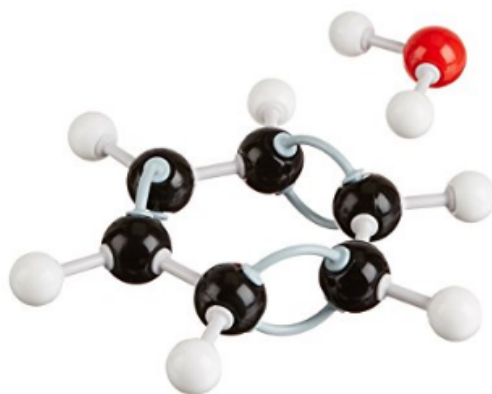


# Molecular models

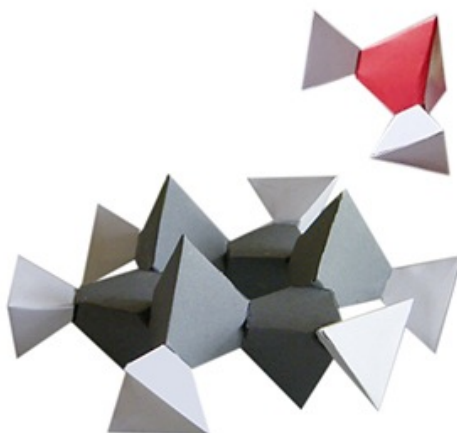
*Shannon and Ian Jacobs*

I want to do Chemistry. I fancy myself mixing and making new things and I want to learn all about that now. Dad says “Yes ... but ...” He says that Chemistry is not easy to get into if you don’t know the names of atoms like carbon and oxygen and how each atom attaches itself to others. He says we should start with models of molecules.



Schools make models with balls and springs.

We could buy a set but he says that if we want to make benzene (whatever that is) we might run out of bits, so it’s better to make our own models from paper (like this) so we never run out.



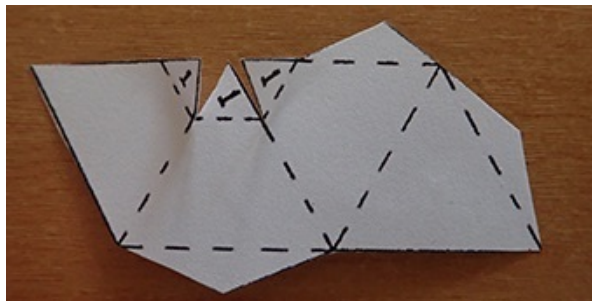
He says the balls are nice but tetrahedral models are better, and I’ll understand why when I’ve made some: so let’s do it!

## Making models

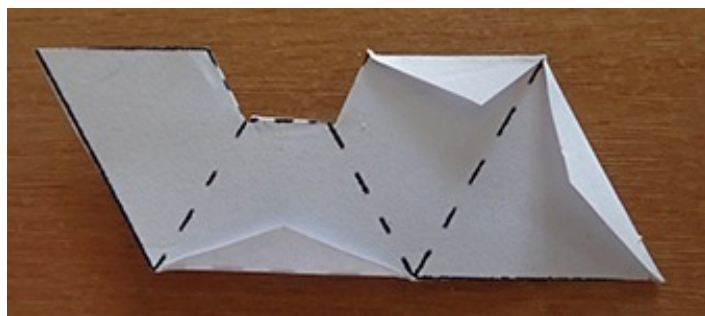
Print the double sided sheet in the pdf linked at the bottom of the page on one sheet of A4 paper. The front has four patches of colour: green, red, blue and black. The other side (below) has lines for cutting and folding.



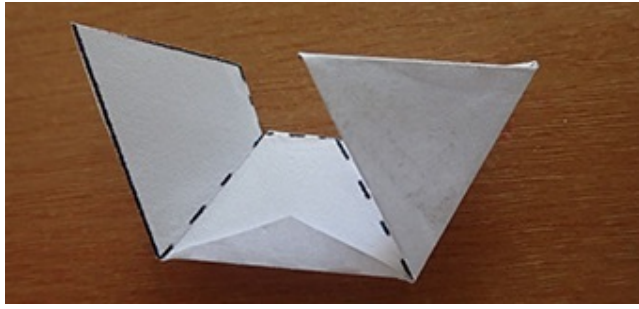
*Make sure you cut and fold exactly on the lines.*



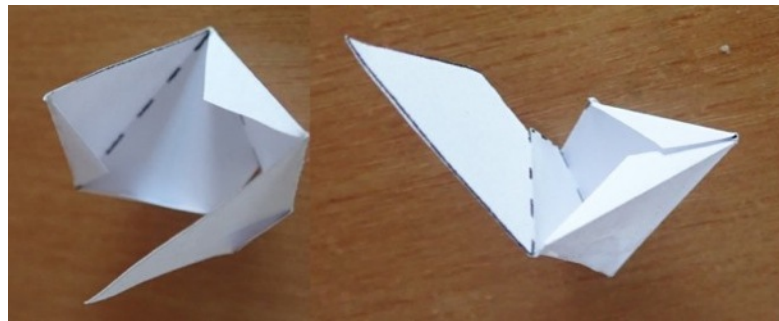
**1** *Cut out a white hydrogen net. Fold the triangles down and the tags up.*



