

CHM 1321B  
SAMPLE Final Exam

IMPORTANT: this is a *sample* final only, to be used as a practice *as part of your studying*

April 2012

Professor: Alison Flynn

ANSWERS

Time: 3 hours

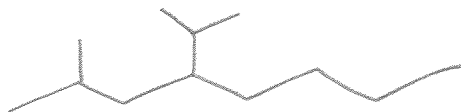
Last Name: \_\_\_\_\_ First Name: \_\_\_\_\_

Student Number: \_\_\_\_\_ Seat number: \_\_\_\_\_

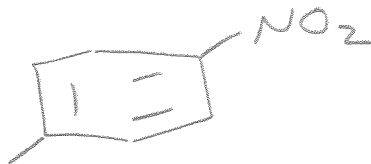
Notes:

- The marks are given as a guide and are subject to minor changes
- A faculty-approved calculator and molecular models are permitted
- Show stereochemistry where applicable
- The final page of the exam has a  $pK_a$  table and a periodic table
- Total number of pages: 15
- Approximate number of points: 148

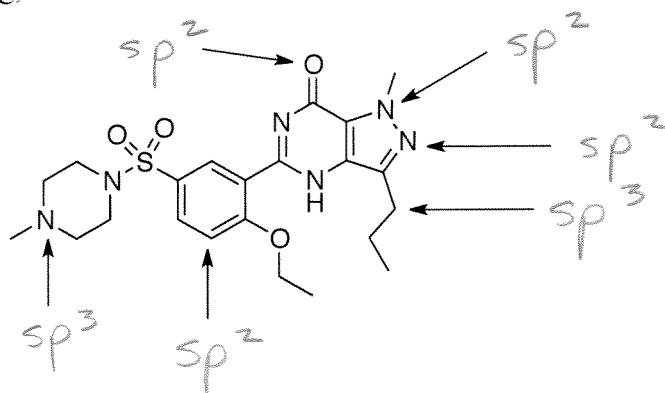
1. Draw 2-methyl-4-(1-methylethyl)octane



2. Draw para-nitrotoluene



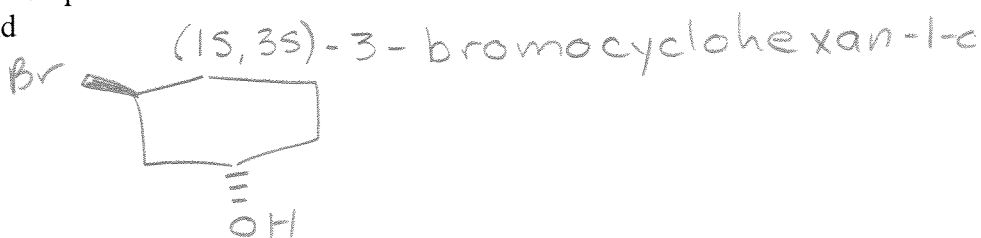
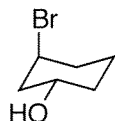
3. Identify the hybridization of each of the indicated atoms in viagra, an erectile dysfunction drug, shown below.



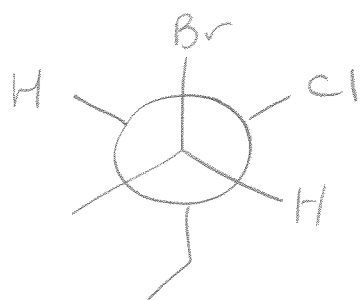
4.

a. Draw the following compound in two dimensions.

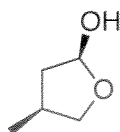
b. Name the compound



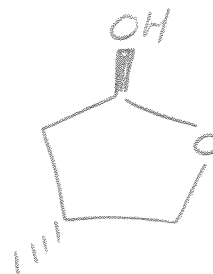
5. Draw 2-bromo-3-chloropentane in a Newman projection looking down the C2-C3 bond. (staggered conformation)



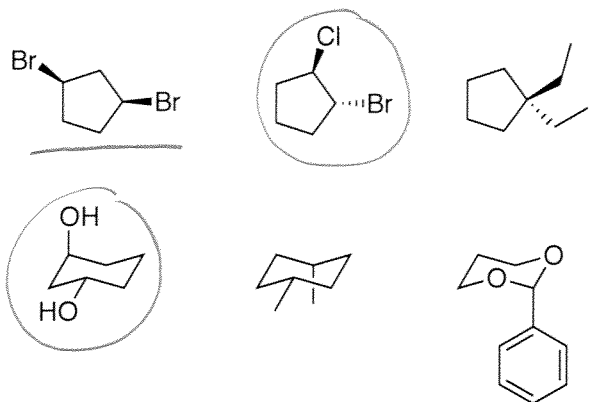
6. Draw a diastereomer of the structure shown.



or

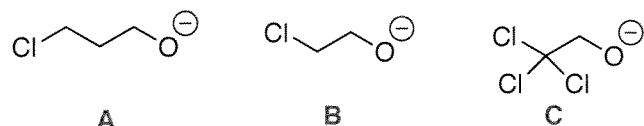


7. Circle the chiral molecule(s) and underline the meso compound(s):



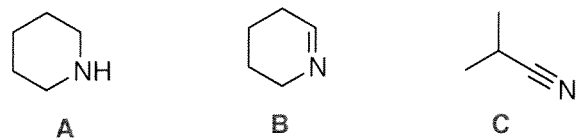
8. Rank the bases in each group in increasing order of basicity (base strength):

a.



