OCSP 2020 | Lecture #4

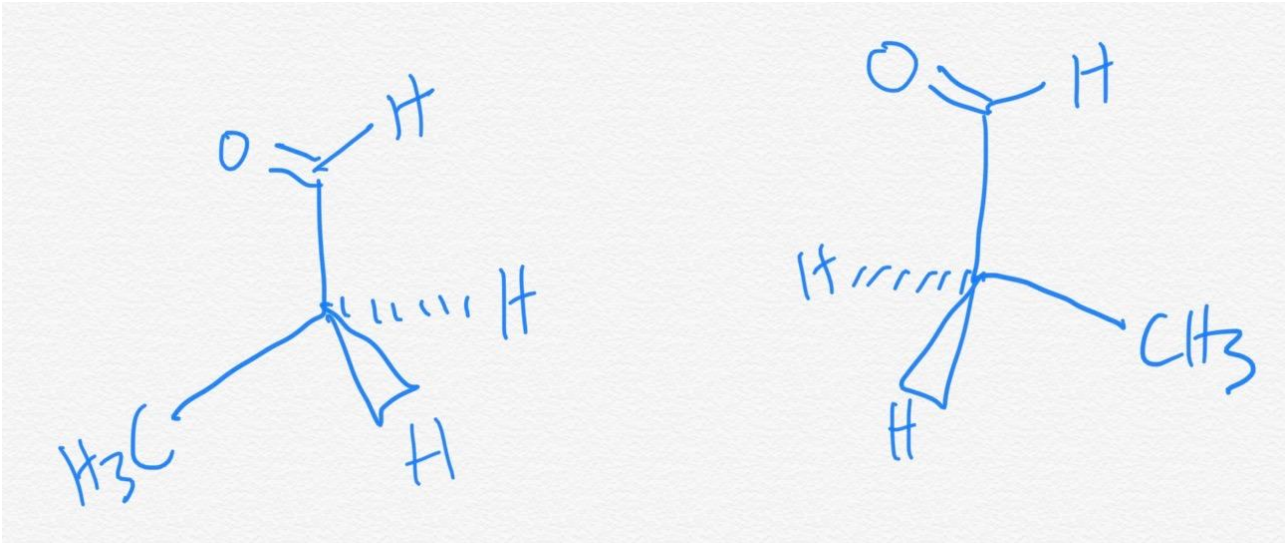
Today’s Agenda

- Intro to stereochemistry
- Chirality
- Stereoisomers: enantiomers, diastereomers, meso compounds

Questions?

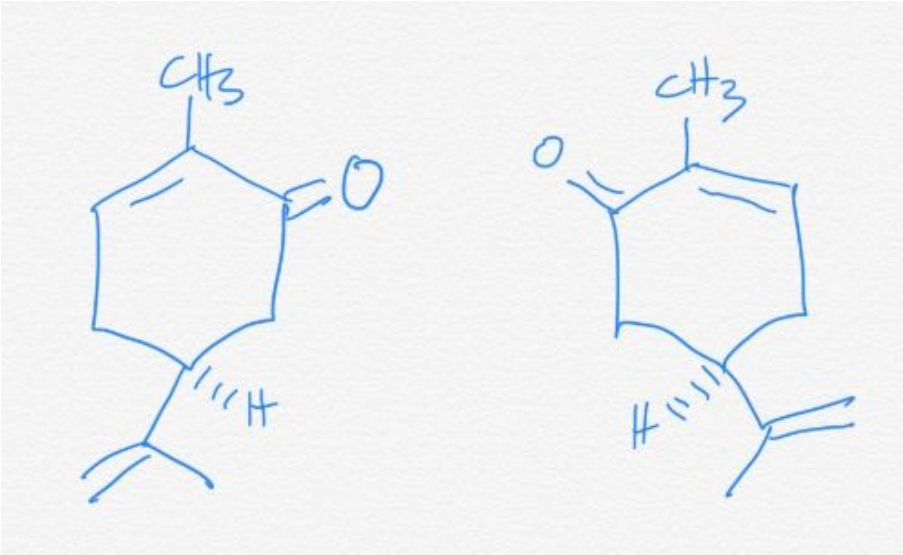
- So that we can finish all the material on time, we request that you ask any longer questions at the end of lecture

Are these molecules the same, or different?



