32390 FUSED MOLECULE SET

Purpose:

To permit the construction of a wide range of molecular models which are easily visible from any point in a classroom or laboratory.

Contents:

Atom		Bonds	Color
20	Hydrogen w/single bonds	1	White
7	Carbon	4	Black
6	Carbon	3	Black
2	Carbon	2 double	Black
6	Oxygen	2	Red
2	Oxygen	1 double	Red
1	Nitrogen	4	Blue
2	Nitrogen	3	Blue
2	Sulfur	4	Yellow
4	Halogens	1	Green
5	Double & Triple Bonds	(caps with dowel)	
25	Single Bonds	(dowel)	

Background:

The atoms are represented in two distinct sizes in various colors. All hydrogen atoms are 1.5" in diameter and have plastic inserts already cemented into them. Oxygen, Nitrogen and Carbon atoms are approximately 3" in diameter. This size difference approximates the true ratio of a hydrogen atom to oxygen, nitrogen and carbon atoms.

The atoms are constructed of molded plastic foam which allows for building large lightweight molecules that will not fall apart easily. (Internal variations in molded foam balls may occasionally cause loose sockets. A loose socket may be re-cemented in place using white glue).

Atoms vary in size. The smallest, hydrogen, has a covalent radius of approximately one twenty six millionth of a millimeter (0.37Å or Angstrom units) and the largest, cesium and francium, have a radii six times greater than hydrogen. The 1.5" diameter ball used in this kit is hydrogen and the finished model may be considered about 500 million times the actual size.

All balls are provided with flats at valance bonds, points at which atoms are held together by electron force. When two balls are assembled, a fused or blended appearance is represented. This approximates the actual molecular proportions as the distance between centers of two bonded atoms is less than the sum of their two radii. This distance varies somewhat in different molecules, however, the variation is far overshadowed by the fact that the diameter of an atom is at best a nebulous figure. The actual electron cloud which determines size does not have a measurable diameter and assumptions must be made from inter-nuclear distances which can be measure

Examples:

Use the wood dowel connectors for joining balls other than hydrogen. Push connectors into holes as needed. Connectors in the hydrogen balls should not be removed.

Some simple molecules are the water molecule (H_2O) and the ammonia molecule (NH_3). Each is considered flat or planar, although both are suspected to be modifications of tetrahedral arrangements. The bond angle of the water molecule is 105° , however, the 110° spacing is sufficiently accurate for the model.

Carbon dioxide is a good example to demonstrate the double bond molecule. The molecule is linear and it's double bond is shown by using one the double bond connectors which, when assembled, shows a white collar between bonded atoms. C_2H_2 acetylene, another linear molecule, has a triple bond joining the carbon atoms.

There are other simple molecules that may be constructed:
H_2O_2 , hydrogen peroxide which distinctly shows two valence points common to oxygen bond,
HCl , hydrogen chloride or hydrochloric acid, displays the single valence of chlorine,
HNO_3, nitric acid, shows the usual trivalent nitrogen atom,
H_2SO_4, sulfuric acid, displays the normally four bonded or tetrahedral sulfur atom.

CARBON COMPOUNDS:

Carbon compounds are a special class with a wide variation of organic types. Carbon is tetrahedrally bonded as shown by the examples of CCl_4, carbon tetrachloride and $CHCL_3$, chloroform. The CH_4 methane molecule is a basic building block. If another carbon atom is added along with more hydrogen atoms to fill out the bonds, a C_2H_6 ethane molecule is formed. Adding again creates a C_3H_8 propane molecule. Continuing the procedure of adding one carbon and two hydrogen atoms in the typical aliphatic chain results in C_4H_{10} butane; C_5H_{12} pentane, etc.... (The last two examples cited are not illustrated).

The C_6H_6 benzene ring is well illustrated by using the carbon atoms which are provided with three flats. Many variations can be built upon the benzene ring. An oxygen atom and hydrogen atom combined represent an OH "hydroxyl" group. Joining a carbon and hydrogen atom to the hydroxyl group creates a well known series: CH_3OH, which is methanol or methyl alcohol; adding another carbon and two hydrogen creates C_2H_5OH, which is ethanol or ethyl alcohol; by continued additions becomes C_6H_5OH, phenol or carbolic acid. Note its similarity to the benzene ring.

ISOMERISM:

Often two or more compounds exist whose characteristics are quite different, but contain the same number of the same atoms. This is known as "Isomerism" and accounts, in part, for the huge number of organic compounds. An example is the C_2H_5OH ethanol molecule described above, which is a liquid. The same atoms arranged as C_2H_6O creates methyl ether, a colorless gas.

A final example of the hundreds of isomers that can be constructed is the $C_7H_5N_3O_6$ trinitrotoluene or TNT. This is essentially a benzene ring to which other groups are added. Construct the model as follows: Join six trivalent carbons into a ring. Assemble three NO_2 groups and join them to three alternate carbons of the carbon ring. Be sure to join N to C, not O to C. Make one CH_3 group and join to an unfilled carbon on the carbon ring. Complete the assembly by adding a hydrogen atom to each of the two remaining unfilled carbons of the ring.

Numerous models may be constructed with ease by referring to a standard chemistry textbook which uses structural formulas in the text. The following table is given as a guide to basic knowledge pertaining to molecular model studies.

Atom	Relative Diameter	Color
Hydrogen	0.75	White
Oxygen	1.48	Red
Nitrogen	1.50	Blue
Carbon	1.54	Black
Sulfur	2.08	Yellow
Halogens	1.44 - 2.66	Green

Time Allocation:

No advance preparation prior to model assembly is required for this product. Individual experiment times will vary depending on methods of instruction, but normally will not exceed one class period to make and use any three models.