

Exam 1

Professor R. Hoenigman

I pledge to uphold the CU Honor Code:

Signature _____

Name (printed) _____

Last four digits of your student ID number _____

Recitation TA _____

Recitation number, day, and time _____

You have 1 hour and 30 minutes to complete this exam.

No model kits or calculators allowed.

Periodic table and scratch paper are attached.

PUT YOUR NAME ON ALL PAGES OF THE EXAM.

DO NOT TURN THIS PAGE UNTIL INSTRUCTED TO DO SO.

Recitation Sections:

#	Day	Time	TA
211	Monday	8 am	Noel
251	Monday	2 pm	Carolynn
291	Monday	5 pm	Heather
252	Tuesday	12 pm	Sam
293	Tuesday	5 pm	Carolynn
212	Wednesday	8 am	Noel
253	Wednesday	1 pm	Tom
292	Wednesday	5 pm	Heather
213	Friday	8 am	Heather

Score:

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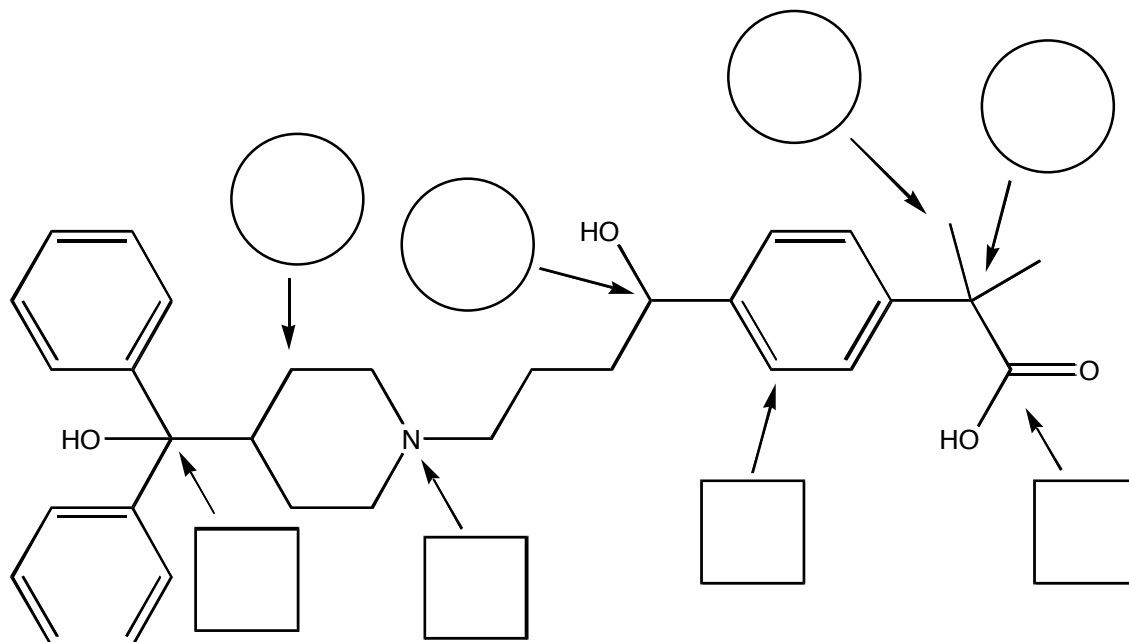
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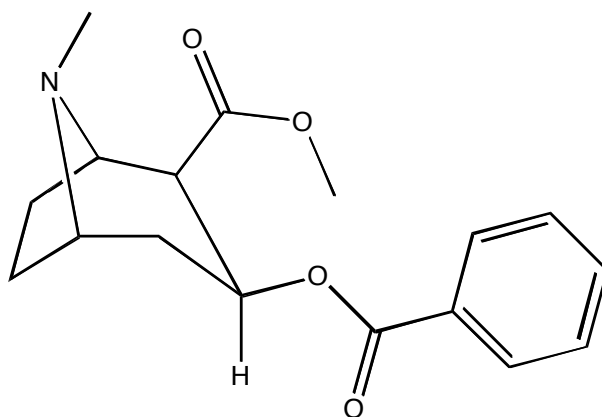
TOTAL _____/100

1. (8 pts) Allegra®, shown below, is a common antihistamine.

- A. Label each atom indicated by a box as sp^3 , sp^2 , sp , or none of these.
B. Label each atom indicated by a circle as 1° , 2° , 3° , or 4° .

