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



b. 1-chloropropane, C1-C2 bond





HH H

BEST- ANTI

WORST- FULLY ECLIPSED (steric and torsional strain energy)

c. 2-methylbutane, C2-C3 bond





equal in energy - mirror images BEST - only one Gauche steric interaction



equal in energy - mirror images 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).



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



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



Torsional strain from eclipsing interaction (the first conformation is staggered)

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



Torsional strain from eclipsing interaction (the first conformation is staggered and has no torsional strain) and Steric strain from Methyl-Methyl overlap

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



Torsional strain from eclipsing interaction (the first conformation is staggered)

e. 2,3-dimethylpentane, C3-C4 (front carbon is C3) STERICS



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

f. 2,3-dimethylpentane, C3-C4 (front carbon is C4) <u>STERICS</u> (both have torsional strain so that doesn't make the second one less stable)



Larger steric strain from Isopropyl-Methyl eclipsing interaction than the methyl-methyl overlap in the first conformation (both have torsional strain)

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



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