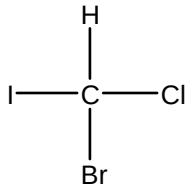
*Tyger, Tyger, burning bright*
*In the forests of the night,*
*What Immortal hand & eye*
*Dare frame thy fearful symmetry?*
William Blake (1793)

I. Asymmetric carbon

*A carbon with 4 different substituents is an asymmetric carbon.*

**Construct a carbon with one each white/yellow (H), green (Cl), orange (Br) and purple (I) substituents.**




We are about to explore the highly unusual world of the asymmetric carbon!

1a. (1 point) Draw a 3-dimensional dashed-wedged representation of your asymmetric carbon. Name it!

A fool sees not the same tree that a wise man sees.
**William Blake**

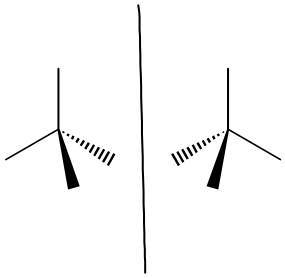
II. Chiral Molecules

*A chiral molecule is <u>non-superimposable</u> on its mirror image.*
(Conformations are ignored)

**Construct the mirror image of your first CHClBrI molecule.**
Did you name it bromochloroiodomethane?

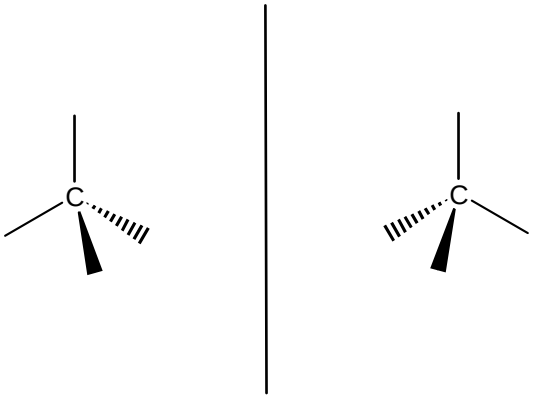
Do you need a mirror to do this? Try to superimpose the mirror images on each other. Are they the same molecule or difference molecules?

*A chiral molecule and its mirror image are called <u>enantiomers</u>.*



How's my mirror plane?
Call 1-800-GET-REAL

1b. (1 point) <u>Draw your pair of enantiomers using the "dashed-wedged line notation."</u>




*Molecules with only one asymmetric carbon are <u>always</u> chiral.*

> Hath not the potter power over the clay, of the same lump to make one vessel unto honour, and another unto dishonour?
> **Bible**, Romans 9:21

III. More Chiral Molecules

**Construct 3-bromo-2,2-dichloro-1-iodobutane**

Find the asymmetric carbon.

**Construct the mirror image of your molecule.**

2. (1 point) Draw a pair of enantiomers for 3-bromo-2,2-dichloro-1-iodobutane using the "dashed-wedged line notation."

IV. Your Very Own Chiral Molecule

**Construct your own chiral molecule.**

3. (1 point) Draw the pair of enantiomers of your molecule using the "dashed-wedged line notation."

V. Absolute Stereochemistry

> We can be absolutely certain only about things we do not understand.
> **Eric Hoffer**, The True Believer

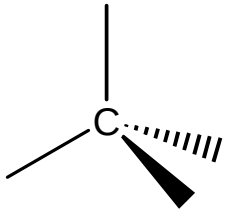
A. Assign priority to the substituents of the asymmetric carbon.

Rule 1 - Rank the 4 atoms bonded to the asymmetric carbon in order of their atomic mass: a>b>c>d - highest atomic number to lowest atomic number.

**Construct CHClBrI (**bromochloroiodomethane) **again.**

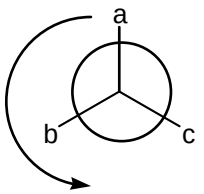
Assign priorities to the asymmetric carbon of bromochloroiodomethane.

4a. (1 point) Draw your bromochloroiodomethane molecule (dashed-wedged line notation) with its assigned priorities.

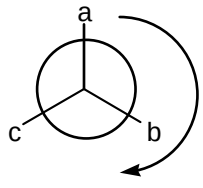



B. Assign an absolute stereochemistry to bromochloroiodomethane.

**Rule 2 -** Put the lowest priority group (d) in the back and view the molecule along the bond from the chiral carbon to the "d" group.
**Rule 3** - Draw an arrow through the first priority group, through the second, to the third.




S




R

If the arrow points clockwise the asymmetric carbon is "R". If the arrow points counterclockwise the asymmetric carbon is "S".