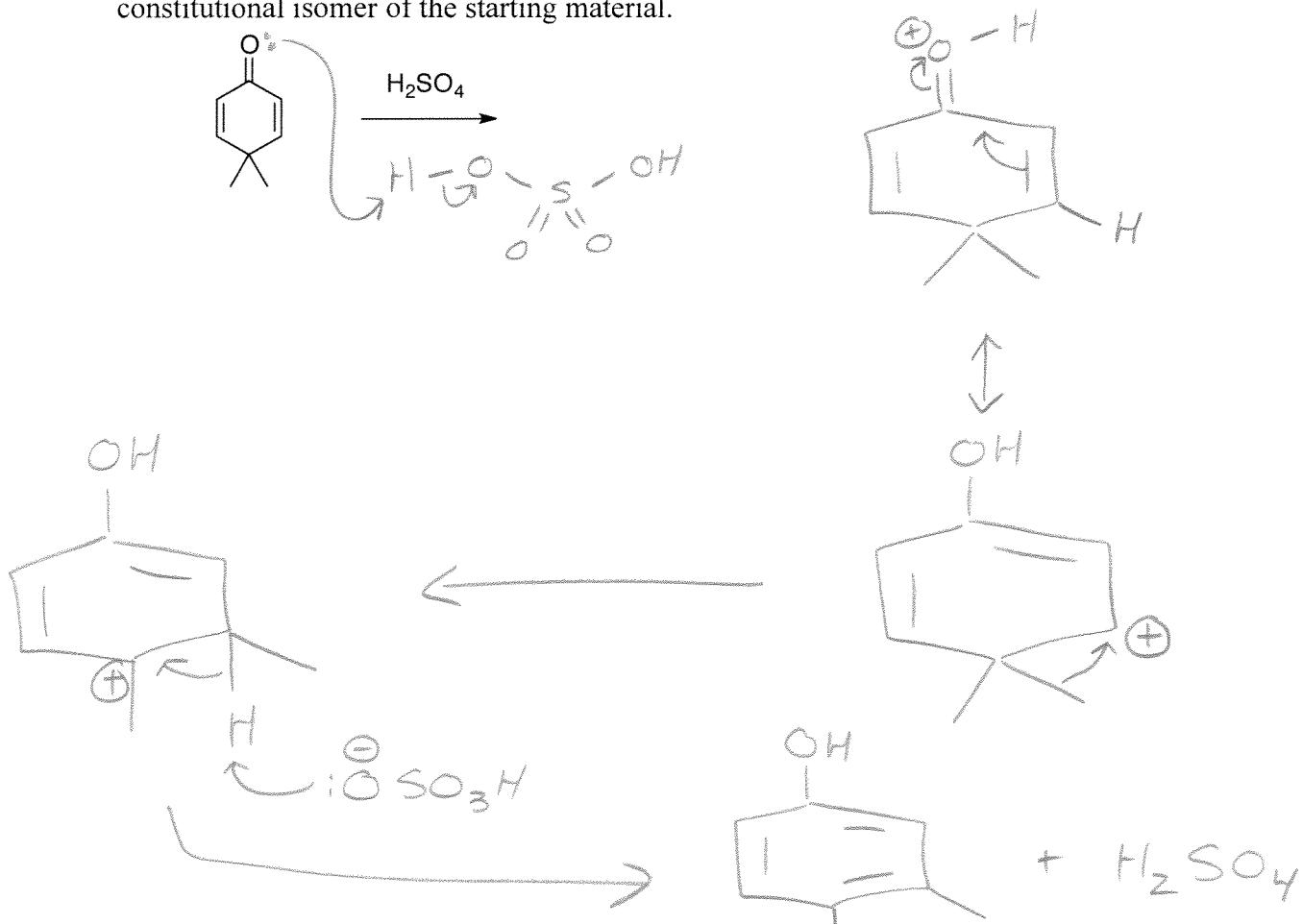
strongest  
 $C < B < A$

b.

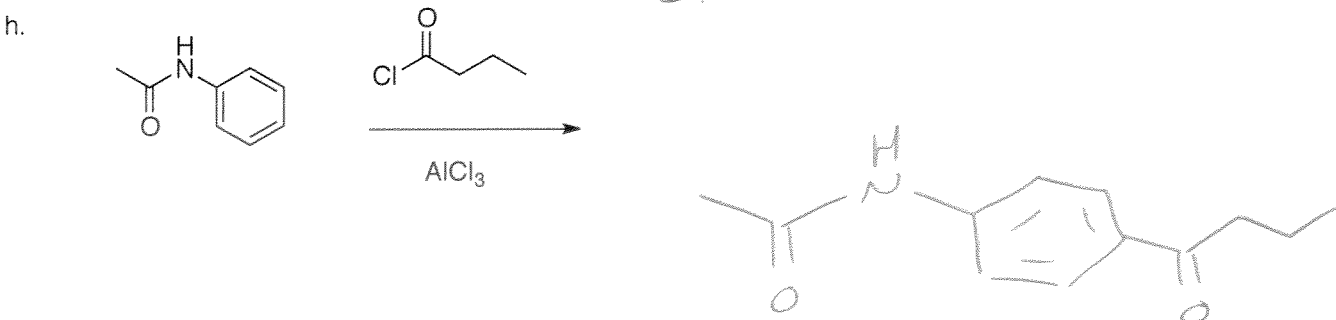
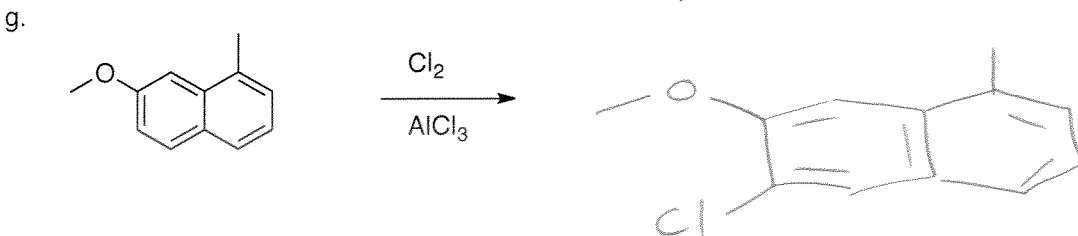
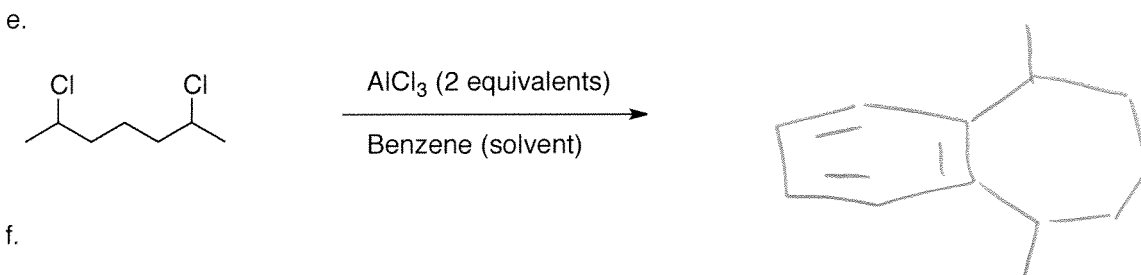
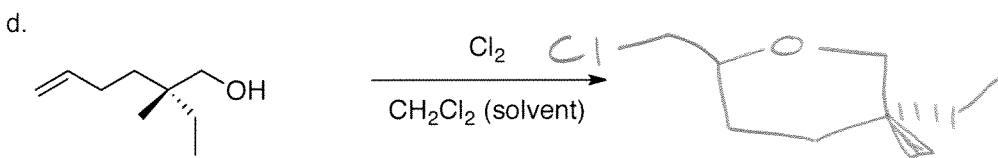
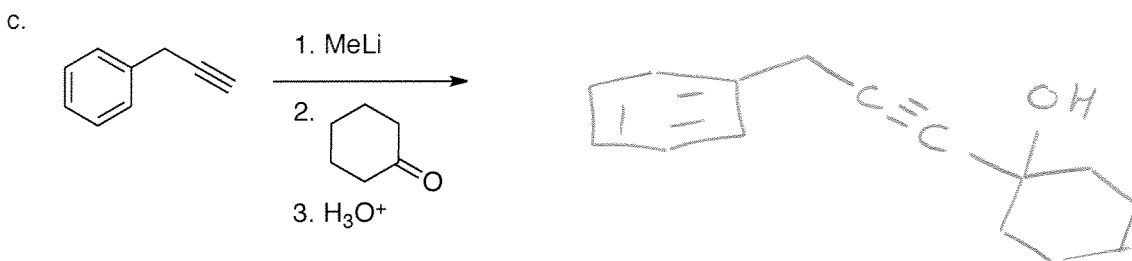
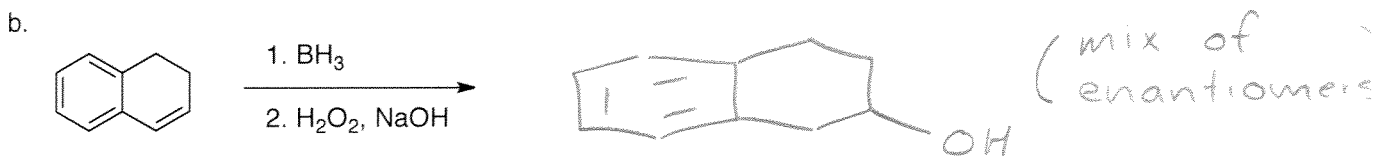
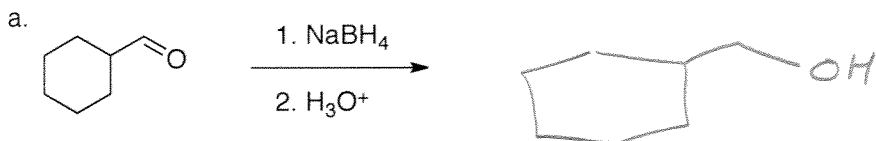


