

## Stereochemistry and Projections Answers:

1.0:

1. A

C1 is the aldehyde carbon and we go down to CH<sub>2</sub>OH, which will be C5. If we follow the rules of stereo-configuration: OH takes priority, the aldehyde COH then the carbon chain. If H is on vertical axis R=clockwise and S= anti-clockwise. However here H is horizontal so R=anti-clockwise and S= clockwise. Answer is (A)

2. B

Same as in question 1. (B) is the answer

3) A

In general, a meso compound should contain two or more identical substituted stereocenters. Also, it has an internal symmetry plane that divides the compound in half. These two halves reflect each other by the internal mirror. From the compounds shown above, none of them satisfies this description. Answer is (B)

4) D

A hemiacetal linkage occurs when carbon atoms with the aldehyde (or keto) group reversibly bonds to one of the other carbons by "sharing" a hydroxyl oxygen, forming a C-O-C linkage. This linkage can occur between C2 – C5 or C2- C4. Answer is (D)

5) D

A hemiacetal linkage occurs when carbon atoms with the aldehyde (or keto) group reversibly bonds to one of the other carbons by "sharing" a hydroxyl oxygen, forming a C-O-C linkage. This linkage can occur between C2 – C6 or C2- C5. Answer is (4)

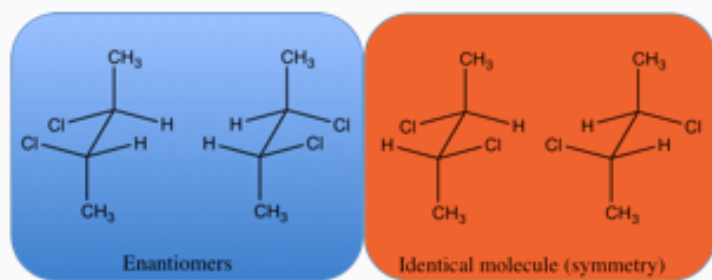
1.1:

1) D

This type of question is known as the knowledge limiting questions, whereby the examinee is only provided with partial or incorrect information that is restricted by assumptions or simplifications. The safest way to solve this question is through the process of elimination.

By analysing the molecular structure of each molecule, it is immediately clear that only A and C are chiral molecules based on the definition of a chiral centre, where a carbon must have four different groups attached to it. However, upon closer inspection, compound C (2,3-dichlorobutane) has two stereogenic centres, which may result in achiral characteristics despite the presence of chiral centres (meso forms).

To look closely at this question, compound C has potentially 4 stereoisomers, consisting of 2 pairs of enantiomers. Compound C has a meso form, where a plane of symmetry can be found for one pair of its enantiomers:



This is where the wording of the question is important. The question never stated nor went deep enough to specify the presence of meso forms and whether we need to confirm their presence. This means that even though compound C can be potentially achiral, none of the answers provided suggests the need to consider this effect, thus the only correct answer can only be D.

For a more complex demonstration of this type of question, refer to in-class lecture 2, under Strategies and Styles.

2) A

Carbon 2 of compound A is the only chiral center. Since the number of possible stereoisomers is given by  $2^n$ , where  $n$  is the number of chiral centers, this has only two stereoisomers.

1.2:

1) B

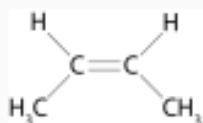
Structural isomers are compounds that have the same chemical formula, but with their atomic constituents bonded together in differing ways. In this case, each of the the compounds has the chemical formula  $C_4H_8$ , making them all structural isomers of each other. Thus, answer B is correct.

2) A

A structural isomer has the same chemical formula as another molecule, but with a different structural arrangement. The molecules shown in the stem have a the formula  $C_4H_8$ . Of the options given, only cyclobutane has this composition, making answer A correct.

