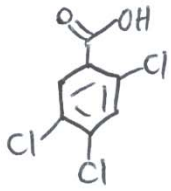
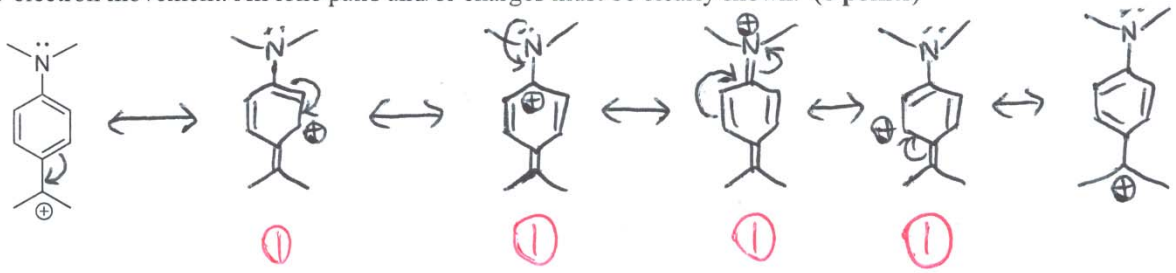
1. Draw the structure of 2,4,5-trichlorobenzoic acid. **(1 point)**



All or nothing

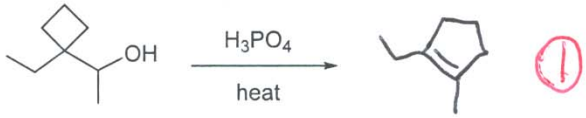
2. Draw <u>at least four</u> more resonance structures of the following compound, using curved arrows to show electron movement. All lone pairs and/or charges must be clearly shown. **(6 points)**



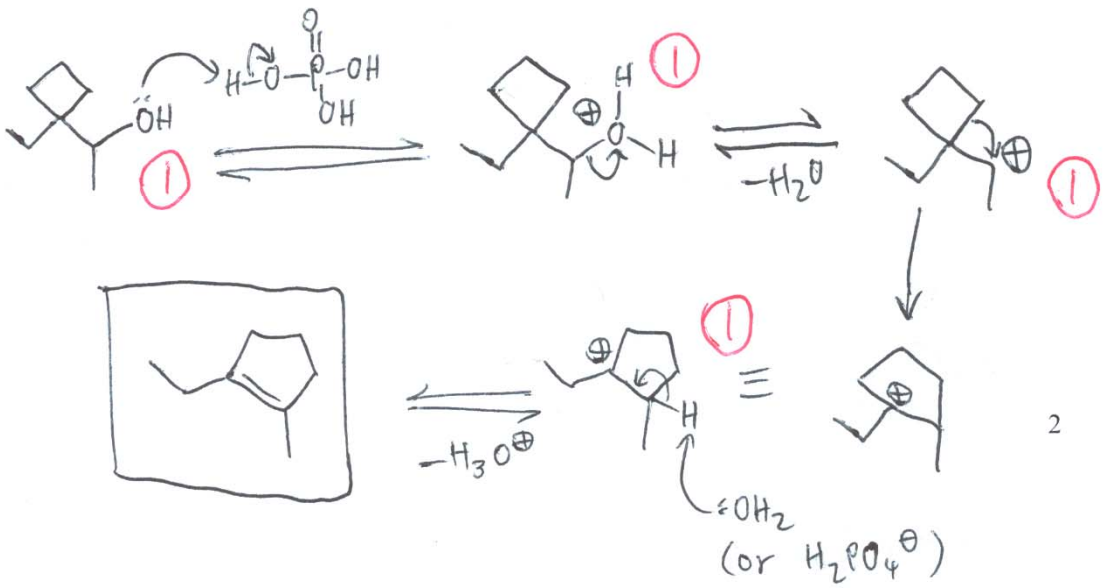
(1) (1) (1) (1)

(2) for:  (-0.5 for each incorrect, up to a max. of -2.)

