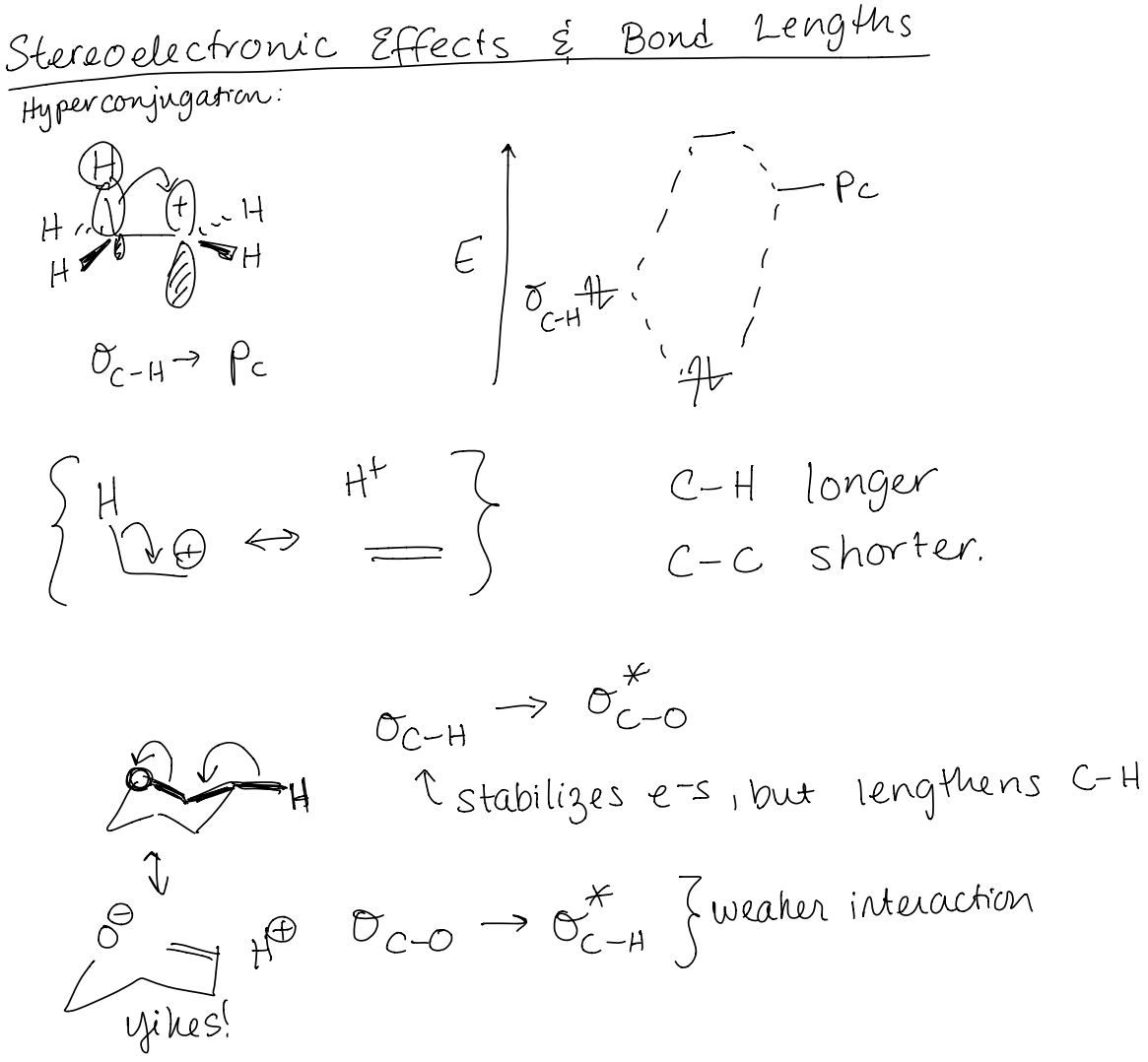
Lecture 11: Conformational Analysis (continued)

Announcements:

- Midterm 1 on Thursday.
  Material included: everything through last week (not today's class).
  Items allowed: pen or pencil, model kit
- Office hours: Wed 2:30-3:30 (208 LDL, Mary)
  Thurs 10-11 (220 BRL, Scott)

