Chemistry 210 -- EXAM 4 (Fall 2003 - Dr. Robertson)

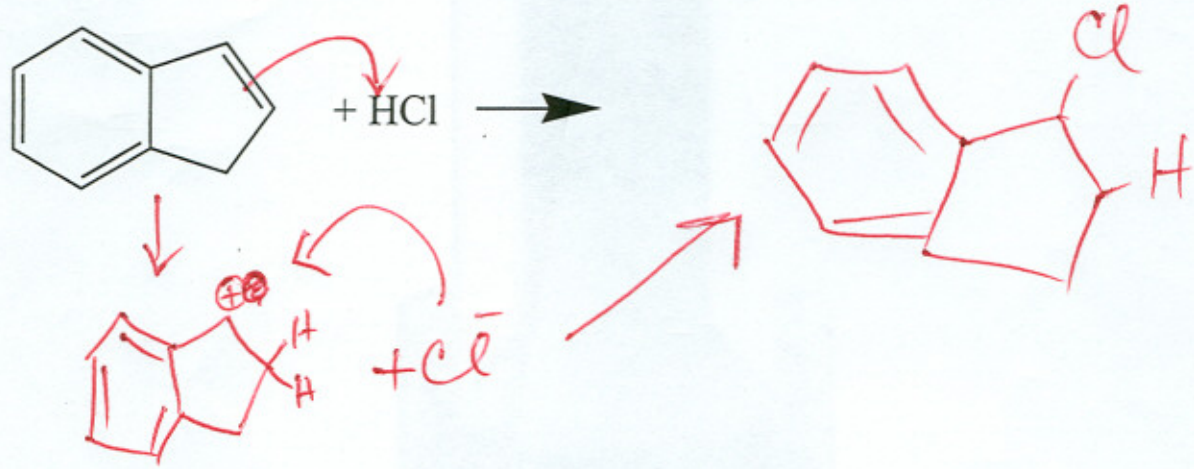
***** *BEFORE BEGINNING EXAM, PLEASE READ THE FOLLOWING* *****

The exam consists of this cover sheet, which contains an extra credit problem, which is optional. There are 10 problems to solve. The time limit for this exam is *2 hours*. Please read problems carefully so that you understand the entire problem. *No work = no credit.*

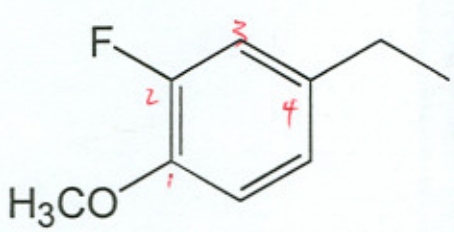
Signed _____ Key

OPTIONAL EXTRA CREDIT (4 points total):

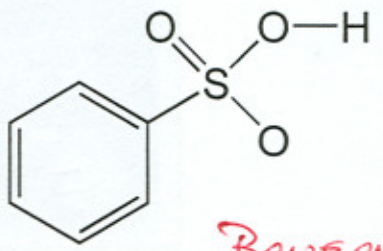
(2 Points) Show (i) the correct reaction mechanism and (ii) correct product for the following reaction (consider this an "allylic" type reaction for correct placement of the Cl atom in the 5-membered ring):



(2 Points) Give the correct names for the following compounds:



2-Fluoro-4-ethylanisole



Benzene sulfonic acid

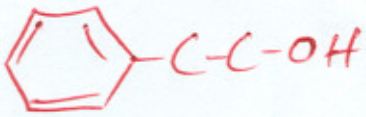
Chemistry 210
Exam 4 (December 10, 2003)

Name Key
ID# _____

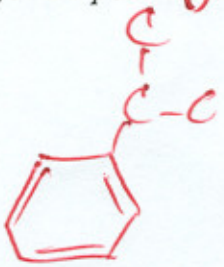
For reactions, if you need the structure of a reactant, you can ask for it, for a 1 point deduction.