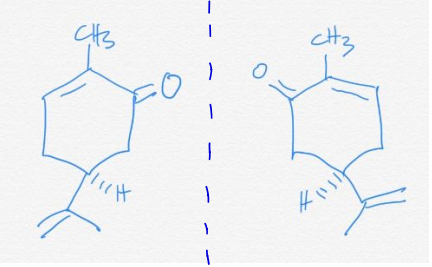
Both have same formula.

Are these molecules the same or different?

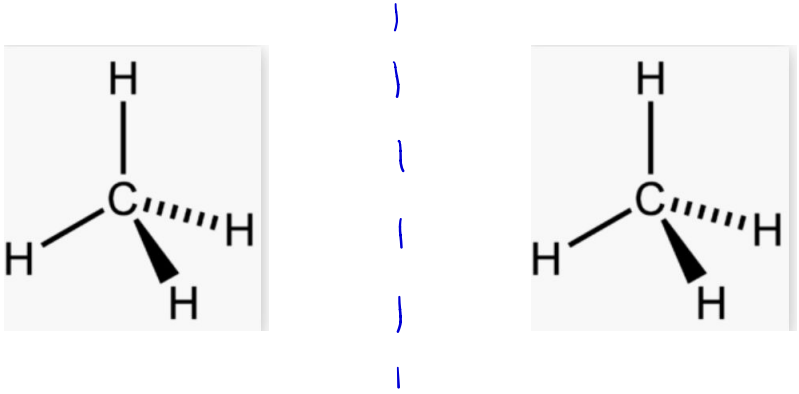


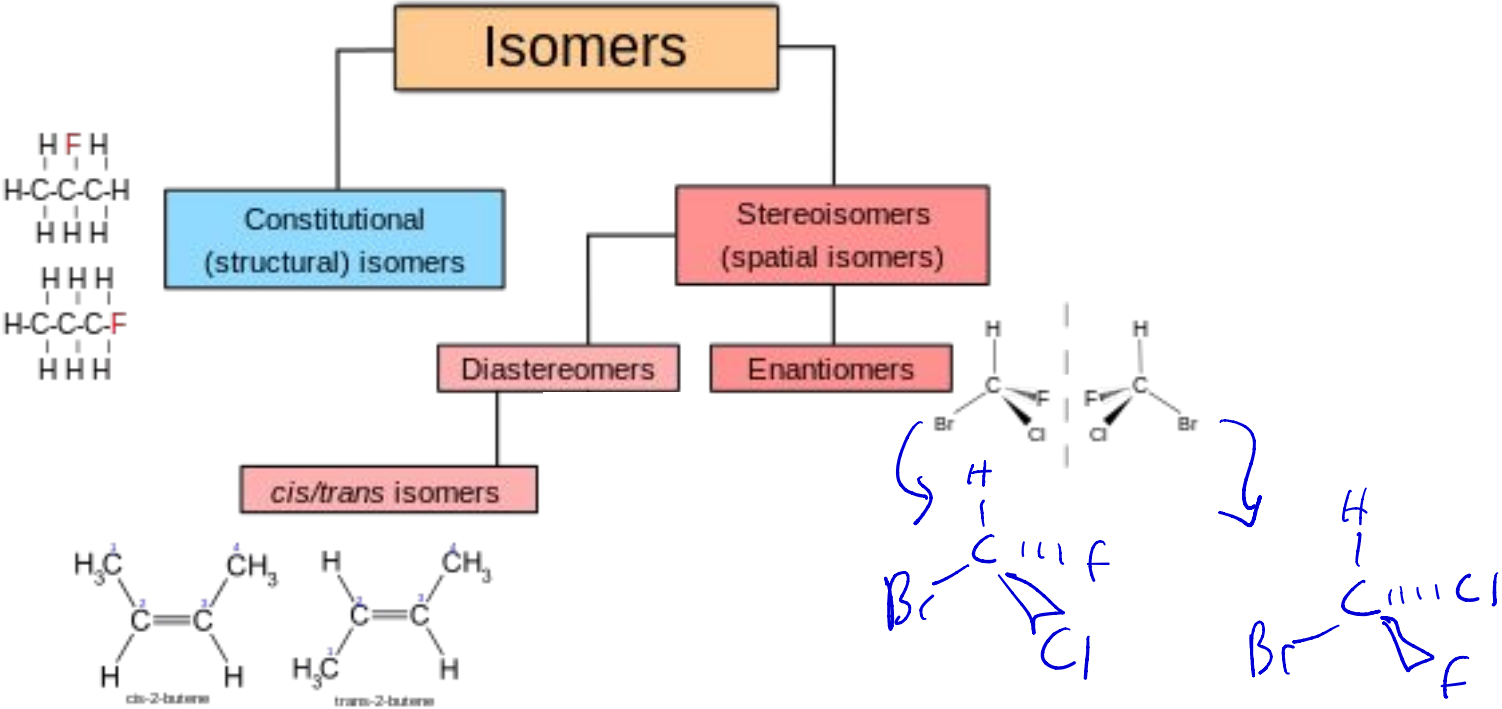
Both have same molecular formula

Different! They are **stereoisomers**.



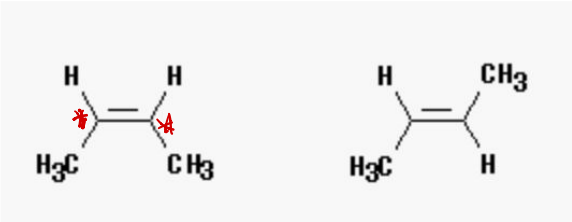
- **Remember: **isomers** are molecules the with same formula, but distinct structures
- **Structural/Constitutional isomers:** molecules with same formula, different connectivity
- **Stereoisomer:** molecules which differ only in the spatial arrangement of their atoms
