

 Assuming the compounds below are flat and atoms that have a lone pair (drawn or not drawn) are sp<sup>2</sup> or sp hybridized, indicate whether the compounds are aromatic, antiaromatic, or neither (10 points).



3. Using the structural skeletons provided, draw resonance structures for the following cation to show how the charge is distributed throughout the structure. Include the appropriate curved arrows needed to convert one structure to the next (12 points)



4. Provide the major product for each of the following reactions. Be careful to account for the regiochemistry and stereochemistry in each transformation (40 points).



5. Provide the major product for the following Diels-Alder reactions. Relative stereochemistry and regiochemistry is very important (10 points).



6. Use the diagram below to give the product of the the following reaction (4 points).



7. Provide reagents for the following reactions (8 points).



8. Provide the products for the following multistep reactions. Show intermediate products for partial credit (8 points).



9. Give the major products for the following reactions (you will likely need arrows here) (8 points).



10. Draw a detailed mechanism for the following reaction. Be sure to show all resonance structures, and curly arrows. Note you can use B: on any charged structure as necessary (12 points).



11. Provide a retrosynthetic analysis for the following molecule. Your only source of carbon containing starting materials is cyclopentanone and methane (both shown below). To receive full credit, you must work backwards, and you must include reagents. (10 points)



Alternate route (not as good because it does not give cis diol)

