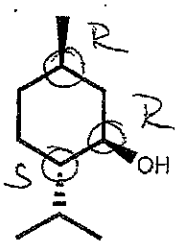
1a) (9 points) The molecule shown below is the terpene menthol in its naturally occurring stereoisomer, which is found in peppermint and mint oils.

CIRCLE each sp3 stereogenic center (chiral center), and assign the configuration (R or S).



1P each circle

2P R/S correct

possible

1b) (3 points) How many stereoisomers of menthol exist? Briefly explain your answer!

$2^n = 8$ $n = 3$

1P 2P

1c) (8 points) Draw two stereoisomers of menthol that

i) result in opposite signs of optical rotation in a polarimeter

correct structure of two enantiomers 2P each

only the word "enantiomers" 1P

- If forget to draw in OH in both i) + ii) = -2 overall
- If missed stereocenter in #1 + carry over into drawing (-2)

2P if just drew enantiomer of menthol + not the other

ii) have different melting points

diastereomers 2P each

only word. diastereomers 1P

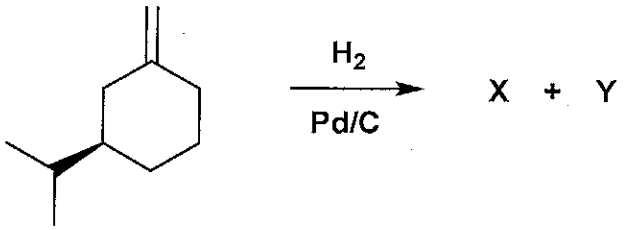
2P if just drew diastereomer of menthol + not other

Name _____

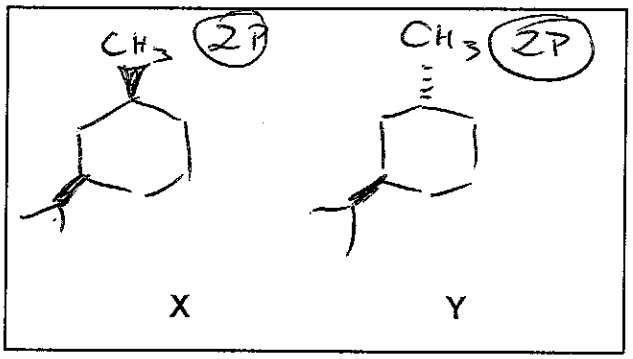
2) (31 points in total, continued on next page)

(1) not OK! no stereochem. -1P

The following reaction gives two reaction products X and Y. Provide the information requested below. Note: the starting material is a <u>single</u> <u>enantiomer</u>.



2a) (4 points) Draw the structure of X and Y in the box.



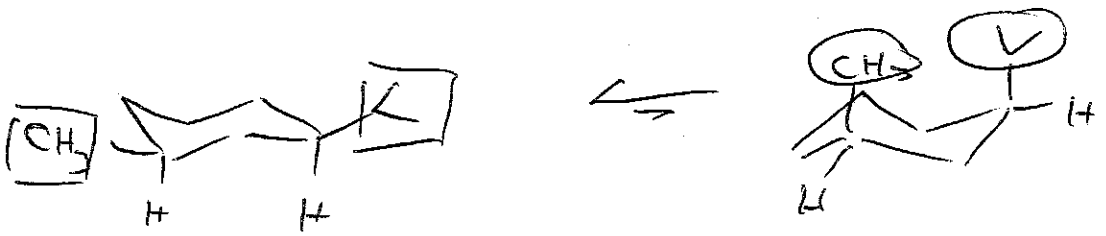
2b) (1 point) What is the stereochemical relationship between X and Y?

Diastereomers 1P

2c) (16 points) Draw <u>all four</u> chair conformations for X and Y below!

Circle all <u>non-H</u> substituents that are in an axial orientation and put a square around all in an equatorial orientation!

3P each correct structure + 1P each correct subst. = 16P



Y

-2P (4 total) if no clear chair flip (ax/eq still correct)
-1P for each subst. drawn wrong/vaguely

Name: _____

2d) (6 points) Draw equilibria between the chair conformations from c) and circle the conformers which you expect to be more stable in those equilibria! Explain:

Explain your choice!

