

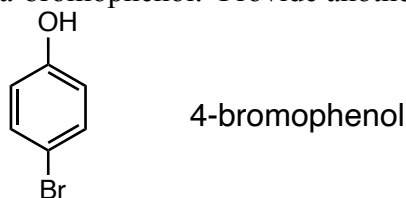
Problem Set Chapter 19

Organic Chemistry for
Life Sciences: CHM 224

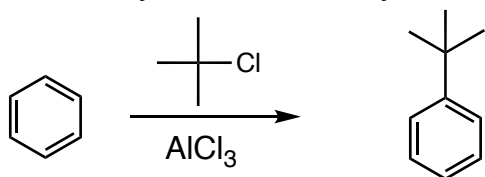
Name _____

PRACTICE Problem Set

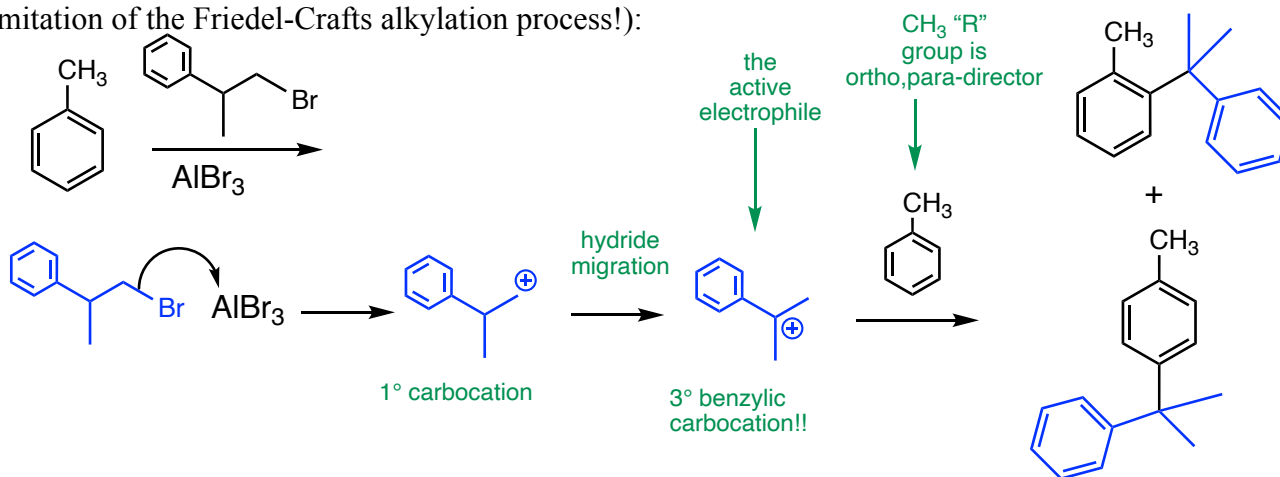
1. Draw the structure of para-bromophenol. Provide another acceptable name for this compound.



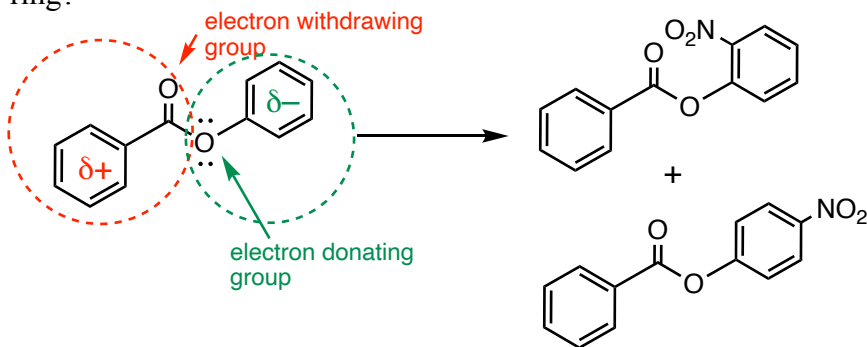
2. Provide a synthesis of tert-butylbenzene starting with benzene and any other necessary reagents.



3. What would be the expected product of the following Friedel-Crafts reaction (HINT: remember the major limitation of the Friedel-Crafts alkylation process!):

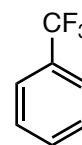


4. The compound below has two benzene rings. If only **1 equivalent** of HNO₃, H₂SO₄ is added, which ring would be preferentially nitrated? What would be the product(s) of the reaction resulting from reaction at that ring?



