CHEM 234 | the exam cover sheets look kind of like this | Ian R. Gould

PRINTED **FIRST** NAME _____ *PRINTED* **LAST** NAME _____ *ASU ID or Posting ID* _____

*Person on your **LEFT** (or **Aisle**)*

*Person on your **RIGHT** (or **Aisle**)*

- ***PRINT YOUR NAME ON EACH PAGE!***
- ***READ THE DIRECTIONS CAREFULLY!***
- ***USE BLANK PAGES AS SCRATCH PAPER***
  work on blank pages will not be graded...
- ***WRITE CLEARLY!***
- ***MOLECULAR MODELS ARE ALLOWED***
- ***DO NOT USE RED INK***
- ***DON'T CHEAT, USE COMMON SENSE!***

THIS IS A CHM 234
PRACTICE EXAM

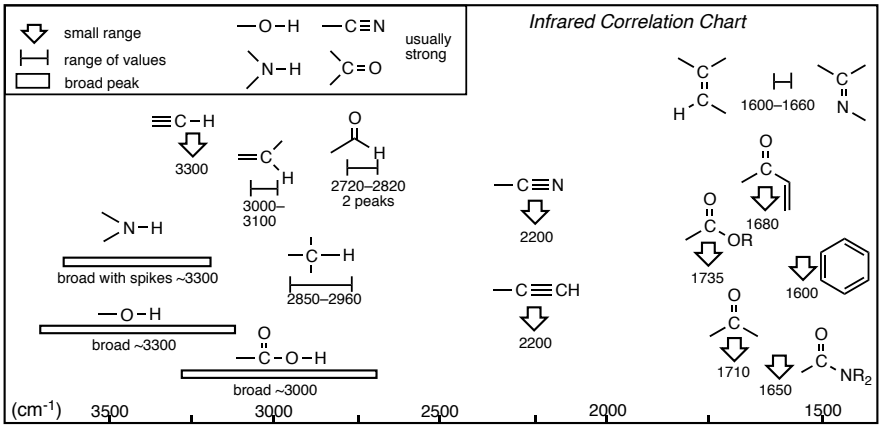
MIDTERM #2
PRACTICE TEST #1

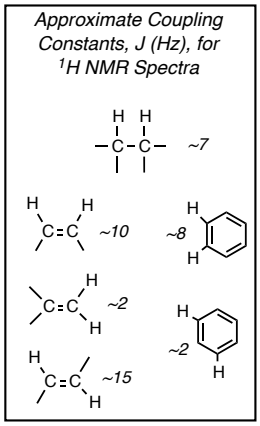
Extra Credit_____/5 **Total (incl Extra)**_____/175+5

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

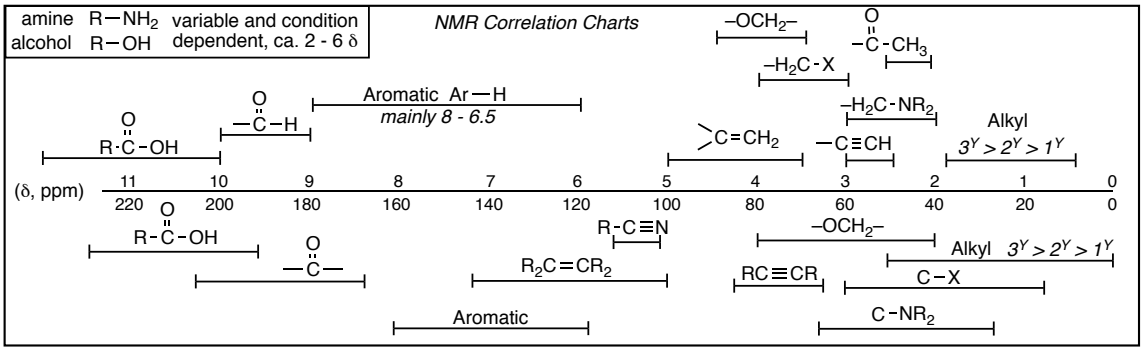
Interaction Energies, kcal/mol

Eclipsing		Gauche	
H/H	~1.0	Me/Me	~0.9
H/Me	~1.4	Et/Me	~0.95
Me/Me	~2.6	i-Pr/Me	~1.1
Me/Et	~2.9	t-Bu/Me	~2.7



