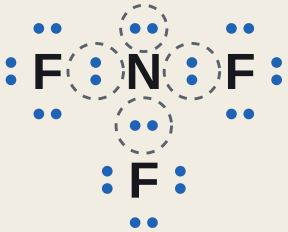
A9 · Molecular shapes · Completed notes

Goals: Explain that groups of electrons around a centre atom push as far apart as they can. Count the groups and the lone pairs around a centre atom. Predict and draw the shape: linear, trigonal planar, tetrahedral, trigonal pyramidal or angular.

These are the completed notes. The blanks are filled in and each question is worked.

Slide 1 of 6 · Groups of electrons push apart

In lessons A5 to A8 you drew molecules as flat diagrams. A real molecule is not flat. Today you find its shape.



4 groups around N

3 bonding pairs

1 lone pair

groups push each other apart

Key ideas

Groups of electrons **repel** each other.

This idea is called **VSEPR**.

A lone pair is **1** group.

A single, a double or a triple **bond** is 1 group.

Example

In CO_2, carbon has 2 double bonds and no lone pairs. How many groups are around carbon?

1. Each double bond is 1 group.
2. So carbon has 2 groups.

Try it

In NH_3, nitrogen has 3 single bonds and 1 lone pair. How many groups are around nitrogen?

1. Each bond is 1 group. The lone pair is 1 group.
2. 3 + 1 = 4 groups.

Slide 2 of 6 · No lone pairs on the centre atom

On the last slide you counted the groups around a centre atom. Each number of groups gives a shape. Start with centre atoms that have only bonds.

2 groups, 0 lone pairs



carbon disulfide, CS_2 — **linear**

Key ideas

2 groups give a **linear** shape.

3 groups give a **trigonal planar** shape.

4 groups give a **tetrahedral** shape.

Example

CO_2 has 2 groups around carbon and no lone pairs. Name its shape.

1. 2 groups get farthest apart on opposite sides.
2. So CO_2 is linear.

Try it

Silane, SiH_4, has 4 single bonds around silicon and no lone pairs. Name its shape.

1. 4 groups point to the corners of a tetrahedron.
2. So SiH_4 is tetrahedral.

Slide 3 of 6 · Lone pairs on the centre atom

On the last slide, every group was a bond. Now one or two groups are lone pairs. A lone pair takes up a place, but it is not an atom.

4 groups, 1 lone pair



nitrogen trifluoride, NF_3 — **trigonal pyramidal**

Groups	Lone pairs	Shape
2	0	linear
3	0	trigonal planar
4	0	tetrahedral
4	1	trigonal pyramidal
4	2	angular

Key ideas

4 groups with 1 lone pair give a **trigonal pyramidal** shape.

4 groups with 2 lone pairs give an **angular** shape.

The shape is named from the **atoms only**.

Example

PCl_3 has 3 bonds and 1 lone pair around phosphorus. Name its shape.

1. That is 4 groups, and 1 is a lone pair.
2. So PCl_3 is trigonal pyramidal.

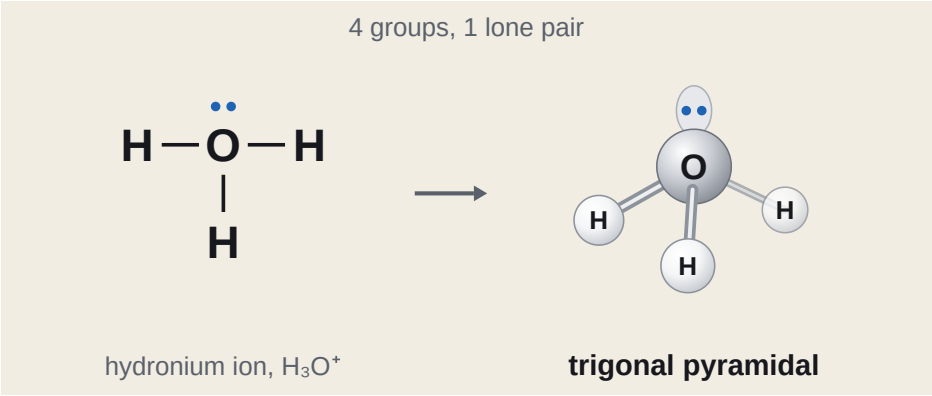
Try it

SF_2 has 2 bonds and 2 lone pairs around sulfur. Name its shape.

