**NAME (PRINT CLEARLY)** Answer Key v2

***I am on my honor that I will not discuss the contents of this exam with anyone until after 6:00 pm on Monday, October 28, and will notify Dr. Brush if I am made aware of any cases of academic dishonesty.***

**I understand and agree to these conditions (signature)**_____

**CHEM 243 ORGANIC CHEMISTRY I**
**Exam II (version-2), Friday, October 25, 2024**

Answer all questions in the space provided, continuing on the back if necessary. **Read each question carefully and be sure to answer all parts to each question!** This exam is worth a total of 150 points.

Exams will be returned within one week. An answer key to this exam will be linked to the course web page.

**(34) 1.** _____

**(46) 2.** _____

**(15) 3.** _____

**(13) 4.** _____

**(14) 5.** _____

**(14) 6.** _____

**Sub-total (136) =** _____ **x 1.103 =** _____

**Total Points:** _____ **(150) =** _____**%**

**Total Worksheet Points to date:** _____ **=** _____**%**

**Class Grade Estimate:**

**Exam I (150)** _____ **+ Exam II (150)** _____ **+ WS% x 1.5** _____ **=** _____ **(SUM)**

**SUM / 4.5 =** _____**% (raw class % - does not include project grade or lab grade)**

**IF YOU DO NOT UNDERSTAND A QUESTION, PLEASE ASK FOR AN EXPLANATION!**

**1. (34 Points) Answer the following questions as indicated.**

(a) Are the following statements about conformers **TRUE** or **FALSE**?

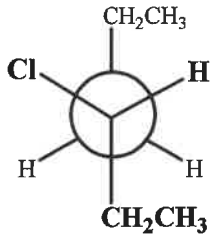
T maximum cyclohexane stability occurs when the largest functional group is in an equatorial position

F the least stable Newman projection will have the largest substituents anti to each other

T in cyclohexane ring-flip conformers, the axial and equatorial substituents switch positions

F conformers and constitutional isomers are essentially the same type of isomer

(b) Rank these Newman Projections in order of their relative stability (1 = least stable.....4 = most stable).

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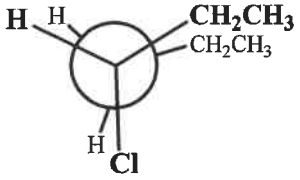
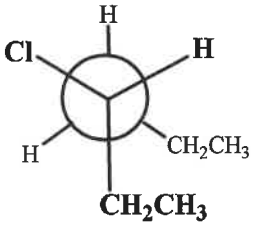



1

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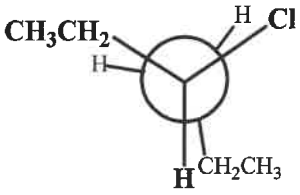
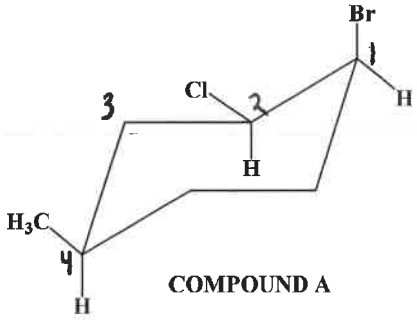


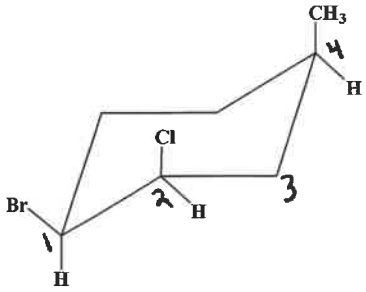

2

(c) Consider **Compound (A)** drawn at the right. Identify the relationship of each compound Compound (A):

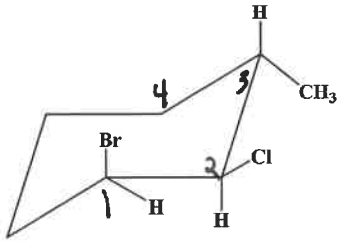
**Conformer, Constitutional Isomer, or Different:**



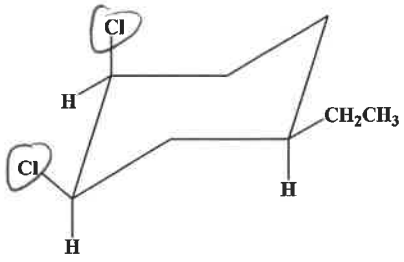

**COMPOUND A**




Conformer




Constitutional Isomer




Different

(d) Are the following statements about stereoisomers **TRUE** or **FALSE**?

