

4.2 - Covalent bonding

A covalent bond forms by atoms sharing electrons

The octet rule states that when atoms react they tend to achieve a outer shell with eight electrons.

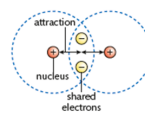
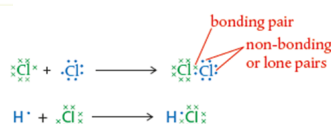
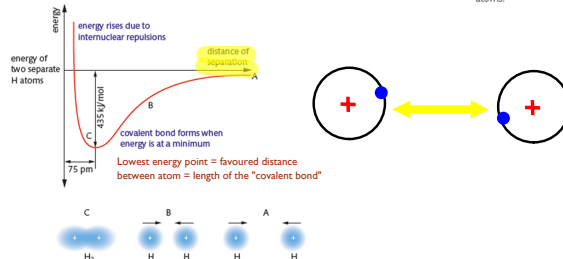
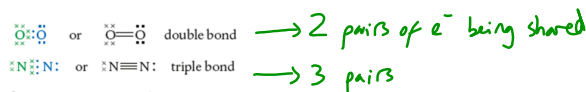


Figure 4.5 In a covalent bond the shared electrons are attracted to the nuclei of both atoms.

How does this diagram relate to a covalent bond?



Atoms can share more than one pair of electrons to form multiple bonds



Short bonds are strong bonds

- Bond length:** a measure of the distance between the two bonded nuclei.
- Bond strength:** usually described in terms of **bond enthalpy**, which will be discussed in Chapter 5, and is effectively a measure of the energy required to break the bond.

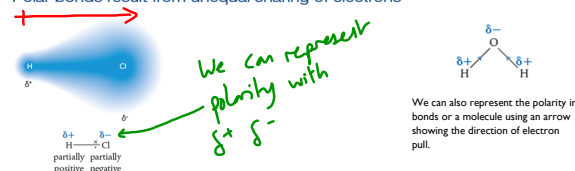
As atomic radius increases as we go down a group, we would expect the atoms to form molecules with longer bonds. For example:



How and why does bond order (single, double, triple bond etc.) affect bond length strength?

Hydrocarbon	C_2H_6	C_2H_4	C_2H_2
Structural formula	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C}-\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	$\begin{array}{c} \text{H} & \text{H} \\ \diagdown & / \\ \text{C}=\text{C} \\ / & \diagdown \\ \text{H} & \text{H} \end{array}$	$\text{H}-\text{C}\equiv\text{C}-\text{H}$
Bond between carbon atoms	single	double	triple
Bond length / pm	154	134	120
Bond enthalpy / kJ mol^{-1}	346	614	839

Polar bonds result from unequal sharing of electrons



We can now see that there is a continuum between ionic bonding and pure covalent bonding instead of a clear cut mid point. This can be used to explain the unusual properties of some substances.

Ionic	Polar covalent	Pure covalent
complete transfer of electrons	partial transfer of electrons unequal sharing of electrons	equal sharing of electrons
Na^+Cl^-	HF , HCl , HBr , HI	Cl_2
ionic lattice		discrete molecules

Exercises

10 Which substance contains only ionic bonds?

- A NaNO_3 B H_3PO_4 C NH_4Cl D CaCl_2

11 Which of the following molecules contains the shortest bond between carbon and oxygen?

- A CO_2 B H_3COCH_3 C CO D CH_3COOH

12 For each of these molecules, identify any polar bonds and label them using δ^+ and δ^- appropriately:

- (a) HBr (b) CO_2 (c) ClF

- (d) O_2 (e) NH_3

13 Use the electronegativity values in Section 8 of the IB data booklet to predict which bond in each of the following pairs is more polar.

- (a) C-H or C-Cl (b) Si-Li or Si-Cl (c) N-Cl or N-Mg