Today:

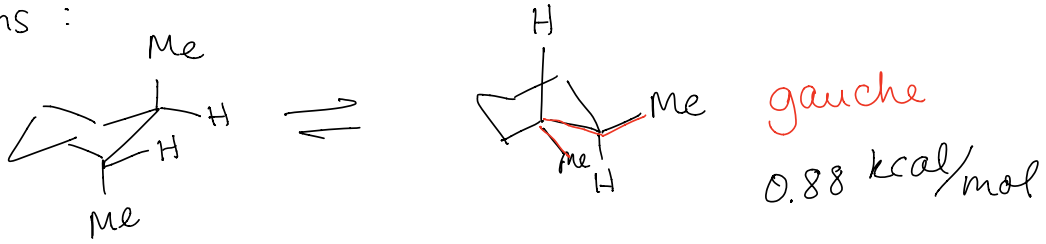
- Stereoelectronic effects that lengthen or shorten bonds (review)
- Conformational Analysis of Cyclic Systems (continued)



Cyclohexane : Disubstituted

1,2 (vicinal)

1) Trans :



gauche

0.88 kcal/mol

Prediction ΔG° = 1 gauche butane − 2 A(Me)

= +0.88 − 2 (1.74)

= −2.6 kcal/mol

Observed ΔG° = − 2.74 kcal/mol

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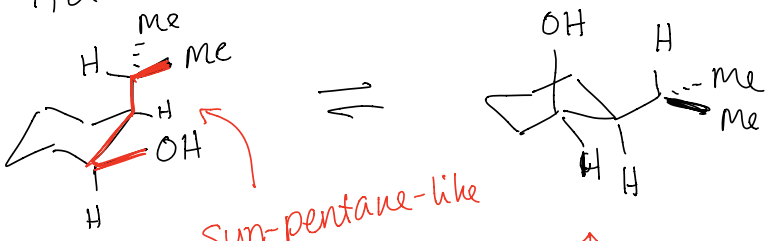
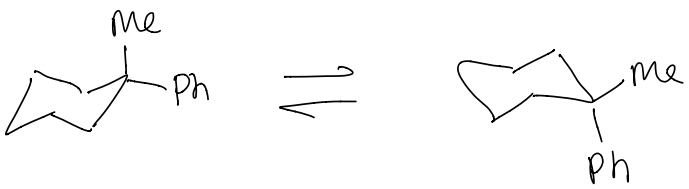
cis-1,2



Syn-pentane-like interaction

↑ more strongly preferred than A-values predict

1,1 (Geminal)



