4n+2 Rule Aromatic Cyclic Alkenes

If we consider first the rings, from 6 to 10.

Note that some ring have only bonding and nonbonding orbitals but ring 8 also has nonbonding orbitals. Can you see this. The odd numbered rings have an unpaired electron in an orbital. Would they want to lose or gain this electron? Why? Why does 8 have unpaired electrons. Note that some of the rings have their bonding orbitals filled. Which are they? These are the rings that will be aromatic.

The rings with a unpaired electron in an antibonding orbital would like to lose that electron while the rings with an upaired electron in a bonding orbital want to gain an electron. Thus we conclude that rings 6 and 10 are especially stable since they have all the bonding orbitals filled with electrons and all are paired. Can you figure out the rule for when you have this situation.

The especially stable molecules are named aromatic and are planar. The other members of this group all are nonplanar (or distorted from planar) because they are more stable with localized bonds then nonlocalized bonds.

The rule for aromatic rings is 4n+2 where n is the number of C atoms. These compounds all have half the MOs are bonding and half are nonbonding. Since you have (4n+2)/2 bonding orbitals and 4n+2 electrons and each orbital takes 2 electrons all the bonding orbitals are filled up and the molecules are aromatic.

Now consider the even number rings that don't meet the 4n+2 rule. These are rings of 4, 8, 12,14,16,…atoms. These rings have a central pair of orbitals that is non-bonding and is half filled. (Note that you have single orbitals at low and high energy and all the other are pairs thus for 4,8,12,14,16 member rings you get 2,4,10,14 orbitals that will form degenerate pairs. Thus one of the pairs will be nonbonding). Thus the molecule can distorts to split the nonbonding orbitals and then both electrons can go into the more stable orbital. Thus it is best to distort. On the other hand if the orbitals are filled then distortion does not help you.

Why are the odd number unstable and they tend to form H_{n+1}C_n.

Now try these. Which are aromatic which distort and which are unstable and react?
For the odd number rings we get the following diagrams:

It shows that all the odd rings have a degeneracy problem. Thus if they distort they will become more stable. This is what happens. For 5, 7, and 4n+1 the anion is stable while for 4n+3 you have the cation stable.