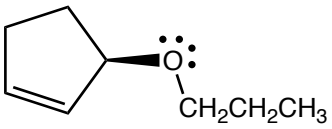


amine R—NH_2 variable and condition
alcohol R—OH dependent, ca. 2 - 6 δ

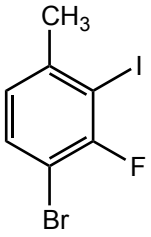


Question 1 Give the IUPAC name for the following compounds. Be sure to use cis/trans, E/Z or R/S where appropriate.

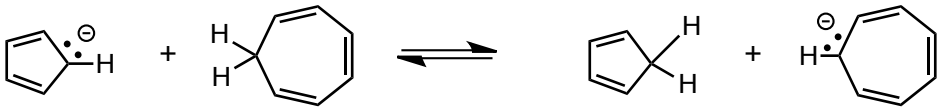
a)



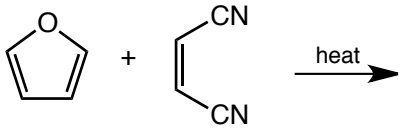
b)

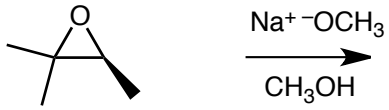


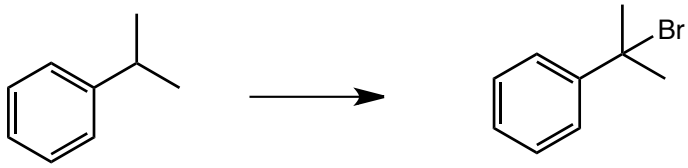
Question 2. For the Bronsted acid/base reaction below:
a) Give the curved arrow-pushing in both directions
b) Draw a reaction energy diagram and include a drawing of the transition state
c) Label the acids/bases and which are stronger and give a brief explanation
d) Indicate which reaction is faster (left to right or vica versa) and on which side the equilibrium lies and which acid has the smaller and which the larger pKa

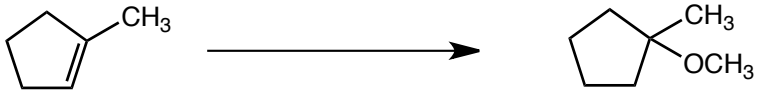


Question 3 For each reaction
1) Provide the missing **reagents/conditions or major organic products as appropriate**
2) **State** whether the OVERALL reaction is Addition, Elimination, Substitution or Rearrangement
3) **Briefly explain** whether the a solution of the product would be optically active or not
4) Pay attention to stereochemistry including racemic mixtures unless specified

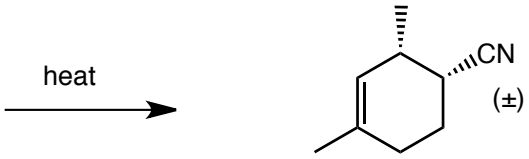
a) 

b) 

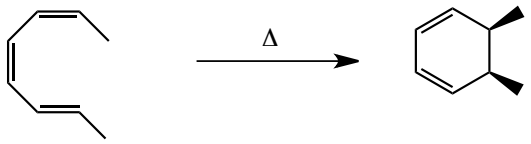
c) 

d) 

Question 4. Provide the missing reactants for the following Diels-Alder reaction.



