CHEMISTRY 313-01
MIDTERM # 1
September 29, 2005

Name .....

The total number of points in this midterm is 100. The total exam time is 120 min (2 h). Good luck!

1. (12 pts) Mark as true (**T**) or false (**F**) the following statements. Do not explain!
   - σ–bonds are stronger than π-bonds;
   - Single bonds are always σ-bonds;
   - The *gauche* conformation of butane is a global minimum;
   - The chair conformation of cyclohexane is a local minimum;
   - Cyclopropane has the largest amount of angle strain;
   - Molecules with polar bonds always have non-zero dipole moments;
   - Stronger acids have lower pK_a values;
   - Lewis acids are proton donors;
   - Increasing oxidation number indicates an oxidation process;
   - Concerted reactions have no more than two elementary steps;
   - The *Hammond* postulate relates the energies and structures of two neighboring species on the potential energy profile;
   - S_N2 processes are always bimolecular;

2. (5 pts) Provide the structural formula for each of the following molecules.

***trans*-1,2-dimethyllcyclobutane**	**tetrahydropyran**	**neopentyl iodide**	**isobutyl alcohol**	**2-cyclopropyl-2-propanol**

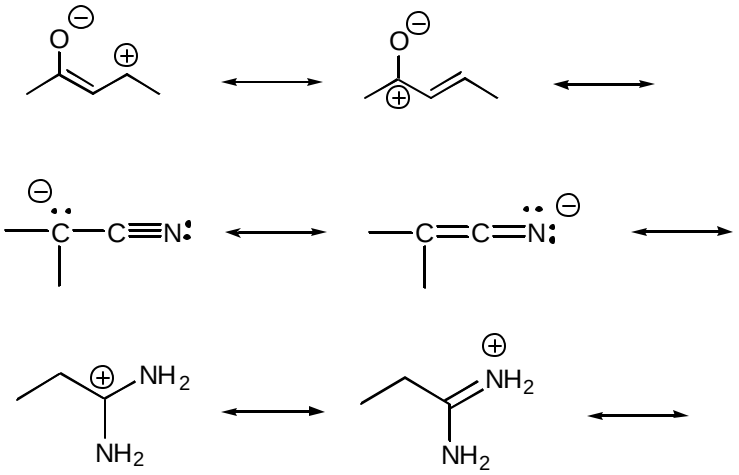
3. (2 pts) While the name *sec*-butyl bromide defines a specific structure, the name *sec*-pentyl bromide is ambiguous. Briefly explain!

4. (2 pts) Provide a structure for each of the following compounds:
   a. Bicyclo[2,2,2]octane.
   b. Spiro[2,2]pentane.

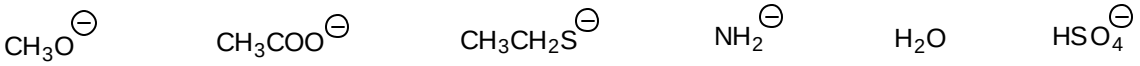
5. (2 pts) Write the structure of the hexane isomer that has only primary and tertiary carbon atoms.

6. (3 pts) Without referring to tables, decide which member of each of the following pairs would have the higher boiling point. Do not explain!
   a. Pentane or 2-methylbutane;
   b. Heptane or pentane;
   c. Propane or 2-chloropropane;
   d. 2-Chlorobutane or 2-butanol;

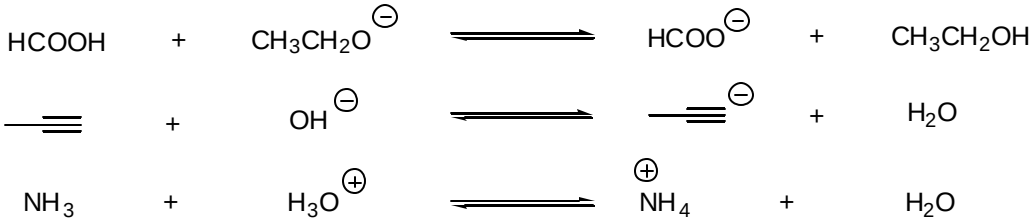
7. (6 pts) Several sets of resonance forms are given below. In each case draw <u>one</u> additional resonance form, then rank the resonance forms (Some forms may have equal ranking!).



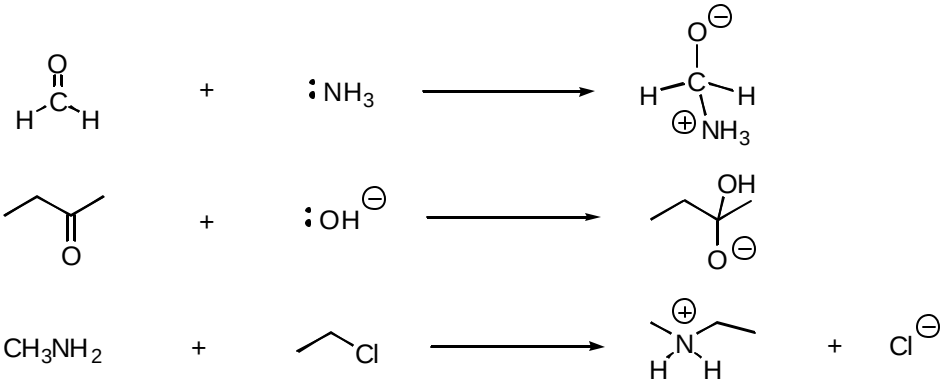
8. (4 pts) Rank the following species in order of increasing basicity. <u>Do not explain</u>!



