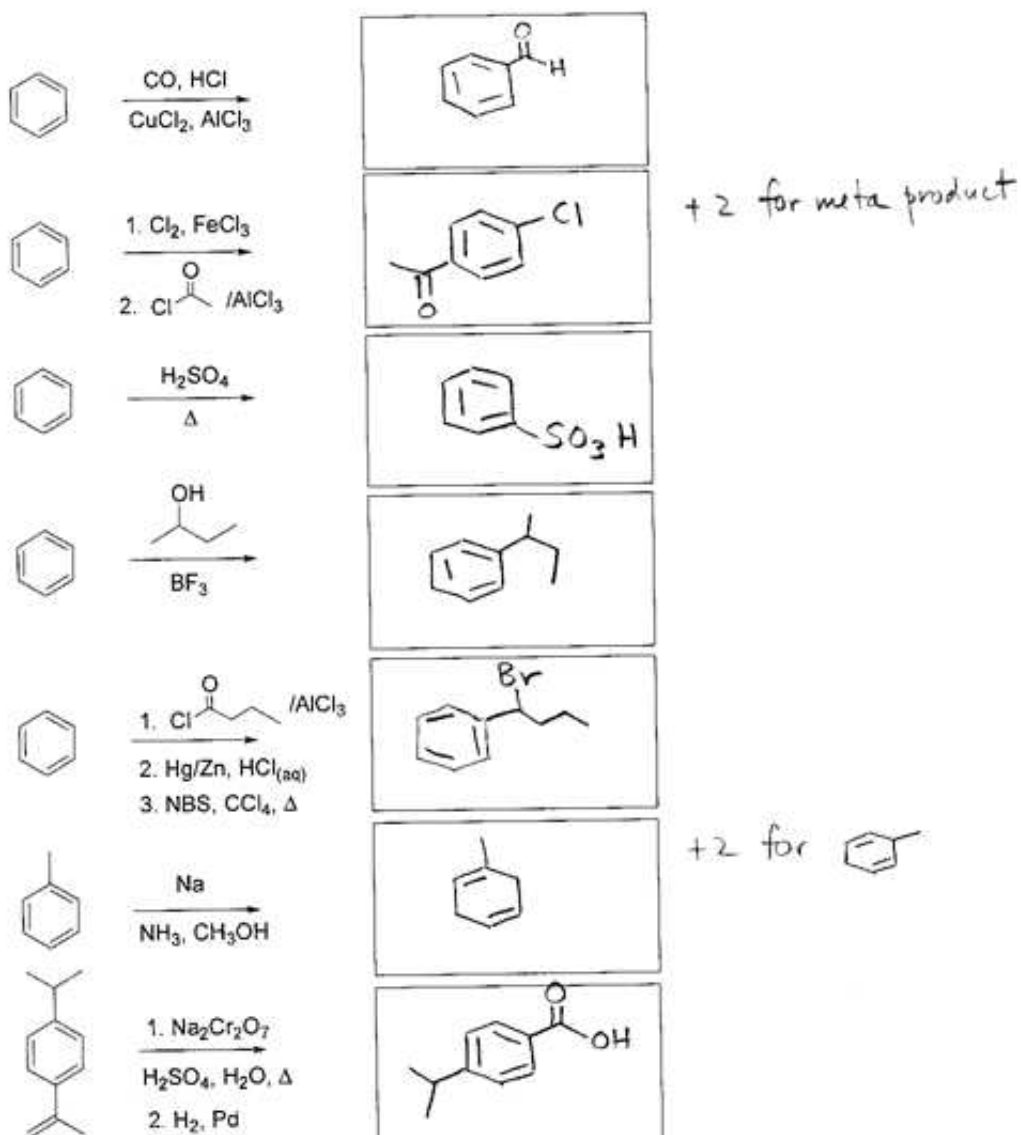
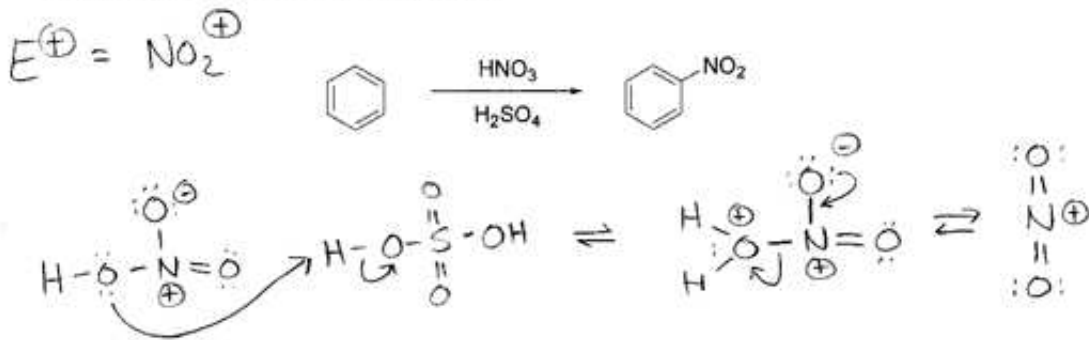


