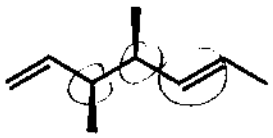
1. How many *stereoisomers* in total are possible for this compound (one of them is shown)? (5 points)

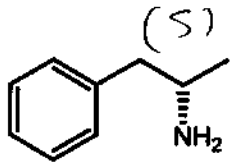


3 stereocenters $2^3 = 8$ isomers

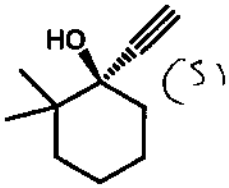
2. Provide a name for the isomer shown for the compound in Question 1. (5 points)

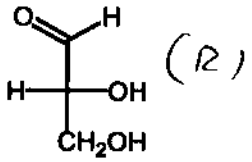
(3S, 4S, 5E)-3,4-dimethylhepta-1,5-diene

3. Assign the *configurations* of each stereocenter in the following compounds using the appropriate notation (15 points)



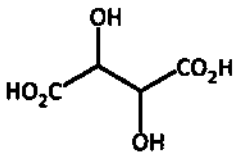
amphetamine

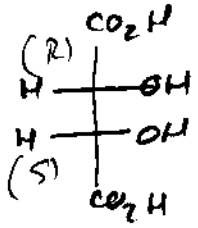




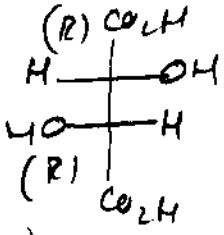
glyceraldehyde

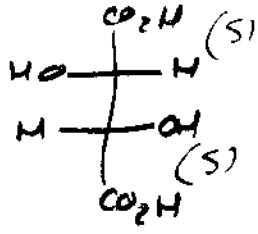
4. Show *all* of the stereoisomers for tartaric acid (shown below). Label each asymmetric carbon with the corresponding *configuration*. Indicate the relationship between each pair of isomers as *enantiomers* or *diastereomers*. If one of the isomers is a *meso* compound, then circle and label it. Use either bond-angle perspective drawings or Fisher projections to show the structures. (20 points)





meso





enantiomers

the meso compound taken w/ either enantiomer constitutes diastereomers

5. Indicate whether the following statements are ~~*absolutely*~~ true or false. (12 points)

a. All *enantiomers* are optically active. T

b. (2*R*,3*R*)-pentane-2,3-diol is the *enantiomer* of (2*S*,3*S*)-pentane-2,3-diol. T

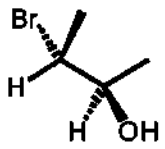
c. If a molecule lacks a sigma plane (s) then it is chiral. F it could have i

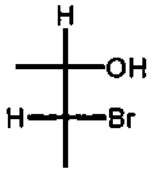
d. All *meso* compounds are optically active. F all are achiral

e. *cis*-1,3-dimethylcycloheptane is chiral. F a meso compound

f. If a molecule with one asymmetric carbon has a positive (+) rotation then the absolute configuration must be (*R*). F no direct correlation between (+) and R or S

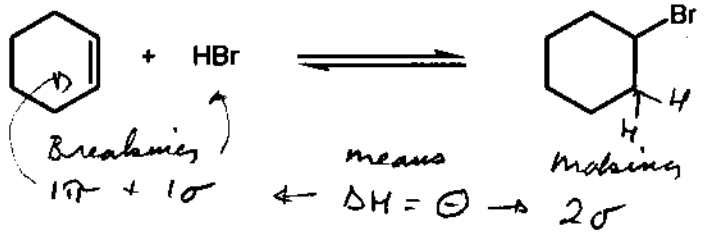
6. What is the relationship between the following two structures? Are they *enantiomers*, *diastereomers*, *constitutional isomers*, or *identical*? (5 points)





identical

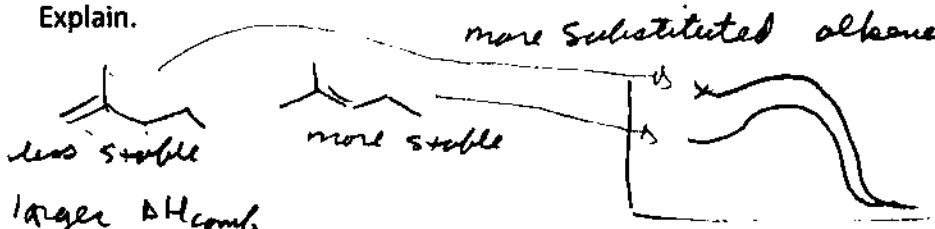
7. How is the following reaction dependent on temperature? Clearly explain using the thermodynamic relationship, $\Delta G = \Delta H - T\Delta S$ (hint: sigma bonds are stronger than pi bonds) (10 points)



2 moles → 1 mole means ΔS = ⊖

So @ Low T ΔH dominates and reaction is spontaneous ΔG = ⊖ at high T -TΔS term which is ⊕ dominates, and reverse is spontaneous

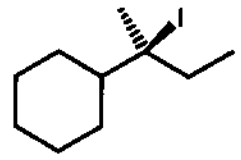
8. Which alkene has the larger heat of combustion (ΔH_{comb}), 2-methyl-1-pentene or 2-methyl-2-pentene? Explain. (10 points)



larger ΔH_{comb}.