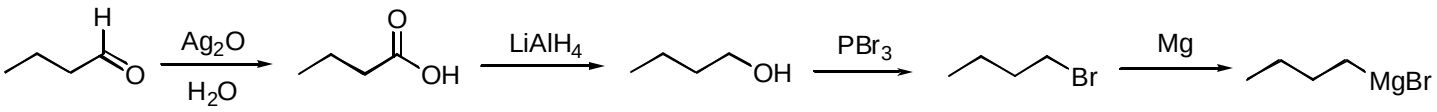
9. (6 pts) Predict the shift of equilibrium (<u>to the left or right</u>) for the following acid – base reactions.



10. (6 pts) Label the reactants in the following acid – base reactions as *Lewis* acids (electrophiles) or *Lewis* bases (nucleophiles).



11. (6 pts) The following is a multistep transformation. Label each step as a **reduction**, **oxidation** or **not redox** with respect to the organic compound.



12. (4 pts) Provide formulas for the following functional groups:

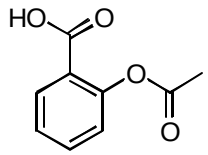
a. Thiol;

b. Nitrile;

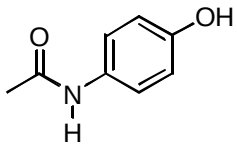
c. Aldehyde;

d. Alkyne;

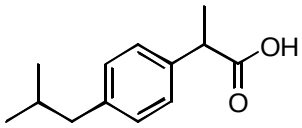
13. (6 pts) Circle and name all functional groups in the following structures.



aspirin



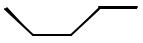
acetaminophen (Tylenol)

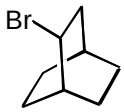
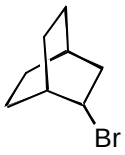


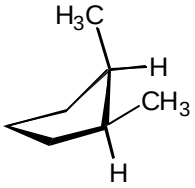
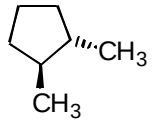
ibuprofen (Advil)

14. (4 pts) Give the relationship between the following pairs of structures. There are four (4) possible relationships: **same compound**, **constitutional isomers**, ***cis-trans* isomers**, **not isomers** (i.e. different molecular formula).

a. $CH_3CH_2CH_2CH_3$ and $(CH_3)_3CH$

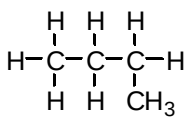
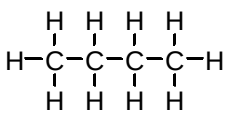
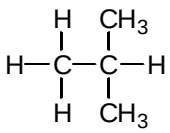
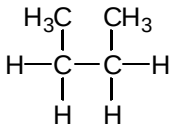
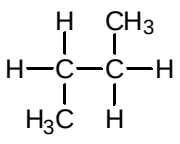
b.  and 

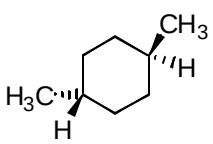
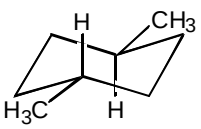
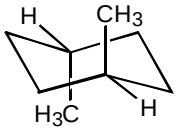
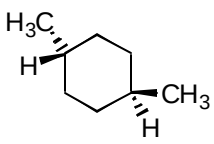
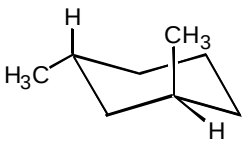
c.  and 

d.  and 

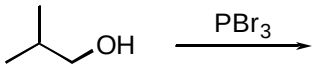
15. (4 pts) There are several isomeric fluorides with formula C_4H_9F. Draw the bond – line formulas of all isomers, provide appropriate names and label the structures as primary, secondary or tertiary fluorides.

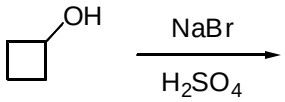
16. (4 pts) In each of the following sets indicate the (one) structure that represents a different compound.

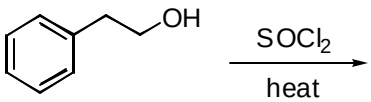






17. (6 pts) Draw the structure of the principle organic product of each of the following reactions.





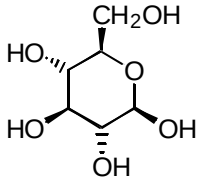


18. (6 pts) Using *Newman* projections, draw the conformations arising upon a full 360° turn (in 60° steps) around the **C2 – C3** bond of 3-methylpentane. Represent the energy changes on a qualitative potential energy/dihedral angle diagram. Assign the proper term (i.e. minimum, transition state, etc.) to each conformation (*Hint:* An ethyl group is larger and more sterically demanding than a methyl group!!).

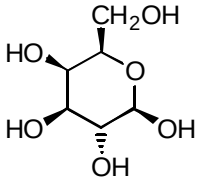
19. (6 pts) Determine whether the *cis*- or *trans*-isomer of 1-ethyl-3-methylcyclohexane is the more stable isomer by providing explicit structural analysis.

20. (6 pts) Consider isomeric pentanols ($C_5H_{10}O$)
    a. Indicate the alcohol that is most likely to undergo a reaction with HBr according to the S_N1 mechanism (*Hint:* What type of alcohols react fastest in S_N1 reactions?).
    b. Write the individual elementary steps.
    c. Provide a potential energy profile and label appropriately all minima and maxima on the profile.
    d. Classify each elementary step according to molecularity.
    e. Classify each transition state as reactant- or product-like.
    f. Indicate the rate-determining step.

21. **(3 pts) BONUS PROBLEM (In order to receive credit for this problem, it has to be solved entirely!!).** The structural formulas below belong to two naturally occurring, isomeric carbohydrates: glucose and galactose. Determine which of the two isomers is the more stable one. Support your decision by appropriate structural representations.



β-D-glucose



β-D-galactose