CHEM6394: Stereochemistry
Prof. Ognjen Š. Miljanić

First Midterm Exam
February 27, 2024

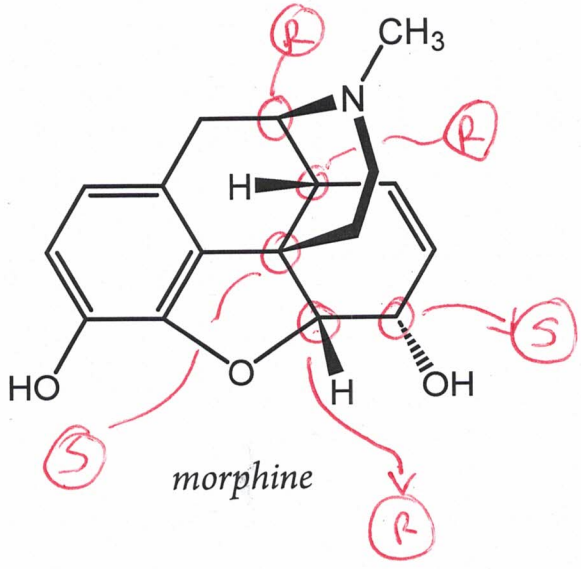
Name: Answer Key
(print legibly) Last First

Last 4 Digits of Student ID Number: _____

Read all directions very carefully. Write your answer legibly in the designated spaces. Total number of points is 200. This exam is supposed to have six (6) pages, with the last page intentionally left blank.

40

1. Morphine is a non-synthetic narcotic with a high potential for abuse and is derived from opium. It is used for the treatment of pain. How many chiral centers are there in the molecule of morphine, shown below? Clearly mark all the chiral centers. Then assign their configurations as (*R*) or (*S*). *40 points*

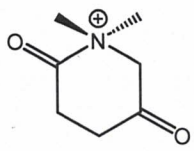


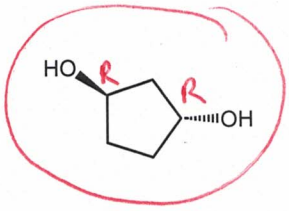
morphine

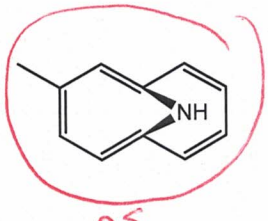
DO NOT WRITE IN THIS SPACE
200
FINAL SCORE

60

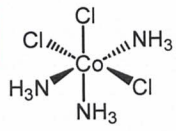
2. Circle all chiral molecules. For each chiral molecule, assign the configuration of its chiral elements with appropriate R/S, A/C, M/P, or Δ/Λ designators. *60 points*

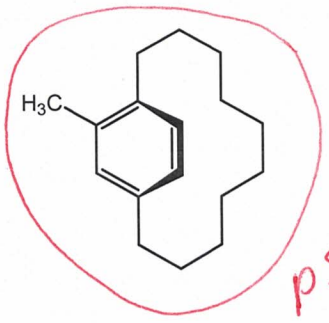




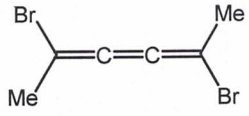


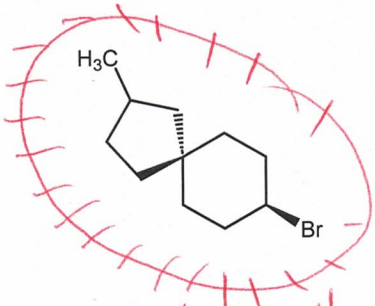
PS



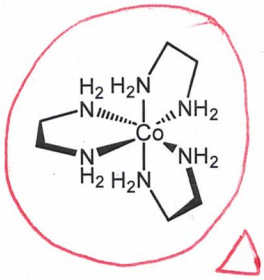


PS

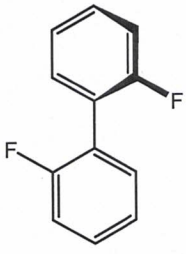


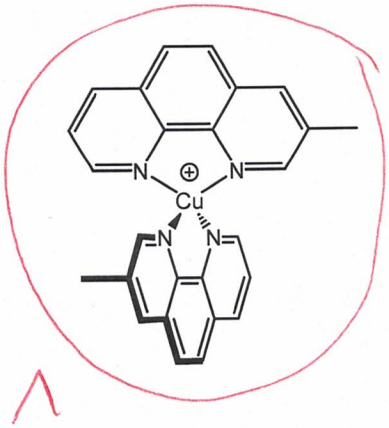


not chiral!

