

Covalent Bonding Map

Edexcel A Level Chemistry · Topic 2 Bonding and Structure · Covalent Bonding

1 The covalent bond

2A.7

- Non-metal atoms **share** a pair of electrons
- Both **nuclei attract** the shared pair between them
- A strong electrostatic attraction
- Attraction to the pair outweighs nuclear repulsion
- Giant covalent solids: very high melting temperatures

2 Dot-and-cross diagrams

2A.8 i

- Outer shells overlap; shared pairs in the overlap
- Dots for one atom, crosses for the other
- Lone pairs**: unshared outer pairs
- Usually 8 round each atom (2 for H)
- Double bond: 2 pairs ($\text{O}=\text{C}=\text{O}$); triple: 3 ($\text{N}\equiv\text{N}$)



3 Bond length and strength

2A.9

- Bond length**: distance between the two nuclei
- Attraction to the pair balances nuclear repulsion
- More shared pairs: shorter, stronger
- $\text{C}\equiv\text{C}$ 120 < $\text{C}=\text{C}$ 134 < $\text{C}-\text{C}$ 154 pm
- $\text{C}=\text{C}$: $\sigma + \pi$, stronger but not twice $\text{C}-\text{C}$

4 Dative covalent bonds

2A.8 ii

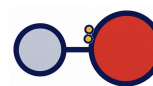
- Both shared electrons from **one atom**
- Donor: a **lone pair**; acceptor: an **empty orbital**
- Drawn as an arrow: $\text{H}_3\text{N}\rightarrow\text{H}^+$
- NH_4^+ and H_3O^+ : brackets and + round the ion
- Al_2Cl_6 : two $\text{Cl}\rightarrow\text{Al}$ dative bonds



5 Electronegativity

2A.13

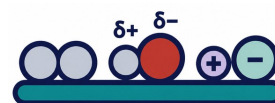
- Attraction of an atom for a **bonding pair**
- Pauling scale: F 4.0 the highest
- Increases across** a period: more protons
- Decreases down** a group: larger, more shielded
- O 3.5, N 3.0, Cl 3.0, C 2.5, H 2.1



6 Polarity and the continuum

2A.14

- Different electronegativities: a **polar bond**
- δ^- on the more electronegative atom
- Difference 0: non-polar; small: polar covalent
- Large difference: **ionic**, electron transferred
- Ionic and covalent: ends of one **continuum**



Electronegativity difference and bond type

Pauling values; the boundaries are gradual, not sharp

Bond	Electronegativities	Difference	Partial charges	Bond type
Cl-Cl	3.0, 3.0	0	none	non-polar covalent
C-H	2.5, 2.1	0.4	almost none	almost non-polar
H-Cl	2.1, 3.0	0.9	$\text{H}\delta^+ \text{Cl}\delta^-$	polar covalent
O-H	3.5, 2.1	1.4	$\text{O}\delta^- \text{H}\delta^+$	polar covalent
Al-Cl	1.5, 3.0	1.5	$\text{Al}\delta^+ \text{Cl}\delta^-$	polar, ionic character
Na-Cl	0.9, 3.0	2.1	$\text{Na}^+ \text{Cl}^-$	ionic

Worked examples

Drawing a molecule

- Count outer electrons of each atom
- Share until each has 8 (H: 2)
- Add the lone pairs last

Spotting a dative bond

- Is there a lone pair (N, O, Cl)?
- Is there an empty orbital (H^+ , B, Al)?
- Arrow from the lone pair to it

Comparing bonds

- More pairs: shorter, stronger
- Bigger difference: more polar
- Very big difference: ionic

Polar bonds do not always make polar molecules: the shape decides (Shapes of Molecules).