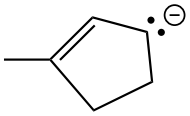
Question 5. The purpose of this question is to determine whether the provided product is allowed or forbidden



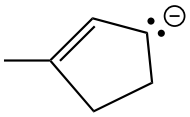
1) draw the arrow-pushing that describes formation of the PROVIDED product
2) How many electrons are involved in the reaction?
3) FOR THE PROVIDED PRODUCT (which may or may not be allowed), would the ring closing be disrotatory or conrotatory?
4) FOR THE PROVIDED PRODUCT (which may or may not be allowed), would the transition state be Hückel or Möbius?
5) Is PROVIDED PRODUCT allowed or forbidden and why?

Question 6) For the following ion, draw all reasonable resonance contributors, draw an "actual" structure that includes partial bonds and partial charges (use δ to indicate partial charges), and draw the HOMO and LUMOs on TOP of the provided structures

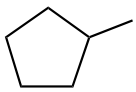
HOMO and resonance

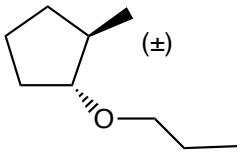


LUMO

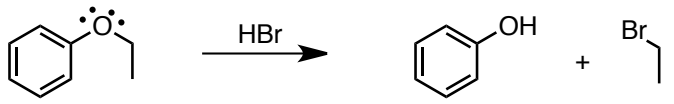


Question 7. Show how you would synthesize the target compond on the right from the starting compound on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

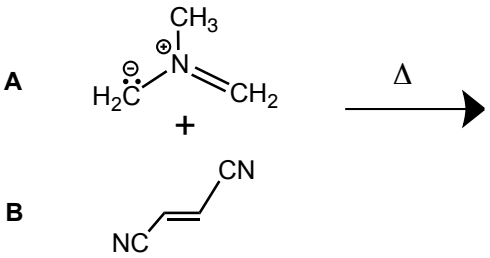




Question 8) Explain why the products of the following reaction are an alcohol and a bromide, rather than two bromides, Draw a mechanism to support your reasoning

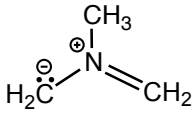


Question 9). Give the curved arrow-pushing and the ALLOWED product of the following cycloaddition reaction

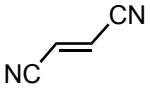


b) Give a pictorial representation of the wavefunction of the HOMO ON TOP OF THE STRUCTURE below for A, indicate the number and positions of any vertical nodes (ignore horizontal nodes)

HOMO



c) Give a pictorial representation of the wavefunction of the LUMO ON TOP OF THE STRUCTURE below for B, indicate the number and positions of any vertical nodes (ignore horizontal nodes)



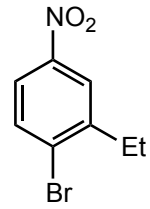
LUMO

d) Give a brief justification for the stereochemistry in your allowed product, you must include the following terms in your justification: suprafacial and/or antarafacial, HOMO, LUMO, bonding and/or anti-bonding

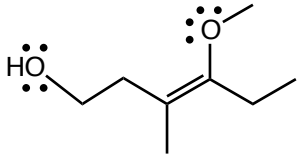
START OF PRACTICE TEST #2

Question 1 Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

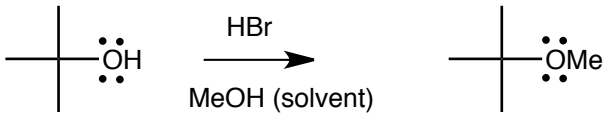
a)



b)

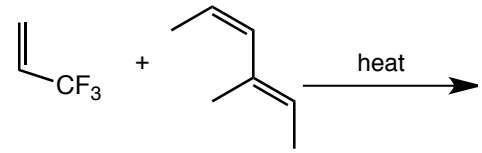


Question 2. Give a complete curved arrow pushing mechanism, and...
1) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB)
2) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM

