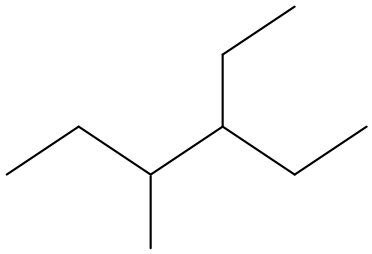
ORGO/BIO CHAPTER 7 HW

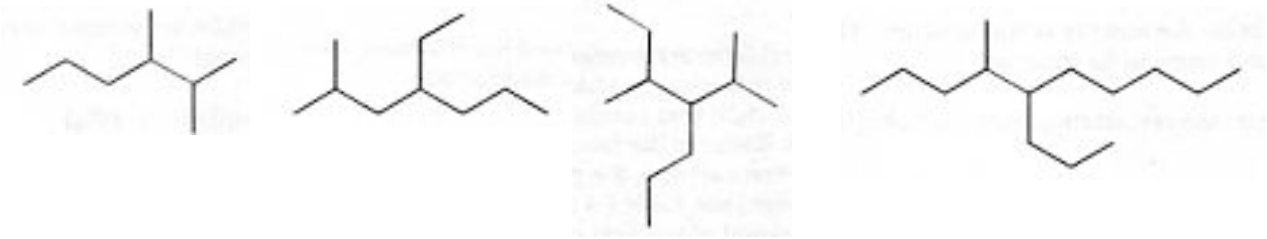
1. Before we get started on naming, here are some old school names for a few common complex substituents. What are their structures? What are their IUPAC names?

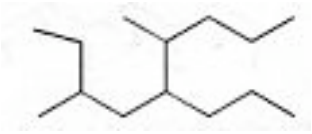
a. isopropyl b. sec-butyl c. t-butyl

2. More naming rules… Name the following molecule:
You may be asking "But which name is correct?"
Time to make another rule:

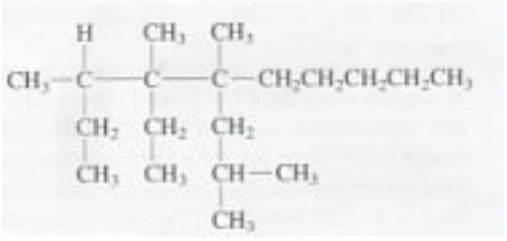


3. Let's name some alkanes! Wahoo! Give the IUPAC names for the following molecules.





$CH_3C(Cl)_2CH(CH_3)_2$ $(CH_3CH_2)_2CHCH(CH_3)CH_2CH_3$



$$\begin{array}{c} CH_3CHCH_3 \\ | \\ CH_3(CH_2)_2\text{-}C\text{-}(CH_2)_3CH_3 \\ | \\ CH_3CHCH_3 \end{array}$$

4. Draw the following molecules.
a. 2,3,4-trimethylheptane
b. 4-isopropyl-3,4-dimethyloctane
c. 5-(1-methylpropyl)-6-propyldodecane
d. 3-isopropyl-2,2,4-trimethylhexane
e. 1,4-dibromo-2-methylbutane

5. Draw the structural formulas for the isomers of pentane and name them by the IUPAC system.

6. Draw and name the isomers of dichloro-pentane, $C_5H_{10}Cl_2$.

Conformational analysis!

7. Consider the rotational conformations of an ethane molecule. Draw Newman projections for this molecule depicting staggered and eclipsed conformations.

8. Consider the C_2-C_3 bond (the bond between carbon atoms 2 and 3) of an n-pentane molecule. Draw Newman projections depicting the following conformations, or conformers (rotational isomers): staggered anti, eclipsed, staggered gauche, totally eclipsed.

9. List the conformations named in the question above in order of *increasing* stability.

10. Using a Newman projection, draw the lowest-energy conformation for propane, sighting down the C_1-C_2 bond.

11. Using a Newman projection, draw the lowest-energy conformation for 1,1-dibromo-2-chloroethane.

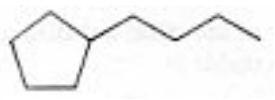
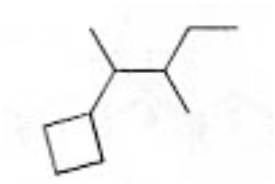
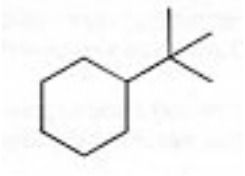
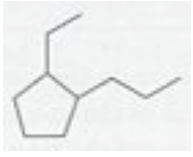
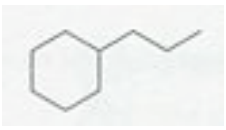
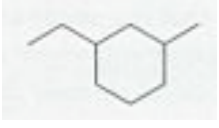
12. Make a potential energy versus rotation graph for a 360° rotation of the C-C bond in the molecule 1,2-difluoro-ethane. Draw Newman projections for each 60° conformer. Label each projection accordingly (e.g. eclipsed). You may start with whichever conformer you like at 0°!

