

O R G A N I C C H E M I S T R Y I

Exam # 2

29 Oct

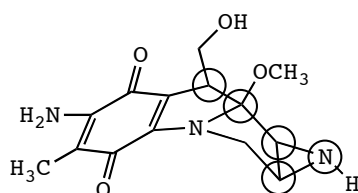
5:00 P.M.-6:20 P.M.

Name _____

P L E A S E P R I N T

Instructions Write all answers on these pages. Regrade requests are due one week after the exam is returned. Good luck!

(1) [6 points] Circle the chirality centers in this molecule.



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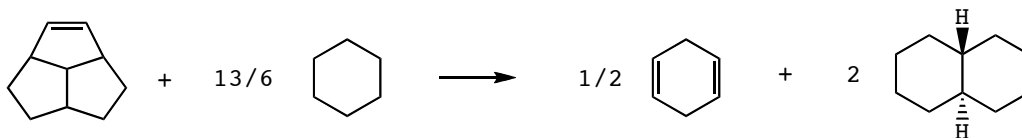
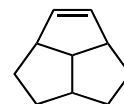
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TOTAL____/100

(2) The molecule at right is tetrahydrotriquinacene ($\Delta H_f^\circ = 13$ kJ/mol).

(a) [9 points] Write a balanced homodesmotic reaction whose standard enthalpy of reaction ΔH_{rxn}° is identified with tetrahydrotriquinacene's strain energy E_{strain} .

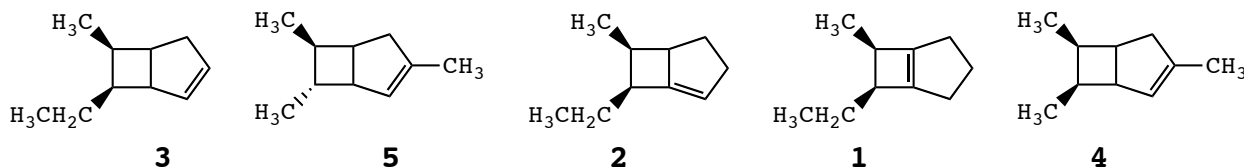


(b) [4 points] Using information on the cover page, calculate tetrahydrotriquinacene's E_{strain} in units of kilojoule per mole. Show work for maximum credit; write your answer in the space provided.

$$\Delta H_{rxn}^\circ = (1/2 \times 105) + (2 \times -182) - (13) - (13/6 \times -123) = -58$$

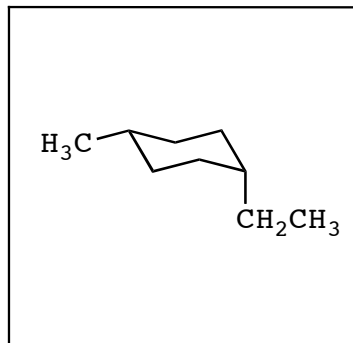
$$E_{strain} = 58 \text{ kJ/mol}$$

(3) [5 points] Rank these C₁₀H₁₆ isomers in order of strain (1 = most strained).

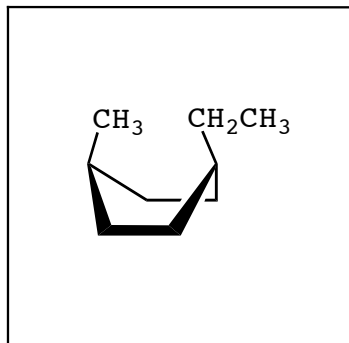


(4) [9 points] In the boxes provided draw **(a)** the least stable chair conformation, **(b)** the least stable boat conformation, and **(c)** the most stable chair conformation of *cis*-1-ethyl-4-methylcyclohexane.