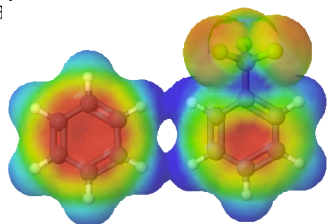
- the left benzene ring has an electron-withdrawing group (COG) directly attached that **depletes** electron density in the ring
- the right benzene ring has an electron-donating group (OR) directly attached that **increases** electron density in the ring, and therefore, reactivity towards electrophiles
- the OR group is ortho, para directing and so the NO₂ group ends up at the positions ortho and para to the OR

Open the "Model Kit" from the course webpage. Click on "Name" under "Load Models" and type in trifluoromethylbenzene which has the structure provided. Then click on "Draw" under "Load Models", click on the benzene ring and click once to add a benzene molecule. Click on "Append Molecule". Both benzene and trifluoromethylbenzene should be visible on the screen. Click "MEP" under "Other Model Actions" to create the electrostatic potential map for both compounds and answer the two questions below.



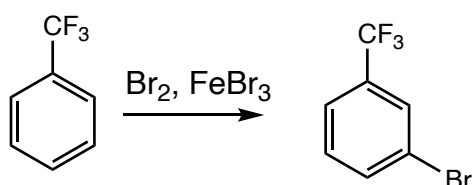
trifluoromethylbenzene

5. Based on the amount of electron density at the center of the benzene ring as revealed by the electrostatic potential map, is the CF₃ group acting as an electron donating or as an electron-withdrawing group? Briefly explain.



- the benzene ring (on the right) for trifluoromethylbenzene is significantly less electron rich as indicated by the lesser volume of red color.
- the CF₃ group must, therefore, be acting as an electron withdrawing group and pulling electron density out of the benzene pi system

6. Based on what was learned from question 6, what is(are) the expected product(s) of the following reaction:

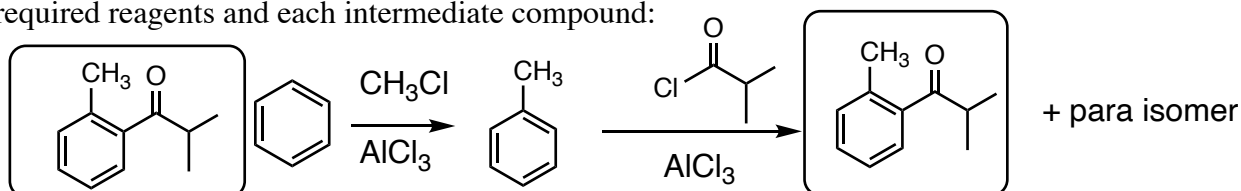


- because the CF₃ is apparently an electron withdrawing group, it is expected to be a meta-director

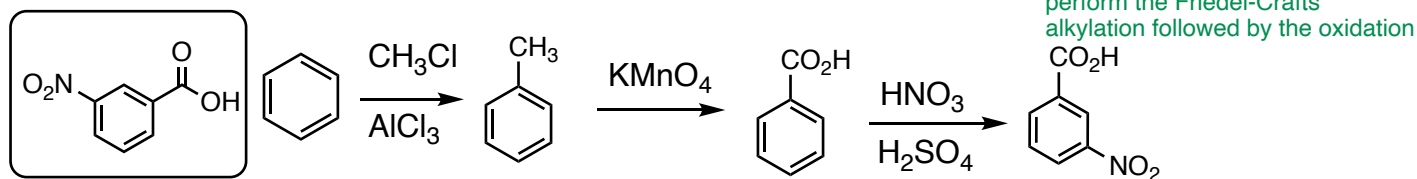
7. Will reaction of trifluoromethylbenzene with HNO₃/H₂SO₄ be faster or slower than the reaction with benzene under otherwise identical reaction conditions? Briefly explain.

Since the CF₃ is acting as an electron-withdrawing group (deactivating) it will slow down the rate of reaction of electrophiles relative to benzene

8. Provide a reasonable stepwise synthesis for the following compound starting from benzene and showing required reagents and each intermediate compound:



9. Provide a reasonable stepwise synthesis for the following compound starting from benzene and showing required reagents and each intermediate compound:

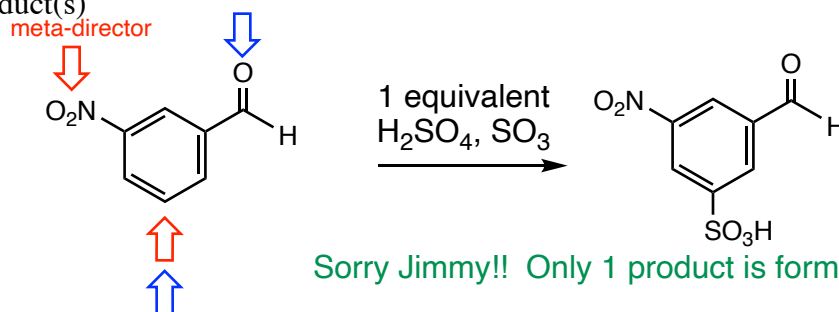


- you could also nitrate first, then perform the Friedel-Crafts alkylation followed by the oxidation

10. Jimmy predicts that 4 major products will be formed in the reaction below. Is Jimmy correct? If not, draw the predicted product(s)



Jimmy



Sorry Jimmy!! Only 1 product is formed!