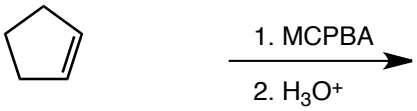


Question 3 For each reaction
1) Provide the missing **reagents/conditions or major organic products as appropriate**
2) **State** whether the OVERALL reaction is Addition, Elimination, Substitution or Rearrangement
3) **Briefly explain** whether the a solution of the product would be optically active or not
4) Pay attention to stereochemistry including racemic mixtures unless specified

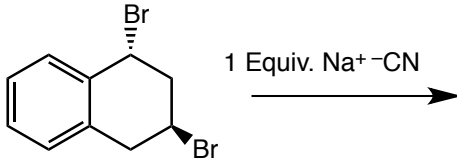
a)



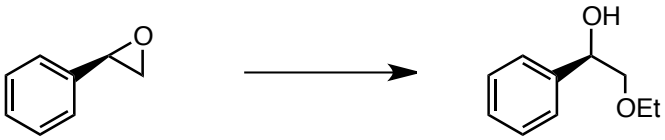
b)



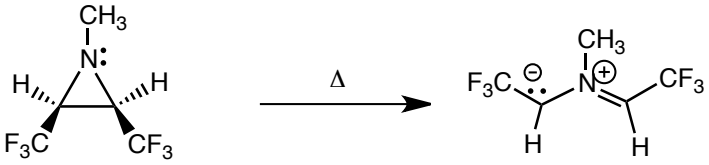
c)



d)

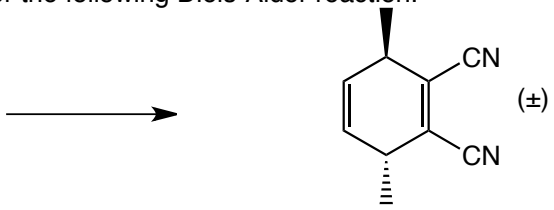


Question 4) The purpose of this question is to determine whether the provided product is allowed or forbidden

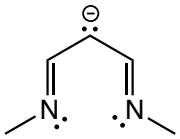


1) draw the arrow-pushing that describes formation of the product
2) How many electrons are involved in the reaction?
3) FOR THE PROVIDED PRODUCT (which may or may not be allowed), would the ring opening be disrotatory or conrotatory?
4) FOR THE PROVIDED PRODUCT (which may or may not be allowed), would the transition state be Hückel or Möbius?
5) Is THE REACTION SHOWN allowed or forbidden, and why?

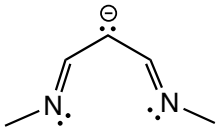
Question 4. Provide the missing reactants for the following Diels-Alder reaction.



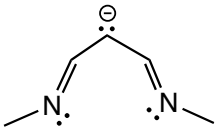
Question 5. For the following structure:
a) Draw all additional reasonable resonance contributorts
b) Draw on TOP of the structure a pictorial representatrion of the wavefunction of both the HOMO and the LUMO, give the number of vertical node (only) and indicate their positions.



resonance contributors

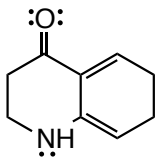


HOMO

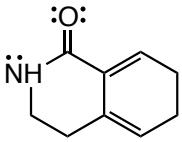


LUMO

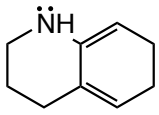
Question 6. Rank the following structures in order of increasing rate of reaction in a Diels-Alder reaction with fumaronitrile (shown), and give a brief explanation that includes the terms "donating group", "withdrawing group", "energy of the electrons", "HOMO".