  - **Chiral:** molecules which can be differentiated from their mirror image
  - **Achiral:** molecules which can be superimposed on their mirror image

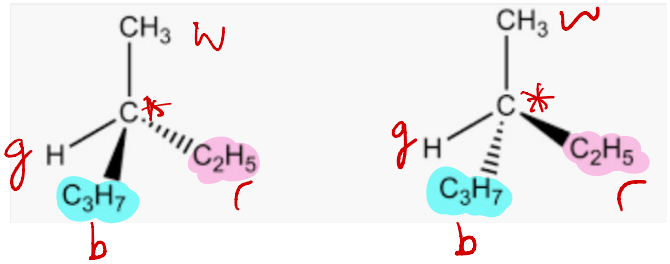


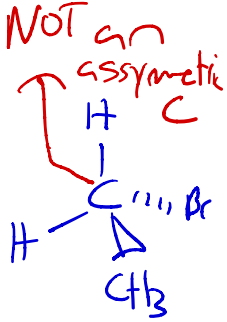

Isomers
Constitutional (structural) isomers
Stereoisomers (spatial isomers)
Diastereomers
Enantiomers
cis/trans isomers
cis-2-butene
trans-2-butene

Important Definitions

- **Stereocenter:** an atom where changing 2 attached groups changes the configuration--*most often* C or S, N
  - Can be in an alkene (C=C) or an alkane (C-C)





