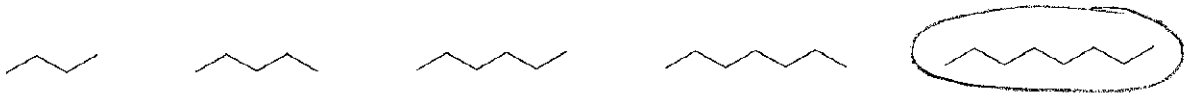
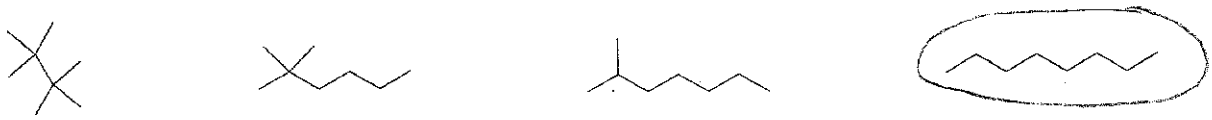
Key - Exam 2 - Summer 09
3311

1) Circle the best answer to each of the following questions. (4 pts each)

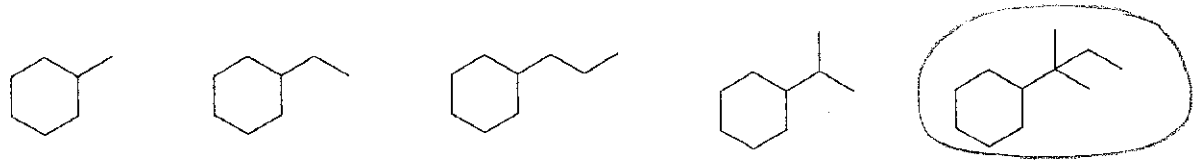
1a) Which of these structures is octane?



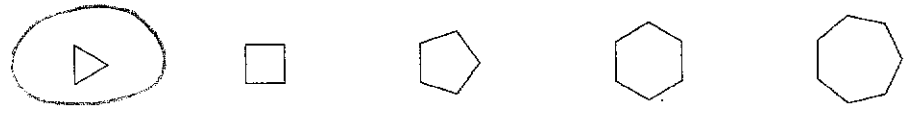
1b) Which of the following $C_8H_{18}$ constitutional isomers has the *largest* heat of combustion, *i.e.*, gives off the most energy in a combustion reaction?



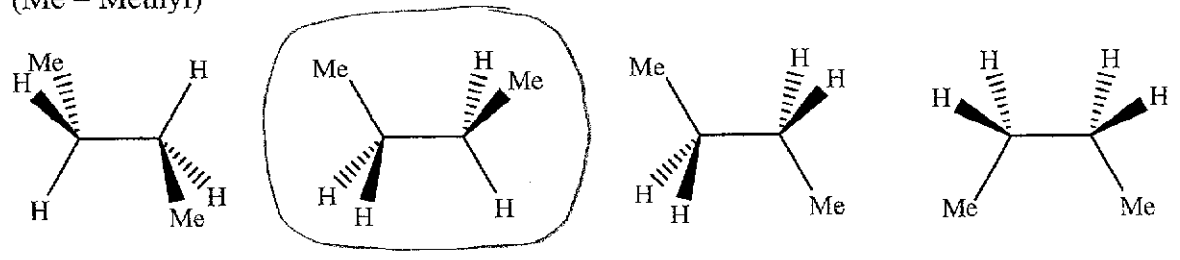
1c) For which of the following do you expect there to be the greatest percentage of molecules in the conformation with the substituent in an equatorial position?



