

# **D/L and R/S system of nomenclature**

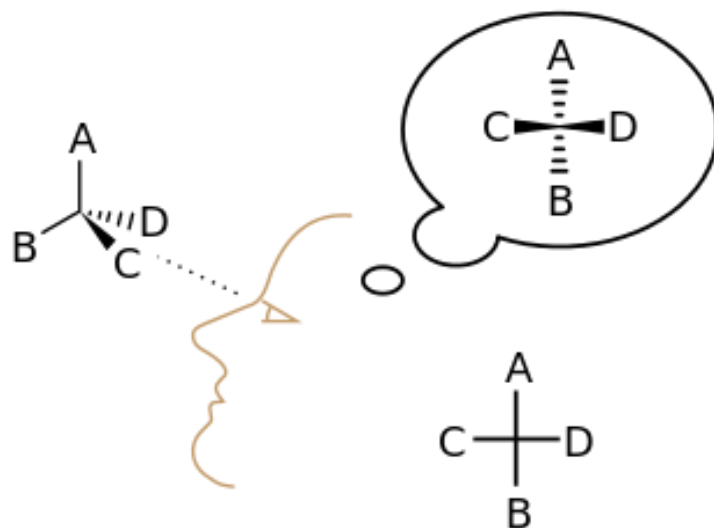
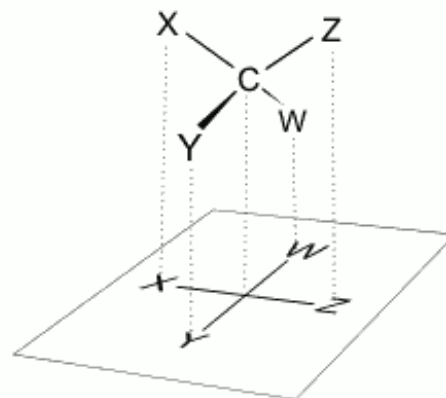
# Definition

## DEFINITION

- An optical isomer can be named by the spatial configuration of its atoms.
- The system that is used to designate the configurations of chiral carbons of naturally occurring compounds is called the **D and L convention** or system.
- This descriptor (D and L) represent an older system for distinguishing enantiomers of Carbohydrates and Amino acids.

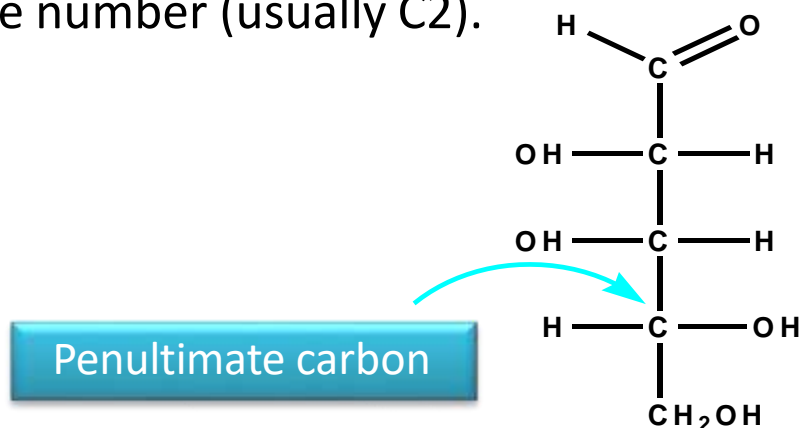
# Fischer Projection

- ❖ The **Fischer projection**, devised by Hermann Emil Fischer in 1891, is a two-dimensional representation of a three-dimensional organic molecule by projection.
- ❖ Fischer projections were originally proposed for the depiction of carbohydrates and used by chemists, particularly inorganic chemistry and biochemistry.