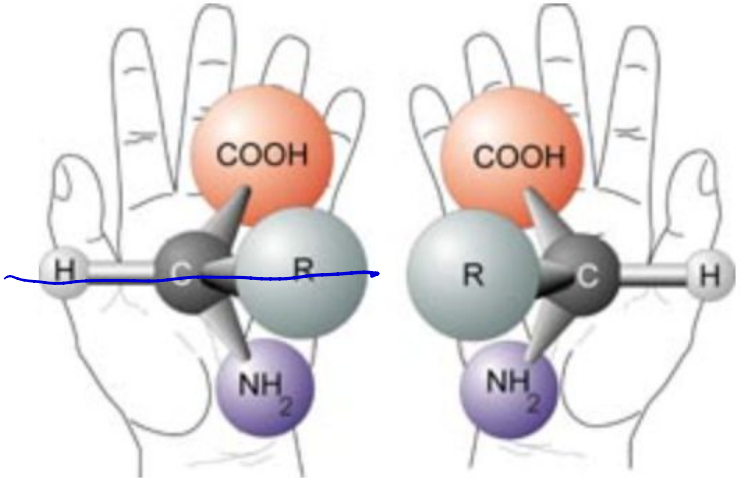


chiral C, assymetric C or assymtric Center

- **Chiral center:** an atom, frequently a C, surrounded by 4 different groups
  - Neither necessary nor sufficient for chirality in a molecule

Types of Stereoisomers

- **Enantiomers:** stereoisomers which are non-superimposable mirror images
  ↳ chiral



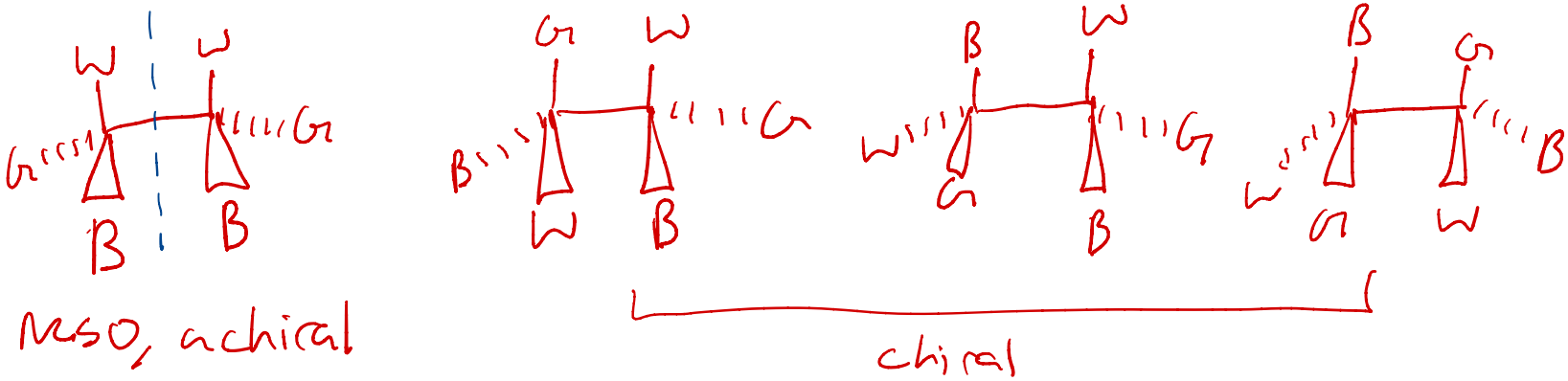
A pair of enantiomers and a pair of hands

Types of Stereoisomers (cont.)

- **Diastereomers:** stereoisomers with at least 2 stereocenters which are **non**-superimposable, **non**-mirror images → chiral
- **Meso compounds:** an achiral stereoisomer which contains at least 2 stereocenters AND has a plane of symmetry; *if compounds are meso, they CANNOT be enantiomers!*
- Determining number of stereoisomers: $2^{(\#\text{ of stereocenters})}$

$2^2 = 4$ stereoisomers

Example of 4 stereoisomers:



Optical Activity → measured by polarimeter

- Chiral molecules rotate plane polarized light -- **“optically active”**
  - Enantiomers rotate PPL in opposite directions (same magnitude)
  - One enantiomer (**dextrorotatory** enantiomer) rotates it clockwise (+)
  - The other enantiomer (**levorotatory** enantiomer) rotates it counterclockwise (-)
- Achiral molecules do not rotate PPL -- “optically **in**active”
- Observed rotation of PPL depends on many factors, including polarimeter cell length and specific rotation
  - Will be covered during 3570!

