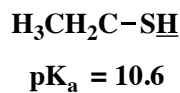
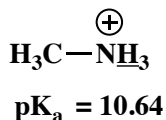
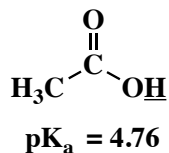
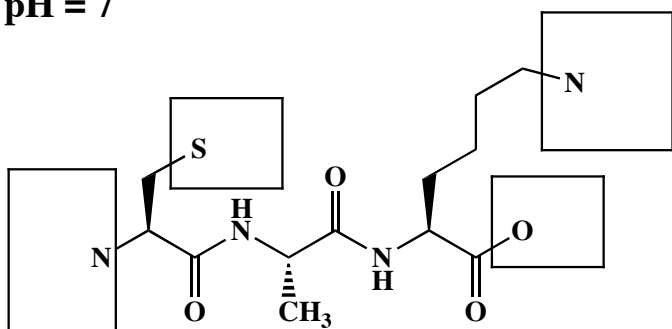


Homework 2
Organic Chemistry MCAT Review
Summer 2012
Brent Iverson

1. Complete the following two structures by adding appropriate numbers of lone pair electrons, H atoms, and formal charges to the atoms in the boxes. You must adjust your answers to indicate the predominant species at each indicated pH value. (You do not have to add anything such as H atoms to atoms not drawn in the boxes.) This problem is testing your understanding of the relationship of protonation state to pH to pKa values for certain functional groups we have discussed. Next, in the space provided, write the overall charge on each structure at the indicated pH. For your reference, here are the relevant pKa values:

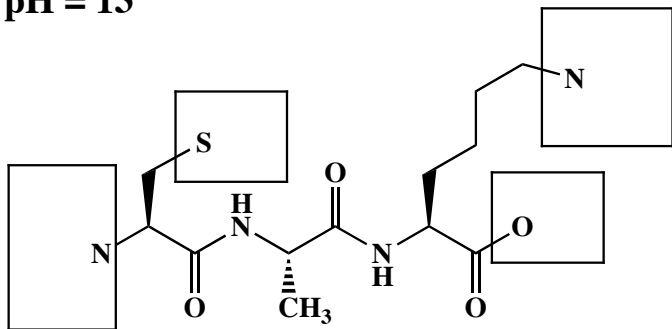


pH = 7



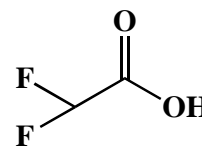
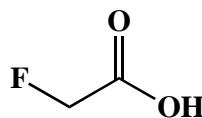
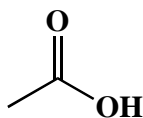
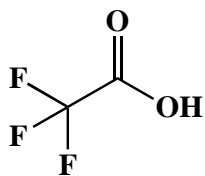
Total charge on molecule: _____

pH = 13

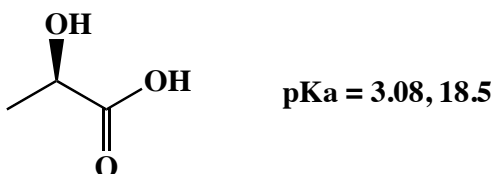


Total charge on molecule: _____

1 (cont.) Rank the following from weakest to strongest acid, with a 4 under the weakest acid and a 1 under the strongest acid.



Consider the following acid that has two different pKa values as listed:



In the space provided, draw the predominant form of this acid in water at pH 10.0



