

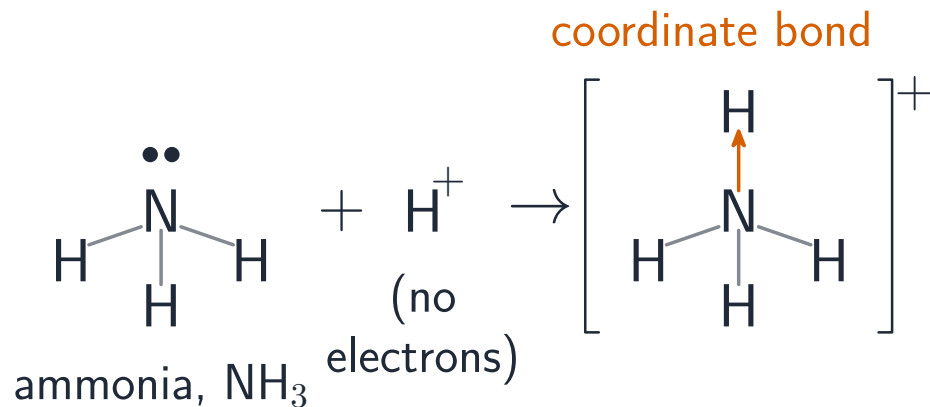
Exercise walk-through

3.2

Ionic bonding

A-Level Chemistry

Covalent and coordinate bonds



A **covalent bond** is a shared pair of electrons.

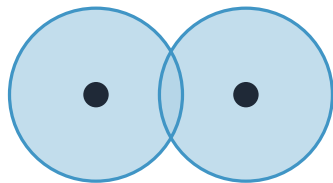
In a **coordinate bond** (dative) **both** electrons come from one atom – e.g. N's lone pair makes NH_4^+ .

Sigma and pi bonds

Covalent bonds form when **orbitals** overlap:

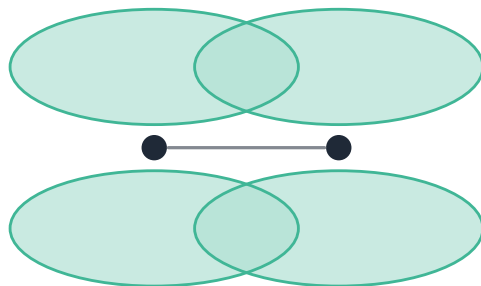
- a **sigma bond** σ – head-on **overlap**
- a **pi bond** π – sideways p-orbital overlap

Double = $1\sigma + 1\pi$; triple = $1\sigma + 2\pi$. **Hybridisation** : sp , sp^2 , sp^3 .



σ bond:

head-on overlap



π bond: sideways overlap
of p orbitals

Bond energy and bond length

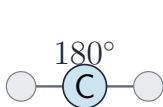
- **bond energy** is the energy needed to break one mole of a particular covalent bond in the gas state.
- **bond length** is the distance between the centres of the two bonded atoms.

Shapes of molecules

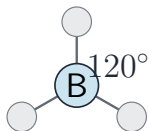
VSEPR theory : electron pairs push apart as far as possible.

A **lone pair** repels harder than a bonding pair, squeezing the **bond angle** ($\sim 2.5^\circ$ each) – so NH_3 is 107° , H_2O 104.5° .

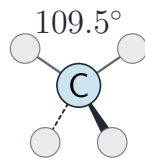
Shapes of molecules, in detail



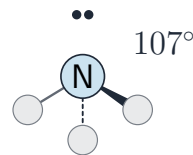
linear
CO2



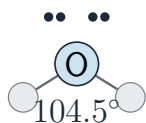
trigonal planar
BF3



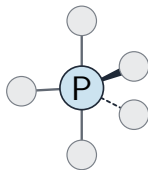
tetrahedral
CH4



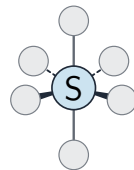
pyramidal
NH3



bent
H2O



trig. bipyramidal
PF5, 120° & 90°



octahedral
SF6, 90°

The seven shapes from VSEPR theory; the lone pairs on NH3 and H2O push harder, squeezing the bond angle below 109.5°

Exercises 2.1-3.1

2.1 Define **ionic bonding**.

[2]

2.2 State the charges on the ions in magnesium oxide.

[1]

3.1 Ionic bonding is best described as:

[1]

☐

A a shared pair of electrons

B the electrostatic attraction between oppositely charged ions

C positive ions in a sea of electrons

D weak forces between molecules

Exercises 2.1·3.1

2.1 Define **ionic bonding**.

[2]

2.1

- the electrostatic attraction between oppositely charged ions (cations and anions)
-

2.2 State the charges on the ions in magnesium oxide.

[1]

2.2

- Mg^{2+} and O^{2-}
-

3.1 Ionic bonding is best described as:

[1]

☐

A a shared pair of electrons

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C positive ions in a sea of electrons

D weak forces between molecules

3.1 B

- Ionic bonding is the electrostatic attraction between oppositely charged ions

Exercises 3.2·3.3

3.2 Which compound contains ions with charges 2+ and 2−?

[1]

☐

A NaCl

B MgO

C CaF₂

D HCl

3.3 Describe, in terms of electron transfer, how the ionic bond forms in calcium fluoride, CaF₂.

[3]

Exercises 3.2-3.3

3.2 Which compound contains ions with charges 2+ and 2-?

[1]

☐

A NaCl

B MgO

C CaF₂

D HCl

3.2 B

- MgO has Mg²⁺ and O²⁻

3.3 Describe, in terms of electron transfer, how the ionic bond forms in calcium fluoride, CaF₂.

[3]

3.3

- each calcium atom loses 2 electrons to form Ca²⁺; each of two fluorine atoms gains 1 electron to form F⁻; the oppositely charged ions attract in a lattice

Exercise 3.4

3.4 Explain why magnesium oxide has a higher melting point than sodium chloride. [2]

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3.4

- MgO has ions with higher charges ($2+/2-$ vs $1+/1-$), so a stronger electrostatic attraction needing more energy to break