3. Draw the major product of the following reaction and provide a mechanism. **(5 points)**

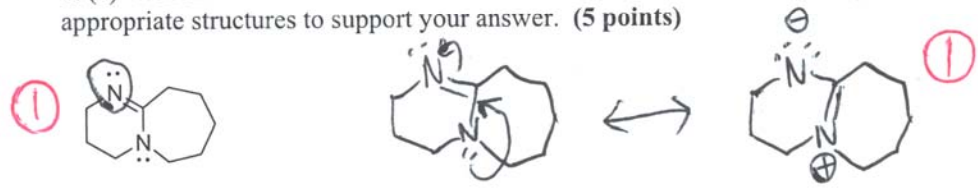


(1)



(1) (1) (1) (1)

4. (a) Which N atom is more basic? Circle the more basic N and explain your choice using appropriate structures to support your answer. **(5 points)**



(1) (1)

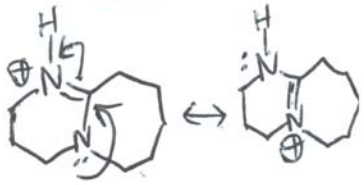
(2) for: ↷ ⟷ ⊕ ⊖ ..

(-0.5 for each incorrect, up to a max. of -2)

Protonation at the indicated N leads to a resonance-stabilized cation, where ⊕ is delocalized. (1)

or

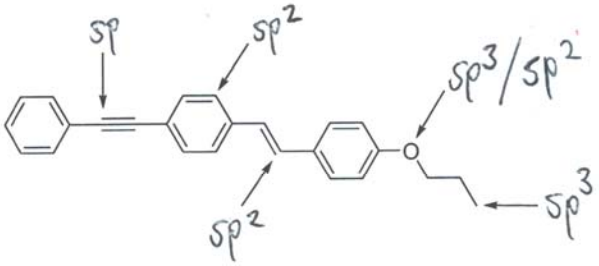
i.e



(b) The above compound is commonly known by which acronym? **(1 point)**

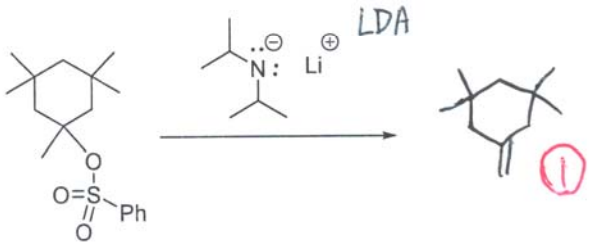
DBU

5. Identify the hybridization state of each of the atoms indicated with an arrow. **(5 points)**



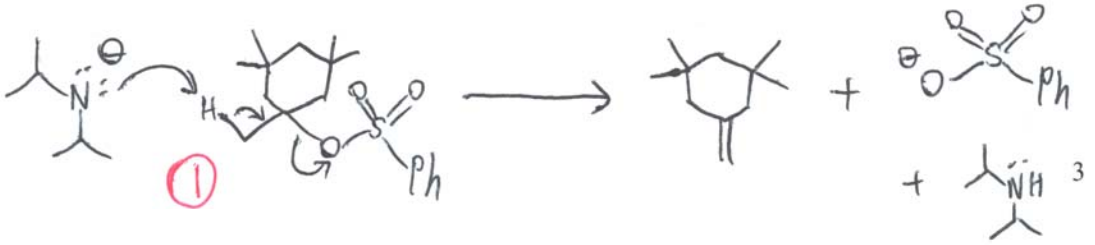
(1) each

6. (a) Predict the major product, (b) explain your product choice, and (c) draw a mechanism to account for its formation. **(4 points)**



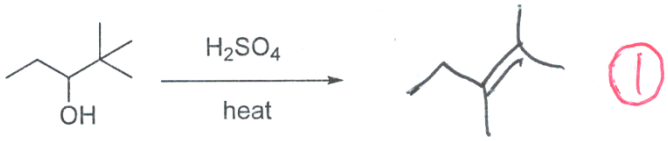
(1)

(1) Bulky / hindered base attacks the most accessible H to give the less substituted alkene. (1)

