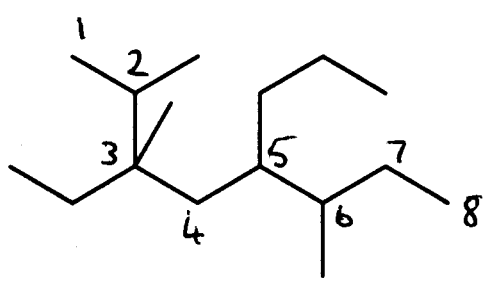
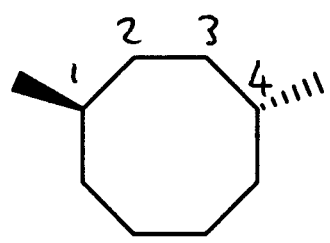
Chemistry 341 Fall 2003
First hour exam M. Walker

YOUR NAME ANSWER KEY

150 points total. Please answer directly onto the exam paper. You may use molecular models.

1. (14 points) Give a systematic name for both of the following compounds, including cis/trans where appropriate:

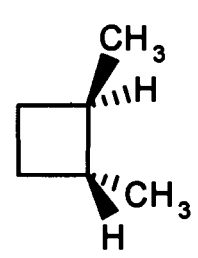
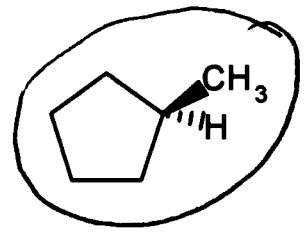




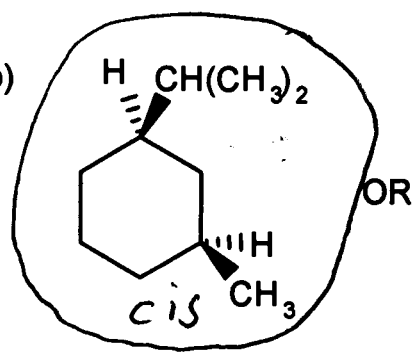
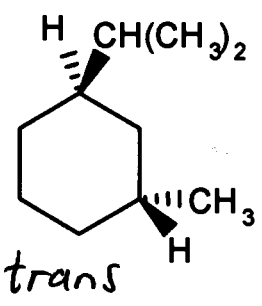
trans-1,4-dimethylcyclooctane

3-ethyl-2,3,6-trimethyl-5-propyloctane

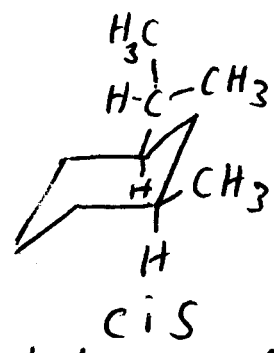
2. (30 points) Which is the more stable structure in each the following pairs?

(a)  OR 

4-memb. ring has a lot of ring strain

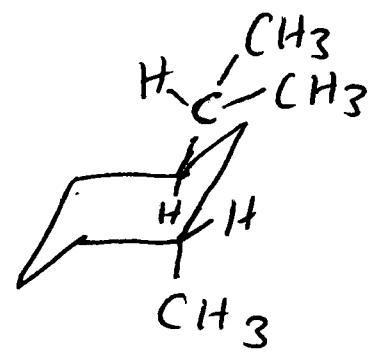
(b)  OR 

cis trans

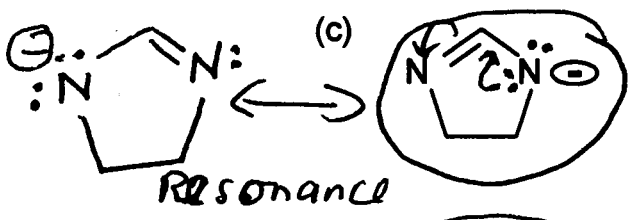
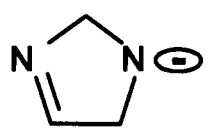


cis

Both big groups equatorial - more stable

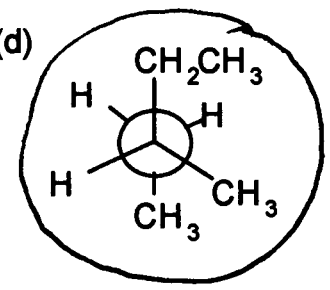
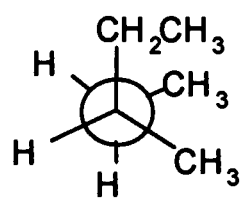