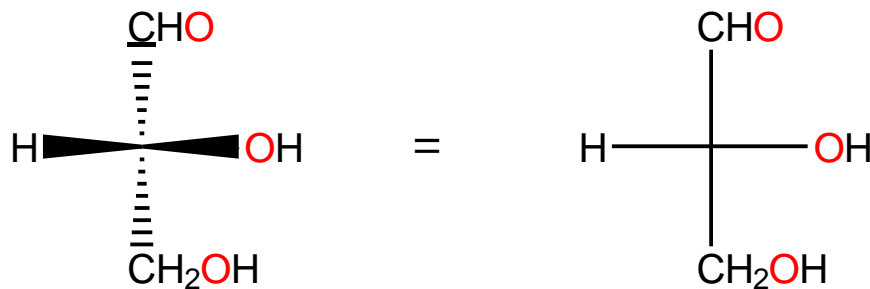
# Rules for Fischer Projection

- All bonds are depicted as horizontal or vertical lines. The carbon chain is depicted vertically, with carbon atoms represented by the center of crossing lines. The orientation of the carbon chain is so that the C1 carbon is at the top.
- In an aldose, the carbon of the aldehyde group is C1; in a ketose the carbon of the ketone group has the lowest possible number (usually C2).



# Rules for Fischer Projection

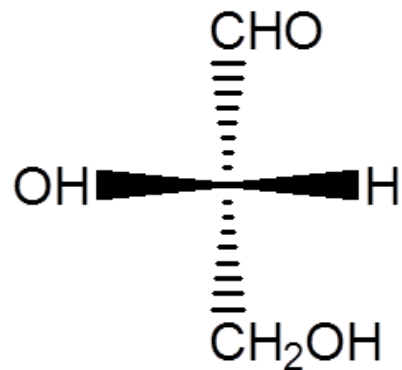
A Fischer projection is used to differentiate between L- and D- molecules. On a Fischer projection, the penultimate carbon of D sugars are depicted with hydrogen on the left and hydroxyl on the right. L sugars will be shown with the hydrogen on the right and the hydroxyl on the left.



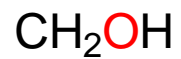
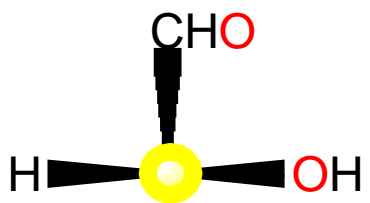
D-Glyceraldehyde

# Rules for Fischer Projection

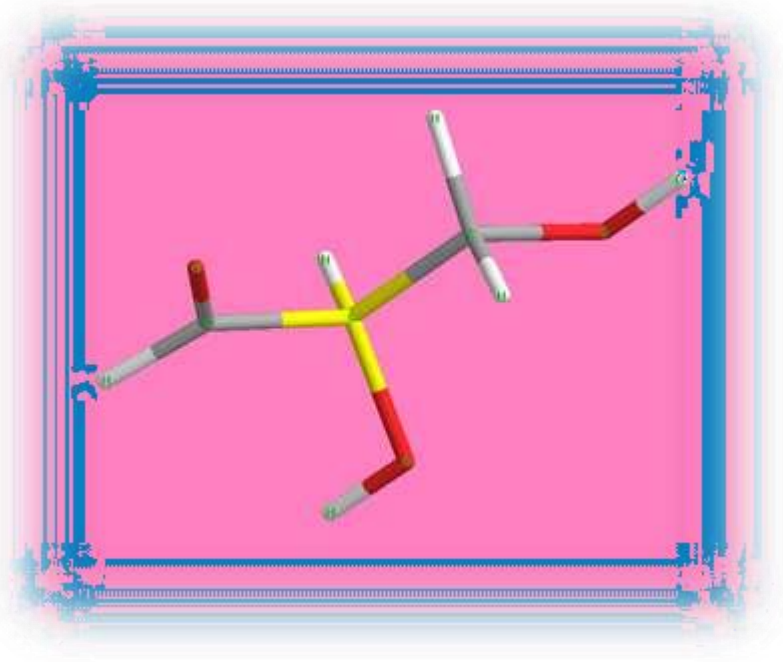
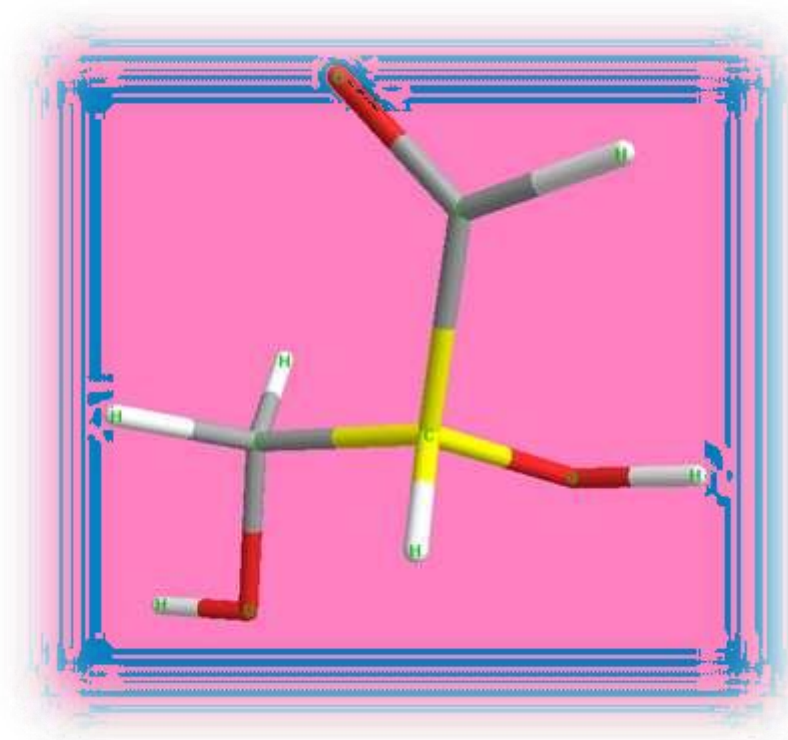
- In a Fischer projection, all horizontal bonds project toward the viewer (coming out of the plane of the page), while vertical bonds project away from the viewer (behind the plane of the page).