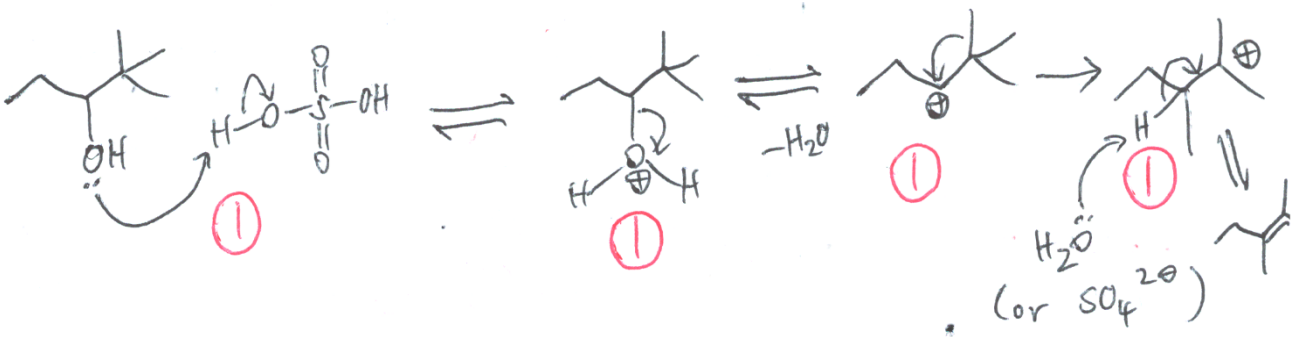


(1)

7. Predict the major product, and draw a mechanism for its formation: **(5 points)**

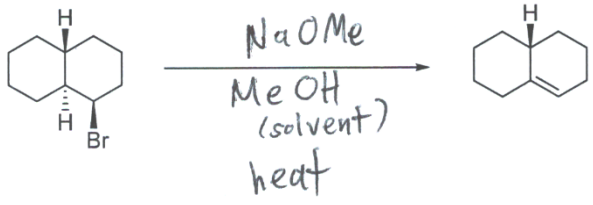


(1)



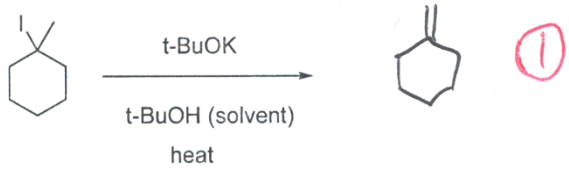
(1) (1) (1) (1)

8. (a) Propose reagent(s), solvent(s), and reaction conditions for the following transformation: **(3 points)**



Small, strong base (1)
Polar (a)protic solvent (1)
Heat (1)

(b) Draw the major product(s) of the following reaction and explain your answer. **(3 points)**



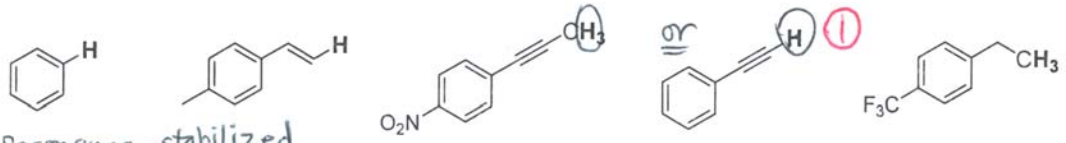
(1)

(1)

t-BuOK is a bulky/hindered base.
It attacks the more accessible H
to give the less substituted alkene.

(1)

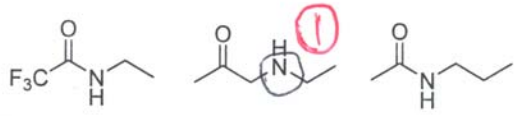
9. Circle the most acidic proton in the following set and briefly explain your choice. **(2 points)**



Struct 3: Resonance-stabilized.

