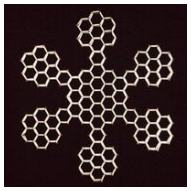


Teaching resource 3

Water and ice

You will need:	
24 white hydrogen H^b	24 grey straws
12 red oxygen O^k	24 white longer straws

Water can demonstrate extraordinary behavior: It is an excellent solvent, has a remarkably high melting point and boiling point for its low molecular mass, exhibits an unusually high surface tension and expands on freezing.

Use these simple demonstrations to show some of these characteristics.

Structure of Water

The unit of water is a molecule represented by the formula H_2O. Use a red oxygen atom and two white hydrogen atoms joined by grey straws to make a model of water as illustrated in Figure 1 below:

Figure 1

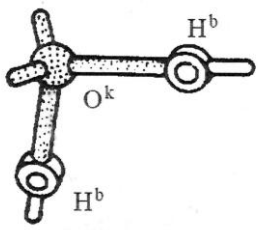
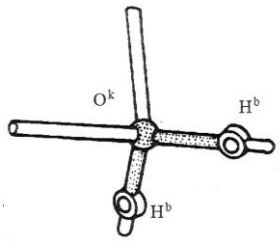


Figure 2



The two unused prongs on the oxygen atom are important: Each may be taken as representing an extra electron pair which projects from the oxygen nucleus. These 'lone pairs' play an important part in the chemistry of water. They are negatively charged and can therefore attract the positively charged hydrogen atoms of the other water molecules.

Add two white straws to the spare prongs of the red oxygen atom to make a tetrahedral shape as shown in figure 2.

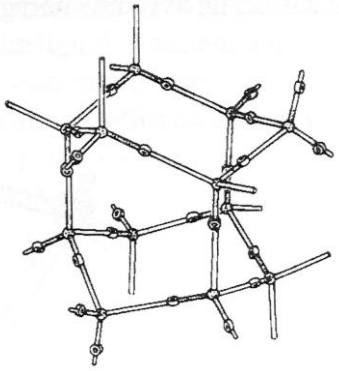
Water in the liquid state
Separate water molecules only exist in steam. In liquid water neighbouring water molecules are loosely linked together. These links between molecules are constantly breaking and forming.

Join several of the water molecules together with the white straws taking care always to join a red oxygen atom to a white hydrogen atom. The white straws represent the weak bonds between molecules which are known as hydrogen bonds.

Water as ice
As the temperature drops so the amount of hydrogen bonding increases and gets stronger. When liquid water turns to ice, hydrogen bonding links each water molecule to four others in a tetrahedral arrangement. This structure is more open than the random arrangement of molecules in the liquid phase. It reduces the density which is why ice floats on water.

To make an accurate structure of ice take 12 water molecules (as shown in figure 2) and join them together to make the cage structure shown in Figure 3. Note the highly symmetrical, hexagonal nature of the cage. This is what cause snowflakes to form in hexagonal states.

Figure 3



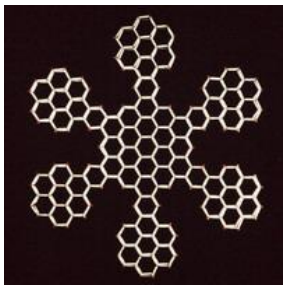


Figure 4: Minit Ice Model

Continuing to make and join the hexagonal cages will form a complete snowflake such as in the model above.

Why does water expand in freezing?
When the ice cage is completely bonded the structure becomes 'open' with empty space which water does not have therefore causing water to expand upon freezing.

Water as a solvent
View our related 'Teaching Resource 1. Why salt dissolves in water' to explore this topic.

Products which can be used for this demonstration:

0046 Orbit Basic Structures Class Set | 0026 Orbit Basic Structures Individual Set
0048 Orbit Lattices Structures Class Set | 0028 Orbit Lattice structures Individual Set
0041 Large Class set
1249 Ice Colorwave model | 0093 Ice Minit Proview model

Or you can order sufficient individual atoms from the Orbit, Minit or Unit systems for your individual needs.