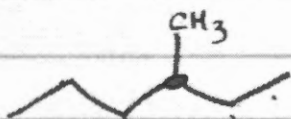


Stereoisomerism

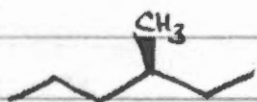
- This is an important 3-dimensional evaluation of organic molecules. The way groups are uniquely ordered spatially can have profoundly different biological effects.

We learned how to name the following alkane



3-methylhexane

but the carbon with the dot on it can have 2 different spatial orientations.



the CH₃ group is coming toward you

OR



the CH₃ group is pointing away from you

These are different molecules!

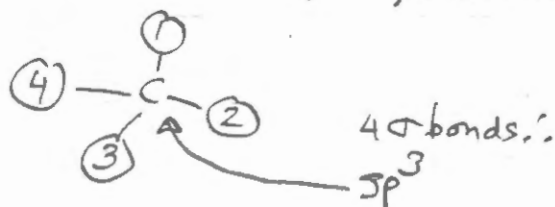
Stereoisomers

→ Same molecular formula

→ you name the isomers the same, but they differ in their 3D spatial arrangement

For organic chemistry we focus on the stereoisomerism created by the carbon atom. Other atoms can create stereoisomerism, but for now, we will focus on [C]arbon

Chiral Carbon Center: carbon attached to 4 different substituents/groups
 $\therefore$ the carbon must be sp^3 hybridized.



Let's go back to 3-methylhexane



$\therefore$ this carbon is a chiral center

• Carbon is attached to

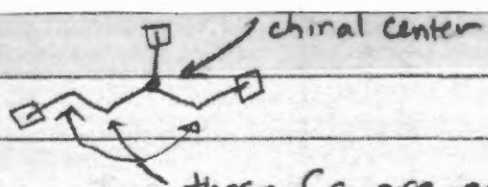
① methyl

② propyl

③ ethyl

④ H

not drawn explicitly



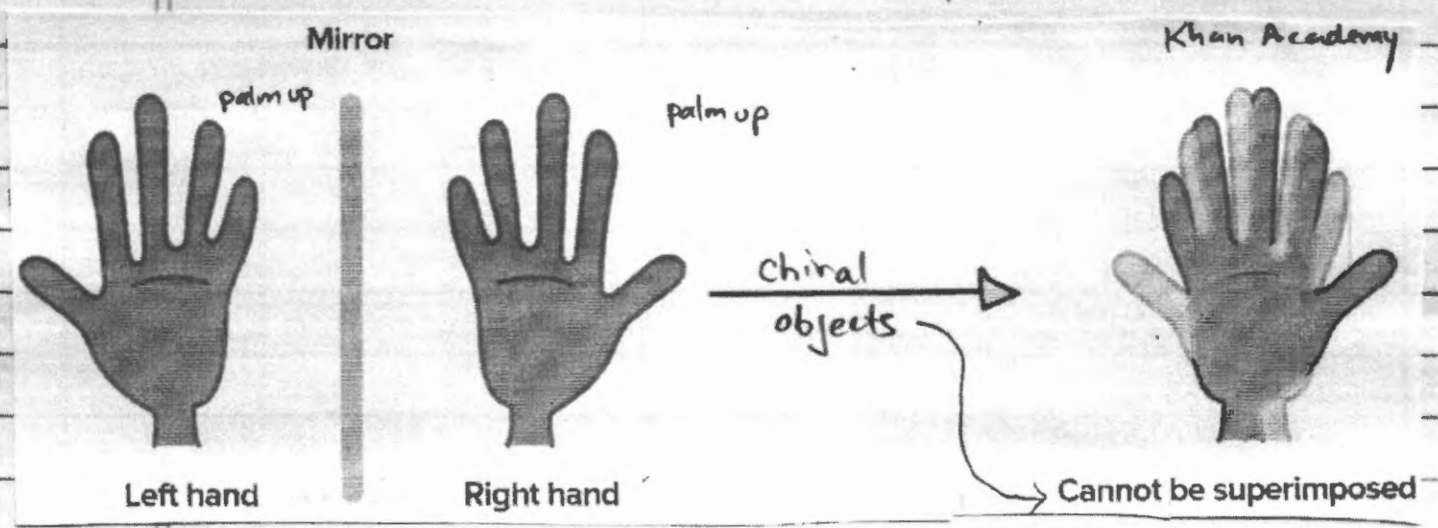
these Cs are each bonded to 2H
 $\therefore$ they are NOT chiral centers

Cs in a box (above) are each bonded to 3H
 $\therefore$ they are NOT chiral centers

What is special about a molecule that has 1 chiral center? Well, the molecule will be chiral!

chiral (derived from Greek = *chiro* $\Rightarrow$ "handed")