$C < B < A$

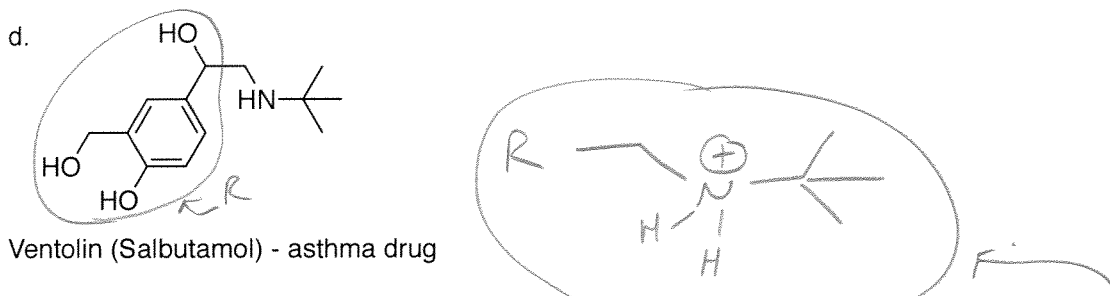
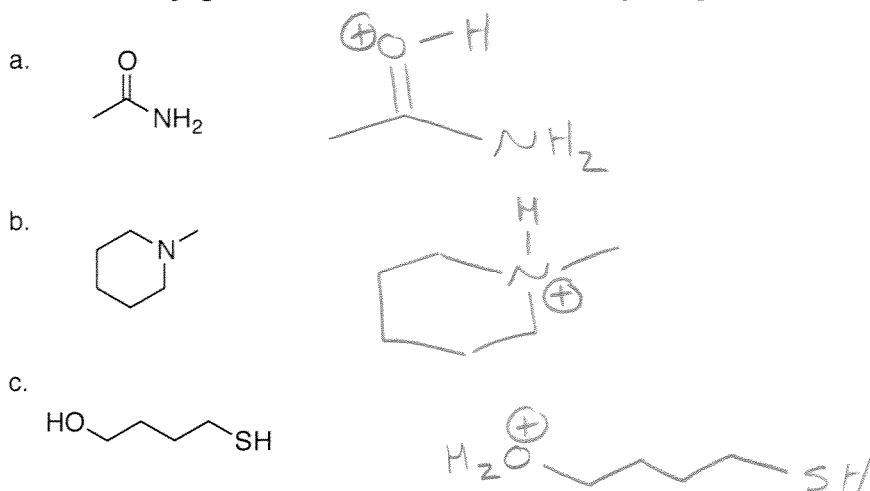
9. Propose a mechanism for the following transformation, which gives a more stable constitutional isomer of the starting material.



10. Give the major organic product of each of the following transformations:

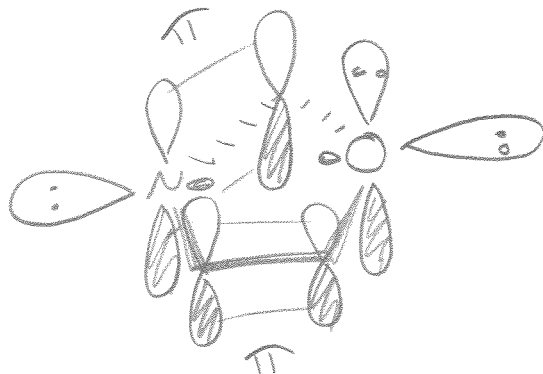


11. Draw the conjugate acid of each of the following compounds:

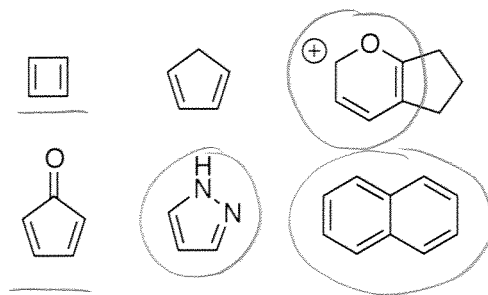


12. Circle the form of ventolin (above) that would be found in the body at physiological pH (7.4).

13. Draw the orbitals that show the location of lone pair(s) and  $\pi$  electrons for the following compound.

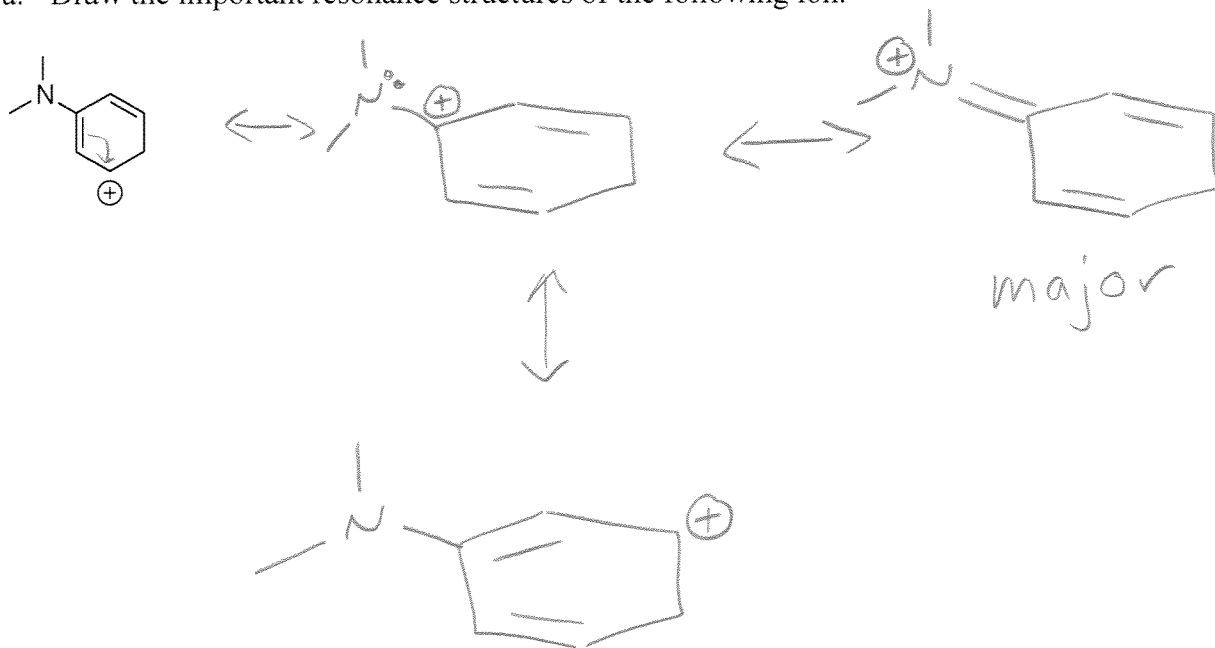


14. Circle the aromatic ring(s), underline the anti-aromatic ring(s), and do nothing with the non-aromatic ring(s).



15.

a. Draw the important resonance structures of the following ion.



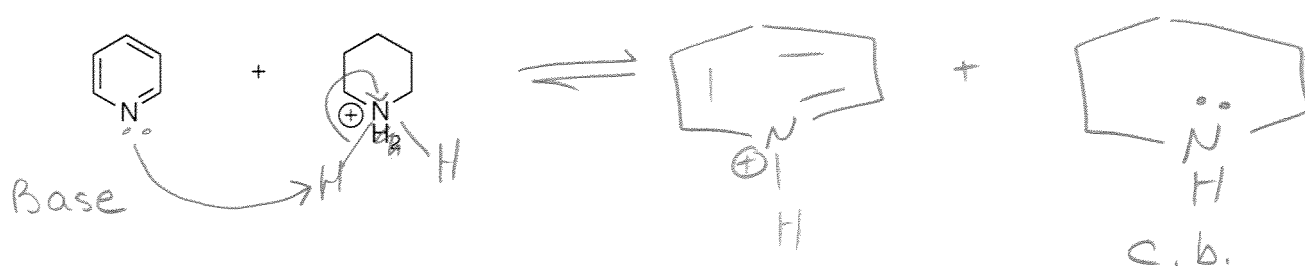
b. Label the major resonance structure.

c. Explain your choice in part b.