A

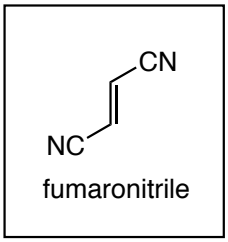


B



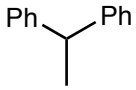
C

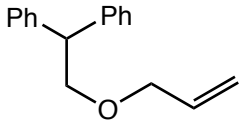
___ < ___ < ___



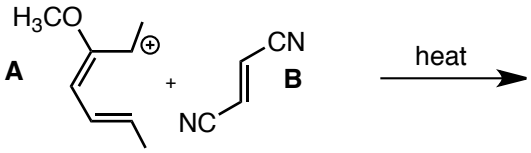
fumaronitrile

Question 7. Show how you would synthesize the target componds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

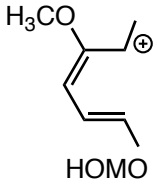


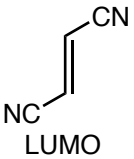


Question 7 (20 pts.)
a) Give the curved arrow-pushing and the ALLOWED product of the following cycloaddition. State whether the product is achiral, a mso compound, a pure enntiomer or a racemic mixture



b) Draw the HOMO for reactant **A** and the LUMO for reactant **B** on top of the structures below, understanding that it may not be possible to get the geometry of the orbitals with respect to the structures exactly correct because the structures have to be drawn flat on the paper

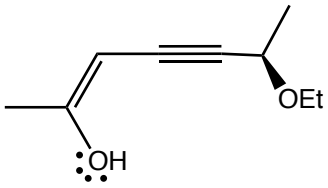




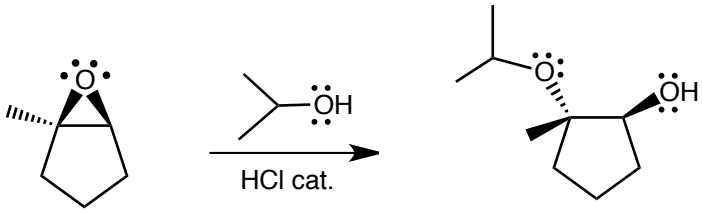
c) does the allowed reaction proceed suprafacial/suprafacial or suprafacial/antarafacial?

START OF PRACTICE TEST #3

Question 1 Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

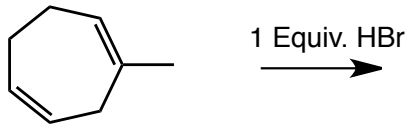


Question 2. Give a complete curved arrow pushing mechanism, and...
1) Indicate the Lewis acid/Lewis base (LA, LB) at each step as appropriate, and whether they are also Brønsted acids/bases (LA/BA, LB,BB)
2) GIVE THE NUMBER OF STEPS IN YOUR MECHANISM

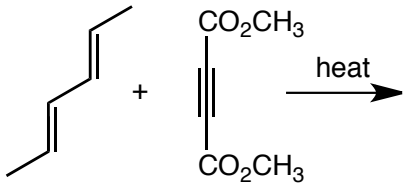


Question 4 For each reaction
1) Provide the missing **reagents/conditions or major organic products as appropriate**
2) Pay attention to stereochemistry including racemic mixtures unless specified
3) State whether a solution of the product(s) would be optically active or not and give a brief explanation

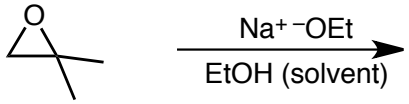
a)



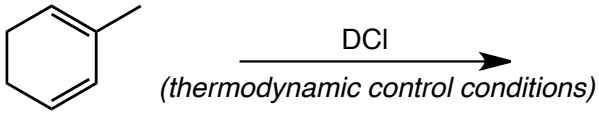
b)



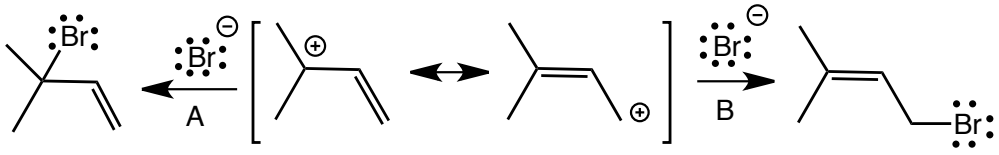
c)



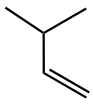
d)



