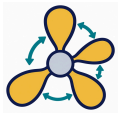
# Shapes of Molecules and Ions Map

AQA A-level Chemistry · 3.1.3 Bonding · Shapes of molecules and ions

## 1 Electron-pair repulsion 3.1.3.5

- Count the pairs round the **central atom**
- Pairs **repel**: as far apart as possible
- The arrangement of pairs sets the shape
- A double or triple bond: **one region**
- Name the shape from the **atoms** only



## 2 Bonding pairs only 3.1.3.5

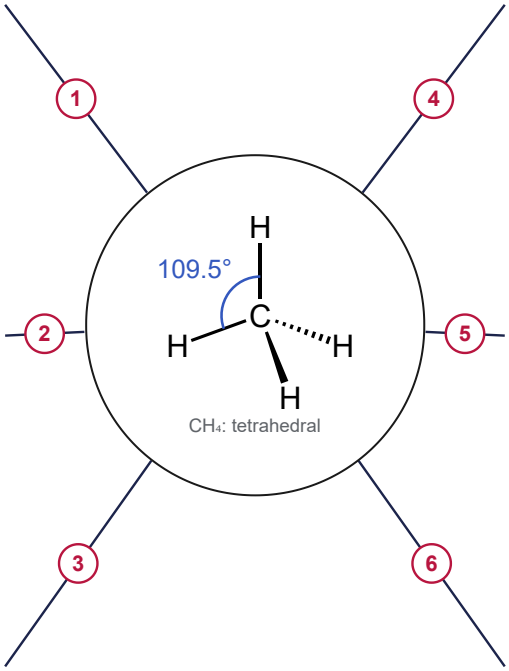
- 2: **linear**, 180° ($BeCl_2$, $CO_2$)
- 3: **trigonal planar**, 120° ($BCl_3$)
- 4: **tetrahedral**, 109.5° ($CH_4$, $NH_4^+$)
- 5: **trigonal bipyramidal**, 120° and 90° ($PCl_5$)
- 6: **octahedral**, 90° ($SF_6$)



## 3 Lone pairs 3.1.3.5

- A lone pair is held by one nucleus: repels **more**
- Lone–lone > lone–bond > bond–bond
- About 2.5° less per lone pair
- $NH_3$: **pyramidal**, 107°
- $H_2O$: **bent**, 104.5°






## 4 Five and six pairs 3.1.3.5

- Period 3 atoms can hold more than 8
- Five pairs: lone pairs go **equatorial**
- $SF_4$ seesaw; $ClF_3$ T-shaped (87.5°)
- Six pairs, two lone: **opposite**
- $XeF_4$ square planar; $IF_5$ square pyramidal



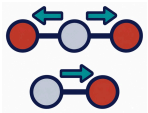
## 5 Related species 3.1.3.5

- Adjust the centre's electrons for the **charge**
- Same pairs: **same shape**
- $H_3O^+$ like $NH_3$: pyramidal
- $NH_2^-$ like $H_2O$: bent
- $PH_3$ like $NH_3$; $H_2S$ like $H_2O$



## 6 Polar molecules 3.1.3.6

- Polar bonds give bond **dipoles** (δ+ → δ−)
- Polar molecule: an **overall** dipole
- Symmetrical, identical atoms: dipoles **cancel**
- Non-polar: $CO_2$, $BF_3$, $CCl_4$, $SF_6$
- Polar: $H_2O$, $NH_3$, $CHCl_3$, HCl



## Electron pairs and shapes

pairs round the central atom; each lone pair closes the angles by about 2.5°

| Pairs | Bonding | Lone | Shape | Angle | Example |
|---|---|---|---|---|---|
| 2 | 2 | 0 | linear | 180° | $BeCl_2$, $CO_2$ |
| 3 | 3 | 0 | trigonal planar | 120° | $BCl_3$, $C_2H_4$ |
| 4 | 4 | 0 | tetrahedral | 109.5° | $CH_4$, $NH_4^+$ |
| 4 | 3 | 1 | pyramidal | 107° | $NH_3$, $H_3O^+$ |
| 4 | 2 | 2 | bent | 104.5° | $H_2O$, $NH_2^-$ |
| 5 | 5 | 0 | trigonal bipyramidal | 120°, 90° | $PCl_5$ |
| 6 | 6 | 0 | octahedral | 90° | $SF_6$ |
| 6 | 4 | 2 | square planar | 90° | $XeF_4$ |

## Worked examples

### Predicting a shape

- Outer electrons, ± the charge
- Bonds, then lone pairs
- Arrange the pairs; name from atoms

### Bond angles

- No lone pairs: the regular angle
- Each lone pair: about 2.5° less
- Double bond: one region

### Is it polar?

- Are there polar bonds?
- What is the shape?
- Symmetrical, identical atoms: non-polar

Polar molecules attract each other through permanent dipoles (Forces between molecules, 3.1.3.7).

**Online Learning System** · onlinelearningsystem.net · © 2026 Online Learning System. All rights reserved. Not for redistribution.