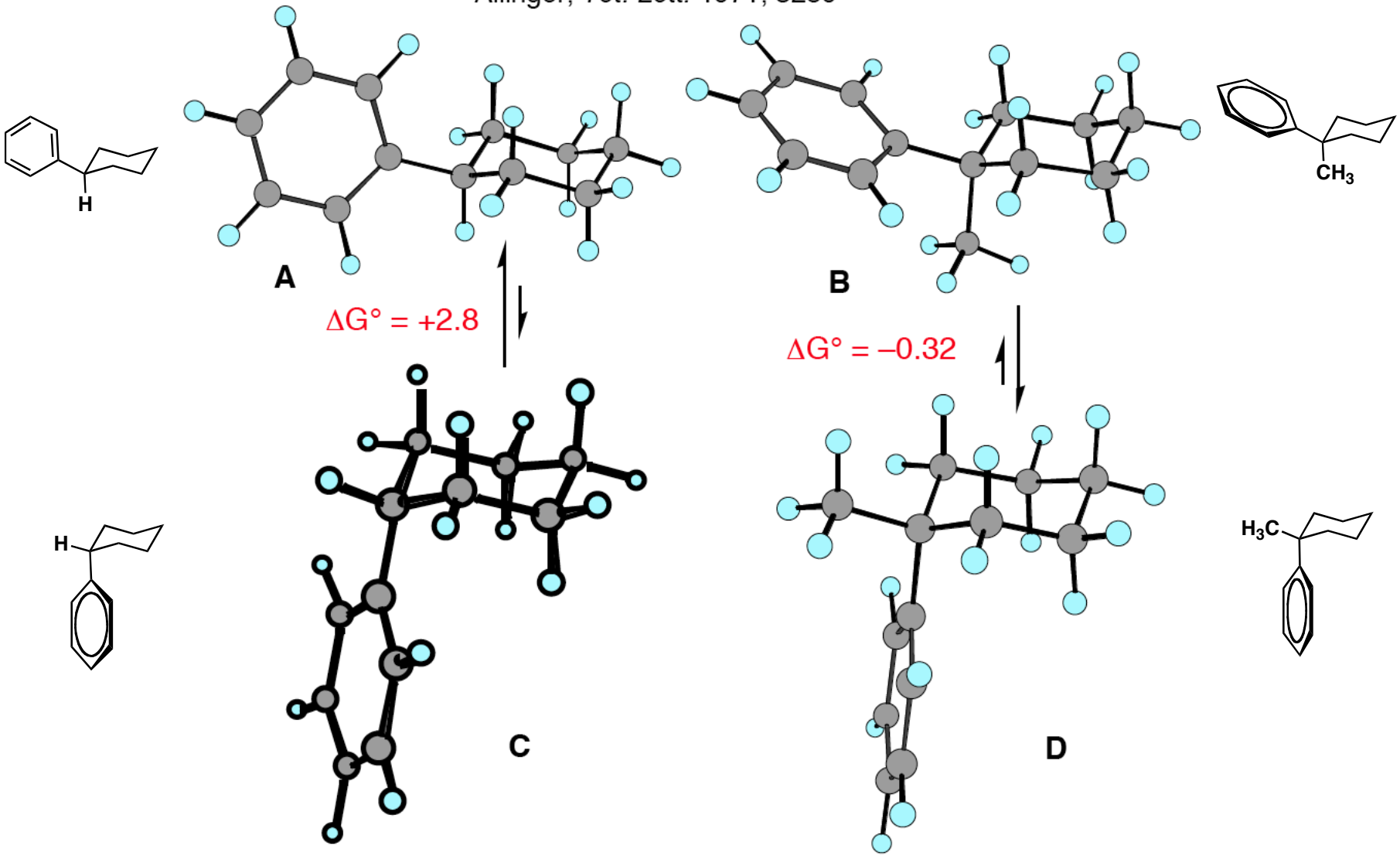
Prediction: $\Delta G^\circ = A(Ph) - A(Me)$

$= +2.8 - 1.7$

$\Delta G^\circ = +1.1$ kcal/mol

Observed: $\Delta G^\circ = -0.32$ kcal/mol

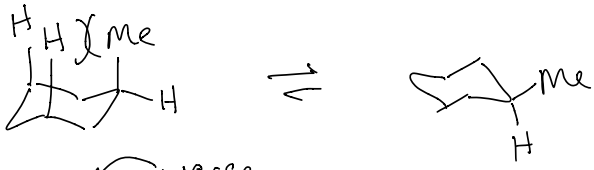
Allinger, *Tet. Lett.* 1971, 3259



Note the difference in the Ph substituent in **A** & **B**.

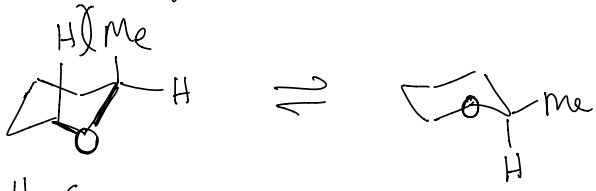
Heteroatoms

$-\Delta G^\circ$ (kcal/mol)

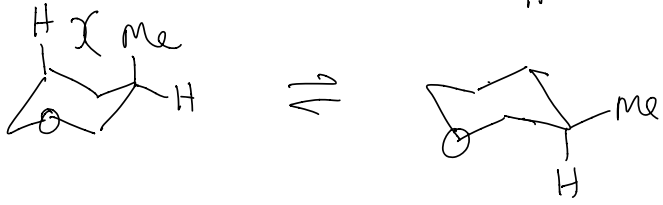


1.74

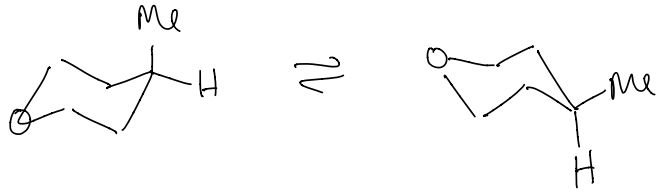
worse



2.86 C–O shorter than C–C.

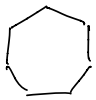


1.43 only 1 1,3-diaxial



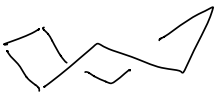
1.95

Similar w/ NH instead of O.