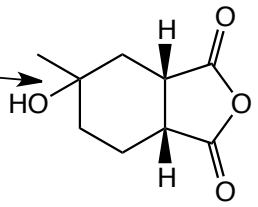
Question 5) Indicate which reaction is more exothermic, give an explanation



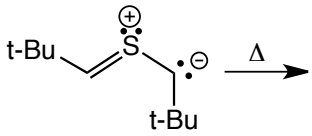
Question 5. Show how you would synthesize the target componds on the right from the starting compounds on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.



ignore stereochemistry here

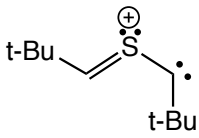


Question 6) The ylide below undergoes an electrocyclic ring closure reaction

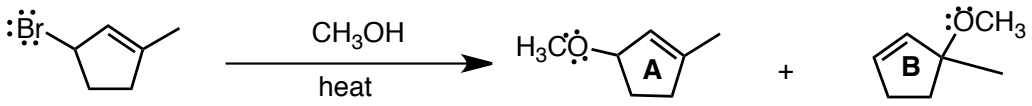


a) give the curved arrow-pushing that accounts for product formation
b) draw the product, paying special attention to relative stereochemistry of any substituents
c) indicate the locations of any chiral (asymmetric) carbons atoms with the * symbol, and state whether it is racemic, a meso compound or achiral
d) give the NUMBER of electrons involved in the reaction
e) state whether the allowed reaction proceeds via a Huckel or a Mobius transition state
f) state whether the allowed reaction proceeds via a conrotatory or a disrotatory ring closing

g) Draw a pictorial representation of the HOMO on top of the structure below, give the number of vertical nodes (only) and oindicate their positions



Question 7. a) Give a full curved-arrow pushing mechanism for formation of both products of the provided reaction. One of these products would be formed preferentially under conditions of kinetic control, the other preferentially under conditions of thermodynamic control, indicate which is which. Indicate the Lewis acid and base at each step and whether they are also Bronsted acids/bases.

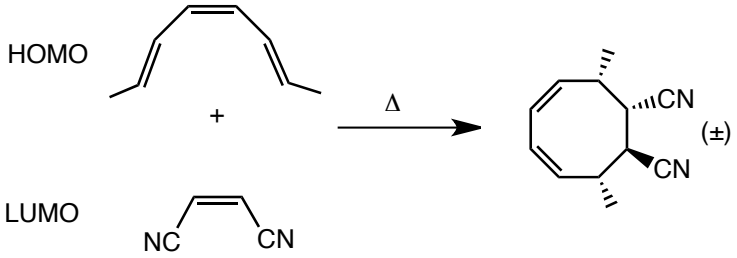


b) Give a reaction energy diagram for both reactions in the SAME DIAGRAM

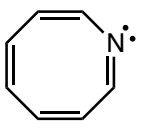
c) Give a brief explanation of how temperature is related to kinetic and thermodynamic control

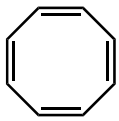
Question 8. The purpose of this question is to determine whether the provided product of the cycloaddition reaction given below is allowed or forbidden (there are several possible products of this reaction, we will focus our attention on this one to see if it is allowed)

a) give the curved arrow-pushing that accounts for product formation
b) draw the HOMO and LUMO ON TOP OF THE structures as indicated above, and give the number of vertical nodes and clearly indicate their positions
c) IGNORING THE PROVIDED product for now, use the information from the F.M.O.s to decide whether the ALLOWED reaction would be suprafacial/suprafacial or suprafacial/ antarafacial
*your answer*_____
d) Using the sterochemistry of the PROVIDED PRODUCT, decide state whether the it was formed via suprafacial/suprafacial or suprafacial/ antarafacial cycloaddition
*your answer*_____
d) state whether the PROVIDED PRODUCT is allowed or forbidden, and give a BRIEF explanation that mentions the frontier molecular orbitals.



