

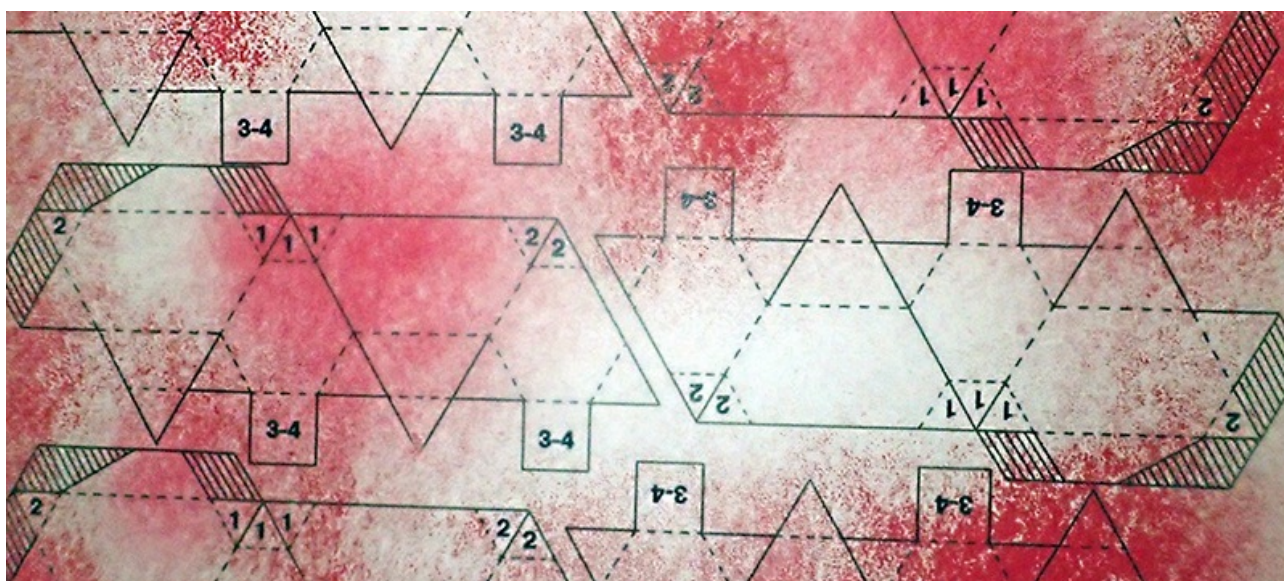
# Double bonds

*Shannon and Ian Jacobs*

To model the covalent bonding of atoms Lewis imagined valence electrons shared between orbitals (atoms). The idea was to make each atom have a complete set of eight outer electrons to complete the shell (except for hydrogen that has a full shell with just two electrons).

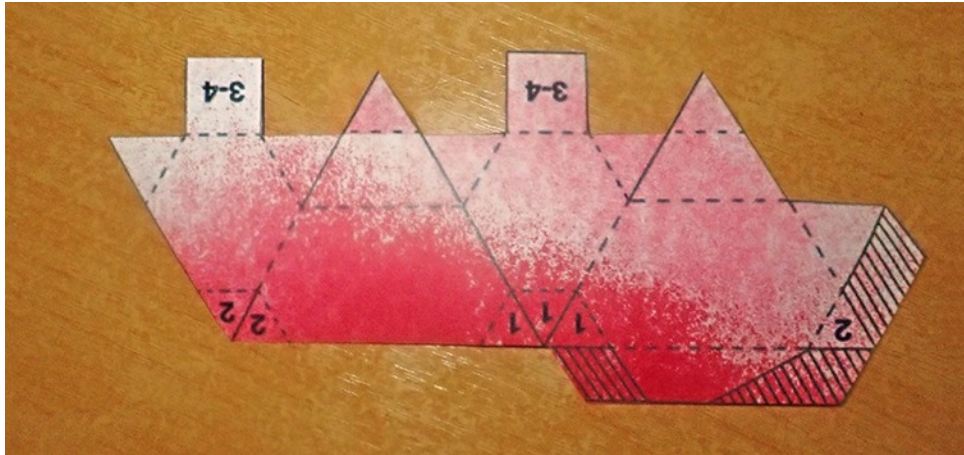
The simple paper models we made in *Molecular models* (linked above) had triangular snub points to represent single bonds. To model a double bond, with two pairs of shared electrons, imagine the edge of a tetrahedron snubbed to make a wide flat connection between the two points. Now imagine squeezing the end points inwards, keeping flat sides and edges on the modified tetrahedron, until the flattened edge becomes a square.