All atoms have a full octet in this <sup>(major)</sup> structure, while one atom lacks an octet in all other structures

16. For the following reaction:

a. Draw the mechanism and products.



b. Predict the direction of the equilibrium.



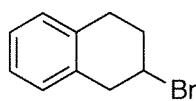
c. Explain your choice in part b.

- compare bases
- Base's N is  $sp^2$ , C.B.'s N is  $sp^3$
- $sp^2$  atoms have more s character + so can better stabilize the e<sup>-</sup>s

17. Draw the starting materials that should be used to form each of the compounds below.

One of the starting materials in each set should contain a  $\pi$  bond.

a.



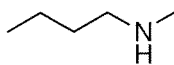
+

HBr

AIBN  
(or ROOR)

weaker base

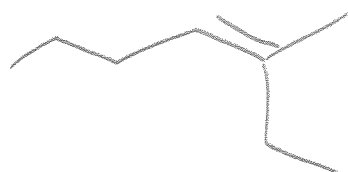
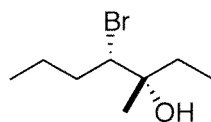
b.



+  $\text{NaBH}_3\text{CN}$

+ HOAc

c.



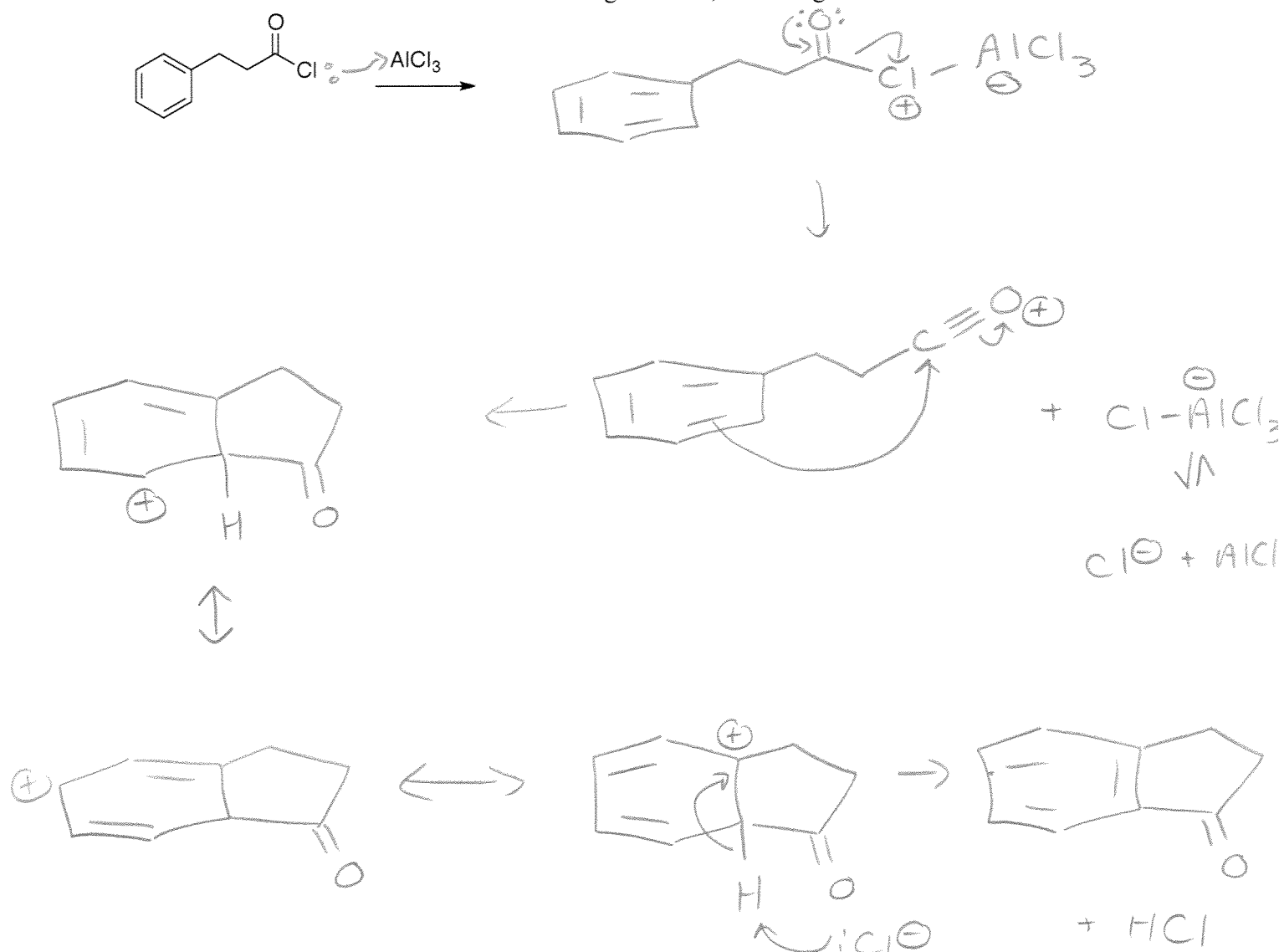
+

$\text{Br}_2$

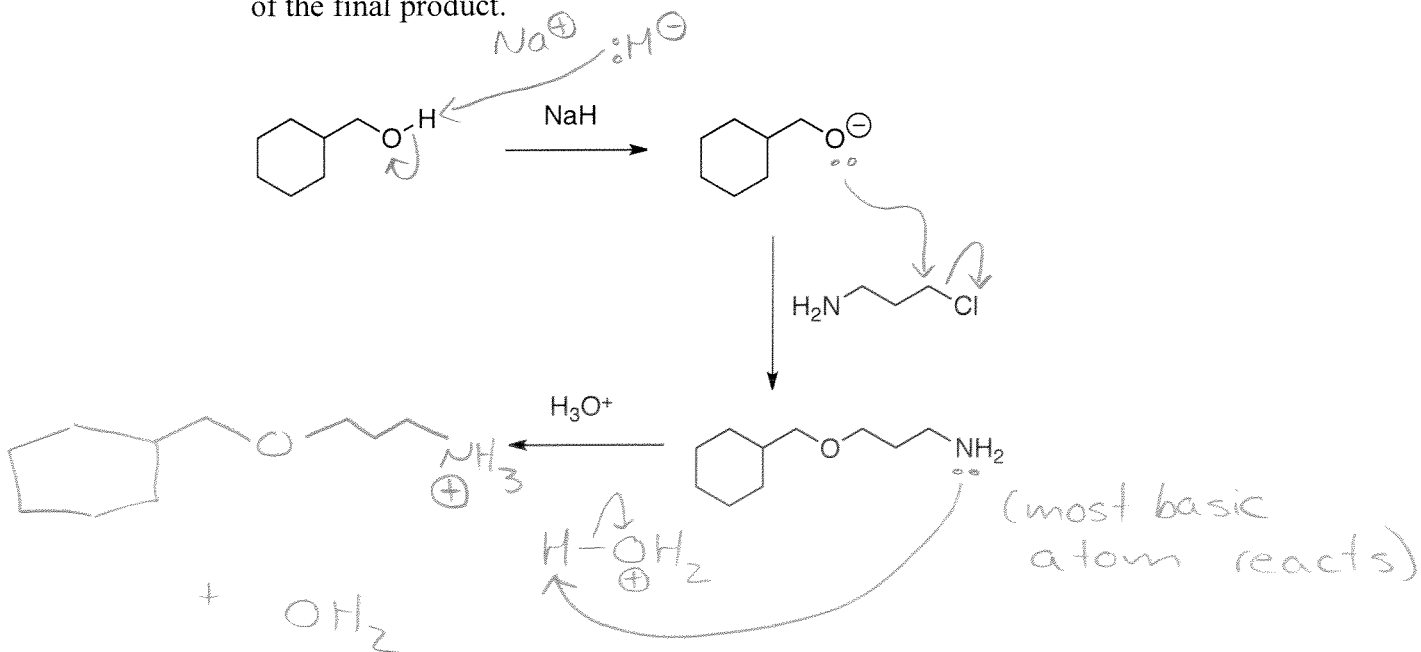
$\text{H}_2\text{O}$

(note the Z stereochemistry)