1. That is 4 groups, and 2 are lone pairs.
2. So SF_2 is angular.

Slide 4 of 6 · Ions, and molecules with two centre atoms

You now have five shapes, all in the table on the last slide. The same count works wherever there is a centre atom.



Key ideas

An **ion** has a shape too.

H_3O^+ is **trigonal pyramidal**.

A molecule with two centre atoms has a shape around **each one**.

Example

The ammonium ion, NH_4^+, has 4 bonds and no lone pairs around nitrogen. Name its shape.

1. That is 4 groups, and none is a lone pair.
2. So NH_4^+ is tetrahedral.

Try it

In hydrogen peroxide, H_2O_2, each oxygen has 2 bonds and 2 lone pairs. Name the shape around each oxygen.

1. That is 4 groups, and 2 are lone pairs.
2. So the shape around each oxygen is angular.

Slide 5 of 6 · Method: how to predict the shape around a centre atom

You found every shape so far in the same way. Each time you did the same four things. Here they are as steps.

1. **Draw** the electron dot diagram.
2. **Count** the groups around the centre atom.
3. **Count** how many groups are lone pairs.
4. **Name** the shape from the table.



Check: a double or triple bond is 1 group.

Used again in: lessons A10 and A11

Key ideas

Step 1: draw the electron dot **diagram**.

Step 2: count the **groups** around the centre atom.

Step 3: count the **lone pairs**.

Step 4: name the **shape**.

Example

Use the four steps to find the shape of hydrogen sulfide, H_2S.

1. Step 1: sulfur is in the middle, with a single bond to each hydrogen.
2. Step 2: sulfur has 2 bonds and 2 lone pairs. That is 4 groups.
3. Step 3: 2 of the groups are lone pairs.
4. Step 4: H_2S is angular.

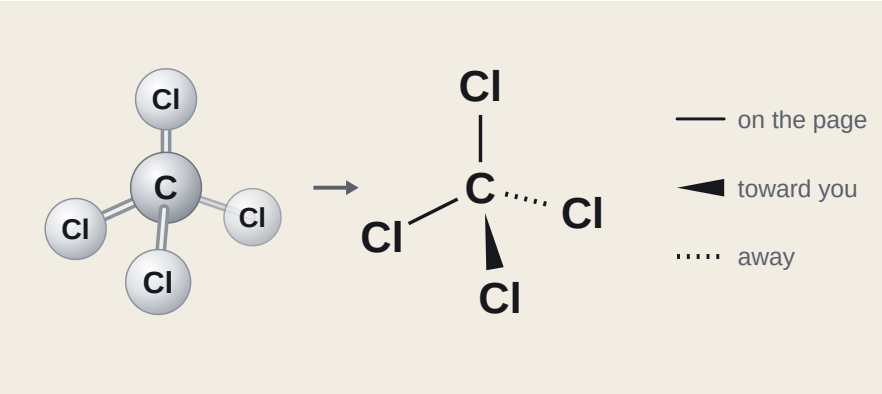
Try it

Use the four steps to find the shape of formaldehyde, CH_2O.

1. Step 1: carbon is in the middle, with 2 single bonds and 1 double bond.
2. Step 2: that is 3 groups.
3. Step 3: carbon has no lone pairs.
4. Step 4: CH_2O is trigonal planar.

Slide 6 of 6 · Drawing a shape on paper

The shapes in this lesson are not flat, but paper is. Three kinds of line show which way a bond points.



Key ideas

A plain line is a bond that lies **flat** on the page.

A solid **wedge** is a bond that points toward you.

A **dashed** line is a bond that points away from you.

Example

Draw methane, CH_4, as a tetrahedral molecule. Say which lines you used.

1. Carbon is in the middle.
2. Draw 2 plain lines, 1 wedge and 1 dashed line to the hydrogen atoms.

Try it

In a drawing of a molecule, one bond is a dashed line. Which way does that bond point?

1. A dashed line is a bond that points away from you.
2. It points into the page.