

## Overview of Pauling and Valence Bond Theory

### Skills to Develop

- List some of Pauling's contributions to chemistry
- Describe some of the limitations of valence bond theory

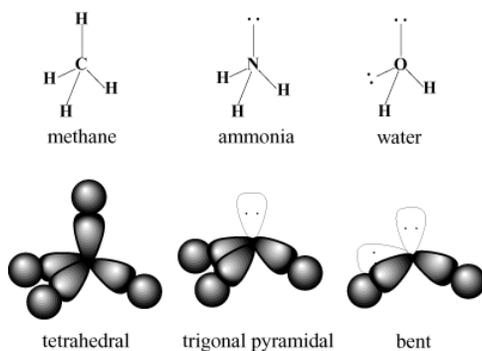
Pauling's father died when he was young and his mother had some medical and psychological problems, so he started working to support the family when he was 13. His mother wanted him to keep working to support her instead of going to college, but he didn't listen. He worked over the summer to earn tuition, but before his third year his mother took the money he had saved for tuition. Luckily, the college gave him a job to cover his tuition. He read Lewis and Langmuir's papers on chemical bonding, and applied to graduate school at Berkeley, where Lewis was. Unfortunately, Berkeley lost his application letter, so he went to Caltech. (After that, Lewis changed the graduate admission process so there would be no more mistakes!)



Linus Pauling

In graduate school, Pauling studied X-ray crystallography, which gave him a good understanding of the structures of molecules, such as bond lengths and bond angles, that was very useful for his later work. However, he had some trouble because he didn't want to give the usual credit to his teachers when he published papers. Pauling wanted to work with Lewis after he finished his doctorate, but the head of Caltech's chemistry department, Noyes, convinced him to go to Europe instead. The reason was that Noyes wanted Pauling to be a professor at Caltech, and was afraid Lewis would give him a job at Berkeley if they were allowed to meet. In Europe, Pauling studied the new quantum mechanics.

Pauling's big contribution to chemistry was valence bond theory, which combined his knowledge of quantum mechanical theory with his knowledge of basic chemical facts, like bond lengths and and bond strengths and shapes of molecules. Valence bond theory, like Lewis's bonding theory, provides a simple model that is useful for predicting and understanding the structures of molecules, especially for organic chemistry. Later Pauling applied his understanding of molecular shapes and bonding to a pretty good explanation of protein structures. Later still, he became famous for peace activism and promoting ascorbic acid (vitamin C) as a cure for colds and cancer.



Examples of using valence bond theory to predict the structures of molecules.

Valence bond theory is good for explaining the "ground state" properties of molecules, or the properties of molecules that only involve the lowest energy states. However, just like a hydrogen atom can be "excited" by light, moving the electron from  $n = 1$  to  $n = 2, 3, 4, \dots$  states, molecules have excited states that can be very important for reactions, colors, etc. Valence bond theory is not good for anything involving excited states, so we will talk about Molecular Orbital Theory as our next big topic.

### Contributors and Attributions

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