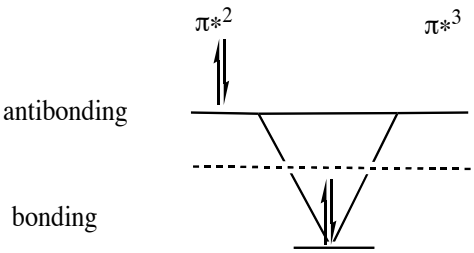
4N+2, N=0

2π electrons

stable: aromatic

Cyclopropenyl anion





π^1

4N, N=1

4π electrons

unstable: antiaromatic

5. Draw the overlapping p-orbitals that make up the aromatic system of the following molecules. Indicate the location of the nitrogen lone pairs, and indicate whether each nitrogen in basic or non-basic. How many p electrons does each nitrogen donate to the aromatic pi system?