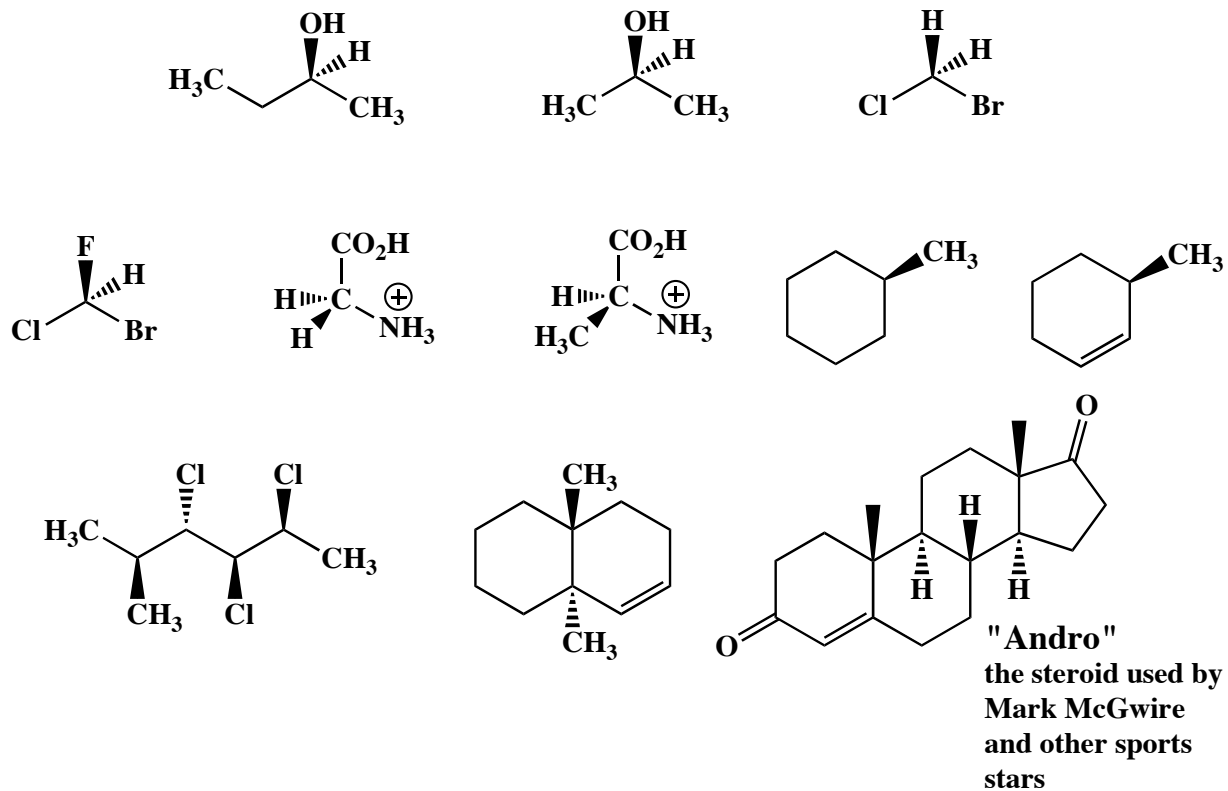
In the space provided, draw the predominant form of this acid in water at pH 7.0



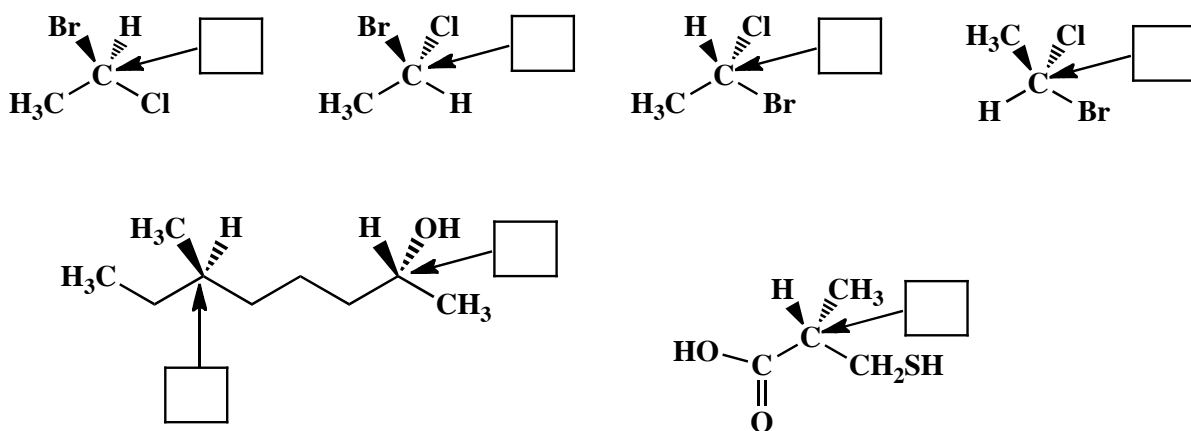
In the space provided, draw the predominant form of this acid in water at pH 1.0



