HYBRID ATOMIC ORBITAL MODELS

A covalent or molecular compound is defined as a compound in which covalent bonds are formed between the atoms. In forming the covalent bond, a pair of electrons is shared between two atoms in a new type of orbital. This new type of orbital results from the overlap of the atomic orbitals.

For many compounds there is no way of explaining the bonding just in terms of s, p and d orbitals. For example, there is no way to describe adequately the bonding in CH_4 which contains four identical C-H bonds. If one of the bonds were formed using an s orbital, and the other three using p orbitals, they would not be identical. Therefore, the concept of hybridization is often used as a method of explaining and predicting the bonding in compounds. This idea visualizes atomic orbitals of different energy of the same atom to combine with each other to form some new type of orbitals of equivalent energy. However, one has to keep in mind that the concept of hybridization is just one method of explaining and predicting bonding and is often used to explain the bonding of molecule of known geometry.

In this activity, the student will construct models of hybrid atomic orbitals of the following types;d^2sp^3 orbitals in the AX_6 molecule, dsp^3 orbitals in the AX_5 molecule, sp^3 orbitals in the AX_4 molecule, sp^2 orbitals in the AX_3 molecule, and the sp orbitals in the AX_2 molecule.

PROCEDURE:

I. Making the Central Atom

A. AX_6, d^2sp^3 – octahedral molecule

1. Draw eight 3”- diameter circles on a cartolina. With a protractor, measure 90° angles on each as shown in Fig 1a. Cut out the circles.

Fig. 1a

2. Cut along the heavy line of the circles. Crease along all lines, then fold cross-hatched section underneath. Glue cross-hatched section underneath as shown in Figure 1b.

Fig. 1b

3. Glue these pieces back to back and insert midribs as shown in Figure 2.

Fig. 2

B. AX_5, dsp^3 – trigonal bipyramidal molecule

1. Draw six 3”- diameter circles on a cartolina. With a protractor, measure 90°, 90°, and 120° angles as shown in Figure 3a. Cut out the circles.

Fig. 3a

2. Cut along heavy lines. Crease along all lines, then fold cross-hatched section underneath. Glue cross-hatched section underneath as shown in Figure 3b.

Fig. 3b

3. Glue these pieces back to back and insert midribs as shown in Figure 4.

Fig. 4

C. AX_4, sp^3 – tetrahedral molecule

1. Draw four 3”- diameter circles on separate cartolina of different colors. With a protractor , measure 109 angles as shown in Figure 5a. Cut out the circles.

Fig. 5a

2. Cut along the heavy lines. Crease along all lines, then fold cross-hatched section underneath. Glue cross-hatched section underneath as shown in Figure 5b.

Fig. 5b

3. Glue these pieces back to back and insert midribs as shown in Figure 6.

Fig. 6

D. AX_3, sp^2 – trigonal planar molecule

1. Draw three 3”- diameter circles on a cartolina and three more on another color of cartolina. With a protractor, measure 90°, 90° and 120° angles as shown in Figure 3a. Cut out the circles.

2. Cut along heavy lines. Crease along all lines, then fold cross-hatched section underneath. Glue cross-hatched section underneath as shown in Figure 3b.

3. Glue these pieces back to back with pieces of the same color glued together. Insert three midribs at 120° angles.

II. Making the X Atoms

1. Draw seventy-two 2'- diameter circles according to the following color breakdown:

   24 pieces – same color
   16 pieces – same color
   20 pieces – same color
   12 pieces – same color

   Cut out the circles.

2. Crease each one along the diameter and glue four pieces of the same color back to back as shown in Figure 7.

Figure 7

III. Construction of the Models

1. To construct an AX_6 model, insert six X atoms of the same color into the six midribs of the A atom.

2. Do the same for the AX_5, AX_4, and AX_3 models, using the same color of X for a single model.

3. Submit your models to the instructor.