It takes more energy to break a double bond than a single bond. A double bond is said to be stronger. An oxygen model made with a net from the sheet below, that has been spray-painted red on the back, will have one square snub point and two sharp points. The square snub point has a larger area than a single bond triangular snub point, modelling increased bond strength, and the bond is shorter, as are real double bonds.



A section of a sheet of nets, spray-painted red on the back, make oxygen models with a double bond. *See below for the link to download the nets.*

Cut out a red net. *Be careful not to remove the shaded tags and not to separate the small triangles labelled 1 and 2. Cut along solid lines only.*

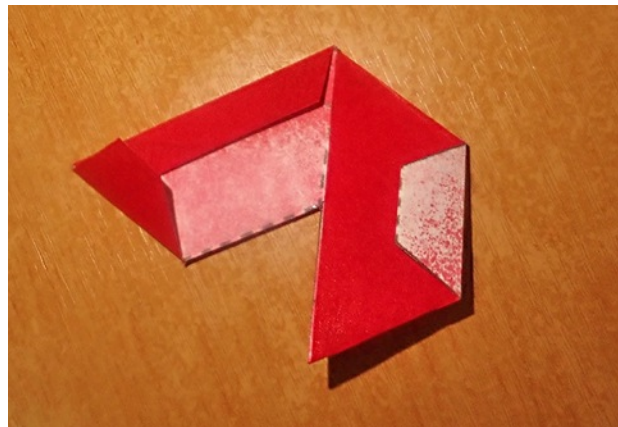


First fold all the tags down. *Make the folds straight and on the lines.*

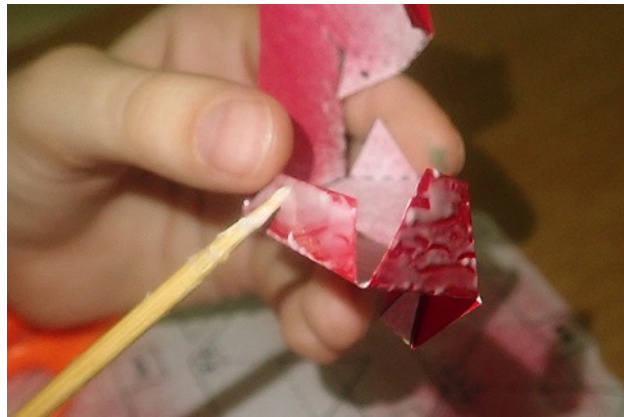


Hold the folded paper flat on a hard surface and crease the folds firmly to make sharp edges.

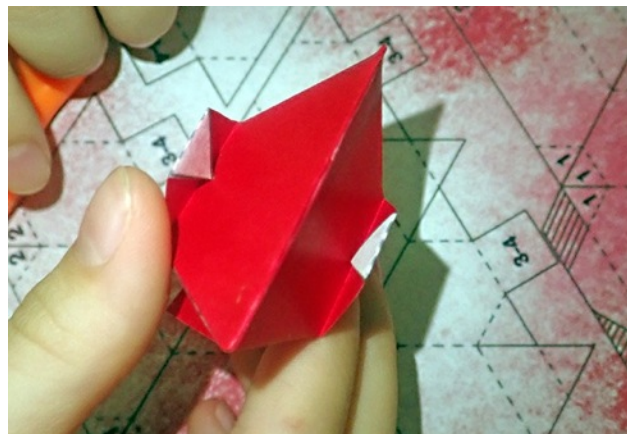
Now fold the two long tags up and crease them again. Fold and crease the paper along the dashed lines to make the edges of your model. *Be careful to always line up the dashes with an edge as shown.*



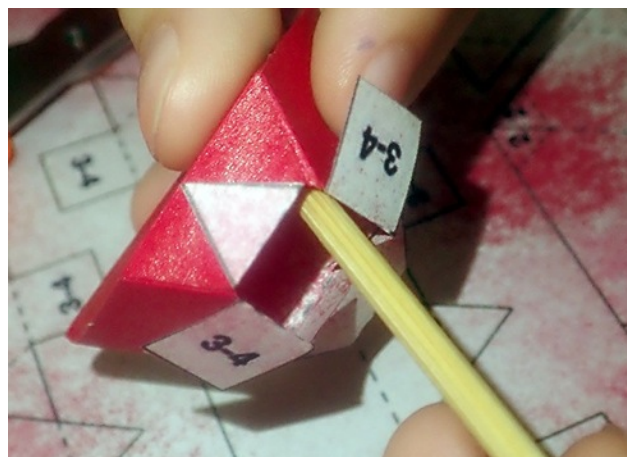
Open the model up and check that the corners will be sharp and properly formed. Put glue on both the long tags. Place the glued tags inside the faces of the model at the same time, forming a sharp point.