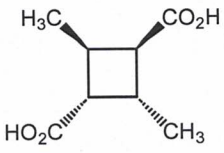


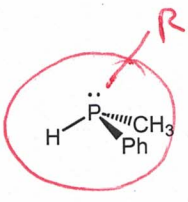
Δ

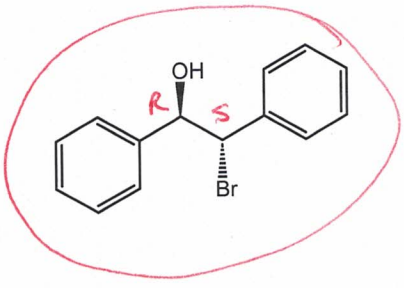


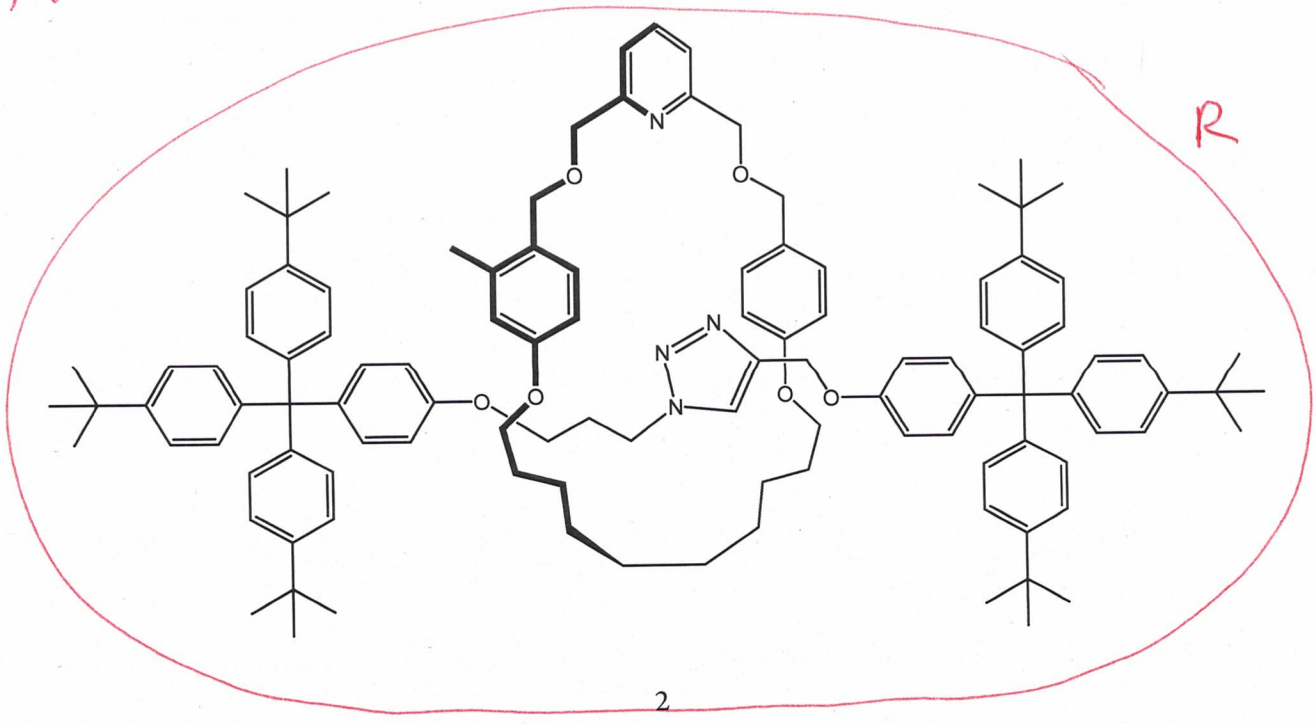


Λ









R

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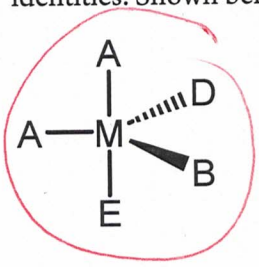
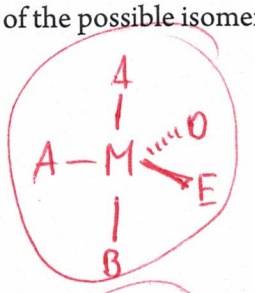
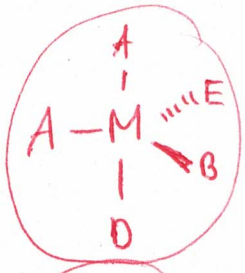
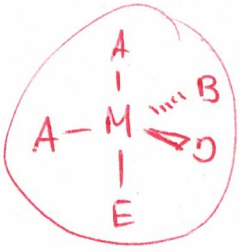
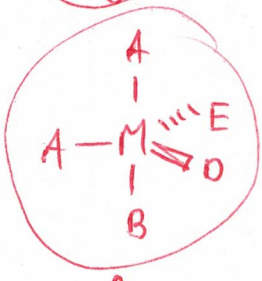
3. Draw all the possible isomers of a hypothetical MA_2BDE complex, which has trigonal bipyramidal symmetry on the central atom M. Circle the chiral ones, assuming that substituents A, B, D, and E have different chemical identities. Shown below is one of the possible isomers. *40 points*

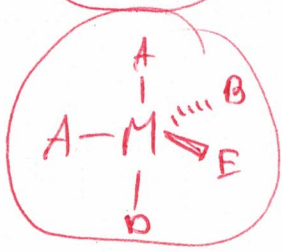




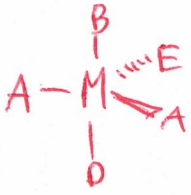


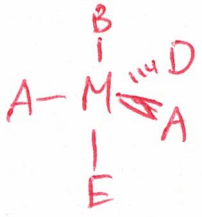


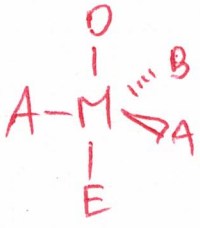


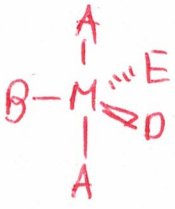


Chiral







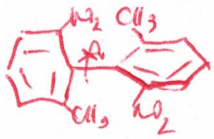


20