13. Sequence the following molecules in predicted order of increasing *ring strain*:

cyclobutane, cyclohexane, cyclopropane, cyclopentane

Hint: If this doesn't come to you readily, try to build the molecules with a kit; that will help.

14. Let's name some cycloalkanes! Wahoo II! Give the IUPAC names for the following molecules.

15. Let's draw cycloalkanes! Draw the following molecules.
a. 1,1,2-trimethylcyclobutane
b. 2-t-butyl-1,1-dimethylcyclohexane
c. 4-sec-butyl-5-cyclopentylnonane
d. 1-cyclopropyl-1,2-diethylcyclooctane
e. 1,1,2,2,3,3,4,4-octamethylcyclobutane

16. Use Haworth projections (a touch of 3D) to draw the following molecules:
a. 1,2-difluorocyclopentane (Yo! There are two geometric isomers of this molecule: cis and trans. Please draw both, and indicate which is which.)
b. cis-1,2-dimethylcyclohexane
c. trans-1-ethyl-2-methyl-cyclohexane
d. cis-1,3-dimethylcyclohexane

17. Do your best to draw a 3D boat conformation of cyclohexane without the hydrogens.

18. Do your best to draw a 3D chair conformation of cyclohexane without the hydrogens.

19. Now draw a 3D chair conformation of cyclohexane with all the hydrogens. Label the equatorial and axial hydrogens. Hint: think horizontal and vertical hydrogens, respectively.

20. Make sense of a cyclohexane ring flip. Draw a 3D depiction of the ring flip. Grab a modeling kit, build cyclohexane, and feel the ring flip for yourself. Ooo la la…

Notes to self:
The chair conformation of cyclohexane is far more stable than the boat conformation.
Large substituents prefer to be in equatorial positions to axial positions in cyclohexanes. Axial strain ≠ happy cycloalkane

21. Draw the two different chair conformations of cis-1,3-dimethylcyclohexane and determine which conformation is more stable or if they are equally stable. Build models to help.

22. Draw the two different chair conformations of trans-1,3-dimethylcyclohexane and determine which conformation is more stable or if they are equally stable. Build models to help.

23. Draw the two different chair conformations of trans-1,4-dimethylcyclohexane and determine which conformation is more stable or if they are equally stable. Build models to help.

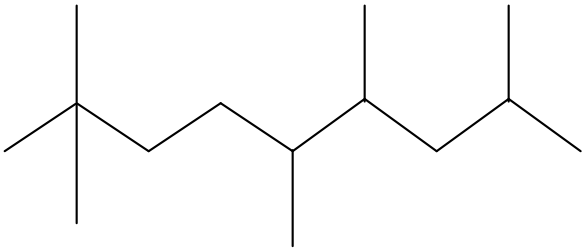
24. Draw the most stable conformation of cis-1-t-butyl-4-methylcyclohexane.

<u>Intro to organic reactions!</u>

25. Write the balanced equation for the combustion of one <u>molecule</u> of methane. Then try to show the reaction mechanism using arrow-pushing. Be creative as you attempt this feat.

Intro to organic chain reaction mechanisms!

26. Degrees of substitution (on a carbon atom). Not an intuitively obvious necessary skill to have now, but it's useful as it's related to chemical reactivity. In the following structure, identify each carbon atom as being primary (1^o), secondary (2^o), tertiary (3^o), or quaternary (4^o).



27. What is a *free radical*?

28. Chain reaction bromination of alkanes
a. Show a step-wise mechanism for the formation of bromo-methane from bromine and methane. Label the following steps: initiation (with light; bromine is red, and hence the Br-Br bond is very sensitive to visible light), propogation, and termination. Use arrow-pushing, please.

b. Show a step-wise mechanism for the formation of dibromo-methane from bromine and methane. Use arrow-pushing, please.

c. Show a step-wise mechanism for the formation of bromo-butane from bromine and n-butane. Use arrow-pushing, please. Indicate major and minor products.

d. Show a step-wise mechanism for the formation of bromo-butane from bromine and methyl-propane. Use arrow-pushing, please. Indicate major and minor products.

e. Show a step-wise mechanism for the formation of bromo-pentane from bromine and methyl-butane. Use arrow-pushing, please. Indicate major and minor products. Which product would be the predominant product?

An energetic aside…
29. Compare the bond-energies (related to bond dissociation energies) of the following bonds:
a. C − C versus C═C versus C≡C
b. C bonded to F, C bonded to Cl, C bonded to Br, C bonded to I.
c. primary, secondary, and tertiary C − H bonds.

30. Draw all the isomers for the simplest alkane having <u>only</u> one 4^o C, one 3^o C, and one 2^o C.

31. The following names are *incorrect*. Please give the correct IUPAC names.
a. 3-chloro-4-methylpentane
b. 2-ethylhexane
c. 1,1-dimethylnonane