Topics
- Conformations of butane
- Conformations of cycloalkanes
  - Heats of combustion
  - Ring strain
- Cyclohexane

Butane: Newman projections

\[ \text{anti} \quad \uparrow \quad \text{keep} \quad \frac{\text{from}}{\text{fixed}} \quad \downarrow \quad \text{eclipse} \quad \text{I} \]

\[ \Delta G = \text{heat} \quad \text{of} \quad \text{rotation} \]

Energy Diagram

Cycloalkanes: general formula: \((\text{C}_2\text{H}_n)\)

Heat of combustion

\[ (\text{C}_2\text{H}_n)_n + \frac{3}{2}n\text{O}_2 \rightarrow n\text{CO}_2 + n\text{H}_2\text{O} \]

For cyclohexane:

\[ \bigcirc = (\text{C}_2\text{H}_6)_n + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} \]

\[ \Delta H = -3952 \text{ kJ/mol} \quad \text{(strongly exothermic)} \]
<table>
<thead>
<tr>
<th>n</th>
<th>compound</th>
<th>ΔH per mol CH₂ (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>cyclohexane</td>
<td>-1059</td>
</tr>
<tr>
<td>5</td>
<td>cyclopentane</td>
<td>-1064</td>
</tr>
<tr>
<td>4</td>
<td>cyclobutane</td>
<td>-1086</td>
</tr>
<tr>
<td>3</td>
<td>cyclopropane</td>
<td>-1097</td>
</tr>
</tbody>
</table>

Why do we see this increase? You'd expect the ΔH per mol CH₂ to be the same for all!

**Cyclopropane:** angle & torsional strain

Δ - all sp³ carbons
- expect bond angle to be 109°
- actual/required angle 60°$
  \[
  \text{bond angle compression of } 49°
  \]
- overlap is not as good
  - can't get strong bond like bent bonds

Δ - all H's are eclipsed!
- 24 kJ/mol from H eclipsed torsional strain