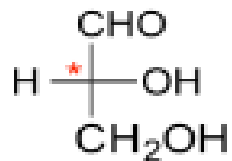
- However, any rotation of 180° doesn't change the molecule's representation. Swapping two pairs of groups attached to the central carbon atom still represents the same molecule as was represented by the original Fischer projection.



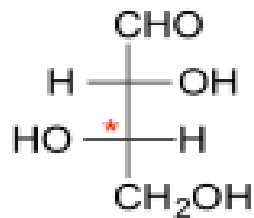
(R)-2,3-dihydroxypropanal



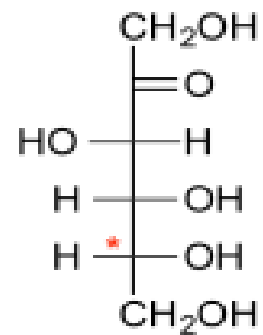
# Examples



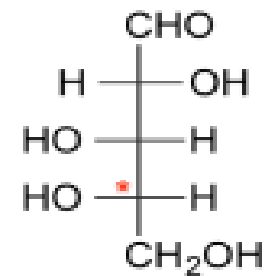
D-glyceraldehyde



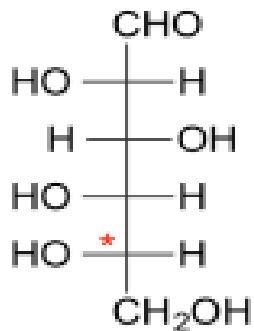
L-threose



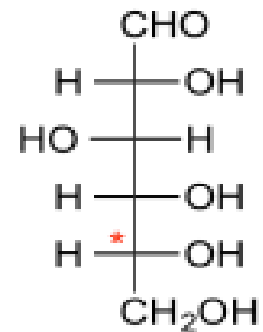
D-fructose



L-arabinose



L-glucose

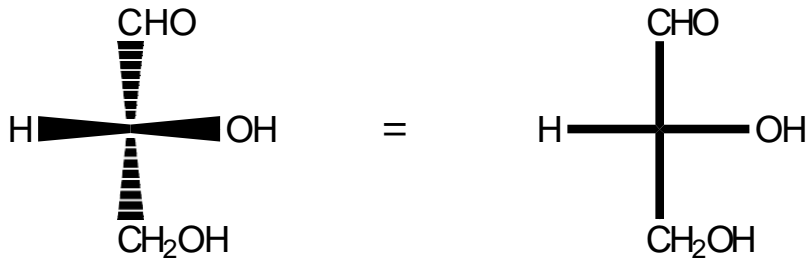


D-glucose

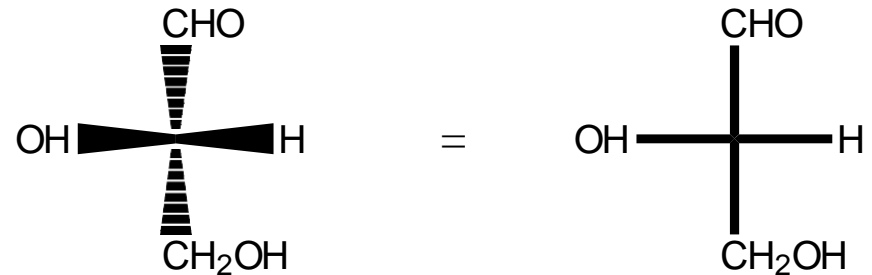


# D- and L- Configuration

- The descriptor D and L represent a system for distinguishing enantiomers, relating the sense of chirality of any molecule to that of D- and L- Glyceraldehyde.
- D- and L- Glyceraldehyde are shown below in Fischer projection...

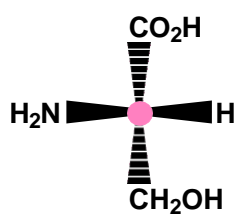


D-Glyceraldehyde

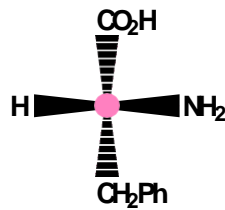


L-Glyceraldehyde

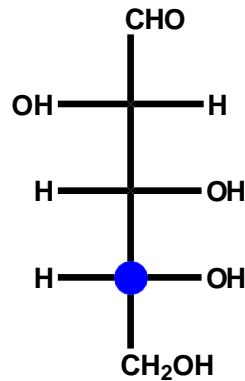
- ❖ To name more complex carbohydrates and amino acids, one draw a similar Fischer projection where  $\text{CH}_2\text{OH}$  or R is on the bottom and the carbonyl group (aldehyde, ketone or carboxylic acid) is on the top.
