LESSON 12

Famous molecules

Q1. Do some modelling to decide which of these are unlikely to be molecules: CH_2Cl_2, CCl_5, $CHCl_3$, CCl_4, and CH_2Cl. *[CCl_5 cannot be modelled, and CH_2Cl gives a model with an empty hole. Neither of these can be found in any dictionary.]*

- CH_2Cl_2 is the methylene chloride molecule. You will see its name in hardware stores, written on cans of paint remover.
- $CHCl_3$ is the molecule of chloroform, an anaesthetic well known to readers of detective stories.
- CCl_4 : you did not have enough Cl cubes to model it, but answer the next question to find why carbon tetrachloride is an effective fire extinguisher.

Q2. Work out the molecular weight of CCl_4 stuff, and decide whether it would rise or sink when it is made hot enough to be a gas. *[12 u + (4 x 35) u = 152 u. The molecular weight is so much greater than air's molecular weight that when the liquid is squirted on to the flames, the CCl_4 gas formed sinks, and blankets the fire, preventing the air from reaching it.]*

Q3. Now model two different molecules with the formula C_2H_6O.

Q4. Can you model a third molecule with the same formula? *[It's impossible, and there is no third substance made of C_2H_6O molecules in any dictionary.]*

Q5. Find some way of showing on paper the two C_2H_6O structures. *[Perhaps CH_3-O-CH_3 and CH_3-CH_2-OH. Even drawing the models would do the job.]*

The molecules in which O is sandwiched between two C atoms make a gas. Zillions of the other C_2H_6O molecules make a liquid called ethanol, or ethyl alcohol, or sometimes just alcohol. It is the stuff in beer, wine and whisky that makes people drunk if they have too much.

All the molecules in this lesson can be found in an English dictionary, and here are some bigger molecules to look up (too big unfortunately for you to model): paracetamol, glucose, nicotine, vitamin C, TNT, and adrenalin.

Notes for Parents

The understanding of carbon tetrachloride as a fire extinguisher is a simple illustration of why molecular weights are needed in science. Water (H_2O) hosed on a fire gives steam, which is lighter than air and quickly escapes upwards, so water must be continuously played on the fire to put it out. Because its gas stays low a little carbon tetrachloride can in some cases be more effective than a lot of water.

The atomic weights of He, H, F, C, O, F and Br are all close to integers, but Cl's is close to 35.5 u, so the molecular weight of CCl_4 is nearer 154 u than 152 u. For present purposes that is an unimportant detail.

A dictionary sometimes gives not just the formula, but the structure of a molecule. For example, under "ethylene glycol" (used as antifreeze in cars) Longmans English dictionary gives its structure $HOCH_2CH_2OH$, instead of its less informative formula, $C_2H_6O_2$. The formula can easily be got by adding up the various atoms in the structure.

The Notes for Parents of Lesson 10 shows by an example how the structures of molecules were determined. That was a very simple example. Assigning structures to bigger molecules by chemical arguments inspired extreme ingenuity, and though not widely known about, was (we chemists believe) one of the greatest of human achievements. The climax of these methods came in the 1920s, when the structure of strychnine was determined: a molecule of 47 atoms arranged in 7 rings. Nowadays the structures of molecules are determined by much quicker methods.