Struct 4: H is attached to an sp-hybridized C, which has the greatest s-character and largest inductive effect. (1)

10. Circle the most basic nitrogen in the following set and briefly explain your choice. **(2 points)**

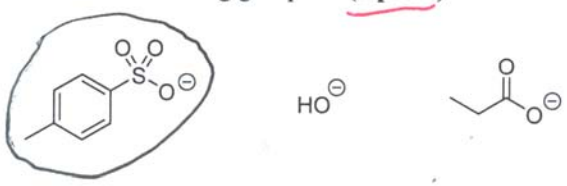


This N is not in conjugation with C=O. (1) It is an amine, which is more basic than the other two amides.

11. Circle the more acidic proton and briefly explain your choice. **(2 points)**

The larger Se is better able to stabilize the negative charge in the conjugate base. (due to larger diffuse orbitals) (CF_3 is too far to be relevant.) (1)

12. Circle the best leaving group: **(1 point)**



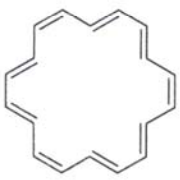
13. Decide whether each of the following is aromatic, anti-aromatic, or non-aromatic. **(5 points)**

a)  aromatic

b)  aromatic

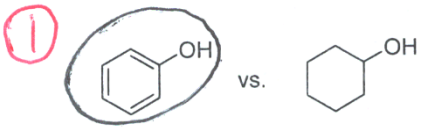
c)  non-aromatic

d)  anti-aromatic

e)  aromatic

(1) each

14. a) Circle the more acidic compound. **(1 point)**

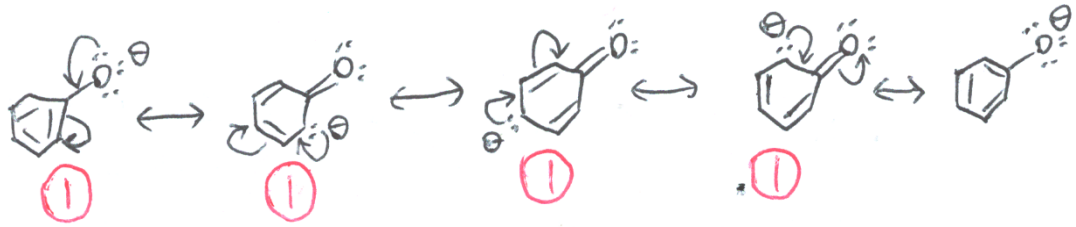


b) Explain your choice above with the aid of appropriate structures. **(6 points)**

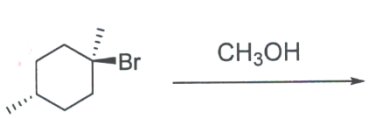
Conjugate base (phenoxide) is stabilized by inductive (sp^2 vs. sp^3 carbons) and resonance effects.

(sp^2 has more s-character)

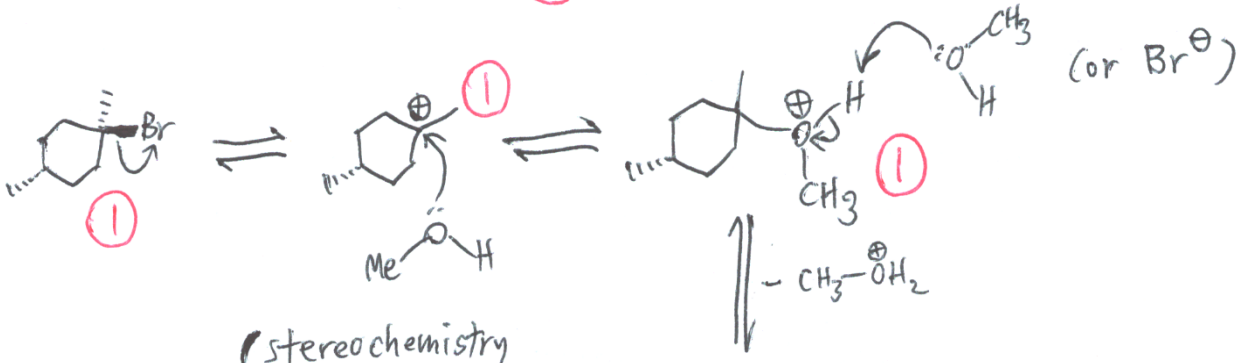
Resonance structures:



