A9 · Molecular shapes · Practice key

This is the worked key. Every practice question is worked step by step.

Worked examples

Read these first. There is one for each kind of question in this lesson.

Example 1 · Predict the shape of a molecule

Use the four steps to find the shape of phosphine, PH_3.

1. Draw the electron dot diagram: phosphorus is in the middle, with 3 single bonds and 1 lone pair.
2. Count the groups around the centre atom: 3 bonds and 1 lone pair are 4 groups.
3. Count how many groups are lone pairs: 1.
4. Name the shape from the table: 4 groups with 1 lone pair is trigonal pyramidal.

Answer: PH_3 is trigonal pyramidal.

Example 2 · Predict the shape of an ion

In the carbonate ion, CO_3^{2-}, carbon has 2 single bonds and 1 double bond, and no lone pairs. Find its shape.

1. Count the groups around the centre atom: each bond is 1 group, so there are 3 groups.
2. Count how many groups are lone pairs: none.
3. Name the shape from the table: 3 groups with no lone pairs is trigonal planar.
4. Check: the double bond counted as 1 group.

Answer: CO_3^{2-} is trigonal planar.

Practice

Questions 1 to 4 are easy. Questions 5 to 8 are medium. Questions 9 and 10 are harder.

EASY

1. What does VSEPR say about the groups of electrons around a centre atom?

1. Groups of electrons repel each other.
2. They move as far apart as they can.

EASY

2. A centre atom has 1 double bond and 2 single bonds, and no lone pairs. How many groups are around it?

1. Each bond is 1 group. This is true for a double bond too.
2. So there are 3 groups.

EASY

3. A centre atom has 4 groups, and none is a lone pair. Name the shape.

1. 4 groups point to the corners of a tetrahedron.
2. The shape is tetrahedral.

EASY

4. In a drawing of a molecule, which kind of line shows a bond that points toward you? Which shows a bond that points away?

1. A solid wedge is a bond that points toward you.
2. A dashed line is a bond that points away from you.

MEDIUM

5. In HCN, carbon has 1 single bond and 1 triple bond, and no lone pairs. Name the shape.

1. Each bond is 1 group, so carbon has 2 groups.
2. 2 groups with no lone pairs is linear.

MEDIUM

6. In OCl_2, oxygen has 2 single bonds and 2 lone pairs. Name the shape.

1. That is 4 groups, and 2 are lone pairs.
2. So OCl_2 is angular.

MEDIUM

7. In the nitrate ion, NO_3^-, nitrogen has 2 single bonds and 1 double bond, and no lone pairs. Name the shape.

1. Each bond is 1 group, so nitrogen has 3 groups.
2. 3 groups with no lone pairs is trigonal planar.

MEDIUM

8. Use the four steps to find the shape of the phosphonium ion, PH_4^+.

1. Step 1: phosphorus is in the middle, with a single bond to each hydrogen.
2. Step 2: 4 bonds are 4 groups.
3. Step 3: no group is a lone pair.
4. Step 4: PH_4^+ is tetrahedral.

HARDER

9. Methanol, CH_3OH, has two centre atoms. Carbon has 4 single bonds. Oxygen has 2 single bonds and 2 lone pairs. Name the shape around each centre atom.

1. Carbon has 4 groups and no lone pairs. The shape around carbon is tetrahedral.
2. Oxygen has 4 groups, and 2 are lone pairs. The shape around oxygen is angular.

HARDER

10. NH_3 and CH_4 each have 4 groups around the centre atom. Explain why their shapes have different names.

1. In CH_4 all 4 groups are bonds, so it is tetrahedral.
2. In NH_3 one group is a lone pair. Only 3 corners hold an atom.
3. The shape is named from the atoms only, so NH_3 is trigonal pyramidal.