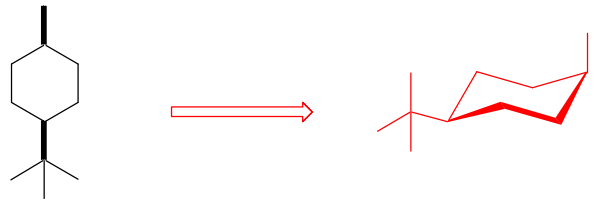
Dr. Peter Norris

Chemistry 3719 Fall 2000 Practice Exam I

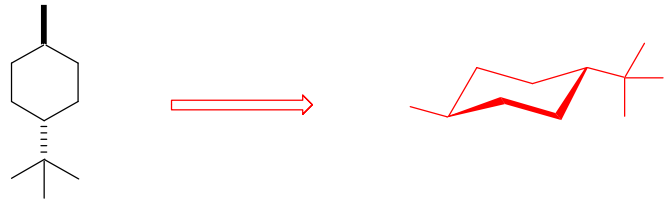
This exam is worth 100 points and you have 50 minutes to complete it. You may use molecular models to help you with any of the problems.

Good luck.

1. (6 pts) Draw the following molecules in their lowest energy chair conformations.

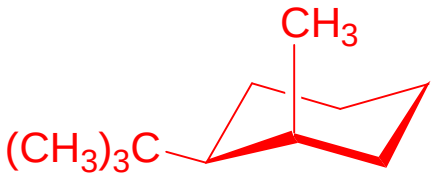


Cis-1-*t*-butyl-4-methylcyclohexane
t-Butyl group **has to be equatorial**



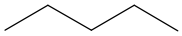
Trans-1-*t*-butyl-4-methylcyclohexane
t-Butyl group **has to be equatorial**

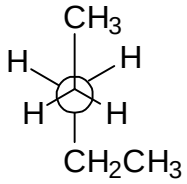
2. (5 pts) Write a structural formula for the most stable conformation of *cis*-1-*tert*-butyl-2-methyl-cyclohexane.



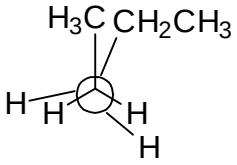
Both groups are pointing "up" from the ring, therefore they are cis, again the very bulky t-butyl group will be equatorial

3. (10 pts) Draw a Newman projection that depicts looking down the C-2 – C-3 bond of *n*-pentane. Rotate around the C-2 – C-3 bond axis and draw Newman projections for the most stable staggered conformation, the least stable eclipsed conformation and one of the gauche forms.

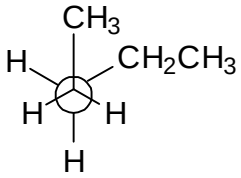

≡ $CH_3CH_2CH_2CH_2CH_3$



Staggered
(most stable)

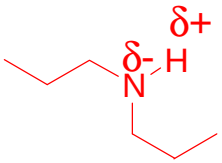


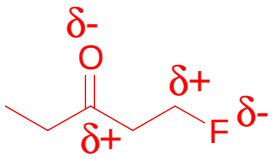
Eclipsed
(least stable)

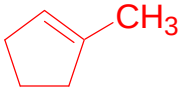


Gauche
(in between)

4. (6 pts) Using the δ+/δ- notation indicate the polarization (if any) within each of the following molecules:

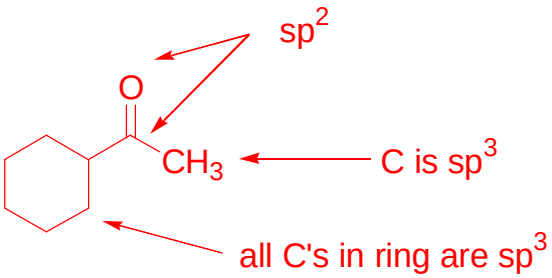




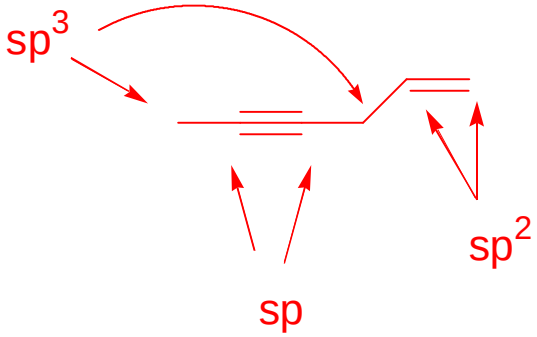


5. (9 pts) Label the hybridization of each C atom in the following molecules:

