

Chemistry 3A – Exam #1

Student Name: _____

Student ID Number: _____

TA or Section: _____

Point Breakdown

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Problem 5 _____ / 13

_____ / 17

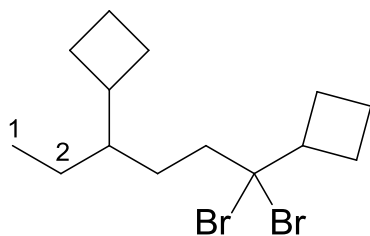
Total _____ / 150

Check that you have 9 pages.

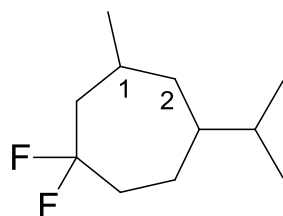
You will have 120 minutes for this exam.

**REMEMBER: Opposites attract,
formal charges are required, and
the octet rule is super important**

1. A. Provide systematic names for the following molecules. Use common names where appropriate. Continue numbering the carbons based on the first 2 carbons. (4 pts)



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1. B. The following names are incorrect. Draw the molecule according to the name written. Write the correct name in the provided box. (8 pts)

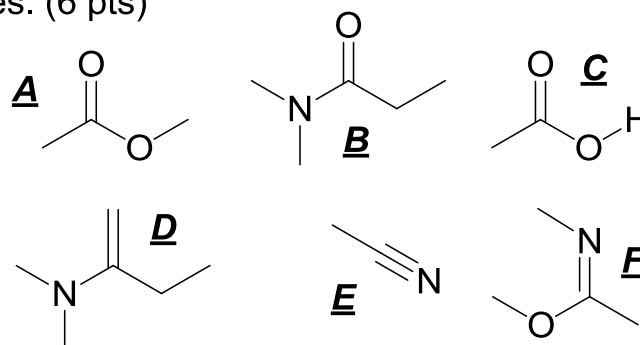
Incorrect name: <i>sec</i> Butylethane	
Molecule drawing:	Correct name:
Incorrect name: tetraMethylmethane	
Molecule drawing:	Correct name:

1. C. Match the names with the structures by placing the letter for the structure next to the name based on the functional group. There are more structures than names. (6 pts)