Our hands are chiral: that is, they are not superimposable



$\therefore$ each hand is chiral

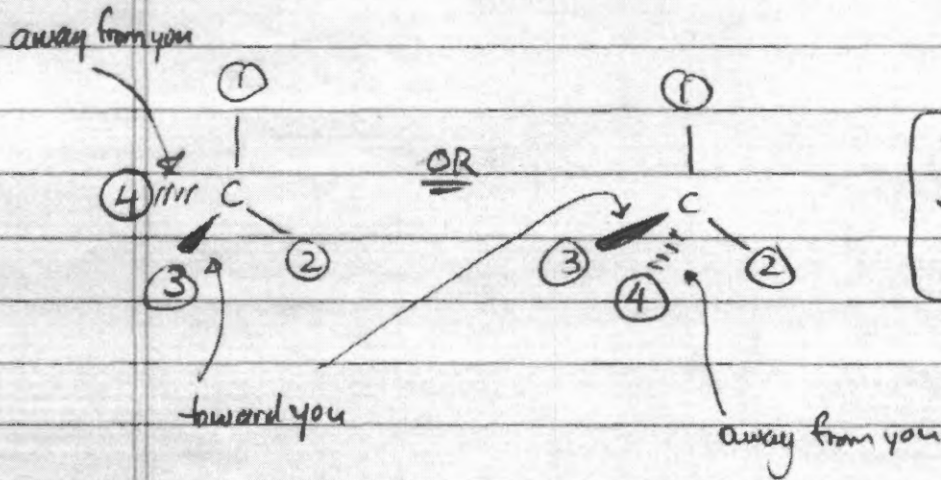
$\rightarrow$ i.e. each hand is not superimposable on its mirror image

To recap

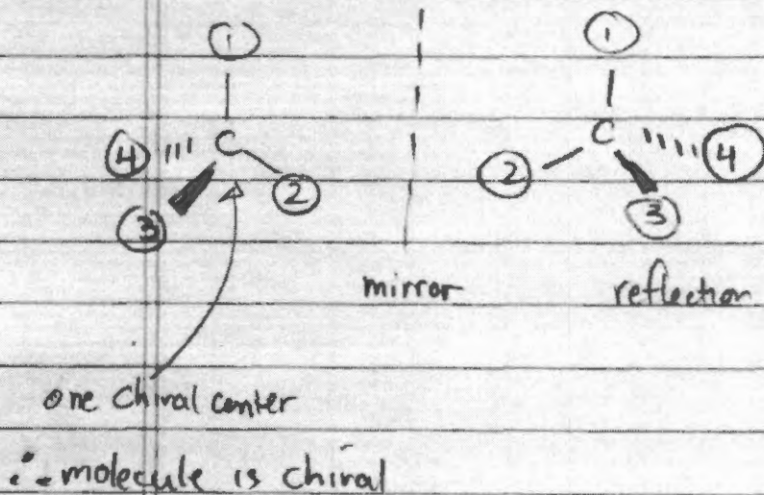
chiral center = C

= sp^3

= attached to 4 unique (different) substituents (groups)



These are identical, only thing that has changed in angle of view.



Like the "hands" on the chiral molecule on the left is NOT superimposable on its mirror image on the right.

Enantiomer: is a stereoisomer that is non-superimposable on its mirror image. ∴ an enantiomer is a chiral molecule

To assign **[R]** and **[S]** stereochemistry we will use the spirit of the Olympic Games

1st place: commercial endorsements, talk shows etc.

2nd place: city greeting, local newspaper write-up

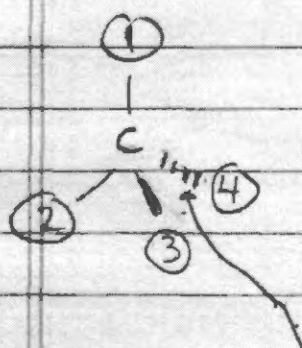
3rd place: party in the driveway of their neighborhood

4th place: ignored no fanfare, back to work as professor

①, ②, ③ are important ④ is ignored

Cahn -
Ingold
-Prelog

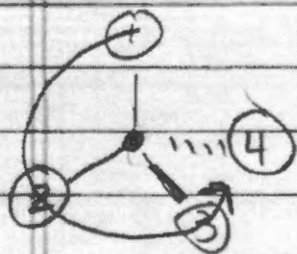
R, S ①, ②, ③, ④ rankings are determined by the atom directly attached to the chiral carbon