3) C

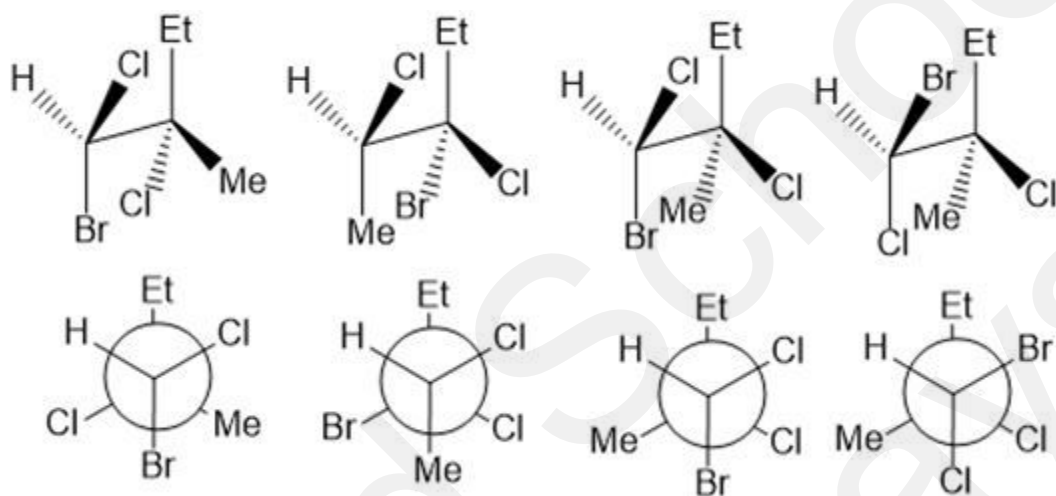
Of the four compounds given, only compound 4 can exist as more than one stereoisomer due to the central double bond, thus answer C is correct. Compound 4 in the stem is a trans form, while the other possible stereoisomer has a cis configuration.



1.3:

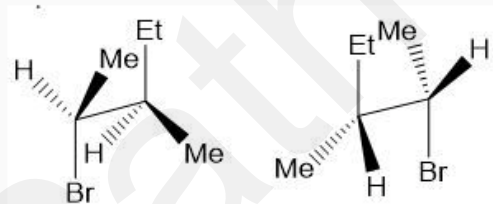
1. C

The Newman projections corresponding to each sawhorse are shown below.

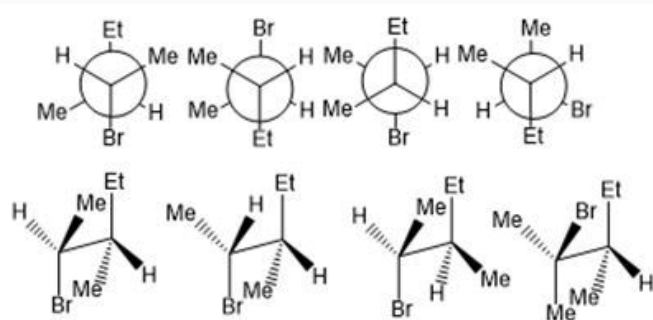


2. C

The right answer is slightly tricky in that instead of looking down the axis between the two carbons below from the "front", they have instead looked from the "back" of the molecule. This is perhaps easier to understand by rotating the molecule while keeping the bonds in the same respective positions as below.

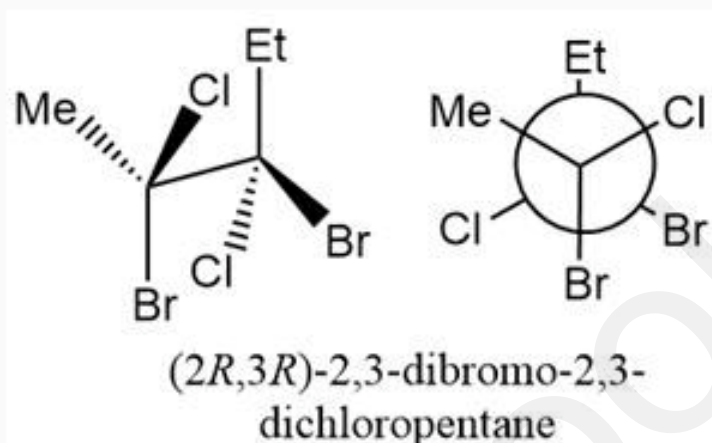


As can be seen, ethyl is at the top between a methyl and a hydrogen, with bromine at the bottom - this rules out D. The hydrogens are coming out of the page, so will be on the right when looking down the interatomic axis, where the methyls are going into the page and so will be on the left. The sawhorses corresponding to each Newman are shown below.