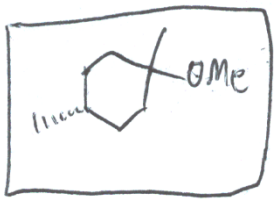
15. a) Predict the S_N1 product(s) and write the mechanism of the following reaction. **(4 points)**



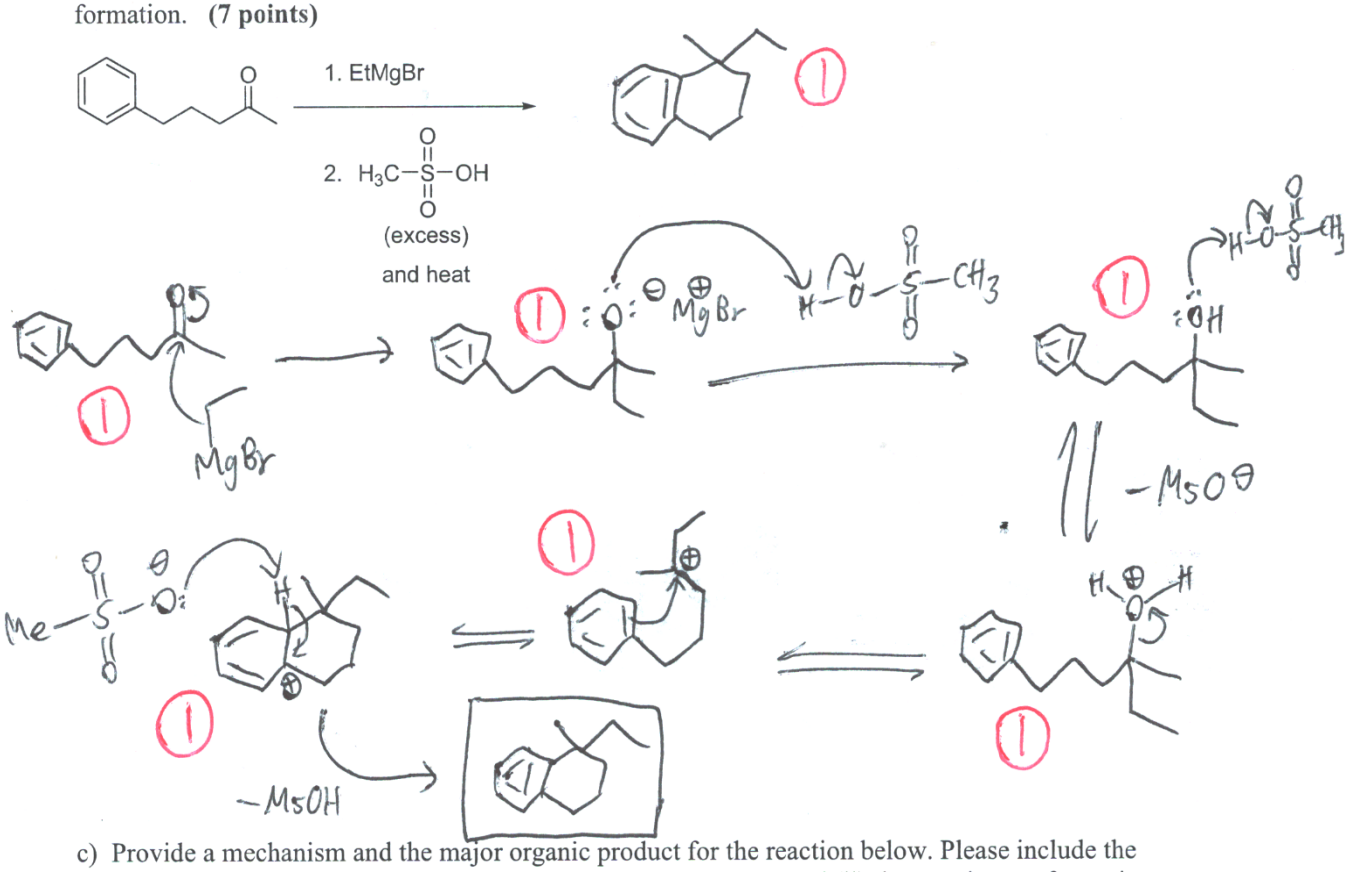
(±) racemic mixt.