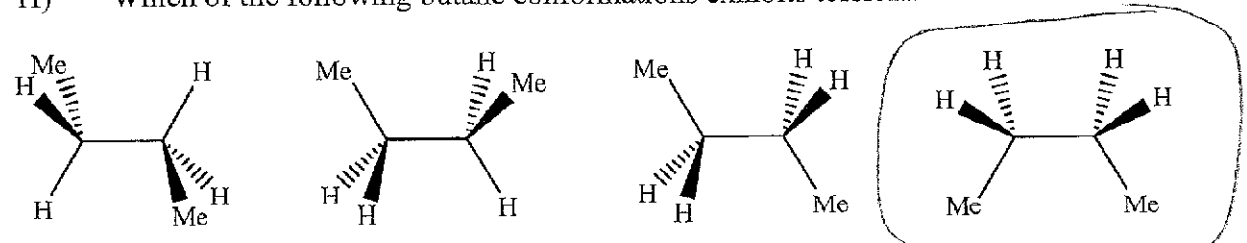
1d) Which of the following cycloalkanes is planar in its most stable conformation?



1e) Which of the following butane molecules is in the gauche conformation?
(Me = Methyl)

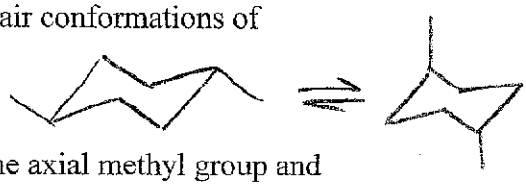



1f) Which of the following butane conformations exhibits torsional strain?



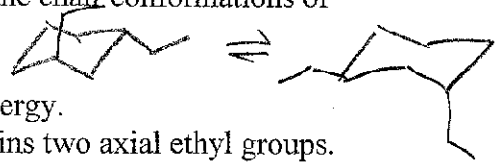
2) For each of the following, select the *best* answer and write the corresponding letter on the line next to the question. (4 pts each)

D Which of the statements below correctly describes the chair conformations of *trans*-1,4-dimethylcyclohexane?



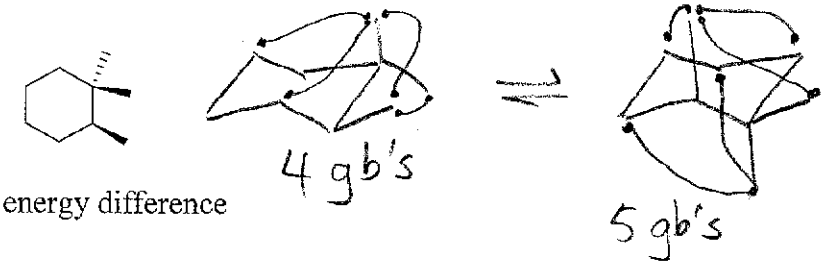
a. The two chair conformations are of equal energy.
b. The higher energy chair conformation contains one axial methyl group and one equatorial methyl group.
c. The lower energy chair conformation contains one axial methyl group and one equatorial methyl group.
(d.) The higher energy chair conformation contains two axial methyl groups.
e. The lower energy chair conformation contains two axial methyl groups.

A Which of the statements below correctly describes the chair conformations of *trans*-1,3-diethylcyclohexane?



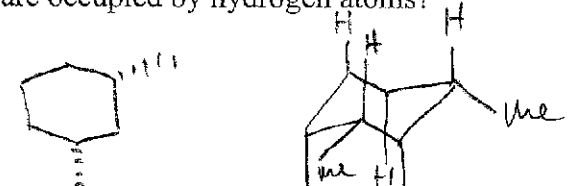
(a.) The two chair conformations are equal in energy.
b. The higher energy chair conformation contains two axial ethyl groups.
c. The higher energy chair conformation contains two equatorial ethyl groups.
d. The lower energy chair conformation contains two axial ethyl groups.
e. The lower energy chair conformation contains two equatorial ethyl groups.