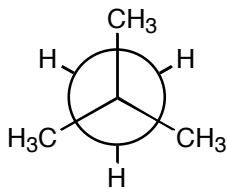
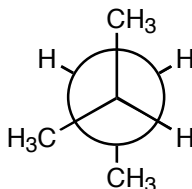


2. (2 pts) Cocaine is commonly available as a hydrogen chloride salt (known as “blow”). Blow can be reacted with a base to produce the freebase form of cocaine (known as “crack”, shown below). Which atom in freebase cocaine is the most basic atom? Clearly circle your choice.



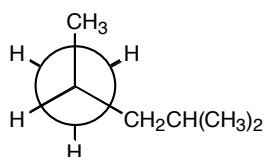
3. (10 pts) State whether the following pairs of compounds are constitutional isomers, stereoisomers, conformers, resonance structures, the same structure, or have no relation. Place your answer in the box.

A.

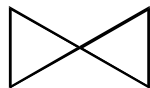
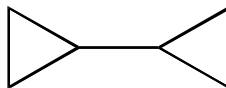
*and*

B.

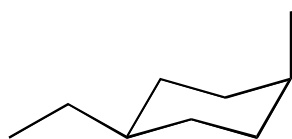
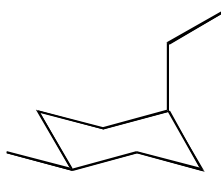
2,4-dimethylpentane

and

C.

*and*

D.

*and*

E.

4-isobutyl-1,1-dimethylcyclohexane

or

1,1-dimethyl-4-(1-methylpropyl)cyclohexane

4. (10 pts) The heat of combustion of cyclohexane is approximately 945 kcal/mol (~3950 kJ/mol) and the heat of combustion of cyclopropane is approximately 500 kcal/mol (~2090 kJ/mol).

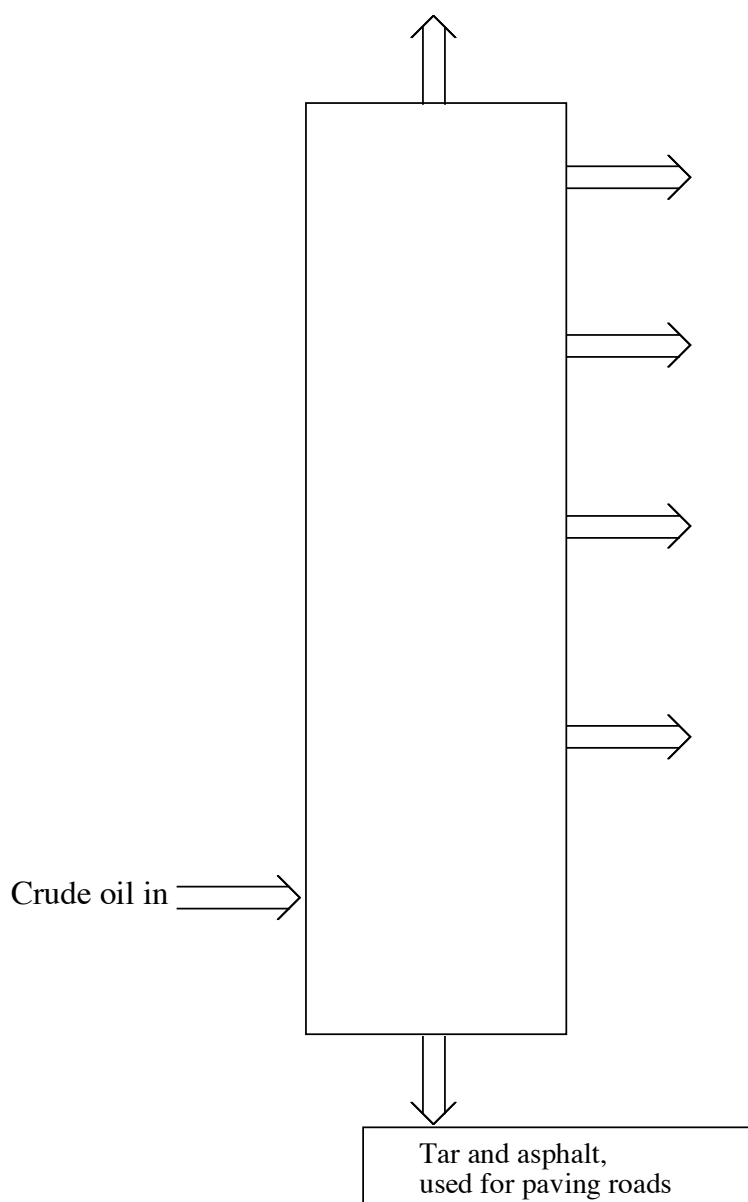
- A. Why does cyclohexane liberate nearly twice as much energy as cyclopropane upon reaction with oxygen?
- B. In the late 1800's Baeyer suggested that all cycloalkanes were planer and cyclopentane would be the most stable cycloalkane. How do chemists know that Baeyer was wrong, and that cyclohexane is the most stable cycloalkane and, in fact, has no ring strain? (*i.e.* What experimental evidence supports this statement?)
- C. Use the fact that cyclohexane is unstrained to calculate the strain energy of cyclopropane.
- D. What two structural factors contribute to the strain energy of cyclopropane?
- E. Why are these two factors absent in chair cyclohexane?