- ❖ The D descriptor is used when the OH or  $\text{NH}_2$  on the penultimate(second from the bottom) carbon points to the right and L is used when the OH or  $\text{NH}_2$  points to the left.



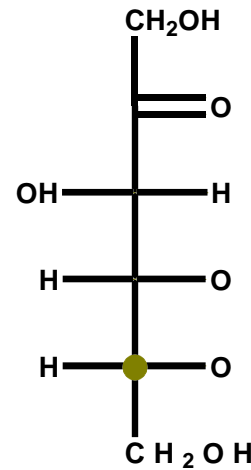
L-Serine



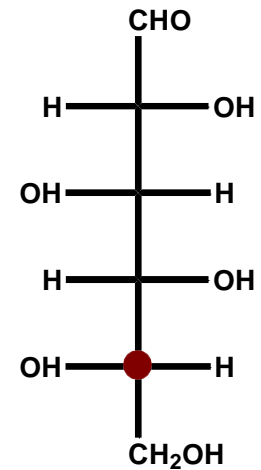
D-Phenylalanine



D-Arabinose



D-Fructose



L-Idose

- The D and L nomenclature system is fundamentally different than the R/S or E/Z systems.
- The D and L descriptors derive from only one stereogenic center in the molecule and are used to name the entire molecule. The name of the sugar defines the stereochemistry of all the other stereogenic centers.
- Each sugar has a different arrangement of the stereogenic centers along the carbon backbone.
- In contrast, normally a separate R/S or E/Z descriptor is used to name each individual stereogenic unit in a molecule.
- The D/L nomenclature is a carry over from very early carbohydrate chemistry.
- The terms are now reversed primarily for sugars and amino acids. Thus it is commonly stated that all natural amino acids are L, while natural sugars are D.

## R/S System of nomenclature

Chemists need a convenient way to distinguish one stereoisomer from another. The **Cahn-Ingold-Prelog system** is a set of rules that allows us to unambiguously define the stereochemical configuration of any stereocenter, using the designations '**R**' (from the Latin *rectus*, meaning right-handed) or '**S**' (from the Latin *sinister*, meaning left-handed).