16 1. Show structures for:

2-phenylethanol



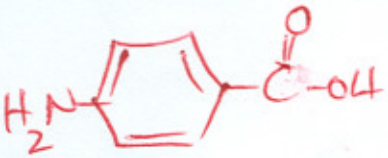
isopropylbenzene



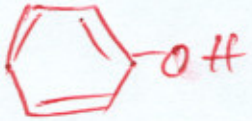
p-nitrotoluene

m-xylene

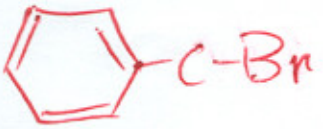
p-aminobenzoic acid



phenol



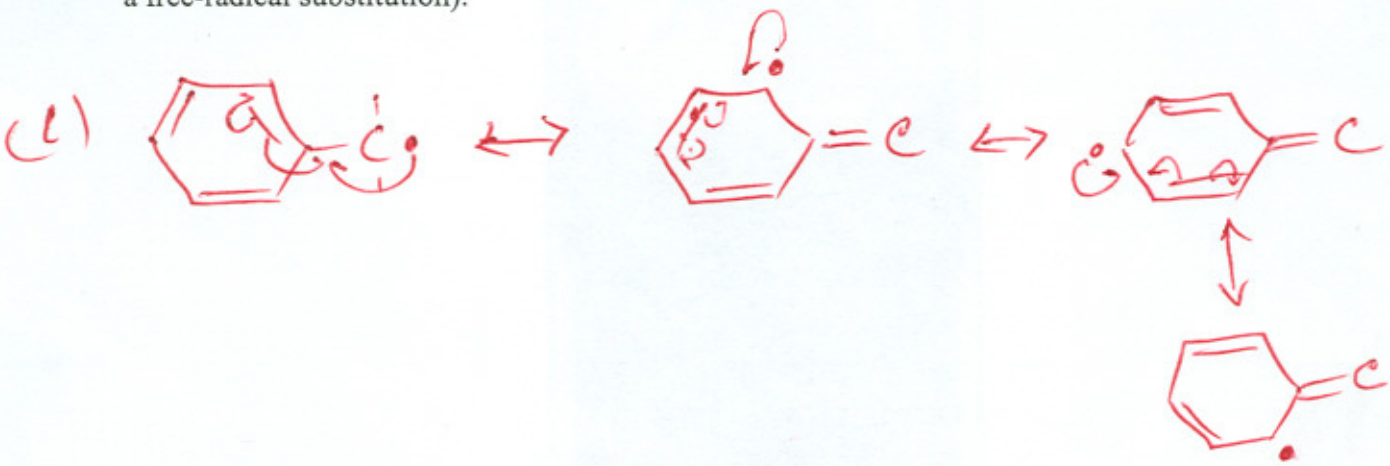
Benzylbromide



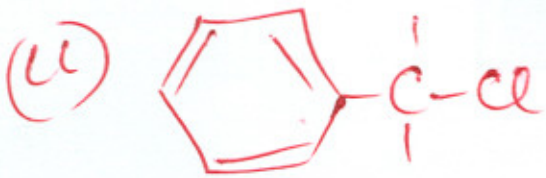
naphthalene

8 2. (i) Show the structure of a benzyl free radical. Then, show 3 additional resonance structures derived from this free radical. (ii) Show the *major* product for the free radical chlorination of toluene (which undergoes a free-radical substitution).

(i)

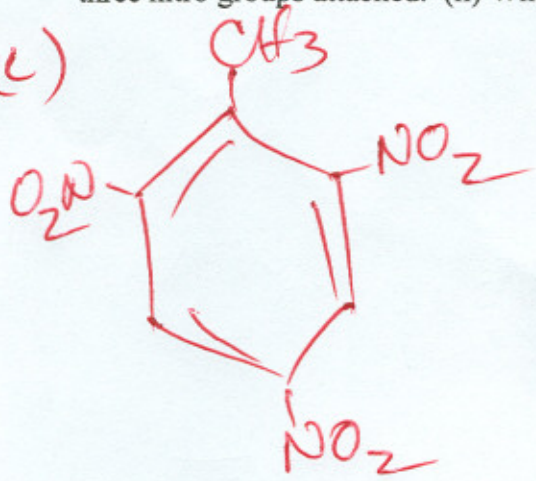


(ii)



8 3. (i) Starting with toluene, show the product ~~if you under~~ nitration ~~reactions~~ to produce a molecule having three nitro groups attached. (ii) What is the name of this compound?