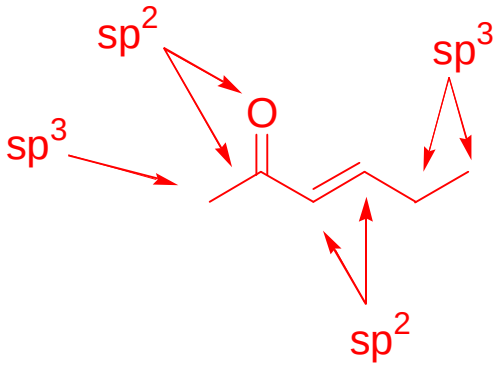
a.



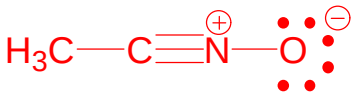
b.

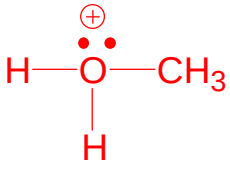


c.



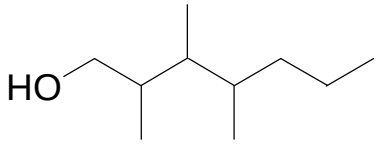
6. (6 pts) Fill in any formal charges that are missing from the following structures.





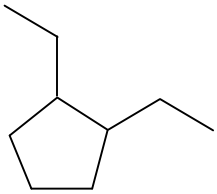
7. (10 pts) Give acceptable IUPAC names for the following organic molecules:

a.



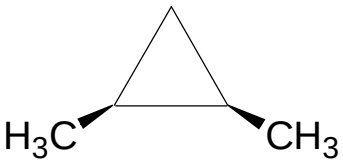
2,3,4-trimethylheptan-1-ol

b.



1,2-diethylcyclopentane

c.

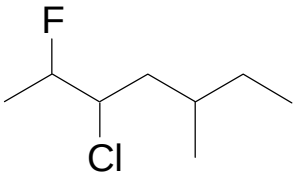


Cis-1,2-dimethylcyclopropane

d.

Trans-1-ethyl-4-methylcyclohexane

e.

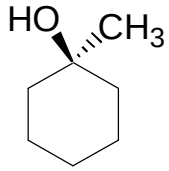


3-chloro-2-fluoro-5-methylheptane

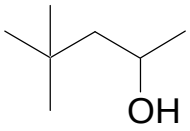
8. (5 pts) Ethanol (CH_3CH_2OH) and propane ($CH_3CH_2CH_3$) are similar in molecular weight but ethanol boils at 78 ^oC whereas propane boils at –42 ^oC. Explain.

In addition to any van der Waals interactions in ethanol, the alcohol contains a hydroxyl group, which is capable of forming intermolecular hydrogen bonds between molecules. Propane only has the relatively weak van der Waals forces, therefore propane boils at a much lower temperature than ethanol.

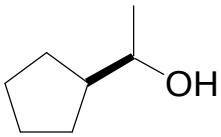
9. (6 pts) Classify each of the following alcohols as being 3^o, 2^o or 1^o.



3^o alcohol



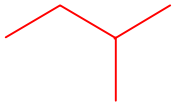
2^o alcohol



2^o alcohol

10. (10 pts) Draw all of the isomers of C_5H_{12} and give them acceptable IUPAC names.

Pentane
(n-pentane)