See 2c : 2P for each correct equilibrium ⓐ circle

1,3

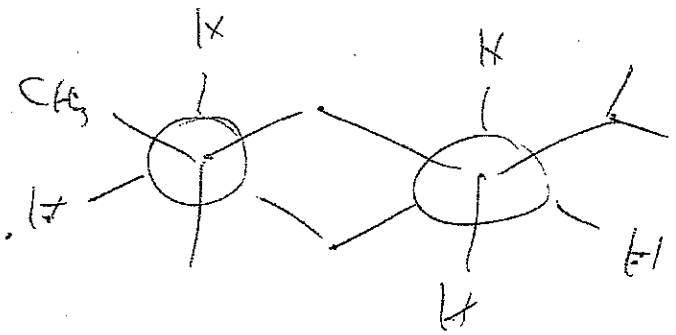
1P : diaxial interaction
1P : < bigger subst. } need to be correct

(0.5 P for mentioning 'eq is more stable')

(e) (4 points) Identify the conformer from all conformations from c) which is the most stable one. Draw a Newman projection for this conformer!

all ~~axial~~ equatorial in X!

2P

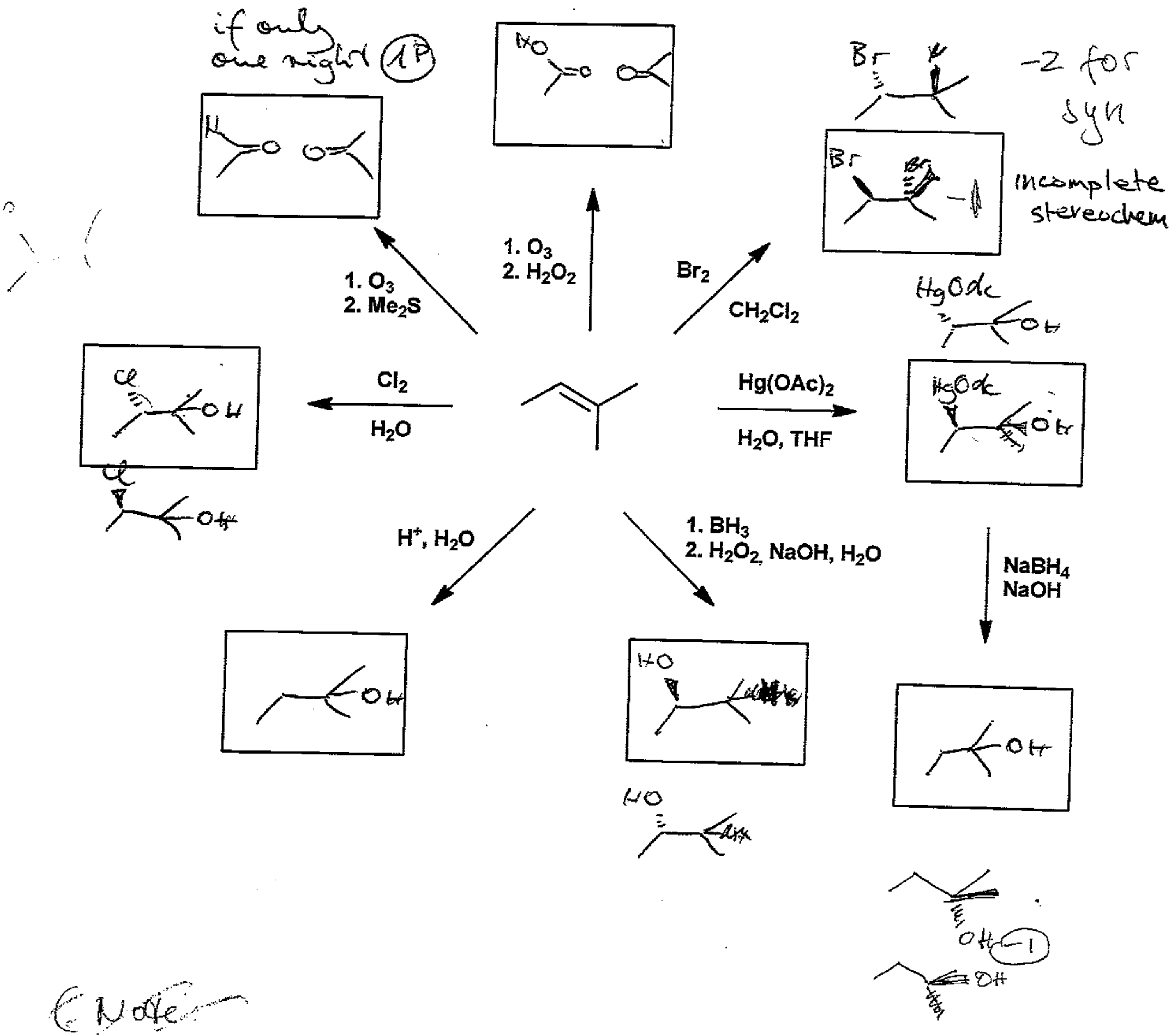


2P

Name ________________