# RULES FOR ASSIGNING AN R/S DESIGNATION TO A CHIRAL CENTER

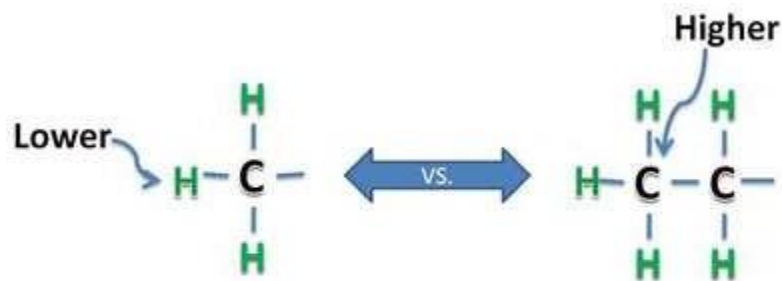
- 1: Assign priorities to the four substituents, with #1 being the highest priority and #4 the lowest. Priorities are based on the atomic number.
- 2: Trace a circle from #1 to #2 to #3.
- 3: Determine the orientation of the #4 priority group.

# RULE NO. 1

Assign priorities to the four substituents, with #1 being the highest priority and #4 the lowest. Priorities are based on the atomic number.

First, examine at the atoms directly attached to the stereocenter of the compound. A substituent with a higher atomic number takes precedence over a substituent with a lower atomic number. Hydrogen is the lowest possible priority substituent, because it has the lowest atomic number.

If the chains are similar, proceed down the chain, until a point of difference.

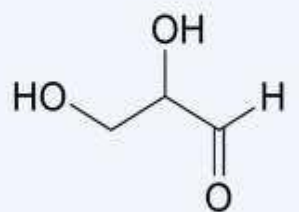


The "H-" (left) ranks lower than the "C-" (right) based on the first point of difference and their relative molecular weights

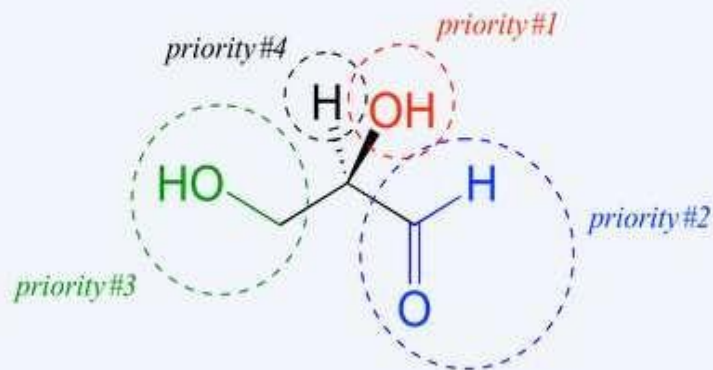
# RULE NO. 2

**Trace a circle from #1 to #2 to #3.**

Assigning R/S configuration to glyceraldehyde:

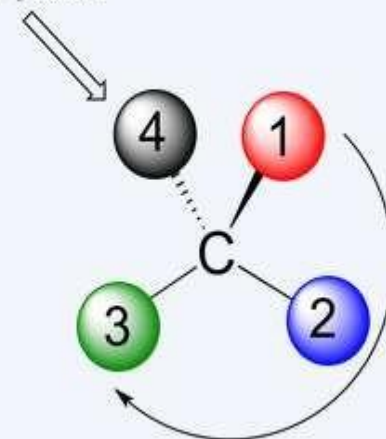


glyceraldehyde



(R)-glyceraldehyde

#4 priority group  
pointing away from us

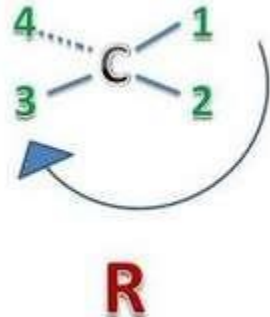
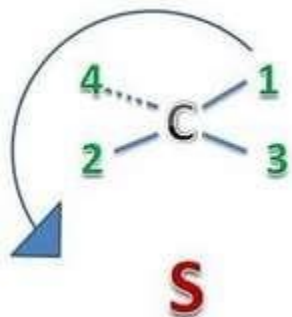