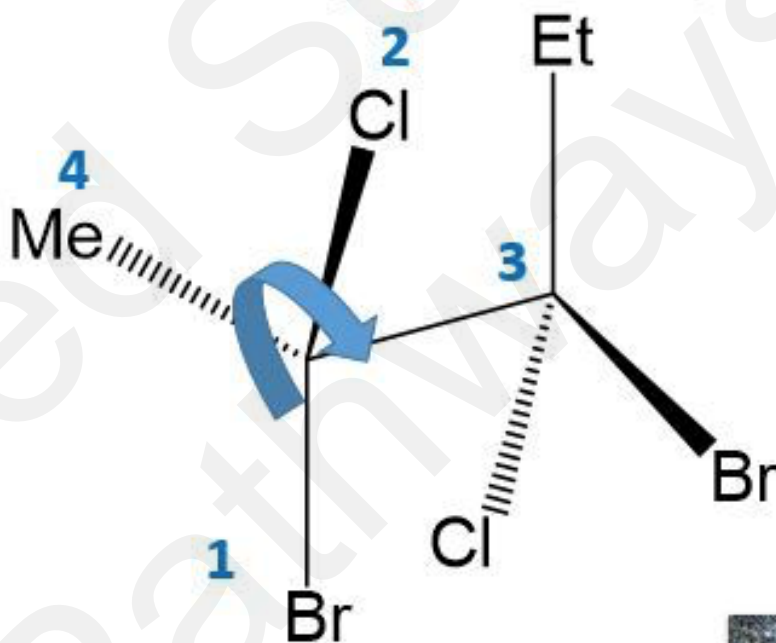


3. A

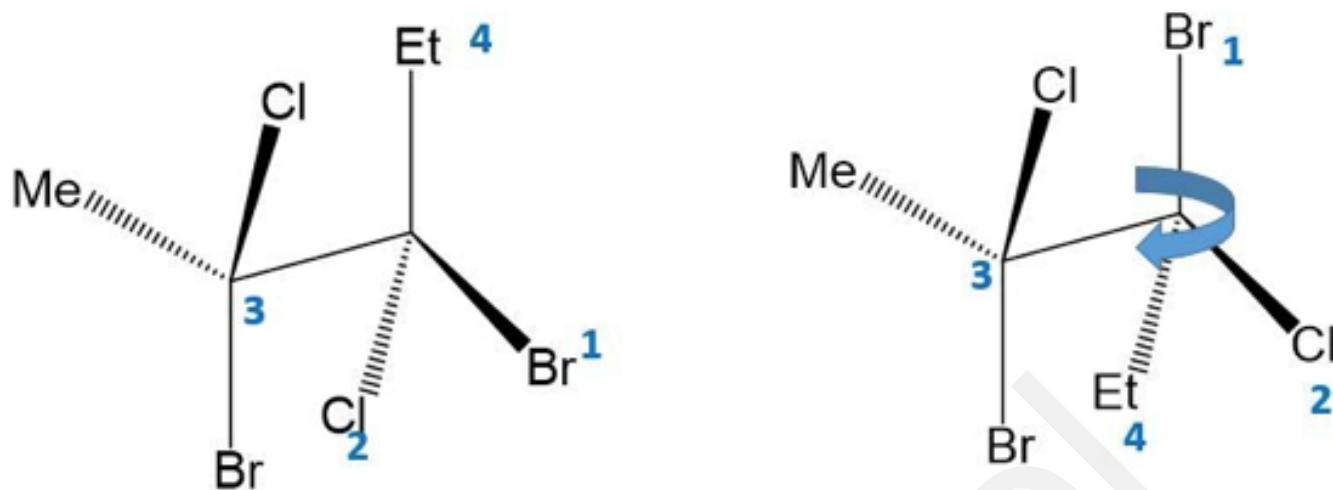
Carbon 2 is that attached to the methyl group, with carbon 3 attached to the ethyl group. The sawhorse projection is shown below.