3. (24 points) Draw the reaction products for all the reactions given below in each box. Also draw all stereoismers next to (or in) each box, if they are formed.

3P each box : -1P if only one enantiomer drawn
-2P if no stereo isomer drawn

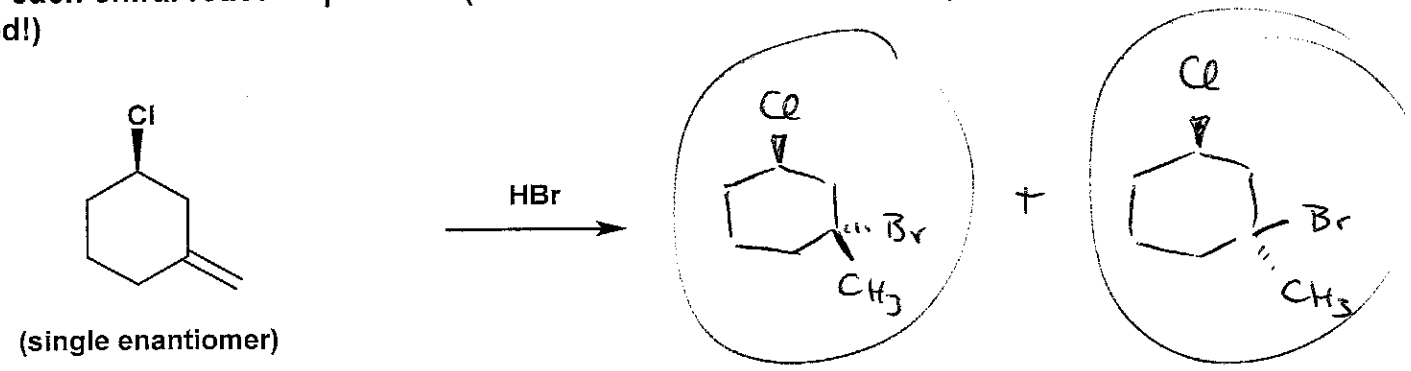


E Note

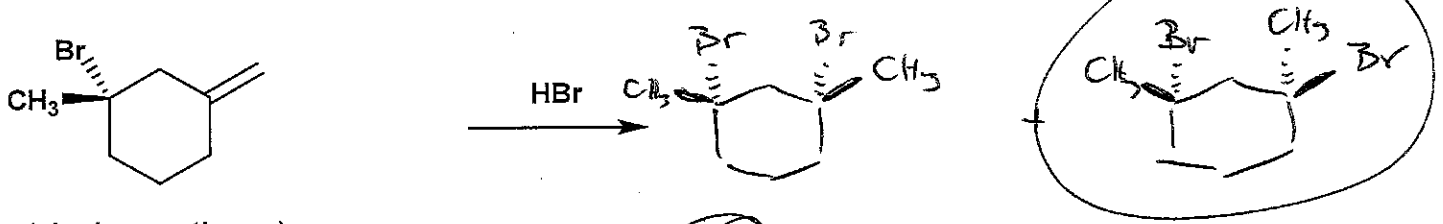
(1P) for correct of regioisomer (no stereochem)

Name _____

4a) (10 points) Draw all of the products of the following reactions of an alkene with HBr! Circle each chiral reaction product! (Note: You can assume that only one regioisomer is formed!)



