Working out the shapes of molecules

1. Add together the number of valence electrons from the central atom, and the number of electrons contributed to bonding by the ligands; include the ion charge if there is one.

2. Divide the total by 2. This gives the number of electron pairs, and so the electron distribution around the central atom (see the Table below).

Number of electron pairs	Shape of electron cloud
2	linear
3	trigonal
4	tetrahedral
5	trigonal bipyramidal
6	octahedral

Example 1 Predict the geometry of NCl_3

Valence electrons of nitrogen = 5
Electrons from 3 chlorine atoms = 3
Total number of electrons = 8
Number of electron pairs = 4

The electron pairs are arranged **tetrahedrally**.

Number of ligands = 3
Number of bonding pairs = 3
Number of lone pairs = 1

Molecule is **pyramidal**.

Example 2 Predict the geometry of PCl_4^-

Valence electrons of phosphorus = 5
Electrons from 4 chlorine atoms = 4
Electron from molecular charge = 1
Total number of electrons = 10
Number of electron pairs = 5

The electron pairs are arranged in a **trigonal bipyramid**.

Number of ligands = 4
Number of bonding pairs = 4
Number of lone pairs = 1

Molecule is **pyramidal** (but with a square base).

Example 3 Predict the geometry of NH_4^+

Valence electrons of nitrogen = 5
Electrons from 4 hydrogen atoms = 4
Electron from molecular charge = -1
Total number of electrons = 8
Number of electron pairs = 4

The electron pairs are arranged **tetrahedrally**.

Number of ligands = 4
Number of bonding pairs = 4
Number of lone pairs = 0

The molecule is **tetrahedral**.

Example 4 Predict the shape of ICl_4^+

Valence electrons of iodine = 7
Electrons from 4 chlorine atoms = 4
Electron from molecular charge = –1
Total number of electrons = 10
Number of electron pairs = 5

The electron pairs are arranged in a **trigonal bipyramid**

Number of ligands = 4
Number of bonding pairs = 4
Number of lone pairs = 1

The molecule is **pyramidal** (but with a square base).