2. For the following molecules, label each chiral center with an asterisk (*).

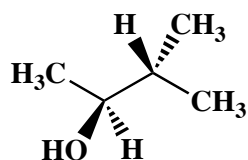
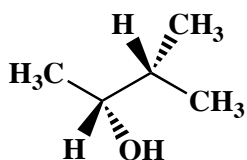


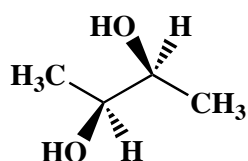
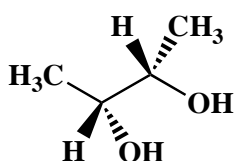
3. Label each chiral center as "R" or "S".

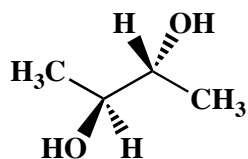
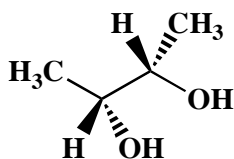


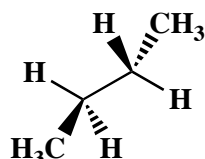
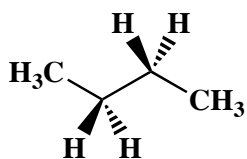
4. For each pair of molecules, on the line provided state whether they are (1) **enantiomers**, (2) **diastereomers**, (3) **constitutional isomers**, or (4) **different conformations of the same molecule**. Each pair of molecules will best be described by one of these four terms. **Next draw a circle around all the molecules that would be optically active (i.e rotate the plane of plane polarized light), and write "MESO" under any meso compounds.**

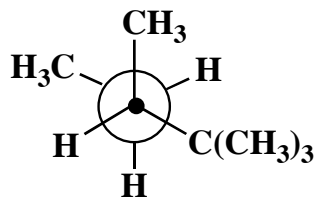
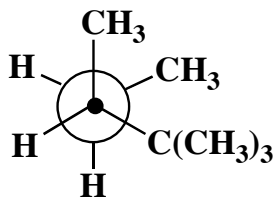
Relationship:

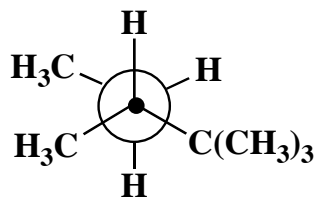
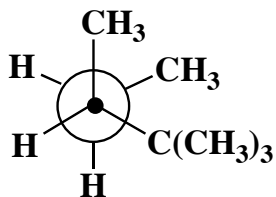




