Newman Projections – More Practice – Answer Key

I. For each of the following, draw the best (most stable) and worst (least stable) Newman projection, relative to the bond indicated in each question. The most stable conformations will be staggered conformations with the largest groups ANTI to each other. The least stable, highest energy conformation will have an eclipsed conformation with the largest groups sterically overlapped on top of each other.

a. butane, C2-C3 bond

\[ \text{BEST- ANTI} \]

\[ \text{WORST- FULLY ECLIPSED (steric and torsional strain energy)} \]

b. 1-chloropropane, C1-C2 bond

\[ \text{BEST- ANTI} \]

\[ \text{WORST- FULLY ECLIPSED (steric and torsional strain energy)} \]

c. 2-methylbutane, C2-C3 bond

\[ \text{equal in energy - mirror images} \]

\[ \text{BEST - only one Gauche steric interaction} \]

\[ \text{equal in energy - mirror images} \]

\[ \text{WORST - one methyl eclipsed with another methyl (steric AND torsional strain energy)} \]
d. 2,2-dimethylbutane, C2-C3 bond

BEST - two Gauche steric interactions (unavoidable in any staggered situation)

WORST - eclipsed and always with a methyl-methyl steric overlap (steric AND torsional strain energy)

e. 2-chloro-2-methylpentane, C2-C3 bond (Cl is smaller than methyl)

BEST - lowest energy occurs when largest group (ethyl) is Gauche to smallest group (Cl) and not both methyls (steric interaction)

WORST - highest energy occurs when largest group overlaps with either methyl group (bigger than Cl) (steric AND torsional strain energies)

II. Rotation Barriers: Rank the rotational barriers relative to the highlighted bonds, with 1 having the highest barrier of rotation (assume that a chloride is smaller than a methyl group).

6 5 4 1 2 3

The worst conformation is one that is totally eclipsed and the energy of the totally eclipsed conformation increases with increasing steric interactions. Larger groups have more steric strain and this results in a larger barrier of rotation. Isopropyl groups (in #1 and #2) are larger than ethyl groups (in #1, # and #3), which are larger than methyl groups, etc.
III. For each of the following, determine what strain energy is involved in each Newman projection (torsional and/or steric) to explain why the first Newman projection is more stable than the second. (-Cl is smaller than any alkyl group)

a. Butane, C2-C3 (front carbon is C2) **STERICS**

![Steric interaction - one Gauche interaction](image)

b. Butane, C2-C3 (front carbon is C2) **TORSIONAL**

![Torsional strain from eclipsing interaction](image)

c. Butane, C2-C3 (front carbon is C2) **TORSIONAL** and **STERICS**

![Torsional strain from eclipsing interaction](image) and **Steric strain from Methyl-Methyl overlap**

d. Ethane, C1-C2 (front carbon is C1) **TORSIONAL**

![Torsional strain from eclipsing interaction](image)
e. 2,3-dimethylpentane, C3-C4 (front carbon is C3) **STERICS**

![STERICS Diagram](image)

Larger steric strain from Isopropyl-Methyl Gauche interaction than the methyl-methyl overlap in the first conformation

g. 2-methylbutane, C2-C3 (front carbon is C3) **STERICS**

![STERICS Diagram](image)

Steric interaction - two Gauche interactions in the second conformation but only one in the first