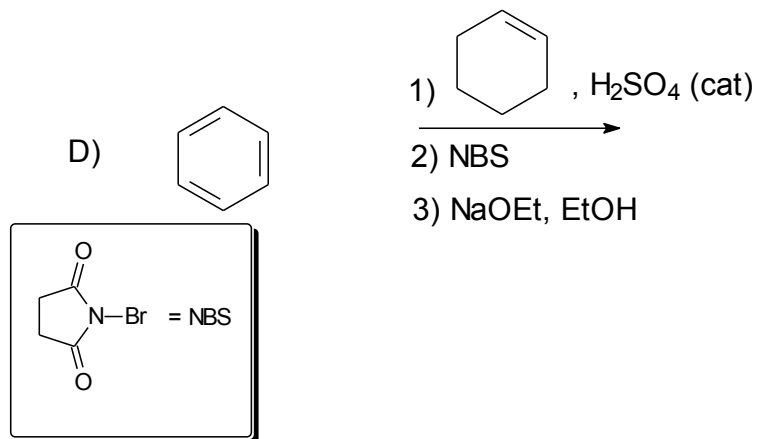
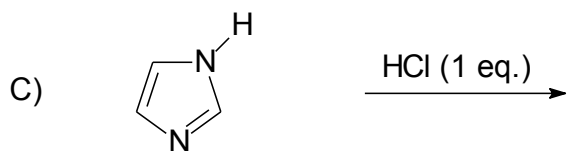
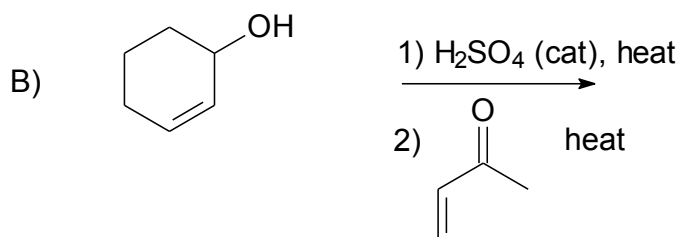
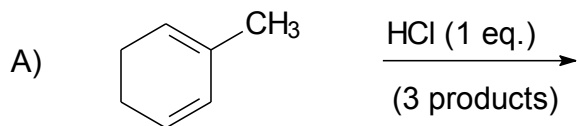
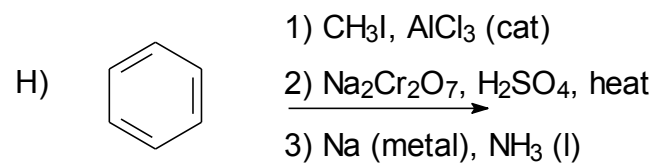
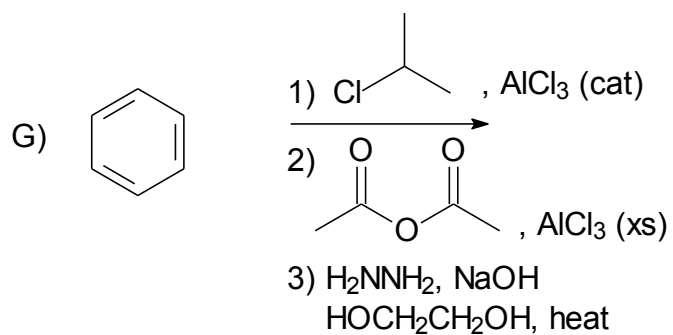
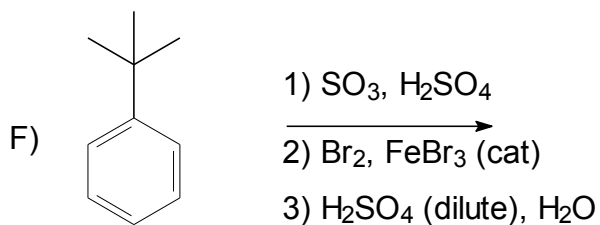
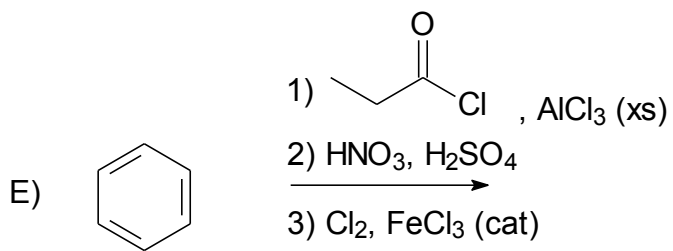
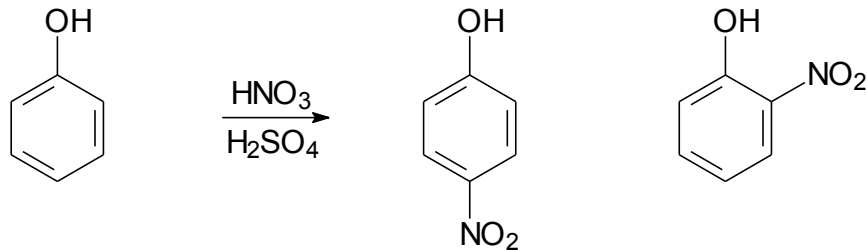


