12. Boron nitride, $BN_{(s)}$, is a network covalent compound with unique properties. It has very high melting and boiling points, conducts heat well, is a soft slippery solid like graphite, but unlike graphite, is a nonconductor of electricity. It is used as an additive to plastics, ceramic mixes, and lubricants, where it adds lubricating and thermal transmission properties and, to ceramics, increased strength. It can be used as a dry lubricant in powdered form. The network structure is planar hexagonal sheets, much like graphite, except that the hexagon corners are alternating B and N atoms. As in graphite, the atoms within a single crystal sheet of boron nitride are strongly bonded with covalent bonds, while each sheet is attracted to the next only by London force.
13. Biological computers have been a scientific dream for years. The progressive technology of miniaturization is driven by the fact that the more transistors one can place on a microchip, the faster and more powerful the processor will be. The logical limit to miniaturization is at the level where individual switches would be molecular (or even atomic) in size. Current mechanical computers depend on a huge number of possible circuits through microscopic transistor "switches" engraved photographically on silicon-based semiconducting microchips.

    Recently, Dr. Ehud Shapiro, working at the Weismann Institute in Israel, constructed a different kind of mechanical computer that is designed along the theoretical lines of proposed biological computers. The key point here is that such a computer operates as a continuous ribbon of individual information "cells." These cells are scanned by a read/write head that moves along the ribbon from cell to cell, reading symbols, writing symbols, and changing its control state as it goes. Alan Turing created such a concept on paper in 1936, and the system has been called a Turing Machine ever since. Biologists believe that ribosomes operate in a somewhat similar fashion—they may be thought of as biological computers preprogrammed by messenger RNA to assemble proteins.

    Scientists theorize that someday the ability to build such computers from biological components might result, for example, in microscopic devices that could be programmed to adjust any desired chemical levels within the body. Perhaps they might also produce needed proteins on demand, and replace many or most medical treatments now in existence. The possibilities seem endless, and will certainly include applications not yet dreamed of.

CHAPTER 4 LAB ACTIVITIES

ACTIVITY 4.3.1 SHAPES OF MOLECULES

(Page 277)

Prediction

(a) According to the VSEPR theory,

CCl_4 should be tetrahedral, with 4 bond pairs around the carbon atom.

C_2Cl_4 should be trigonal planar at each end, with three groups of electrons (one double bond and two single bonds) around each carbon atom. The overall molecule should be flat (i.e., in one plane).

C_2F_2 should be linear around each carbon atom, with two groups of electons (a triple bond and a single bond) around each carbon atom. The overall shape of the molecule should also be linear.

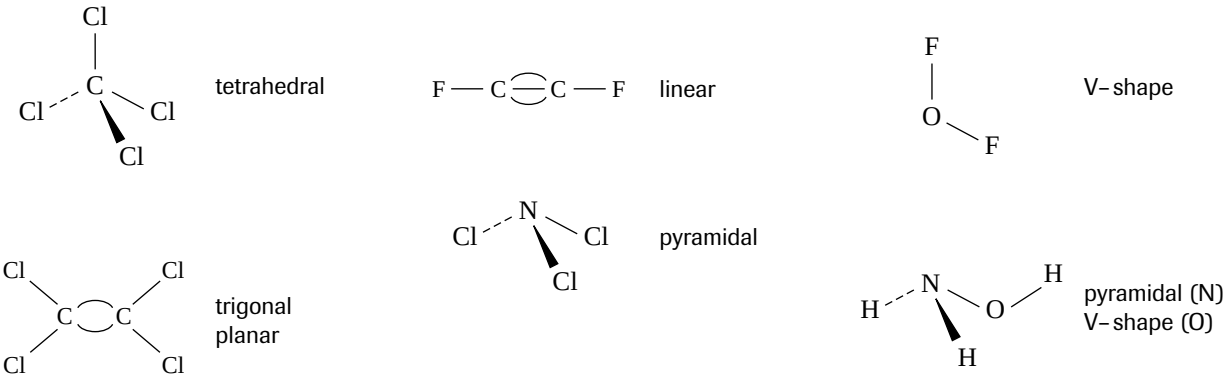
NCl_3 should be pyramidal, with 3 bond pairs and 1 lone pair around the nitrogen atom.

OF_2 should be V-shaped, with 2 bond pairs and 2 lone pairs around the oxygen atom.

NH_2OH should be pyramidal around the nitrogen, with 3 bond pairs and 1 lone pair around the nitrogen atom; and V-shaped around the oxygen, with 2 bond pairs and 2 lone pairs around the oxygen atom. There is no simple description of the overall shape of the whole molecule.

Evidence/Analysis

(b)



Evaluation

(c) The evidence from the molecular models agrees with the predictions for each central atom. In all cases, except NH_2OH, the shape of the whole molecule was predicted. NH_2OH does not seem to have an overall shape because the ends of the molecule can rotate. Therefore, the predictions are generally verified, indicating an adequate understanding of VSEPR theory as it applies to the structure of small molecules. Additional information may be needed to know if there is a preferred orientation of molecules with two or more central atoms which can rotate about a bond axis.

INVESTIGATION 4.4.1 TESTING FOR POLAR MOLECULES

(Page 277)

Prediction

(a) According to the empirical rules in Table 1, water, ethanol, 1,2-ethanediol, and acetone all have polar molecules because they fall into the category of oxygen and other atoms, or carbon and two other kinds of atoms. Pentane and hexane have nonpolar molecules because they fall into the category of carbon and only one other kind of atom.

Evidence

(b)

Testing Liquids with Charged Strips

Substance	Chemical formula	Effect of charged strip	
		Acetate	Vinyl
acetone	$(CH_3)_2CO_{(l)}$	attracted	attracted
1,2-ethanediol	$C_2H_4(OH)_{2(l)}$	attracted	attracted
ethanol	$C_2H_5OH_{(l)}$	attracted	attracted
hexane	$C_6H_{14(l)}$	no effect	no effect
pentane	$C_5H_{12(l)}$	no effect	no effect
water	$H_2O_{(l)}$	attracted	attracted

Analysis

(c) According to the evidence collected, acetone, 1,2-ethanediol, ethanol, and water all have polar molecules because they were all attracted to the charged strips. Hexane and pentane were not attracted. Therefore, they do not have polar molecules.

Evaluation

(d) The experimental design seems very simple with no obvious flaws. The question was clearly answered. An improvement might be to specify more specifically where the charged strip should be placed. It is also not clear if the strips were charged the same each time. This could be somewhat controlled by rubbing the strip the same number of times each time it is charged. Neither of these should substantially affect the results. If quantitative results are desired, more sophisticated equipment and procedure would be required. Overall, I am reasonably confident with the evidence.

(e) The results clearly agree with the prediction. Therefore, the prediction has been verified and the empirical rules appear acceptable.

LAB EXERCISE 4.5.1 BOILING POINTS AND INTERMOLECULAR FORCES

(Page 278)

Prediction

(a) Molecules of the hydrogen compounds of one group will all be similar in shape and polarity (polar versus nonpolar). Therefore, the dipole–dipole forces between molecules for members of the same group should be similar. For example, the Group 14 hydrogen compounds all have symmetrical tetrahedral molecules and therefore should be nonpolar. The other groups have molecules that are all nonsymmetrical and therefore will be somewhat polar, producing some dipole–dipole effects. The only significant difference within a group of hydrogen compounds will be the increasing number of electrons per molecule as you go down the group. Therefore, based on the rule for London forces, the strength of these forces should increase down the group and the boiling points should increase accordingly. This tendency should produce a graph that has the following general trend for each group of hydrogen compounds.