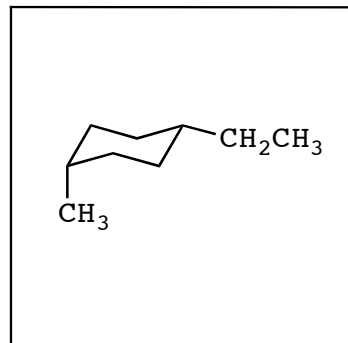
least stable chair



least stable boat



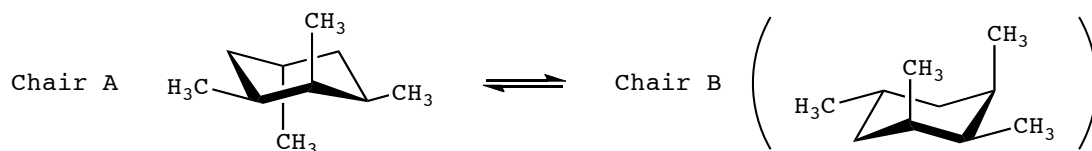
most stable chair



(5) [12 points] Fill in the spaces in response to each question about the structures in the table below. If the answer is "no" or "none", say so: spaces left blank will be marked wrong.

yes Is a center of symmetry (<i>i</i>) present?	no Is a center of symmetry (<i>i</i>) present?	yes Is a center of symmetry (<i>i</i>) present?
four How many planes of symmetry (σ) are present?	two How many planes of symmetry (σ) are present?	none How many planes of symmetry (σ) are present?
three How many C_2 axes of symmetry are present?	one How many C_2 axes of symmetry are present?	none How many C_2 axes of symmetry are present?
no Is an axis of symmetry of order higher than two ($C_n, n > 2$) present? If so, what is its order?	no Is an axis of symmetry of order higher than two ($C_n, n > 2$) present? If so, what is its order?	no Is an axis of symmetry of order higher than two ($C_n, n > 2$) present? If so, what is its order?

(6) The Chair A shown below is in equilibrium with Chair B.



(a) [8 points] Using information on the cover page, calculate the strain energy E_{strain} of both chairs; write your answers in the spaces provided.

E_{strain} of Chair A = **24** kJ/mol

E_{strain} of Chair B = **31** kJ/mol

(b) [4 points] Using information on the cover page and assuming that $\Delta E = \Delta G^\circ$, calculate the equilibrium constant K_{eq} to two significant figures of the process Chair A \rightleftharpoons Chair B. Show work for maximum credit and write your answer in the space provided.

$$\Delta E \text{ (A} \rightarrow \text{B)} = 31 - 24 = 7; K_{eq} = \exp(-0.404 \times 7) = 0.059$$

$$K_{eq} \text{ (Chair A} \rightleftharpoons \text{Chair B)} = 0.059 \text{ (= 1/17)}$$

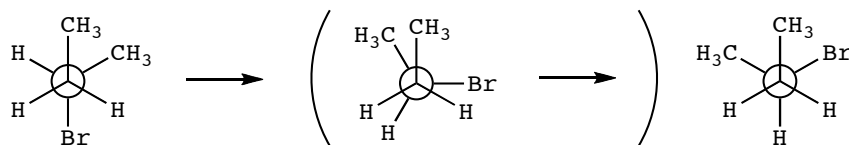
(c) [4 points] Calculate the percentage of each chair at equilibrium at 25 °C. Show work for maximum credit and write your answer in the spaces provided.

$$\% \text{ A} = 100 \times [17/(1 + 17)] = 94; \% \text{ B} = 100 \times [1/(1 + 17)] = 6$$