4b. (1 point) Label your molecule in “4a” R or S.

C. More about priorities

Rule 4 - If two adjacent atoms are the same look further down the respective substituent chains for a tie-breaker. One higher atomic number atom takes priority over any number of lower atomic number atoms. (Same as “E” and “Z” for alkenes)

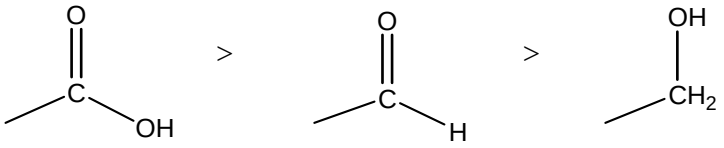
**Construct 3-bromo-2,2-dichloro-1-iodobutane again.**

Assign priorities to the asymmetric carbon of 3-bromo-2,2-dichloro-1-iodobutane.

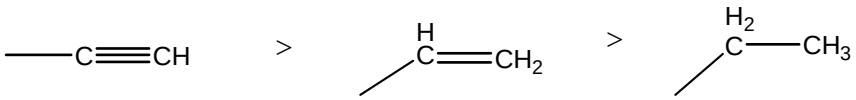
5. (2 points) Draw your 3-bromo-2,2-dichloro-1-iodobutane_molecule (dashed-wedged line notation) with its assigned priorities.
Assign an absolute stereochemistry to the molecule (R or S).

*"Would you tell me, please, which way I ought to go from here?"*
*"That depends a good deal on where you want to get to," said the Cat.*
*"I don’t much care where--" said Alice.*
*"Then it doesn’t matter which way you go," said the Cat.*
*"--so long as I get SOMEWHERE," Alice added as an explanation.*
*"Oh, you’re sure to do that," said the Cat.* Alice in Wonderland by Lewis Carroll

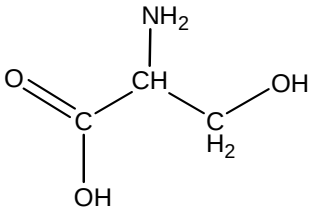
Rule 5 - Multiple bonds to a similar atomic number atom take priority over single bonds.




or




**Construct the amino acid "serine":**



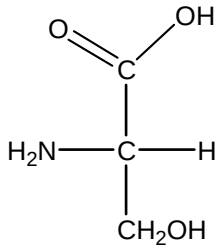

Assign priorities to the asymmetric carbon of your serine.

6a. (2 points) Draw your molecule (dashed-wedged line notation) with its assigned priorities. Assign an absolute stereochemistry to the molecule.

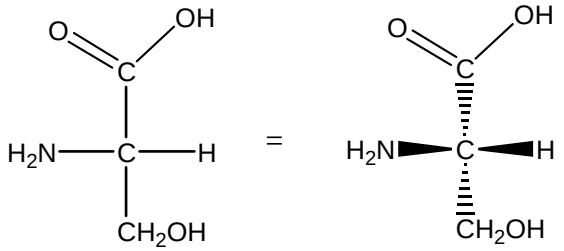
(Rule 6 - There are no more rules except in the case of exceptions.)

## Fischer Projections

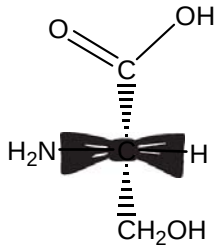
A biochemist would draw L-serine like this:



This is the "Fischer Projection" way of saying that the absolute stereochemistry is:

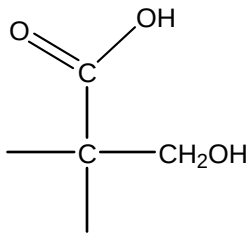


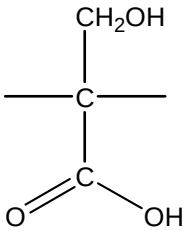
(It looks like serine with a bow-tie)



6b. (1 point) <u>What is the absolute configuration (R or S) of L-serine?</u>

6c. <u>(1 point) Draw correct positions of "H" and "$NH_2$" on the following Fischer representations of L-serine:</u>



