AP CHEMISTRY • EXERCISE SHEET

2.7 VSEPR and Bond Hybridization

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

KEY WORDS hybridization 杂化 • vsepr 价层电子对互斥 • electron domains 电子域 • lone pairs 孤对电子

Objective

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

You must be able to:

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

1 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 ≈ 107° (lone pair squeezes it).

■ **Hybridization from domain count**

2 domains → sp; 3 → sp^2; 4 → 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

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°.