Methyl group axial - less stable

(c)  OR 

Resonance No resonance possible

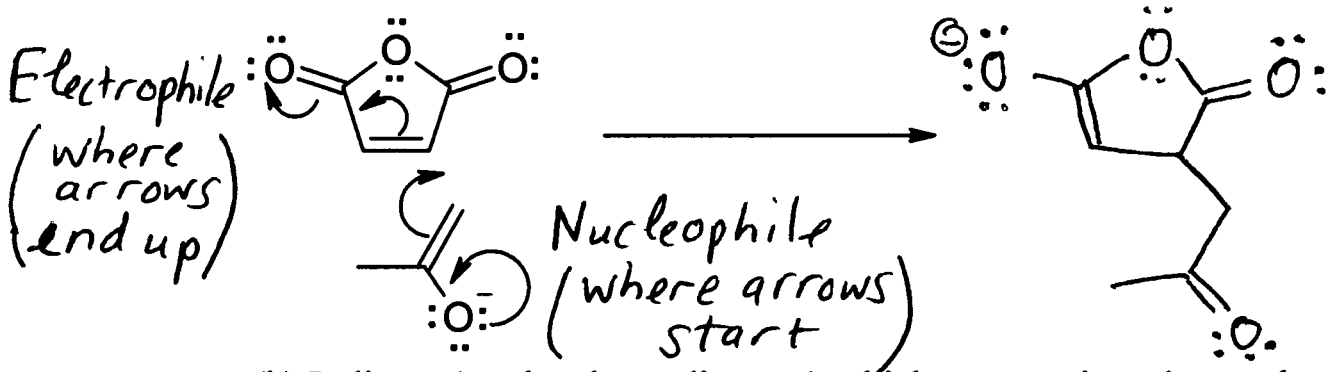
Resonance stabilizes the ion by delocalizing the charge

(d)  OR 

One gauche interaction (Other group is anti)

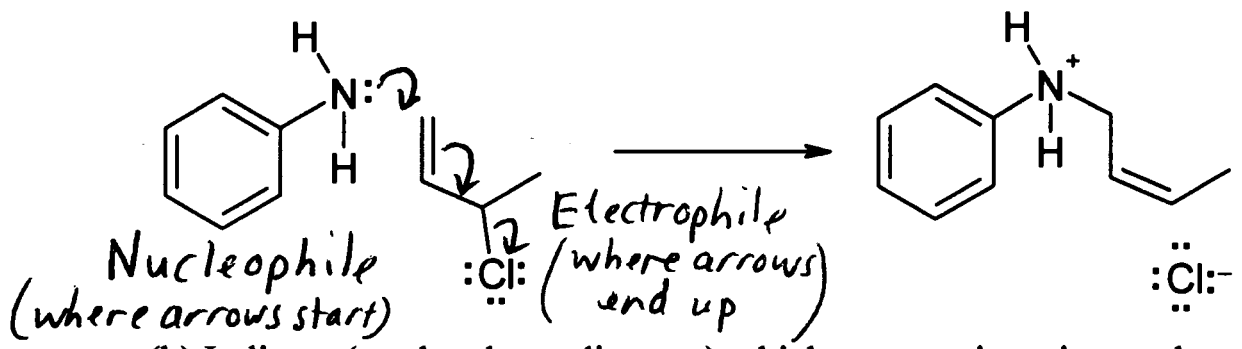
Two gauche interactions

3. (15 points) (a) What is the product of the following reaction?



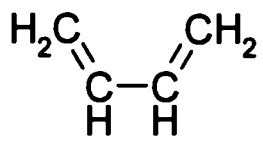
(b) Indicate (on the above diagram) which reactant is acting as the nucleophile, and which is acting as the electrophile.

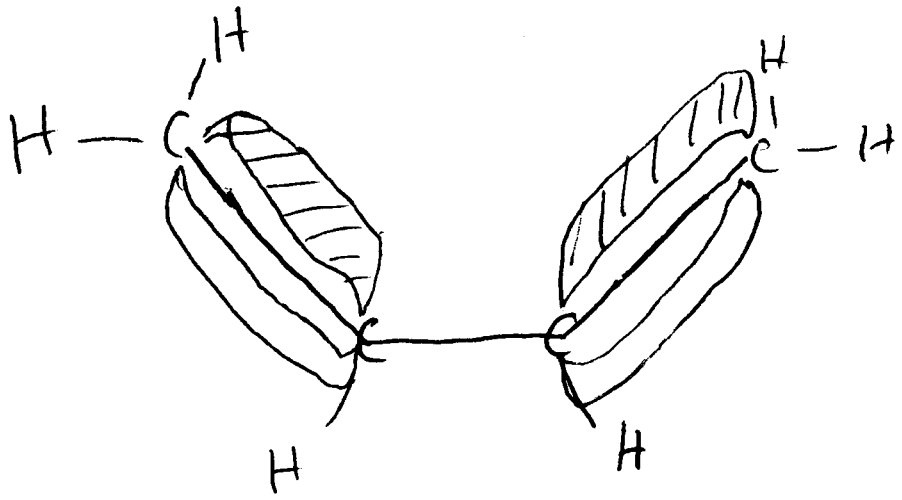
4. (15 points) (a) Use curved arrows to indicate the electron flow in the following reaction:



(b) Indicate (on the above diagram) which reactant is acting as the nucleophile, and which is acting as the electrophile.