% of Chair A = **94%**

% of Chair B = **6%**

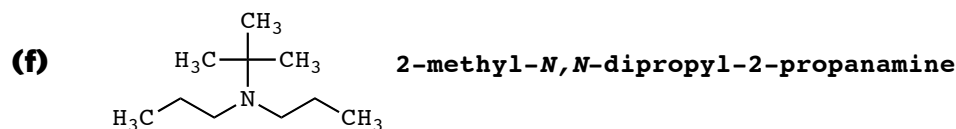
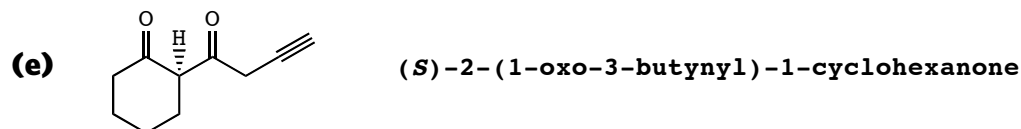
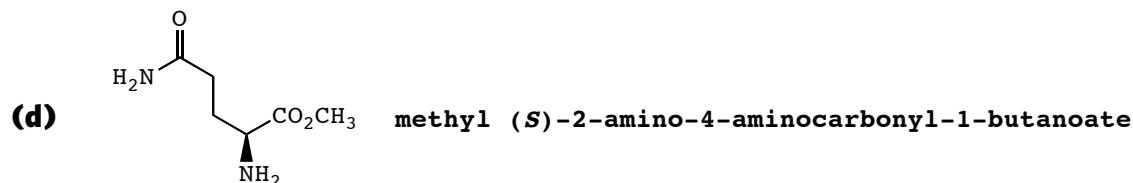
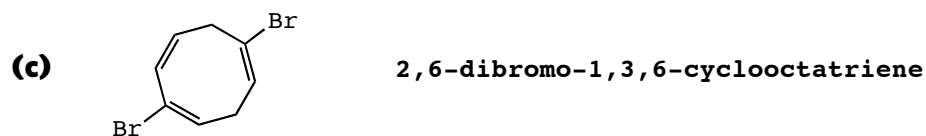
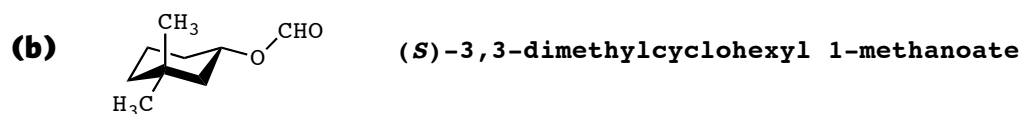
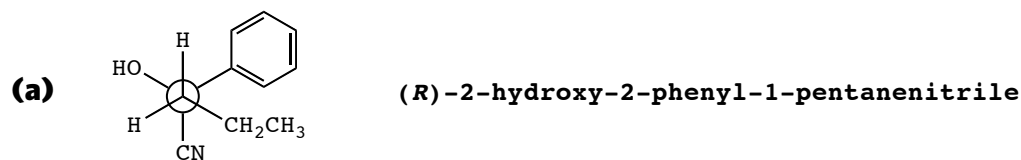
(7) [6 points] Using information on the cover page, calculate the rate constant k at 25 °C to two significant figures of the conformational change shown below. If an interaction is not listed on the cover page, assume that its energy cost is zero. Show work for maximum credit and write your answer in the space provided.



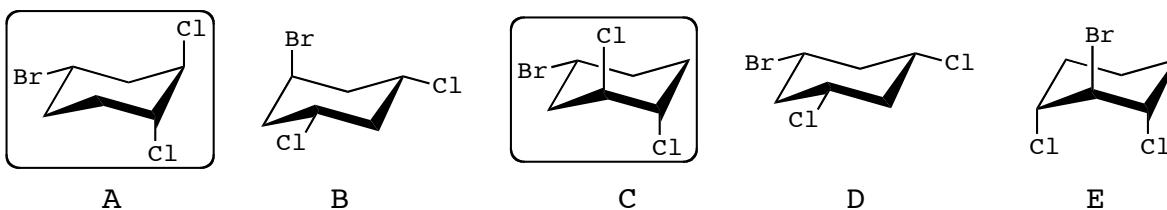
$$\Delta E^\ddagger = 28 - 4 = 24; k = (6.21 \times 10^{12}) \times \exp(-0.404 \times 24) = 3.8 \times 10^8$$

$$k = 3.8 \times 10^8 \text{ s}^{-1}$$

(8) [24 points] Write the systematic name of these compounds; include stereochemical descriptors where appropriate. Do not write names employing nicknames or common names.



(9a) [5 points] Circle the structures that are chiral.



(9b) [2 points] Which structure is a diastereomer of B? Answer **D**

(9c) [2 points] Which structure is the enantiomer of C? Answer **A**