Balloons, Hybrid Orbitals and Multiple Bonds

Structures of Organic Compounds

Introduction

The use of two shapes of balloons along with color-coordination can facilitate students' understanding of hybridization and the formation of multiple bonds. The balloons represent electron clouds (single electrons).

Concepts

- Hybrid orbitals
- Multiple bonds
- Sigma and pi bonds

Materials

Balloons, airship, 4 (color A) Balloons, round, 12″, same color, 8

Balloons, airship, 4 (color B)

Safety Precautions

The materials used in this activity are considered nonhazardous. Follow all laboratory safety guidelines.

Procedure

1. Inflate and tie off all the balloons. The round balloons represent hybrid orbitals. The airship balloons represent P orbitals.
2. Build two sets of four 12-inch balloons (sp^3 hybrid) twisting the necks of the balloons together.
3. Have two students hold the balloon clusters so that two of the balloons meet head-to-head forming a single (sigma) bond. See Figure 1.

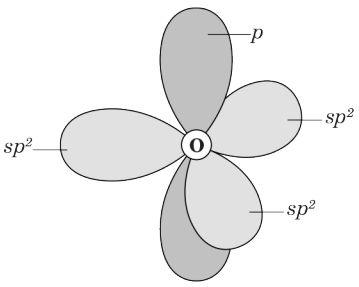

Figure 1.

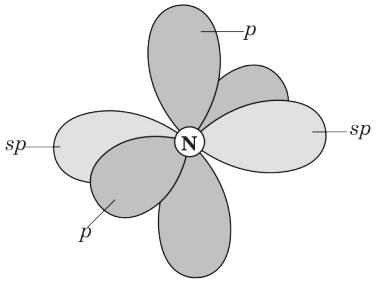

Figure 2.

4. Remove one round balloon from each cluster, and add two airship balloons (color A) to each cluster. Arrange the three round balloons in one plane with the two airship balloons above and below the plane (sp^2 hybrid). Using two students, position the balloon clusters so that a pair of round balloons meets head-to-head in the center with the airship balloons positioned vertically. Bend the airship balloons together above and below the plane forming a pi bond. See Figure 2.
5. Remove one round balloon from each cluster. Add two airship balloons (color B) to each cluster. Arrange the balloons so that the two round balloons in each cluster are opposite each other, color A airship balloons are opposite each other, and color B balloons are opposite each other (sp hybrid).

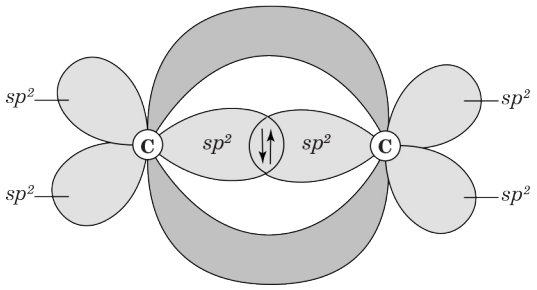

Figure 3.

6. Using three students, hold the clusters so that a pair of round balloons meets head-to-head in the center. Coordinate the airship balloons so that color A is vertical and color B is horizontal. Bend color A balloons above and below the plane and hold them together forming one pi bond.
7. Bend color B balloons front and back and hold them together forming a second pi bond. See Figure 3.

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Discussion

The round balloons represent the hybridized orbitals. The balloons (electron clouds) repel and seek the geometric arrangement that provides maximum distance between electron clouds. Using color-coordinated airship balloons to represent the unhybridized p orbitals allows the visualization of pi bond formation.

An extension of this demonstration can include modeling dsp^3 hybridization by using five round balloons clustered together. The d^2sp^3 hybrid can be modeled with six round balloons. Various combinations of filled and empty orbitals and their resulting molecular geometries can be demonstrated by using one color of balloon for shared orbitals and a different color for unshared (lone) orbitals.

Allowing students to manipulate the large balloon models seems to correlate the abstract concepts of sigma and pi bonding and hybridization represented with textbook diagrams with a meaningful mental picture. Further study of bonding concepts with the use of traditional molecular models is successful after students have worked with the balloons.

Flinn Scientific Best Practices for Teaching Chemistry Video Series

A video of the *Balloons, Hybrid Orbitals and Multiple Bonds* activity, presented by Steve Long, is available in *Structures of Organic Compounds*, part of the Flinn Scientific Best Practices for Teaching Chemistry video series.

Materials for *Balloons, Hybrid Orbitals and Multiple Bonds* are available from Flinn Scientific, Inc.