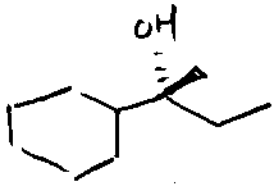
9. For the following substitution reactions show the product (or products). Indicate whether the reaction proceeds by the S_N1 or S_N2 mechanism. (10 points)

a.



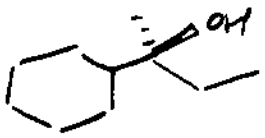
H_2O

S_N1



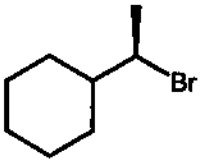
major (inversion)

+



minor (retention)

b.

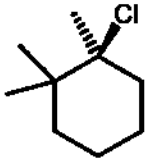


NaCN

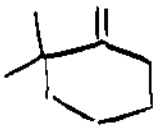
DMSO

10. For the following elimination reactions show the product (or products). Be clear about the stereochemistry of the product (if any). (10 points)

a.

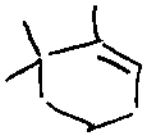


NaOEt



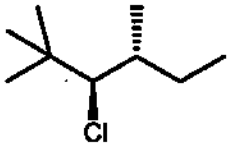
minor (Hoffman)

+

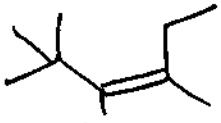


major (Zaitzev)

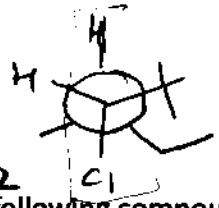
b.



NaOEt



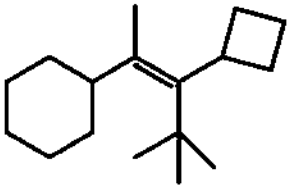
This is the only conformation to undergo E2



leads to...

only product

11. Name the following compound. Assign stereochemistry where appropriate. (5 points)

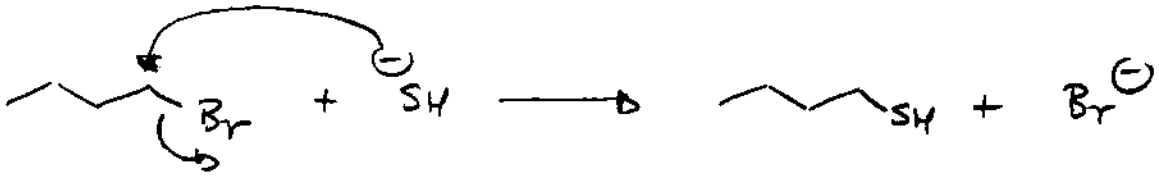


(Z)-3-cyclobutyl-2-cyclohexyl-4,4-dimethyl-pent-2-ene

12. Consider the following S_N2 reaction: (25 points)

a. Draw the mechanism for this reaction.
b. What is the rate equation for this reaction?
c. What would happen to the rate if the solvent is changed from DMSO to ethanol?
d. Draw an energy diagram for this reaction.
e. Draw the transition state for this reaction.

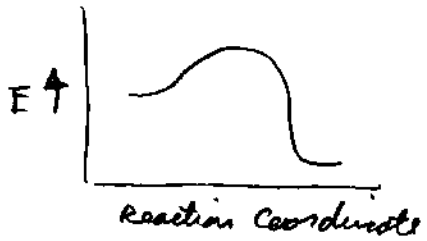
a.



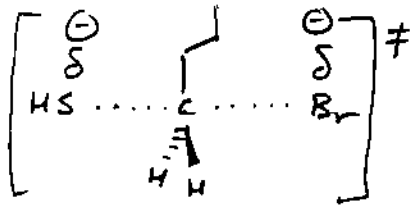
b. Rate = $k[\text{R-Br}][^{\ominus}SH]$

c. In ethanol the nucleophile is more highly solvated by H-bonding - so it reacts slower than in DMSO

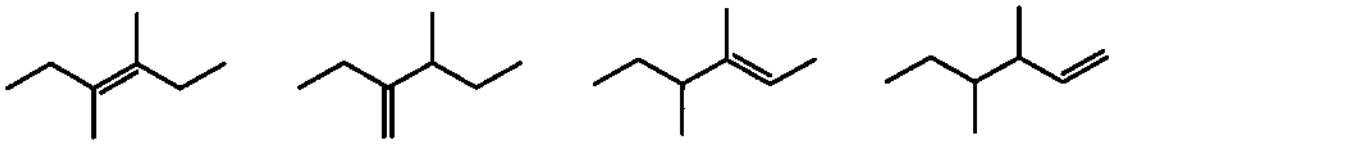
d.



e.



13. Indicate the order of stability for the following series of alkenes. Use 1 for most stable and 4 for least stable. (8 points)



1 tetra substituted
3 di
2 tri
4 least stable mono

14. EXTRA CREDIT Explain why fluoride (F^-) is a better nucleophile in DMSO than in ethanol. (10 EC points)

In ethanol $F^{\ominus}$ is surrounded by solvent molecules due to the H-bonding w/ the polar protic solvent. In DMSO, there is hardly any solvation, so the $F^{\ominus}$ is more accessible to do a Nucleophilic attack