For the chiral centre on the left, assigning priorities is fairly straightforward - Br and Cl are 1 and 2 by atomic number, and Me is clearly lower priority than the other chain, so they are 4 and 3 respectively. The molecule is already oriented with the methyl going away from us, and the other three groups are clockwise, so this is *R*.



For the chiral centre on the right, assigning is again quite simple and basically the same as above. However, we don't have the lowest priority group going into the page - the easiest thing I find to do in this case is rotate the molecule, rotating the Et to replace the Cl, the Cl to the Br and the Br to the Et to give the orientation as on the right below. As we can see, the three highest groups are now clockwise with the lowest priority group into the page and so this is the *R* isomer.



4) B

The most stable conformation is typically staggered i.e. where the groups are spaced at  $60^\circ$  intervals around the circle as in B and C, as this results in the least clashing. The next consideration is trying to get the big groups away from one another - in this molecule, the biggest group on the 3-carbon is obviously the ethyl group. C looks correct as the ethyl groups are as far from one another as possible, but more careful analysis shows that this is another molecule (3,4-dimethylhexane) and so not the answer. This leaves B.

1.4:

1. B

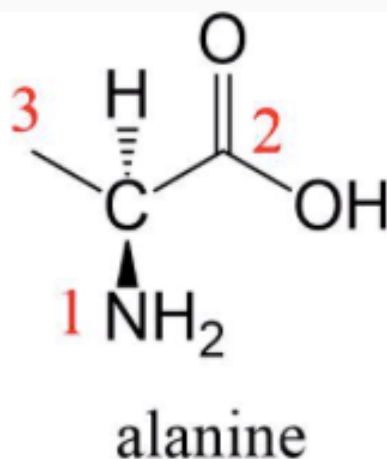
Recall that a stereocentre is a carbon with four different groups attached - although C1 is drawn with a bond to OH coming out of the page, it is attached to 2 hydrogens and so is not a stereocentre. C2 is attached to a H, an OH, a carbon with an alcohol and a carbon with an aldehyde - it is the stereocentre

2. D

As stated in the preamble, the L/D-system (and indeed any stereochemistry nomenclature) is only useful for chiral molecules - glycine is not a chiral molecule, as the central carbon is attached to two hydrogens. It thus doesn't have L or D isomers

3. C

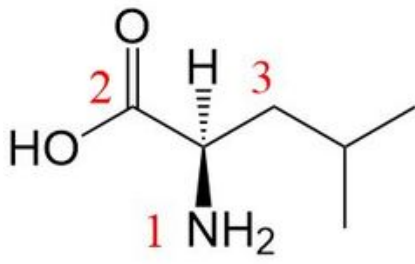
Assigning the chirality of this molecule is relatively simple as it is already oriented in the perfect position for both naming systems. For R/S nomenclature, the group hierarchy is as below, and the groups are oriented anticlockwise, so that this is the S isomer. For L/D nomenclature, CO  $\rightarrow$  R  $\rightarrow$  N is anticlockwise, so this is the L-isomer.



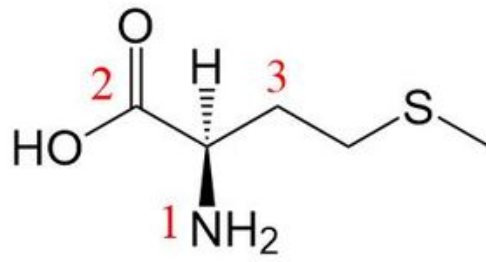


4) D

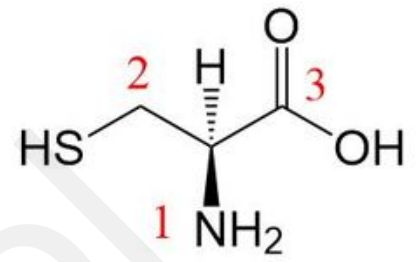
Clearly, A and C cannot be correct because if one is right, then the other must be as well - always try to use logic if possible to rule out answers. The R-isomers of the first two molecules (and alanine) are D-isomers, but looking at the last molecule it is clear that the R-isomer can sometimes be a L-isomer (CO  $\rightarrow$  R  $\rightarrow$  N is counterclockwise) so there is no clear relationship.



R-leucine



R-methionine



R-cysteine

Med School  
Pathways