Answers to Hour Examination #1, Chemistry 301/301X - 2004

1a.

b

\[
\begin{align*}
\text{i} & \quad \begin{array}{c}
\text{anti}
\end{array} \\
\text{ii} & \quad \begin{array}{c}
\text{gauche}
\end{array}
\end{align*}
\]

c. A planar hydrazine would require $sp^2$ nitrogens. Their lone pairs would reside in aligned $p$-orbitals, which is energetically destabilizing as electrons are forced into antibonding orbitals.
The $sp^2$ bonds emanating from boron in BF$_3$ contain more $s$ character than do the $sp^3$ bonds in BF$_4$ and thus form correspondingly shorter sigma bonds with fluorine. Furthermore, and most importantly, the empty $p$ orbital on boron in BF$_3$ can accept electron density from neighboring fluorines (overlapping $2p$ orbitals), leading to resonance structures with double bond character in each of the B—F bonds, thus shortening the bond distance between them.

c. Two possible answers:

1. \[ \text{H}_3\text{C} - \begin{array}{c} \text{N} \\ \text{N} \end{array} \text{N} + \]

   The central nitrogen must be $sp$ in this linear molecule

2. \[ \text{H}_3\text{C} - \begin{array}{c} \text{N} \\ \text{N} \end{array} \text{N} = \]

   The central nitrogen must still be $sp$ in this linear molecule - of course - you can't move atoms in resonance.

3. \[ \text{H}_3\text{C} - \begin{array}{c} \text{N} \\ \text{N} \end{array} \text{N} = \]

   The central nitrogen must still be $sp$ in this linear molecule - of course - you can't move atoms in resonance.
3. 

C
chiral
A

B
chiral

C
(Z/E)

C更多于四个成员的环：

this one is so close to a cyclopropane that we should not take off for a miss

4. 

a. These MO’s are H2 bonding and antibonding (Φ1, Φ2) and the three MO’s of cyclic
H₃ (Φ₃, Φ₄, Φ₅):

b. H₅ must have 5 MO’s, as it is constructed from five H 1s orbitals, or five MO’s.

c. Only the lowest of the cyclic H₃ orbitals (Φ₃) can interact with the lower MO of H₂ (Φ₁). This interaction produces two new MO’s (A and B). All other potential interactions involve orthogonal, “net-zero” interactions. Thus, the remaining three orbitals; two from cyclic H₃ (Φ₄ and Φ₅) and the antibonding orbital of H₂ (Φ₂) make up the other three MO’s of H₅ (C, D, E).

d. Assume MO’s with equal numbers of nodes have equal energy.
e. Five electrons go in as shown, obeying Hund’s rule.

![Diagram showing the addition of five electrons to a molecule, with labels A, B, C, D, E.]

5a. 

![Chemical reactions involving the addition of $H_2O^+$ and $H_3O^+$ to a cyclic compound labeled as 1 ($C_7H_{12}$).]
5b. When the concentration of water goes down, it becomes less able to add to the tertiary carbocation intermediate (there simply is less of it). Other Lewis bases begin to compete with water for the cation. Other Lewis bases? What can that be? It is right there in front of you - the pi electrons of the alkene acting as Lewis (Brønsted) base in step one. By the way, you knew that something was bringing two of those starting alkenes together, because the formula goes from $C_7$ to $C_{14}$. So the first step is:

![Image of chemical reaction]

We are now on proton "high" - this cation is deprotonated to give the most stable possible alkene - the tetrastubstituted $3$. We will hear more about this reaction later.