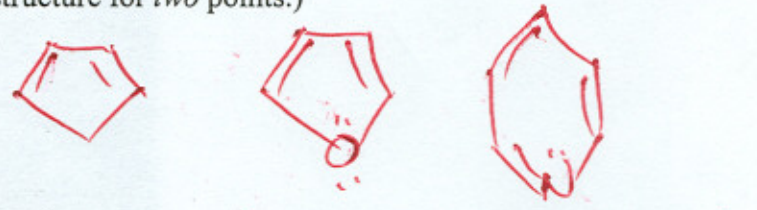
(i)



(ii) 2,4,6-trinitrotoluene

12 4. (i) What is Hückels Rule for aromaticity (3 pts)? (ii) Show structures for: cyclopentadiene, furan, and pyridine (2 pts each). (iii) Which of these compounds is aromatic (3 pts)? (If you need structures, for each structure you need, I will give you the structure for *two* points.)

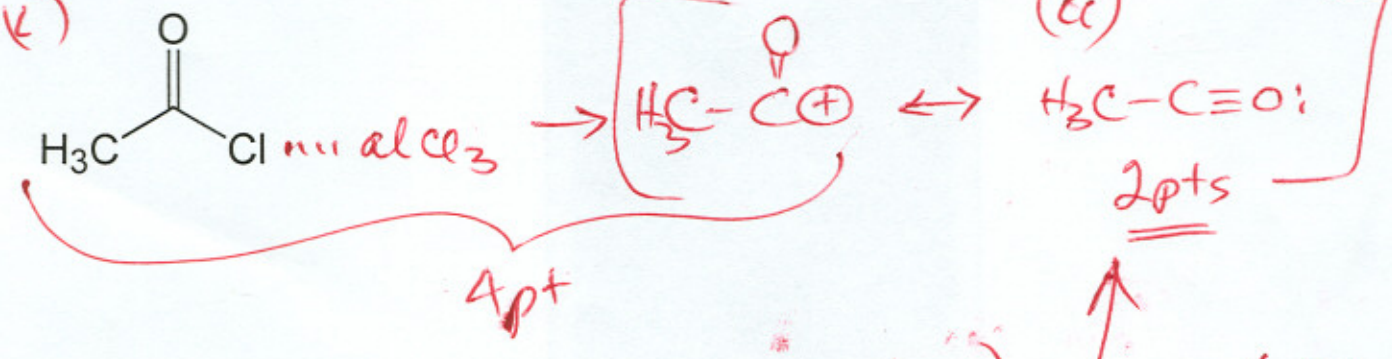
(i) $4n+2$ (ii)



(iii) NOT aromatic — aromatic — aromatic

8 5. (i) Show how you could produce an acylium ion from acetyl chloride (structure is shown) and $AlCl_3$ as catalyst (4 pts). (ii) Draw one resonance structure of this ion (2 pts). (iii) Which of these resonance forms is more stable (2 pts)?

(i)