5. (5 pts) How many C_8H_{16} constitutional isomers can be named as cyclopentanes according to IUPAC nomenclature? Give a numeric answer between 1 and 10 in the box below. To solve this problem use the scratch paper to draw the substituted cyclopentane isomers.

6. (12 pts) Petroleum, a major source of alkanes, is processed in a refinery, such as the Colorado Mining Company in Commerce City.

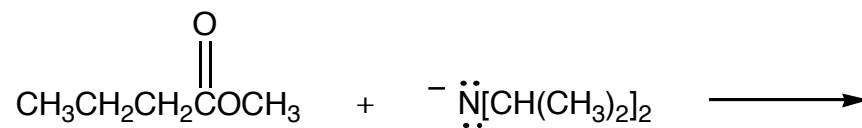
A. List the three steps of refining petroleum.

B. On the diagram below, label 3 out of 5 products from the distillation of crude oil and give one use for each of the 3 products you label. One example is given in the diagram.



7. (10 pts) This problem is a two-part question.

- A. For the following acid-base reaction, use curved arrows to show the formation of products. Show all major resonance structure(s) of the conjugate base. Be sure to include all non-zero formal charges.



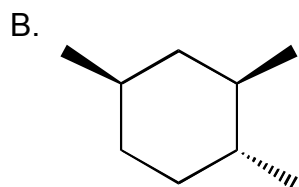
- B. Predict whether the equilibrium lies to the left or right. Explain your reasoning.

8. (15 pts) For each of the following pairs, circle the compound that has the *lower* heat of combustion. In the box, give a brief reason for your choice.

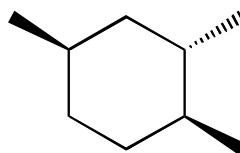
A. *cis*-1-isopropyl-3-methylcyclobutane

or

trans-1-isopropyl-3-methylcyclobutane



or



C. *cis*-1-ethyl-2-sec-butylcyclopropane

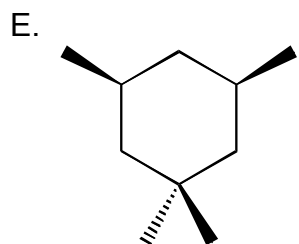
or

trans-1-ethyl-2-isopropylcyclobutane

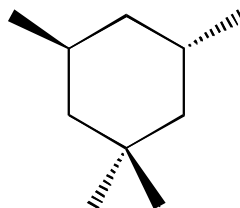
D. *cis*-1-*tert*-butyl-4-(1,1-dimethylpropyl)cyclohexane

or

trans-1-*tert*-butyl-4-(1,1-dimethylpropyl)cyclohexane

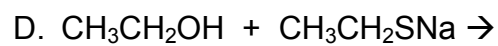
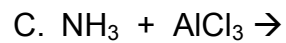
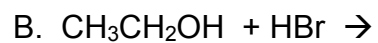
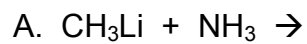


or



9. (18 pts) Draw a Newman projection for the most stable conformation of propane, as viewed down the C1-C2 bond. Draw a potential energy diagram illustrating how the energy changes qualitatively as a function of the torsional angle between a hydrogen atom and the methyl group. Draw Newman projections for each maximum and minimum conformation. Clearly label your axes and show the relative energy of each conformation. Label the conformations as gauche, anti, staggered, and/or eclipsed. You need only show rotation from $\theta = 0^\circ$ to $\theta = 120^\circ$.

10. (10 pts) Complete the following acid-base reactions. Show all non-zero formal charges. If no reaction occurs write NR.



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Scratch Page

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