B The energy difference between the two chair conformations of the molecule shown here is approximately:



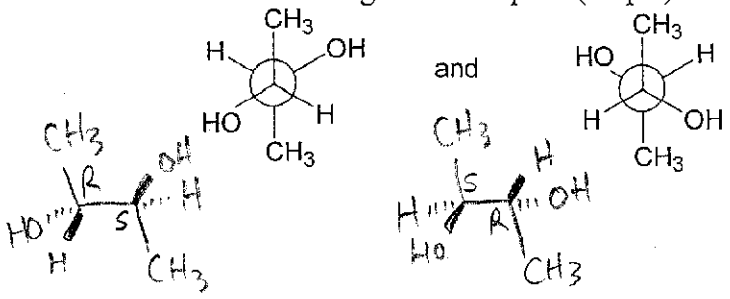

a. 0 kcal/mol – there is no energy difference
(b.) 0.8 kcal/mol
c. 1.6 kcal/mol
d. 2.4 kcal/mol
e. None of these

E In the lowest energy chair conformation of *cis*-1,3-dimethylcyclohexane, how many axial positions are occupied by hydrogen atoms?

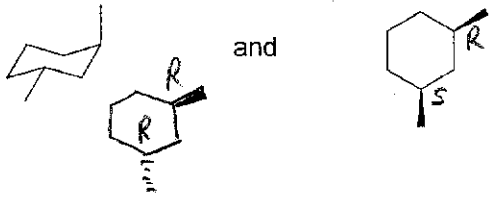



a. 2
b. 3
c. 4
d. 5

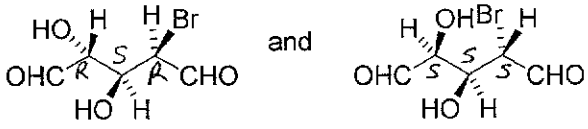
3) Determine the relationship between each of the following pairs of molecules. Choices are: identical, enantiomers, diastereomers, or constitutional isomers. Circle your choice to the right of each pair. (16 pts)




Identical
Enantiomers
Diastereomers
Constitutional isomers



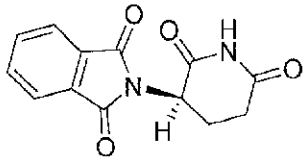

Identical
Enantiomers
Diastereomers
Constitutional isomers




Identical
Enantiomers
Diastereomers
Constitutional isomers

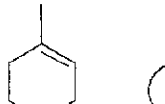

Identical
Enantiomers
Diastereomers
Constitutional isomers

3b) In class we discussed thalidomide. Is this the *R* or *S* enantiomer of thalidomide? (3 pts)



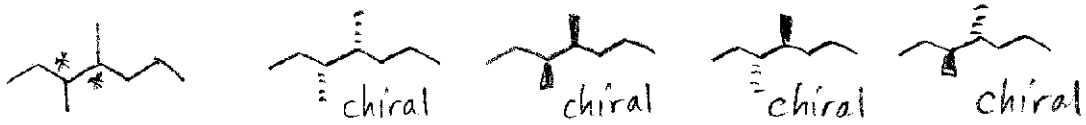

R S

You will isolate limonene, the major component of orange oil, by steam distillation in lab. Is this the *R* or *S* enantiomer of limonene? (3 pts)



R S

4) (23 pts) Consider the molecule **3,4-dimethylheptane.** Draw 3,4-dimethylheptane in bond-line form. Do not show any stereochemistry (*i.e.* no wedges or dashes).




How many asymmetric carbons are there in this molecule (circle the answer)?

**0** **1** **(2)** **3** **4** **5**

How many stereoisomers exist for this molecule (circle the answer)? (drawn above)

**0** **1** **2** **3** **(4)** **5**

How many of these stereoisomers are chiral?

**0** **1** **2** **3** **(4)** **5**

How many of these stereoisomers are achiral and meso?