T stereoisomers must have the same formulas and connectivity

F diastereomers have the same melting points and boiling points

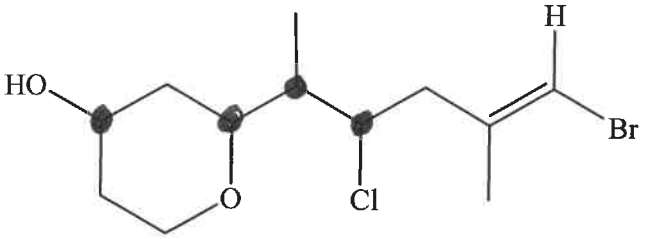
T a racemic mixture is a mixture of two enantiomers

T enantiomers have the same formula and connectivity, but opposite configurations

T all chiral carbons must be sp3 hybridized with tetrahedral geometry

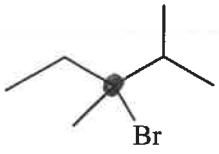
F stereoisomers with configurations of (1R, 3S, 4R) and (1S, 3R, 4S) represent diastereomers

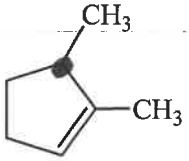
(e) Place a large "dot" (•) on each chiral carbon in the molecule drawn to the right.

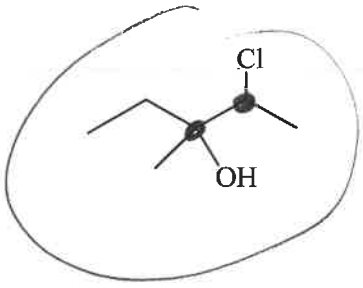


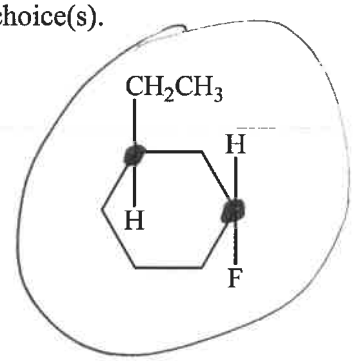

(f) Based on you answer to (e), what is the maximum number of stereoisomers? $2^4 = 16$

(g) Which of the following molecules will have at least one diastereomer? CIRCLE your choice(s).



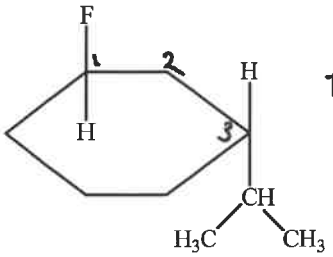

(h) Explain your answer to question (g) above.

Diastereomers are stereoisomers with two or more chiral carbons.

**2. (46 Points) Nomenclature.**

- If a name is given draw an accurate zig-zag structure, using wedge and dash bonds for all chiral carbons.
- If a structure is drawn, give the IUPAC name where you assign configurations using the proper R/S prefix.