Cycloheptane  C&S-A, Fig 2.17

chair

($2.16 \frac{kcal}{mole}$)

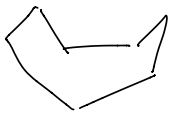


twist chair

($0 \frac{kcal}{mol}$)

boat

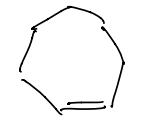
($3.02 \frac{kcal}{mol}$)

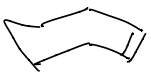


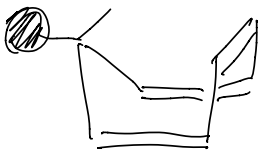
twist boat

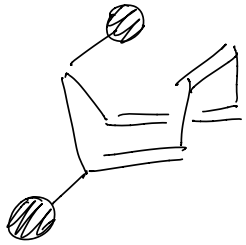
($2.5 \frac{kcal}{mol}$)

Olefins & substituents preferrentially oriented to eliminate eclipsing interactions:

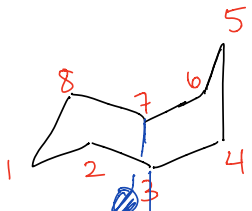








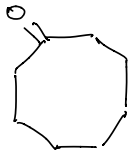
Cyclooctane

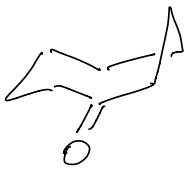


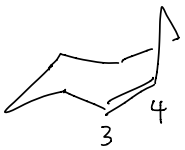
transannular strain between pseudo-axial substituents

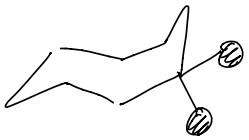
Methyl Position	1	2	3	4	5
$-\Delta G$ ($\frac{\text{pseudo eq}}{\text{pseudo axial}}$) (kcal/mol)	1.8	2.8	7.45	-0.3	6.1

Derivatives:

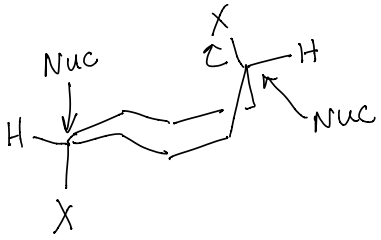






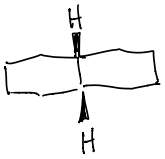


S_N2: @ C_1 or C5



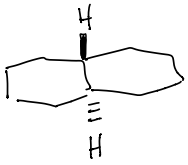
Bicyclic Ring Systems

Decalin (6/6)

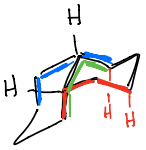


cis

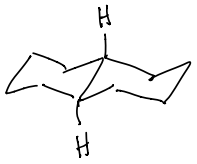
vs.



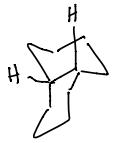
trans



3x gauche-butane
3x .88
≃ 2.64 kcal/mol
Pretty close.



$\nleftrightarrow \Delta G^\circ = \emptyset$

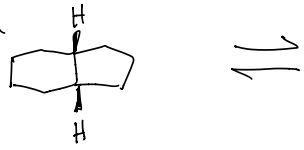


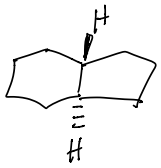
ΔG°_{rel} +2.4 kcal/mol 0.0

Why?

Hydrindane (6/5)

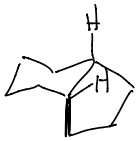
flexible





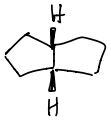
rigid

$\Delta G^\circ = +0.5$ kcal/mol

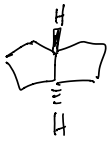


Entropy beats out enthalpy.

5,5



favored



Lots of strain!

$\Delta G^\circ = +6.4$ kcal/mol