1.(40 pts) Draw the structure(s) of the major organic product(s) in the following reactions. For partial credit, draw the structure(s) of the major product(s) after each step in a multistep sequence. You may presume all electrophilic aromatic substitutions on pages 1 and 2 produce the monosubstitution products only

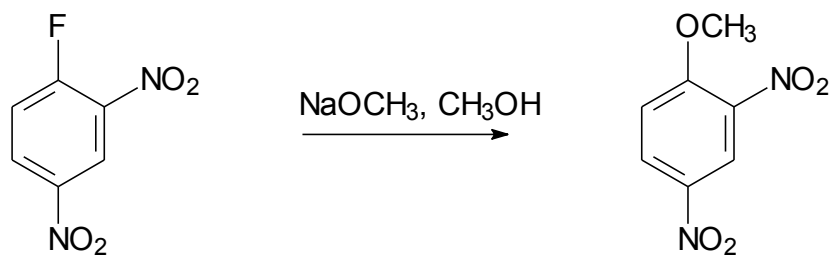




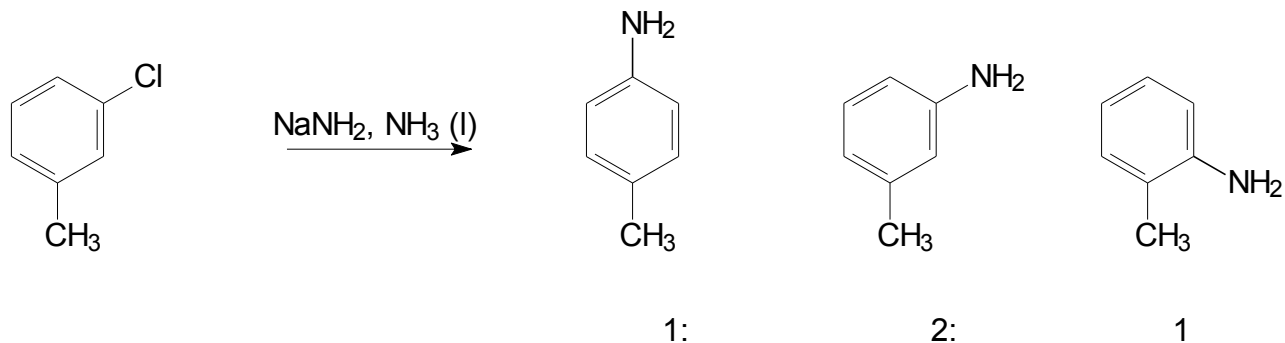
2. (15 pts) Nitration of phenol produces a 1:1 ratio of 4-nitrophenol and 2-nitrophenol. Provide a complete, step by step mechanism for the following transformation (both products). Draw the structures of all intermediates formed in the mechanism. (*including resonance structures*).



3. (15 pts) Provide a complete, step by step mechanism for the following transformation. Draw the structures of all intermediates formed in the mechanism (*including resonance structures*).



4. (15 pts) When 3-chlorotoluene is treated with sodium amide in liquid ammonia, three products are formed in about a 1:2:1 ratio. Propose a reasonable mechanism which would account for the formation of all three products. Use curved arrow notation to indicate the movement of electrons.



5. Suggest a sequence of reagents which would accomplish the following transformations. **More than one step will be required.** Draw the structures of all stable products (you do not need to draw reactive intermediates) formed in the proposed reaction sequence. Do not show any mechanisms.

