

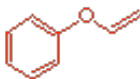
**CHEM 163 MIDTERM**  
**February 15, 2000**  
**Dr. John C. Vederas**

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**I. Structure and Nomenclature - 55 Points -**

**A.** Draw structures for which names are given, or name the given structures by any correct (systematic or common) nomenclature. Be sure to give cis or trans (or if appropriate Z or E) or R or S assignment to the isomer where indicated by asterisks (\*\*\*) . **(4 points each)**

1. phenyl vinyl ether



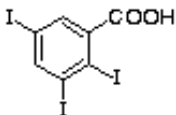
2. ethylene glycol (antifreeze)



3. pyridine



4.



induces flowering in fruit trees

**2,3,5-triiodobenzoic acid**

\*\*\* 5.



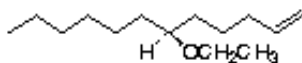
(a pheromone which induces interspecies mating of male cotton bollworms with female tobacco budworms thereby killing both)

**cis (or Z) 11-hexadecen-1-ol**

6. Tetradeca-2,4-diyne-1-ol (a sperm attractant for coral polyps)

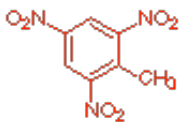


\*\*\* 7.



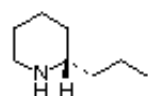
**S-6-ethoxy-1-dodecene**

8. 2,4,6-trinitrotoluene (TNT)

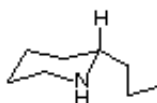


**B. Determine whether the following pairs of structures are identical, structural isomers, diastereomers or enantiomers. (4 points each)**

1.



and



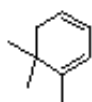
**Identical**

coniine - hemlock poison

2.

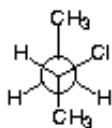


and



**Structural Isomers**

3.

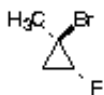


and

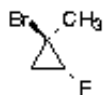


**Identical**

4.

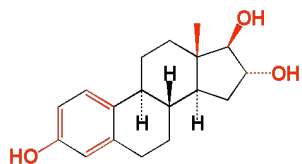


and



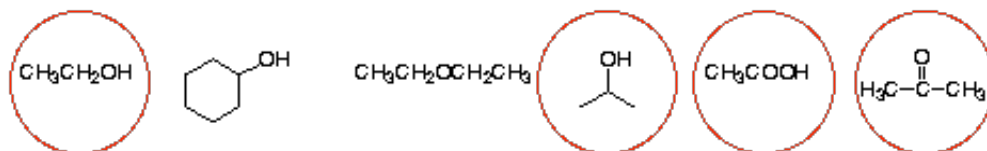
**Identical**

**C. Large amounts of estriol are produced by the human placenta during pregnancy. Unlike most female sex hormones, this compound can also be obtained from plant sources (e.g. pussywillows). One of its chemical names is estra-1,3,5-triene-3,16alpha,17beta-triol. Complete the structure of estriol with correct stereochemistry (do not forget the methyl group(s) necessary to complete the estrane (estrogen) skeleton). (7 points)**

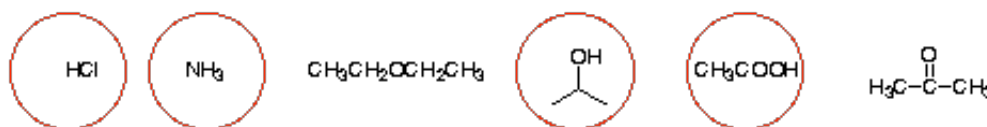


## II. Physical Properties and Reactivity - 23 Points

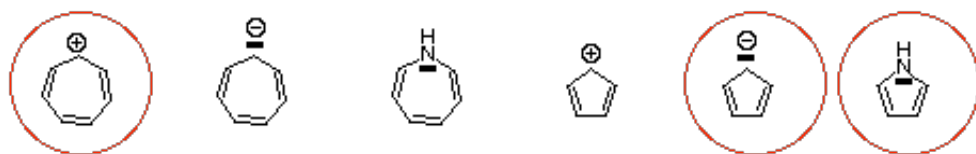
A. In the group below circle all compounds which are miscible (infinitely soluble) with water. **3 pts**