Question 9) Classify the following structures as aromatic, non-aromatic or anti-aromatic, assume all structures are as flat as possible, AND give the number of electrons involved in the conjugated system

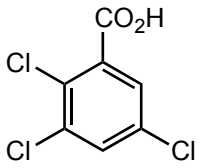




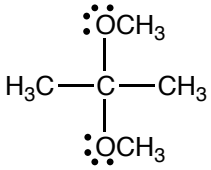
START OF PRACTICE TEST #4

Question 1 Give the IUPAC name for the following compound. Be sure to use cis/trans, E/Z or R/S where appropriate.

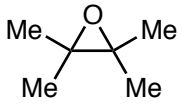
a)



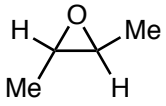
b)



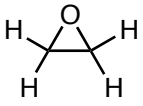
Question 2) Rank the following in order of icreasing rate of reaction in a base catalyzed hydrolysis reaction (addition of water in the presence of hydroxide) and give a brief explanation (hint, think abouyt the slowest, rate determining step for base catalyzed hydrolysis)



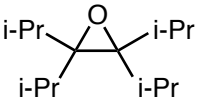
A



B



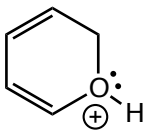
C

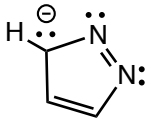


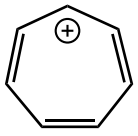
D

___ < ___ < ___ < ___

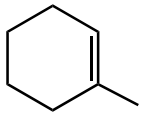
Question 3) Classify the following structures as aromatic, non-aromatic or anti-aromatic, assume all structures are as flat as possible, AND give the number of electrons involved in the conjugated system



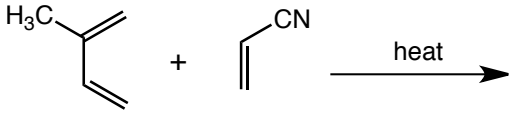




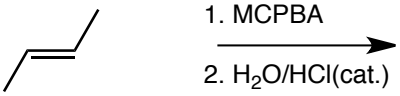
Question 4. For each reaction.
1) Provide the missing **reagents/conditions or major organic products as appropriate**
2) Pay attention to stereochemistry including racemic mixtures unless specified

a) 
1. MCPBA
2. MeOH/HCl (cat.)

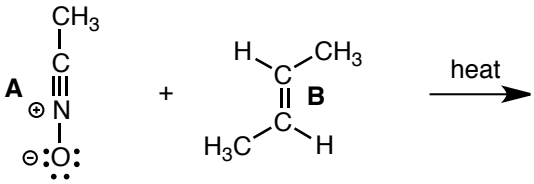
(ignore stereochemistry)

b) 

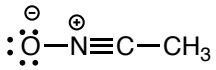
c) 

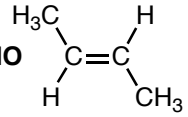
d) 

Question 5) a) Give the curved arrow pushing and the product of the following reaction. Pay attention to stereochemistry and state whether a solution of the product(s) would be opticlly active or not.

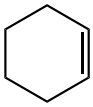


For BOTH of the reactants **A** and **B**:
b) Give a pictorial representation of the requested frontier molecular orbital as requested on top of the provided structure
c) Give the number of electrons in the conjugated system that are relevant to the reaction
d) State whether the allowed reaction is suprafacial or antarafacial

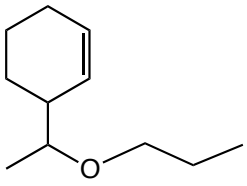
A: HOMO 

B: LUMO 

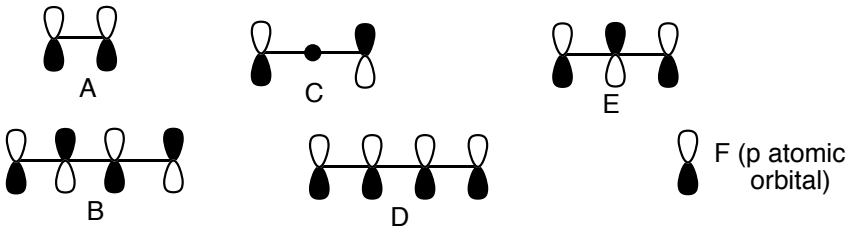
Question 6. Show how you would synthesize the target compound on the right from the starting compound on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.