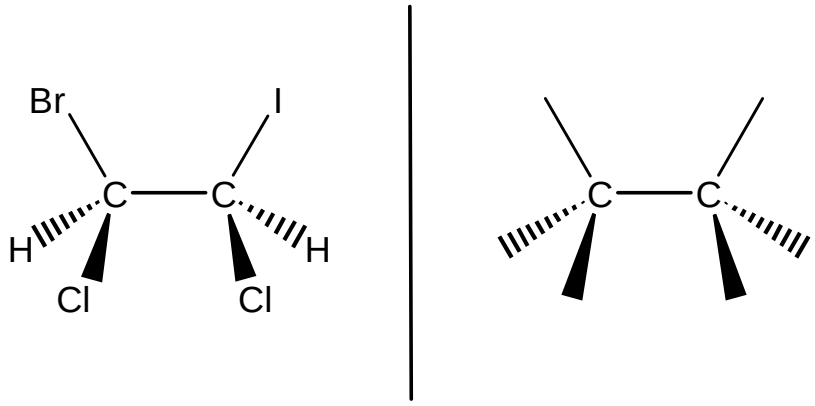


VI. Molecules with 2 asymmetric carbons

A. Diastereomers

**Construct the 1-bromo-1,2-dichloro-2-iodoethane isomer shown below.**
**Construct the mirror image of this 1-bromo-1,2-dichloro-2-iodoethane isomer.**

7. (2 points) Draw the enantiomers using the dash-wedge structures below :
Assign absolute stereochemistry to each asymmetric carbon of your enantiomers:

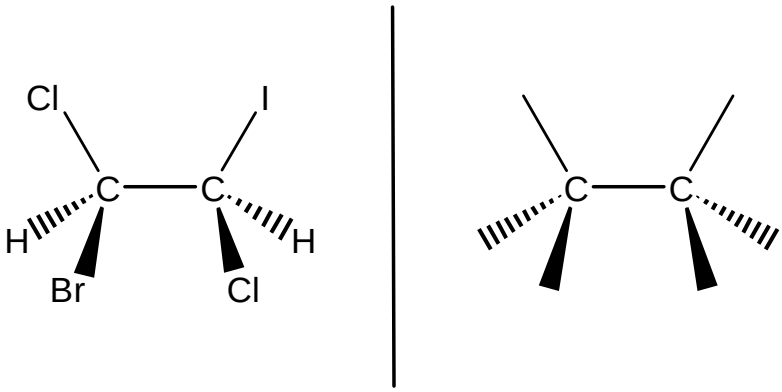



**Switch the -Br and –Cl on the "1" carbon of your original 1-bromo-1,2-dichloro-2-iodoethane.** (You are reversing the absolute stereochemistry at that carbon.)

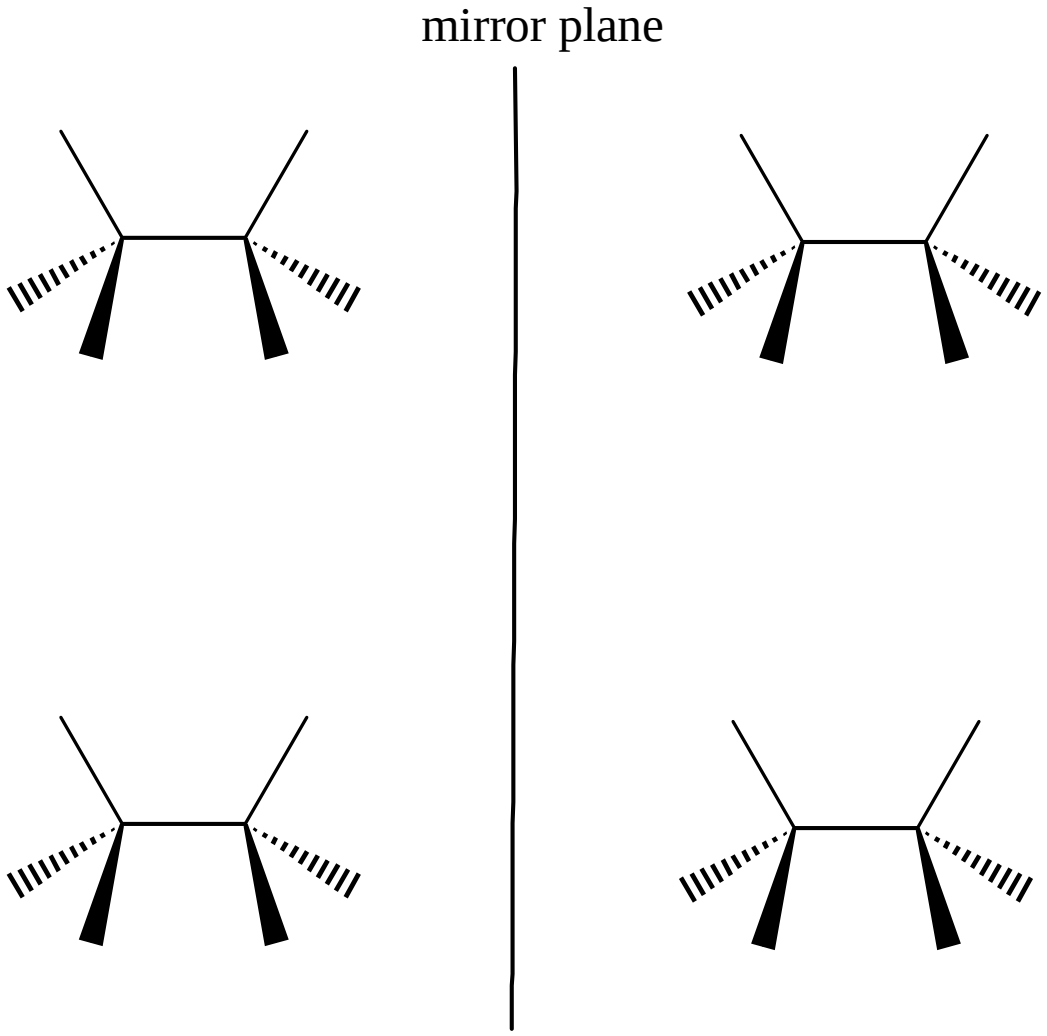
Try to superimpose your new stereoisomer on your other 1-bromo-1,2-dichloro-2-iodoethane. You have created yet another stereoisomer of 1-bromo-1,2-dichloro-2-iodoethane!