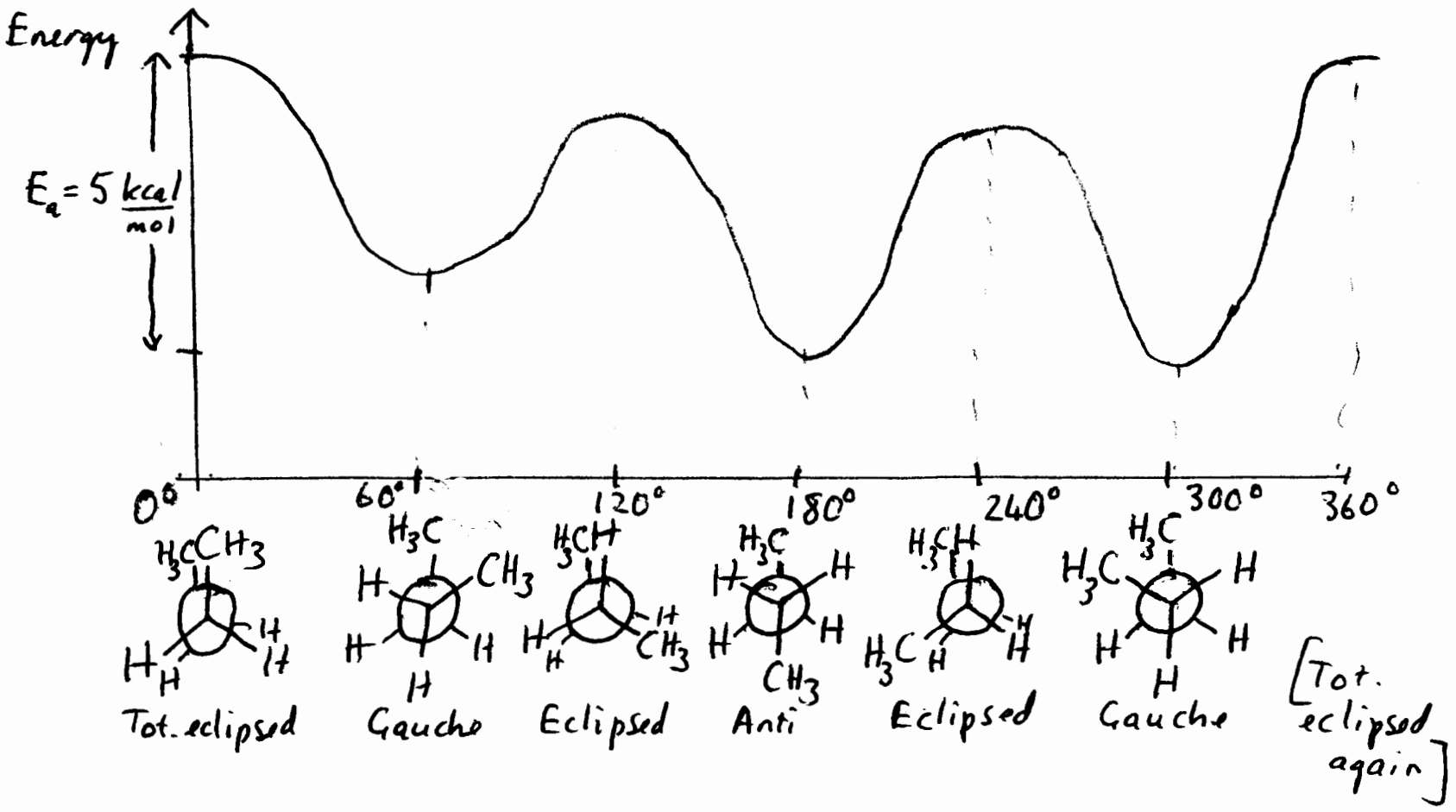
5. (10 points) Draw the pi bonding MOs for 1,3-butadiene (shown below):





[We will in fact learn later that the pi bonding MOs for 1,3-butadiene are more complicated - see p642-4, but for now a simple view is OK]

6. (30 points) (a) Draw an energy curve, and draw the six main conformations of butane Show how these conformations correspond to the maxima and minima.



(a) What MO orbitals are present in the carbon2-carbon3 bond in butane?