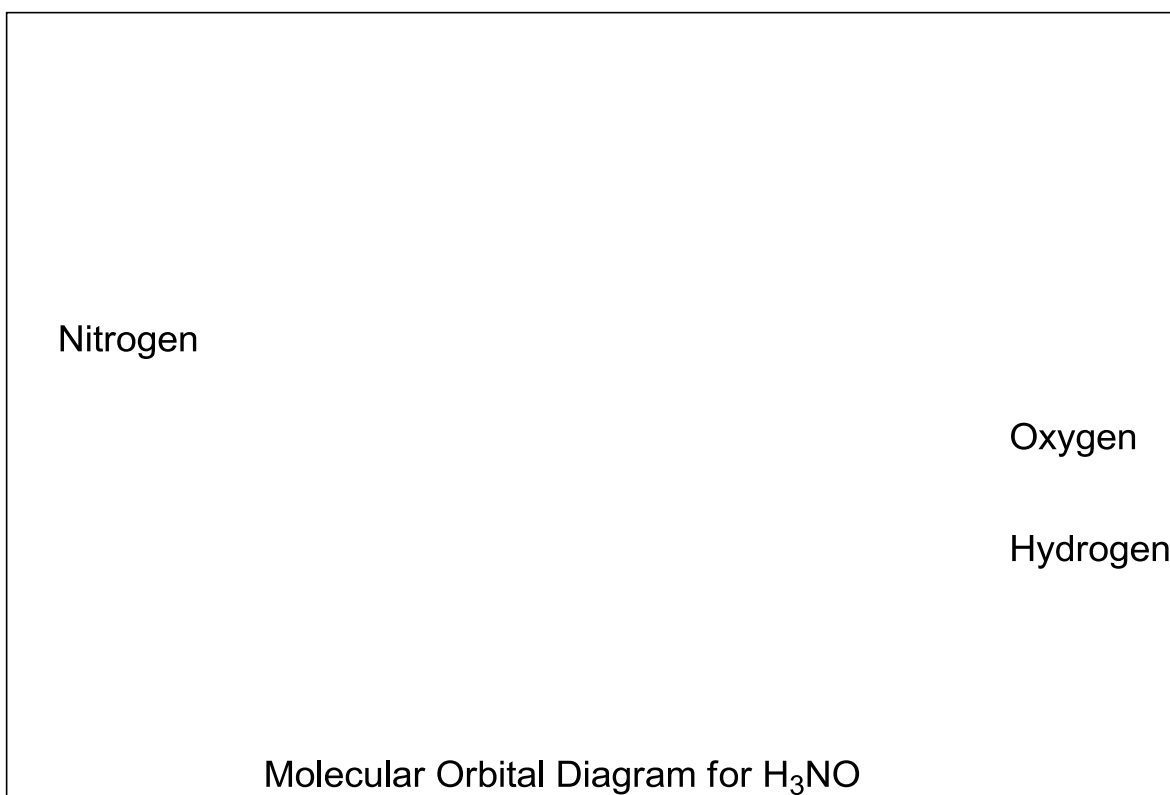
a methyl ester

a dimethyl amide

acetonitrile

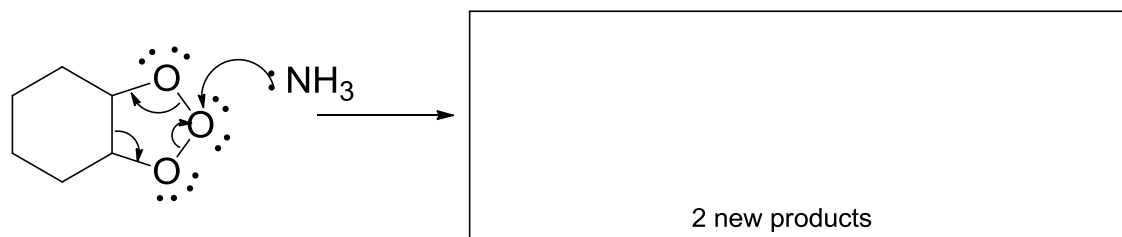
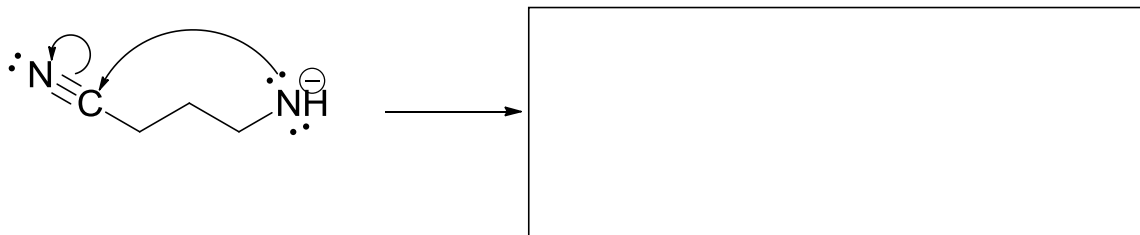
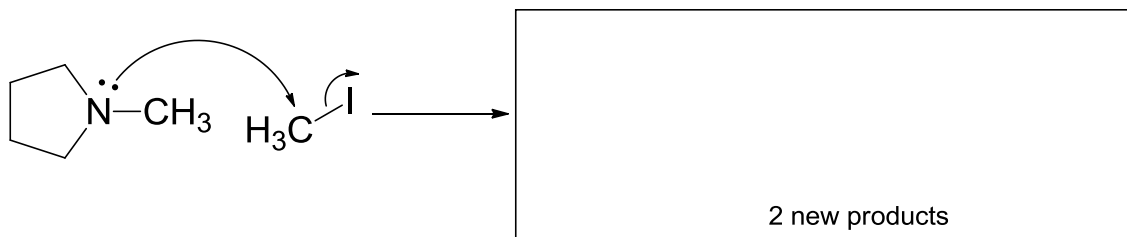