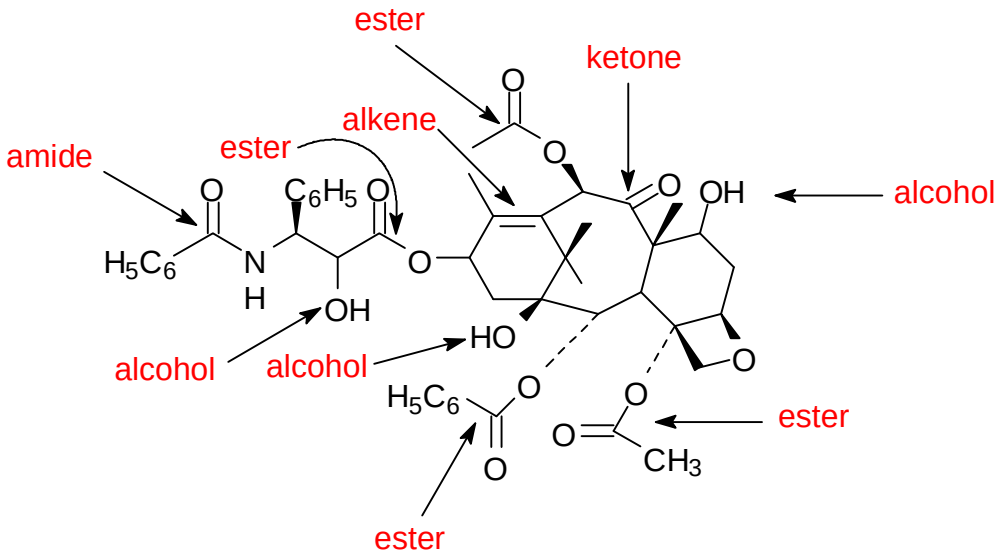


2-methylbutane

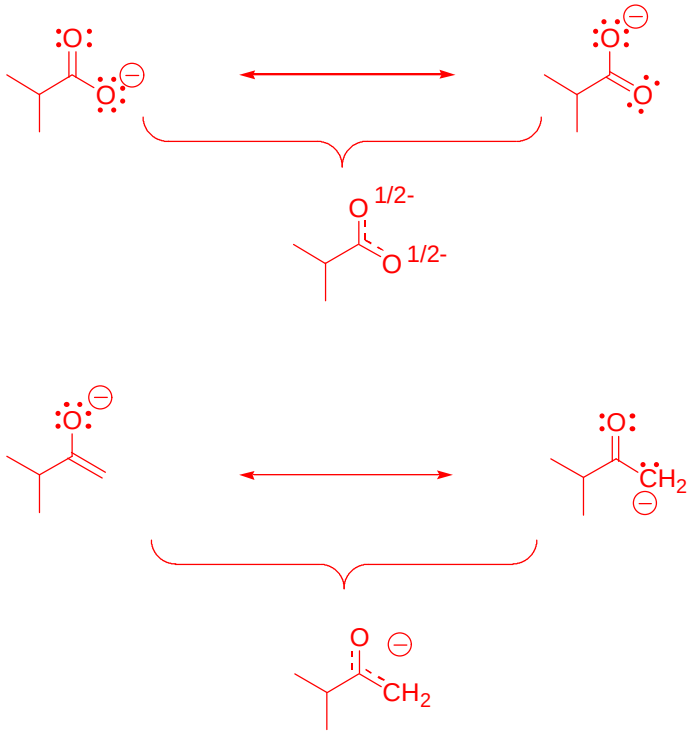
2,2-dimethylpropane

11. (10 pts) Taxol is an important anticancer drug isolated from the Pacific yew tree and synthesized by several research groups in the 1990's. Label each of the following functional groups within taxol:

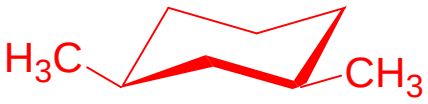
alkene, amide, ketone, alcohol, ester

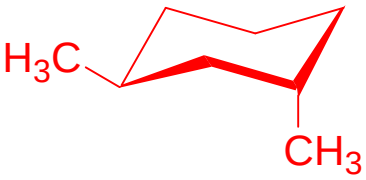


12. (6 pts) Draw the second resonance form and the <u>overall resonance hybrid</u> for the following anions.



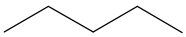
13. (5 pts) Explain using diagrams why *cis*-1,3-dimethylcyclohexane is thermodynamically more stable than *trans*-1,3-dimethylcyclohexane.



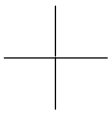


The *cis* isomer (above left) has both large methyl groups in equatorial positions thereby avoiding any unfavourable 1-3 interactions. The *trans* isomer (top right) has to have one methyl group axial (even if you flip to the other chair form), therefore this is less stable than the *cis* isomer.

14. (6 pts) The two compounds **1** and **2** have the same molecular weight and molecular formula and are defined as constitutional isomers. Translate the two structures to show all of the C and H atoms in each molecule, name the two compounds and explain why **1** has a higher boiling point (36 ^{o}C) than **2** (9 ^{o}C).



1



2

$CH_3CH_2CH_2CH_2CH_3$

$(CH_3)_4C$

Pentane (n-pentane)

2,2-dimethylpropane

Pentane has a higher boiling point than the isomeric 2,2-dimethylpropane since it is linear. Molecules of pentane are therefore able to interact more via van der Waals forces, whereas the branched alkane **2**, which is more spherical in shape, is limited in its van der Waals interactions with other molecules.