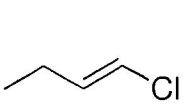
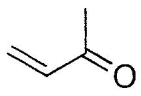
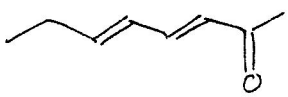
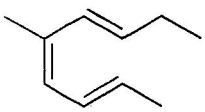
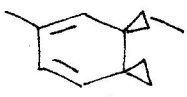
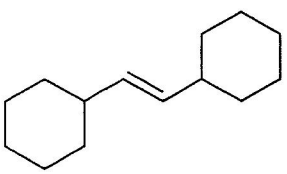
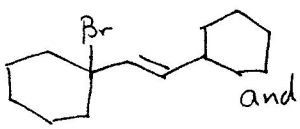
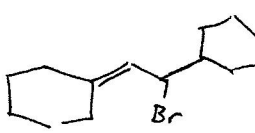
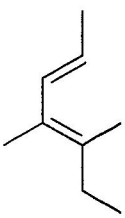
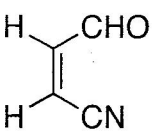
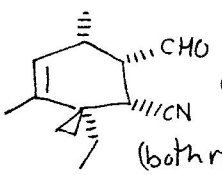
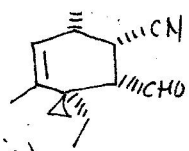
1. **Reactions:** (28 pts). Draw the structure of the expected organic product(s) formed in the following reactions *including correct stereochemistry.* Assume all reagents listed are present in *excess* unless otherwise noted. If no reaction occurs, state 'No Reaction'.

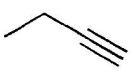
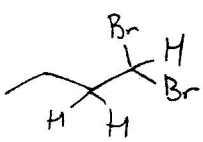
A)  H_2O, H_2SO_4, heat → NR

B)  +  $Pd(OAc)_2$, PR_3, heat → 

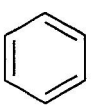
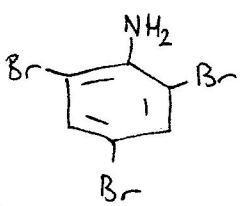
C)  heat, (disrotatory) →  +  (racemic)

D)  NBS, hv →  and 

E)  +  heat →  and  (both racemic)

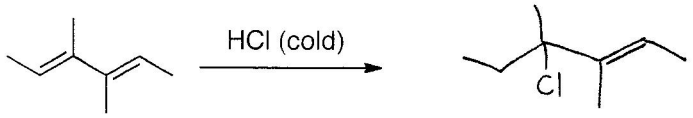
F)  HBr, ROOR → 

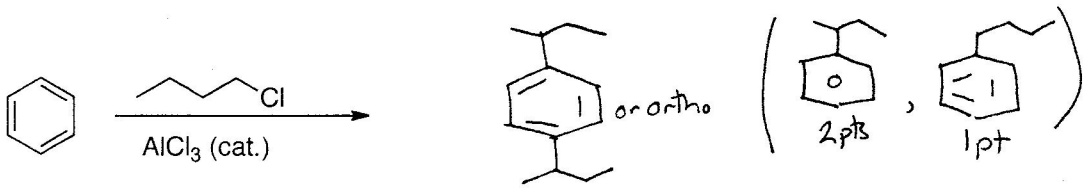
4 pts each

G)  1) HNO_3, H_2SO_4; 2) H_2, Ni; 3) Br_2 (excess) → 

2. **Reactions:** (8 pts). Draw the structure of the expected organic product(s) formed in the following reactions *including correct stereochemistry.* Assume all reagents listed are present in *excess* unless otherwise noted. If no reaction occurs, state 'No Reaction'.

4pts each

H) 

I) 

3. **Vocabulary:** (18 pts) Fill in the blanks with the appropriate vocabulary word. If two bold words are given circle the correct one.

1pt each

A) Halogens are resonance donators, but are generally deactivating towards electrophilic aromatic substitution. They are also ortho/para directors.

B) A meta director is **always / sometimes /** (**never**) an activating group.

C) (**True**) **/ False** A Diels-Alder works best with an electron-rich diene and an electron-poor dieneophile

D) **True /** (**False**) Heat can close a conjugated diene to a cyclobutene and does so in a conrotory manner.