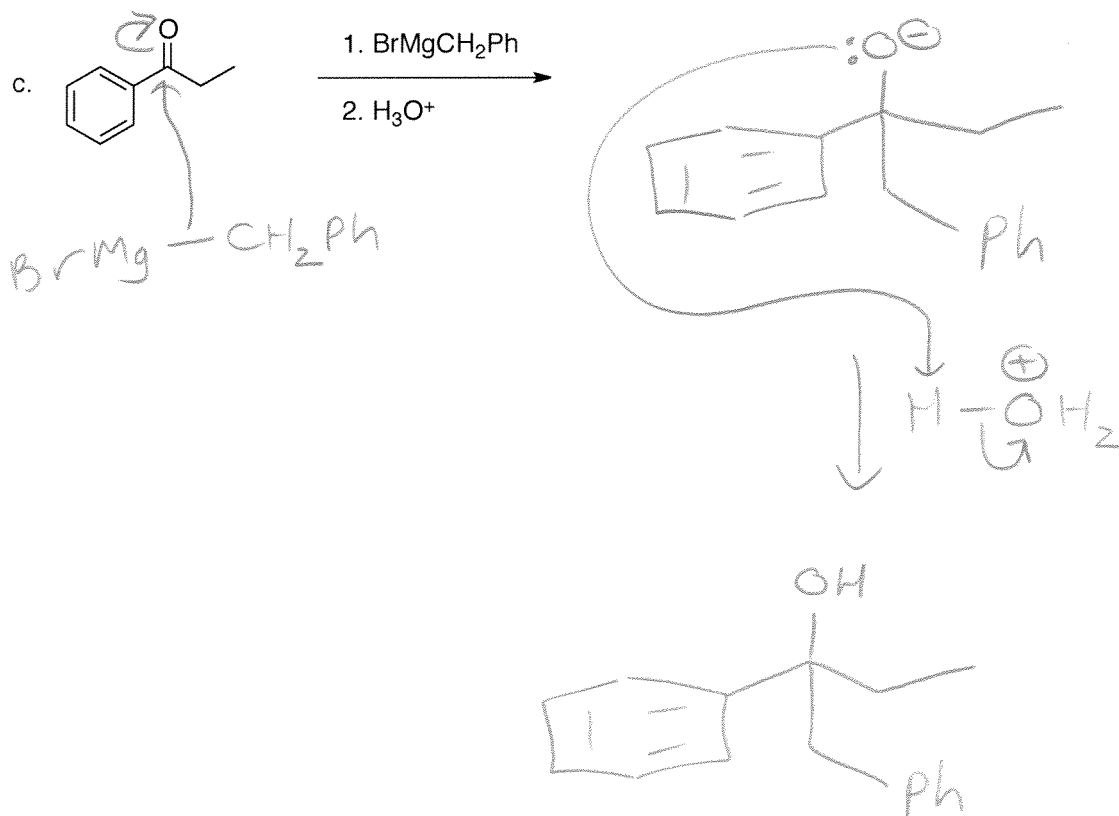
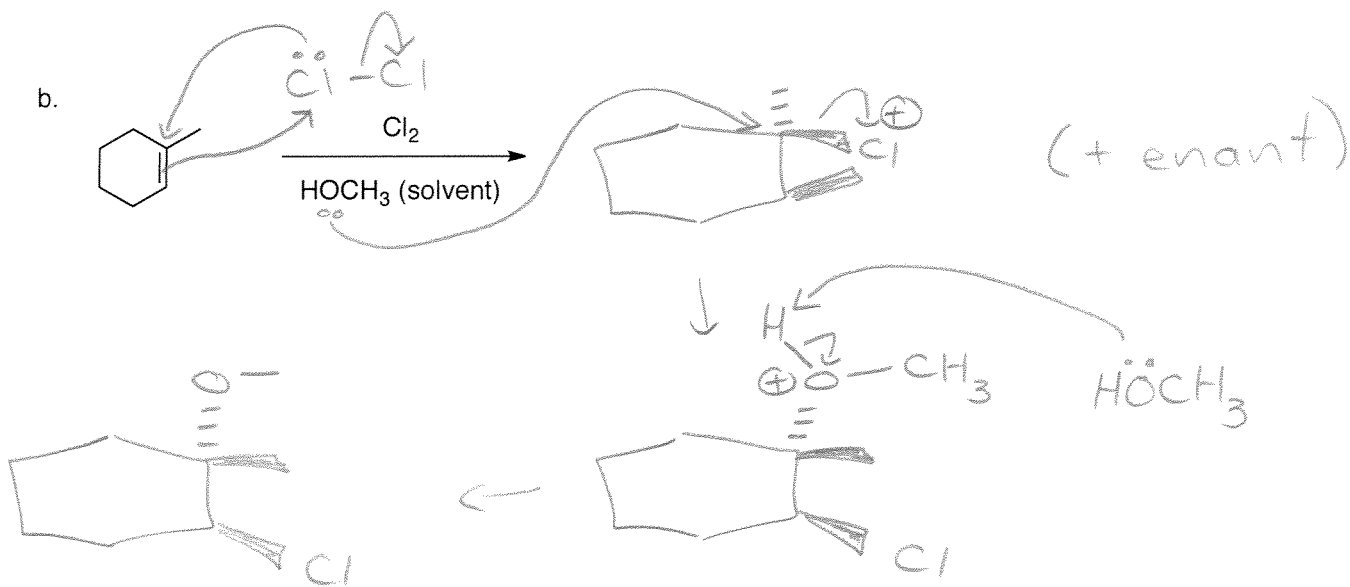
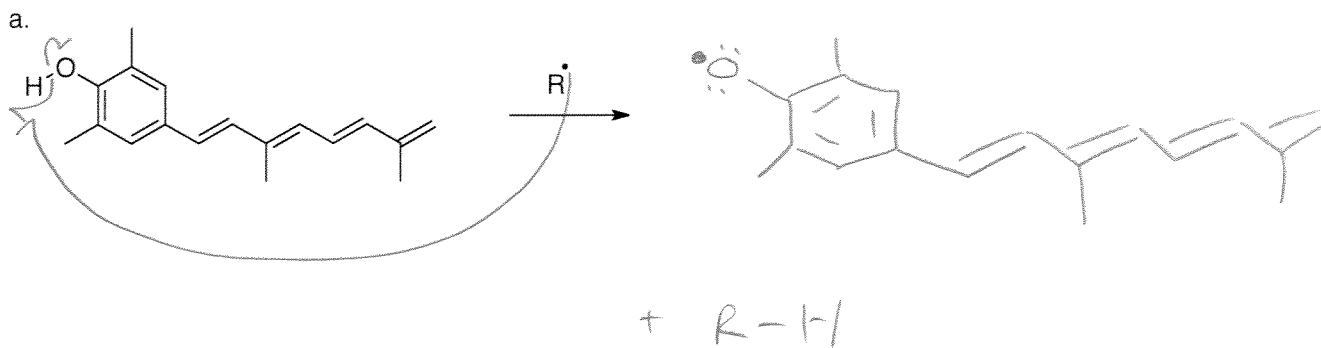
18. Give the full mechanism of the following reaction, including resonance structures.



