

Lab 7. Geometric Isomers

Prelab Assignment

Before coming to lab:

- Read this lab handout thoroughly and then answer the pre-lab questions at the end (i.e. pp. 9 – 10) of this lab exercise and be prepared to hand them in at the start of your lab period.
- This lab exercise does not require a report in your lab notebook. The report for this exercise consists of completing the attached Report pages (pp. 5 – 8) as you carry out the procedures on pp. 2 – 4.

Purpose

In this lab you will observe some of the physical properties (melting point and solubility in water) of two unknowns and then identify each unknown as either maleic or fumaric acid. You will then treat each unknown with heat and hydrochloric acid (HCl acts as a catalyst) to break the double bond (i.e. break the π -bond). The product that reforms after this treatment should be the more stable isomer. You will confirm this by testing the product's solubility in water.

Introduction

This experiment deals with the topic of isomerism. *Isomers* are chemical compounds that have the same chemical formula, but different chemical structure. A special type of isomerism, called *cis/trans* isomerism, may occur in molecules which possess a double bond. *Cis/trans isomers* are also called *geometric isomers*.

Why is geometric isomerism important? In many instances, the shift from one geometric structure to another turns out to have profound chemical or biochemical significance. The chemistry of vision provides an interesting example. As you may know from biology, the retina is our light detector at the back of the eye. Photoreceptor cells in the retina (rod cells) contain *11-cis-retinal*, a compound derived from *vitamin A*. When light reaches the retina, the *cis*-retinal compound rapidly flips into the *trans*-isomer, and the process gives out a signal to nerve cells and hence to the brain. Then, an enzyme catalyzes the reverse process by flipping *trans*-retinal back to the *cis*-isomer, ready for the next light signal. This is the role of *cis-trans* isomerism in vision.

Criteria for a compound to exhibit geometric isomerism

Geometric (cis-trans) isomers are compounds which have the same chemical formula but differ in the spatial arrangement of the groups that are attached to a *double bond* or *to a ring*. How does this come about?

- The molecule must have a double bond or a ring structure. There is free rotation around a single (σ) bond, and restricted rotation around a double ($1 \sigma + 1 \pi$) bond. Therefore, groups which are attached to the carbon atoms of a double bond are held fixed on one side of the double bond or the other. A similar argument applies to a cyclic (ring) compound.
- The two groups attached to the first carbon atom involved (in a double bond or ring) must be *different from each other*. The other two groups *attached to the other* carbon atom must also be different from each other. Otherwise the two isomers will be indistinguishable!

Geometric Isomers Lab Answers

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