3.5 Shapes of molecules

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS vsepr theory • bond angle • tetrahedral • trigonal planar • lone pair

Objective

Build the skills to answer exam questions on **shapes of molecules** – using **VSEPR theory** to predict shapes and **bond angles** .

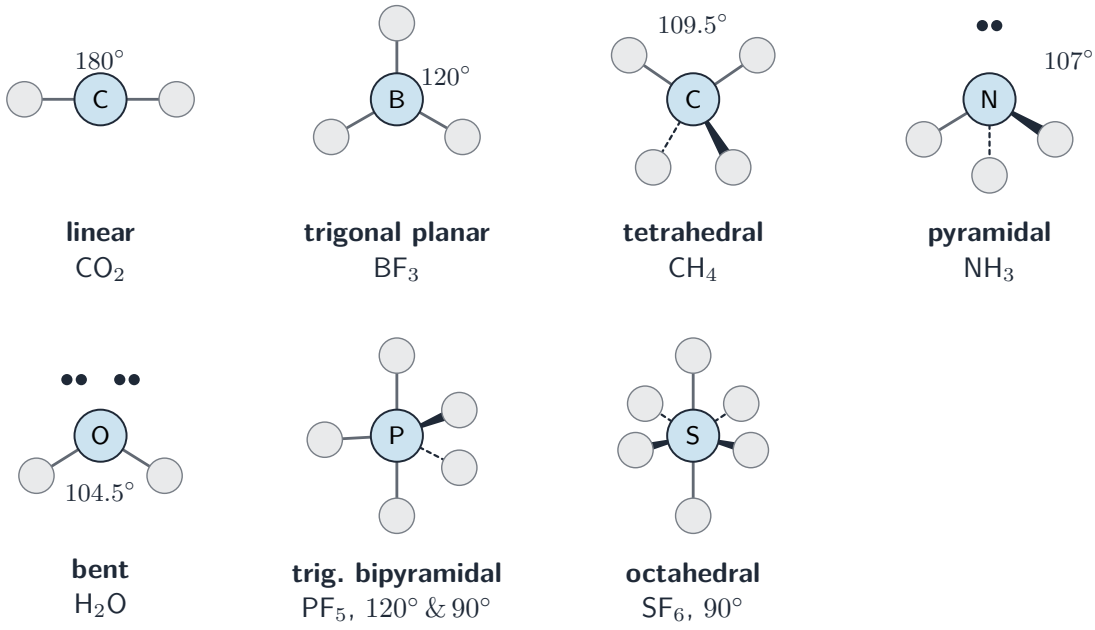
You must be able to:

- state and explain the shapes and bond angles of the standard molecules
- predict the shapes of analogous molecules and ions
- explain the effect of lone pairs on bond angle

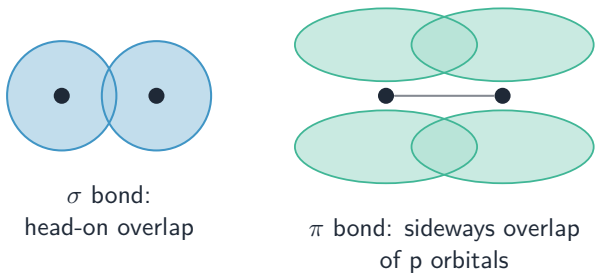
1 Key knowledge and worked examples

■ VSEPR theory

Electron pairs around the central atom repel and push as far apart as possible. A **lone pair** repels more than a **bonding pair**, squeezing the bond angle by about 2.5° each.



The seven shapes; lone pairs on NH_3 and H_2O squeeze the angle below 109.5°



Bonding pairs set the shape; sigma and pi bonds

molecule	shape	angle
CO_2	linear	180°
BF_3	trigonal planar	120°
CH_4	tetrahedral	109.5°
NH_3	pyramidal	107°
H_2O	bent	104.5°
PF_5	trigonal bipyramidal	120° & 90°
SF_6	octahedral	90°

2 Practice

2.1 State the shape and bond angle of a methane molecule, CH_4. [2]

2.2 State the shape of an ammonia molecule, NH_3. [1]

3 Exam-style questions

3.1 What is the bond angle in a carbon dioxide molecule, CO_2? [1]

- ☐ **A** 104.5°
- **B** 109.5°
- **C** 120°
- **D** 180°

3.2 Why is the bond angle in water (104.5°) smaller than in methane (109.5°)? [1]

- ☐ **A** water has more bonds
- **B** the two lone pairs on oxygen repel more, squeezing the angle
- **C** oxygen is bigger than carbon
- **D** water has a double bond

3.3 (a) Using VSEPR theory, explain the shape of a BF_3 molecule. [2]

(b) Predict the shape and bond angle of an NH_4^+ ion. [2]

3.4 Explain why ammonia (107°) has a smaller bond angle than methane (109.5°). [2]