E) A (**NH_2**) **-OH / -CH_3 / -$NHCOCH_3$** group on a benzene is the most activating towards electrophilic aromatic substitution. All these functional groups are ortho/para directors

F) We generally get UV absorption by an organic molecule when we have at least **1 /** (**2**) **5 / 7 / 11** conjugated alkenes. We generally get visible color in an organic molecule when we have at least **1 / 2 / 5 / 7 /** (**11**) conjugated alkenes

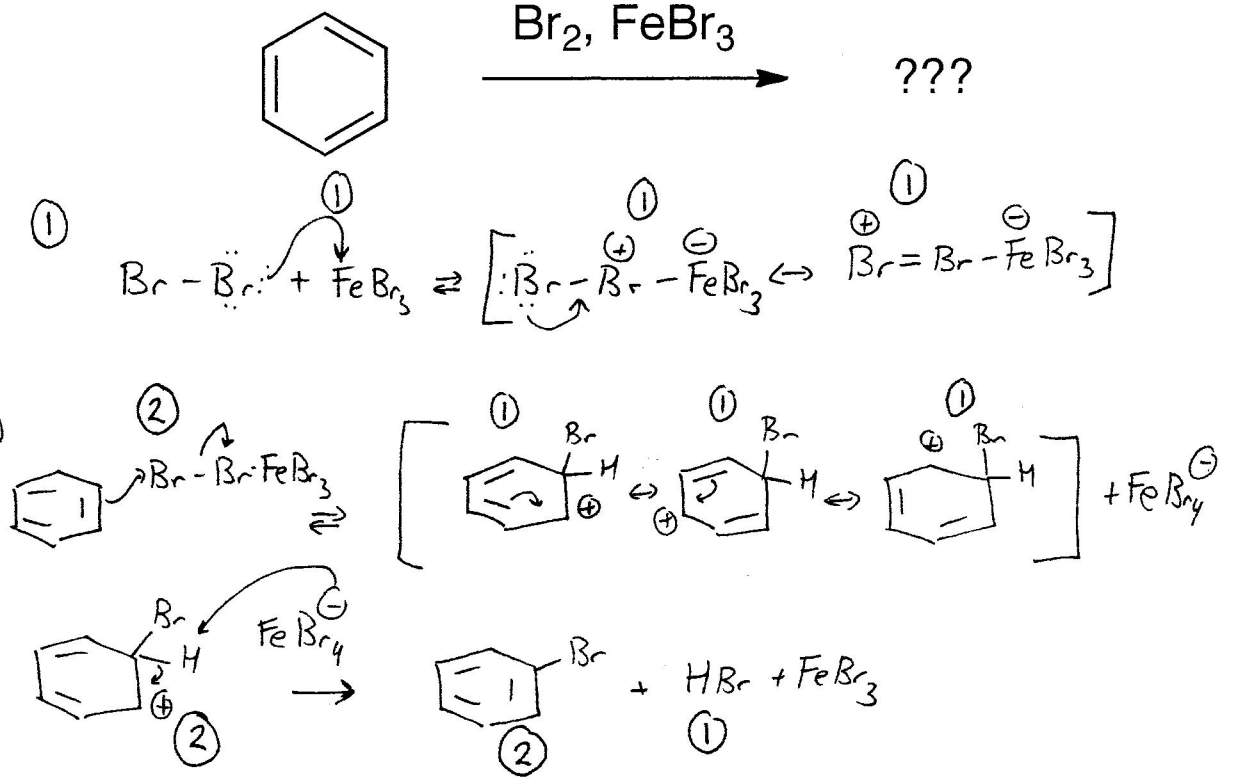
G) Aromatic systems must be cyclic, conjugated, planer and have $4n+2$ pi electrons.

H) A reaction under thermodynamic control gives the most stable product and generally occurs when the reaction is (**hot**) **cold**.