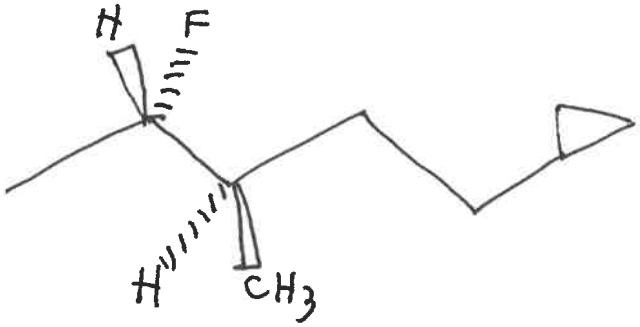
(a)



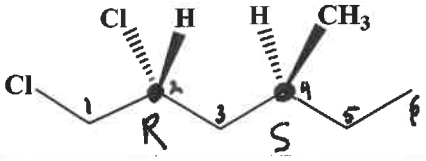

trans - 1-fluoro-3-isopropylcyclohexane

**(use cis/trans designations, NOT R or S)**

(b) (2S, 3R)-5-cyclopropyl-2-fluoro-3-methyl pentane

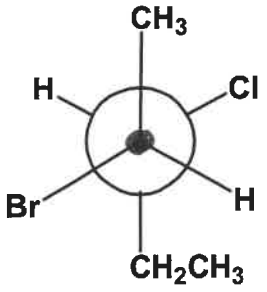


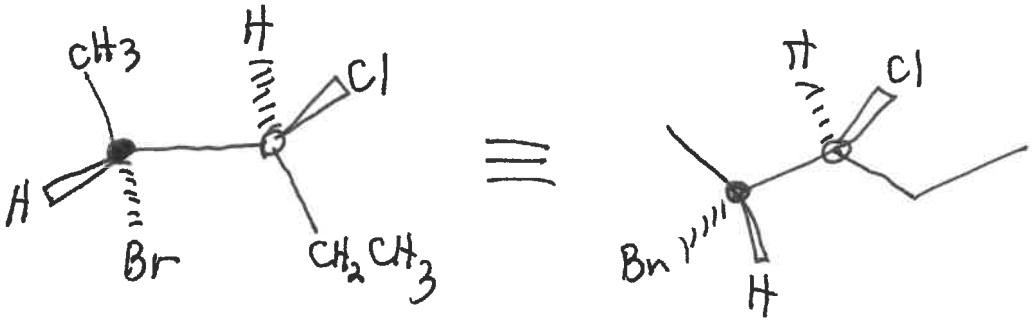

(c)




(2R, 4S) - 1,2-dichloro-4-methyl hexane

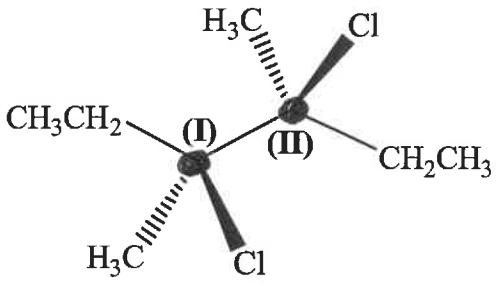
(d) Draw an accurate zig-zag line structure for the following Newman Projection. Be sure to draw the correct 3D orientation at any chiral carbon with wedge and dash bonds. **DO NOT name the compound.**



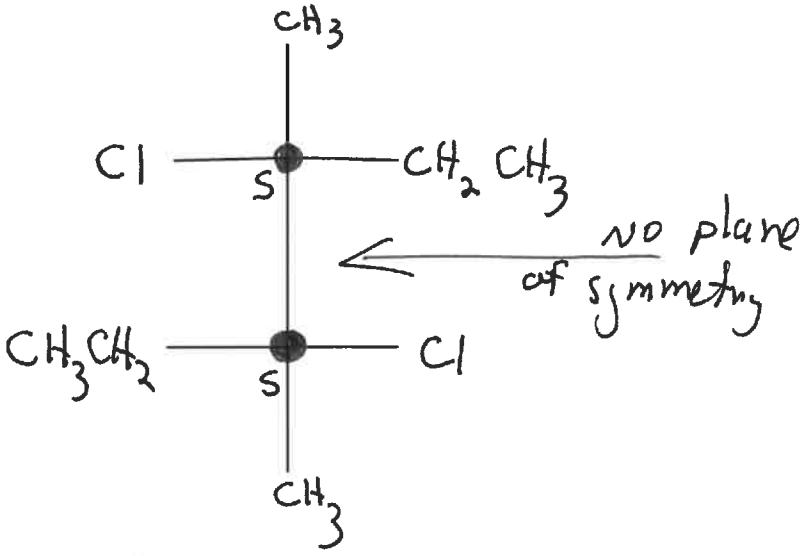
(e) In the molecule drawn to the right, label each chiral center with the correct R/S configuration (fill in the blanks below). **DO NOT** name this compound.

(I) S (II) S




(f) Using the template at the right, draw a Fisher projection for the compound in (e).

**The atoms or groups with the lowest priorities must be on the vertical axes.**



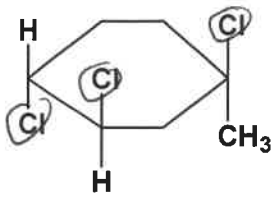

(g) Based on your **Fisher Projection** above, is this a meso compound? Circle: **YES** or **NO**

(h) EXPLAIN your answer to (g).

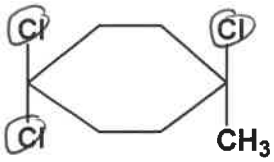
There is no plane of symmetry between the two chiral carbons, & the configurations are S & S (not S&R or R&S).

**3. (15 Points)** How are the following pairs of compounds related?

**Constitutional Isomers** **Conformers** **Enantiomers** **Diastereomers**

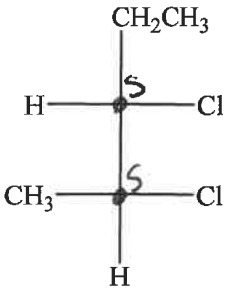


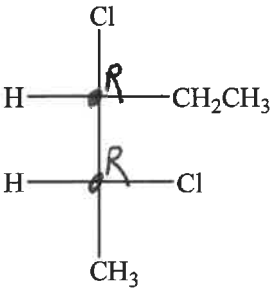

$C_7H_{11}Cl_3$



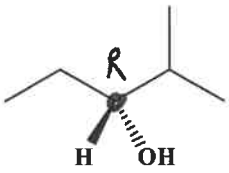

$C_7H_{11}Cl_3$

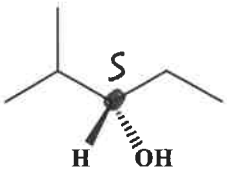
Constitutional Isomers



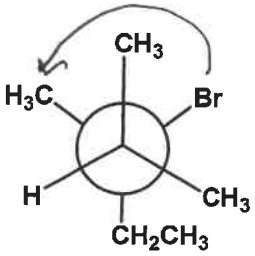



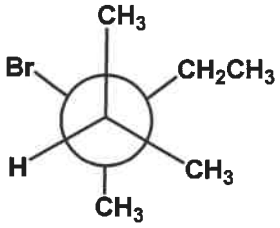

Enantiomers



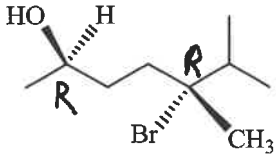



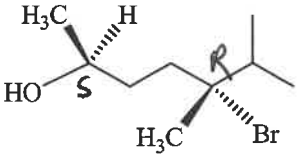

Enantiomers



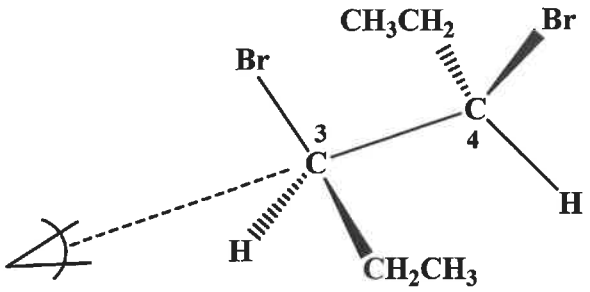

Conformers

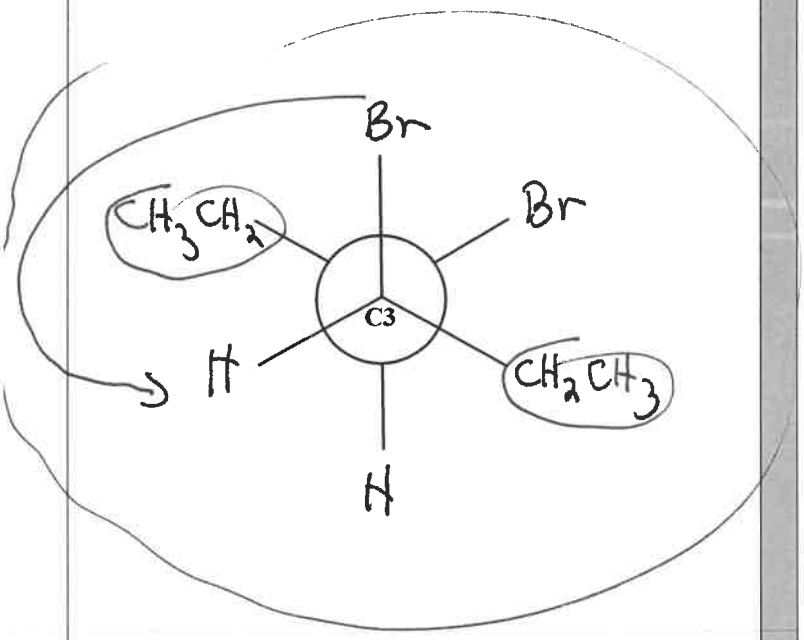
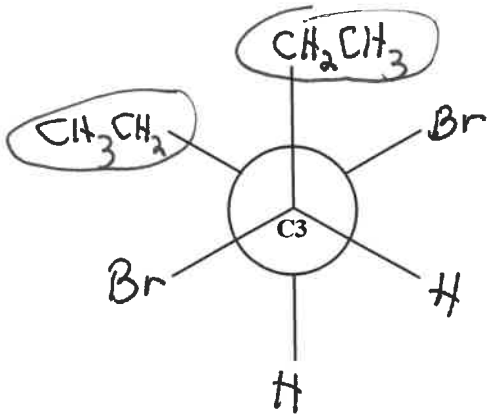



Diastereomers

**4. (13 Points) Alkane Conformations.**
Consider the 3D "zig-zag" structure for the compound drawn at the right, and the **Left-to-Right** view looking at C3 and down the C3-C4 bond:




| (a) **CONFORMER A.** Draw a Newman Projection looking **at C3** and down the C3-C4 bond. | (b) **CONFORMER B.** Rotate Conformer A so that the two **Br atoms are anti** to each other: |
|---|---|
|  |  |





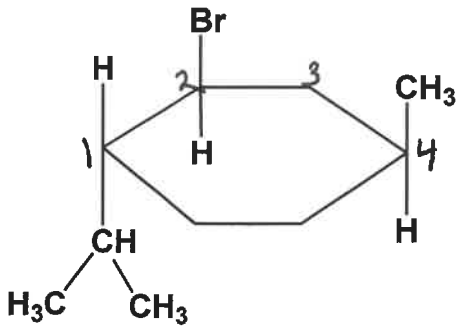
(c) **CIRCLE** the most stable conformer. **Explain** your answer.