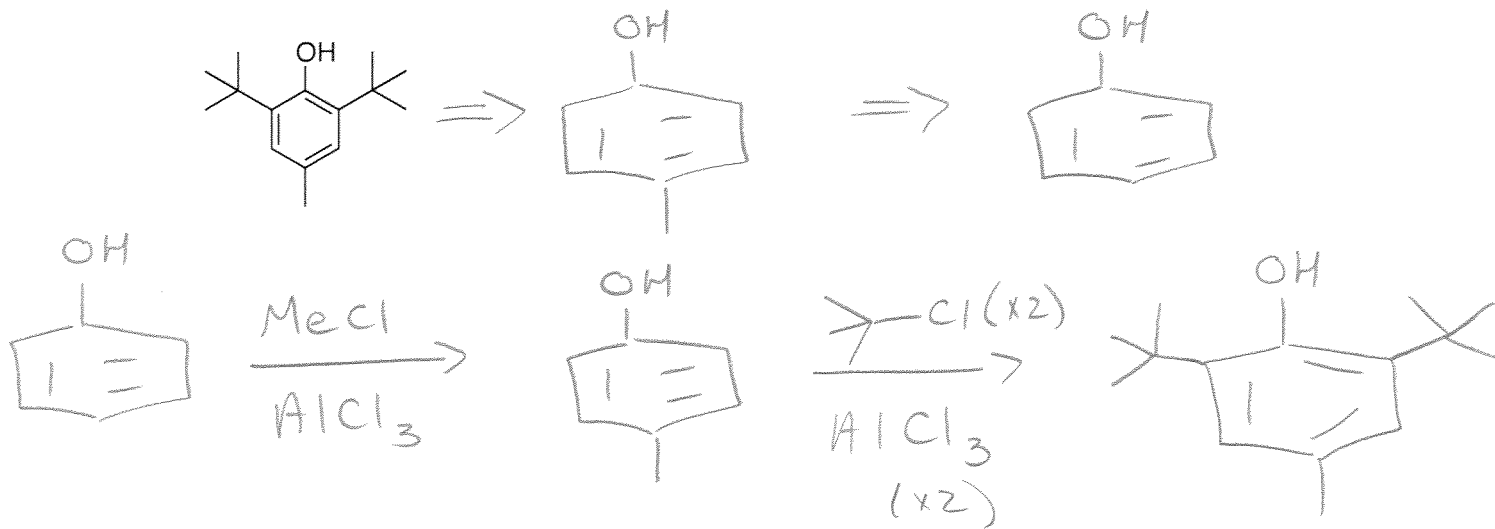
19. Complete the mechanism for each step of the following reaction and predict the structure of the final product.



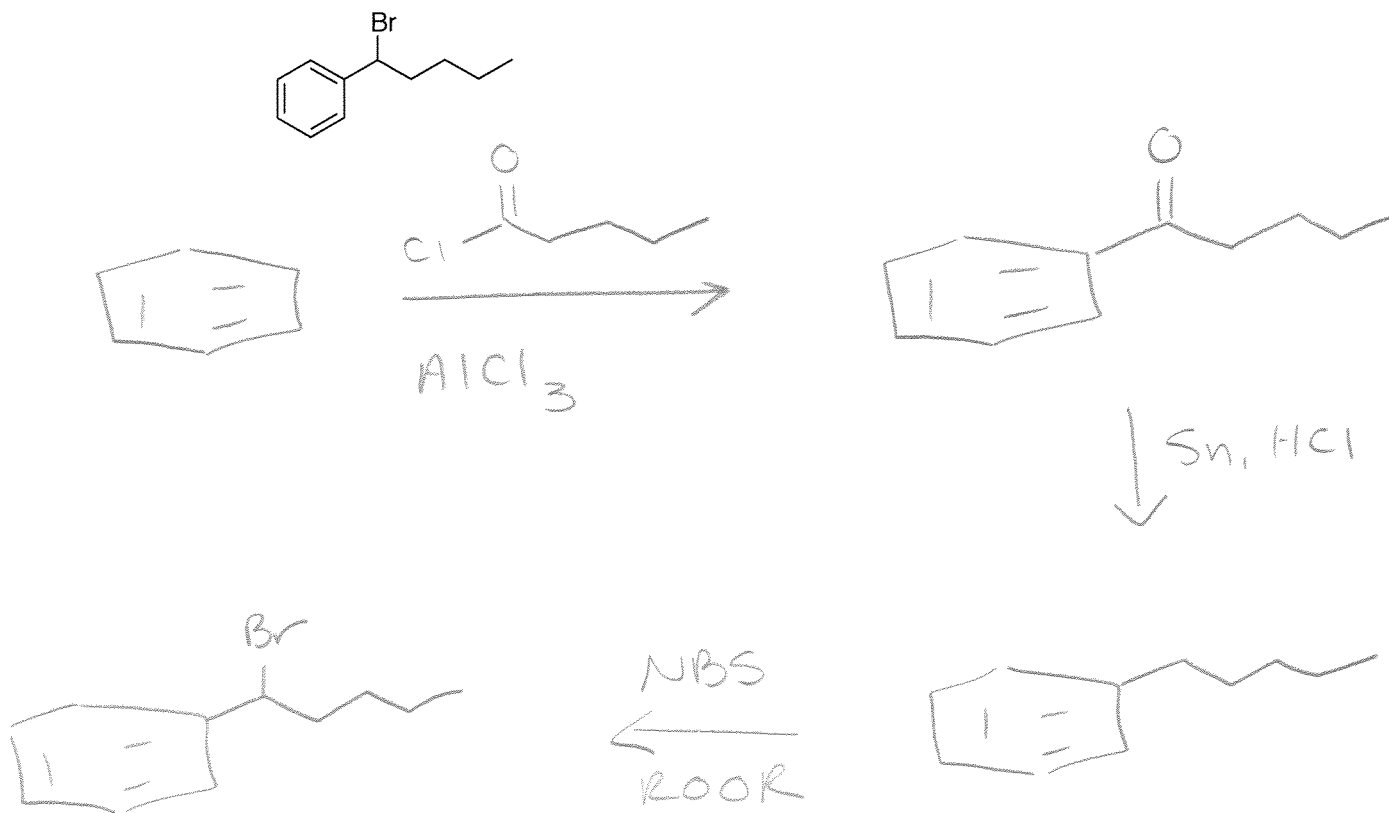
20. Give the full mechanism for each of the following reactions. (major organic prod)



21. Propose a synthesis of the antioxidant BHT, shown below, from phenol (hydroxybenzene) and using any other reagents that you require. You must include a retrosynthesis.

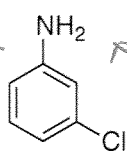


22. Propose a synthesis of the following compound from benzene and using any other reagents that you require.



23. Propose a synthesis of the following compound from benzene and using any other reagents that you require. An analysis and brainstorming are also required.

