The Fundamental Basics of Nitrogen Inversion

Definition: Simply put, nitrogen inversion is when a nitrogen compound turns inside out.

More specifically, nitrogen inversion is the process in which the **lone pair** of an **sp3** nitrogen atom disappears and appears on the other side.

Conditions for Nitrogen Inversion:
1. Nitrogen has to have a lone pair!
2. Inversion has to be ALLOWED!

Practice problems: Determine whether the structures undergo nitrogen inversion. Try these on your own first.

1. \[ \text{Structure} \]
2. Does not undergo nitrogen inversion because it does not have a **lone pair**.

3. Does not undergo nitrogen inversion because it is **not allowed**. There is too much strain involved in moving the lone pair around because the nitrogen is locked in place by the rings. Therefore, it is not allowed to undergo nitrogen inversion.

3. Does have nitrogen inversion because it has a lone pair and it is not locked in place within a ring, and there is not too much strain involved.

**Why is Nitrogen Inversion important?**

When nitrogen inversion occurs, that nitrogen atom, **cannot be a stereocenter**, even when the criteria for being a stereocenter is met.

Practice Problem: Determine whether the nitrogen atom is a
Stereocenter.

1.

\[
\begin{array}{c}
\text{H} \\
\text{N} \\
\text{CH}_3 \\
\text{O} \\
\text{HO-}
\end{array}
\]

Solution:
1. The nitrogen atom cannot be a stereocenter. Why? It has a lone pair and 3 substituents that are different, so it should be an stereocenter. But, it has a lone pair, which allows nitrogen inversion to occur. Therefore, the nitrogen atom cannot be a stereocenter.

Now, some of you may wonder, can nitrogen ever be a stereocenter?
1. Yes! It can be a stereocenter, when it does not undergo nitrogen inversion.

When does it not undergo nitrogen inversion?
1. When either, the nitrogen atom does not have a lone pair OR when the inversion simply isn’t allowed because of strain.

Practice Problems: Determine whether the nitrogen is a stereocenter.
1.

\[
\begin{array}{c}
\text{O}^{-} \\
\text{CH}_3-\text{C}-\text{Cl} \\
\text{CH}_3\text{CH}_2-\text{N}-\text{H}
\end{array}
\]

2.
3. Solution:

1. Nitrogen is a stereocenter because it has 3 different substituents and nitrogen inversion does not occur because there is no lone pair.
2. Nitrogen is a stereocenter because it has 3 different substituents and the nitrogen inversion is not likely to occur because or=f too much strain.
3. Nitrogen is not a stereocenter because remember, there needs to be at least 3 different substituents for there to be a stereocenter. So always keep in mind, the possibility of nitrogen inversion, but at the same time, don’t forget the other criteria that makes a stereocenter.

Summary:

1. Nitrogen inversion occurs when
   a. There is a lone pair
   b. When it is allowed.
2. When nitrogen inversion occurs, the nitrogen CANNOT be a stereocenter.
3. Nitrogen can still be a stereocenter when
   a. There is no lone pair
   b. When nitrogen inversion is not allowed to occur.

Works Cited
Professor Hardinger’s Thinkbook


<&http://chemwiki.ucdavis.edu/Organic_Chemistry/Organic_Chemistry_With_ a_Biological_Emphasis/Chapter__3%3A_Conformations_and_Stereochemistry/Section_3.3%3A_Stereoisomerism__chirality,_stereocenters,_enantiomers>