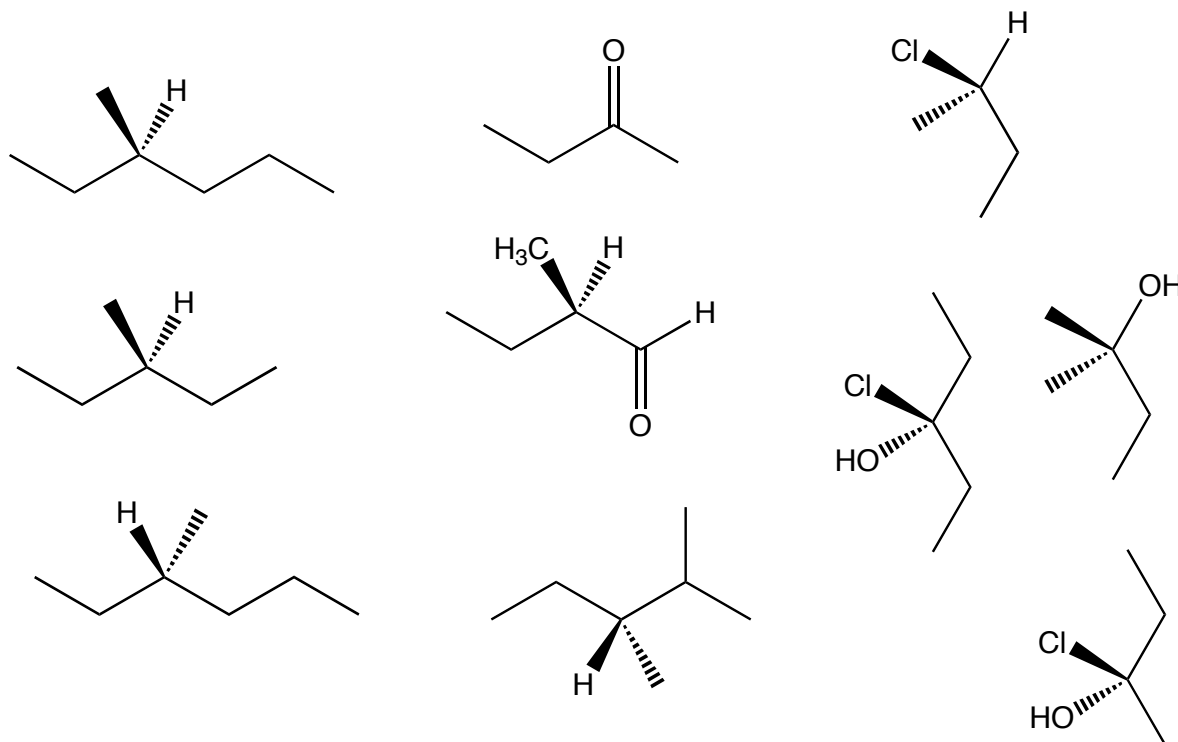




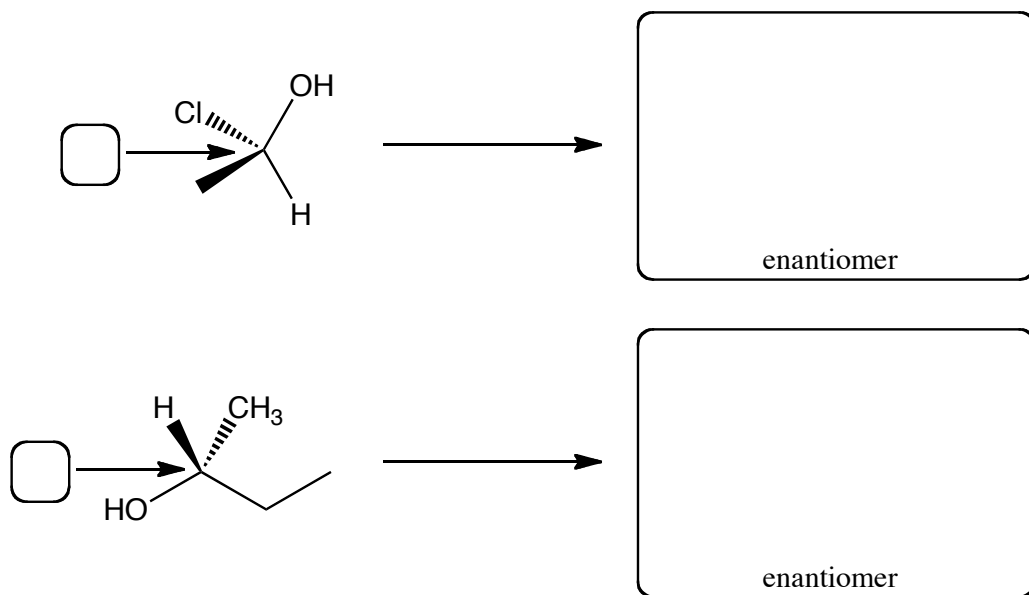




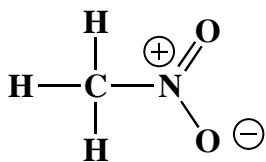
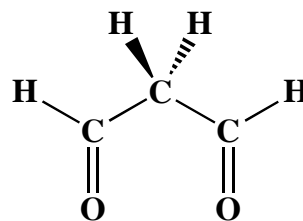
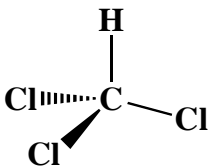
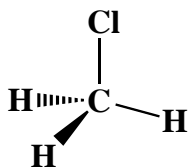
5. Circle the molecules that are chiral. For each one that is, determine the configuration of the chiral center and write "R" or "S" next to the chiral center.



6. For each molecule, label the chiral centers as "R" or "S". Then, in the space provided to the right of each molecule, draw its enantiomer.



7. For the following molecules, use the dipole moment symbol \rightarrow to show the direction of the molecular dipole moment in all molecules that have an overall molecular dipole.

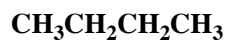


For the molecule above list the molecular dipole for the conformation shown.

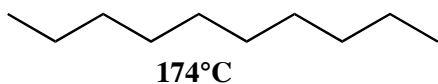
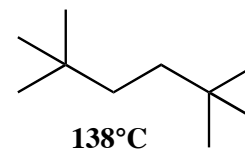
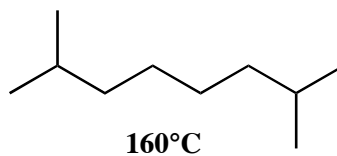
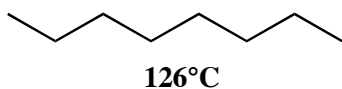
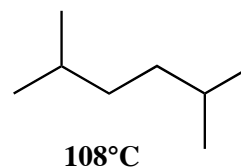
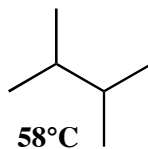
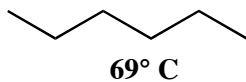
8. A hydrogen bond is the strongest interaction seen among neutral molecules. In the space provided, draw two molecules of methanol (CH_3OH) and show a hydrogen bond between them. Use a dashed line to indicate the hydrogen bond. Show all lone pairs.