2. Construct the molecular orbital diagram for the molecule H_3NO , using the following guidelines and labeling schemes. The nitrogen is the central atom. Please be sure to include everything asked for below. (16 pts)
- Assume the nitrogen and oxygen atoms are both sp^3 hybridized
 - Indicate the relative energy levels of any atomic and hybrid orbitals on both the left and right of the diagram
 - Clearly indicate which orbitals are being combined to make MOs
 - Fill in all of the electrons
 - Label all of the levels (σ , π , π^* , non-bonding, etc.)
 - Label the HOMO and LUMO

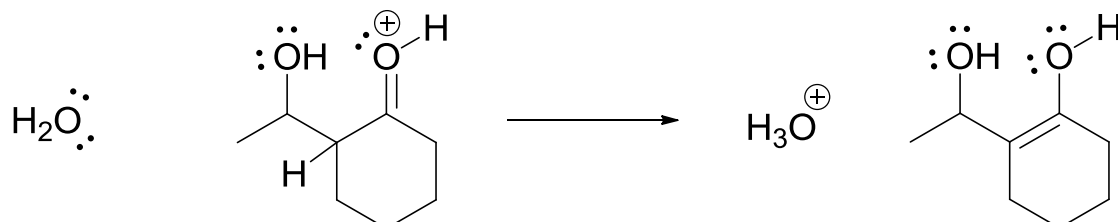
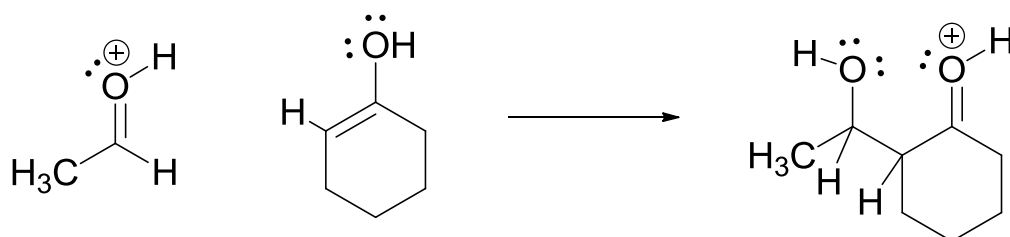
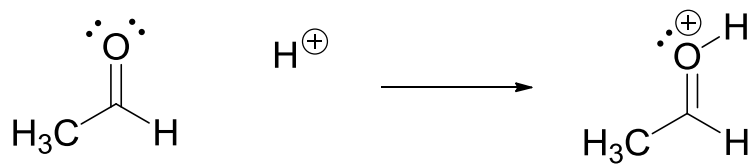


- g. Draw the 3D representation of H_3NO below. You do not need to show the location of lone pairs on oxygen. Feel free to use our template from class. You must clearly show all formal charges.

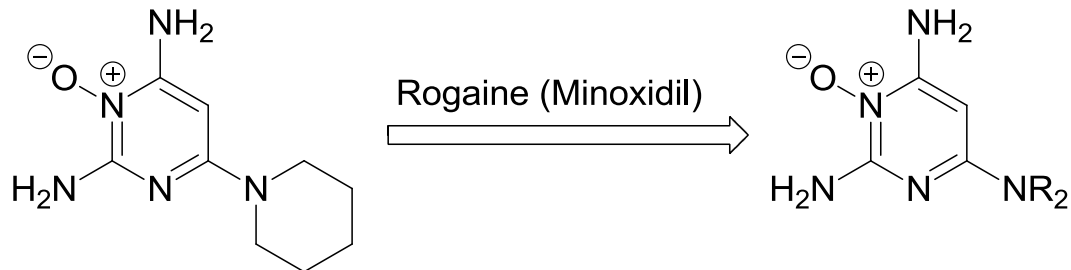
3. A. Provide the products following the electron-pushing arrows shown. Remember to pay attention to formal charges. (15 points)



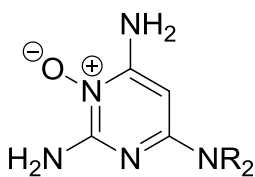
3. B. Add appropriate electron-pushing arrows for the following reactions. (14 points)



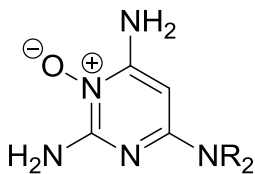
4. Minoxidil is a vasodilator medication. It's also known as Rogaine[®].



