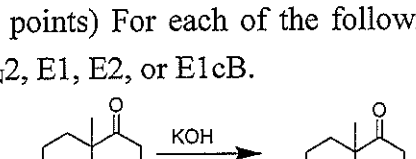
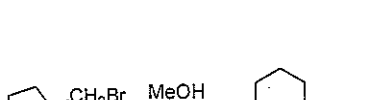
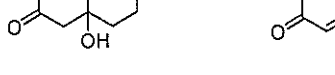
1. (6 points) Which alkene, (3*E*)-3-hexene or (3*Z*)-3-hexene, would add bromine to yield a meso dibromide product? Which would yield a racemic mixture? Provide your reaction mechanisms.

2. (3 points) Give the mechanism of NBS bromination of cyclohexene in the presence of light.

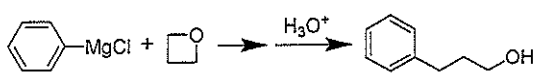
3. (6 points) For each of the following reactions, assign the type of reaction: S_N1, S_N2, E1, E2, or E1cB.

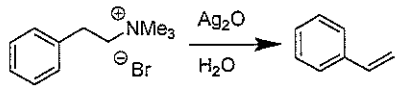
(a) 

(b) 

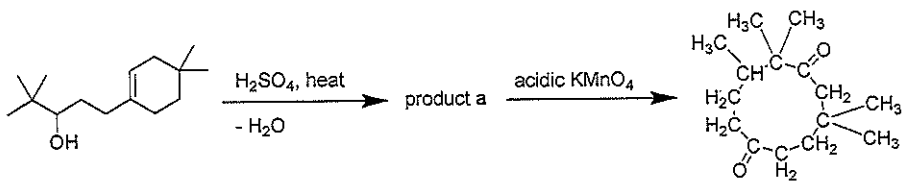
(c) 

(d)

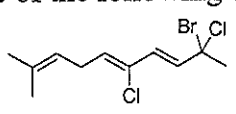
(e) 

(f) 

4. (4 points) Give the structure of the product **a** in the following reaction transformation:

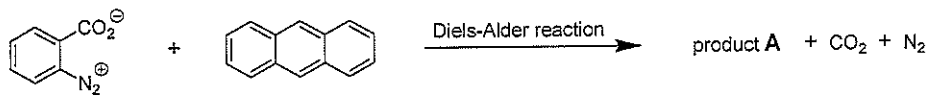


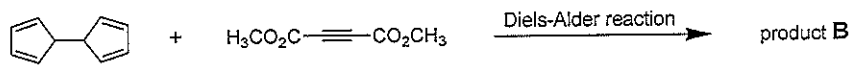
5. (3 points) Give the IUPAC name of the following structure.



6. (4 points) What product or products would you expect to obtain from reaction of cyclohexa-1,3-diene with 1 mol DBr in ether?

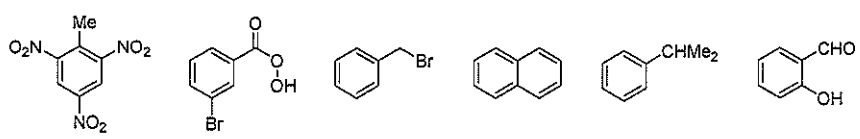
7. (8 points) Complete the following two Diels-Alder reaction schemes:

(a) 

(b) 

In addition, how many ^1H peaks are associated with product **A** in its ^1H NMR spectrum? Provide its theoretical NMR spectral data.

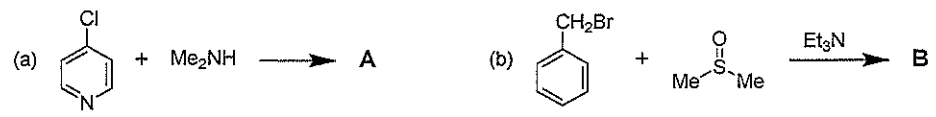
8. (6 points) Name each of the below aromatic compounds:



9. (6 points) Propose a structure each for the compound that fits the following proton NMR spectral data:
   (a) $C_4H_8O_2$; δ 3.71 (s, 8H)
   (b) $C_4H_8O_2$; δ 8.04 (s, 1H), 4.16 (t, 2H), 1.61 (m, 2H), 0.96 (t, 3H)
   (c) $C_4H_8O_2$; δ 4.70 (s, 2H), 3.80 (t, 4H), 1.68 (quintet, 2H)

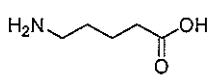
10. (6 points) Give one specific reaction example for each of the following name reactions: (a) Claisen condensation, (b) Claisen rearrangement, (c) Hofmann elimination, (d) Hofmann rearrangement, (e) Wittig olefination, and (f) Ritter reaction.

11. (6 points) Give the major product of the following reactions. In addition, name the product and provide its reaction mechanism.



12. (3 points) Using ethyl acetate as the only source of carbon, how can you prepare acetone?

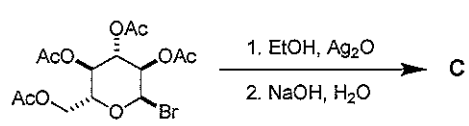
13. (4 points) Give your synthesis of 5-aminopentanoic acid, starting from cyclopentanone.



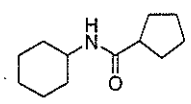
5-aminopentanoic acid

14. (6 points) Give names and structures of any two natural amino acids.

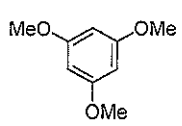
15. (6 points) Identify the major product **C** with correct stereoisomer in the following reaction transformation. Name, also, the major product **C**.



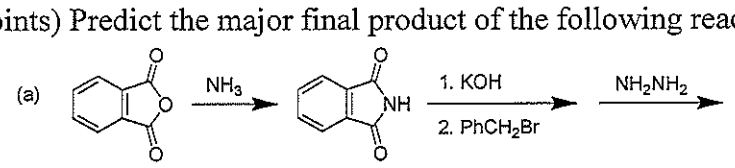
16. (4 points) Propose a synthesis of the following product, starting from cyclohexanone as the only source of carbon.

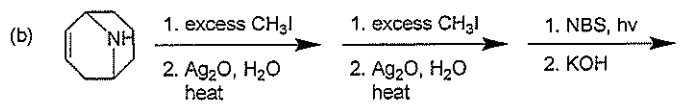


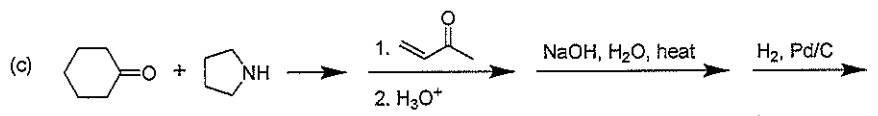
17. (4 points) Starting from benzene, how would you synthesize the below 1,3,5-trimethoxybenzene:



18. (6 points) Predict the major final product of the following reactions:







19. (6 points) Give a specific reaction example for each of the following name reactions: (a) Henry reaction, (b) Robinson annulation, (c) Stork reaction, (d) Dieckmann cyclization, (e) Claisen condensation, (f) Hell-Volhard-Zelinsky reaction.

20. (3 points) Give product structure of the following Knoevenagel reaction: