

# Assignment Redesign Example

## Organic Chemistry

From AI-Vulnerable to AI-Resistant

### BEFORE: Vulnerable to AI

#### Problem Set #3: Conformational Analysis

*Due Monday, 4pm*

1. a) Using Newman projections, draw all of the staggered and eclipsed conformers of 2,3-dimethylpentane with respect to rotation about the C2–C3 bond.  
b) Assign the relative energies of each of the conformers in part a.  
c) Starting with the highest energy eclipsed conformer, draw a potential energy diagram for a 360° rotation around the C2-C3 bond.  
d) What is the barrier to rotation around the C2-C3 bond?
2. Draw Newman projections along the indicated bonds in A and B. Use these Newman projections to explain the energy difference between the two envelope conformations.
3. For each of the following, draw both possible chair conformers, and circle the one that is preferred.
4. *cis*-1-*tert*-butyl-4-methylcyclohexane prefers the conformation with the *tert*-butyl group equatorial. But *cis*-5-*tert*-butyl-2-methyl-1,3-dioxane prefers to put the *tert*-butyl group axial. Use what you know about conformational analysis to explain this apparent contradiction.

#### Why This Is Vulnerable

- **Standard textbook problems** — Newman projections and chair conformations are well-documented; AI can generate correct drawings and explanations instantly.
- **Answer-focused** — Asks only for final products, not reasoning process.
- **No prediction or self-assessment** — Students don't have to commit to an idea before checking it.
- **Easily searchable** — These exact problem types appear in countless organic chemistry resources online.

## AFTER: Al-Resistant Redesign

### Problem Set #3: Conformational Analysis

This problem set builds on what we started in Wednesday's lecture. The goal isn't just to draw correct structures — it's to develop your chemical intuition about why molecules prefer certain shapes.

#### Problem 1: Newman Projections of 2,3-Dimethylpentane

- a) Before you draw anything:** Looking at the structure of 2,3-dimethylpentane, predict which conformer around the C2-C3 bond will be highest in energy and which will be lowest. Write 1-2 sentences explaining your prediction based on what you remember from lecture.
- b)** Now draw all staggered and eclipsed conformers using Newman projections. For each one, label the key steric interactions (gauche, eclipsed Me-Me, etc.).
- c)** Assign relative energies. **Did your prediction match?** If not, identify where your intuition went wrong.
- d)** Draw the potential energy diagram for 360° rotation. **Circle one transition state and one energy minimum on your diagram, and write one sentence explaining what's happening structurally at each point.**
- e)** What is the barrier to rotation? In your own words, explain what this number physically means — what would a molecule "experience" at this barrier?

#### Problem 2: Cyclopentane Envelope Conformations

The envelope conformation puts the substituent either at the "flap" (A, more stable) or at the "base" (B, less stable).

- a) Predict first:** Before drawing Newman projections, which position do you think has more steric strain? Why?
- b)** Draw Newman projections along the indicated bonds for both A and B.
- c)** Use your Newman projections to explain the energy difference. **Does this match your prediction from part (a)?** If not, what did you miss?

#### Problem 3: Chair Conformations

For each molecule, draw both chair conformers.

- a) Before circling your answer:** For each molecule, write which substituent "wins" (gets to be equatorial) and why. Use A-values from your lecture notes.
- b)** Circle the preferred conformer.
- c) Pick one of the three molecules.** If someone argued for the opposite conformer, what would their reasoning be? Why is it wrong?

#### Problem 4: The tert-Butyl Paradox

cis-1-tert-butyl-4-methylcyclohexane puts the tert-butyl group equatorial (as expected). But cis-5-tert-butyl-2-methyl-1,3-dioxane puts it axial. This seems like a contradiction.

- a)** Draw both chair conformers for each molecule, labeling all axial and equatorial positions.
- b) This is the key question:** What's different about the 1,3-dioxane ring that changes the calculation?
- c)** In 2-3 sentences, explain this to a classmate who missed lecture — without just saying "the oxygens make it different." *What specifically do the oxygens change about the steric environment?*

### Reflection (required — worth 5 points)

Which problem on this set was hardest for you, and why? What's one thing you're still uncertain about that you want to ask in recitation?

#### Submission:

- Your completed problem set (handwritten or digital)
- Come to recitation prepared to explain Problem 4 to a partner — you may be randomly called on

## What Changed and Why

**Predict First:** Students commit to an answer before drawing, exposing their reasoning (right or wrong).

**Metacognition:** "Did your prediction match? If not, where did your intuition go wrong?"

**Explain to Others:** "Explain this to a classmate who missed lecture" requires real understanding, not copied answers.

**Argue the Opposite:** "If someone argued for the opposite conformer, what would their reasoning be?" prevents one-track AI responses.

**Reflection Required:** "Which problem was hardest and why?" is personal and can't be faked.

**Live Component:** "Come to recitation prepared to explain Problem 4" — they need to understand what they submit.

## A Note on Drawings

AI can generate Newman projections and chair conformations. But the redesigned assignment doesn't just ask for drawings — it asks students to **predict before drawing, compare predictions to results, and explain their reasoning in their own words**. Even if a student uses AI to check their structures, they still have to engage with the thinking process to complete the assignment.

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