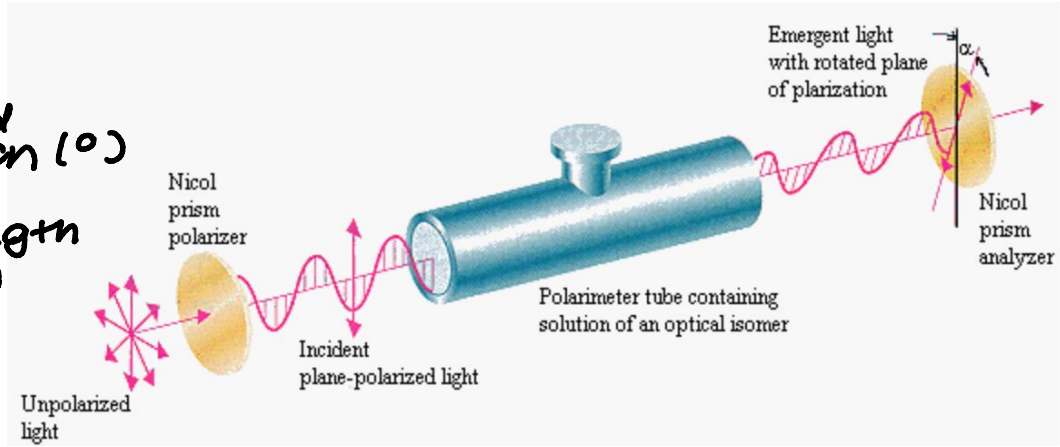
$$[\alpha]_{\lambda}^{T} = \frac{\alpha_{obs}}{c \times l}$$

observed rotation (°)

