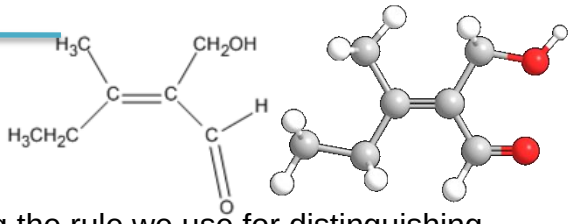
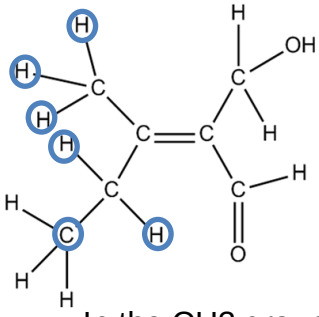
E3- Geometric Isomers Extension Theory Sheet

The example on the right looks quite difficult but it's actually not hard to assign it as E or Z. The only difference is that we are going to add an extra rule to the rules used on the basic theory sheet.



Let's focus on the left-hand end of the molecule. Following the rule we use for distinguishing the priority (Cahn-Ingold Priority Rules) we look at what has the highest atomic number.



On this example, only carbon atoms are attached directly to the carbon atoms forming the double bond. This where the first hurdle lies, they obviously have the same atomic number, so this rule needs to be extended. We move to the next attached atom that is directly attached to each carbons, and then compare their priorities using the same rule we have been using.

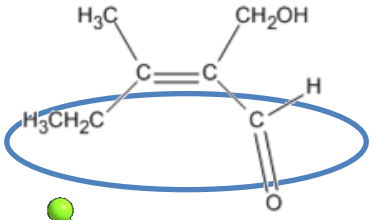
In the CH3 group there are 3 hydrogens atoms directly attached (H H H). In the CH3CH2 groupthere is a carbon and two hydrogens attached (C H H), this means that the C has the priority over H so the group CH3CH2 has the priority.

So now we look on the right-hand side of the molecule, the atoms are again the same, C, so we move to the next atom that is directly attached.

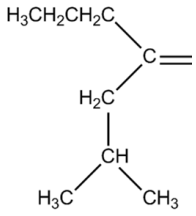
TOP TIP! When looking at a molecule that is directly attached by a double bond you count the atom twice!

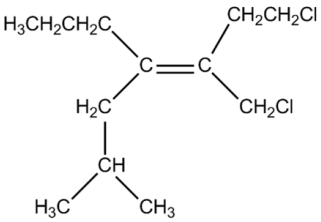
In the CH2OH group there is oxygen and two hydrogen atoms attached (O H H). In the CHO group the carbon is directly attached to two xygen atoms and a hydrogen to (O O H). (The oxygen is listed first as it has a higher atomic number!) **Note that the C=O counts as the C bonded to 2 oxygen atoms (Double bonds count as the atom being bonded to the other atom twice).** O O H has a higher atomic number this takes priority.

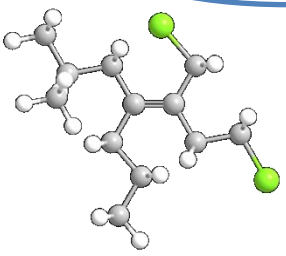
The two priority groups are CH2CH3 and CHO, and these are on the same side so it is aa **(Z)-Alkene**



By just adding one other simple rule you can now solve harder isomers!







Let's start on the left side of the molecule again. In both groups the left carbon-carbon double bond is attached to two carbons, which is then attached to another carbon two carbons; both lists will read C H H. So we continue moving until we find a difference between the two groups. The next attached atom on the top left is C H H, on the bottom left it is C C H. They still have a carbon which has the same atomic number; however the bottom carbon is attached to two carbons instead of the top carbon which is only attached to one, so group C4H9 gets the priority. Now look at the right, they are yet again both attached to a carbon, then the CH2Cl group is then attached to Cl H H. The other group is attached to C H H, so CH2Cl gets the priority. So this is also a (Z) isomer.

Produced by Emma Burnett at Newcastle University as part of a Nuffield Bursary Project. Edited by Steven Carman as part of a MChem project.

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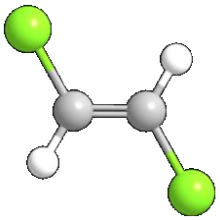
The effect of geometric isomers on physical properties - Extension

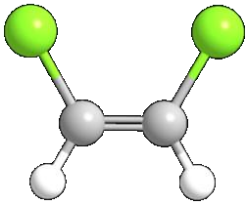
Taking the example 1,2-dichloroethene, we will compare the boiling and melting points between the two isomers.

	Boiling point (°C)	Melting point (°C)
cis-1,2-dichloroethene	60	-80
trans-1,2-dichloroethene	48	-50

As you can see the boiling point of trans-1,2-dichloroethene is lower, but it has a higher melting point.

The boiling point doesn't differ as much as the melting point because they are both liquids. However, in a solid, melting points will differ dramatically. The trans form is usually more stable because the priority groups are further away from each other and will pack better, whereas with cis one side of the molecule will be slightly negative and the other slightly positive, therefore it is polar. The cis isomer has dipole-dipole interactions and will need more energy to break bonds increasing the boiling point.





There will still be polar bonds in trans isomers, but as a total molecule they are non-polar because the slight charge on the top and bottom balance out and so does the left and right. Therefore, only the intermolecular attractions within the molecule are Van der Waals forces and don't need much energy to break the bonds; reducing the boiling points.

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