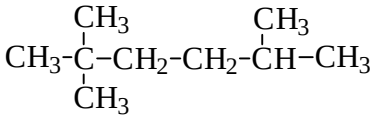
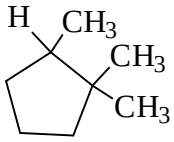
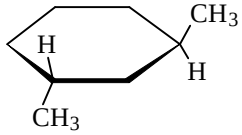
Exam # 1
Chemistry 2401 – Sept 23, 2005

(9) I. Name each of the following.

A. 

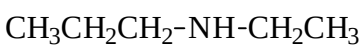
B. 

C. 

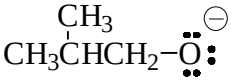
2,2,5-trimethylhexane 1,1,2-trimethylcyclopentane trans-1,3-dimethylcyclohexane

(21) II. Draw structural formulas for each of the following.

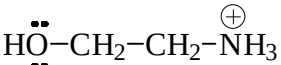
A. A secondary amine that contains five carbon atoms.



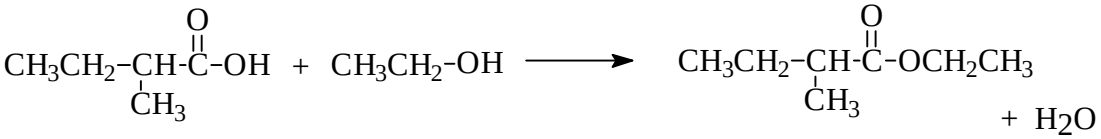
B. The conjugate base of isobutyl alcohol



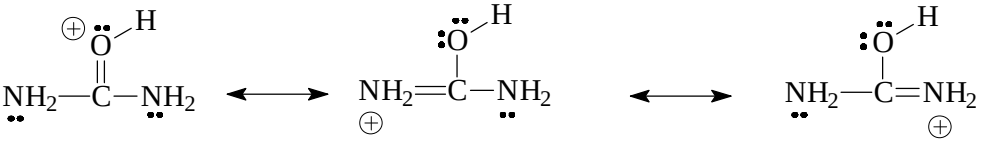
C. The conjugate acid of the compound below.



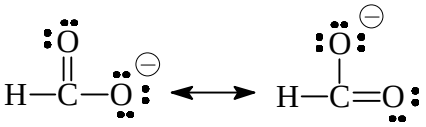
D. The ester that would result from the reaction shown below.

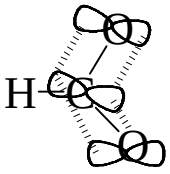


E. Two additional resonance structures for the conjugate acid of urea (below).

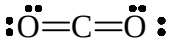


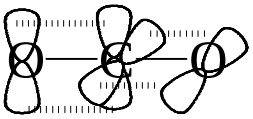
F. The interaction of the p orbitals that produces the pi bonding in formate anion that is represented below by two resonance structures. I drew the framework for you.





G. The interaction of the p orbitals that produces the pi bonding in carbon dioxide. I drew the framework for you again.





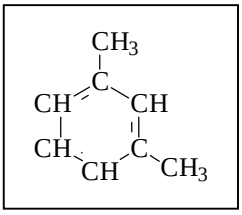
(20) III. The answer to each of the following is a number. Put that number in the space provided.

__6__ A. The number of outer shell electrons in an atom of sulfur (at # = 16).

__2__ B. The number of half-filled orbitals in an atom of sulfur.

__18__ C. The number of electrons in a sulfide anion, S^{-2}.

__5__ D. The number of C-13 NMR signals produced by m-xylene (structure on the right).



__4__ E. The number of C-13 NMR signals from m-xylene that appear in its DEPT-135 spectrum.

__3__ F. The number of nonbonded electron **pairs** in acetanilide (C_8H_8NO).

__4__ G. The number of covalent bonds to a nitrogen atom with a formal charge of +1.

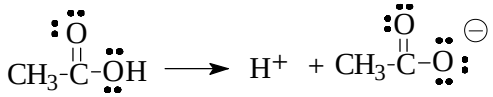
__9__ H. The total number of carbon atoms in a molecule of 2,4-dimethyl-3-ethylpentane.

__3__ I. The number of tertiary carbon atoms in 2,4-dimethyl-3-ethylpentane.

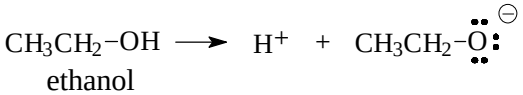
__2__ J. The number of hydrogen atoms bonded to the nitrogen atom in a primary amine.

( ) IV. Explain briefly each of the following.

A. Why acetic acid (pK_a = 4.7) is a much stronger acid than ethanol (pK_a = 16).



acetic acid

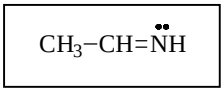
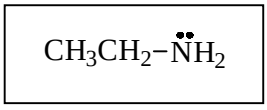


ethanol

Resonance structures may be drawn for the conjugate base of acetic acid. This is a recognition of the fact that the negative charge on the acetate ion is actually spread over two oxygen atoms instead of one as it is in the ethanol conjugate base. Distribution of the charge over a larger area produces a lower energy (more stable) ion which is formed in greater amount which translates into acetic acid being a better proton donor.

B. "The energy content of the real molecule is **always** lower in energy than any of the resonance structures that we might draw to represent it." How can we be so sure that this statement is **always** correct?

Molecules exist in the lowest energy state available to them. If one of the resonance structures were lower in energy, then the molecule would look like that rather than the way it actually looks. Since it in fact looks like a composite of the resonance structures, that arrangement must be lower in energy.

C. Explain why  is a weaker base than  .

The nitrogen in the structure on the left is sp^2 hybridized while the one on the right is sp^3 hybridized. The pair of electrons in the sp^3 hybridized orbital extends out further from the nitrogen and is donated to an acid more readily.