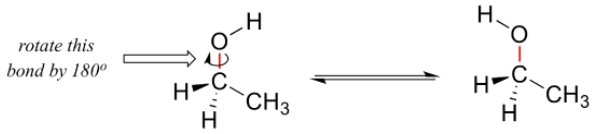
2.6: BOND ROTATION

Learning Objective

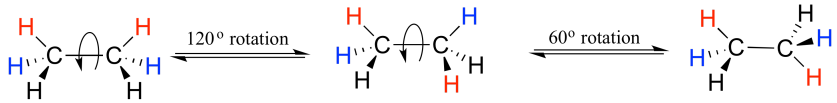
- distinguish between bonds that can rotate and those that cannot

Sigma Bonds can Rotate

We learned in section 2.1 that single bonds in organic molecules are free to rotate, due to the 'end-to-end' (sigma) nature of their orbital overlap. Consider the carbon-oxygen bond in ethanol, for example: with a 180^o rotation about this bond, the shape of the molecule would look quite different:

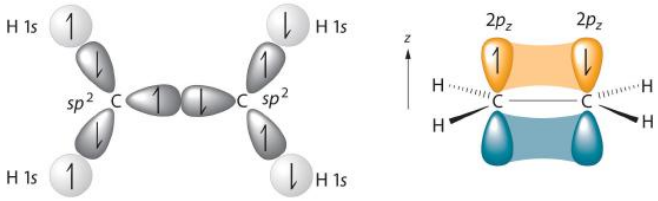


For ethane, rotation about the carbon-carbon sigma bond results in many different possible three-dimensional arrangements of the atoms.



PI BONDS ARE RIGID

Pi bonds are created from overlapping p orbitals. The lobes of the p orbitals prevent the atoms sharing pi bonds from rotating as shown in the diagram below.

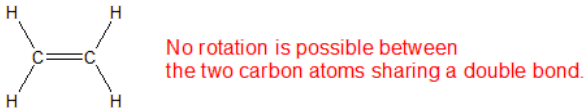


(a) C_2H_4 σ-bonded framework (b) C_2H_4 π bonding

DOUBLE AND TRIPLE BONDS CANNOT ROTATE

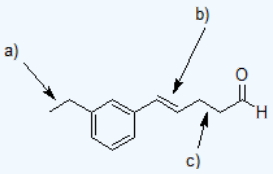
The pi bonds in double and triple bonds prevent these bonds from rotating. This rigidity has an effect on the physical structure of compounds and can influence chemical reactivity. For now, we want to build the habit of looking at static drawings and diagrams of organic compounds and visualizing their dynamic nature.

For ethene, there is no rotation about the carbon-carbon double bond because of the pi bond.



Exercise

1. Label the selected bonds in the compound below as "Rotates" or "Rigid."



Answer

1. Arrows for (a) and (c) are pointing to single bonds that can rotate. Arrow (b) is pointing to a double bond that is rigid because of the pi bond.