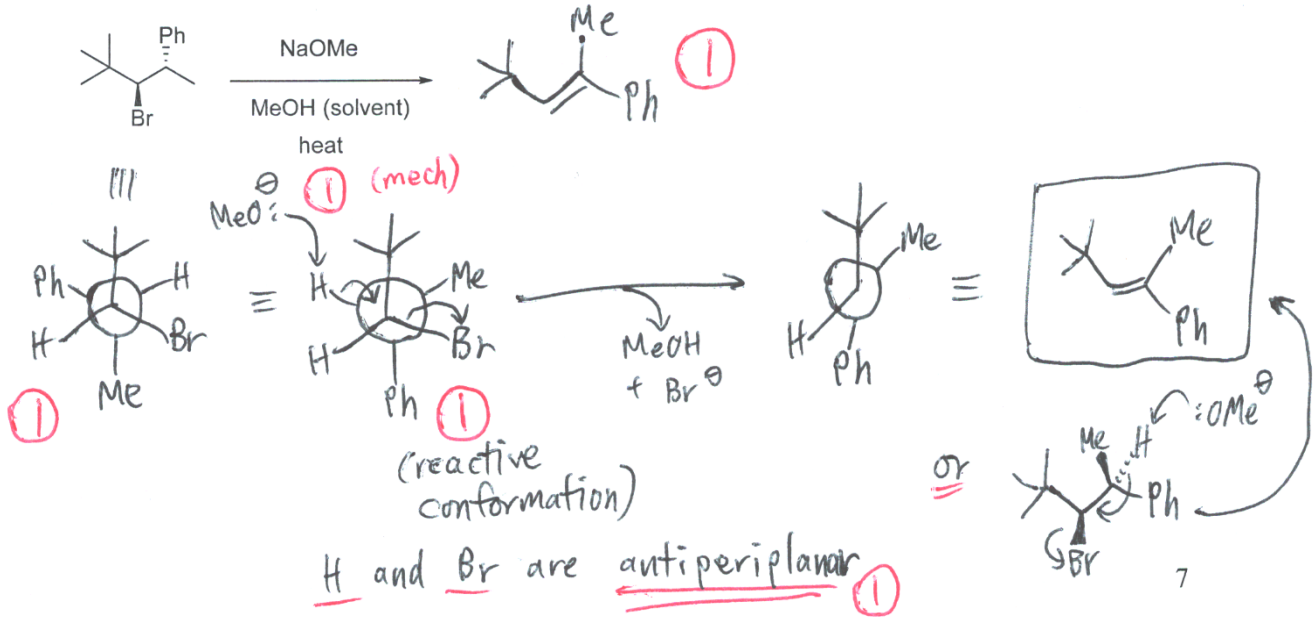
(stereochemistry is lost when carbocation forms.)



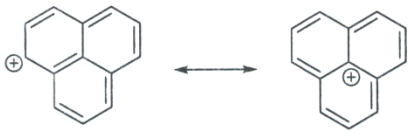
b) Provide the major organic product of the following and draw the entire mechanism for its formation. **(7 points)**



c) Provide a mechanism and the major organic product for the reaction below. Please include the Newman projections of: (i) the starting material as drawn below, and (ii) the reactive conformation. Briefly explain the significance of your reactive conformation. **(5 points)**



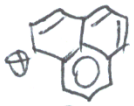
Bonus! (**3 points** - all or nothing!)
Tertiary carbocations are in general more stable than secondary ones. This is not the case for the example below, however. Explain why.



secondary carbocation

tertiary carbocation

Also :



↑ stable aromatic sextet

peripheral ring system

Antiaromatic (unstable) system with 12 π electrons (4n)

* See 13.(d) of this exam!

========== End of exam ==========