(single enantiomer)



(single enantiomer)

(2P) each correct structure

(1P) each correct circle

4b) (15 points) Peter Müller, an exchange student from Köln (Germany), says:

"It is very easy to change the regiochemistry of the top reaction in 4a) by the addition of a peroxide"!

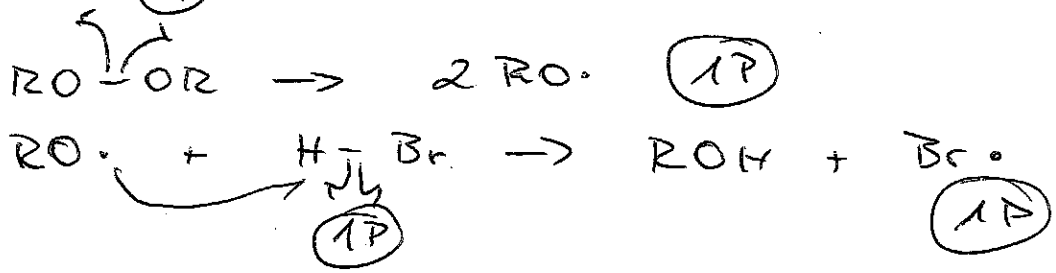
i) **Give a detailed reaction mechanism (using curved arrows) for the initiation and propagation of this reaction (continue on next page if needed). NOTE: You may abbreviate the alkene appropriately!**

Name _____

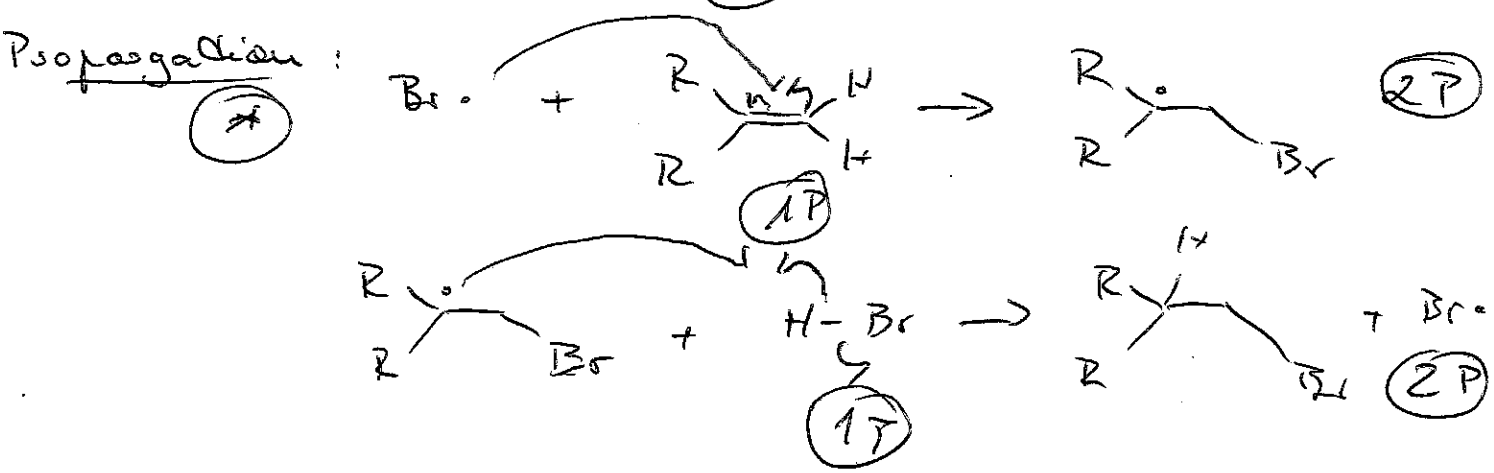
-2P for ⇝ instead ~

4b) (continued)

Initiation:



Propagation:



ii) **Explain the reason for the regioselectivity of this reaction!**

* reaction that determines regioselectivity.

Radical ~ carbocation

~ stabilization by alkyl substituents

2P

Br· reacts at less branched C preferably (steric)

iii) **What pair of terms do we use to describe the regioselectivity for the reactions in part 4a, and the different regioselectivity for the reaction described in 4b?"**

2P

Markownikow /

anti-Markownikow