*Stereoisomers that are not mirror images are called diastereomers.*

8. (2 points) Draw your new 1-bromo-1,2-dichloro-2-iodoethane and its mirror image.
Assign absolute stereochemistry to your new pair of enantiomers.



9a. Redraw the four stereoisomers of 1-bromo-1,2-dichloro-2-iodoethane.
Label them RR, SS, 1R2S and 1S2R




9b. (1 point) Which are enantiomers (2 pairs)?

9c. (1 point) Which are diastereomers (4 pairs)?

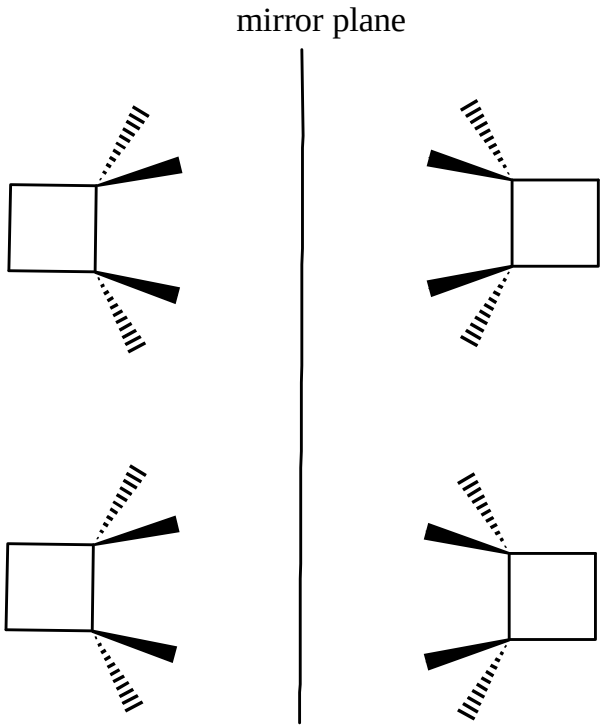
*Mirror, mirror on the wall,*
*Who's the fairest of them all?*
*The Wicked Queen*

VII. Cyclic Compounds:

**Construct 1,2-dichlorocyclobutane. Use "springy" bonds for the carbon ring.**

**Construct the mirror image of your 1,2-dichlorocyclobutane.**

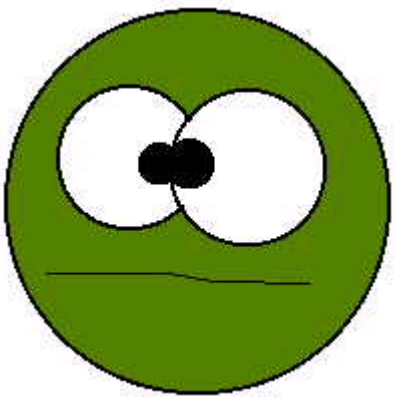
10a. (1 point) Draw all stereoisomers of 1,2-dichlorocyclobutane and assign their absolute stereochemistries:




10b. (1 point) Which mirror image pair is identical?

*Molecules with two or more asymmetric carbons that are not chiral are called "meso".*

Are your eyes crossed yet?



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