4. Define, in your own words, the following terms. Be succinct but precise, and feel free to use chemical structures to illustrate your definitions. *4 × 5 = 20 points*

Conformation is a spatial arrangement of ~~molecules~~ atoms in a molecule that can be interconverted with breaking any σ or π bonds. Cyclohexane and butane conformations are common examples.

Atropisomerism is a type of isomerism caused by hindered rotation around a single bond.



Stereogenic center is an atom—typically a tetrahedral carbon—on which an exchange of substituents results in stereoisomers. Not all stereogenic centers are chiral, but all chiral centers are stereogenic.

Topological Chirality is chirality caused by the shape of the molecule rather than its substitution.

molecular trefoil knots are topologically chiral

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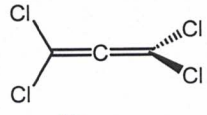
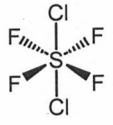
5. Which point groups do the following molecules belong to? *40 points*

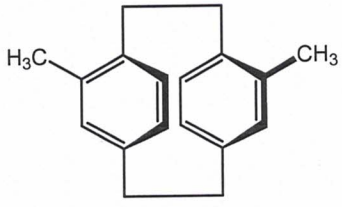


C_{2v}



D_{4h}

C_{3v}



C_2

Chart for the Determination of Point Groups