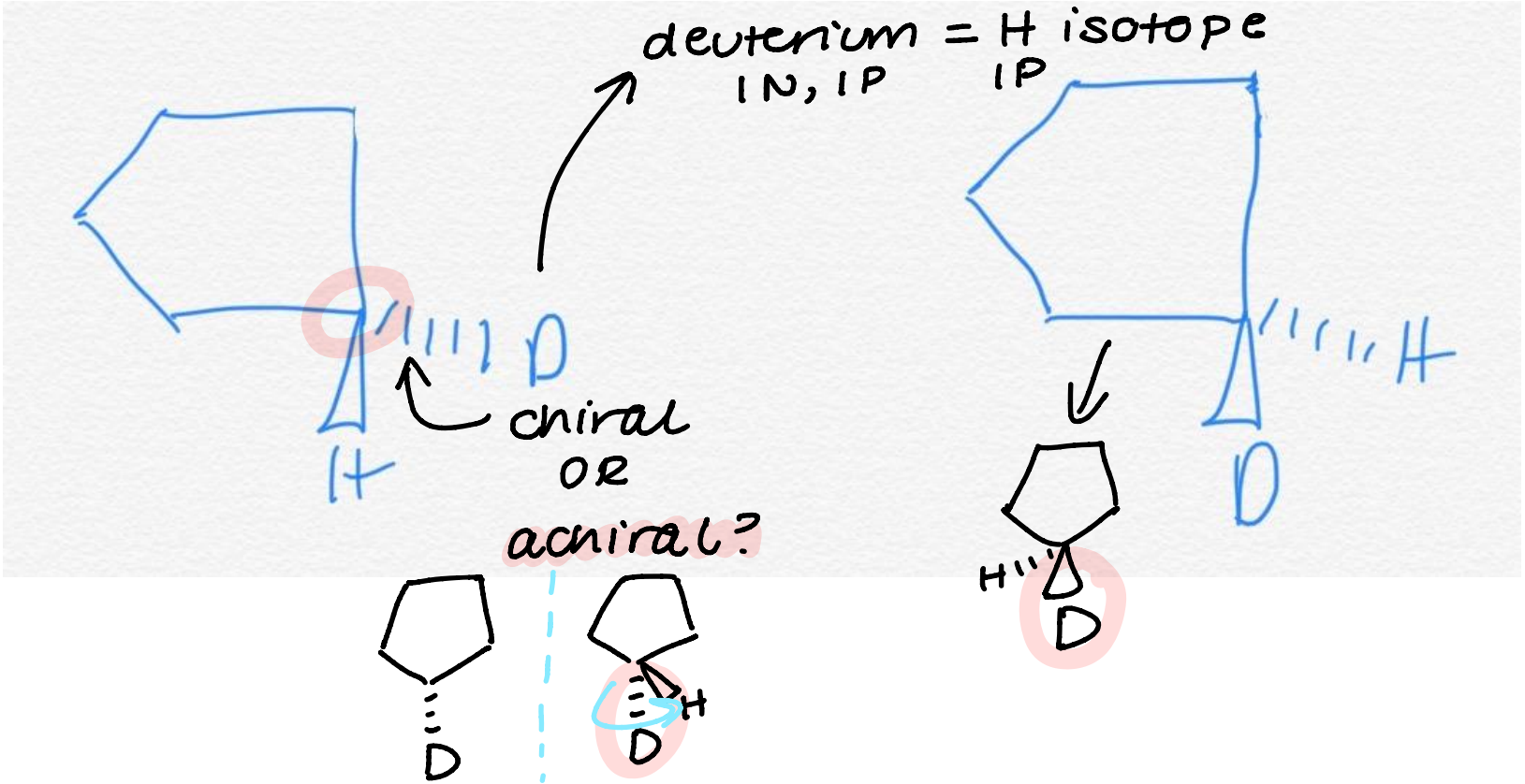
conc

cell/length path

specific rotation (°)



Practice | Are these molecules the same?

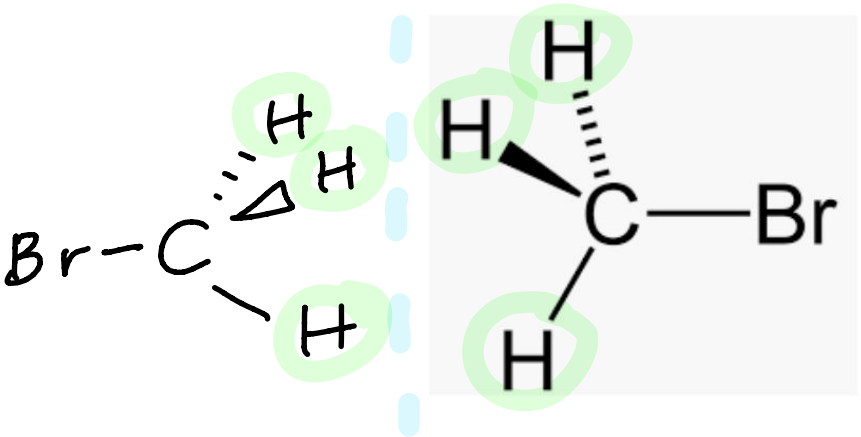


Practice | Is this molecule chiral?

mirror images that are different

- Remember, chiral molecules *usually* have a stereocenter

change 2 of attached groups, different conformation



are they different? → NO!

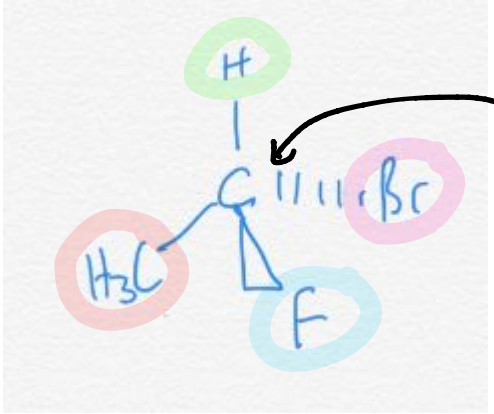
achiral

Practice | Does this molecule rotate PPL?

plane polarized light

↓

chiral!



stereocenter? yes!