Carboxylic acids exist in solution as characteristic "dimers". Draw the structure of the dimer formed by butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$.

9. Rank the following in order of boiling point, with a **1** under the molecule with the lowest boiling point and a **4** under the molecule with the highest boiling point.

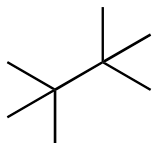


10. A series of alkanes are listed along with their boiling points.



A) From the data listed, draw two different conclusions regarding how boiling point changes with structure.

B) The boiling point of 2,2,3,3-tetramethylbutane is 106° C, in line with the other alkanes. However, 2,2,3,3-tetramethylbutane is a solid at room temperature, not a liquid like the others, because it has a melting point of 104° C. It is only a liquid for the span of 2° C!! For comparison, octane is only a solid below -57° C. Briefly explain why 2,2,3,3-tetramethylbutane exhibits this unusual behavior.

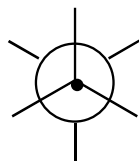
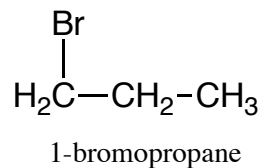


Boiling point 106° C
Melting Point 104° C

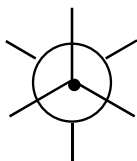


Boiling point 126° C
Melting Point -57° C

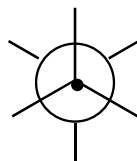
11. The following molecule is called 1-bromopropane. On the templates provided, draw both gauche conformations, as well as the anti conformation. Circle the most stable conformation of 1-bromopropane.