B. In the group below circle all of the molecules which can hydrogen bond to an identical one. **3 pts**

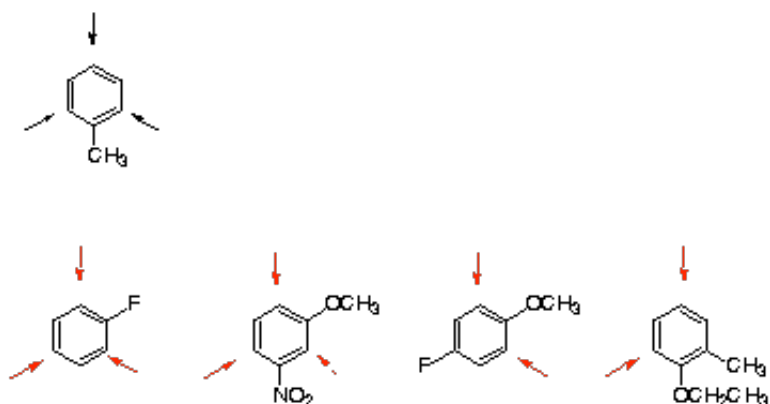


C. In the group below circle all aromatic compounds or ions. **3 pts**

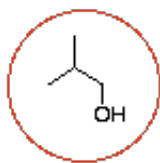


D. In the group below use an arrow to indicate position(s) on the aromatic ring which would be most likely to be attacked by chlorine in the presence of  $\text{FeCl}_3$  (**4 pts - 1 pt each**)

Example:

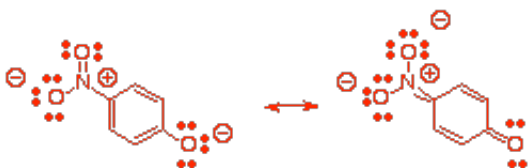
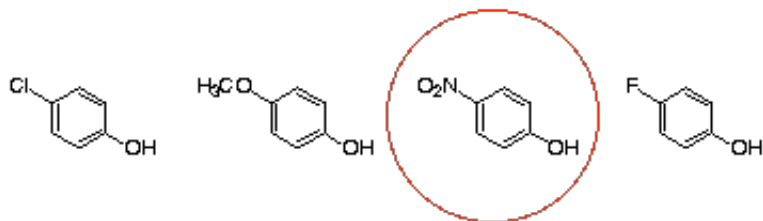


E. Circle the most acidic of the two alcohols shown below. Use two words or less to name the effect that explains why it is much more acidic (more stable anion) than the other (by a factor of ca 1000) (**4 pts**)



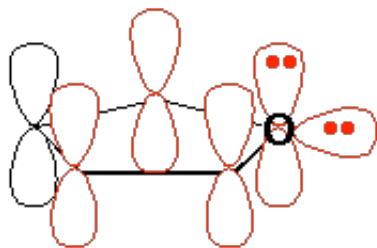
**Inductive Effect**

F. In the group below, circle the most acidic compound. Use two resonance structures of the corresponding anion to show what makes your choice especially acidic. (6 pts: 1 pt for correct circle)



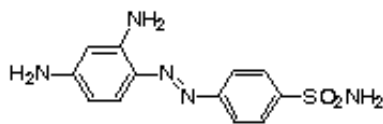
### III. Definitions and Applications - 11 Points

A. Furan is a heterocyclic aromatic compound that occurs in oils obtained by distillation of pine resin. Its molecular formula is  $C_4H_4O$ . In the part structure below draw the p atomic orbitals involved in forming the aromatic system in correct geometry. One has been drawn for you already. Also indicate the geometry of any orbital(s) having a lone (unshared) pair of electrons that are not part of the aromatic system. If there are none that fit this description, write "No additional lone pairs" (5 points)



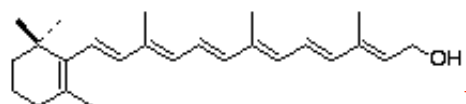
B. The three compounds shown below were discussed in class. Identify them by common name and briefly (10 words or less) describe their importance or use. (6 points total - 2 pts each)

1.



