

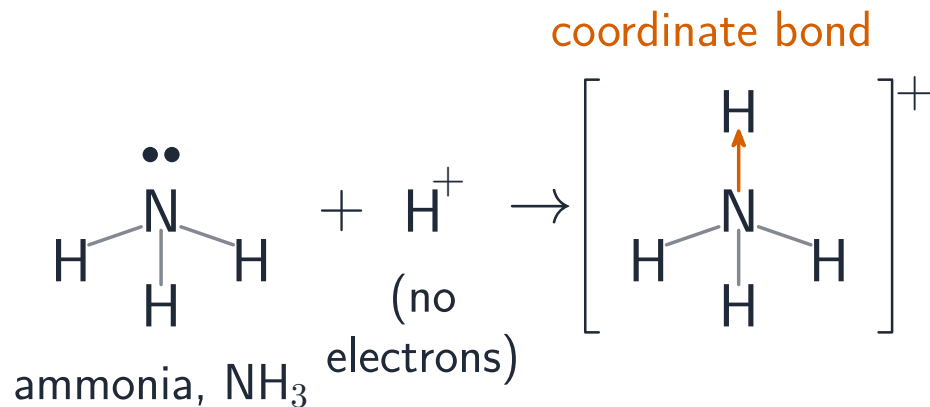
Exercise walk-through

3.1

Electronegativity and bonding

A-Level Chemistry

Covalent and coordinate bonds



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

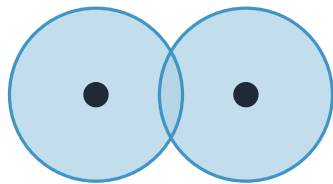
In a **coordinate bond** (dative) **both** electrons come from one atom – e.g. N's lone pair makes NH_4^+ .

Sigma and pi bonds

Covalent bonds form when **orbitals** overlap:

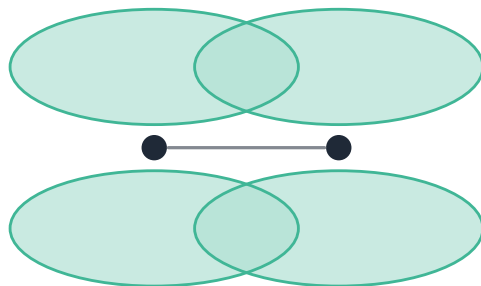
- a **sigma bond** σ – head-on **overlap**
- a **pi bond** π – sideways p-orbital overlap

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

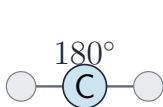
- **bond energy** is the energy needed to break one mole of a particular covalent bond in the gas state.
- **bond length** is the distance between the centres of the two bonded atoms.

Shapes of molecules

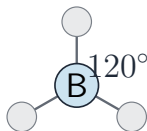
VSEPR theory : electron pairs push apart as far as possible.

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° .

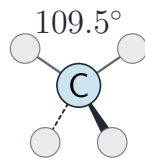
Shapes of molecules, in detail



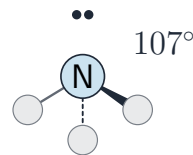
linear
CO2



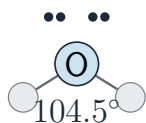
trigonal planar
BF3



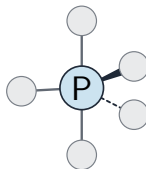
tetrahedral
CH4



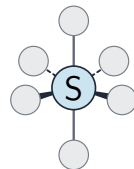
pyramidal
NH3



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 **electronegativity**.

[1]

2.2 State the most electronegative element.

[1]

3.1 Electronegativity increases across Period 3 because:

[1]

☐

A the atomic radius increases

B the nuclear charge increases while shielding stays similar

C more shells are added

D the atoms gain electrons

Exercises 2.1·3.1

2.1 Define **electronegativity**.

[1]

2.1

- the power of an atom to attract the electrons in a bond towards itself

2.2 State the most electronegative element.

[1]

2.2

- fluorine

3.1 Electronegativity increases across Period 3 because:

[1]

☐

A the atomic radius increases

B the nuclear charge increases while shielding stays similar

C more shells are added

D the atoms gain electrons

3.1 B

- Rising nuclear charge with similar shielding pulls bonding electrons more strongly

Exercises 3.2-3.3

3.2 Two elements have a **large** difference in electronegativity. The bond between them is likely to be: [1]

- ☐ **A** metallic
B ionic
C pure covalent
D a hydrogen bond

3.3 Explain why electronegativity decreases down Group 17. [3]

Exercises 3.2-3.3

3.2 Two elements have a **large** difference in electronegativity. The bond between them is likely to be: [1]

- ☐ **A** metallic
B ionic
C pure covalent
D a hydrogen bond

3.2 B

- A large electronegativity difference gives an ionic bond

3.3 Explain why electronegativity decreases down Group 17. [3]

3.3

- down the group each element has more shells, so a larger atomic radius and more shielding; the nucleus attracts the bonding electrons less strongly, so electronegativity falls

Exercise 3.4

3.4 Using electronegativity, explain why the bond in HCl is polar.

[2]

Exercise 3.4

3.4 Using electronegativity, explain why the bond in HCl is polar. [2]

3.4

- chlorine is more electronegative than hydrogen, so it pulls the bonding electrons closer, giving Cl a $\delta-$ and H a $\delta+$ – a polar bond