Gauche



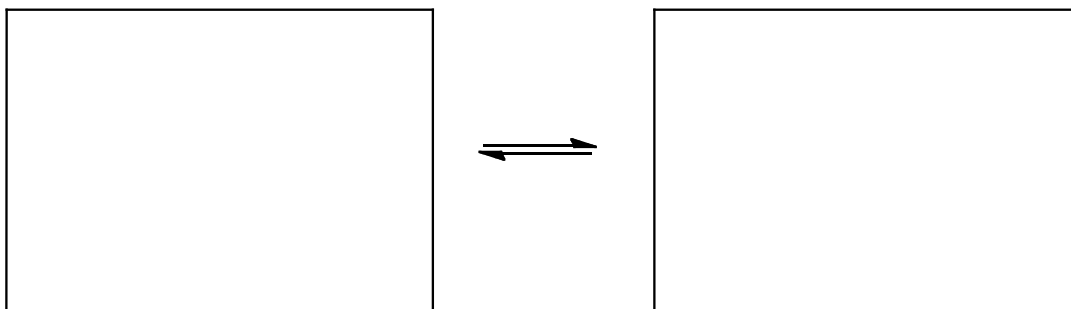
Gauche



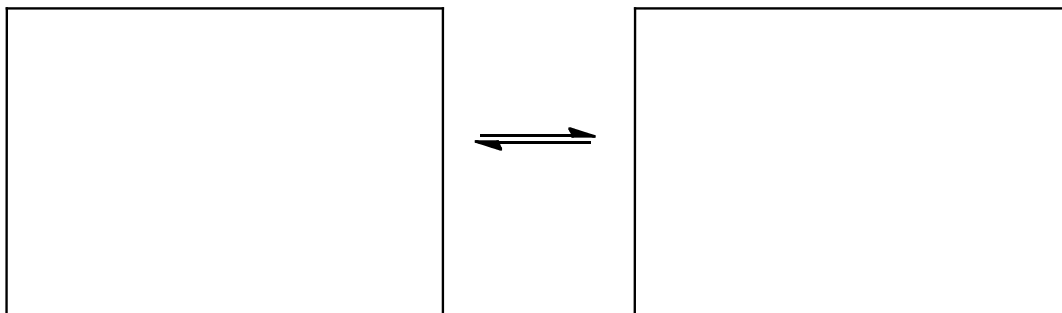
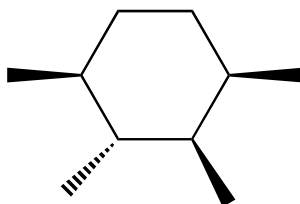
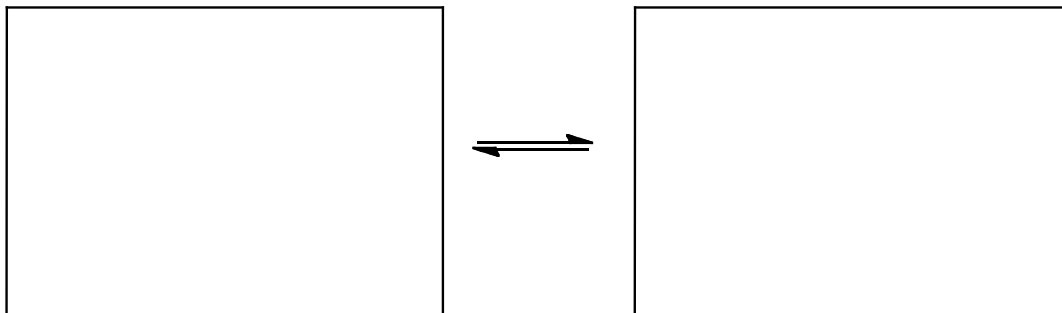
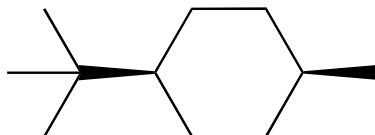
Anti