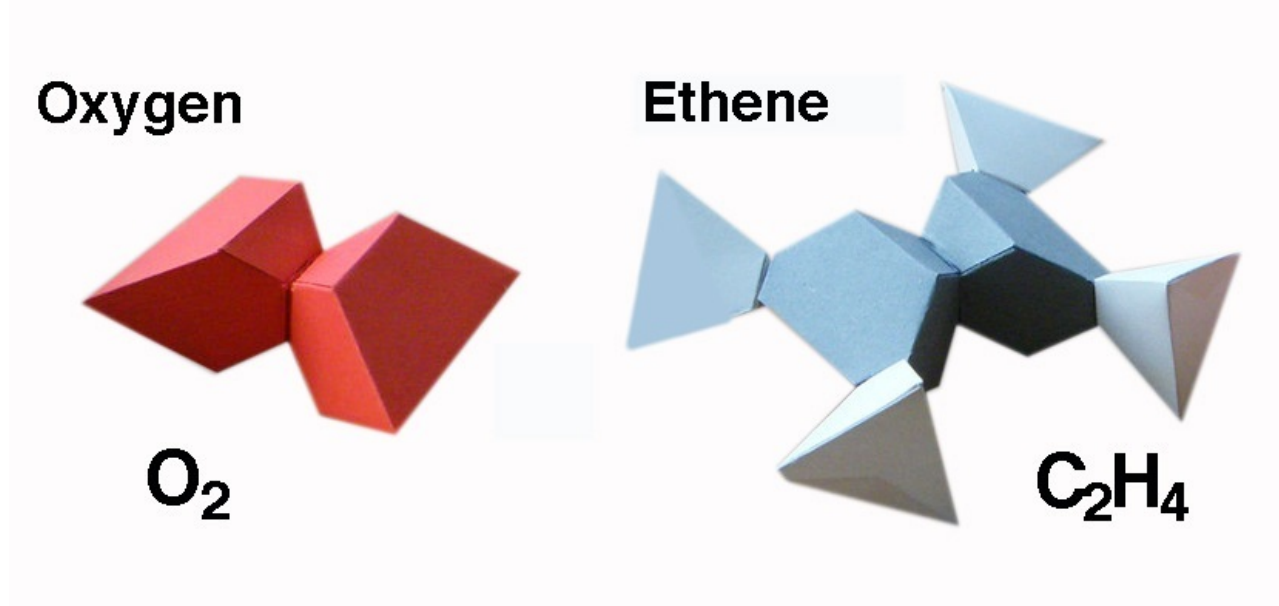
Inspect the sharp point and the newly glued edges. Complete the square snub point one side at a time, putting glue on the triangular tags.



Reach inside the model to push the tags firmly into position.



Spray-paint a second pair of the same nets black to represent carbon. Cut out the nets and *this time remove all the shaded tags and separate the small triangles labelled 1 and 2*. The carbon model will have one square double bond snub point and two single bond triangular points. Make up four hydrogen nets. Two double-bond oxygens and two carbons with four hydrogen models make the two models below.



The stable form of oxygen in the atmosphere is the double bonded  $O_2$  molecule. Note the shortened bond of larger area. (We will model the unstable ozone molecule  $O_3$  in a later article.)

An ethene molecule (also known as ethylene) has two double bonded carbon atoms surrounded by four single bonds to four hydrogen atoms.

Ethene is the gas used to ripen fruit. If you see a rack of uniformly ripe mangoes in a shop they were probably ripened with ethene. Try this at home for yourself by putting an apple, which emits ethene, in a sealed plastic bag with green bananas or mangoes.

Ethene is an important raw material for the manufacture of polythene (*poly-ethylene*) and polystyrene. We will describe models of small sections of these monster molecules in a later article.