	# of Protons (Atomic #)		Ranking
Br	Br	35	①
	Cl	17	②
	C	6	③
	H	1	④

④ is on dotted line and

in back, so in this structure, it is already ignored. So focus on ①, ②, ③

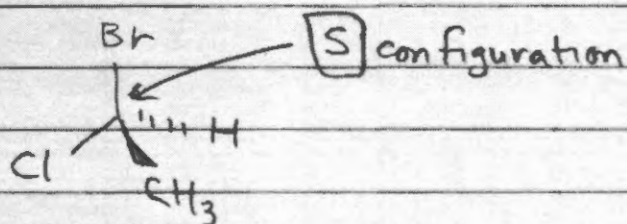


- ① connect ① ② ③ with one line and IGNORE ④
- ② place arrowhead at end of your line
- ③ Redraw line in blank area of page

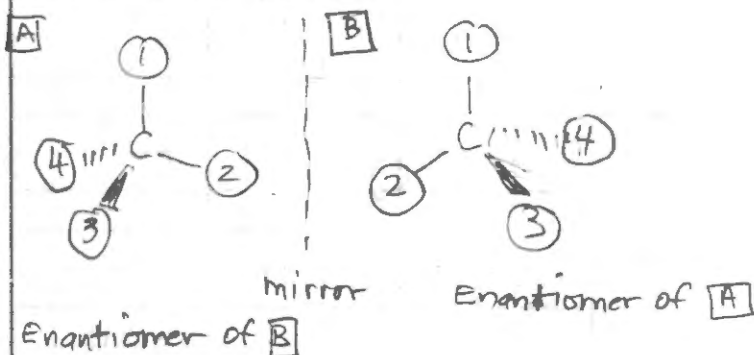
↻ turn steering wheel in that direction
turns you to the LEFT

Sinister

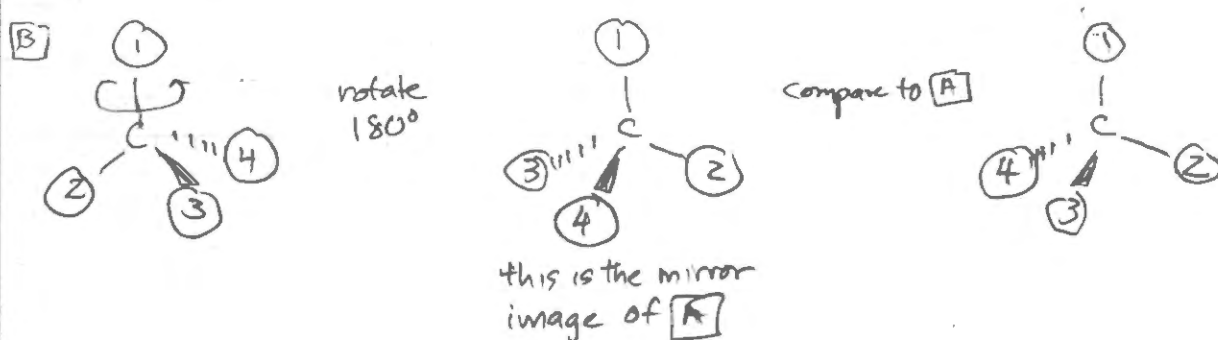
∴ the chiral center of this molecule has 'S' stereochemistry



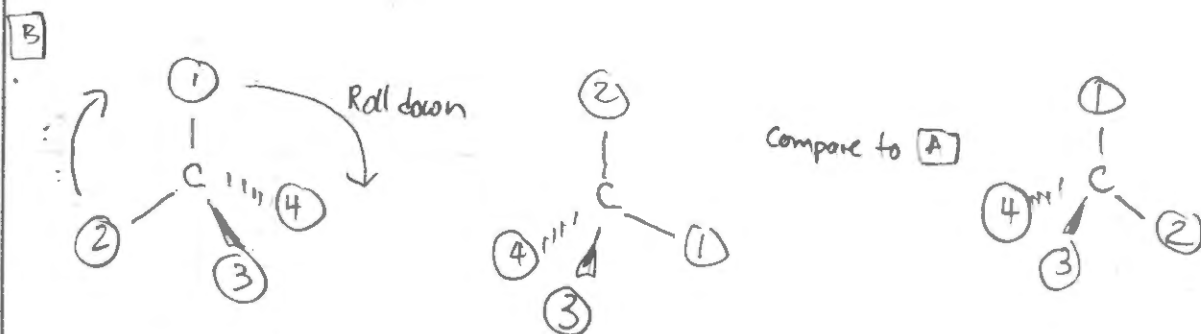
Let's look back at



Let's evaluate the equivalent of **B** where as many number align with **A**



Note, that **B**, the mirror image of **A** can superimpose ① and ② but not ③ and ④. The mirror image has ③ and ④ exchanged.