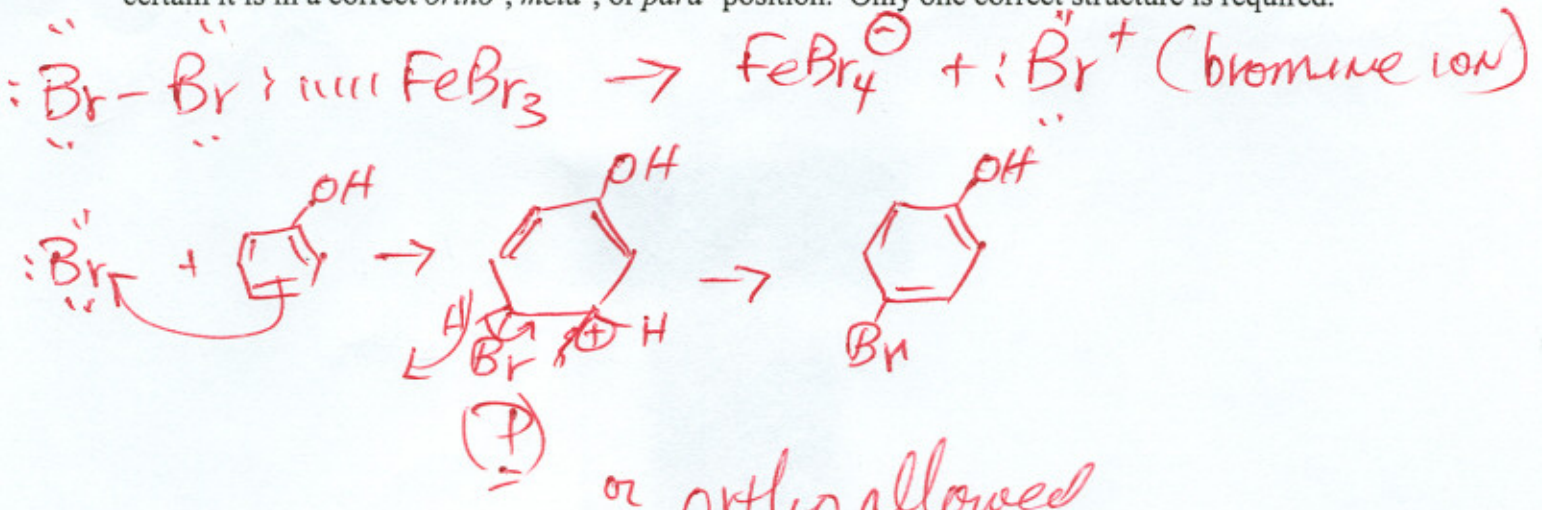
4pts

(ii)

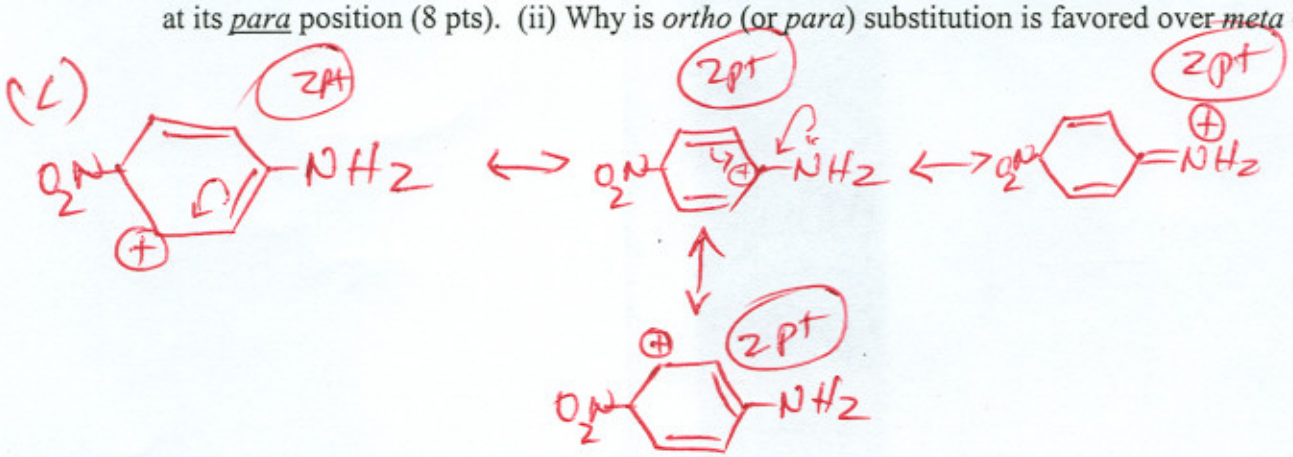
2pts

(iii) Most stable due to octet rule. (2pts)

10 6. (i) Show the reaction mechanism for bromination of phenol, including the catalyst required to produce the bromine ion (Br^+, the electrophile) from Br_2 (6 pts). (*Intermediate resonance structures are not needed.*) (ii) Show the structure for the original reaction intermediate (as a carbocation), making certain it is in a correct *ortho-*, *meta-*, or *para-* position. Only one correct structure is required.

