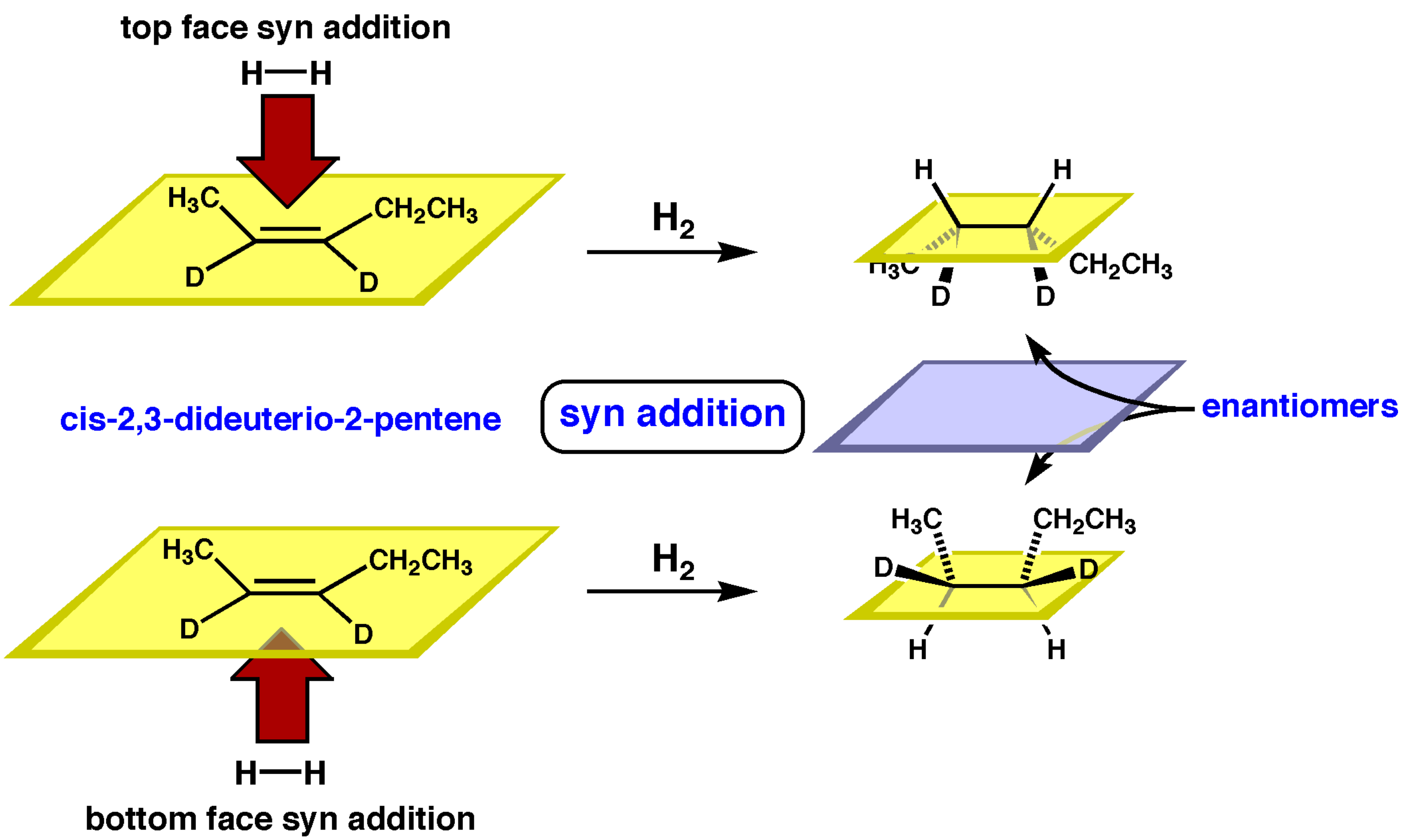
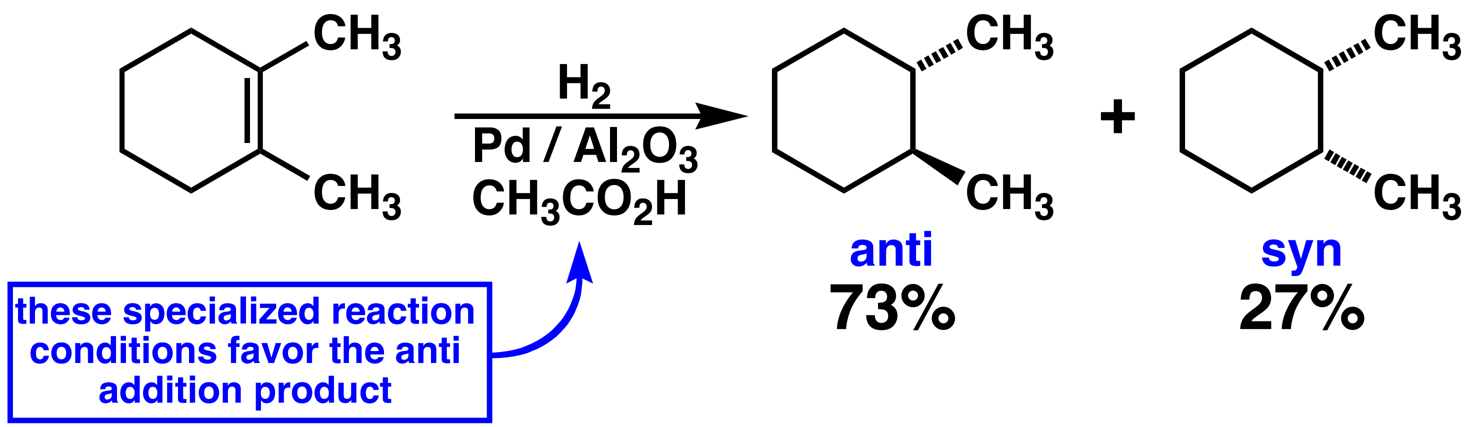
Stereoisomers and Addition Reactions