clockwise = R

# RULE NO. 3

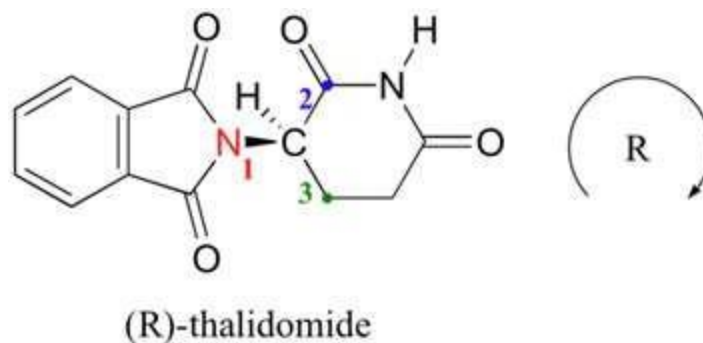
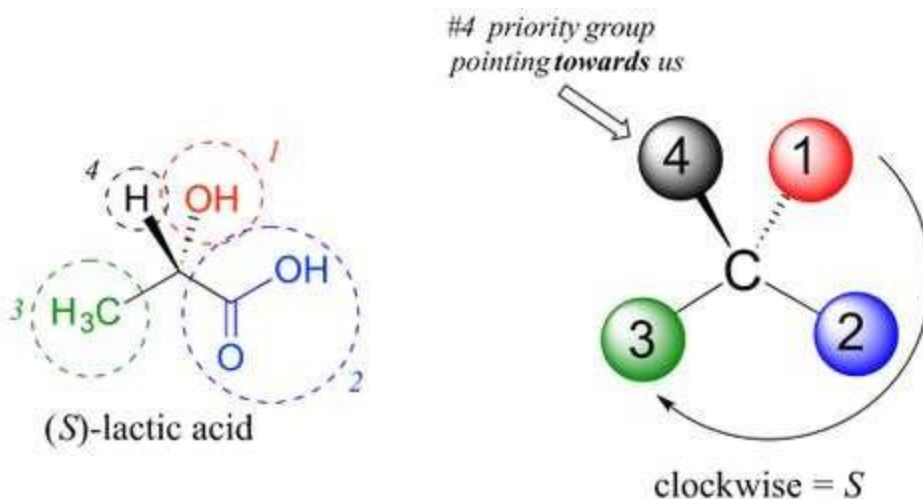
Determine the orientation of the #4 priority group. If it is oriented into the plane of the page (away from you), *group pointing away from you* a clockwise circle in part 2 corresponds to the *R* configuration, while a counterclockwise circle corresponds to the *S* configuration.

If it is oriented out of the plane of the page (toward you) (*group pointing toward you*): a clockwise circle in part 2 corresponds to the *S* configuration, while a counterclockwise circle corresponds to the *R* configuration



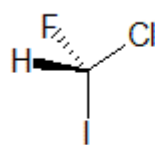
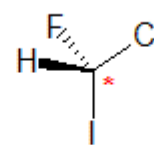
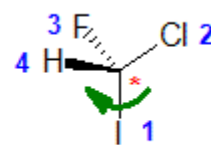
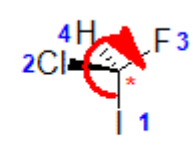


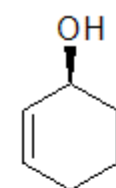
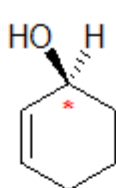
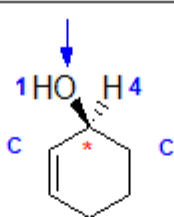
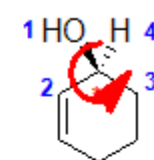
# EXAMPLES



<https://www.youtube.com/watch?v=ixx4Ti2pX8o>

# Summary

|   |   |   |   |                |                               |  |   |
|---|---|---|---|----------------|-------------------------------|--|---|
|  |  |  |  | starting point | identify the chiral center(s) | assign the relative priorities then rotate the low priority group away (to the back) | determine the sense of groups 1 - 3<br><b>clockwise = R</b> |
|---|---|---|---|----------------|-------------------------------|--|---|

|   |   |   |   |                |   |   |   |
|---|---|---|---|----------------|---|---|---|
|  |  |  |  | starting point | identify the chiral center(s) and show the implied H atom | assign the relative priorities....<br>$O > C > C > H$<br><br>Because we have two C groups we need to list the groups the C are attached to in atomic number order ( <b>note</b> how the multiple bond is handled) | the first point of difference is the $C > H$ so the C group on the left is the higher priority<br><br>with the low priority group already at the back, determine the sense of groups 1 - 3<br><b>counterclockwise = S</b> |
|---|---|---|---|----------------|---|---|---|