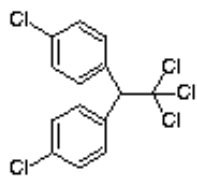
**Prontosil - first Sulfa Drug - first broad spectrum antibiotic**

2.



**Retinol or Vitamin A - an essential nutrient converted to visual pigment - part credit for beta-carotene**

3.

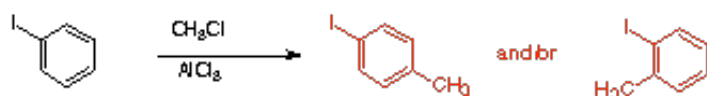


**DDT - insecticide and environmental contaminant**

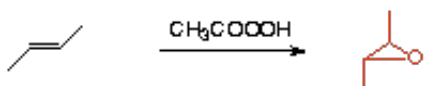
#### IV. Reactions - 30 Points

A. Show the structure of the major organic product of each of the following reactions. Show stereochemistry where indicated by asterisks (\*\*\*). (3 points each - 15 points total)

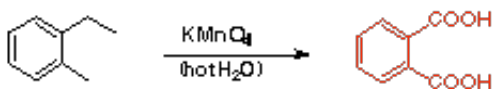
1.



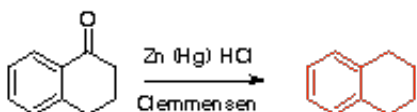
\*\*\* 2.



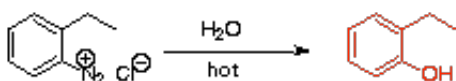
3.



4.

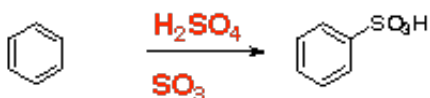


5.

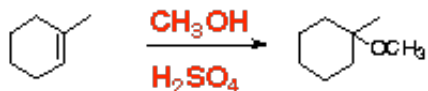


B. Show reagents that will do the required transformations. In some cases two steps may be necessary. (3 pts each - 15 pts total)

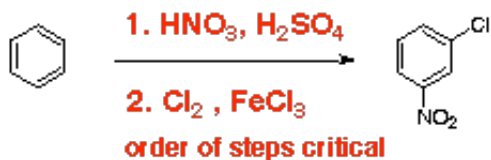
1.



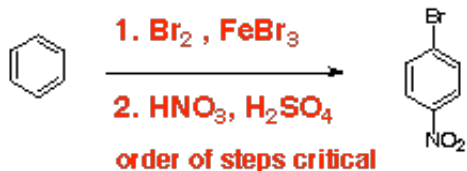
2.



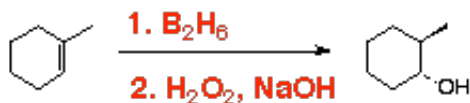
3.



4.

