CHEM 12A

Student Evaluation

From your GSIs

Fall 2020

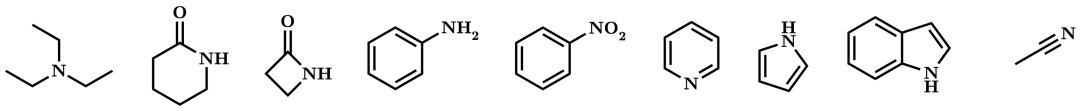
Preface

For CHEM 375, your GSIs are tasked with evaluating students with a comprehensive handout focusing on one common theme in organic chemistry. To this end, we've chosen resonance for both its pervasive recurrence across many topics in the course and its power and importance in explaining these topics.

Please complete the following questions in a timely manner. This is not meant to be a stressful exercise but rather a useful study tool. Completing these problems will be a valuable exercise that will help you complete problem sets and think critically on exam problems. **For making an honest attempt to complete this handout, you will be awarded 2 bonus points**. We know each of you is busy and likely balancing a dizzying amount of other courses. We deeply appreciate your time!

Problem 1

For the following structures,



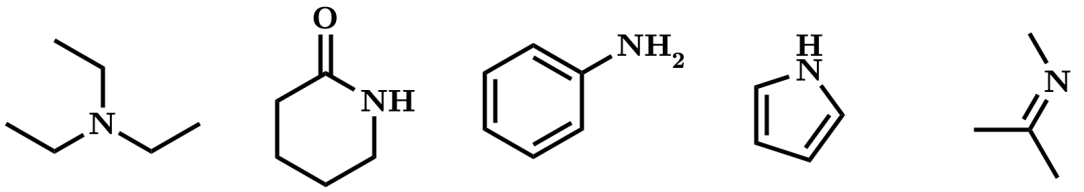
1. Draw all nitrogen lone pairs,
2. give the hybridizations of the nitrogen atoms, and
3. indicate which orbitals the resonating lone pairs occupy.

Problem 2

Nitrogen is normally sp^3 hybridized with 4 electron domains, though in some molecules in **Problem 1**, they behave differently. Explain this phenomenon for the compounds in which this does not hold true.

Problem 3

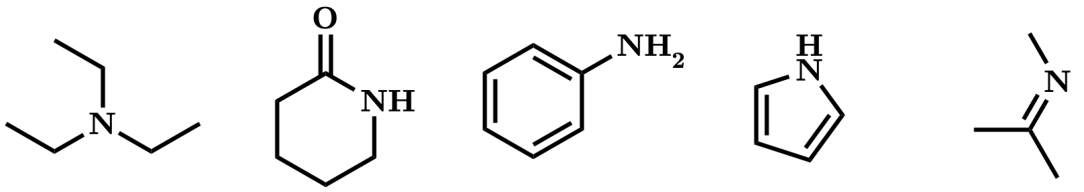
For the following structures,



1. Draw the resonance structures of the following compounds. *Do not increase the total number of formal charges on the molecule by more than 2.*

Problem 4

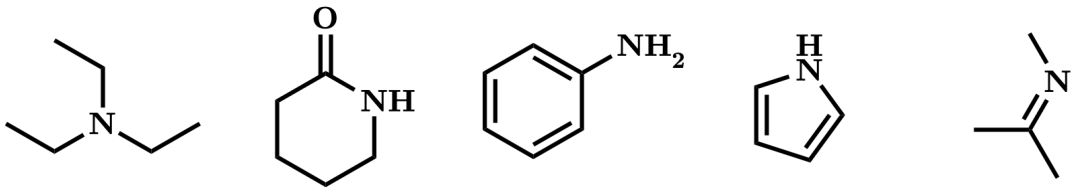
For the following structures,



1. Without using hybridization arguments, use resonance to justify the basicity of each of the nitrogen atoms in the following compounds, and
2. rank the compounds in order of increasing basicity from 1 being the least basic to 5 being the most basic.

Problem 5

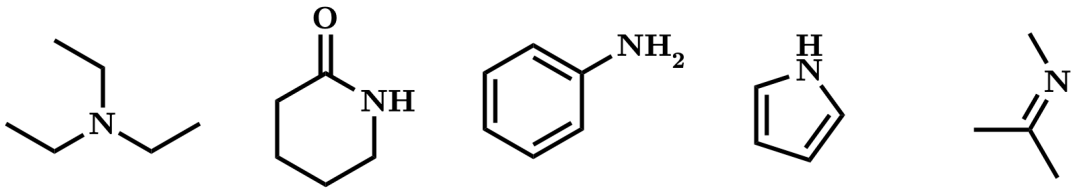
For the following structures,



1. Draw the conjugate acids of each below,
2. estimate the pK_as of these conjugate acids, and
3. provide a reason for their estimated pK_as.

Problem 6

For the following structures,



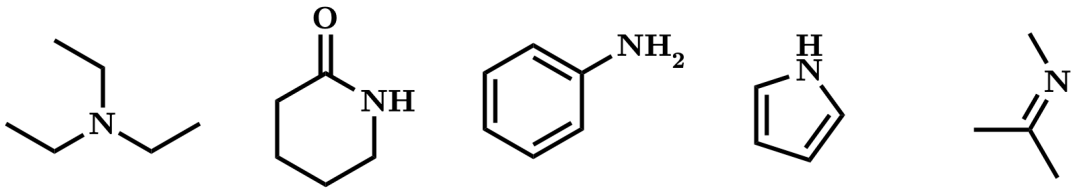
1. Use hybridization and resonance to rank the following compounds in order of increasing s-character of the nitrogen lone pair from 1 being the least s-character to 5 being the most s-character.

Problem 7

In general, what do your answers to questions 2–6 tell you about the trend between s-character and basicity?

Problem 8

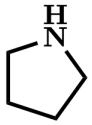
For the following structures,



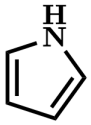
1. Rank the following compounds in order of increasing HOMO energy from 1 being the lowest HOMO energy to 5 being the highest HOMO energy. *Hint: Nitrogen e^- delocalization is especially strong in pyrrole.*

Problem 9

Consider structures A (pyrrolidine) and B (pyrrole) below.



A



B

1. Circle which compound above is more basic, and
2. explain why you chose that compound.

Problem 10

Use resonance to explain why the following reactions form their respective products.