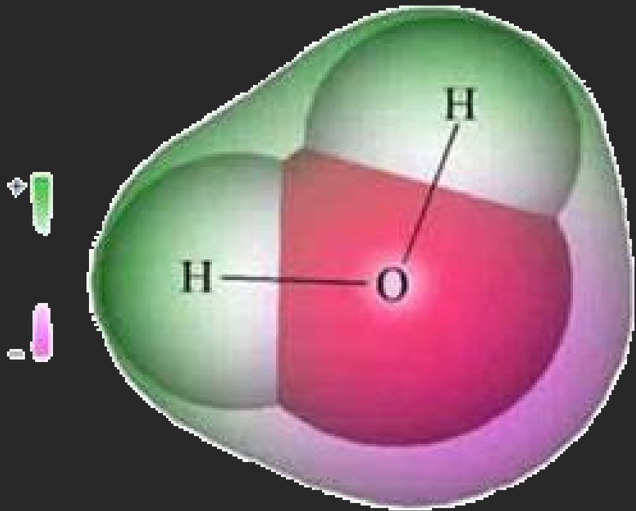
COVALENT BONDING part 2

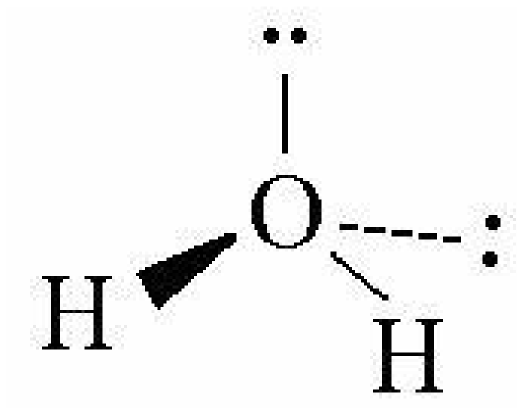


Water

Hydrogen and oxygen combine to form water.

Oxygen (2, 6) needs to gain two electrons to become like neon (2, 8) Hydrogen needs to gain one electron to become like helium.

Hence covalent bonds are formed between one oxygen atom and two hydrogen atoms to form the covalent molecule water:



In this way each hydrogen atom and the oxygen atom ‘consider’ that they have achieved the noble gas configuration (because each atom ‘counts’ both electrons in the shared pair).

The actual appearances of the two covalent molecules in these examples is shown in Figure 2.3. While strong covalent bonds bind the atoms together within each molecule, the molecules are able to move about more or less independently of one another.

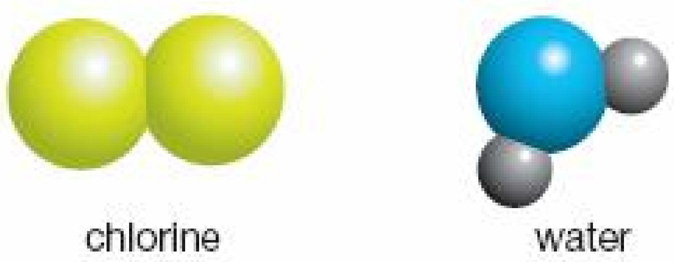


FIGURE 2.3
Simple covalent molecules

Substances (elements or compounds) that are made up of simple covalent molecules as in Figure 2.3 are called **covalent molecular substances** or sometimes just *molecular substances* (to distinguish them from *covalent lattices*

COVALENCY AND THE PERIODIC TABLE

Covalent bonding occurs when *both* of the elements forming the compound need to gain electrons to attain noble gas configurations—in the above two examples, chlorine and chlorine, hydrogen and oxygen.

Elements in the centre and to the right of the Periodic Table tend to form covalent compounds—elements such as carbon, silicon, nitrogen, phosphorus, oxygen, sulfur, fluorine, chlorine (though the last four commonly form ionic compounds also).

The number of covalent bonds an atom forms is the number of electrons that an atom needs to gain to acquire a noble gas configuration—one for hydrogen and chlorine, two for oxygen (as in the above examples), three for nitrogen and four for carbon.

The position of an element in the Periodic Table tells us how many electrons the atom needs to gain to attain a noble gas configuration and so it tells us how many covalent bonds the atom will form.

Nitrogen (Group 5) needs another three electrons so it forms three covalent bonds (for example in ammonia, NH_3). Carbon (Group 4) needs another four electrons so it forms four covalent bonds (for example in methane CH_4).

EXERCISES

5 Draw electron-dot diagrams and give molecular formulae for the covalent molecules formed between:

a hydrogen and chlorine

b two bromine atoms

*c nitrogen and hydrogen

*d sulfur and fluorine

6 Explain why:

a the compound formed between fluorine and oxygen is F_2O and not FO_2 or FO

*b ammonia is NH_3 and not NH_2 or NH_4

7 Decide the formula you would expect, and give your reasons, for the compound formed between:

a sulfur and chlorine

b hydrogen and iodine

*c silicon and hydrogen

*d phosphorus and fluorine

8 a Draw electron-dot structures for the bromide ion and the oxide ion.

*b In a very small number of compounds nitrogen exists as the nitride ion. Draw an electron-dot structure for this ion.

c Draw electron-dot structures for barium and caesium atoms and the ions they form.

PROPERTIES OF COVALENT MOLECULAR AND IONIC SUBSTANCES

TABLE 2.1 Contrasting properties of covalent molecular and ionic substances

Ionic substances	Covalent molecular substances
solids at room temperature	at room temperature, generally *gases* (N_2, SO_2, NH_3) or *liquids* (H_2O, CCl_4, methanol CH_3OH); a few are solids (I_2, PCl_5, CBr_4)
high melting points (typically above 400°C) and *high boiling points* (typically over 1000°C)	*low melting points* (generally below 200°C) and *low boiling points* (generally below 400°C)
hard and brittle	when solid they are *soft*
as solids *they do **not** conduct electricity*	pure covalent substances *do not conduct electricity* either as solids or as liquids
when molten or when in aqueous solution *they **do** conduct electricity*.	in aqueous solution *do not conduct electricity* (unless they actually react with water to form ions)

These properties can be explained by the nature of the two types of bonding.