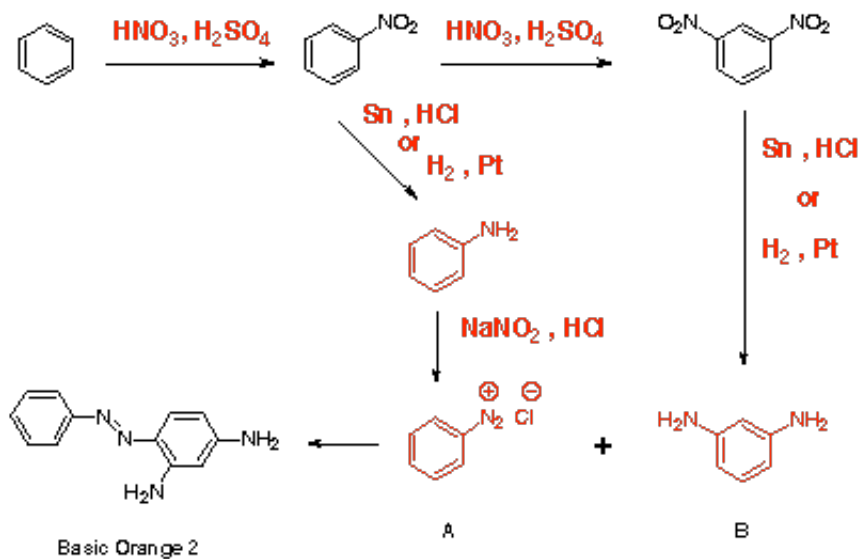


5.



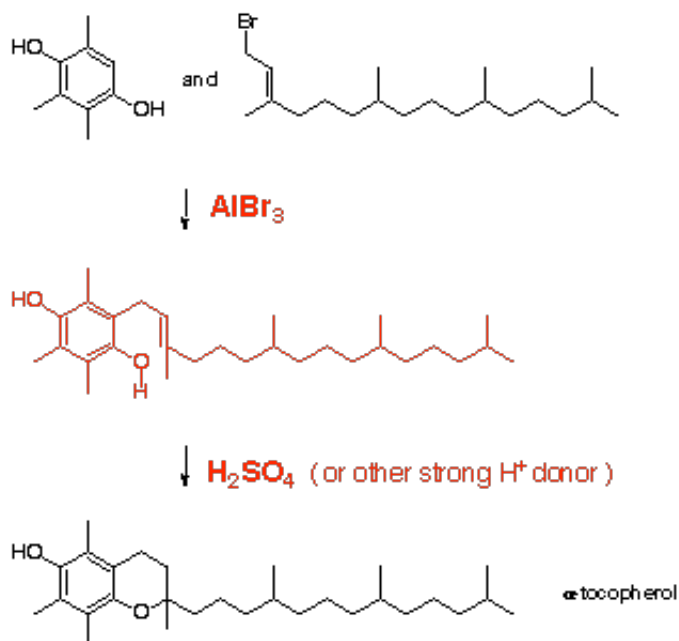
## V. Synthesis and Mechanism - 31 Points - Should be 24 points

A. Basic Orange 2 was the first azo dye made commercially (1875) and is still used for dyeing leather and paper. It can be synthesized in several steps as outlined below. Show how it can be synthesized from benzene by providing necessary inorganic reagents and showing the structures of compounds generated by each reaction. Hint: nitrobenzene and m-dinitrobenzene provide the two aromatic portions. (7 points)