4. A. Provide resonance contributors where all atoms have filled octets for the structures below. Pay special attention to the specifications in each box. (15 pts).



Three more contributors, each with a **NEUTRAL** oxygen atom and a **NEGATIVE** carbon atom.

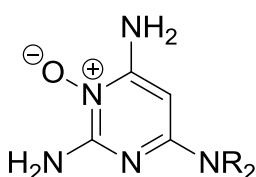


Two more contributors where all **atoms inside the shown ring** are **neutral**

4. B. Match the four terms on the left with the four definitions on the right.
Place the letter of the definition in the box next to the appropriate term.
(6 pts)

Bronsted Acid	<input type="checkbox"/>	A Molecule with a lone pair of electrons on an atom with a partial negative charge
Electrophile	<input type="checkbox"/>	B Molecule with a partial positive charge
Bronsted Base	<input type="checkbox"/>	C Molecule that will donate a proton
Nucleophile	<input type="checkbox"/>	D Molecule with a lone pair of electrons that can accept a proton

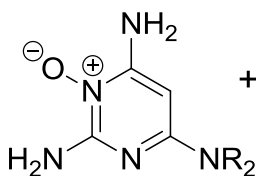
4. C. Circle the Nitrogen atom on Minoxidil that is the most basic. (2 pts)



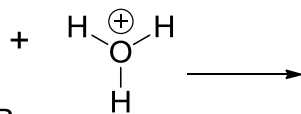
Minoxidil

Two resonance contributors for question 4.D.

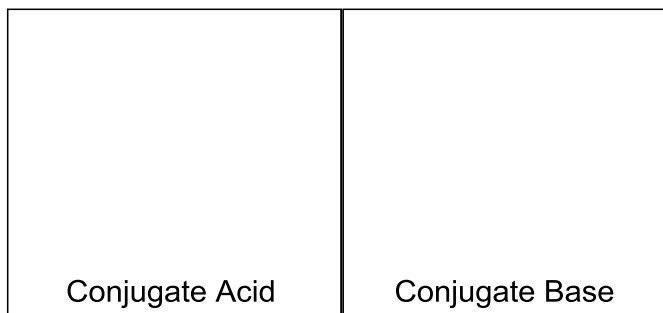
4. D. Draw two resonance contributors in the space above to prove your choice in 4.C. They must have filled octets. (6 pts)
4. E. Draw the products of the reaction between the most basic nitrogen on Minoxidil and hydronium below. Make sure the formal charges are correct and that the products are in the appropriate boxes. (6 pts)



Minoxidil

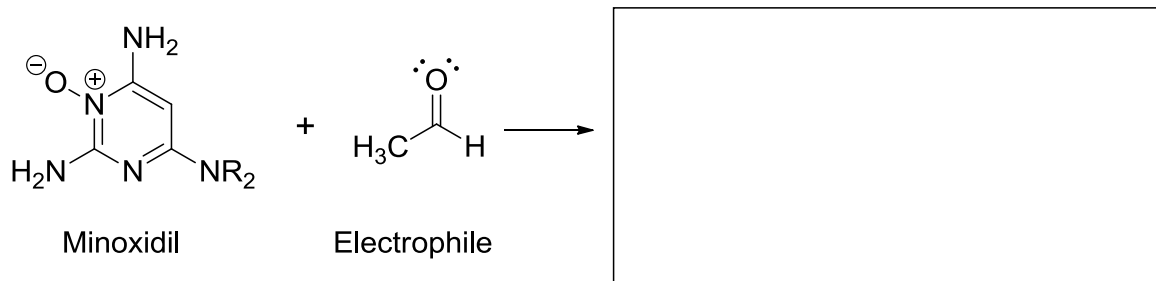


Hydronium



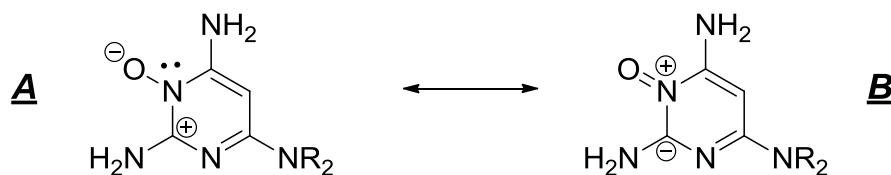
4. F. Add electron-pushing arrows to the reactants above that lead to the products drawn. (4 pts)