Many addition reactions have important stereochemical consequences and as we have previously seen, new details about a reaction mechanism will be unveiled when we examine the stereochemical relationship between reactants and products. For example, the hydrogenation to alkenes normally results in both hydrogen atoms adding to the same side, or **face** of the planar double bond. Same-face addition of atoms to a double bond is known as **syn addition**. An example of syn addition is illustrated for the hydrogenation of cis-2,3-dideuterio-2-pentene (deuterium, D is the nuclear isotope of hydrogen with an atomic mass of 2). Syn addition can take place from either the bottom or top. Because both top and bottom face addition are equally possible, an equimolar mixture of an enantiomer pair results. An equamolar mixture of enantiomers is known as a racemic mixture. Note that different products result from the trans alkene.



Anti vs. Syn Stereoselectivity

Although hydrogenation generally follows syn addition, special conditions exist that favor anti addition. In anti addition, one hydrogen atom adds to one face while the other adds to the other. The hydrogenation conditions shown in the reaction below exhibit **anti stereoselectivity**. You should draw the implied hydrogen atoms in the two products, showing their proper stereochemial orientation. The “anti” and “syn” products are diastereomers. The enantiomer of the anti product is not shown but is produced with equal preference to the anti isomer that is shown (i.e., of the 73% anti product, half of this amount is one enantiomer and half is the other). The syn product is a meso molecule. Can you find the plane of symmetry?

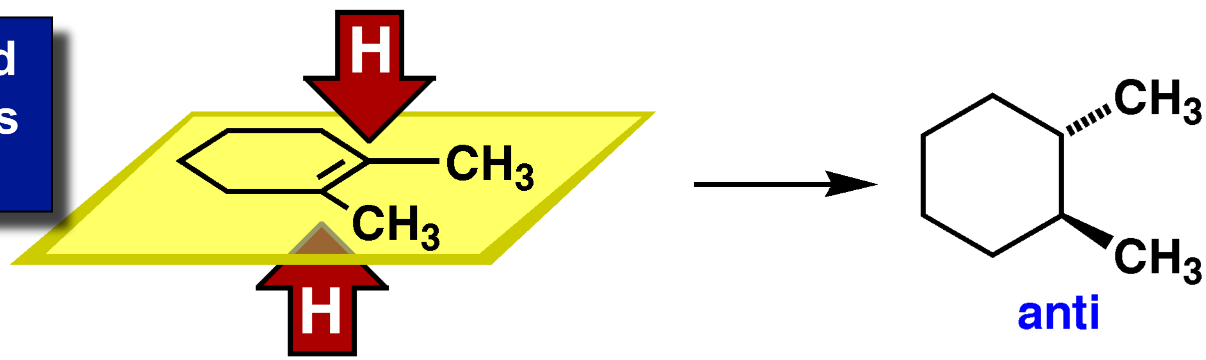


The specific set of conditions written above and below the reaction arrow describe to a chemist important details about how the reaction was performed. In this particular case, palladium metal was deposited on solid aluminum oxide and the reaction was conducted in a solvent of acetic acid (CH_3CO_2H) in the presence of gaseous hydrogen. **Please note that it is NOT important for you to memorize these specialized conditions or even understand the mechanistic details of how these conditions produce anti products. What is important is that you have the ability to examine a reactant / product pair and determine the mode of addition (syn vs. anti).**

Same Face Addition = Syn
Opposite Face Addition = Anti

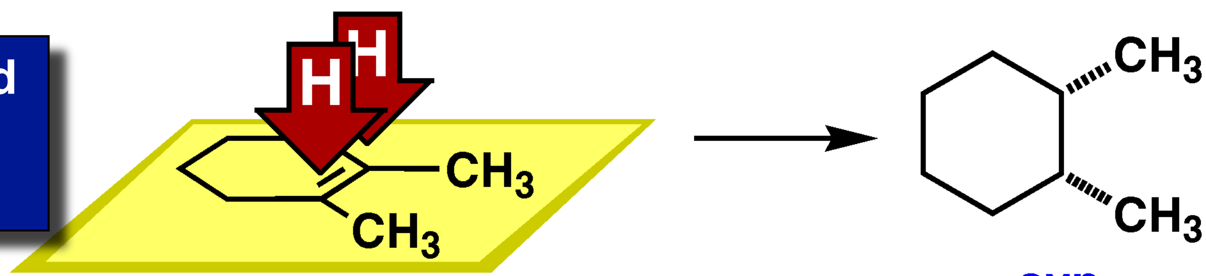
By comparing the stereochemistry of the products and reactant, it can be seen that the anti diastereomer arises from the addition of hydrogen atoms to opposite faces of the double bond, while the syn product results from same face addition.

Hydrogen atoms add to the opposite faces of the double bond



anti

Hydrogen atoms add to the same face of the double bond



syn