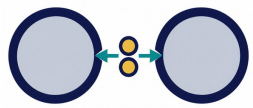
Covalent Bonding Map

Cambridge International AS & A Level Chemistry · Topic 3 Chemical bonding · Covalent bonding

1 Covalent bonds

3.4.1, 3.7

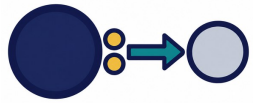
- Two nuclei attracted to a **shared pair**
- Dot-and-cross: shared pairs in the overlap
- **Lone pairs**: outer pairs not shared
- Double bond: 2 pairs; triple bond: 3
- Period 3 can **expand the octet**: PCl_5, SF_6, SO_2



2 Coordinate bonds

3.4.1(c)

- Both shared electrons from **one atom**
- Donor: a **lone pair**; acceptor: an empty orbital
- $NH_3 + HCl \rightarrow NH_4^+Cl^-$
- Al_2Cl_6: two Cl → Al bonds
- Once formed: like any other bond

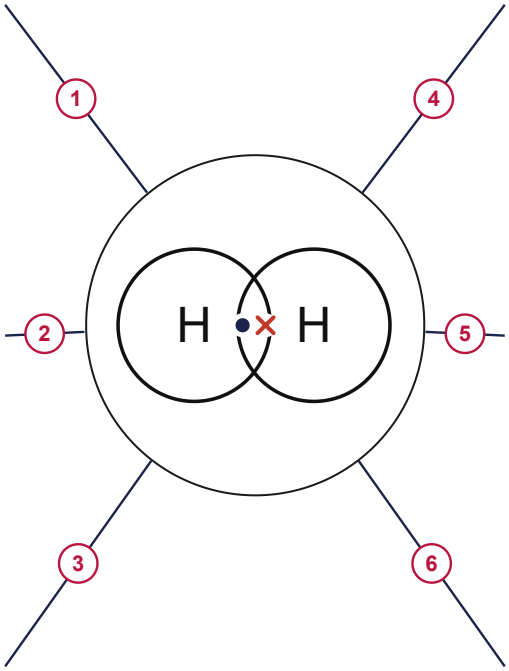


3 σ and π bonds

3.4.2(a)–(b)

- **σ**: direct overlap between the nuclei
- **π**: sideways overlap of p orbitals
- π density above and below the σ bond
- Single σ; double σ + π; triple σ + 2π
- π bonds stop rotation; π weaker than σ

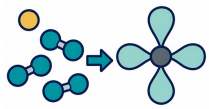




4 Hybridisation

3.4.2(c)

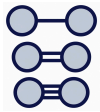
- Atomic orbitals mix: **hybrid** orbitals
- **sp^3**: four, 109.5° (CH_4, C_2H_6)
- **sp^2**: three, 120°, one p left (C_2H_4)
- **sp**: two, 180°, two p left (HCN, C_2H_2)
- Leftover p orbitals make π bonds



5 Bond energy and length

3.4.3

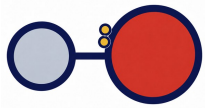
- **Bond energy**: break one mole, gaseous
- **Bond length**: internuclear distance
- More shared pairs: **shorter, stronger**
- Larger atoms: longer, weaker (H–F to H–I)
- Strong bonds: unreactive (N≡N)



6 Electronegativity

3.1, 3.6.2

- Power of an atom to **attract electrons**
- **Up** across a period, **down** a group
- Nuclear charge, radius, shielding
- Different values: a **polar** bond, δ+ and δ−
- Large Pauling difference: **ionic**



Bond length and bond energy

data-booklet style values; more shared pairs and smaller atoms give shorter, stronger bonds

Bond	Shared pairs	σ + π	Length / pm	Energy / kJ mol^{-1}
C–C	1	σ	154	350
C=C	2	σ + π	134	610
C≡C	3	σ + 2π	120	840
N≡N	3	σ + 2π	110	945
H–Cl	1	σ	127	431
H–I	1	σ	161	299

Worked examples

Counting σ and π

- Every bond line: one σ
- Each extra line: one π
- HCN: two σ, two π

Spotting a coordinate bond

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

Bond type from Pauling values

- Difference 0: non-polar
- Small: polar covalent
- Large (NaCl 2.1): ionic

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

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