**(0)** **1** **2** **3** **4** **5**

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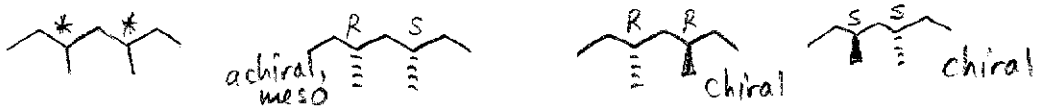
Now consider the molecule **3,5-dimethylheptane.** Draw 3,5-dimethylheptane in bond-line form. Do not show any stereochemistry (*i.e.*, no wedges or dashes).




How many asymmetric carbons are there in this molecule (circle the answer)?

**0** **1** **(2)** **3** **4** **5**

How many stereoisomers exist for this molecule (circle the answer)? (drawn above)

**0** **1** **2** **(3)** **4** **5**

How many of these stereoisomers are chiral?

**0** **1** **(2)** **3** **4** **5**

How many of these stereoisomers are achiral and meso?

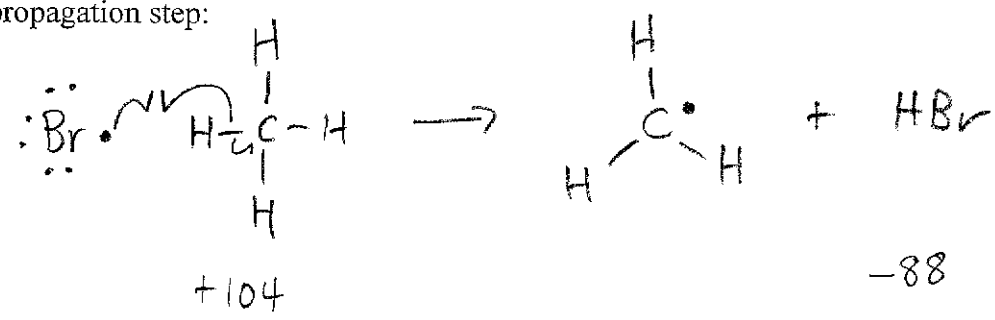
**0** **(1)** **2** **3** **4** **5**

5) (15 pts) Draw a mechanism for the two propagation steps in the bromination of methane. The overall reaction is shown here:

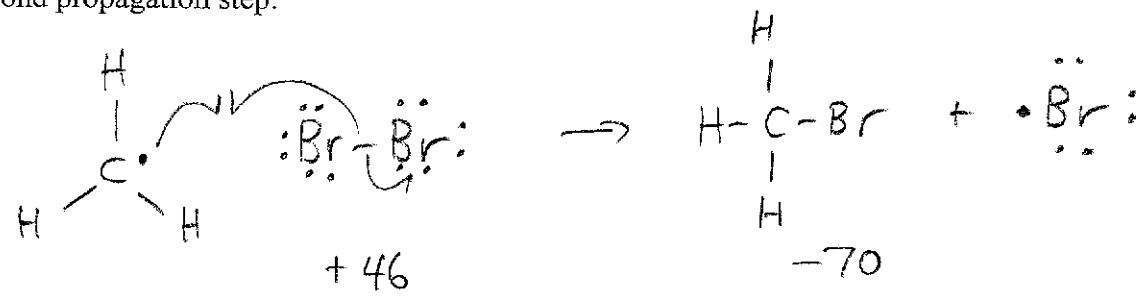
$$CH_4 + Br_2 \rightarrow CH_3Br + HBr$$

For full credit, include all curved arrows, unpaired electrons, lone pairs of electrons, and any non-zero formal charges.

First propagation step:




Second propagation step:




Calculate the overall enthalpy change for the bromination of methane. Bond dissociation energies you will need are shown below. Draw a box around your answer.

C-H in methane: 104 kcal/mol
Br-Br: 46 kcal/mol
H-Br: 88 kcal/mol
C-Br in $CH_3Br$: 70 kcal/mol

$+104 - 88 = +16$

$+46 - 70 = -24$

$\Delta H_{rxn} = -8$ kcal/mol