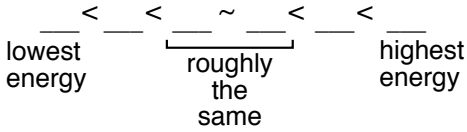


(ignore stereochemistry)

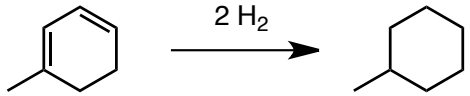


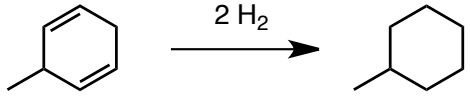
Question 7. Consider the energy of an electron in each of the following π-molecular orbitals AND a p atomic orbital on a carbon atom and rank them in order of increasing energy. Two of the energies will be essentially equal, as indicated below

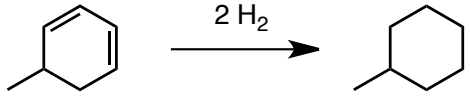




Question 8) Rank the following reactions, A, B and C, in order of INCREASING exothermicity. Give a BRIEF explanation

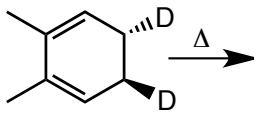
A 

B 

C 

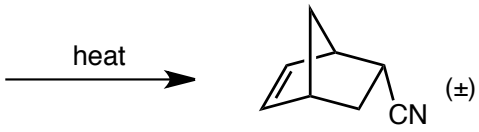
_____ < _____ < _____
lowest exothermicity — highest exothermicity

Question 9) The structure below undergoes an electrocyclic ring opening reaction (remember, D means deuterium, an isotope of hydrogen that is often used as a labelled hydrogen atom)

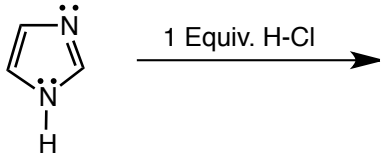


a) give the curved arrow-pushing that accounts for product formation
b) draw the product, paying special attention to relative stereochemistry of any substituents
c) give the NUMBER of electrons involved in the reaction
d) state whether the allowed reaction proceeds via a Huckel or a Mobius transition state
e) state whether the allowed reaction proceeds via a conrotatory or a disrotatory ring closing

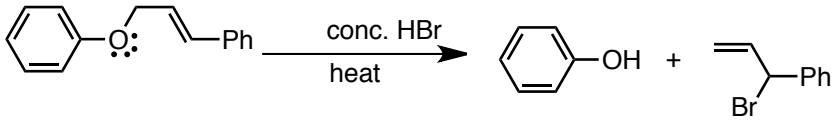
Question 10. Provide the missing reactants for the following Diels-Alder reaction.



Question 11. One equivalent of H-Cl will preferentially protonate one of the nitrogens in imidazole (shown below) and not the other. Give the major product pf the reaction shown below and give a brief explanation for your choice of product



Question 12) Provide a detailed (arrow pushing) mechanisms for the following transformations. draw all important resonance structures. For each intermolecular step, identify the Lewis acid and base (LA/LB) as appropriate, and whether they are also Bronsted acids/bases (BA/BB), give the number of steps in your mechanism (hint BOTH SN1 and SN2 can occur at allylic carbon atoms)



Question 13. Show how you would synthesize the target compond on the right from the starting compound on the left. Show reagents and conditions, and the structures of important intermediate compounds. Do not show any (arrow pushing) mechanisms.