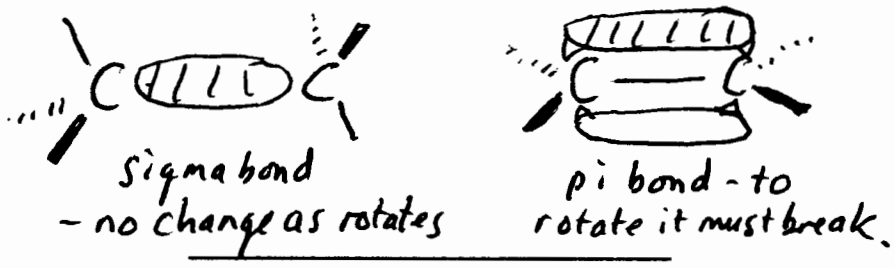
Sigma σ

(b) What MO orbitals are present in the carbon2-carbon3 bond in 2-butene ($CH_3CH=CHCH_3$)?

Sigma and pi (σ and π)

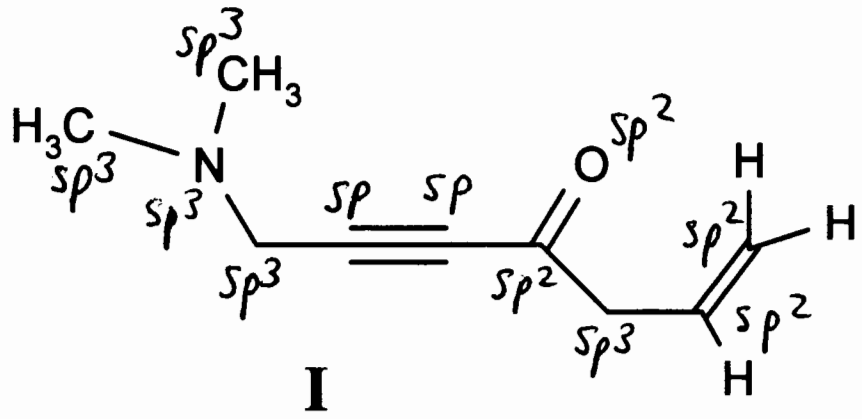
(c) Considering your answers to (b) and (c), explain briefly why there is free rotation* about the C2-C3 single bond in butane but not in the C2-C3 double bond in 2-butene.

A sigma bond is cylindrically symmetrical and thus it can rotate freely. However a pi bond lies outside the interatomic axis, and it has two parts to it. It cannot rotate ~~freely~~ without breaking first. Thus it acts like a "stick in the spokes" of a bicycle, preventing the rotation of a C=C double bond.



* On Earth at 25 °C.

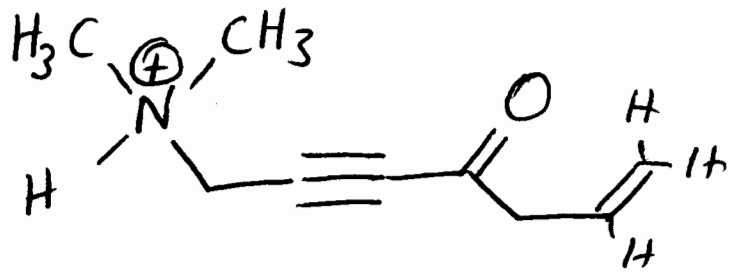
7. (20 points) All parts of this question relate to the structure **I** shown below.



I

(a) Indicate the hybridization of each atom (except hydrogens) in **I**.

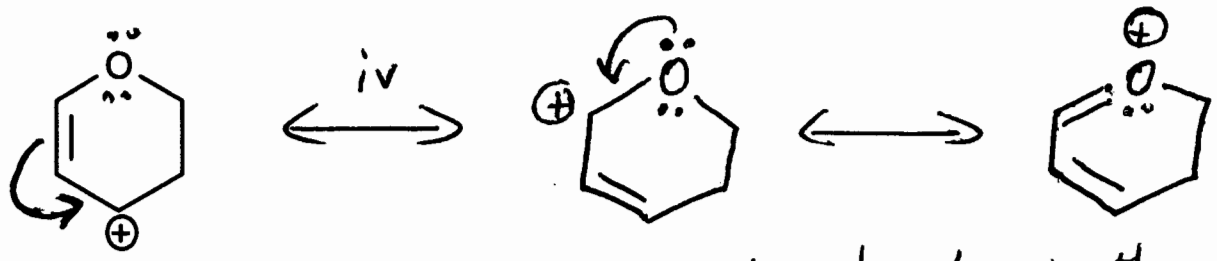
(b) Draw a structure for the conjugate acid of **I**, at the amine position.



(c) List all functional groups present in **I**.

Amine (not on the "required" list for 2004)
Alkyne
Ketone
Alkene

8. (16 points) Draw all major resonance forms for the following compound, and indicate which is the most important contributor.



If your answer put double bonds elsewhere in the ring, check the hydrogens at each position - you probably moved some! [FORBIDDEN]