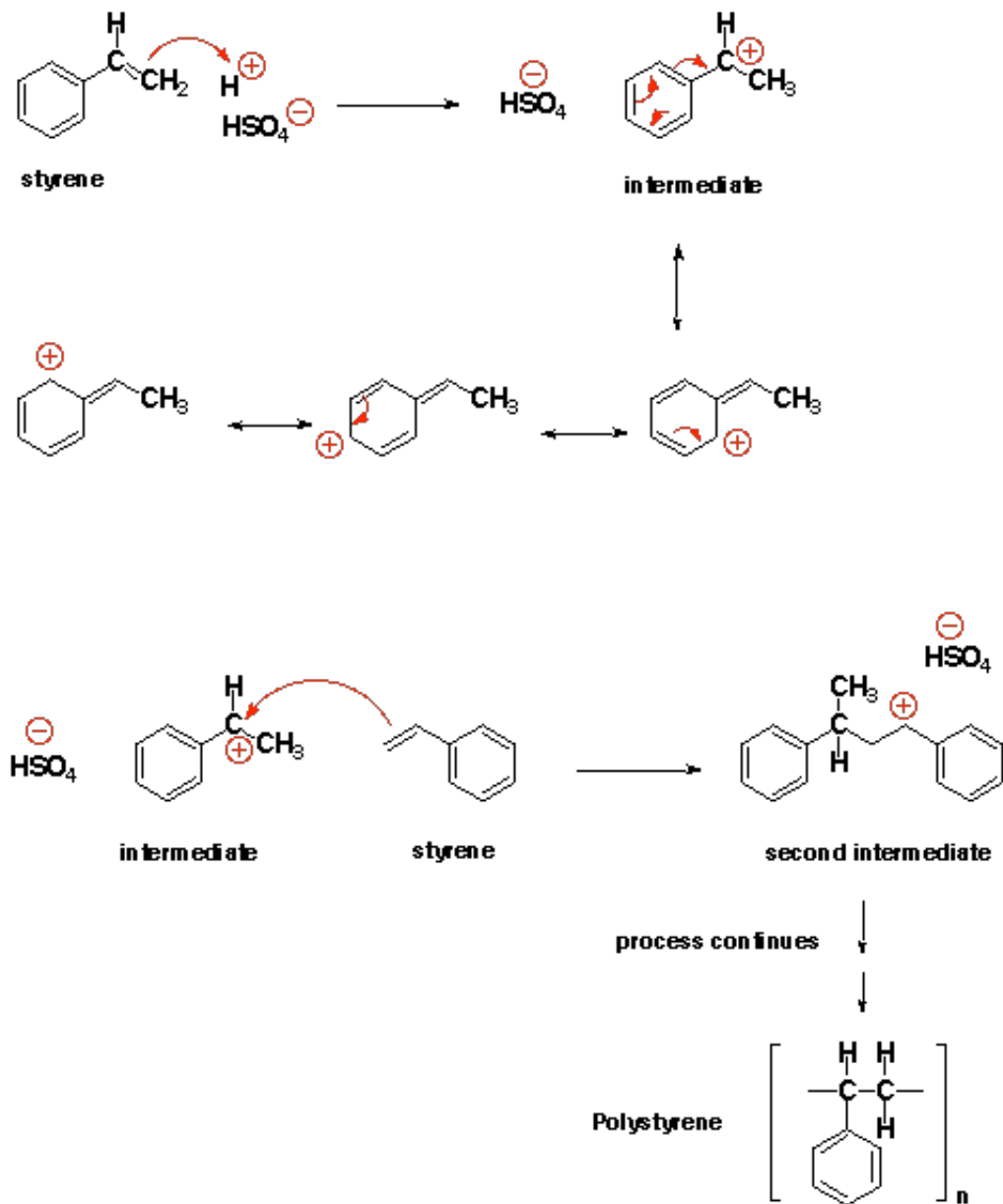
B. Vitamin E is a mixture of substances known as tocopherols (Greek *tokos* (childbirth) and *phero* (to bear)) which act as biological antioxidants and are abundant in vegetable oils, cereal and eggs. Tocopherol deficiency in rats causes sterility, fetal resorption by pregnant females, and atrophy of reproductive organs in males. However, Vitamin E deficiency disease has not been recognized in humans. Show how to synthesize

alpha-tocopherol in several steps from the indicated starting materials by providing necessary reagents and showing the structures of compounds generated by each reaction. (5 points)



C. The mechanism of sulfuric acid-catalyzed polymerization of styrene to polystyrene is depicted below. Resonance stabilized intermediates are shown. However, the entire mechanism is missing charges and curved arrows to depict the movement of electrons. Provide all missing charges and arrows - check carefully as each one is worth points. (12 p

oints)



**Extra Credit (3 points):** Provide a detailed "step by step" mechanism for the reaction shown below. Be sure to show the structures of the key intermediate(s) and indicate the movement of electrons using the curved arrow convention. (Answer provided on sample midterm at Website)