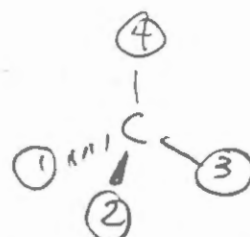
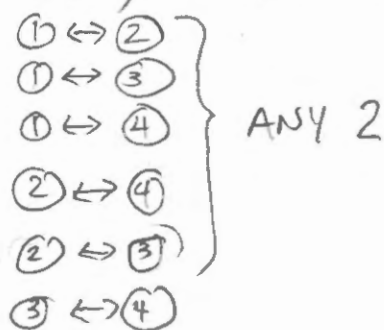
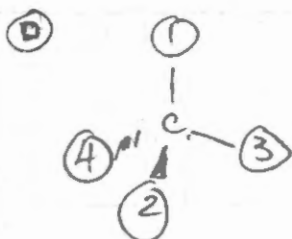


Note, **B** is now rotated to show that ③ and ④ superimpose with those in **A** (the mirror image of **B**). However, ① and ② are exchanged.

Summary.

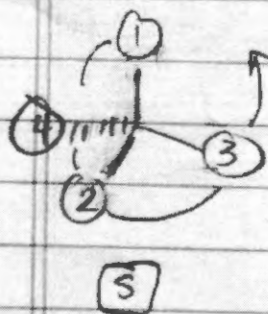
A mirror image of a chiral carbon center can be drawn by exchanging the location of 2 groups.

Therefore, I know I can draw the mirror image of compound ① by exchanging ANY 2 numbers

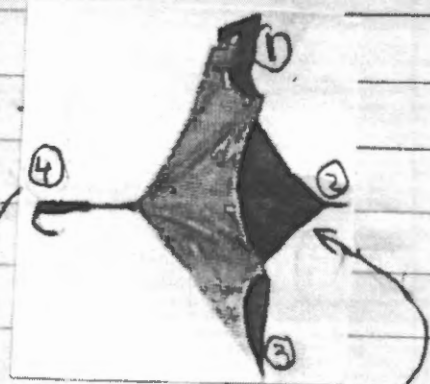


① $\leftrightarrow$ ④ exchange
This is enantiomer
(mirror image of ①)

Notice how ④ in previous example was conveniently in the back, because that's the way the molecule was drawn.



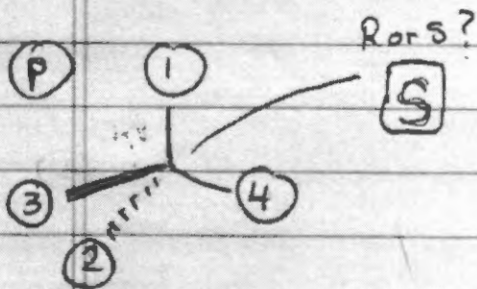
Look at these 3D structures as if you were looking into an inverted umbrella



④ is the handle ignored

Looking into "cavity of inverted umbrella"

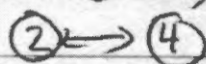
What if drawn like this ... ④ is not on the (dashed) line



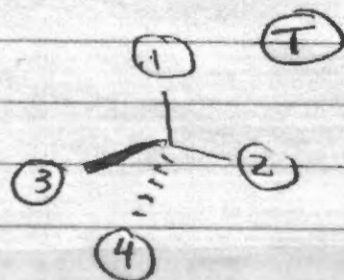
Let's get it there!

① What happens if I exchange ANY two numbers? I make the enantiomer of (P)!

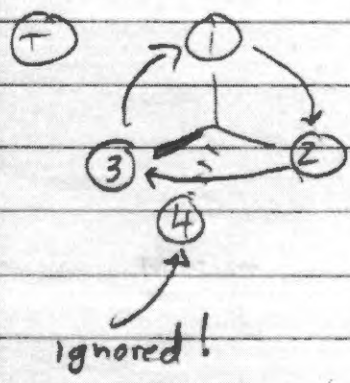
② So let's exchange the number on (dashed) bond with ④



(T) is the enantiomer of (P) if we connect 1,2,3 we will get the opposite configuration of (P)



Let's figure out if (T) is R or S,

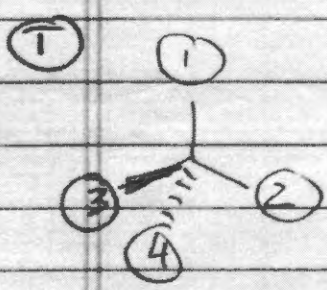


cpd right $\therefore$ (T) has R stereochemistry

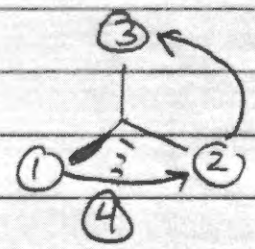
$\therefore$ cpd (P) on previous page has S stereochemistry.

Alternatively, we know (T) is the enantiomer of (P), so if I switch any other two numbers that does not include (4) (4 must stay on min line) then I make the enantiomer of (T) which is (P)

Let's do it



Leave (4) on (min) line but switch say (1) and (3)



left turn

S

just like we determined above by switch R configuration of (T) to get the S configuration of (P)

here we determined (S) directly from 'double switch' structure!