

Molecular Models of Real and Mock Illicit Drugs from a Forensic Chemistry Activity

June Featured Molecules

The Featured Molecules for this month come from the paper by Shawn Hasan, Deborah Bromfield-Lee, Maria T. Oliver-Hoyo, and Jose A. Cintron-Maldonado (1). The authors describe a forensic chemistry exercise in which model compounds are used to simulate the behavior of various drugs in a series of chemical tests. Structures of a number of the chemicals used in the experiment, and several of the drugs they are serving as proxy for, have been added to the molecule collection. Other substances used in the experiment are already part of the collection, including caffeine and aspirin.

One structure that may be both intriguing and confusing to students is that of chlorpromazine (Thorazine, Figure 1). A majority of students might well expect the ring portion of the molecule to show a planar structure. This is not what is found from calculations at the HF/6311++G(d,p) level in both the gas phase and in water. Instead, the three rings are in a V-like

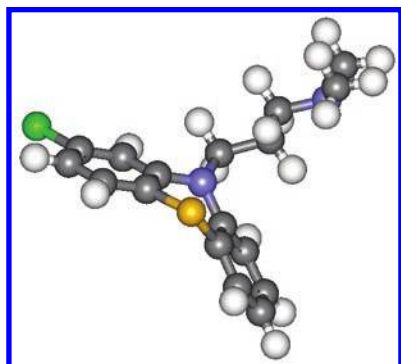


Figure 1. Molecular model of chlorpromazine (Thorazine). Chlorpromazine is classified as an antipsychotic drug for humans and is often used as a tranquilizer drug for animals.

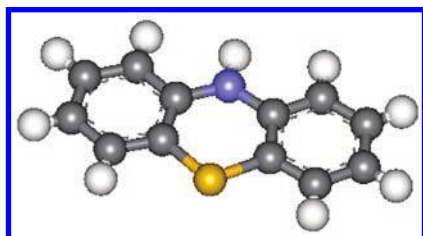


Figure 2. Molecular model of phenothiazine. Phenothiazine is used as an intermediate chemical in the manufacture of various antipsychotic drugs.

formation with a deformation of approximately 50 degrees from planarity. Tracking down the source of this non-planarity would be a useful computational exercise. Does it arise from the presence of the alkyl chain (steric effect), from the chloro group (electronic effect), or from electronic effects involving the elements of the heterocyclic ring?

As a starting point to addressing these questions, students could be introduced to the use of model compounds in computation. One such compound would be the parent ring system phenothiazine (Figure 2). That molecule contains neither a chloro substituent nor an extended alkyl group. Is it also found to be non-planar? Is the deformation angle the same, larger, or smaller than in chlorpromazine? Does the addition of chloro group to phenothiazine change the angle significantly? What about the addition of an alkyl group? If the model compound is forced to be planar are all of the vibrational frequencies real (positive)? If not, what type of deformation is suggested by the imaginary (negative) vibration?

Literature Cited

1. Hasan, Shawn; Bromfield-Lee, Deborah; Oliver-Hoyo, Maria T.; Cintron-Maldonado, Jose A. Using Laboratory Chemicals To Imitate Illicit Drugs in a Forensic Chemistry Activity. *J. Chem. Educ.* 2008, 85, 813–816.

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<http://www.jce.divched.org/Journal/Issues/2008/Jun/abs880.html>

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Supplement

Find “Molecular Models of Real and Mock Illicit Drugs from a Forensic Chemistry Activity” in the JCE Digital Library at <http://www.JCE.DivCHED.org/JCEWWW/Features/MonthlyMolecules/2008/Jun/>.

The molecules added to the collection this month are:

- 2-chloroacetophenone
- acetaminophen
- chlorpromazine
- codeine
- diphenhydramine
- ibuprofen
- indole
- LSD
- methapyrilene
- psilocybin