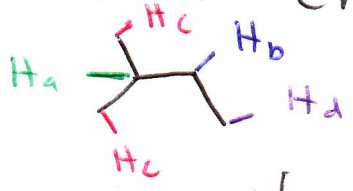
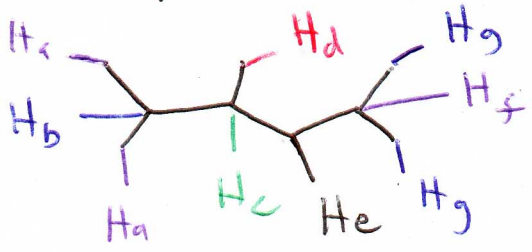
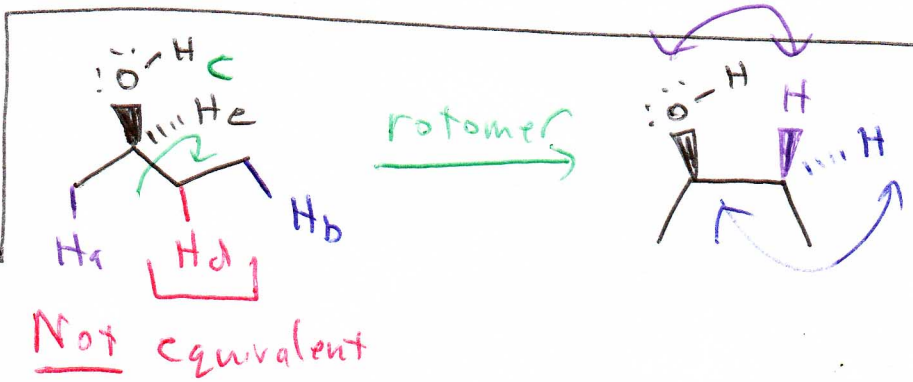
Chemical Equivalency



If the chemical environment around two atoms is identical - meaning that the two atoms have exactly the same neighbors through the structure of a molecule - those two atoms are called chemically equivalent. A unique NMR signal is generated for each unique (chemically inequivalent) type of atom.

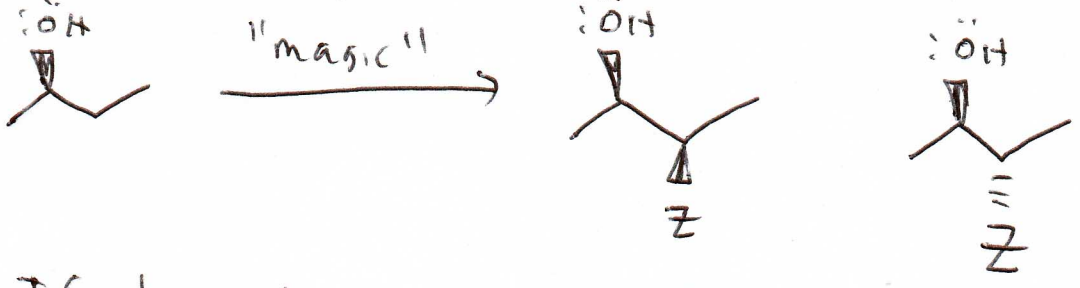




Not equivalent

The interactions between the two indicated hydrogens with the OH group are different, since the two hydrogens are slightly different distances from the OH group.

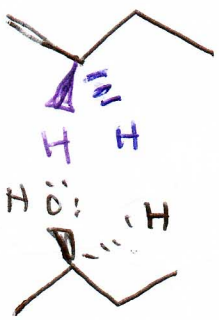
∴ The hydrogens are chemically inequivalent



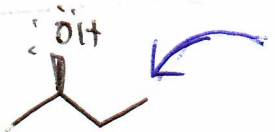
If, by replacing one hydrogen versus another with an arbitrary functional group, diastereomers are generated, the hydrogens are known as diastereotopic.

Diastereotopic protons are always chemically inequivalent.

If, by replacing one hydrogen versus another with an arbitrary group, enantiomers are formed, the hydrogens are known as enantiotopic

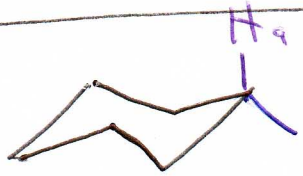


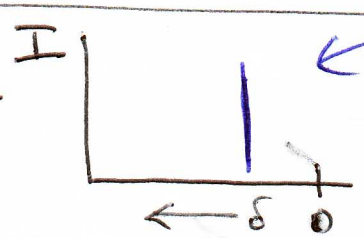
Enantiotopic protons are chemically equivalent in achiral environments, but chemically inequivalent in chiral environments.



No matter which of the hydrogens at the end of this molecule are replaced, the exact same product would result (no stereocenter is formed). Therefore, these hydrogens are entirely equivalent → homotopic

Homotopic protons are always chemically equivalent





ERT, ring flips occur rapidly enough that the signals of the two types hydrogens become averaged together.

Far below room temperature, ring flips no longer occur, so the two types of hydrogens can be distinguished.