↓

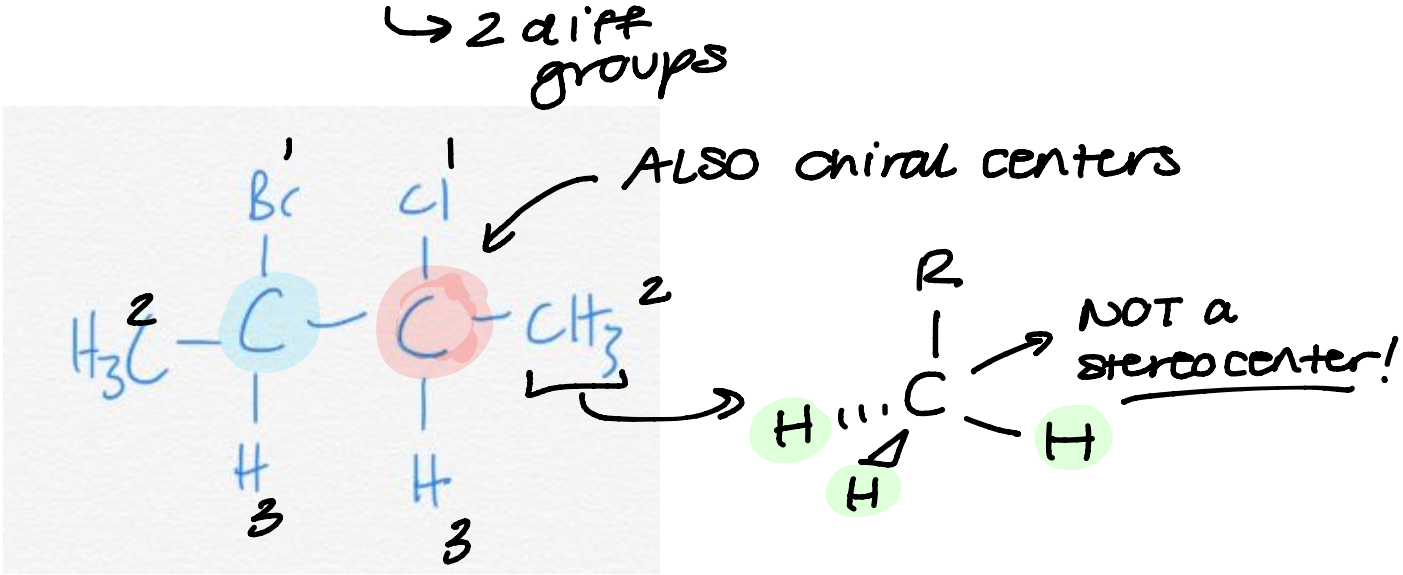
4 different groups

↑

chiral center? yes!

* all chiral centers are stereocenters, ↗ 2
but not all stereocenters are chiral centers
↓
4

Practice | How many stereocenters are in this molecule?

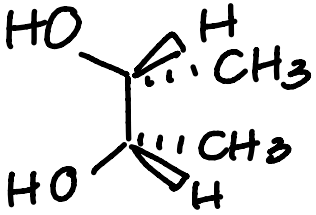


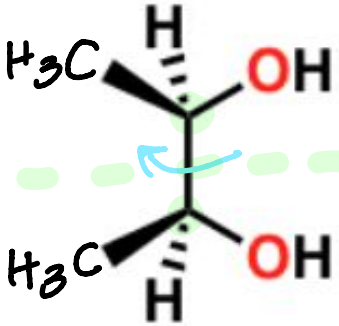
non-superimposable mirror images

CHALLENGE | Are the molecules the same, enantiomers, diastereomers, or meso?

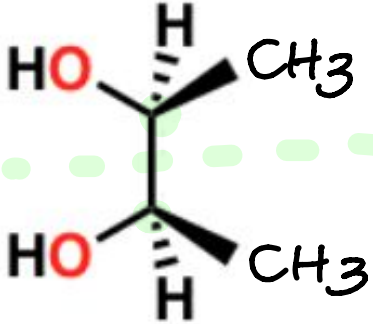
non-superimposable NON-MIRROR images

↳ ≥ 2 stereocenters; symmetrical





* Meso compounds



Advice for stereochem

- Make flashcards (via quizlet) to help memorize definitions
- Write the terms out - focus on how the definitions are *related*
- Do practice problems!

MEME TIME BABEYYY