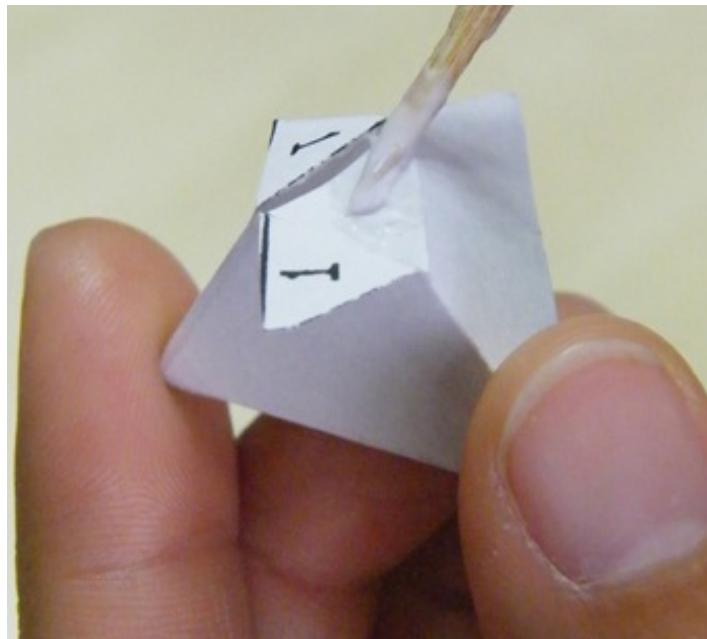
*Crease the fold lines firmly.*



**2** *Fold the edge lines up and crease them firmly.*



**3** *Lift the tags so the tag-folds become right angle bends. Spread a little glue on the single tag (left) with a skewer and press it in place on the inside. Put glue on both remaining tags (right) and press the last side in place.*



**4** *Close the snub point one flap at a time and add glue.*

You have a white snub-tetrahedron that represents a hydrogen atom: make more. It's easier the second time.

*Be careful to keep your hands clean so you don't get glue on the outside of the model. Be careful to cut and fold on the lines, make sharp straight edges and flat sides. You might want to throw away your first tries because they are not as neat as your new ones.*

### **A model of a water molecule: H<sub>2</sub>O**

*Cut out the red oxygen net with two sets of small triangles.*

*Follow steps 1-4 above. Make a red tetrahedron with snub points.*

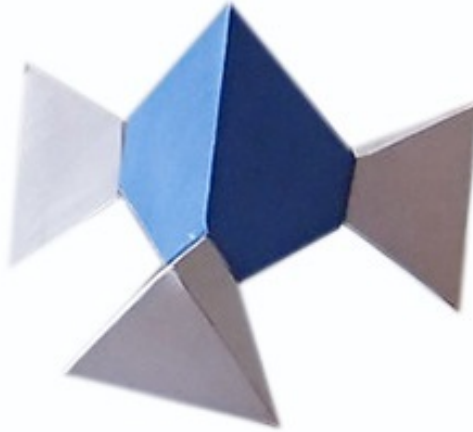


*Take two white hydrogen models and glue them to the snub points of the oxygen model to make a **water molecule**.*

**Note:** *your model is bent like a real water molecule. With these tetrahedral models the bend is automatic. If you use balls and springs you must be told where to drill the holes. This is an important advantage of these models because water, like ammonia below, is a **polar molecule** (look that up on the web) and the bend in the molecule determines the unusual and very important properties of water.*

## A model of an ammonia molecule: $\text{NH}_3$

*Cut out the blue **nitrogen** net with three sets of small triangles.*



*Follow steps 1- 5 to make a blue tetrahedron and add three hydrogen models to make an **ammonia molecule**.*

## A model of a methane molecule: $\text{CH}_4$

*Cut out the black **carbon** net with four sets of small triangles.*



*Follow steps 1- 5 to make a black tetrahedron and add four hydrogen models to make a **methane molecule**.*



## A model of a hydrogen fluoride molecule: HF

*Cut out the green **fluorine** net with one snub point.*

*Follow steps 1- 5 to make a green tetrahedron and add one hydrogen model to make a **hydrogen fluoride molecule**.*



That's it: a set of molecular models.



Methane: **CH<sub>4</sub>**, Ammonia: **NH<sub>3</sub>**, Water: **H<sub>2</sub>O**, Hydrogen fluoride: **HF**

## More information

**Methane** ( $\text{CH}_4$ ) is fart gas, from people yes, but mostly from cows. There are lots of cows in the world, and they are bigger than people. Methane also bubbles up from natural bogs and from land-fills. The gas burns well and can be used to power engines to generate electric current.

*I wonder if I could make a methane digester in the garden without alarming the neighbours or my mother?*

**Ammonia** ( $\text{NH}_3$ ) is made by bacteria acting on urea. Urea is the salt in urine. Now we use 'Pampers' this common smell has gone from houses, but Daddy says that when he was little mothers used cloth nappies inside plastic pants at night to stop little children and babies wetting their beds. In the morning the nappy smelt of ammonia. It's a strange smell, difficult to describe. Look in a supermarket for a floor cleaner with ammonia. Buy a bottle, take the top off and smell it. The smell is the very small amount of ammonia gas that evaporates from the floor cleaner. Ammonia dissolves so well in water that there are tricks that can be done with it. Lookup *ammonia fountain* on the web.

*I wonder if I could make floor cleaner with ammonia at home?*

**Water** ( $\text{H}_2\text{O}$ ) is everywhere, in the taps in the house, and in the air as a gas called water vapour.

*Without water there would be no life on earth.*

**Hydrogen fluoride** is off limits: sorry. We're not going to make that one. HF dissolves in water to make hydrofluoric acid, which is so corrosive that it dissolves glass. Glass artists use it to draw pictures on glass.

*That acid can be bought, but please leave it alone for now.*