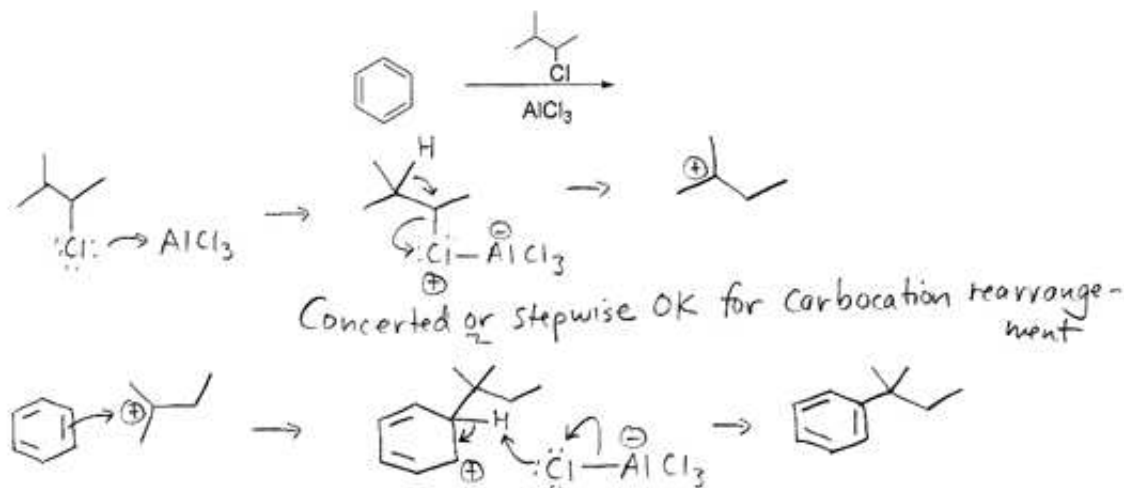
1) Predict the major organic product of each of the following reactions or reaction sequences. If no reaction occurs, write "N.R." (35 pts)



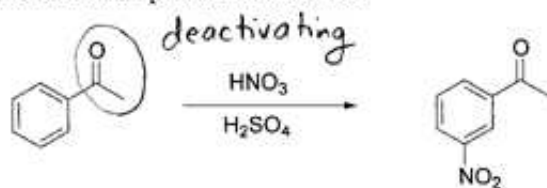
2a) Draw an arrow-pushing mechanism for the formation of the electrophile only in the following transformation. Show all bonds, arrows, formal charges and necessary lone pairs clearly to receive full credit (10 pts).



2b) Predict the product and draw an arrow-pushing mechanism for the following transformation. Show all bonds, arrows, formal charges and necessary lone pairs clearly to receive full credit (10 pts).



3) When acetophenone is subjected to nitration conditions (nitric acid and sulfuric acid), only the *meta* substitution product is observed:



3a) Is the rate of this reaction faster or slower than the nitration of benzene (circle one)? (5 pts)

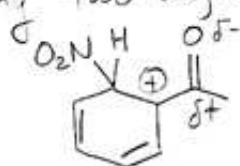
Faster

Slower

Carbonyl group is deactivating

3b) Explain the observed regioselectivity of this reaction. Include any necessary chemical structures or diagrams that support your explanation (20 pts).

Formation of either the ortho or para products would go through an intermediate carbocation that is destabilized by having two adjacent like charges:

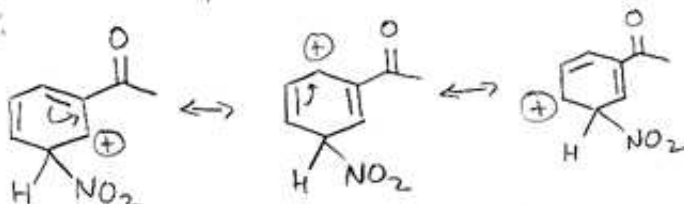


ortho attack



para attack

Formation of the meta product does not involve this destabilization:



The carbocation formation is rate determining and endothermic, meaning that the transition state for this step will most closely resemble the intermediates shown above, both structurally + energetically. So the ortho/para pathways, since they have high E intermediates, will have higher E_a than the meta pathway (relatively more stable intermediate), leading to the observed regioselectivity. (Energy diagram is nice but not essential if explanation is clear.)

4) Propose multi-step syntheses of each of the following target molecules using the starting materials shown. You may use any inorganic reagents and organic reagents containing four or fewer carbons. You don't have to draw any mechanisms, just write the reagents needed for each step and the product of each step (20 pts).