All three of the above conformations are examples of a _____ conformation

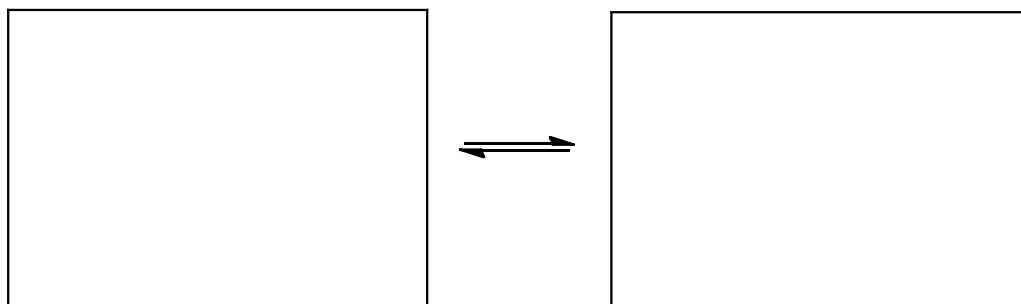
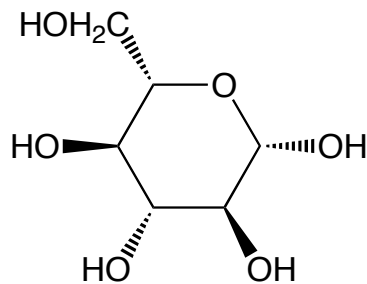
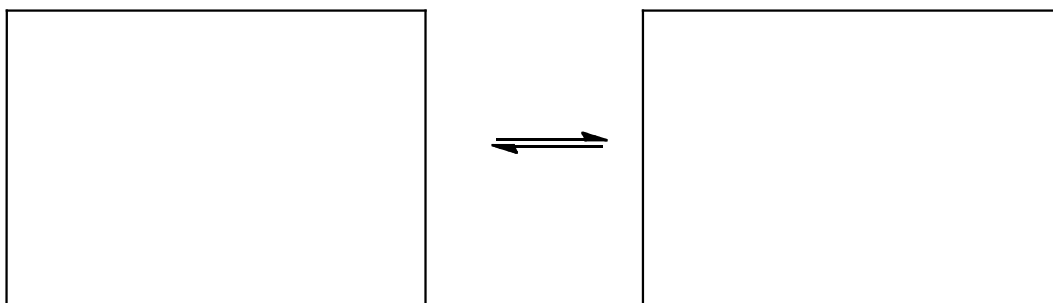
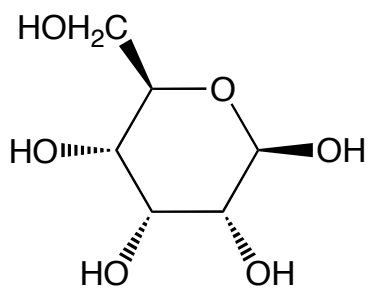
12. Draw the alternative chair conformations of *cis*-1,3-diethylcyclohexane. Draw a circle around that is more stable, i.e. the one that predominates at equilibrium.



13. Draw the alternative chair conformations of the following cyclohexane derivatives. When there is a difference in energy, circle the more stable chair conformation (i.e. the one that predominates at equilibrium).



13. First place an asterick next to each chiral center. Next draw the alternative chair conformations of the following carbohydrate derivatives. When there is a difference in energy, circle the more stable chair conformation (i.e. the one that predominates at equilibrium).



NOTICE THIS!

Are the above two carbohydrates the same molecule, enantiomers or diastereomers ?