Analysis



added  
meta

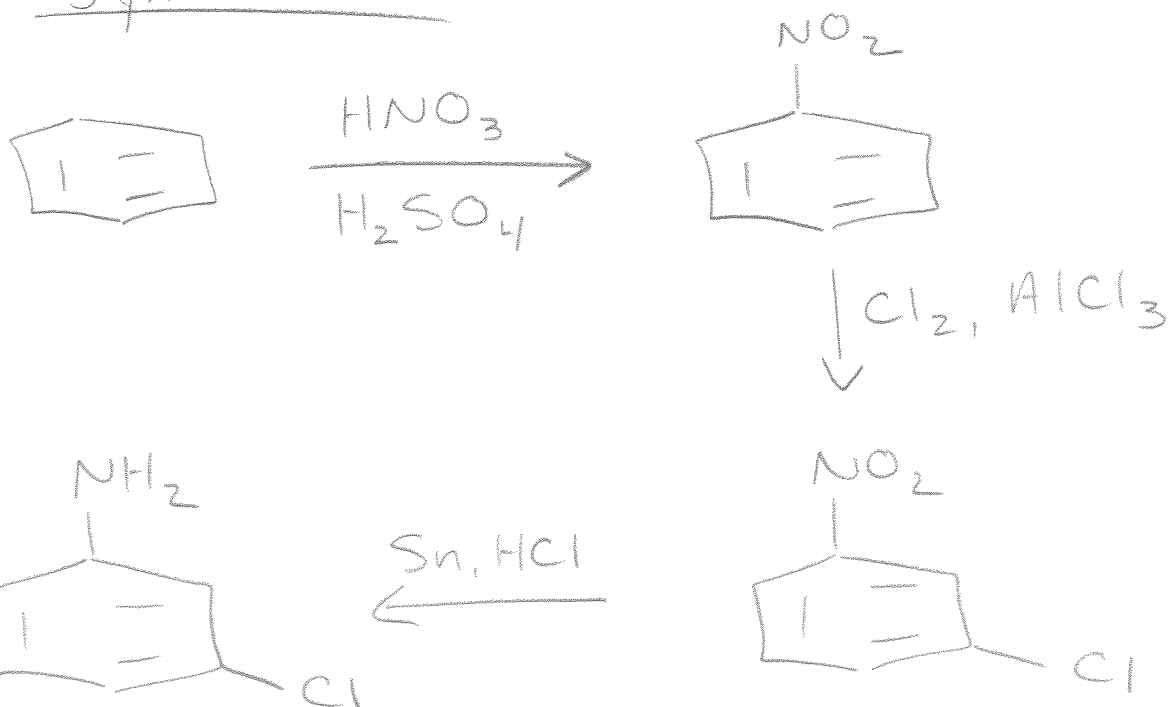
both are o/p directing groups  
stereochem: N/A.

Brainstorm: nitration  $\rightarrow$   $\text{NO}_2$  <sup>m-</sup>director

Friedel-Crafts chlorination  $\rightarrow$  Cl

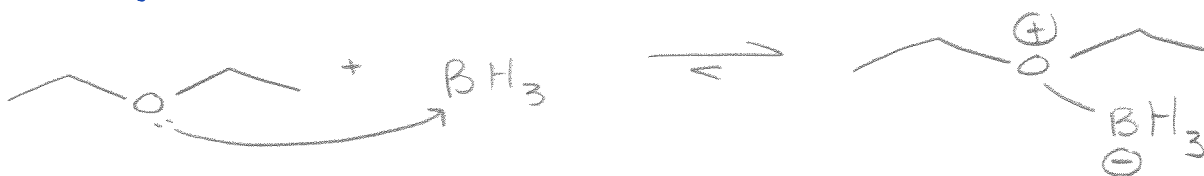
$\text{NO}_2 \xrightarrow{?} \text{NH}_2$

Synthesis

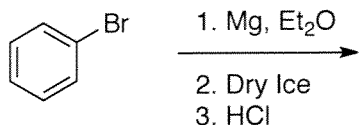


24.  $\text{BH}_3$  is stabilized for storage through a reaction with a solvent such as diethyl ether ( $\text{Et}_2\text{O}$ ). Propose a mechanism for that reaction.

(Lewis acid/base rxn)  $\text{Et}_2\text{O}$



25. Consider the Grignard reaction of bromobenzene.



a. Draw the Lewis structure of dry ice.



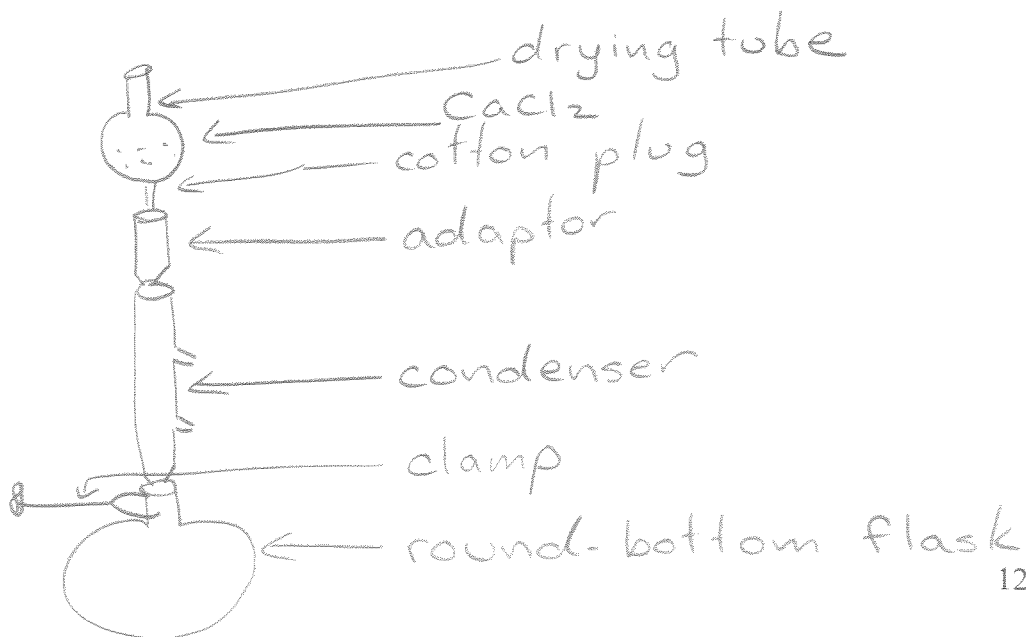
b. The literature mp of benzoic acid is  $122^\circ\text{C}$ . If you obtain a melting point of  $115^\circ\text{C}$ , what does that tell you about your product?

Impure

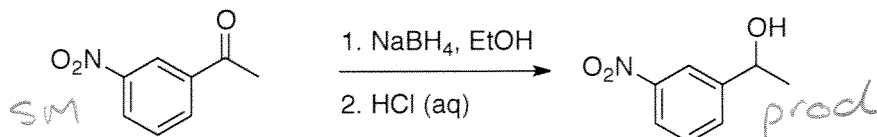
c. When the solution boils during this reaction, what is present in the bubbles? Name the molecule(s), as appropriate.



d. Draw and label the apparatus used in that reaction.