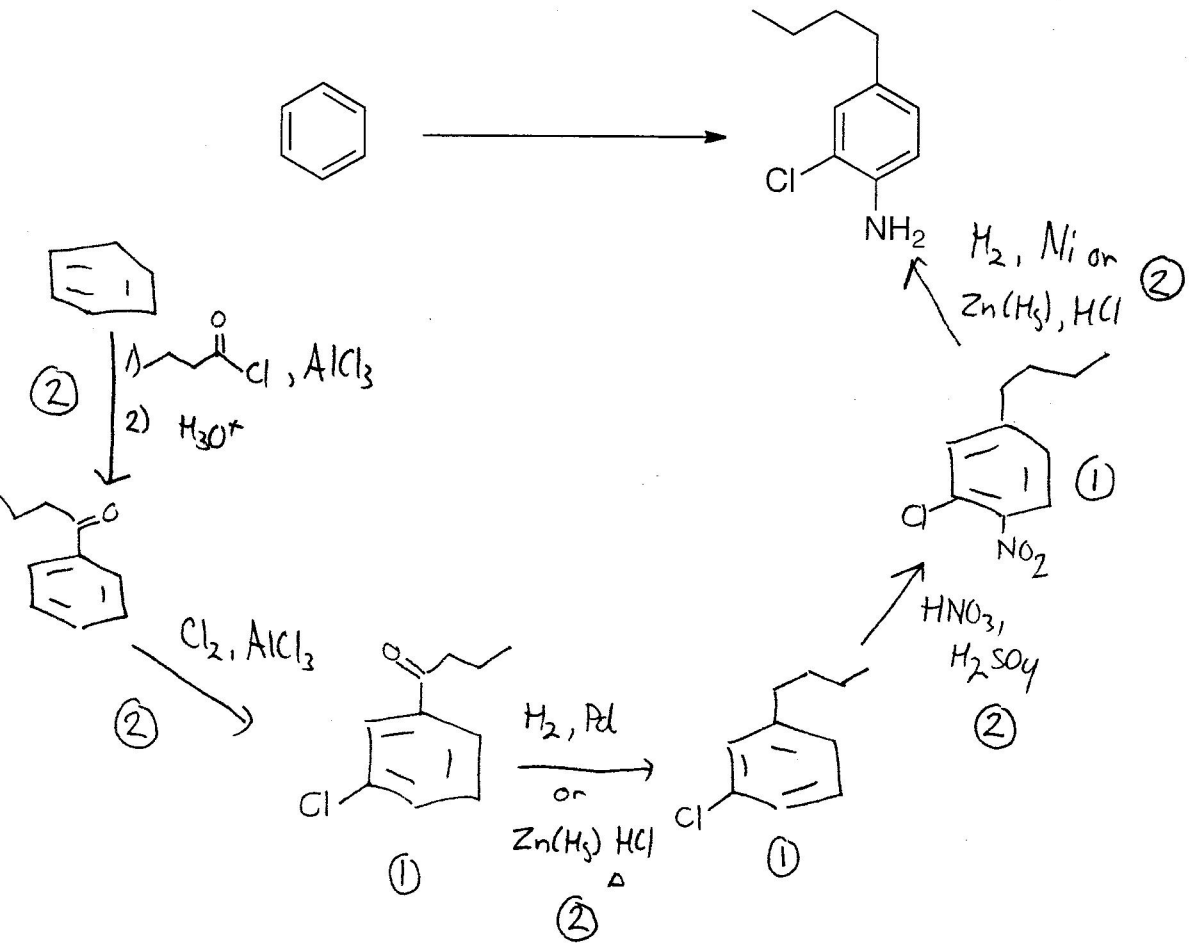
I) (**True**) **False** Conjugated alkenes are more stable than non-conjugated alkenes.

J) A conjugated system must have at least **2 /** (**4**) **6 / 10** parallel p-orbitals. These orbitals are **always /** (**sometimes**) **never** alkenes

4. **Mechanism:** (13 pts.). Show detailed reaction mechanisms for the following reaction. Include all relevant resonance structures and the structure of the expected products.

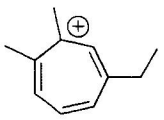


5. **Synthesis:** (14 pts) Show how you would carry out the following synthesis. Include the reagents you would need for each step and the structure of the intermediate products formed in each step.

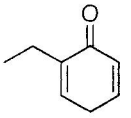


Points for any working synthesis

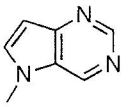
6. **Identification:** (6 pts) Label each compound as aromatic, non-aromatic, or anti aromatic.



Aromatic

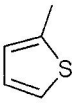


non aromatic

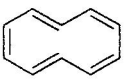


aromatic

antiaromatic



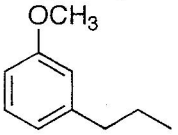
aromatic



nonaromatic

7. **Nomenclature:** (8pts.) Provide the systematic names or structure of each of the following compounds include E/Z where relevant.

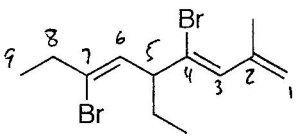
A)



1-methoxy-3-propyl benzene

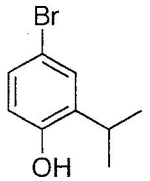
m-propyl anisole

B)



(3Z,6Z)4,7-dibromo-5-ethyl-2-methylnona-1,3,6-triene

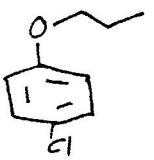
C)



2-bromo-2-isopropyl phenol

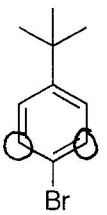
4-bromo-2-(methylethyl benzenol

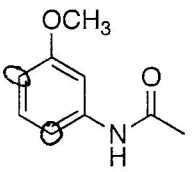
D) p-propoxychlorobenzene

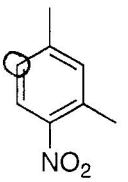


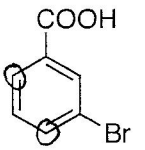
2pts each -1 per major error

8. **Reactivity:** (8 pts) Circle the carbon(s) on each molecule that is/are most likely to undergo reaction in an electrophilic aromatic substitution reaction.



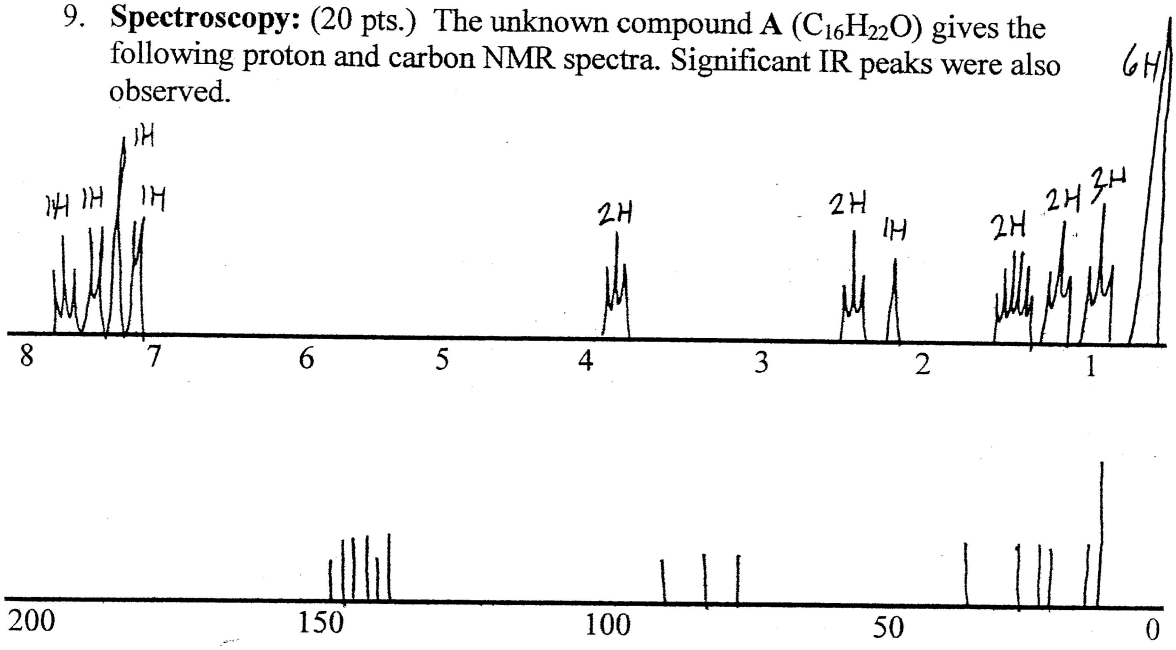






2pts per molecule

9. **Spectroscopy:** (20 pts.) The unknown compound **A** ($C_{16}H_{22}O$) gives the following proton and carbon NMR spectra. Significant IR peaks were also observed.



IR: 3324 (sharp), 3034, 2957, 2253, 1592, 1210, 792, 702, and fingerprint cm^{-1}.

DBE = 6 1 pt

≡ → ≡–H 3pt (2pt)

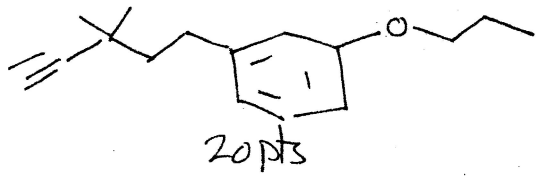
O → R, R O 3pt (2pt)

(?) → O 3pt (2pt)

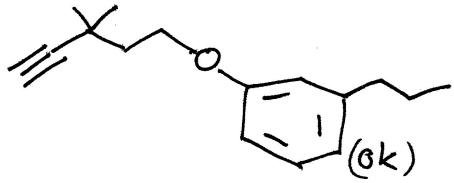
? ? → Ph 5pt 3pt (2pt)

Ph–CH_3 1pt each

CH_3, CH_3, C 3pt



20 pts



(ok)