# 2.7 VSEPR and Bond Hybridization

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

**KEY WORDS** hybridization • vsepr • electron domains • lone pairs

## Objective

Build the skills to answer exam questions on **VSEPR and hybridization** – predicting molecular shape.

**You must be able to:**

- count **electron domains** (bonds + lone pairs) around the central atom
- use **VSEPR** to predict the shape and bond angles
- assign **hybridization** ($sp$, $sp^2$, $sp^3$) from the domain count

## 1 Key knowledge and worked examples

Study these first. Each one shows the method for a question type used later – follow the steps and you can do the Practice and Exam-style questions yourself.

### Count the domains

Electron domains repel and spread as far apart as possible. Count bonding groups (a double/triple bond counts as **one** domain) plus lone pairs on the central atom.

### Shape from domains

| domains | arrangement | angle |
|---|---|---|
| 2 | linear | 180° |
| 3 | trigonal planar | 120° |
| 4 | tetrahedral | 109.5° |

Lone pairs occupy a domain but are **not** drawn as part of the shape name, so they bend the visible geometry (e.g. water is "bent").

■ **Lone pairs change the shape name**

$NH_3$ has 4 domains (3 bonds + 1 lone pair): electron geometry tetrahedral, but the **molecular shape** is **trigonal pyramidal**, angle $\approx 107°$ (lone pair squeezes it).

■ **Hybridization from domain count**

2 domains $\rightarrow$ *sp*; 3 $\rightarrow$ $sp^2$; 4 $\rightarrow$ $sp^3$. For $CO_2$ (2 domains), carbon is *sp*; for $CH_4$ (4), $sp^3$.

## 2 Practice

Now apply the methods above.

**2.1** How many electron domains are around C in $CH_4$? [1]

**2.2** State the shape and bond angle of $CH_4$. [2]

**2.3** State the hybridization of carbon in $CO_2$. [1]

## 3 Exam-style questions

**3.1** A central atom with 3 electron domains and no lone pairs has the shape [1]

☐ **A** linear
**B** trigonal planar
**C** tetrahedral
**D** bent

**3.2** Consider $H_2O$.

(a) Count the electron domains on oxygen. [1]

(b) State the molecular shape and approximate bond angle. [2]

(c) State the hybridization of oxygen. [1]

**3.3** Explain why the bond angle in $NH_3$ (107°) is smaller than in $CH_4$ (109.5°). [2]

## Solutions

Each answer shows the steps, then the **result**.

**2.1**

- 4

**2.2**

- Tetrahedral, 109.5°

**2.3**

- *sp*

**3.1 B**

- 3 domains with no lone pairs is trigonal planar

**3.2**

(a)

- 4 (2 bonds + 2 lone pairs)

(b)

- Bent, $\approx 104.5°$

(c)

- $sp^3$

**3.3**

- $NH_3$ has one lone pair, which repels more strongly than a bonding pair and pushes the N–H bonds closer together, reducing the angle below the tetrahedral 109.5°