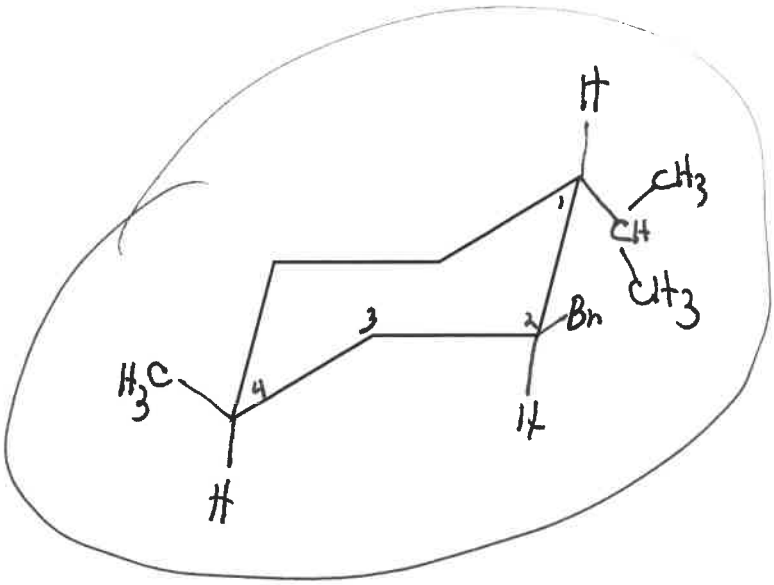
The two largest groups ($-CH_2CH_3$) are anti to each other which minimizes steric hindrance.

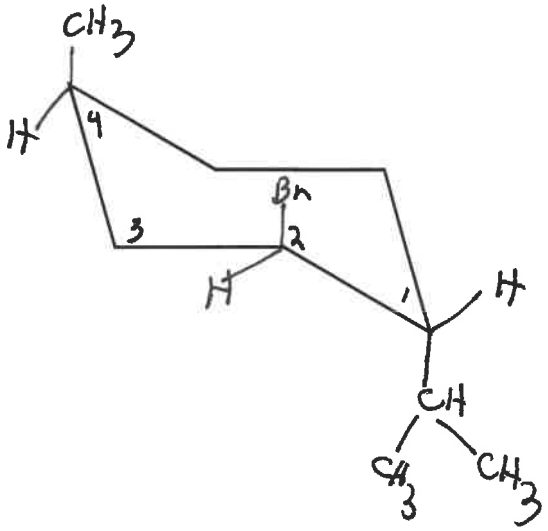
**5. (10 points) Cyclohexane Conformations.**

(a) Using the chair templates below, draw both chair conformers of Compound A, drawn at the right. Be sure to include the three H atoms.

**Compound A**




(b) **CIRCLE** the most stable conformer, and **EXPLAIN** your answer.

The largest group (isopropyl) is in an equatorial position which minimizes steric hindrance.

**6. (14 points) Calculations: % Yield. Be sure to use correct significant figures.**

0.2503 g of Compound A were reacted with 5.000 g of Bromine ($Br_2$), forming 0.6198 g of Compound B:

$$\underset{\text{Compound A}}{C_5H_{10}} + Br_2 \longrightarrow \underset{\text{Compound B}}{C_5H_{10}Br_2}$$

Complete **boxes a-f** in the following table to determine the **Limiting Reactant** and to calculate the **% Yield**.

| Compound | Molecular mass | grams | moles | (c) Place an "X" in the box of the Limiting Reactant |
|---|---|---|---|---|
| **Compound A** | 70.13 g/mole | 0.2503 g | (a) 0.003569 | X |
| **$Br_2$** | 159.8 g/mole | 5.000 g | (b) 0.03129 | |

| Compound | Molecular mass | grams | moles |
|---|---|---|---|
| **Compound B** | 229.9 g/mole | 0.6198 g | (d) 0.002696 |

| | |
|---|---|
| **(e) Theoretical Yield of Compound B (in moles) =** 0.003569 mole | **(f) % Yield =** 75.54% |

**You are required to show all calculations below:**

(a) $0.2503\ g \times \frac{1\ mole}{70.13\ g} = 0.003569\ mole = 3.569 \times 10^{-3}\ mole$

(b) $5.000\ g \times \frac{1\ mole}{159.8\ g} = 0.03129\ mole = 3.129 \times 10^{-2}\ mole$

(d) $0.6198\ g \times \frac{1\ mole}{229.9\ g} = 0.002696\ mole = 2.696 \times 10^{-3}\ mole$

(f) $\%\ yield = \frac{0.002696\ mole}{0.003569\ mole} \times 100 = 75.54\%$