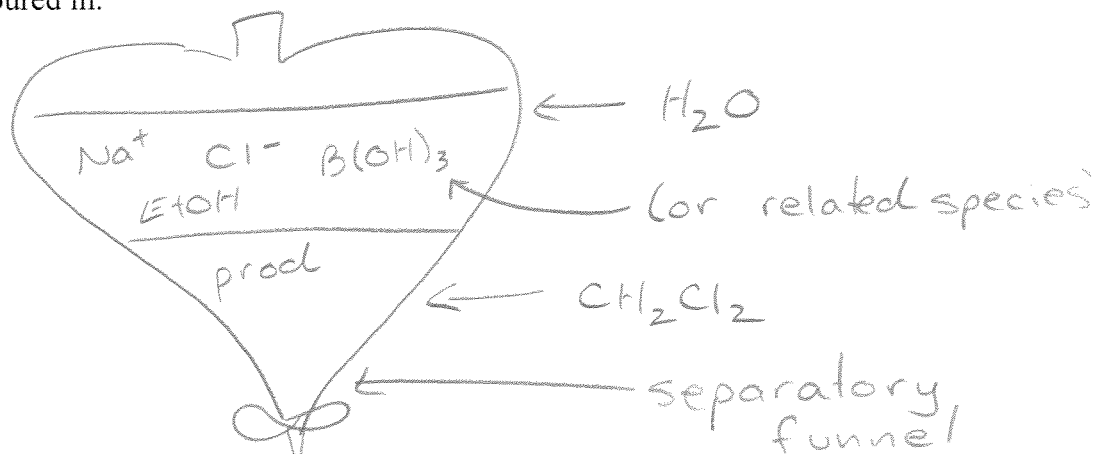


26. Consider the reduction of nitroacetophenone:

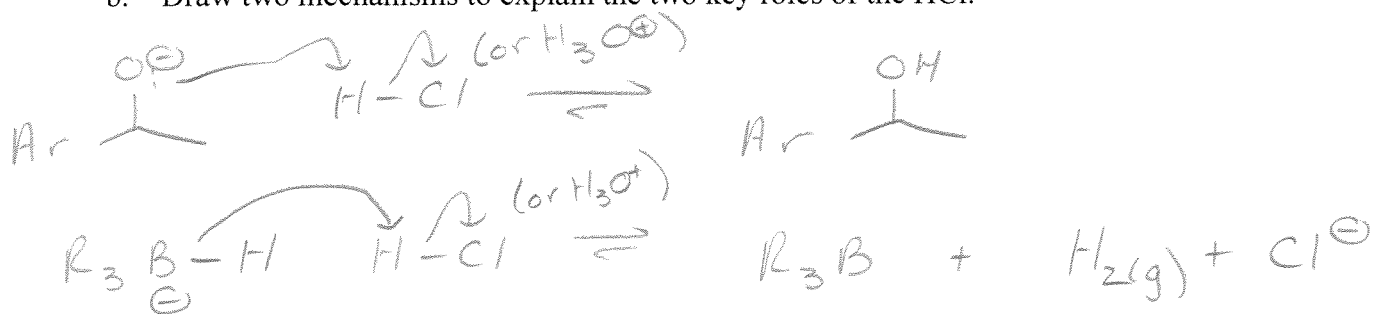


**Procedure:** After adding a solution of 3M HCl to the reaction mixture, pour the mixture into a separatory funnel and rinse the flask with approximately 5 mL of dichloromethane (density = 1.32 g/mL). Extract the aqueous layer with 2 additional portions of 5 mL portions of dichloromethane and collect all the organic extracts in the same flask.

- a. Draw and label a diagram of the separatory funnel when the mixture (and dichloromethane) are first poured in.

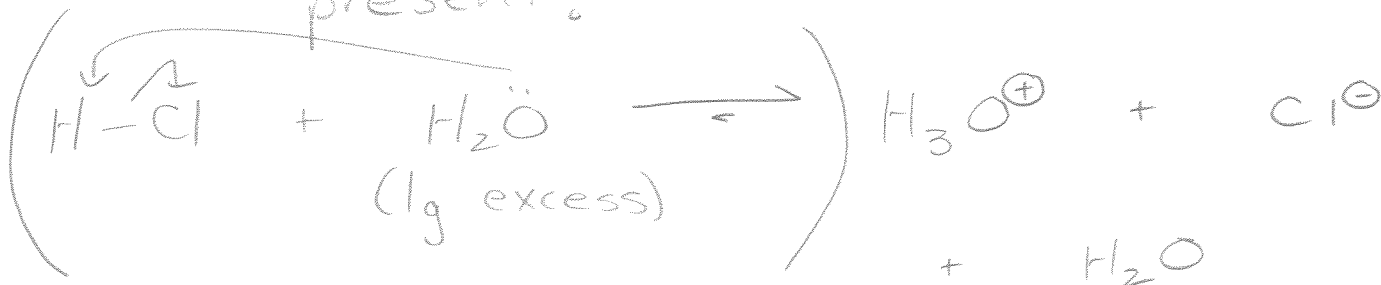


- b. Draw two mechanisms to explain the two key roles of the HCl.



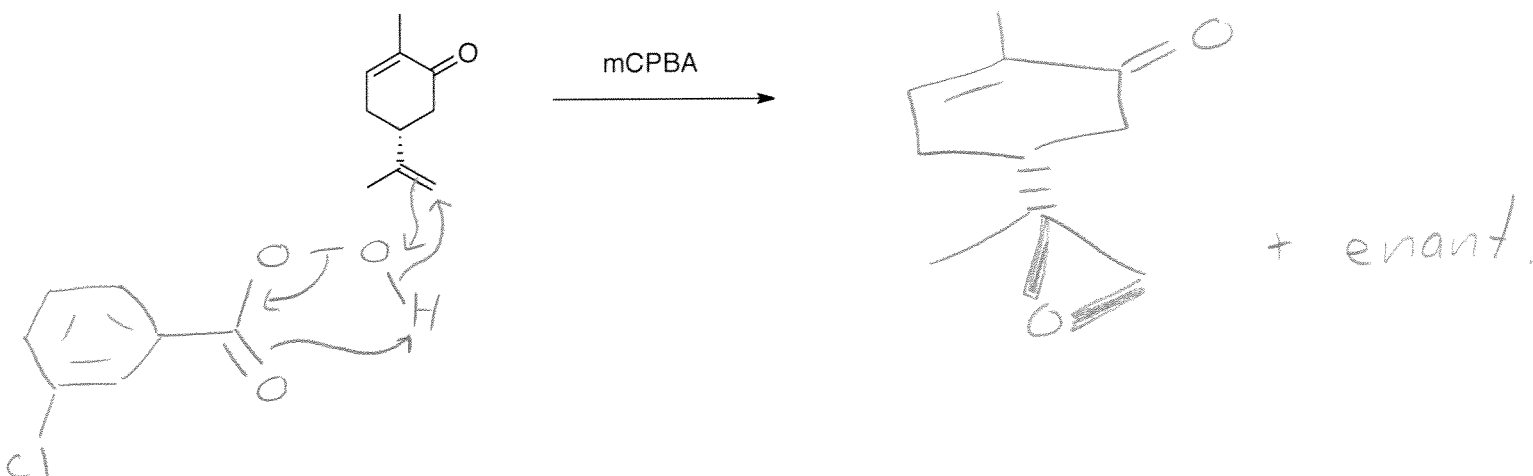
- ~~c. How could you reduce the nitro group to create aniline?~~

A solution of  $\text{HCl (aq)}$  contains almost no  $\text{HCl}$ . What are the species that are actually present?



27.

- a. Draw the mechanism for the reaction of carvone with mCPBA.



- b. Explain the regioselectivity of the reaction (i.e. why does one  $\pi$  bond react preferentially over the other)?

is more nucleophilic/  
 $e^-$  rich

$\leftrightarrow$   
 $\uparrow$   
 $e^-$  deficient due to resonance,  $\therefore$  less nucleophilic

~~When you did a TLC of the reaction mixture, you dipped the TLC plate in a solution of potassium permanganate (the purple solution). Why did the spots on the TLC change colour?~~

$\uparrow$   $KMnO_4$

The  $KMnO_4$  oxidizes alkenes + turns yellow/brown in the process (the colour of the  $MnO_2$  product)

- d. This (R) enantiomer of carvone smells like spearmint, while the (S) enantiomer smells like caraway (a spice). Explain why there is a difference in smells when the structures are so similar.

BONUS

enantiomers interact differently with other chiral molecules, such as the smell receptors in our nose.