4. G. Show the product of the reaction between the nucleophilic oxygen atom on Minoxidil and the electrophilic carbon on the electrophile. (3 pts)



4. H. Add appropriate electron-pushing arrows to the reactants to show the formation of the product you drew in 4.G. (4 pts)

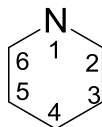
4. I. Circle the more important resonance contributor below. (3 pts)



4. J. Explain your answer to 4.I. in the box below. **You may use 1 sentence and no more than 10 words.** (3 pts)

4. K. Based on your answer to 4.I., do you think the carbon atoms on Minoxidil are more likely to act as electrophiles or nucleophiles? Explain. (2 pts)

5. A. Draw the flat-ring representation of the "Chair" molecule depicted in the box below. Please use the provided template and use wedges and dashes. Add the appropriate formal charges. (3 pts)



5. B. Draw the chair-flipped structure in the box on the right. (3 pts)
5. C. Using the data provided below, calculate the ΔG for the chair flip and write the answer in the appropriate box. Show your work. (5 pts)
5. D. Based on your ΔG , draw in the equilibrium arrow for this chair-flip in the appropriate box. (2 pts)

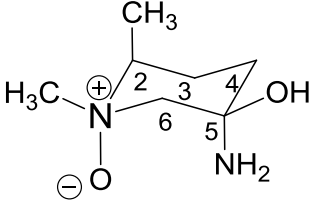
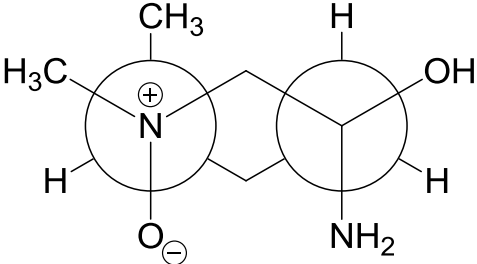
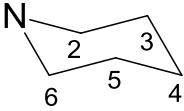
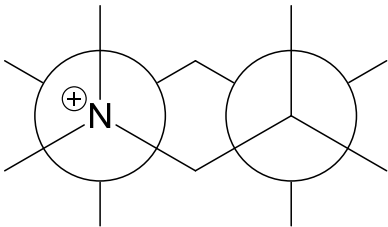
<p>Chair</p>	$\Delta G =$	<p>Chair-flipped structure</p>
equilibrium arrow		

Show work:

The energies reported are from flipping the piperidine chair conformer with the indicated substituent **equatorial to the conformer with the substituent axial.**

Substituent	ΔG° (kcal/mol)	Substituent	ΔG° (kcal/mol)
O^\ominus	2.0	NH_2	1.5
Me	1.70	OH	1.0

5. E. The double-barrel Newman Projection of the "Chair" molecule has been provided below. The eyes are looking from N→2 and from 5→4. Catalog all of the SUBSTITUENT-SUBSTITUENT steric interactions. Label them as either Gauche or 1,3-diaxial. (4 pts)

Chair	Chair-flipped structure
  <p data-bbox="297 915 690 951">Newman N→2 and 5→4</p>	  <p data-bbox="902 915 1295 951">Newman N→2 and 5→4</p>
Substituent-Substituent steric interactions	Substituent-Substituent steric interactions

5. F. Redraw the substituents on the Chair-flipped structure above. Fill in the substituents on the double-barrel Newman Projection looking down the N→2 and 5→4 bonds. (3 pts)
5. G. Catalog all of the SUBSTITUENT-SUBSTITUENT steric interactions present in the Chair-flipped structure. Label them as either Gauche or 1,3-diaxial. (4 pts)
5. H. The negatively charged oxygen is less basic than expected. Explain this using the inductive effect. Use 1 sentence. (3 pts)

5. I. The negatively charged oxygen is even less basic in the "chair" than in the "chair-flipped" conformation. Explain. (3 pts)