7.5: In Depth- In-Phase and Out-of-Phase

46

In Depth: In-Phase and Out-of-Phase

D6.2 Constructive and Destructive Interference

Forming a chemical bond by overlap of two atomic orbitals, which we just described, is equivalent to *constructive interference* of the electron waves for the two hydrogen atoms. It occurs when the two waves are *in-phase*.

For example, in a one-dimensional vibrating string, in-phase means when two waves are both vibrating up (or down) at the same time. In the video below, both ends of the wave device are moving up (or down) at the same time. This results in a bigger wave in the middle, where the two waves overlap.

https://mediaspace.wisc.edu/id/1_0vj...yerId=25717641

A second possibility is that the two waves are *out-of-phase*—one is moving up when the other is moving down. This results in *destructive interference* between the waves. This is shown in the video below. Note that in the destructive-interference video there is a point in the middle of the wave device that never moves up or down. This point has zero amplitude all the time and is a *node*.

https://mediaspace.wisc.edu/id/1_ycc...yerId=25717641

An atom is three dimensional, so it is difficult or impossible to visualize the waves corresponding to an electron in an atom. The principle of in-phase or out-of-phase remains the same, though. In-phase results in constructive interference and larger values of the wave function between two nuclei. Larger wave function corresponds to larger electron density, which attracts the two nuclei. Out-of-phase atomic wave functions result in a node between the nuclei, which leaves two unscreened nuclei that repel.