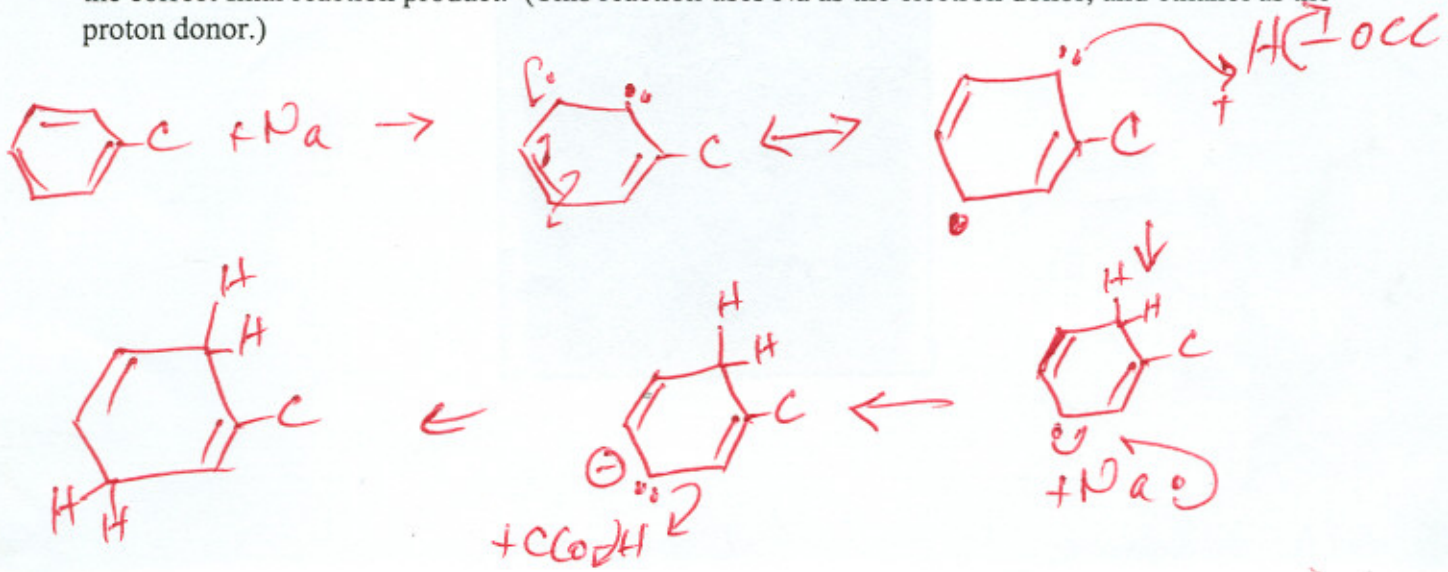


12 7. (i) Starting with aniline show *all* possible resonance structures (4 resonance contributors) for nitration at its *para* position (8 pts). (ii) Why is *ortho* (or *para*) substitution is favored over *meta* (4 pts)?



(ii) O or P puts (+) charge on carbon #1

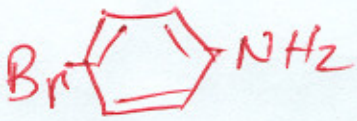
5 8. Show the reaction pathway (mechanism) for a Birch reduction (hydrogenation) of toluene, including the correct final reaction product. (This reaction uses Na as the electron donor, and ethanol as the proton donor.)



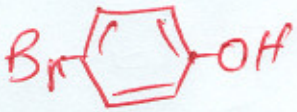
16 9. Show the *major* product (*no* reaction mechanism required) for bromination of the following (draw the structure of the compound listed first, then attach the bromine ion to the correct carbon):

toluene

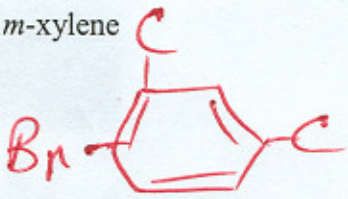
aniline



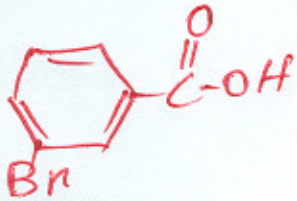
Phenol



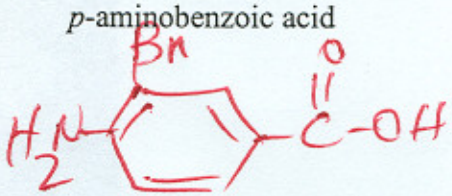
m-xylene



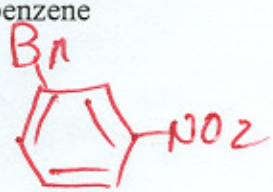
benzoic acid



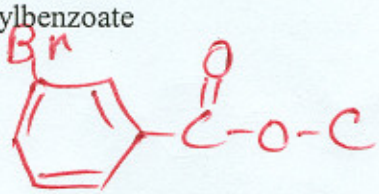
p-aminobenzoic acid



Nitrobenzene



methylbenzoate



5 10. You want to produce pure, without any side products, octyl benzene. Show how you could use a Friedel-Crafts *acylation* reaction, followed by catalytic hydrogenation, to produce this product.